TUESDAY MORNING

Open Open Open. The Rise of Open Scientific Publishing and the Archaeological Discipline: Managing the Paradigm Shift

Education and Dissemination

Room: SCE 216

Organizers: Arianna Traviglia, Xavier Rodier

9:50 AM - 10:10 AM	**Rocks-Macqueen, Doug**, *The Last of the Publishers*
10:10 AM - 10:30 AM	**Roued-Cunliffe, Henriette, Peter Jensen**, *What is Open Data in an Archaeological Context?*
10:30 AM - 10:50 AM	**Brin, Adam, Francis Pierce-McManamon, Leigh Anne Ellison**, *The Challenges of Open Access for Archaeological Repositories*
10:50 AM - 11:10 AM	**Kondo, Yasuhisa, Atsushi Noguchi**, *Best Practices and Challenges in Promoting Open Science in Archaeology: Two Narratives from Japan*
11:10 AM - 11:30 AM	**Rodier, Xavier, Olivier Marlet**, *How to Combine Archaeological Archives, Linked Open Data and Academic Publication, a French Experience*
11:30 AM - 11:50 AM	**Buard, Pierre-Yves, Elisabeth Zadora-Rio**, *Publishing an Archaeological Excavation Report in a Logicist Workflow*
11:50 AM - 12:10 PM	**Kansa, Eric, Anne Austin, Ixchel Faniel, Sarah Kansa, Ran Boynter, Jennifer Jacobs, Phoebe France**, *A Reality Check: The Impact of Open data in Archaeology*

Same as it ever was... Same as it ever was

Critical Reflections

Room: SCE 217

Organizers: Hugh Corley, Lorna-Jane Richardson

9:50 AM - 10:10 AM	**Pageau, Hanna**, *An Inclusive Archaeology: Being Able in Archaeology*
10:10 AM - 10:30 AM	**Foreman, Penelope**, "*Well, actually...*": *The Othering of Women in the Computing and Programming Communities and its Effects on Digital Archaeology*
10:30 AM - 10:50 AM	**Ni Chiobhain Enqvist, Delia**, *Whose (maritime) Archaeology is It Anyway?*
10:50 AM - 11:10 AM	**Hassett, Brenna, Suzanne Pilaar Birch, Victoria Herridge, Rebecca Wragg Sykes**, *TrowelBlazers: Raising Horizons for a Diverse Digital Archaeology*
11:10 AM - 11:30 AM	**Corley, Hugh**, *Privilege and Digital Archaeology*
11:30 AM - 11:50 AM	**Richardson, Lorna-Jane**, *Digital Archaeology and Digital Inequalities: A View from a Sociology Department*
11:50 AM - 12:30 PM	*Discussion*

Urbanism at the Micro, Meso and Macro Scales: Advances in Computational and Quantitative Methods to Study Cities and their Built Environments

GIS

Room: SCE Auditorium

Organizers: Eleftheria Paliou, Adrian Chase

9:50 AM - 10:10 AM	**Cabaniss, Andrew**, *Diversity from the Bottom Up: Modeling Cities as Communities of Diverse Households*
10:10 AM - 10:30 AM	**Cesaretti, Rudolf**, *Re-Evaluating Settlement Population Estimation: An Analogue-Based Method for Modeling Patterned Variation in Population Density*
10:30 AM - 10:50 AM	**Levine, Evan, Daniel Plekhov**, *Patterns of Urbanism in Bactria: Reevaluating a Paradigm Through Remote Sensing*
10:50 AM - 11:10 AM	**Hermitt, Elijah, Erika Maxson, Kirk French, Damien Marken, Derek Shaffer, Timothy Murtha**, *Hydrologic Design in Three Maya cities: Using Regional Topographic Data, Hydrologic Analysis in GIS and Archaeology for a Comparative Analysis of Palenque, Tikal, and El Peru*
11:10 AM - 11:30 AM	**Baumanova, Monika, Ladislav Smejda, Heinz Ruther**, *The Streets of Timbuktu Old Town. Moving Goods, People and Ideas on the Coast of the Sahara*
11:30 AM - 11:50 AM	**Shpuza, Ermal**, *The Effect of Gridiron Street Pattern on the Urban Growth of Adriatic and Ionian Coastal Cities 1800-2010*

11:50 AM - 12:10 PM	**Crawford, Katherine**, *Unravelling Urban Religious Landscapes: Modelling Processions at Ostia*
12:10 PM - 12:30 PM	**Klassen, Sarah, Jonathan Weed, Damian Evans**, *Discerning the Urban Morphology of Angkor Using a Semi-Supervised Algorithm for Manifold Learning*

General Papers

General - GIS

Room: SCE House

Organizers: , , , ,

9:50 AM - 10:10 AM	**Caswell, Edward**, *An Analysis of Selected Variables that Affect the Production of Cost Surfaces*
10:10 AM - 10:30 AM	**Becker, Daniel, Christian Willmes, Andreas Bolten, María de Andrés-Herrero, Gerd-Christian Weniger, Georg Bareth**, *Influence of Differences in Digital Elevation Models and their Resolution on Slope-Based Site Catchment Modelling*
10:30 AM - 10:50 AM	**Beusing, Ruth**, *Temporal-GIS Tools for Mixed and Meso-scale Archaeological Data*
10:50 AM - 11:10 AM	**James, Vivian**, *Context as Theory: Towards Unification of Computer Applications and Quantitative Methods in Archaeology*
11:10 AM - 11:30 AM	**Sharp, Kayeleigh**, *Testing the 'Small-Site' Approach with Multivariate Spatial Statistical and Archaeological Network Analysis*
11:30 AM - 11:50 AM	**Groen, Mike**, *Geospatial Analysis, Predictive Modelling and Modern Clandestine Burials*
11:50 AM - 12:10 PM	**Slayton, Emma, Jan Athenstädt, Corinne Hofman, Jan Hildenbrand**, *Seafaring with Mental Sign Posts: Connecting Materials with Canoe Routes in the Archaic Age Northern Lesser Antilles*

The Creation of Big Data Labs for Archaeology, Heritage, and Global Initiatives

Broader View - Digital Archaeology and the Humanities

Room: SCW 460/462

Organizers: Herbert Maschner, Thomas Levy

9:50 AM - 10:10 AM	**Maschner, Herbert**, *CVAST: The USF Center for Virtualization and Applied Spatial Technologies*

10:10 AM - 10:30 AM	**Levy, Thomas, Margie Burton**, *The UC San Diego Center for Cyber-Archaeology and Sustainability*
10:30 AM - 10:50 AM	**Forte, Maurizio**, *The Dig@Lab at Duke University*
10:50 AM - 11:10 AM	**Watrall, Ethan**, *MATRIX: The Center for Digital Humanities & Social Sciences*
11:10 AM - 11:30 AM	**Foley, Catherine**, *KORA: A Digital Repository for Cultural Heritage Collections*
11:30 AM - 11:50 AM	**Watrall, Ethan**, *mbira: A Platform to Build, Serve, and Manage Mobile Heritage Experiences*
11:50 AM - 12:10 PM	**Tanasi, Davide**, *Learning Through Objects: 3D Digital Imaging, 3D Printing and Haptic Technology for Public Outreach in Archaeology*
12:10 PM - 12:30 PM	**Colobran, Miquel, Juan Antonio Barcelo, Igor Bogdanovic**, *Reusing Archeological Information to Improve Modeling and Research. An Interoperability Data Schema.*

NEH Roundtable on Advanced Challenges in Theory and Practice in 3D Modeling

3D Acquisition / Object Modeling

Room: SCW 464

Organizers: Alyson Gill, Heather Richards-Rissetto, Lisa Snyder

9:50 AM - 10:10 AM	**Carter, William**, *The Life of Attributes: Meta and Paradata as 3D Point and Object DNA for Heritage Providence*
10:10 AM - 10:30 AM	**Clinton, Miriam**, *A Workflow to Integrate 3D Data Acquisition with Traditional Artifact Study? Lessons from Mouliana*
10:30 AM - 10:50 AM	**Ulguim, Priscilla**, *3D Digital Models and Bioarchaeology: Challenges and Proposals for Practice*
10:50 AM - 11:10 AM	**Massari, Lauren, William Rourk, Shayne Brandon, Jama Coartney, Worthy Martin, Chip German**, *Challenges in Processing, Delivering, and Archiving Large Amounts of 3D Data*
11:10 AM - 11:30 AM	**Mudge, Mark**, *Computational Photography, Scientific Imaging, and the Preservation of 3D Digital Representations*
11:30 AM - 11:50 AM	**Richards-Rissetto, Heather**, *Challenges of Peer-review: Where Does 3D Archaeological Scholarship Fall Under the Umbrella of Digital Humanities Scholarship?*

11:50 AM - 12:30 PM | **Richards-Rissetto, Heather**, *Roundtable*

Rip – Model – Learn: Towards the Total Model

Broader View - Digital Archaeology and the Humanities

Room: SCW 466/468

Organizers: Carlo Bianchini, Alfonso Ippolito, Carlo Inglese, Luca Senatore

9:50 AM - 10:10 AM | **Luce, Fabio**, *Digital Surveying and Ideal Reconstruction for Total Hybrid Model. The Case of Fort Presanella in Val di Sole*.

10:10 AM - 10:30 AM | **Filippucci, Marco, Fabio Bianconi, Federica Magi Meconi**, *Models and Parameterization of the Five Orders of Architecture*

10:30 AM - 10:50 AM | **Eve, Stuart, Guy Hunt, Michael Johnson, Jessica Ogden, John Layt**, *10 Years of Online Archaeological Databases - Revolution, Convolution, Evolution*

10:50 AM - 11:10 AM | **Empler, Tommaso**, *3D Modeling to Reconstruct a Paleontological Site: Museum of Casal de' Pazzi in Rome*

11:10 AM - 11:30 AM | **Senatore, Luca, Michela Cigola, Arturo Gallozzi**, *New Methodologies for Knowledge and Valorization: The Digital Survey Made by Remote-controlled Mobile Platform. The Case Study of the Roman Casinum City*

11:30 AM - 11:50 AM | **Caldarone, Adriana**, *3D Printing and Augmented Reality: Integration, Methods and Communication for Cultural Heritage*.

11:50 AM - 12:10 PM | **Bercigli, Monica, Stefano Bertocci**, *Digital Documentation of Masada Fortress in Israel: Integrated Methodologies of Survey and Representation*

12:10 PM - 12:30 PM | **Carnevali, Laura, Marco Carpiceci, Andrea Angelini**, *Problems Concerning Elaboration and Representation in Italian Rock-hewn Architecture*

TUESDAY AFTERNOON

Digital Archaeology - Where are We and How do We Fit In?

Critical Reflections

Room: SCE 216

Organizers: Paul Reilly, John Pouncett, Stephen Stead

12:30 PM - 1:30 PM | **Brin, Adam, Francis Pierce-McManamon, Leigh Anne Ellison**, *The Archaeological Data Lifecycle*

Archaeology In and Out of the Classroom: Digital Approaches to Archaeological Instruction

Education and Dissemination

Room: SCE 216

Organizer: Jeffrey Emanuel

2:00 PM - 2:20 PM — **Gandolfi, Eleonora**, *Public Engagement in Compulsory-age Education with MOOCs: A Case Study from the Italian and English Context*

2:20 PM - 2:40 PM — **Rourk, Will, Andrew Johnston, Lauren Massari, Shayne Brandon, Arin Bennett, Jama Coartney, Worthy Martin**, *Cultural Heritage Data Synthesis for Architectural History Field Methods*

2:40 PM - 3:00 PM — **Golubiewski-Davis, Kristina, Samantha Porter, Matt Edling, John Soderberg, Gilbert Tostevin**, *The Use and Reuse of 3D Scanned Lithic Refits*

3:00 PM - 3:20 PM — **Galvin, Elizabeth, Jennifer Wexler**, *Virtual Viewing: Engaging Audiences with the African Rock Art Digital Collection at The British Museum*

The Technology Lag: A Panel Discussion Regarding the Use of the Computing Technologies Toolkit For Cultural Resource Com

Critical Reflections

Room: SCE 216

Organizers: Brian Seymour, Michael Scafuri, Sarah Kessick, Timothy Dodson

4:00 PM - 5:30 PM — **Seymour, Brian**, *General Discussion Outline*

Ground-penetrating Radar Advancements in the Americas

Geophysics/Remote Sensing

Room: SCE 217

Organizer: Peter Leach

2:00 PM - 2:20 PM — **Morris, Isabel**, *Today's Surveys and Tomorrow's Inversions: GPR Attribute Analysis*

2:20 PM - 2:40 PM — **Sturm, Jennie**, *Ground-Penetrating Radar in Chaco Canyon, New Mexico: 40 years of Mapping Chaco's Buried Past*

2:40 PM - 3:00 PM	**Lowry, Sarah, Shawn Patch**, *Mississippian Villages in East Tennessee: Geophysical Case Studies at Five Sites to Examine Community Layout and Land Use*
3:00 PM - 3:20 PM	**Leach, Peter, Richard Boisvert**, *High-frequency GPR for Real-time 'Digital Bisection' of Archaeological Features*

Non Invasive Methods to Assess Above and Underground Spatial Pattern

Geophysics/Remote Sensing

Room: SCE 217

Organizers: Michael Märker, Christian Sommer

4:00 PM - 4:20 PM	**Märker, Michael, Ivano Rellini, Luigi Mucerino, Volker Hochschild**, *Assessment of Subsurface Neolithic/ Palaeolithic Sites in the Southern Gargano Area, Apulia, Italy*
4:20 PM - 4:40 PM	**Stavilă, Andrei**, *Bronze Age Tell or Not? Research Methods for Revealing the Internal Habitation Pattern of Alioş – „Valea Alioşu" site, Timiş County, Romania*
4:40 PM - 5:00 PM	**Pihokker, Matthew**, *Determining Spatial Relationships Between Domestic Sites and Cemeteries of the Central Peloponnese*
5:00 PM - 5:20 PM	**Hegyi, Alexandru, Petru Urdea**, *2D and 3D Electrical Resistivity Tomography Imaging of Archaeological Structures - Case Studies from Romania*

Urbanism at the Micro, Meso and Macro Scales: Advances in Computational and Quantitative Methods to Study Cities and their Built Environments

GIS

Room: SCE Auditorium

Organizers: Eleftheria Paliou, Adrian Chase

2:00 PM - 2:20 PM	**Chase, Adrian**, *Erasing the Garden City: Interpolation of Architectural Volume from LiDAR Derived DEMs*
2:20 PM - 2:40 PM	**Prufer, Keith, Amy Thompson**, *Processes of Urban Development Among the Ancient Maya of Uxbenká and Ix Kuku'il, Southern Belize*
2:40 PM - 3:00 PM	**Hare, Timothy**, *Mapping and 3D Modeling at the Household, Neighborhood, and Regional Levels Using UAVs, Photogrammetry, and LiDAR*
3:00 PM - 3:20 PM	**Forte, Maurizio, Nevio Danelon, David Johnston, Katherine McCusker, Everett Newton**, *Vulci3000 Project - A Digital Challenge*

3:20 PM - 3:40 PM	**Landeschi, Giacomo, Stefan Lindgren, Jesper Blid Kullberg, Henrik Gerding, Alcestis Papadimitriou, Jenny Wallensten, Nicolò Dell'Unto, Angeliki Kossiva**, *Integrated Digital Methods for Investigating a Hidden Cityscape: The Case of Ancient Hermion*
4:00 PM - 4:20 PM	**Kubicka, Anna**, *The Metrological Research of Machu Picchu Settlement. Application of a Cosine Quantogram Method for 3D Laser Data.*
4:20 PM - 4:40 PM	**Vadala, Jeffrey, Brian Denham**, *Virtual Reality as a Tool for Spatial Analysis at Cerro Maya, Belize (Cerros)*
4:40 PM - 5:00 PM	**Goodwin, Graham, Heather Richards-Rissetto**, *Modeling Acoustics in Ancient Maya Cities: Moving Towards a Synesthetic Experience Using 3D Simulation*
5:00 PM - 5:20 PM	**Hanus, Kasper**, *Understanding Urban Pattern of Silk Road Oasis-Cities Using Archival Aerial Images.*
5:20 PM - 5:40 PM	*Discussion*

The Creation of Big Data Labs for Archaeology, Heritage, and Global Initiatives

Broader View - Digital Archaeology and the Humanities

Room: SCE House

Organizers: Herbert Maschner, Thomas Levy

5:40 PM - 7:30 PM	**Elliott Smith, Rosemary, Taylor Harman, Carolyn Breeze, Thomas Levy**, *ArchaeoSTOR: A User-friendly Archaeological Database*
5:40 PM - 7:30 PM	**Lu, Qin-Qin, Zhengyao Jin**, *Scientific Database and the Big Data Approach for the Bronze Age of China*
5:40 PM - 7:30 PM	**Du Vernay, Jeffrey**, *3D Mapping and Visualizing the Galerie de paléontologie et d'anatomie comparée at the Muséum national d'histoire naturelle, Paris*
5:40 PM - 7:30 PM	**McLeod, James**, *Three-Dimensional Documentation and Examination of a Medieval Period Cistern at Alarcos in the Castilla-La Mancha Region of Spain*
5:40 PM - 7:30 PM	**Howland, Matthew**, *Developing a Standardized Workflow for Digital Preservation and Analysis of Archaeological Ceramics*
5:40 PM - 7:30 PM	**Banaszek, Łukasz, Kamila Oleś**, *Data Hub for Early Medieval Architecture? Crossing the Borders of an Unfriendly Tradition*
2:00 PM - 2:20 PM	**Banaszek, Łukasz, Kamila Oleś**, *Making Use of the Publicly Available Spatial Data and Bringing the Past to the People: a Case Study of the Pomeranian Wall, Poland*

2:20 PM - 2:40 PM	**McCusker, Katherine, Maurizio Forte, David Johnston, Everette Newton**, *Adding the Aerial Multi-spectral Perspective: A Holistic View of Vulci through Multi-layered Data Sets*
2:40 PM - 3:00 PM	**Harrison, Laura**, *Mobilizing a Salvage Archaeology Dataset to Build a 3D Interpretive Visualization*
3:00 PM - 3:20 PM	**Smitheram, Craig, Thomas Levy**, *The Center for Cyber-Archaeology and Sustainability (CCAS): Pedagogy and Student Engagement in At-Risk World Heritage Initiatives*
3:20 PM - 3:40 PM	**Lercari, Nicola, Jeffrey Weekley**, *Leveraging the UC Merced WAVE and Pacific Research Platform to Create At-Risk Global Cultural Heritage Networks*
4:00 PM - 4:20 PM	**Frey, Jon**, *From Analog to Digital in Archaeological Archives*
4:20 PM - 4:40 PM	**Spring, Adam**, *Solutions in Photogrammetric Selectivity. Optimizing High Fidelity Meshes from Casual Photography. The Trajan's Forum Project Examples*
4:40 PM - 5:00 PM	**Forte, Maurizio, Nevio Danelon, Julia Liu**, *The Trajan's Forum Project: Dig@lab and the Framework of Big Data*.
5:00 PM - 5:20 PM	**Liss, Brady, Matthew Howland, Thomas Levy**, *Running on Autopilot: Testing Google Earth Engine for the Automatic Identification of Archaeological Features in Satellite Imagery*
5:20 PM - 5:40 PM	**Johnson, Andrew, Steve Savage, Tom Levy**, *The ASOR Cultural Heritage Initiative-TerraWatchers Collaborative: Crowd-Sourced Monitoring of At Risk Cultural Heritage Sites in the Middle East*

Methods, Tools, Disruption ... : From Information Delivery to Interaction

Broader View - Digital Archaeology and the Humanities

Room: SCW 464

Organizer: Ian Johnson

2:00 PM - 2:10 PM	**Gunn, Scott**, *Archaeological Field Data Collection Using Ruggedized Android Tablets and Free and Open Source Software*
2:10 PM - 2:20 PM	**Brennan, Matthew, Bernard Frischer**, *Photomodeling for Rapid Documentation and Survey of Complex Urban Spaces and Archaeology*
2:20 PM - 2:30 PM	**Laugier, Elise, Jesse Casana**, *Cultural Heritage Monitoring using Time-Sequenced Satellite Imagery: A Case Study from the Syrian Civil War*
2:30 PM - 2:40 PM	**Casana, Jesse, Jackson Cothren**, *The CORONA Atlas Project: Orthorectification and Analysis of Declassified, Cold War-era Satellite Imagery*

2:40 PM - 2:50 PM	**Meyer, Dominique, Eric Lo, Thomas Wypych, Dominique Rissolo, Falko Kuester**, *From Air to Model- A Workflow for Automated UAV Surveying, Data Transmission and Rapid Cloud Distributed Photogrammetry Processing*
2:50 PM - 3:00 PM	**Tolle, Karsten, David Wigg-Wolf**, *Improving Data Quality by Rules – A Numismatic example*
3:00 PM - 3:40 PM	*Discussion*

Geographic Relations in Databases on Cultural Heritage

Networks/Modeling

Room: SCW 464

Organizers: Michael Märker, Volker Hochschild, Espen Uleberg, Mieko Matsumoto

4:00 PM - 4:20 PM	**Perucchetti, Laura, Peter Bray, Mark Pollard**, *The Use of GIS to Understand the Circulation of Metal in the Prehistoric Alps*.
4:20 PM - 4:40 PM	**Uleberg, Espen, Mieko Matsumoto**, *Display matters? Enhanced Visualization for Unique Aspects of Norwegian Stone Age Site Distribution*
4:40 PM - 5:00 PM	**Willmes, Christian, Daniel Becker, Yasa Yener, Olaf Bubenzer, Georg Bareth**, *Open Science, e-Science and Geospatial Data Management to Support Research in Archaeology*
5:00 PM - 5:20 PM	**Märker, Michael, Volker Hochschild, Christian Sommer**, *How to Integrate and Illustrate Aspects of Landscape Evolution and Human Evolution*
5:20 PM - 5:40 PM	*Discussion*

Rip – Model – Learn: Towards the Total Model

Broader View - Digital Archaeology and the Humanities

Room: SCW 466/468

Organizers: Carlo Bianchini, Alfonso Ippolito, Carlo Inglese, Luca Senatore

2:00 PM - 2:20 PM	**Mancini, Matteo Flavio, Leonardo Baglioni**, *Integrated Surveying Techniques for Analysis of Archaeological Artifact*
2:20 PM - 2:40 PM	**Gallozzi, Arturo, Leonardo Paris, Wissam Wahbeh**, *3D Models and Interactive Comunication for Archaeology. The Nymphaeum Ponari in Cassino*

2:40 PM - 3:00 PM	**Carpiceci, Marco, Carlo Inglese, Andrea Angelini**, *Survey, Representation, Analysis and Cataloguing of the Rock-hewn Architecture in Cappadocia*
3:00 PM - 3:20 PM	**Chiavoni, Emanuela, Daniela Esposito**, *The Archaeological Park of the Porto of Traian: Knowledge, Preservation and Fruition*
3:20 PM - 3:40 PM	**Piumatti, Paolo, Rosa Tamborrino**, *3D Digital Modelling and Digital Urban History: A Methodology for Studying the Processes of Transformation of Nubian Temples and Landscape in the Site of Lake Nasser.*
4:00 PM - 4:20 PM	**Pirinu, Andrea**, *Graphic Analysis of Historic Documents, Architectural Survey, Applied Geophysics in Support of Archaeological Investigation. The Urban Wall of Cagliari (Sardinia, Italy)*
4:20 PM - 4:40 PM	**Attenni, Martina, Alfonso Ippolito**, *Representing Intangible Heritage: Questions About Method*
4:40 PM - 5:00 PM	**Inglese, Carlo, Carlo Bianchini, Alfonso Ippolito, Martina Attenni, Valeria Caniglia**, *Tradition and Innovation: From Worksite Plans to Digital Models*
5:00 PM - 5:20 PM	**Porfiri, Francesca, Carlo Bianchini**, *The Microcosm of Tiberius's Cave in Sperlonga: Analysis, Investigation and Digital Reconstruction of the Ancient "Sculpture's Theatre"*
5:20 PM - 5:40 PM	**Bianchini, Carlo, Alessandro Viscogliosi, giorgia potestà, Gaia Lisa Tacchi**, *Tradition and Hi-tech in the Construction of a Total Model: The Complex of Pietrabbondante*

WEDNESDAY MORNING

Mechanics, Mods and Mashups: Games of the Past for the Future Designed by Archaeologists

Education and Dissemination

Room: SCE 216

Organizer: Erik Champion

8:30 AM - 9:00 AM	**Booker, Emily**, *"I Don't Want to Set the World on Fire": Ruin Interactions and Attitudes in Fallout 4*
9:00 AM - 9:30 AM	**Bryant, Robert, Sandra Blakely, Joanna Mundy, Cole Furrh**, *Sailing with the Gods: Argonauts and Samothracians in an Ancient Sea*
9:30 AM - 10:00 AM	**Eve, Stuart**, *How Waterloo was Won*
10:00 AM - 10:30 AM	**Linde, Lennart**, *Blur the Lines – Games as Tools for Archaeological Research*
10:50 AM - 11:20 AM	**Underberg-Goode, Natalie**, *Arpilleras and Ayni: Roleplaying Reciprocity*
11:20 AM - 11:50 AM	**Hiriart, Juan**, *Designing and Using Game Environments as Historical Learning Contexts*
11:50 AM - 12:30 PM	*Discussion*

Automation is Here to Stay! The Hitch-hiker's Guide to Automated Object Detection and Image Processing in Remote Sensing

Geophysics/Remote Sensing

Room: SCE 217

Organizers: Arianna Traviglia, Dave Cowley

8:30 AM - 8:50 AM	**Cowley, Dave, Arianna Traviglia**, *Hitching the Right Ride? Concepts and Issues for Developing Automated Object Detection and Image Processing in Remote Sensing Archaeology*
8:50 AM - 9:10 AM	**Kramer, Iris**, *Creating a Future for Automation by Targeting Models to their End-users*.
9:10 AM - 9:30 AM	**Zambanini, Sebastian, Simon Brenner, Robert Sablatnig**, *Adapting to the Problem at Hand: Image Registration and Object Detection for Automatic WW2 Aerial Photograph Processing*
9:30 AM - 9:50 AM	**Green, Ashely, Paul Cheetham, Timothy Darvill**, *Information Systems and Ad Hoc Workflow Models as Viable Applications to Improve the Pre-excavation Detection of Characteristic Human Interments*
9:50 AM - 10:10 AM	**Ramel, Jean-Yves, Clément Laplaige, Xavier Rodier, Shuo Bai**, *Extraction of Linear Structures from LIDAR Images Using a Machine Learning Approach*
10:50 AM - 12:30 PM	*Discussion*

General - Data Management and Textual Analysis

General

Room: SCE 218

Organizers: , , , ,

8:30 AM - 8:50 AM	**Bischoff, Robert**, *Moving Forward with Digital Databases: Current Opinions and Potential Solutions*
8:50 AM - 9:10 AM	**Schroer, Carla, Mark Mudge**, *Digital Lab Notebook Creation for Computational Photography*
9:10 AM - 9:30 AM	**Casey, Christian**, *Digital Demotic: Opportunities and Challenges*
10:50 AM - 11:10 AM	**Gad, Moataz, Yasmin Mohamed**, *Treatment of Lime Stone Colored with Egyptian Blue Pigment Using Different Techniques of Documentation*
11:10 AM - 11:30 AM	**Mohamed, Mohamed**, *Analytical Study and Conservation Processes of Scribe Box from Old Kingdom*
11:30 AM - 11:50 AM	**Bray, Peter, Mark Pollard**, *The Characterisation Hypothesis for Scientific Metallurgy: Classes of Structure in Chemical Datasets and their Visualisation*
11:50 AM - 12:10 PM	**Sonnemann, Till, Jason Laffoon, Termeh Shafie**, *Enhancing Archaeological Material Provenance Studies by Manipulating Isoscapes*

12:10 PM - 12:30 PM	**Foreman, Penelope**, *The Colour Out of Space: Digital Media as Mouthpieces for Material Agency*

From Physical to Digital, From Interactive to Immersive: Uses of Three–Dimensional Representation, Mixed Reality, and More in the Sharing and Exploration of Archaeological Data

VR

Room: SCE Auditorium

Organizer: Jeffrey Emanuel

8:30 AM - 8:50 AM	**Vurpillot, Damien**, *Making Virtual Reality Real: What Can We Learn by Bringing Together Virtual Reality and Visual Attention Analysis?*
8:50 AM - 9:10 AM	**Bremer, Thomas, Sebastian Plesch, Kay Kohlmeyer, Susanne Brandhorst, Arie Kai-Browne, Timo Falke**, *VR:TA - A Virtual Reality Toolset for Archaeologists*
9:10 AM - 9:30 AM	**Hollis, Luke**, *MorgantinaVR: Cityscale Handheld AR and Cross-platform VR for Visulizaing Georeferenced Datasets as a Part of a Microservices Software Architecture*
9:30 AM - 9:50 AM	**Burns, Bryan, Jordan Tynes**, *Excavation Progress and Artifact Manipulations in a Virtual Environment*
9:50 AM - 10:10 AM	**Kamash, Zena**, *Digital Digestion: Roman Food and Digital Objects at Corinium Museum*
10:10 AM - 10:30 AM	**Wescoat, Bonna, Arya Basu**, *On the Dynamics of Interactive Exploration over Animation as Methods of Experiential Simulation in the Sanctuary of the Great Gods on Samothrace*
10:50 AM - 11:10 AM	**Rudov, Ivan**, *Combined Method of 3D Model of Archaeological Objects Optimization for a Mobile App*.
11:10 AM - 11:30 AM	**Beale, Nicole, Gareth Beale, Julian Richards, Dawn Hadley, Jonathan Hook, Guy Schofield**, *Virtual Reality and Storytelling for Viking Archaeology*
11:30 AM - 11:50 AM	**Löwenborg, Daniel, John Ljungkvist, Daniel Westergren, Sebastian Wiberg, Staffan Hagberg**, *Augmented History – A Virtual "Window to the Past"*
11:50 AM - 12:10 PM	**Gonzalez-Perez, Cesar, Martin Pereira-Fariña, Chris Reed**, *Toward an Argument Evaluation System on Cultural Heritage Based on Anchoring Inference Theory*
12:10 PM - 12:30 PM	*Discussion*

Women in CAA

Critical Reflections

Room: SCW 460/462

Organizers: Katie Simon, Sara Gale, Lisa Fischer

8:30 AM - 8:40 AM	**Simon, Katie**, *Introduction*
8:40 AM - 8:50 AM	**Ernenwein, Eileen**, *Implicit Gender Bias? What's that?*
8:50 AM - 9:00 AM	**Rocks-Macqueen, Doug**, *Is Equality Enough?*
9:00 AM - 9:10 AM	**Wendrich, Willeke**, *Bringing out the Best: Mentoring Women in Digital Archaeology*
9:10 AM - 9:20 AM	**Wallrodt, John**, *Increasing Academic Approaches to CAA*
9:20 AM - 9:50 AM	*Discussion*
9:50 AM - 10:00 AM	**Fredrick, David**, *Collision Detection: Reflections on Gender from Game Space to Other Spaces*
10:00 AM - 10:10 AM	**Gonzalez-Tennant, Edward**, *Cyberfeminist Perspectives on the Future of Digital Archaeology*
10:10 AM - 10:30 AM	*Discussion*
10:50 AM - 11:00 AM	**Sturm, Jennie**, *Women in Business in the CAA fields*
11:00 AM - 11:10 AM	**Lowry, Sarah**, *Technical Women in Cultural Resource Management: Amplifying the Importance of Non-Traditional Skill Sets in Modern Archaeology*
11:10 AM - 11:20 AM	**Simon, Katie**, *That Was Not OK. Now What?*
11:20 AM - 11:40 AM	*Discussion*
11:40 AM - 11:50 AM	**Gale, Sara**, *How to Maintain an A-Game!: The Importance of Continued Education for Women in Technical Fields*.

11:50 AM - 12:00 PM	**Safi, Kristin**, *Using Technology to Increase Skill Development, Problem Solving, and Collaboration among Women in the CAA*
12:00 PM - 12:10 PM	**Fischer, Lisa**, *A "Digital Divide": Working to Close the Gender Gap*
12:10 PM - 12:25 PM	*Discussion*
12:25 PM - 12:30 PM	**Fischer, Lisa**, *Closing Remarks*

Data, Theory, Methods, and Models. Approaching Anthropology and Archaeology through Computational Modeling

Networks/Modeling

Room: SCW 464

Organizers: Stefani Crabtree, Iza Romanowska

8:30 AM - 8:50 AM	**Crabtree, Stefani**, *An Introduction to Modeling*
8:50 AM - 9:10 AM	**Allison, James**, *Agent-Based Modelling of the Relationships Among Kinship, Residence, and Exchange*
9:10 AM - 9:30 AM	**Weaverdyck, Eli**, *Military Markets in Moesia Inferior: Using Location Analysis and Comparative Modelling to Identify Market Places on Rome's Lower Danubian Frontier*
9:30 AM - 9:50 AM	**Carrignon, Simon, Maria Coto-Sarmiento, Xavier Rubio-Campillo, José Remesal**, *Identifying Social Learning Mechanisms in the Amphorae Production within Roman Empire*
9:50 AM - 10:10 AM	**Graham, Shawn**, *Wetware: Analog Simulation of Roman Socio-Economics*
10:10 AM - 10:30 AM	**van Havre, Grégoire**, *The Dynamics of Brazilian Rock Art Landscape: An Agent-based Modelling Approach to Theories*
10:50 AM - 11:10 AM	**Kay, Andrea, Jed Kaplan**, *Modeling Human-Environment Interaction in Sub-Saharan Africa: Archaeological Data, Ecological Questions*
11:10 AM - 11:30 AM	**Riris, Phil**, *Experiments in Modelling Environmental Impact: A Case Study of Post-Contact Piaroa (Wothuha) Land Use Patterns*
11:30 AM - 11:50 AM	**Kruse, Kristin**, *Spatial Pressure on Alpine Settlements? An Equation Based Case Study in the Silvretta Massif (Switzerland, Canton of Grisons)*

11:50 AM - 12:10 PM	**Reynolds, Adam, Paul Hooper, Stefani Crabtree, Julia Clark**, *Optimizing Long Run Energy Harvesting Strategies in Central Asian Nomadic Pastoralists*
12:10 PM - 12:30 PM	**Romanowska, Iza**, *Hominin Dispersal, Environmental Change and the Evolution of Behavioural Plasticity*

3D Digitization of Sculpture

3D Acquisition / Object Modeling

Room: SCW 466/468

Organizers: Bernard Frischer, Gabriele Guidi

8:30 AM - 8:50 AM	**Frischer, Bernard**, *Digitizing Sculpture: Where We've Been, Where We're Going*
8:50 AM - 9:10 AM	**Vassallo, Valentina, Nicolò Dell'Unto, Sorin Hermon**, *A Quantitative Approach Using 3D Models for a Typo-technological and Manufacturing Study of Terracotta Statuettes. The Case Study of the Ayia Irini (Cyprus) Small Figurines.*
9:10 AM - 9:30 AM	**Brennan, Matthew**, *The Prado Muses - Rethinking the Unity of a Statue Group with the Help of 3D Models*
9:30 AM - 9:50 AM	**Kubicka, Anna, Aleksandra Brzozowska**, *3D Models of Architecture Remains in Archaeological Context. Visualisation as a Tool in Interdisciplinary Research of Polish Archaeological Mission in Kato Paphos on Cyprus.*
9:50 AM - 10:10 AM	**Varner, Eric**, *Digitizing Ancient Sculpture at the Michael C. Carlos Museum, Emory University*
10:10 AM - 10:30 AM	**Guidi, Gabriele, Umair Malik**, *Best Practices and Metrological Issues in Massive 3D Digitization of Sculptures*
10:50 AM - 11:10 AM	**Koutsoudis, Anestis, Georgios- Alexis Ioannakis, Christodoulos Chamzas**, *Incorporating Texture in the Retrieval Process of 3D Models Exploiting Spatial-consistency of Texture Maps*
11:10 AM - 11:30 AM	**Christiaisen, Leif**, *Seymour: Image-based Rendering Solution for High-resolution, Browser-based 3D Graphics*
11:30 AM - 11:50 AM	**Burns, Bryan, Jordan Tynes**, *3D Models for Curatorial Dialogue and Undergraduate Education*
11:50 AM - 12:10 PM	**Sherman, William**, *High-throughput Computing for Large-scale Digitization*
12:10 PM - 12:30 PM	*Discussion*

WEDNESDAY AFTERNOON

Computer Applications in Archaeological Pedagogy: Best Practices for Teaching and Learning

Education and Dissemination

Room: SCE 216

Organizers: Anna Agbe-Davies, Julia Chyla

2:00 PM - 2:20 PM	**Watrall, Ethan**, *Building Scholars and Communities of Practice in Digital Heritage and Archaeology*
2:20 PM - 2:40 PM	**Bollwerk, Elizabeth, Lynsey Bates, Leslie Cooper, Jillian Galle**, *Lessons Learned From Teaching and Training with the Digital Archaeological Archive of Comparative Slavery (DAACS)*
2:40 PM - 3:00 PM	**Lockyear, Kris**, *Flippin' R*
3:00 PM - 3:20 PM	**Martin-Rodilla, Patricia, Cesar Gonzalez-Perez**, *Educational Experiences in Archaeological Information Modelling with the Mind Maps and Object-oriented Paradigms*
3:20 PM - 3:40 PM	**Lambers, Karsten, Fulco Scherjon, Iza Romanowska**, *A Small Private Online Course on 'Modelling and Simulation in Archaeology' at Leiden University*
4:00 PM - 4:20 PM	**McMichael, A.L., Jon Frey, Tommy Truong, Eric Martin**, *Augmenting Art History: AR in the Survey Classroom*
4:20 PM - 4:40 PM	**Pikov, Nikita**, *Augmented Reality (AR) and Digital Photogrammetry as a Way of Preserving and Popularization of Archeological Collections*
4:40 PM - 5:00 PM	**Freeman, Mark, Jeanne Moe**, *Project Archaeology: Assessing Paper and Digital Approaches to Online Learning*
5:00 PM - 5:40 PM	*Discussion*

Differing Perspectives: The Wide World of Geophysical Prospection

Geophysics/Remote Sensing

Room: SCE 217

Organizers: Christine Markussen, Petra Schneidhofer

2:00 PM - 2:20 PM	**Kalayci, Tuna, Meropi Manataki, Apostolos Sarris**, *The More the Merrier? Two Conflicting Stances on Multi-Array Sensors*
2:20 PM - 2:40 PM	**Casana, Jesse, Austin Hill, Elise Laugier**, *Advancing Methodologies for Archaeological Aerial Thermography*
2:40 PM - 3:00 PM	**De Smedt, Philippe**, *The Interpretive Potential of Geophysical Landscape Archaeology: An Electromagnetic Perspective*.
3:00 PM - 3:20 PM	**Herrmann, Jason**, *What to do with Ambiguous Anomalies?*
3:20 PM - 3:40 PM	**Ernenwein, Eileen, Jeremy Menzer**, *3D Ground Truth: Integrating Above Ground Photogrammetry, Ground Penetrating Radar, and Subsurface Laser Scans of a Medieval Tunnel, Mourjou, France*
4:00 PM - 4:20 PM	**Cooper, Lorna**, *Relocating a Forgotten Asian Market Garden in Historic Perth (1833-1936): Using GIS to Integrate and Interrogate Excavated, Archival and Geophysical Information*
4:20 PM - 4:40 PM	**Cannon, Cayla, Eileen Ernenwein, Jay Franklin**, *In Search of the People Who Lived Here Before: From Historic to Prehistoric Significance at a Tennessee State Historic Site*
4:40 PM - 5:00 PM	**Miszk, Łukasz, Martina Seifert, Nikola Babucic, Ewdoksia Papuci-Władyka**, *Old or new? Human Impact and the Mapping of Ancient Nea Paphos*
5:00 PM - 5:20 PM	**Grap, Rachel, Eileen Ernenwein**, *Big Geophysics with Small Tools: Looking for the Big Picture One Step at a Time at Tel Shimron*
5:20 PM - 5:40 PM	*Discussion*

General - 3D Modeling

General

Room: SCE 218

Organizers: , , , ,

2:00 PM - 2:20 PM	**Johnson, Adam**, *Shifting Stones and Data Points: Using Terrestrial Laser Scanning to Assess Damage to Monumental Architecture in Hawai`i*
2:20 PM - 2:40 PM	**Guidi, Gabriele, Laura Micoli, Sara Gonizzi Barsanti**, *Diachronic 3D Reconstruction of Historical Sites in Urban Context*
2:40 PM - 3:00 PM	**Cennamo, Gerardo Maria**, *The Giusso Castle and the Foundation Area of Sicignano degli Alburni (SA). Survey and 3D Modeling for Social and Territorial Valorization Strategies*

Decolonising Digital Archaeology

Critical Reflections

Room: SCE 218

Organizers: Andrew Dufton, Jessica Ogden

4:00 PM - 4:20 PM	**Sheldrick, Nichole**, *Accessing Archaeology: Creating an Open-Access Heritage Database for the Endangered Archaeology in the Middle East & North Africa (EAMENA) Project*
4:20 PM - 4:40 PM	**Huntsman, Theresa, Eric Kansa**, *Context and Community: Accountable, Open Presentation of Digital Archaeology*
4:40 PM - 5:00 PM	**Kamash, Zena**, *'Postcard to Palmyra': Exploring Visitor Responses to the Replica of the Triumphal Arch from Palmyra in Trafalgar Square, London*
5:00 PM - 5:20 PM	**Bianchini, Carlo, Mohammed El Khalili, Nizar Al Adarbeh, Alekos Diacodimitri**, *Survey, 2D and 3D Modelling of the Roman Nymphaeum in Amman: a Multilateral, Cooperative Research Experience*
5:20 PM - 5:40 PM	**Heitman, Carrie**, *Decolonizing an Archive of Archives?*

Path Modelling and the Materiality of Movement

GIS

Room: SCE Auditorium

Organizers: Philip Verhagen, Laure Nuninger, Axel Posluschny

4:00 PM - 4:20 PM	**Caswell, Edward, Michelle De-Gruchy, James Edwards**, *Walking Across Beach Sand is Hard and Other Discoveries: First Results of Assessing the Time Cost of Moving Through Various Terrains*
4:20 PM - 4:40 PM	**Kalayci, Tuna**, *The Volume of Ancient Movement: A Satellite Remote Sensing Approach*
4:40 PM - 5:00 PM	**Field, Sean**, *Least Cost Path Modelling: Computing Functional Correlations in Chacoan Road Systems*
5:00 PM - 5:20 PM	**Rothenberg, Miriam**, *Do All Roads Really Lead to Rome? Modelling Mobility in the Ager Veientanus and the Sangro Valley, Italy*
5:20 PM - 5:40 PM	**Safi, Kristin**, *Considerations for Modeling Mobility and Cultural Interaction Among Maritime Communities*

Visualization as Analysis in Archaeology

Broader View - Digital Archaeology and the Humanities

Room: SCW 460/462

Organizers: Neha Gupta, Michael Carter

2:00 PM - 2:05 PM
Dallas, Costis, *Curation at the Sensor's Gaze: Connecting Representation and Performance in Archaeological Visualization*

2:05 PM - 2:10 PM
Gupta, Neha, Rodolphe Devillers, *Geographic Visualisation as Knowledge Generation in Archaeology*

2:10 PM - 2:15 PM
Huggett, Jeremy, *Continuous Interactivity in Archaeological Visualisation*

2:15 PM - 2:20 PM
Carter, William, *Making and Meaning-Making in Virtual Archaeology*

2:20 PM - 2:25 PM
Higginbottom, Gail, Vincent Mom, *Place: the Physical Embodiment of Collective Information*

2:25 PM - 2:30 PM
Denham, Brian, *Applied Technological Approaches in Heritage and Heritage Management: the Black Butte River Mapping Project*

2:30 PM - 2:35 PM
Kansa, Eric, Neha Gupta, *Visualizing and Navigating Chronology in Large Digital Collections*

2:35 PM - 2:40 PM
Triplett, Edward, Emma Buckingham, *Recontextualizing Decades-old Excavation Materials Through 3D Visualization*

2:40 PM - 2:45 PM
Kubicka, Anna, Aleksandra Brzozowska-Jawornicka, *3D Models of Architecture Remains in Archaeological Context. Visualization as a Tool in Interdisciplinary Research of Polish Archaeological Mission in Kato Paphos on Cyprus.*

2:45 PM - 2:50 PM
Kotoula, Eleni, David Robinson, Matthew Baker, Clare Bedford, Devlin Gandy, David Wheatley, James Miles, Jennifer Perry, *The Gordian Knot Project: An Integrated Approach for Rock Art Visualization*

2:50 PM - 2:55 PM
Pattee, Aaron, *Analyzing the Medieval Landscape of the Pfalz—Castles in the Area of Kaiserslautern*

2:55 PM - 3:00 PM
Pattee, Aaron, Effie Athanassopoulos, Kami Ahrens, Cole Juckette, *Campus Archaeology and 3D Modeling: An Archaeological Collection of Historic Artifacts from the University of Nebraska-Lincoln*

3:00 PM - 3:05 PM
Juckette, Cole, Effie Athanassopoulos, Aaron Pattee, Kami Ahrens, *Campus Archaeology and Digital Mapping: Urban space and Commerce in Lincoln Nebraska, 1870-1920s.*

3:05 PM - 3:10 PM	**Kulhanek, Karin, Andreas Pastoors**, *Tracking in 3D*
3:10 PM - 3:40 PM	*Discussion*
4:00 PM - 5:40 PM	**Kulhanek, Karin, Andreas Pastoors**, *Roundtable*

Data, Theory, Methods, and Models. Approaching Anthropology and Archaeology through Computational Modeling

Networks/Modeling

Room: SCW 464

Organizers: Stefani Crabtree, Iza Romanowska

2:00 PM - 2:20 PM	**Hölzchen, Ericson, Christine Hertler**, *Modeling Resource-driven Out of Africa Hypotheses – Potential and Challenges*
2:20 PM - 2:40 PM	**Bergin, Sean**, *Migrant Farmers and Indigenous Foragers: Evaluating and Understanding Conceptual Models of the Neolithization of the West Mediterranean with a Spatially Explicit Agent-Based Model*
2:40 PM - 3:00 PM	**Davies, Benjamin, Simon Holdaway**, *Making Sense of the Surface: Using Spatial Simulation to Understand Stone Artifact Scatters*
3:00 PM - 3:20 PM	**Ullah, Isaac**, *Completing the Loop: Model-component Coupling and Bidirectional Feedback*.
3:40 PM - 4:00 PM	**Barceló, Juan**, *When All Agents Die. Analyzing the Possible Failures of Agent-based Models*.

Quality Assurance and Quality Control in Image-Based Modeling

3D Acquisition / Object Modeling

Room: SCW 466/468

Organizers: Adam Spring, George Bevan

2:00 PM - 2:20 PM	**Sherman, William**, *Introduction*
2:20 PM - 2:40 PM	**Bryan, Paul**, *Structure-from-Motion (SfM) – a Reliable Survey Tool for Archaeology or an Unreliable Black-box?*

2:40 PM - 3:00 PM	**Bevan, George, Jason Birch**, *Some Considerations on Semi-Global Matching for High-Accuracy Heritage Recording Applications*
3:00 PM - 3:20 PM	**Seguin, Maxime**, *Training with Free and Open-Source Photogrammetric Softwares : One of the Answers to Rectify the Situation?*
3:20 PM - 3:40 PM	**Bevan, George, Jones Kristen**, *An Analytical Stereoplotting Workflow for Archaeological Excavation: Reviving a 20th-century Photogrammetric Technique for the 21st*.
4:00 PM - 4:20 PM	**Meyer, Dominique, Danielle Mercure, Eric Lo, Jamie Hodgkins, Dominique Rissolo, Falko Kuester**, *Evaluating Photogrammetric Reconstructions of Faunal and Lithic Artifacts Compared to Traditional Microscopic Observation, Structured Light Imaging, Laser Scanning, Magnetic Resonance Imaging and Computerized Tomography Scanning*
4:20 PM - 4:40 PM	**Kleinkemper, Larry**, *The Key to Creating a GREAT Model from Laser Scanning and Photogrammetry*
4:40 PM - 5:00 PM	**Liu, Julia, Adam Spring**, *From Scan to Sculpture: Ensuring Quality Control in Digital Restoration*.
5:00 PM - 5:20 PM	**Peters, Caradoc**, *Using Inscribed Stone Surfaces To Examine Low Cost 3D imaging*

THURSDAY MORNING

Web-based Infrastructure as a Collaborative Framework across Archaeological Fieldwork, Lab Work, and Analysis

Collaborative Data Management

Room: SCE 216

Organizers: Fabrizio Galeazzi, Heather Richards-Rissetto

8:30 AM - 8:50 AM	**Johnson, Ian**, *Building Web-based Integration from Data Model through Tablet Data Collection to Analysis*
8:50 AM - 9:10 AM	**Jensen, Peter**, *Semantically Enhanced 3D: Introducing a Web-based Platform for Spatial Integration of Excavation Documentation*
9:10 AM - 9:30 AM	**Cuy, Sebastian, Jan Wieners, Daniel de Oliveira**, *iDAI.field 2.0 - A Modern & Open Framework for Field Recording*
9:30 AM - 9:50 AM	**Landeschi, Giacomo, Danilo Marco Campanaro, Nicolò Dell'Unto**, *A 3D Web-aided Resource for Pompeian Studies (3D WARPS)*
9:50 AM - 10:10 AM	**Zerbini, Andrea**, *Building a Heritage Management Platform for Endangered Archaeology in the Middle East and North Africa*
10:10 AM - 10:30 AM	**Lang, Matthias, Michael Derntl**, *Spacialist – A Virtual Research Environment for the Spatial Humanities*
10:50 AM - 11:10 AM	**Pouncett, John, Chris Green, Chris Gosden, Mark Pollard**, *A Tale of Two Projects: The Role of Web-GIS in Collaborative Research*
11:10 AM - 11:30 AM	**Karenowska, Alexy**, *What do Web-based Platforms Mean for the Ambitions of Archaeology?*
11:30 AM - 11:50 AM	**Richards-Rissetto, Heather, Zachary Day, Shane Bolan**, *Not all Data are Born Digital: Workflows to facilitate Data Integration and Rapid 3D Visualization of Landscapes*
11:50 AM - 12:10 PM	**Wright, Holly**, *One Size does not Fit All: Reflections on Online Research Infrastructures*

12:10 PM - 12:30 PM	**Opitz, Rachel**, *Publishers and Archives as Fieldwork Collaborators*

3DVR Caveats and Accomplishments

VR

Room: SCE 217

Organizer: Willeke Wendrich

8:30 AM - 8:50 AM	**Wendrich, Willeke**, *3DVR Caveats and Accomplishments - Introduction*
8:50 AM - 9:10 AM	**Elgewely, Eiman**, *Evaluation and Enhancement of the Virtual Experience: The Case Study of the "Reviving Karanis in 3D" Project*
9:10 AM - 9:30 AM	**Mezzano, Michela, Noemi Mafrici**, *Saving the Nubian Temples: The Study of the History through Digital Tools*
9:30 AM - 9:50 AM	**Champion, Erik**, *PublicVR and its Relevance to 3DVR and Virtual Heritage*
9:50 AM - 10:10 AM	**Payne, Angie, Vance Green, Fred Limp**, *History Erased and History Recovered: (Re)Creating the Rohwer Japanese Interment Camp*
10:10 AM - 10:30 AM	**Wolter, Thomas**, *Photogrammetric Feature Documentation and Cave Modelling*
10:50 AM - 11:10 AM	**Vurpillot, Damien**, *Exploring Massive Point Clouds: How to Make the Most Out of Available Digital Material*
11:10 AM - 11:30 AM	**Kuester, Falko, Vid Petrovic**, *Giga-Point Rendering for 3D VR*
11:30 AM - 11:50 AM	**Follett, Forrest, Kyle Urquhart**, *A 3D Visualization of Ceramic Materials form Gabii, Italy*
11:50 AM - 12:30 PM	*Discussion*

Mobile GIS and Field Survey - Current Possibilities, Future Needs

GIS

Room: SCE Auditorium

Organizers: Nazarij Buławka, Julia Chyla

8:30 AM - 8:50 AM	**Knoop, Peter**, *Best Practices for Mobile GIS and Information Technology in the Field*
8:50 AM - 9:10 AM	**Hill, Austin**, *Low Cost, High Accuracy Drone Survey Methods*
9:10 AM - 9:30 AM	**Chyla, Julia, Miłosz Giersz, Wiesław Więckowski, Patrycja Prządka-Giersz, Roberto Pimentel-Nita**, *One Step further beyond Field Survey*
9:30 AM - 9:50 AM	**Miszk, Łukasz, Wojciech Ostrowski, Weronika Winiarska**, *Urban sprawl vs. Archaeological Site. A View from Paphos.*
9:50 AM - 10:10 AM	**Pethen, Hannah**, *Accessing the Inaccessible: Detailed 'Off-Site' Archaeological Survey using Satellite Imagery and GIS at the Hatnub Travertine Quarries, Egypt*
10:10 AM - 10:30 AM	**Buławka, Nazarij**, *Ancient Landscapes and Present-day Agriculture – On the Example of Tejen River (Turkmenistan)*

Contributions to Settlement Theory? Archaeological Location Analysis and Modelling

GIS

Room: SCE House

Organizer: Kenneth Kvamme

8:30 AM - 8:50 AM	**Smith, Karl**, *Locations in Experience: Visibility, Seafaring, and the Placement of Pembrokeshire's Iron Age Coastal Promontory Forts*
8:50 AM - 9:10 AM	**Negre, Joan**, *A Geographically based Ripley's Function to Assess Settlement Patterning*
9:10 AM - 9:30 AM	**Zipser, Jan**, *Possible Strategy of Land Use by the Przeworsk Culture People in Widawa Basin (South-Western Poland) and the Probable Settlement Processes*
9:30 AM - 9:50 AM	**Micle, Dorel**, *Landscape and Economics: A GIS Location Analysis of Middle Age water mills from Banat Region (Romania)*
9:50 AM - 10:10 AM	**Tsonev, Tsoni**, *Complexity of Mesolithic Settlements in Northeastern Bulgaria*
10:10 AM - 10:30 AM	*Discussion*
10:50 AM - 11:10 AM	**Higginbottom, Gail, Roger Clay**, *Human Scale and its Impact on Location Modelling*

11:10 AM - 11:30 AM	**Whitley, Thomas**, *Blurring the Lines Between Prediction and Interpretation: Some Thoughts on the Contributions of Energetics, Mobility, and 3D Models to Settlement Theory.*
11:30 AM - 11:50 AM	**Shaffer, Derek, Timothy Murtha, Charles Golden, Bruce Cook, Elijah Hermitt**, *Sites, Landscapes, and LiDAR in the Maya Lowlands: Leveraging high resolution regional LiDAR for improved predictive models*.
11:50 AM - 12:10 PM	**Hobbs, Elizabeth, Michael Bergervoet**, *Designing Locational Models to Test Settlement Theory*
12:10 PM - 12:30 PM	*Discussion*

Everything wrong with…

Critical Reflections

Room: SCW 460/462

Organizers: Doug Rocks-Macqueen, Stefani Crabtree, Philip Riris

8:30 AM - 8:40 AM	**Dennis, L. Meghan**, *Ethics? Ethics? Anyone?*
8:40 AM - 8:50 AM	**Crabtree, Stefani**, *Communicating Archaeological Research to the Press and the Public*
8:50 AM - 9:00 AM	**Rocks-Macqueen, Doug**, *F*ck Public Archaeology*
9:00 AM - 9:10 AM	**Huggett, Jeremy**, *Everything Wrong With … Digital Archaeology*
9:10 AM - 9:20 AM	**Gruber, Ethan**, *Challenges in Analysing Sensitive or Uncertain Data in a Semantic Web Environment*
9:20 AM - 9:30 AM	**Graham, Shawn**, *Everything Wrong with Bots: On Algorithmic Madness*
9:30 AM - 9:40 AM	**Riris, Phil**, *"Twitter is Actually Stupid" - @fart*
9:40 AM - 9:50 AM	**Layt, John**, *Open Source: You're Doing it all Wrong*
9:50 AM - 10:30 AM	*Discussion*

10:50 AM - 11:00 AM	**Newhard, James**, *Turning the Ship without Rocking the Boat: Establishing Archaeological GIS within an Undergraduate Experience*
11:00 AM - 11:10 AM	**Brughmans, Tom**, *Everything Wrong with Exploratory Network Analysis of Archaeological Similarity Networks*
11:10 AM - 11:20 AM	**Walthew, Jessica**, *The Aura as Metadata, The Aura of Metadata*
11:20 AM - 11:30 AM	**Opitz, Rachel**, *How We Measure Shape*
11:30 AM - 11:40 AM	**Johnson, Phyllis**, *How Can Something so Small Cost so Much? Cost- and Time-Efficiency in Microartifact Analysis*
11:40 AM - 11:50 AM	**Eriksen, Kristin**, *3D-models in Archaeology*
11:50 AM - 12:00 PM	**Romanowska, Iza**, *Everything Wrong with Archaeological Models*
12:00 PM - 12:10 PM	**Cooper, Catriona**, *Everything Wrong with Acoustical Modelling*
12:10 PM - 12:30 PM	*Discussion*

Archaeological Networks: Uncertainty, Missing Data, and Statistical Inference

Networks/Modeling

Room: SCW 464

Organizers: Tom Brughmans, Matt Peeples

8:30 AM - 8:50 AM	**Blair, Elliot**, *Social Networks of Mission Santa Catalina de Guale: Comparing and Contrasting Unimodal and Bimodal Approaches*
8:50 AM - 9:10 AM	**Upton, Andrew**, *Frontier Networks: Cultural Transmission and Multiple Relations at the Intersection of Mississippian and Oneota Worlds*
9:10 AM - 9:30 AM	**Munson, Jessica, Viviana Amati, Habiba Habiba, Jonathan Scholnick, Matthew Looper, Yuriy Polyukhovych, Martha Macri**, *Diffusion Networks and the Transmission of Dynastic Rituals in Classic Maya Society*
9:30 AM - 9:50 AM	**Golitko, Mark**, *Historical Contingency in Network Data: Examples from Museum Collections Research*

9:50 AM - 10:10 AM	**van Havre, Grégoire**, *Networks as a Theoretical Framework for Rock Art Studies in Northeast Brazil*
10:10 AM - 10:30 AM	**Johnson, Kent**, *Social Network Analysis of Ancient Families: Exploring the Effects of Known Unknowns using Phenotypic Data from Documented Collections of Human Skeletal Remains*
10:50 AM - 11:10 AM	**Crabtree, Stefani**, *Analyzing Trophic Networks among the Ancestral Pueblo*
11:10 AM - 11:30 AM	**Groenhuijzen, Mark, Philip Verhagen**, *Continuity and Discontinuity in Transport Networks of the Dutch Limes Zone*
11:30 AM - 11:50 AM	**Prignano, Luce, Sergi Lozano, Ignacio Morer, Francesca Fulminante**, *Comparing Network Models for the Evolution of Terrestrial Connections in Central Italy (950—500 BC ca)*
11:50 AM - 12:10 PM	**Brandes, Ulrik, Tom Brughmans**, *New Methods for Visibility Networks in Landscape Archaeology*
12:10 PM - 12:30 PM	*Discussion*

Close Range 3D Data Acquisition, Processing, Querying and Presentation in Cultural Heritage

3D Acquisition / Object Modeling

Room: SCW 466/468

Organizers: Dirk Rieke-Zapp, Vera Moitinho de Almeida, Diego Jiménez-Badillo

8:30 AM - 8:50 AM	**Kampel, Martin, Juraj Sarkisjan**, *Feasibility Study of Consumer Electronic Scanning Devices for Pottery Documentation*
8:50 AM - 9:10 AM	**Filippucci, Marco, Fabio Bianconi, Sofia Catalucci, Gianluca Rossi**, *Drawing, Survey, Measure to Analyzing the Reliability of Photomodelling for Cultural Heritage*
9:10 AM - 9:30 AM	**Kristensen, Steinar, Magne Samdal**, *One Stone, Two Men, Three Methods: Different Methods – Different Data? Rockart Analysis Testing RTI, Photogrammetry and Laserscan*
9:30 AM - 9:50 AM	**Krohn, Anna, Miriam Clinton, Ian Roy**, *One Size Does Not Fit All: A Comparison of 3D Data Capture*
9:50 AM - 10:10 AM	**Noble, Tommy, Neffra Matthews**, *Good Photogrammetry, Good Data, Good Science*
10:10 AM - 10:30 AM	*Discussion*

10:50 AM - 11:10 AM	**Scafuri, Michael**, *The Integration of Multiple 3D Documentation Methodologies in the Modeling and Analysis of an American Civil War Submarine*.
11:10 AM - 11:30 AM	**Mudge, Mark, Carla Schroer**, *Challenges and Insights from the Photogrammetric Capture of a Large-scale Diego Rivera Fresco*
11:30 AM - 11:50 AM	**Johnson, Tyler**, *3D User Interfaces at the Nexus of Technical Processing and Creative Design in Digital Archaeology*
11:50 AM - 12:10 PM	**Kai-Browne, Arie, Thomas Bremer, Kay Kohlmeyer, Julia Gonnella, Sebastian Plesch, Susanne Brandhorst**, *Contextualizing Cultural Heritage – the Cupola of the Torres de las Damas in the Alhambra*
12:10 PM - 12:30 PM	**Rieke-Zapp, Dirk**, *Quantitative Analysis Based on 3D data - Examples*

THURSDAY AFTERNOON

Corpus of Analysis in the Research on Ancient Eastern Mediterranean and Western Asia: Encoding, Information Collection,

Collaborative Data Management

Room: SCE 216

Organizers: Vanessa Juloux, Alessandro di Ludovico

2:00 PM - 2:20 PM	**Di Ludovico, Alessandro**, *Data Description and Integrated Study of Ancient Near Eastern Works of Art: The Potential of Cylinder Seals*
2:20 PM - 2:40 PM	**Ramazzotti, Marco**, *Landscape Archaeology and Artificial Intelligence: The Neural Hypersurface of the Mesopotamian Urban Revolution*
2:40 PM - 3:00 PM	**Prosser, Miller**, *Digital Philology in the Ras Shamra Tablet Inventory Project: Text Curation through Computational Intelligence*
3:00 PM - 3:20 PM	**Eraslan, Doğu**, *Epigraphic Interoperability in/of Encoded Ancient Texts: Some Principals and Deliverables at the Current State of our Encoding Schemes Based on an Encoding of Quadrilingual Vase of Darius I and Some Prospects for the Future*
3:20 PM - 3:40 PM	**Pagé-Perron, Émilie, Terhi Nurmikko-Fuller, Vanessa Juloux**, *Enhancing Collaboration between Digital Assyriology Projects Through Open Access Practices*

Exploring the Symbiotic Relationships of Archaeology and Spatial Humanities

Broader View - Digital Archaeology and the Humanities

Room: SCE 216

Organizers: Armin Volkmann, Heather Richards-Rissetto

4:00 PM - 4:20 PM	**Athanassopoulos, Effie, Kim Shelton**, *Archaeological Practice and 3D Modeling: A Medieval Ceramic Assemblage from Nemea, Greece*
4:20 PM - 4:40 PM	**Isaksen, Leif, Rainer Simon, Elton Barker, Valeria Vitale, Rebecca Kahn**, *Supporting Community Annotation with Recogito 2*
4:40 PM - 5:00 PM	**Rabinowitz, Adam, Ryan Shaw, Patrick Golden, Elijah Fleming, Lorraine Haricombe**, *In Search of Common Ground: Time, Tradition, and Temporal Reconciliation in PeriodO 2*
5:00 PM - 5:20 PM	**Schmidle, Wolfgang, Sebastian Cuy, Nathalie Kallas, Florian Thiery, Jan Wieners**, *Analyzing Reasons for Different Datings of Periods using the ChronOntology Time Gazetteer*
5:20 PM - 5:40 PM	**Kondo, Yasuhisa, Akira Saito, Nozomi Mizota, Tomoko Koyama**, *Synergistic Collaboration between Data Visualization Experts and Historians in Developing a Geodatabase of Forced Resettlement in the Colonial Andes*
5:40 PM - 6:00 PM	*Discussion*

3D Technologies Applied to Music and Sound

VR

Room: SCE 217

Organizers: Bernard Frischer, Jared Katz

2:00 PM - 2:20 PM	**Till, Rupert**, *Integrating Accurate Interactive Acoustics, Music and Soundscapes into Interactive 3D Models of Archaeological Sites and Landscapes*
2:20 PM - 2:40 PM	**Kolar, Miriam, José Cruzado Coronel**, *Auralizing Ancient Spaces: Sonic Re-Presentation from Architectural Models, In-Situ Measurements, and Experimental Analogues*
2:40 PM - 3:00 PM	**Katz, Jared**, *3D Maya Music: Use of 3D Models for the Creation of Typologies and for Public Outreach*
3:00 PM - 3:20 PM	**Puglisi, Julia**, *Acoustics of the South Theatre at Hadrian's Villa: A Preliminary Study using I-Simpa*
3:20 PM - 3:40 PM	**Kimber, Andres**, *Sound and Vision of Cup-marked Stones in Rebala Heritage Reserve, Estonia*

4:00 PM - 4:20 PM	**Koller, Jared**, *Multi-Sensory Landscape Analysis of Spanish Mission Building Practices in the Philippines*
4:20 PM - 4:40 PM	**Cooper, Catriona**, *Listening to the Commons: Acoustically Modelling the Pre-1834 House of Commons, Westminster*
4:40 PM - 5:40 PM	*Discussion*

Contributions to Settlement Theory? Archaeological Location Analysis and Modelling

GIS

Room: SCE House

Organizer: Kenneth Kvamme

2:00 PM - 2:20 PM	**Verhagen, Philip, Antonin Nüsslein, Laure Nuninger**, *To Boldly go where No One has Gone Before: Integrating Socio-cultural, Environmental and Temporal Factors in Site Location Analysis and Predictive Modelling*
2:20 PM - 2:40 PM	**Kvamme, Kenneth**, *The Dimensions of Settlement Choice*
2:40 PM - 3:00 PM	**Cuthbertson, Patrick**, *A Landscape-Based Approach Assessing Hominin Occupation and Dispersal in Lower-Middle Pleistocene Central Asia*
3:00 PM - 3:20 PM	*Discussion*

The Ups and Downs of Archaeological Simulation

Networks/Modeling

Room: SCE House

Organizers: Iza Romanowska, Juan Barceló

4:00 PM - 4:20 PM	**Rocks-Macqueen, Doug**, *The Long Road Ahead for Simulations in Archaeology*
4:20 PM - 4:40 PM	**Linde, Lennart**, *Think Different! - Why "Model Thinking" Shaped the Archaeological Thought Beyond the Hype on ABM*
4:40 PM - 5:40 PM	*Discussion*

Structural Analysis for Cultural Heritage

3D Acquisition / Object Modeling

Room: SCW 460/462

Organizers: Falko Kuester, Michael Hess, Dominique Rissolo

2:00 PM - 2:20 PM

Guidi, Gabriele, Sara Gonizzi Barsanti, *A Novel Pipeline for the Structural Analysis of 3D Digitized Cultural Heritage*

2:20 PM - 2:40 PM

Napolitano, Rebecca, Branko Glisic, *Digital Workflow for Structural Analysis of Discontinuous Media*

2:40 PM - 3:00 PM

Ippolito, Alfonso, Carlo Inglese, Martina Attenni, Valeria Caniglia, *Quantity vs Quality: Advantages and Disadvantages of Imaged Based Modelling*

3:00 PM - 3:20 PM

Hess, Michael, *Non-destructive Techniques for the Structural Health Assessment of Historic Buildings*

3:20 PM - 3:40 PM

Wittich, Christine, Tara Hutchinson, *Seismic Response of Geologic and Heritage Structures: Geometry Acquisition, Numerical Modeling, and Probabilistic Interpretation*

4:00 PM - 4:20 PM

Wood, Richard, M. Ebrahim Mohammadi, *Lidar Damage Evaluation of Historic Temple after the 2015 Gorkha Earthquake*

4:20 PM - 4:40 PM

Schubert, Lutz, Keith Jeffery, *Interpreting Shell Middens through Physics Simulation*

4:40 PM - 5:00 PM

Miles, James, *The Potential of Structural Analysis in Archaeological Simulation and Interpretation: A Case Study of Medieval Winchester Cathedral Close*

5:00 PM - 5:20 PM

Gil, Ana, *A Methodology for Architectural Heritage's Digital Reconstructions. Lisbon Religious Houses as Case Study*

5:20 PM - 5:40 PM

Meyer, Dominique, Gianmarco Guerra, Eric Lo, Michael Hess, Davide Forcellini, Falko Kuester, *Comparing Measured Frequency Responses of the Third Tower of San Marino to Simulation Derived Frequency Responses from a Photogrammetry and LIDAR Acquired 3D Model*

5:40 PM - 6:00 PM

Rissolo, Dominique, Michael Hess, Jose Huchim Herrera, Eric Lo, Vid Petrovic, Dominique Meyer, Falko Kuester, Fabio Amador, *Preliminary Structural Assessment of a Unique Maya Building Platform at Oxkintok, Yucatan*

Archaeological Networks: Uncertainty, Missing Data, and Statistical Inference

Networks/Modeling

Room: SCW 464

Organizers: Tom Brughmans, Matt Peeples

2:00 PM - 2:20 PM	**Rivals, Cécile**, *The Modeling of Urban Spatial Dynamics in Long Time Spans*
2:20 PM - 2:40 PM	**Habiba, Habiba, Viviana Amati, Jessica Munson, Jonathan Scholnick, Yuriy Polyukhovych, Matthew Looper, Martha Macri**, *Inferring Influence Networks of Grapheme Innovation in Classic Maya Hieroglyphic Writing*
2:40 PM - 3:00 PM	**Gjesfjeld, Erik**, *Centrality Measurements and their Application to Archaeological Data*
3:00 PM - 3:20 PM	**Peeples, Matthew, John Roberts**, *Bootstrap Methods for Assessing Variability in Archaeological Networks*
3:20 PM - 3:40 PM	**Cardinal, James**, *Unscrambling the Egg: Quantitative, Assemblage-based Component Consociation Methods for Densely Mixed or Disturbed Contexts*
4:00 PM - 4:20 PM	**Collins-Elliott, Stephen**, *Accounting for Sample Size: Measuring Cultural Distinction through Monte Carlo Approximations of Hellinger Distances*
4:20 PM - 4:40 PM	**Gauthier, Nicolas**, *Assessing the Impact of Parametric Uncertainty in a Simple Model of a Social-ecological Network*
4:40 PM - 5:00 PM	**Gravel-Miguel, Claudine**, *Using an ABM to Evaluate the Impact of Missing Links on our Interpretation of Social Networks*
5:00 PM - 5:40 PM	*Discussion*

Close Range 3D Data Acquisition, Processing, Querying and Presentation in Cultural Heritage

3D Acquisition / Object Modeling

Room: SCW 466/468

Organizers: Dirk Rieke-Zapp, Vera Moitinho de Almeida, Diego Jiménez-Badillo

2:00 PM - 2:20 PM	**Pakhunov, Alexander, Ekaterina Devlet, Alexander Popov**, *How Can We Trace Translocated Boulders with Petroglyphs at the Riverbank?*

2:20 PM - 2:40 PM	**McKee, Arlo**, *A Glimpse at Site Formation Processes from 3D Laser Scanning Ceramic Sherds in East Texas*
2:40 PM - 3:00 PM	**Porter, Samantha, Morgan Roussel, Marie Soressi**, *A Comparative Analysis of Châtelperronian and Protoaurignacian Blade Core Technology Using Data Derived from 3D Models*
3:00 PM - 3:20 PM	**Murray, Michael**, *Practical Applications of Underwater Laser Scanning in Maritime Archaeology Compared to Micro-bathymetry Sonar and Photogrammetry*
3:20 PM - 3:40 PM	**Jiménez-Badillo, Diego, Salvador Ruíz-Correa, Mario Canul-Ku, Rogelio Hasimoto-Beltrán**, *Application of a 3D Morphing Technique to Analyze the Style of Archaeological Models*
3:40 PM - 4:20 PM	**Hanes, Laurence, Tim Collins, Sandra Woolley**, *Classifying the Surfaces of Virtual Cuneiform Tablet Fragments*
4:20 PM - 4:40 PM	**Mara, Hubert**, *Revealing Degraded Script in High Resolution 3D Measurement Data with GigaMesh*
4:40 PM - 5:00 PM	**Rossi, Maria Laura, Carlo Inglese, Antonio Pizzo, Leonardo Paris**, *Geometry as Matrix of Construction of Roman Stone Bridges. The Augustus Bridge in Narni.*
5:00 PM - 5:40 PM	*Discussion*

CAA2017 ATL

CAA Computer Applications & Quantitative Methods in Archaeology

Georgia State University

ABSTRACTS

Agent-Based Modelling of the Relationships Among Kinship, Residence, and Exchange

Allison, James (Brigham Young University)

In the North American Southwest, archaeological research has documented ceramic exchange networks in which the abundance of imported pottery generally declines with distance from the source zone, but households in consumer communities have greatly varying amounts of imported pottery. This paper uses agent-based modelling and insights from ethnographic studies to try to understand the processes responsible for these distributions. Exchange theory and ethnographic data suggest that kinship relations are important in forming exchange networks and that rules about kinship obligations and patterns of post-marriage residence, as well as the size and spacing of settlements, influence the distribution of exchanged goods. The agent-based model used here tracks kinship ties among agents (representing individuals) who give birth, marry, coreside with spouses, and exchange things in a virtual landscape filled with small settlements of up to a few hundred individuals. Exchange of goods in the model preferentially follows kin lines. The results suggest that the differential distribution of goods among spatially proximate households seen in the archaeological cases could result from a small-world network that forms as some individuals move to join spouses in far-off settlements, giving relatives in their home settlement preferential access to exchange goods originating in distant places.

Archaeological Practice and 3D Modeling: A Medieval Ceramic Assemblage from Nemea, Greece

Athanassopoulos, Effie (University Of Nebraska-Lincoln)
Kim Shelton (University Of California, Berkeley)

This presentation reports on the ongoing experimentation with 3D modeling methods and their application to diverse archaeological collections. As 3D modeling methods continue to improve, they offer an attractive alternative for artifact documentation, analysis and sharing of data. Here we present a case study, a collection of 3D models of medieval ceramics from the excavations of the Sanctuary of Zeus at Nemea, Greece. This growing digital collection can illustrate the advantages, potential and challenges presented by the

incorporation of 3D technology into archaeological practice. 3D technology can facilitate documentation, interpretation, and publication of archaeological datasets. The 3D modeling process produces accurate, digital reproductions of the ceramic artifacts that can be used for a variety of typological, functional and other kinds of analyses. Furthermore the models can be stored in a digital library to facilitate preservation and sharing. The models form the core of a valuable research tool that makes available a significant body of archaeological materials. Thus, 3D modeling methods are generating novel kinds of datasets and are altering well-established archaeological practices relying on 2D documentation. However, the longevity of these datasets remains uncertain, as storage space requirements, support of current digital infrastructure, and long-term data accessibility and preservation are matters that do not have standardized solutions, rather require extensive dialogue and collaboration. Thus, as digital experimentation becomes part of archaeological practice, and 3D modeling methods are widely adopted, more effort needs to be invested in disseminating, and preserving these increasingly large archaeological datasets.

Representing Intangible Heritage: Questions About Method

Attenni, Martina (Sapienza Università Di Roma)
Alfonso Ippolito (Sapienza Università Di Roma)

The relation between text and image is an interesting field of enquiry little explored so far. A lot of archaeological heritage is based on descriptions of objects and places while communicating information is more and more linked to the construction of 3D/2D models enhanced by the development of ICT. The construction of such models is especially complicated when the elements no longer exist while their documentation is solely of the descriptive type completely devoid of any images or drawings. The main focus rest on how the 2D/3D representation of an archaeological artifact ought to correspond to what is described as well as try to find out to what extent all words used insert the fruit of interpretation and interaction between different profiles. The object of analysis is the Etruscan Sanctuary at Pyrgi, today almost completely disappeared, and the transition from the documentation constituted by 2D/1D models towards cataloguing structured for semantic categories of 3D/2D/1D models. It allow archiving all information and makes for their objectification because it determines the identity of complex objects which can be subject to critical assessments. Digital models allow communicating heterogeneous information, which include documentation of the current state and a reconstruction of things lost. Digital modalities for communicating archaeological heritage are beset with various problems related to the transparency of the criteria applied for cataloguing and the scientific validity of the processes followed for the construction of models, based also on data capture and data processing from surveying and survey operation.

Making Use of the Publicly Available Spatial Data and Bringing the Past to the People: a Case Study of the Pomeranian Wall, Poland

Banaszek, Łukasz (Center For Virtualization And Applied Spatial Technologies, University Of South Florida Institute Of Prehistory, Adam Mickiewicz University In Poznań (Poland))
Kamila Oleś (Center For Virtualization And Applied Spatial Technologies, University Of South Florida Department Of Archaeology, Charles University In Prague, Czechia)

In many countries airborne lidar data have been gathered extensively for many purposes and these datasets have been made available at a minimal cost or for free. Hence, the data regarding the location of archaeological heritage have been made easily accessible. This is true even in the countries which used to protect such information, mainly due to a perceived threat from metal detectorists. In the case of Poland, such hobbyist groups did not hesitate and reacted to the accessibility of the data much more quickly than the heritage agencies themselves. As a result, on the one hand, numerous discoveries have been made by non-archaeologists. On the other hand, the vast heritage which has not been yet registered and thus remains unprotected (at least according to the law) is exposed to destruction. A citizen science project aiming to make the best use of the energy of hobbyists interested in the detection of World War II fortifications based on the interpretation of lidar derivatives was proposed. The goal of this paper is to present the structure and potential of the project.

Data Hub for Early Medieval Architecture? Crossing the Borders of an Unfriendly Tradition

Banaszek, Łukasz (Center For Virtualization And Applied Spatial Technologies, University Of South Florida. Institute Of Prehistory, Adam Mickiewicz University In Poznań)
Kamila Oleś (Center For Virtualization And Applied Spatial Technologies, University Of South Florida. Department Of Archaeology, Charles University In Prague)

Architecture historian's toolbox comprises of various stylistic and comparative analyses. On that basis, the origins, function, and chronology of studied object is being determined. Thus, the similarities between objects located in distant lands may be identified, and the processes of transposition and reception of peculiar architectural stylistics may be investigated. As a result, spreading of particular ideas may be studied. However, such approach is affected by the accessibility of selected buildings and documentation. Collecting the iconographic sources (i.e. archival section and detail drawings, and photographs) is time consuming and biased due to various limitations. Therefore, the research on transition of architectural style across historic and contemporary borders is challenging. Spreading of Christianity and state formation in Early Medieval Central Europe is studied by various researchers, including architecture historians. The development of

peculiar forms (e.g. basilica, aula regia) and the use of distinctive building materials caused that these processes may be tackled from the perspective of stylistic and comparative analyses. However, the fragmentation of Central Europe makes such approach biased due to different research traditions. Therefore, a need for unified and accessible database emerges. The aim of this poster is to present initial results showing the potential of the application of spatial technologies in studying architectural remains. Undoubtedly, a data hub comprising the digital information about Early Medieval architecture would be much appreciated to investigate such extensive and complex phenomena. Here, we encourage to create one.

When All Agents Die. Analyzing the Possible Failures of Agent-based Models.

Barceló, Juan (Universitat Autonoma De Barcelona)

When running many times a simulated social scenario, we find often situations in which all agents die, even although the simulated population appears to grow in the first steps. Is this a signal that something is wrong in the computer model or its implementation? We analyze this issue in our computer model of cooperation and cultural diversity among Hunter-gatherers in prehistory. We have calculated more than 11000 possible parameter combinations, taking into account the growth and decay of the population and the availability of resources in the environment. When the initial population is too scarce or too big for the local availability of resources, initial population begins to decrease until it disappears. This can be a very trivial test for the Malthus condition, but we have discovered that there are other important correlations affecting social and political relationships between agents, that should be explored. The paper presents a complete sensitivity analysis of the main parameters of a cooperation model, using machine learning tools to explore some apparent dead ends in the original model, relating those simulated results with ethnoarchaeological data from Patagonia

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The Streets of Timbuktu Old Town. Moving Goods, People and Ideas on the Coast of the Sahara

Baumanova, Monika (University Of Basel, Switzerland; University Of Uppsala, Sweden)
Ladislav Smejda (Czech University Of Life Sciences Prague)
Heinz Ruther (The Zamani Project University Of Cape Town)

Timbuktu is a historic city on the edge of the Sahara that was famous as a major trade centre, ecological crossroads and intellectual focal point of Muslim West Africa at least since the 14th century AD. These characteristics that defined its urban life all took place through interaction and public encounters, which can be characterised in space, and so in many ways Timbuktu was its streets. Limited information can today be

recovered through excavation about the past of the town given the difficult environmental and political circumstances. Our paper aims to contribute to how the characteristics for which the town was famous could have been distributed in space. Towns of trade and learning are always major meeting points. Using GIS, satellite photos and spatial integration analysis we examine under what spatial terms these encounters of people, goods, traditions and ideas could have taken place and determined the configuration of the city. We investigate the spatial layout of the Old Town to learn about the ways it mediated interaction of residents and travellers and how it fitted in the overall picture of African pre-modern urbanism.

Virtual Reality and Storytelling for Viking Archaeology

Beale, Nicole (Centre For Digital Heritage, University Of York)
Gareth Beale (Centre For Digital Heritage, University Of York)
Julian Richards (University Of York)
Dawn Hadley (University Of Sheffield)
Jonathan Hook (Department Of Theatre, Film And Television, University Of York)
Guy Schofield (Department Of Theatre, Film And Television, University Of York)

The emergence and increasing use of mixed reality and interactive media for cultural heritage has opened the door to new forms of interpretation and visitor experience. However, the development of experiences which are compelling, appropriate and sufficiently robust for use in a museums setting has been challenging. The DiNAR project (led by researchers from the University of York's Centre for Digital Heritage and Digital Creativity Labs in collaboration with staff from York Museums Trust) was set up in order to address these challenges and to develop creative strategies for the use of virtual and mixed reality within cultural heritage contexts. This presentation will describe the development of virtual reality experiences for the Yorkshire Museum's upcoming Vikings exhibition. The VR experience will enable users to become visually and acoustically immersed in a series of dramatic scenes based around the winter camp of the Great Viking Army at Torksey in AD 872-3. The presentation will explore some of the dynamics of storytelling in VR and the unique possibilities and challenges associated with storytelling in this medium. It will also examine practicalities involved in the integration of these technologies within a museum exhibition including issues of robustness, sustainability and ongoing impact.

Influence of Differences in Digital Elevation Models and their Resolution on Slope-Based Site Catchment Modelling

Becker, Daniel (Institute Of Geography, University Of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany)

Christian Willmes (Institute Of Geography, University Of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany)
Andreas Bolten (Institute Of Geography, University Of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany)
María De Andrés-Herrero (Neanderthal Museum, Talstraße 300, 40822 Mettmann, Germany)
Gerd-Christian Weniger (Neanderthal Museum, Talstraße 300, 40822 Mettmann, Germany)
Georg Bareth (Institute Of Geography, University Of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany)

Digital elevation models (DEMs) are essential input data for slope-based modeling methods, such as site catchment modeling. Slope works as the main input variable for these cost distance modeling (CDM) approaches and is derived from such DEMs. Therefore, it is of key importance to know about the implications that a decision for a specific DEM has on the results of the modeling process. Nevertheless, this topic is often neglected in this kind of studies. We show which quality components of a DEM are the most critical in this context and we present methods (qualitative methods, descriptive statistics and geostatistics) and exemplary CDM results (site catchments) in a selected area on the Iberian Peninsula to evaluate the differences in the data. The inspected DEMs include ASTER GDEM2, SRTM at 3 and 1 arc-second resolution, the EU-DEM and a 5m high resolution DEM from the Spanish National Geographic Institute. The presented approaches and results should be generally applicable if a decision for a specific DEM has to be made in the context of CDM.

Digital Documentation of Masada Fortress in Israel: Integrated Methodologies of Survey and Representation

Bercigli, Monica (Università Degli Studi Di Firenze, DIDA-Dipartimento Di Architettura)
Stefano Bertocci (Università Degli Studi Di Firenze, DIDA-Dipartimento Di Architettura)

The communication and representation strategies are changed a lot during last years because of sociological, economic and cultural changes of society. The connection between architectural work and individual has evolved in step with the technological development and the digitization of information, and also because of this relationship there were significant advances regarding the arrangements for the dissemination of knowledge about the heritage and the possibility to conserve the documentation and essentially of the "memory". Today, the public wants to feel part of this process and the use of specialized software allows the creation of new storage systems and data management, and provides unusual keys of reading of the information. This paper describes the interaction between complex sets of data acquired with 3D Laser scanner and camera and its dissemination through virtual representation systems. The experimental research conducted on the case study of Masada fortress in Israel, explains how the "migration" of data of reality in a virtual environment depends strongly on the structure of an efficient procedural process and the proper use

of available technologies. Digital tools today allow to create customized and open-ended knowledge systems which the user can interface with the elements of the space around him and have an interactive approach and more conscious about the archaeological heritage.

Migrant Farmers and Indigenous Foragers: Evaluating and Understanding Conceptual Models of the Neolithization of the West Mediterranean with a Spatially Explicit Agent-Based Model

Bergin, Sean (School Of Human Evolution & Social Change Arizona State University)

During the sixth millennium BC, agriculture spread across the west Mediterranean with unusual speed and by way of obscure mechanisms. The spread of agriculture is easily one of the most significant and complex events in human prehistory; yet, the spread of agriculture in the west Mediterranean is not as well understood as other regions in Europe. All too often, archaeological models are created to account for the current evidence at the time of their inception and are rarely tested with new evidence. This research uses a spatially explicit agent-based model to compare four influential models that have been proposed for the Impresso-Cardial Neolithic spread in the west Mediterranean: The Wave of Advance model, The Capillary Model, The Maritime Pioneer Colonization model and the Dual model. Paleoenvironmental conditions are also included in the simulation to better inform prehistoric migration choices and to better understand what environmental conditions may have been important to prehistoric farmers. The outcomes of these simulations are compared to the chronological evidence of the initial Neolithic dispersal as a way of evaluating the fit of each conceptual model.

Temporal-GIS Tools for Mixed and Meso-scale Archaeological Data

Beusing, Ruth (Römisch Germanische Kommission Des Deutschen Archäologischen Kommission)

Starting new research projects ideally require research on data collection from different sources and with variant penetration range. Different case studies collecting diachronic data have been processed with different sets of temporal GIS tools. Temporal GIS tools usually cannot be readily used in archaeology since the presence of uncertainty on both the temporal and the spatial scales, especially in cases of mixed databases mentioned above, have to be taken care off. Typically, the temporal information arises from chronometric dating methods, such as radiocarbon dating, dendrochronology or other natural scientific variable dating methods (e.g. phytolith, liquid pitch etc.), which produce estimated rather than exactly known dates. Dating based on typo-chronology, coin circulation or site-based relative chronologies raise not more but similar difficulties. Moreover, spatio-temporal analyses face the whole impact of paleo-spatial uncertainties in past

landscapes, which have to be considered not only in on-site-analyses but also have an impact on meso-scale analyses. This means that in order to reliably make inferences on either or both of the space and time scales, carefully devised models are needed, that take account of the uncertainty and provide probabilistic solutions to the questions posed. Deterministic approaches as well as stochastic models have been applied by researchers working on such problems, e.g. to represent the spread of populations across landscapes without formally fitting them to different available data or to represent changes in space and time. The presented examples try to be aware of known problems and limitations but uses an empirical-probalistic approach.

An Analytical Stereoplotting Workflow for Archaeological Excavation: Reviving a 20th-century Photogrammetric Technique for the 21st.

Bevan, George (Dept. Of Geography And Planning, Queen's University)
Jones Kristen (Queen's University)

Photogrammetry has rapidly become a standard documentation technique in archaeological excavation over the last decade. While offering great benefits, including low-cost, field-portability, and photo-realistic textures, the outputs of dense-stereo matching, either a point-cloud or a mesh, are themselves not yet accepted as final deliverables for archaeological reports. Publication still requires 2D drawings, and with good reason; drawing itself constitutes an intense period of study and reflection on the excavation and should not be quickly discarded in favour of new methods. We propose a combined analog and digital approach to archaeological recording using photogrammetry, and illustrate its application during the 2016 season of excavation at Stobi in the Republic of Macedonia. Rather than drawing from cross-sections of point-clouds, the technique in common use today, we show instead that Analytical Stereoplotting, a method that can be traced back over 100-years to its first uses in the making of topographic maps from stereo pairs of aerial photos, combines the best of manual drawing with photogrammetry. With the advent of inexpensive stereo-display hardware, we show that drawing directly onto oriented digital stereo pairs using 3D glasses offers a more natural and accurate way to create archaeological plans that is closer to manual drawing. As will be shown, however, Analytical Stereoplotting does not work well with the short-baseline and high-overlap "Structure-from-Motion" imagery commonly collected today.

Some Considerations on Semi-Global Matching for High-Accuracy Heritage Recording Applications

Bevan, George (Dept. Of Geography And Planning, Queen's University)
Jason Birch (ADAM Technologies)

Semi-Global Matching (SGM), an algorithm for dense stereo matching first published by in 2005, has been widely adopted by archaeologists, whether intentionally or not, through an implementation in the popular Agisoft Photoscan package. SGM offers considerable advantages in so-called "Structure from Motion" (SfM) photogrammetry, where large numbers of images are taken, often with short baselines, poor quality or adverse look-angles, and little or no prior effort is made to ensure proper network design. SGM, when compared with the older technique of Least-Squares Matching (LSM), can generate matching points on surfaces angled away from the camera, and on surfaces with very little texture,. This means that, when meshed, visually pleasing surfaces, especially when textured, can be generated from large unstructured image-sets taken by operators with little or no knowledge of the underlying principles of photogrammetry. Despite these considerable advantages, there remain serious, unresolved drawbacks that need to be recognized by all users of SGM, especially those in heritage and archaeology, especially when compared with LSM. Many of these problems stem from the fact that SGM is not inherently capable of sup-pixel matching, is prone to high-levels of noise, and is computational very demanding. These issues are usually concealed from the end-user by image-resampling, and local smoothing during dense matching and meshing. Photogrammetry users would do well to ask whether their application demands the (relatively) smaller number of accurate points generated quickly by LSM, or the large number of inaccurate points generated by SGM over much longer compute-times.

Survey, 2D and 3D Modelling of the Roman Nymphaeum in Amman: a Multilateral, Cooperative Research Experience

Bianchini, Carlo (Sapienza Università Di Roma)
Mohammed El Khalili (Hashemite University – Queen Rania Faculty For Heritage And Tourism)
Nizar Al Adarbeh (American Center For Oriental Research)
Alekos Diacodimitri (Sapienza Università Di Roma)

The Roman Nymphaeum is certainly one of the most relevant monuments of present Amman and, in the Ancient Philadelphia, an outstanding example of this particular roman structure devoted to the cult of the Naiads, the Fresh-Water Nymphs. Presently "besieged" by contemporary Arabic city, the Nimphaeum (as well as other roman remains nearby like the Theatre, the Odeon, the Forum) has been put under protection and inserted in a program aiming at preserving, restoring and eventually valorizing its relevant remains. Right in this context has found its place the joint activity we are going to show in this paper carried out by an international team made of Jordanian and Italian researchers. The relevance of this experience, quite apart from the application of the usual 3D capturing technologies, must be found in two different but complementary aspects: • the innovative use of the point cloud as base for orthophotos aiming at pushing the resolution of these images to the limit of the cloud itself. In this framework "giga orthophotos" have been produced and widely used especially for the 2D models' construction. • the cooperative workflow between the

team in Jordan (responsible for most of the capturing campaign) and the italian team that has mainly worked on the modelling phase (2D , 3D) But beyond these "usual" achievemnets, the project has directly addressed the issue concerning the impact of such initiatives not only in terms of capacity building but also of public social awereness raising thanks to specific dissemination/communication activities.

Tradition and Hi-tech in the Construction of a Total Model: The Complex of Pietrabbondante

Bianchini, Carlo (Sapienza Università Di Roma)
Alessandro Viscogliosi (Sapienza Università Di Roma)
Giorgia Potestà (Sapienza Università Di Roma)
Gaia Lisa Tacchi (Sapienza Università Di Roma)

Archaeology has largely profited of the technological innovations introduced by the so-called digital revolution. The core of this completely new way of collecting, storing and interpreting information is certainly the digital model. It can be simply regarded as the “container” of this information but, conversely, also the “portal” for its exploration and eventually extraction and production of content. In this framework, models are becoming increasingly wide and complex, showing a clear tendency towards completeness that, even if unreachable, still appear quite a shared perspective among researchers. Multidisciplinarity, contamination of skills, multisided approach are actually the “meta-requirements” of this challenge that we will try to discuss presenting our work on the archaeological site of Pietrabbondante (Italy), an important italic site marked by the complex theatre-temple that together constitute a peculiar structure. Most of the archaeological material derives from XX century excavations and only a limited part of the original complex has survived (part of the theatre and the temple basement) and almost no trace of the temple’s original design and decorations. The study has then aimed at applying a “total modelling” approach (3D/2D/1D) to the site by: • documenting and normalizing information obtained from previous excavation/study campaigns; • acquiring with 3D capturing technologies the present structures (3D scanning, SfM) • collecting as much as possible of the available sources about the complex also with reference to similar structures; • building a 2D and 3D basic geometric models • providing, finally, a 2D and 3D model of the most probable reconstruction hypothesis.

Moving Forward with Digital Databases: Current Opinions and Potential Solutions

Bischoff, Robert (Brigham Young University)

The use of online databases to distribute primary archaeological data has increased in the U.S., but progress is still limited. Funding and data standardization are the primary obstacles. Examples of progress include requirements by the National Science Foundation (NSF) and the National Endowment for the Humanities (NEH) to include data management plans as part of grant applications. The appropriateness of the data management plan is decided by archaeologists during the review process. The U.S. based Open Context and the Digital Archaeological Record (tDAR) are both referenced by the NSF and NEH, but data is not required to be made accessible online. I conducted a survey of professional archaeologists in several states in the western United States asking whether they used online databases and their opinions on topics related to online databases. In this paper, I present the results of the survey, review literature regarding the use of online databases, and present potential ways to increase the use of online databases to disseminate archaeological data. Almost all survey respondents believe data should be shared publicly, but only half use online databases and fewer are willing to use funds to make data available online. The majority of surveyed archaeologists also support data standards. Data standards would increase data integration, but would need to be limited and flexible in order to incorporate various research designs and regional differences.

Social Networks of Mission Santa Catalina de Guale: Comparing and Contrasting Unimodal and Bimodal Approaches

Blair, Elliot (University Of Alabama)

Social networks are metaphorically and formally powerful tools in exploring past socio-material relationships. Formal approaches using social network analysis (SNA) are complicated by practical and structural considerations that affect how the model is constructed. In this paper I present a series of social network visualizations looking at connections between individuals and glass trade beads circulating within Mission Santa Catalina de Guale, a 17th century Spanish mission located on St. Catherines Island, Georgia. The networks presented were constructed using mortuary data and glass compositional analyses on objects recovered from burial contexts at Mission Santa Catalina. Here, I discuss the methods used to construct these models, and more specifically, I compare and contrast the unimodal and bimodal social networks of the Santa Catalina cemetery, focusing specifically on the ontological strengths and computational weaknesses of the bipartite model.

Lessons Learned From Teaching and Training with the Digital Archaeological Archive of Comparative Slavery (DAACS)

Bollwerk, Elizabeth (Thomas Jefferson Foundation, Inc. Digital Archaeological Archive Of Comparative Slavery)

Lynsey Bates (Thomas Jefferson Foundation, Inc. Digital Archaeological Archive Of Comparative Slavery)
Leslie Cooper (Thomas Jefferson Foundation, Inc. Digital Archaeological Archive Of Comparative Slavery)
Jillian Galle (Thomas Jefferson Foundation, Inc. Digital Archaeological Archive Of Comparative Slavery)

The Digital Archaeological Archive of Comparative Slavery (DAACS) is a Web-based initiative designed to foster inter-site, comparative archaeological research on slavery throughout the Chesapeake, the Carolinas, and the Caribbean. Our goal is to help scholars from different disciplines use archaeological data to advance our historical understanding of the slave-based societies that evolved in the Atlantic World during the colonial and ante-bellum periods. In addition to providing training on historical material culture, an important part of DAACS's mission is to increase digital and data literacy among our community of users. DAACS has sought to engage this challenge in three ways: 1) by clearly explicating the rationale and goals of our data entry protocols and PostgreSQL database to our users 2) by conducting workshops that help scholars and students engage with digital data and learn more about the process of creating standardized and reproducible open data and 3) by providing hands-on material culture training to ensure accurate and reliable artifact identifications and data generation. This talk describes these efforts and discusses four critical lessons that have significance beyond this project.

"I Don't Want to Set the World on Fire": Ruin Interactions and Attitudes in Fallout 4

Booker, Emily (Brown University)

Video games are a popular form of media, with over 155 million gamers in America today, and they thus serve as a unique way to analyze how pop-culture can influence public perceptions of the past. The player's ability to move through, interact with, and have an effect on virtual environments creates intimate, complicated relationships with virtual materials, including artifacts and ruins, that can have real-world effects. Although aspects of archaeology are often included in video games, the discipline is not always portrayed as scholars would like. However, as problematic as games like Tomb Raider or Uncharted might be, they are quickly becoming a key way in which the public learns about and interacts with archaeology. This paper will explore the ways the popular 2015 game Fallout 4 shapes ruined landscapes ('ruinscapes') for specific thematic purposes that ultimately influence player interactions with ruins in both the virtual and real worlds. To do this, I will create a walkthrough exploring the ruinscapes of Fallout 4 and consider how the game's strong themes of anti-capitalism and relative morality can create biases and preconceptions of Mid-Century Modern ruins. Games like Fallout 4 are extremely popular and consumed by millions of gamers worldwide. Video game analysis is an essential element to understanding current public perceptions of ruins and, more generally, archaeology. By considering the representation of virtual ruinscapes and how their thematic underpinnings can affect popular attitudes towards ruins, archaeologists can become better equipped to engage with public audiences.

New Methods for Visibility Networks in Landscape Archaeology

Brandes, Ulrik (University Of Konstanz)
Tom Brughmans (University Of Konstanz)

The representation and study of visual properties as network data is largely restricted to studies in cognitive science, architecture, geography and archaeology. Different network science methods are used in these disciplines to study and represent a very diverse range of phenomena. Despite this strong diversity of topics, only a very small range of network science techniques has been used to study the properties of visibility networks, scholars' assumptions about how lines-of-sight affect human behaviour and the impact of uncertainty. In this paper we argue that a number of the hypotheses landscape archaeologists formulate about how lines-of-sight could have affected past human behaviour can be appropriately studied through visibility networks, and we present network science techniques for representing such hypotheses. After a multi-disciplinary review of visibility network studies, we present new network data representations as well as propose configurations that can be used to represent and study dependence assumptions in landscape archaeology. A range of network science methods will be proposed to study the properties of these networks, to identify the frequency of configurations in observed networks, and to compare observed networks with models representing different assumptions of visibility network creation. Particular emphasis will be placed on probabilistic approaches to assessing the impact of uncertainty in the visibility network. These methods will be illustrated through a brief case study of intervisibility networks of long barrows in Cranborne Chase (Tilley 1994).

The Characterisation Hypothesis for Scientific Metallurgy: Classes of Structure in Chemical Datasets and their Visualisation

Bray, Peter (School Of Archaeology, University Of Oxford)
Mark Pollard (School Of Archaeology, University Of Oxford)

It is striking to compare typologies of metal object form with typologies of metal object chemistry. Typo-chronologists are happy recognising that forms are a loose proxy for date, with many other social and technological processes conflating to produce a shape. While many authors who discuss chemical composition would not recognise "typology" as describing their work. Instead there is a strong assumption that the structures found in chemical datasets are 'true' in some sense, and map simply to geological and technological datasets. This paper will discuss initial efforts to move away from these "provenance and technology" statistical approaches. We have proposed a set of more open classification, characterisation and visualisation approaches for the chemistry of early metals, which allow the identification of overlapping processes of use, re-use, mixing, recycling, design, and accident. Of course, this approach is also not 'true' but finds different

emphases in the same data. This paper will discuss the range of options that are now available to archaeometallurgists after 150 years of research. Can using other archaeological datasets help explain why we get different results using different mathematical approaches? And what are effective and reasonable ways of visualising and communicating these different options?

VR:TA - A Virtual Reality Toolset for Archaeologists

Bremer, Thomas (Professor Of Game Design VR Studio Department Of Culture & Design HTW Berlin - University Of Applied Sciences)
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Timo Falke (VR Studio Department Of Culture & Design HTW Berlin - University Of Applied Sciences)

The Virtual Reality Toolset for Archaeologists (VR:TA) is a collection of packages to support better exploration and examination of archaeological assets in interactive Virtual Environments (VE) based on small- and large-scale 3D-scan data. With these packages, we aim to take advantage of new opportunities offered by VR technology to allow scientific research not easily achieved with traditional media. This paper gives an overview of the VR:TA and describes two packages of our toolset in detail: the measurement tool and the sky tool. We show that for high-complexity 3D-scan assets, our measurement tool in combination with the usage of 6-DoF controllers in VR can create a substantial benefit when creating detailed measurements at multiple scales. The sky tool provides the ability to interactively adjust the time of day using real time global illumination. Also, it allows to adjust the night sky with correct constellations of stars and planets based on star catalogue data at user-defined dates and locations. Apart from these two packages, we introduce a 3D user interface for locomotion and navigation within archaeological VEs. The VR:TA was already evaluated using both a 3D-scan of the Temple of the Storm God in Aleppo and a 3D-scan of an excavated skeleton.

The Prado Muses - Rethinking the Unity of a Statue Group with the Help of 3D Models

Brennan, Matthew (Indiana University School Of Informatics And Computing)

This paper examines a group of eight Ancient Roman sculptures in the Prado Museum. According to the museum, the sculptures were found at Hadrian's Villa and represent a nearly complete sculptural cycle. Some

scholars have used literary sources to cast doubt on the claim that the eight statues belong to the same sculptural cycle from a single ancient context. Using the 16th century drawings of Maarten van Heemskerck, as well as 3D models of the sculpture in the Prado, this paper demonstrates that a fundamental assumption made by the Prado Museum in their attribution of the eight marble sculptures to a single ancient group is, in fact, incorrect. This paper also demonstrates the power of 3D models when used alongside traditional methods of art historical analysis, and the potential in 3D models of aiding new insights. No longer must the art historian study the piece of art in person: they can now use an accurate simulacrum to the same ends, without the barriers of travel costs, institutional permissions, or technical limitations.

Photomodeling for Rapid Documentation and Survey of Complex Urban Spaces and Archaeology

Brennan, Matthew (Indiana University School Of Informatics And Computing)
Bernard Frischer (Indiana University School Of Informatics And Computing)

Photogrammetry, or Photo-modeling, has long been used for aerial survey of landscapes, and, more recently, for the digitization of small artifacts such as archaeological trenches, sculpture, and buildings. Highly accurate, large-scale survey of urban environments, however, has remained the domain of traditional survey methods using laser scanners and total stations, likely due to the complexity of the environments, need for geo-referencing, and centimeter-accuracy. This paper uses as a case-study the photogrammetrical documentation of a complex urban environment, including exteriors, interiors on multiple levels, and an archaeological site to demonstrate photo-modeling's suitability for the rapid and accurate survey of complicated environments. Carried out over the course of one working day in the summer of 2016 as part of Bernard Frischer's "Meridian of Augustus" project, the survey resulted in a highly accurate 3D visualization of an urban street, the interiors of multiple structures and courtyards, basements and associated sub-basements, as well as a preserved archaeological trench, all linked together into a single 3D model that can be viewed on the web. The survey was conducted by a single photographer using terrestrial hand-held photogrammetry and consumer-level photographic equipment. The resulting accuracy of the model, based on preliminary calculations is at most, a pixel size of 2mm and a pixel resolution of 0.5 pixel per mm. A more detailed discussion of pixel accuracy and the overall accuracy of the resultant model will be included in the final paper. This case study shows the effectiveness of photo-modeling not only in the documentation of complex environments, but also in their visualization and dissemination.

The Archaeological Data Lifecycle

Brin, Adam (Arizona State University)
Francis Pierce-McManamon (Arizona State University)
Leigh Anne Ellison (Arizona State University)

Archaeologists have long understood the importance of preserving artifacts from survey and excavation contexts so that future researchers could re-examine these data. Sadly, this practice has not extended to digital data. At a time when other fields (e.g., astronomy, bio-medicine, climatology, etc.) are adopting policies and mandates to connect accessible digital data files with published works (e.g., arXiv, Dryad), archaeologists have been slow to see the benefits of preserving the full archaeological record, digital as well as physical. Our concept for the discipline of archaeology adapts a Data Lifecycle model, common in data management and digital repository arenas, to map the landscape of digital archaeological data and practice. We focus on the steps within three stages in the data lifecycle, which also are key aspects of the practice of archaeology – the Research Process, the Publication Process, and the Curation Process. We highlight seven phases, or kinds of activities involved in these processes: Create, Publish, Preserve, Curate, Discover, Access, and Use. Framing the overall research process into these seven phases allows us to identify gaps in the creation and care of digital data, which suggest needs or opportunities for the discipline to improve.

The Challenges of Open Access for Archaeological Repositories

Brin, Adam (Arizona State University)
Francis Pierce-McManamon (Arizona State University)
Leigh Anne Ellison (Arizona State University)

Our six years of operating a digital repository for archaeology has led us to grapple with a number of challenges in providing open and accessible data. The Digital Archaeological Record (tDAR) generally operates as an open access repository, complete openness is not fully realized because the community, including academic, CRM, and government archaeologists has not fully embraced access without restrictions. A range of challenges to openness remains. US laws strictly limit the sharing of site location and other sensitive information (ARPA) to protect sites from looting. Other challenges are fundamentally social. Researchers may consider their data unworthy or unready for distribution or publication because of less than ideal data quality or documentation, or because they intend to publish more on it. Open data can also pose challenges to researchers who attempt to use it too. It may not be adequately documented, or may reside in formats that are difficult to use, e.g. RDF and JSON (as compared to CSV). To be effective openness, requires both a high level of discoverability and models of citation that appropriately credit the data producers. tDAR was designed with the goal of addressing many of these issues, improving discovery, documentation, citation, translating data in proprietary formats into open formats, and providing tools for users to query and interact with data. Furthermore, by providing frameworks and tools to address the legal and other concerns related to data, we seek to provide an environment in which data can live, thus increasing the likelihood of sharing.

Everything Wrong with Exploratory Network Analysis of Archaeological Similarity Networks

Brughmans, Tom (University Of Konstanz)

The most common use of network data in archaeology represents sites as nodes and similarities between site assemblages as edges. Such archaeological similarity networks are commonly explored statistically and visually. But what determines the usefulness of such exploratory approaches? When does a network representation of similarities of site assemblages allow archaeologists to do things they could not have done through other methods? In this paper I will provide examples of my own uninformative use of this approach, how it did not lead to new insights and can be considered in retrospect an unnecessary investment of my time. However, I will argue that this approach still has great potential in archaeology if archaeologists link their theories more explicitly to network data representations. The formal representation of theorised relationships in archaeological similarity networks will enable the archaeologist to better identify those particular exploratory network analysis techniques that have the potential to lead to new insights.

Structure-from-Motion (SfM) – a Reliable Survey Tool for Archaeology or an Unreliable Black-box?

Bryan, Paul (Geospatial Imaging Team, Historic England)

A look at SketchFab or other online platforms for publishing and sharing 3D data reveals an array of 3D models relating to archaeology. These are increasingly generated using Structure-from-Motion, a survey tool that combines multi-image, convergent and multi-view stereo approaches, due principally to its affordability and accessibility into photogrammetry based workflows. This typically results in 3D content that's interactive and visually appealing but beneath the textured cloak how accurate is the derived data beneath and can it be relied upon for other archaeological applications beyond on-line viewing? This paper will consider the increasing application of SfM across all scales of archaeology and report on projects undertaken by Historic England using SfM, laser scanning and combinations of the two. However as the quality of any photogrammetrically derived output is almost wholly dependent on the quality of the inputs, it will consider the effect sensor size, image resolution, camera configuration, depth of field and control can all have on the SfM process and reliability of results. It will also reference published metric survey standards from Historic England that now include SfM techniques and new technical guidance on multi-image photogrammetry, due in April 2017, that's intended as a guide to the basics of applying photogrammetry across archaeological applications.

Sailing with the Gods: Argonauts and Samothracians in an Ancient Sea

Bryant, Robert (Emory)
Sandra Blakely (Emory University)
Joanna Mundy (Emory University)
Cole Furrh (Emory University)

The goal of the Samothracian sailing simulation is to recreate the ancient social networks of Greece through the lens of the maritime infrastructure as a video game. How did maritime trade affect the societies of the Mediterranean and their interaction? By reconstructing the physical landscape of the ancient Mediterranean in the Unity3D game engine, we can study the behavioral patterns and decision making of contemporary human beings as players when placed under the same stressors and variables as their ancient Greek mariner counterparts. With this data we hope to bolster the existing social network analysis of the area with quantitative human behavior. This data is gleaned by tracking all player interactions of sailing and trading through the simulated environment to search for patterns that help explain ancient analogs. The game also serves as a ludic and pedagogical experience for the players through attached myth and literature that act as the narrative for the world. Currently, we have a working and very functional prototype already tested in a classroom of 60+ students. By the time of this conference, the prototype will be finished with plans for expansion. https://scholarblogs.emory.edu/samothraciannetworks/the-game/play-the-game/

Publishing an Archaeological Excavation Report in a Logicist Workflow

Buard, Pierre-Yves (MRSH, USR3486)
Elisabeth Zadora-Rio ()

The logicist programme, which was initiated in the 1970's by J.C. Gardin, aims: first, to clarify the reasoning processes in the field of archeology; second, to explore new forms of publication, in order to get over the growing imbalance between the flood of publications and our capacities of assimilation. The logicist programme brings out the cognitive structure of archaeological constructs, which establish a bridge between empirical facts, or descriptive propositions, at one end of the argumentation, and interpretative propositions at the other end. This condensation process opens the way for alternative forms of publication, designed to speed up the assimilation of the chain of inference and the consultation of the database on which it stands. In this paper we propose a new publishing workflow respecting the principles of the logicist programme. We show how texts are encoded using XML markup in accordance of TEI recommendations. We explain how the relations between propositions are markup as hypertexts references with simple qualification. Next, we describe how to extract the overall organization of the interpretation process from the XML tree as RDF triple by extrapolating from relations links. We also show how to produce an overview diagram representing

the interpretative process. Our experiments on the digital publication of the Rigny excavation show that our workflow can provide different levels of access to the content, allowing both speed-reading and in-depth consultation.

Ancient Landscapes and Present-day Agriculture – On the Example of Tejen River (Turkmenistan)

Buławka, Nazarij (Institute Of Archaeology, University Of Warsaw Krakowskie Przedmieście 26/28 00-927 Warszawa (Poland))

This paper concerns the recent approach and issues in the studies of oases watered by Tejen, which is the third largest river in Turkmenistan. The territory includes the Serakhs oasis and Tejen alluvial fan. The archaeological research conducted in delta of Tejen River since the 1950s has revealed the existence of settlements dated to Aeneolithic-Early Bronze Age, but the knowledge of other periods is still fragmentary. The better recognised part, Serakhs oasis, has been studied by a Polish team for more than 20 years. The intensive field survey campaigns revealed here more than 150 sites of different periods. The implementation of mobile and desktop GIS has made it possible to address different questions concerning the settlement pattern of the areas. The collected satellite imagery, digital elevation data, topographic maps and the vector data allow us to study the irrigation, as well as the ancient and recent occupation, of the areas in more detail.

3D Models for Curatorial Dialogue and Undergraduate Education

Burns, Bryan (Wellesley College)
Jordan Tynes (Wellesley College)

3D models of Greek and Roman marble sculpture at the Davis Museum of Art at Wellesley College have enabled new dialogues between curators, faculty, and students about the best approaches to the treatment and exhibition of challenging works. High quality, scale models created with a Artec Spider handheld scanner are easily manipulated and distributed, to enable viewers' consideration of a sculpture's fine details and varied condition. We have found student engagement to thrive through this increased accessibility and control over individual works, especially as a supplement to direct autopsy. The freedom to consider works from numerous angles is critical for fragmentary pieces, such as a marble head disassociated from the body that originally anchored its position, and has greatly informed our discussion of optimal position for display. Using a model in conjunction with x-ray imagery of a heavily restored portrait, we can also simulate the appearance of the face after the removal of its modern restorations. Students have also put the Wellesley artifacts in communication with relevant works in other holdings, thanks to the increasing availability of

similar models of ancient sculpture. A further opportunity to engage student work has been created by placing the models in an augmented reality HoloLens application. This device allows viewers to position numerous virtual models within a real physical space, thus curating their own exhibition of artifacts that can be shared with others.

Excavation Progress and Artifact Manipulations in a Virtual Environment

Burns, Bryan (Wellesley College)
Jordan Tynes (Wellesley College)

We are currently exploring new possibilities for presentation and analysis of the ongoing excavation at ancient Eleon in Boeotia (Central Greece) by positioning 3D models in the Unity game engine and experiencing them through the HTC Vive VR platform. Work focused on a group of Early Mycenaean tombs (ca. 1600 BCE) was recorded with drone imagery that enabled the creation of photogrammetric models using Pix4D software. This daily record traced the progress of excavation, enabling analysis of the built environment as recovered at various points of work. The HTC Vive headset allows viewers to experience the excavation area as a physical space of individual tombs within a larger architectural complex. Within this environment, users can also manipulate 3D models of artifacts set in the place of their discovery. Other models, created with various scanning technologies, are reconstructed for the game engine and can be "used" as tools in their original context (e.g., simulated liquid within fragmentary, but virtually restored vessels).

Diversity from the Bottom Up: Modeling Cities as Communities of Diverse Households

Cabaniss, Andrew (Interdepartmental Program In Classical Art And Archaeology)

Community diversity defines urbanism. As a city's population grows in number, the community grows more diverse economically, socially, and behaviorally. Computational approaches to ancient cities must consider diversity an intrinsic part of community structure and account for how it changes through time in order to model longer term dynamics at the community and regional levels. By investigating households as entities of production and consumption responsible for embedding their activities in particular settings, community heterogeneity can be inferred from the material remains of houses. Computational techniques help infer how sampling and partial evidence affect the appearance of variation in archaeological material, and can improve the inference of urban characteristics and dynamics. In this paper, the polis of Metaponto is examined in order to understand household behavioral diversity as it changes through time and as successive waves of expansion and contraction alter the composition of the city and countryside. Information-theoretic inference techniques and multidimensional clustering are used to estimate measures of behavioral diversity and model

changes through time, enabling the behaviors of individual households to be linked into the regional dynamics visible from the extensive survey data.

3D Printing and Augmented Reality: Integration, Methods and Communication for Cultural Heritage.

Caldarone, Adriana (Department Of History, Representation And Restoration In Architecture, Sapienza University Of Rome)

In the last years there has been a revolution in the use of cultural heritage: the user looks for exciting experiences and a "contact" with the site. So, we have to propose innovative means of communication and learning to meet these changing needs, both in research and in terms of documentation. The field of archeology provides new ideas for research in this field: the three-dimensional reconstruction of historical buildings involves the ludic sector, and it is also effective for the diffusion of the historical sites. The paper aims to promote a methodology that begins from the reconstruction of documentary and archaeological sources, it shapes a three dimensional model and prints a real prototype. Physical quality of the printed object can be perceived better and offers both a visual and a tactile approach; from this point of view it is possible to go through all the attractions related to the content of the work. The possibility of integrating the physical object with augmented reality systems (ARtag), appears to be today the innovative field of research of this methodology. Also, this system makes possible an immersive perception of the site. Disclosure moves from the bidimensional area into the three-dimensional reality of space that surrounds the "observer".

In Search of the People Who Lived Here Before: From Historic to Prehistoric Significance at a Tennessee State Historic Site

Cannon, Cayla (East Tennessee State University)
Eileen Ernenwein (East Tennessee State University)
Jay Franklin (East Tennessee State University)

Carter Mansion is a State Historic site where Tennessee's oldest frame house, built in the 1770s, still stands. Tourists who visit the site learn about Tennessee's history, but little about who lived there prehistorically. We know from surface artifacts and decades-old excavations that the site also holds a prehistoric component, which may be vital for understanding Native American settlement and coalescence in the region. Our research in the broader region suggests that there may be a significant piece of Cherokee history here; more evidence is needed. Thus, we set out to examine the site with funding from the Tennessee Historic Commission. Our goals were to use geophysics and targeted test excavations to (1) evaluate an existing map

of the historic structures that have since been lost and determine their level of preservation, (2) search for evidence of prehistoric occupation, particularly houses and associated features of habitation, (3) locate unmarked prehistoric and historic graves, and (4) to determine a suitable location for the repatriation of previously excavated human remains. This required careful survey of the property in 10 x 10 m squares in order to navigate around the mansion and other landscape features. Ground-penetrating radar proved to be especially useful, allowing us to differentiate between prehistoric and historic occupations and identify burials.

Unscrambling the Egg: Quantitative, Assemblage-based Component Consociation Methods for Densely Mixed or Disturbed Contexts

Cardinal, James (New York State Museum)

Stratigraphic mixing is a common scenario, whether in densely layered multi-occupation sites or site contexts that have undergone significant post-depositional disturbance. These scenarios are especially common for later historical sites and for cultural resource management contexts. The obfuscated assemblage content of mixed components frequently reflects multiple subsets of temporal sequences and/or areas of activity, rendering the assignment of component consociations for interpretation of chronology and site integrity difficult. This paper presents a set of methods, in part derived from gene co-expression network analyses, to discern diagnostic artifact subsets within the mixed assemblages and thereby infer pre-taphonomic consociations and contexts. These methods allow not only a quantitative evaluation of stratigraphic integrity, but also automate the assignment of component consociations for further spatial analyses.

Problems Concerning Elaboration and Representation in Italian Rock-hewn Architecture

Carnevali, Laura (Sapienza University Of Rome. Department Of History, Representation And Restoration Of Architecture.)
Marco Carpiceci (Sapienza University Of Rome. Department Of History, Representation And Restoration Of Architecture.)
Andrea Angelini (National Research Council Of Italy. Institute For The Technologies Applied To Cultural Heritage)

Rock-hewn architecture represents the compromise between the rules governing the architecture of the built and those involving the sculpture. Aim of the research was the classification and the survey of some case studies of the Italian rock-hewn architecture, performed with the range-data system by the research unit of the University of Rome Sapienza (DSDRA). Unlike Cappadocia, the Italian rock-hewn architecture differs in two important features: most of the case studies are not completely excavated and often they re-use existing

natural cavities, subsequently anthropized. The second aspect is represented by addition of constructive elements within natural cavities. The detailed analysis of the research has been carried out on the Benedictine Monastery of Subiaco in Rome. The presence of built structures together with those excavated suggested a different methodological approach concerning the elaboration step of the survey pipeline. The excavated parts, that presented a non-geometric morphology, were drawn with the same system of the "contour lines" (equidistant flat polylines) used in Cappadocia project. The constructed parts were elaborated generating a suitable geometrical model from which edges, outlines and apparent outlines of the surfaces were detected, like in the traditional approach of the architectural representation. The coexistence of these two different way of representation allowed to describe exhaustively the Italian architectural complexity. The results (plans, fronts and sections) shows the traditional architectural semiotics, defined by sections, edges and apparent outlines, and the proposed procedure characterized by the equidistant flat polylines.

Survey, Representation, Analysis and Cataloguing of the Rock-hewn Architecture in Cappadocia

Carpiceci, Marco (Sapienza University Of Rome)
Carlo Inglese (Sapienza University Of Rome Department Of History, Drawing And Restoration Of Architecture)
Andrea Angelini (National Research Council Of Italy. Institute For The Technologies Applied To Cultural Heritage)

Since 2013, under the national project PRIN 2010, the research unit of the University of Rome Sapienza performed the survey of the rock-hewn architecture in Cappadocia. The main activity was focused on the churches and the monasteries of two important archaeological areas; the Open Air Museum in Göreme and the village of Sahinefendi. The research concerned the acquisitions on the field, the problems of data processing and their cataloguing and management. According to the typological, formal, geometrical and decorative characteristics of the rock-hewn architecture the aim of the research was the elaboration of a large amount of range-data but also their analysis and classification. Several acquisitions were performed with range-data system (laser scanner) on different types of structures such as cave churches, monasteries and other monuments. The complex morphology and the geometry of the rock-hewn architecture suggested an innovative methodology of representation, based on the principles of the Cartography. In fact this is able to provide the depth in bi-dimensional representations. For that reason the research group proposed the development of the plans, fronts and sections through the use of "contour lines" at a specific equidistance. This innovative representation satisfies the metric rigor of the data avoiding interpretative processes that alter the morphological characteristics of the subject. For instance, the use of different colors for the plans allows to display simultaneously more distribution levels, thus highlighting the vertical connections.

Identifying Social Learning Mechanisms in the Amphorae Production within Roman Empire

Carrignon, Simon (Barcelona Supercomputing Center)
Maria Coto-Sarmiento (Barcelona Supercomputing Center)
Xavier Rubio-Campillo (University Of Edinburgh)
José Remesal (University Of Barcelona (CEIPAC))

The aim of this study is to analyse social learning patterns within amphorae production among workshops in the Roman Empire. Cultural evolution is applied to our study to understand the implication that this production might have on the evolution of social learning of potters. In particular, we can detect some differences in the making techniques processes through time and space that might explain this dynamic of change. However, different debates revolve around how individuals or groups acquired and transmitted techniques skills. Our case of study has been focused on the evolution of the production of olive oil amphorae found in Baetica province from 1st to 3rd century AD. We propose an Agent Based Model using concepts borrowed from studies on cultural evolution to compare different processes of transmission and accumulation in different contexts. To do so the model implements a simple mechanism of pottery production and different social learning processes under different geospatial and cultural constraints. We then use Approximate Bayesian Computation to select among different combinations of parameters of our model the most suitable to reproduce the variation observed in the real data. This analysis provides an useful baseline for the exploration of the social learning processes related with amphorae production in the Roman Empire. We believe that the framework presented here can be used in a diversity of scenarios to better understand the links between social learning and archaeological evidence.

The Life of Attributes: Meta and Paradata as 3D Point and Object DNA for Heritage Providence

Carter, William (Ryerson University)

With the proliferation of Heritage based 3D objects in both digital and 3D printed form, object providence is quickly becoming a critical issue with regards to heritage professionals “duty of care” in an Open Access and consumer-cum-producer Internet enabled world. As the fetishization of technology emboldens professionals and non-professionals alike, Heritage assets both digital and physical have come under increasing threat of appropriation, temporal, cultural and historical ambiguity as well as politicization. This paper discusses the novel application and use of 3D point attributes as a means to embed author/creator identifiers such as ORCID into the DNA of 3D model points and polygonal regions. Using actor network theory, can we manipulate point attributes and networks to store not only meta but paradata alongside authorship identifiers

the same way that textures, colours and light properties are shared procedurally when 3D objects are built in virtual space. Additionally, we discuss the potential deployment of Blockchain and CheckSum methodologies to enable accurate object providence while still allowing public and professional dissemination through Open Access platforms.

Making and Meaning-Making in Virtual Archaeology

Carter, William (Ryerson University)

Ingold uses the metaphor of wayfaring to describe the process of making and manipulating the material, and the material in turn manipulating the maker (2011). In this process of making, and as makers who make course corrections at wayfaring points, the decisions made embody elements of power, agency and authority which draws into question the authenticity of the representative virtual form created. Here artisans, or craft persons, are defined as makers who deploy their accumulated knowledge through reflexive application to the physical, material and materiality of the making process. As such, as a virtual artisan wayfarer, archaeologists embody and assert a technical, creative and archaeological "expertise." This creates a unique perspective to archaeological meaning-making that requires archaeologists to be reflexive of the power, agency and implicit authority naturally embed in the process of making within virtual space. Thus as wayfaring artists, archaeologists need to transparently negotiate the process between virtual builder, viewer and archaeologist, in order to reveal the "continuous correcting" that occurs as decisions are made virtually through making and meaning-making within virtual archaeology. Ultimately, the aim is to enhance understandings of archaeological meaning-making and knowledge construction as applied to and revealed by virtual visualization and the physical interaction of the material record.

Advancing Methodologies for Archaeological Aerial Thermography

Casana, Jesse (Dartmouth)
Austin Hill (Dartmouth)
Elise Laugier (Dartmouth)

Experiments dating back to the 1970s show that a wide range of archaeological features, including subsurface architecture, earthworks, pathways, and artifact concentrations may be visible in an aerial thermal image if it is acquired at an optimal time in diurnal cycle and under favorable ground conditions. In many cases, aerial thermography can rival other geophysical datasets in terms of feature visibility while being acquired at a fraction of the time and cost, yet technological hurdles have largely prevented it from being deployed in most field settings. However, recent research has begun to take advantage of lightweight, uncooled thermal cameras, increasingly sophisticated drones, and powerful photogrammetry software—a set of technological

developments that are collectively revolutionizing archaeologists' ability to deploy aerial thermography. Utilizing data collected in surveys of archaeological sites in North America and the Middle East, this paper presents new methods for acquisition and processing of aerial thermal imagery, highlighting both opportunities and challenges. Because we use a radiometric camera system that collects raw thermal imagery at very high spectral resolution, results offer many possibilities for quantitative, raster-based methods to filter out noise, improve feature recognition, and perform archaeological feature discrimination. Our findings reveal a great deal regarding the varied archaeological sites investigated by this project, and offer researchers a powerful but underutilized method to explore the archaeological record in a way that is rapid, inexpensive, and non-destructive.

The CORONA Atlas Project: Orthorectification and Analysis of Declassified, Cold War-era Satellite Imagery

Casana, Jesse (Department Of Anthropology Dartmouth College)
Jackson Cothren (University Of Arkansas Center For Advanced Spatial Technologies)

Since its declassification in 1996, CORONA imagery acquired from 1960-1972 as part of the United States' first intelligence satellite program has proven to be a powerful resource for archaeological research in many parts of the world. Because it provides high-resolution, stereo views of the entire globe from a half-century ago, CORONA preserves a picture of archaeological sites and landscapes that have often been destroyed or obscured by urban expansion, agricultural intensification, and reservoir construction. Despite its demonstrated value, challenges involved in orthorectification of the unusual cross-path panoramic cameras employed by CORONA satellites have long presented an obstacle to more widespread use of the imagery by archaeologists and other researchers. The CORONA Atlas Project, funded by the NEH and the ACLS, is producing an open-access digital atlas of corrected CORONA imagery, and has also developed an online tool called Sunspot that enables researchers to spatially correct their own imagery with relative ease. This paper presents an update on the status of the expanding global CORONA Atlas Project and an introduction to the Sunspot system, as well as highlighting a series of upcoming workshops and other online resources for CORONA-based archaeological research.

Digital Demotic: Opportunities and Challenges

Casey, Christian (Brown University)

One of the biggest hurdles to the future of language studies in Egyptology is the difficulty of encoding Egyptian texts. However, ongoing work on Unicode support for Egyptian hieroglyphs promises to eliminate

that format's shortcomings and offer a quasi-universal standard for Egyptian. The study of Demotic texts faces an even bigger problem: no encoding exists whatsoever. It may seem obvious to suggest a Unicode encoding for Demotic to complement the latest developments in the encoding of Egyptian, but this is easier said than done. Despite its similarity and deep relationship to the Hieroglyphic and Hieratic scripts, Demotic presents many unique challenges to anyone attempting to codify it. As a result, an encoding of Demotic must gracefully navigate many serious pitfalls, such as the need to be useful to those who specialize in the study of palaeography and the evolution of writing, while serving primarily to represent the script in standardized manner so that data can be organized and searched. This paper offers tools for encoding Demotic texts, which depend on multiple computational methods working in concert. The process of collecting original manuscript data and the algorithms that make this possible will be described in detail. Also, several methods for inputting Demotic text and identifying Demotic signs will be discussed in the hope that input from the scholarly community will identify the best solutions to this complex problem. Upon completion, all materials from this project along with software for digitizing Demotic texts will be made available online.

An Analysis of Selected Variables that Affect the Production of Cost Surfaces

Caswell, Edward (Archaeology Department, Durham University)

This paper will demonstrate the variability in catchment areas that are produced through changing selected variables within the tools available to produce cost surfaces in ArcGIS and QGIS across ten case study zones in Britain. It will demonstrate a computationally efficient way of creating reciprocal cost catchments for large areas. There are numerous computer packages that allow the creation of cost surfaces and least cost paths at the "push of a button" (ArcGIS, QGIS which uses GRASS for its spatial analysis and Idrisi). However, this is often to the detriment of hiding the technicalities of the program's method, which may not always be ideal for the purpose intended. Only a few papers exist which are dedicated to assessing the effects of varying any of the modifiable parameters available to each program (Gietl et al 2008, Magyari-Sáska, et al 2012, Herzog 2014), however, these studies focus only on a limited selection of variables. As such, there are few guides in selecting an appropriate methodology, despite frequent mentions that pre-prepared systems should not be overly relied on. This paper aims to address this issue by building on those works that do exist through research that has been systematically exploring the differences in cost surfaces produced when varying the following parameters: • GIS package (ArcGIS and QGIS). • The resolution of the Digital Elevation Model. • Cost components (slope and terrain). • Algorithms simulating human movement.

Walking Across Beach Sand is Hard and Other Discoveries: First Results of Assessing the Time Cost of Moving Through Various Terrains

Caswell, Edward (Archaeology Department, Durham University)
Michelle De-Gruchy (Durham University)
James Edwards (Department Of Mathematical Sciences, Durham University And Department Of Mathematical Sciences, University Of Bath)

This paper presents wholly new friction co-efficient data for six terrain types found in Britain and the means by which this was recorded. These data measure the cost of human travel in terms of time for ten participants that covered a range of ages, sexes, heights and fitness levels, the first study to do so. Few studies have calculated the relative difficulty of walking across different types of terrain (e.g., grass, asphalt, loose sand, and so on). Nonetheless, we show that these relative values, called terrain coefficients, are integral, alongside slope, for generating computer models of human movement, whether for emergency planning, development, archaeology, the impact of ecological change on migratory patterns or any other purposes. Additionally, the few studies conducted evaluate this relative difficulty through metabolic rate measured through oxygen consumption, or through the use of heartrate monitors. This paper demonstrates that these values are only appropriate for energy-based models (e.g. easiest routes), because it is unlikely that the relationship between metabolic rate and velocity is linear even when terrain is held constant. Rather, our work (returning to four terrains from these earlier studies and adding three additional terrains) has found the effects of terrain to be smaller with statistical significance occurring on an entirely different scale from previous studies. Therefore, these terrain coefficients should only be used for time-based models (e.g., fastest routes).

The Giusso Castle and the Foundation Area of Sicignano degli Alburni (SA). Survey and 3D Modeling for Social and Territorial Valorization Strategies

Cennamo, Gerardo Maria (Università Telematica Internazionale UNINETTUNO)

This paper, part of a larger research program of the Faculty of Engineering in the International Telematic University UNINETTUNO, aims to document, through the survey as main instrument, a path of knowledge about the fortified architecture known as Castello Giusso and its surrounding area, with the ruins of the church of San Matteo Apostolo ed Evangelista. The site is the primitive nucleus of the town, developed in the Middle Ages under the castle and the patronal church as long as existed. The first step has been the survey: the Giusso castle is a vast and articulated architectural complex. For the morphological conditions, advanced technologies were used and therefore the decision to operate with the laser scanning to acquire the measurement of the surfaces. A laser scanner able to acquire reliable data even at various distances was used, creating computer scans of considerable weight. The processing of data (still in progress) has the main aim to create different 3D models: the survey model is essential to obtain a thorough knowledge of the architectural heritage; the stratigraphic model is useful to define the development of the castle in the different age; the virtual reconstruction of the site at the date of the XIX century offers us the vision of the original

morphology with the Church of San Matteo Apostolo ed Evangelista. The castle and the archaeological area around it is an important resource to a sustainable development of the whole town.

Re-Evaluating Settlement Population Estimation: An Analogue-Based Method for Modeling Patterned Variation in Population Density

Cesaretti, Rudolf (Arizona State University, School Of Human Evolution And Social Change)

Population estimation is an intrinsic component of regional settlement pattern analysis because demography provides a basis for inferences about social organization. Most archaeologists employ either 'raw' proxies (e.g. site area) or constant (i.e. "average") population density figures to model site populations. Both of these methods assume that population is directly proportional to archaeological proxies, such that population density is constant. Like settlement patterns themselves, the theoretical basis of archaeological population estimation is ultimately rooted in our understanding of modern and historical analogues. However, closer inspection of these analogues reveals that directly proportional relationships do not characterize regional settlement demography. Instead, population density varies systematically with settlement size and type, in-turn exhibiting regionally-specific density trends and patterns of variability. This finding highlights the pressing need for new population estimation methods that can model variable density patterns based on theoretical expectations, but are also sufficiently flexible incorporate empirical patterns in the archaeological data. To address this problem, a regression-based method is proposed that models the population of archaeological sites from the statistical relationships among a controlled ethno-archaeological analogue case. This method is then evaluated in a case study on the Late Aztec Basin of Mexico, which showcases its versatility as well as its ability to allow empirical patterns in the survey data to emerge.

PublicVR and its Relevance to 3DVR and Virtual Heritage

Champion, Erik (Curtin University)

This paper will explore the design and use of four of the six PublicVR models (Gates of Horus, Egyptian Oracle, Virtual Egypt Temple, Pompeii) which are available on the http://publicVR.org website. The site is managed by Dr Jeffrey Jacobson, based on his research and consultancy projects, featuring Unreal Tournament and Unity. The presentation will review not only how Dr Jacobson has used and designed them for archaeology, education and heritage purposes, but how the models could be used for other projects, and how these projects can be viewed in light of the general advances and restrictions of other well-known virtual heritage projects. References Gillam, Robyn Adams, and Jeffrey Jacobson, eds. 2015. The Egyptian Oracle Project: ancient ceremony in augmented reality. London: Bloomsbury. Note: The presenter has written

publications with Dr Jeffrey Jacobson and has been on the PublicVR advisory board but was not involved directly in the creation of these projects.

Erasing the Garden City: Interpolation of Architectural Volume from LiDAR Derived DEMs

Chase, Adrian (School Of Human Evolution And Social Change, Arizona State University)

LiDAR data collection has greatly advanced survey research in Maya archaeology. LiDAR has facilitated the digitization of muliple archaeological feature types in GIS databases. Digitizing features in GIS platforms automatically provides area and perimeter measurements; however, volume requires additional calculation. This research describes a method for volumetric analysis of digitized features using the vectorized features and the LiDAR-derived DEM. In essence, the archaeological features are digitally removed from the landscape, then an interpolation algorithm allows for reconstruction of an unmodified landscape in their place. This anlaysis compares several interpolation methods with archaeological feature types to determine the best interpolation method for identifying feature types at the Late Classic period Maya city of Caracol in modern Belize. The method facilitates quick processing of the garden city features of Caracol: the storage capacity of residential reservoirs, the modficiation of hillslopes for agricultural terraced fields, and the aggregate volume of architecture required to create the plazuela groups of residential housemounds. Each of these three features factor into the residential cityscape of ancient Caracol. Volume helps compare inequality within household construction, availability of water for use in the dry season, and the amount of labor required to create the vast system of agricultural terraces. This GIS algorithm allows for fast and automated volume measurement of each digitized feature by reconstructing an unmodified landscape and contasting that with the LiDAR-derived DEM to facilitate additional research.

The Archaeological Park of the Porto of Traian: Knowledge, Preservation and Fruition

Chiavoni, Emanuela (Universita' Sapienza Di Roma)
Daniela Esposito (Department Of History, Drawing And Restauration Of Architecture)

The archaeological park of Porto is an area particularly rich naturalistically. It has long been a number of research projects by leading Italian and foreign archeology universities focused on the development of a European model of enhancement of cultural heritage. After the construction of the Port of Claudius in 64 AD, it was built a new harbor basin by the Emperor Trajan in Rome for the increase in supply needs and the new port, hexagonal, was connected with a new river channel Tiber to facilitate the transfer of goods in Rome. Currently the coast is about three kilometers from the old plant, which is located in a strategic

position with respect to Fiumicino Airport. Northeast archaeological area, situated in the commercial heart of the old city, between the hexagonal basin and the route of the output channel, there is the early Christian basilica founded in the fifth century. Most of the eastern sector is occupied by a large space that once again the bulk of the large entrance channel to the Port and the remains of the great Trajan warehouses. This archaeological site is a treasure of unique value to be explored in an interdisciplinary way with new sophisticated tools and analysis technologies and important for the knowledge, conservation and enjoyment. All new digital survey techniques in fact allow you to acquire heterogeneous data, material and immaterial for the construction of models that lead to storing large amounts of information to disclose the complexity of the archaeological areas.

Seymour: Image-based Rendering Solution for High-resolution, Browser-based 3D Graphics

Christiaisen, Leif (PhD Student At Indiana University)

WebGL allows for interactive, 3D graphics to be deployed in modern web browsers but the complexity of the 3D models displayed is still limited by bandwidth and client side processing power. Image-based rendering and multi-resolution streaming have both been presented as solutions to overcome these limitations. Each method has distinct advantages and disadvantages to be considered. In this paper we present Seymour, a new browser based 3D model viewer targeted at users within the cultural heritage community. Seymour is a client-server architecture utilizing image-based rendering. The user interacts with a low resolution model, rotating, translating, zooming etc. On mouseup events a request is sent to the server for a corresponding rendering of the high resolution model. This rendering is then overlaid on the WebGL canvas. The design considerations and architecture of Seymour are fully enumerated and its security demonstrated.

One Step further beyond Field Survey

Chyla, Julia (Antiquity Of Southeastern Europe Research Centre University Of Warsaw)
Miłosz Giersz (Institute Of Archaeology, University Of Warsaw)
Wiesław Więckowski (Institute Of Archaeology, University Of Warsaw)
Patrycja Prządka-Giersz (Faculty Of Artes Liberales, Univeristy Of Warsaw)
Roberto Pimentel-Nita (Antiquity Of Southeastern Europe Research Centre University Of Warsaw)

Geographical Information Systems (GIS), satellite images and remote sensing techniques have given archaeologists a wide range of possibilities in non-destructive site recognition. Furthermore, they play key roles in interpreting and analyzing spatial organization of human behavior in the past landscape. However,

data gathering should not be the sole purpose of archaeological research. Non-destructive field survey was conducted in Huarmey Valley, Peru with the use of mobile GIS. This paper presents use this research as an example of the preparation, gathering and analysis of different kinds of field data. The reinterpretation of the distribution of archaeological sites from the Middle Horizon, based on the results of complex field survey, was an initial step towards developing regional scale patterns. In conjunction, analysis of satellite images and archive photos helped to trace the changes and destruction of sites. This paper stresses the importance of digital data collection with mobile GIS, but also more, how to use them for a certain purpose – for research, planning of future excavations and the protection of the most at risk sites.

A Workflow to Integrate 3D Data Acquisition with Traditional Artifact Study? Lessons from Mouliana

Clinton, Miriam (Rhodes College)

As many scholars working in 3D technology can attest, the archaeological community does not always know how to use 3D models. Often, models are reduced to mere static illustrations, and their capabilities as powerful scientific tools are ignored or relegated to a methodological publication. 3D models, however, have the power to inspire and inform academic debate. Especially in highly traditional fields, though, these capabilities must be presented in a format that is acceptable to both conventional and digital scholars, making for potentially disjointed publications. In summer 2016, the Mouliana Project undertook a new study of artifacts excavated in 1904 and never fully published, with the express goal of giving these important artifacts a scientific review using the latest technology. I supervised the team as we captured 3D data using three different technologies, including LiDAR, photogrammetry, and structured light scanning, while simultaneously completing traditional measurements and creating publication-quality 2D photographs and drawings. Some of this work was redundant, but it was performed to prove the reliability of the 3D technology in a field that does not yet trust it. I present the lessons learned from the 2016 Mouliana Project, offer a suggestion for a workflow for future projects integrating these methodologies, and invite discussions on how best to contextualize the narrative of 3D for a more traditional archaeological audience.

Accounting for Sample Size: Measuring Cultural Distinction through Monte Carlo Approximations of Hellinger Distances

Collins-Elliott, Stephen (University Of Tennessee, Knoxville)

Since Pierre Bourdieu's implementation of correspondence analysis, cultural distinctions can and have been predicated upon quantitative measures of multivariate data. As indicators of specific past practices,

archaeological assemblages of finds can accordingly be compared through categorical distributions of different classes of objects. The issue of sampling size, however, continues to be raised as a way to question the validity of results obtained from quantitative comparisons of archaeological information. In this paper, I offer a way to incorporate information about the size of the sample in obtaining Hellinger distances between categorical distributions, by modelling the acquisition of archaeological finds as an urn problem involving a Bayesian categorical-Dirichlet hierarchy. Monte Carlo methods are then used to obtain values of the measure of cultural differentiation with a credible interval. This method is illustrated using a case study involving ceramic assemblages from Roman Italy (ca. 200 BCE – 20 CE), addressing the issue of cultural change in regional foodways throughout the period of political and social turmoil of the Late Republic.

Reusing Archeological Information to Improve Modeling and Research. An Interoperability Data Schema.

Colobran, Miquel (Universitat Autònoma De Barcelona)
Juan Antonio Barcelo (Universitat Autònoma De Barcelona)
Igor Bogdanovic (Universitat Autònoma De Barcelona)

Currently, archaeological information is stored in digital formats such as excel files, word documents or small and isolated databases. Therefore, there is no way to share information easily. There are no interchangeability platforms, standards and any exchange results in a complicated, if possible, post processing of the information to join two datasets. Computer Science has always had the same big issue of information interchangeability. The problems rely on the interchange format and its structure. The milestone is based on achieving a simple method that permits the reusability of data in any system. A solution consists in a simple text file format with a small known language (tags) and structure. That's how the World Wide Web works. WWW uses the html standard as a data language definition and structure and puts all together inside a flat file. Html, indeed, is the flagship of this model but a more general exists; XML. XML is a software and hardware independent tool for storing and transporting data. As archaeologists we can build and agree our own data structure for data interchange in XML suitable to import/export data from our systems in order to improve information reusability and increase our horizons in research with better data quality and new research questions that could be made with a lot of information in everyone’s hand.

Everything Wrong with Acoustical Modelling

Cooper, Catriona (Allen Archaeology Limited University Of Southampton)

The use of acoustic modelling and the engagement with question of multisensory experience related to studies of the past is beginning to take off. This presentation aims to ask questions about both the methodology used and the theoretical implications of studies of this kind. I am to present for 5 minutes, but may stretch to 7.

Listening to the Commons: Acoustically Modelling the Pre-1834 House of Commons, Westminster

Cooper, Catriona (Allen Archaeology Limited University Of Southampton)

The Virtual St Stephen's project began by creating three dimensional models of St Stephen's Chapel, the first permanent meeting place of the House of Commons. Visualisation, as part of this project, has been used as an interpretative methodology by bringing together research from a wide variety of sources to create a way of engaging with this destroyed space which has been at the centre of British political life for over 700 years. The resulting models not only provide a way of engaging with the destroyed spaces, but can allow a wide variety of data and sources to be brought together and rigorously critiqued. These engagements, however beautiful and impressive, are visual; ocularcentric. In this presentation we discuss the possibilities of moving forward from a visual interpretation of the pre-1834 House of Commons to exploring the potential for creating soundscapes of the same space. Using acoustic technology and the results of the Virtual St Stephen's Project we discuss how the same information has potential to access different experiences and understandings of a space and how it can be applied. In addition, computer based auralisation - the aural equivalent of computer visualisation - enables us to listen to how a space influences the perception of any sound heard within it, and helps to build a more complete multi-sensory representation of a historic environment.

Relocating a Forgotten Asian Market Garden in Historic Perth (1833-1936): Using GIS to Integrate and Interrogate Excavated, Archival and Geophysical Information

Cooper, Lorna (University Of Western Australia)

This project approaches archaeological prospecting by creating a geospatial framework in which to situate archaeological (excavation and the geophysical) and archival (texts, photographs, maps) data relating to a little-known Asian market garden dating from the nineteenth and early twentieth centuries in Dalkeith, Western Australia. The Swan River settlement (1829-1905 CE) is hypothesized to have been more multi-cultural than historic and archival sources have tended to portray. The market gardens were a notable feature of this time, but the identity and contribution of subaltern contributors has been under-emphasized. My approach helps situate this neglected history, which contributed more to the economic and social character of

the area than has been hitherto acknowledged. I have investigated the significant physical changes to the landscape in and around the market gardens and associated Swan River shoreline. I used a combination of geospatial techniques (including georeferencing archival material) and geophysical tools (ground penetrating radar, conductivity and magnetometry) to build a spatial framework, allied to qualitative examination of multiple sources of evidence. This allowed me to interrogate the dominance in the written histories of the initial European settlers in the market gardens and demonstrate the presence of an under-represented Asian market garden history. On a practical level, this spatial modelling provides a method for geospatially referencing diverse data sources, facilitating future research and heritage management.

Privilege and Digital Archaeology

Corley, Hugh (Historic England)

Inherent in any privilege is the disadvantage of others. My privilege, or the unearned advantages of being white, middle-class, western and male like the majority of my colleagues, is the result of factors that I do not control. The many ways I choose to use this privilege are my choice. This paper will consider the impact of privilege within archaeology. How do advantage and disadvantage impact our research, the questions we ask, the success of our projects, how we engage with the public and maintain relevance in a changing world?

Hitching the Right Ride? Concepts and Issues for Developing Automated Object Detection and Image Processing in Remote Sensing Archaeology

Cowley, Dave (Historic Environment Scotland)
Arianna Traviglia (University Ca' Foscari Of Venice)

Recognizing that the development of automated object detection and image processing for remote sensing archaeology has tended to borrow heavily from applications in other disciplines, this paper discusses some of the issues that may arise. These include the challenges of cross-disciplinary working, with its need for explicit terms of reference and terminology to ensure common purpose and effective communication of concepts. In this area of inter-disciplinary working there is also a need to explore the interfaces between traditional ways of doing things – observer-directed survey, observer-driven aerial photo and remote sensing data interpretation – and the potential of automated processing and object detection. Here the explicitness of archaeological understandings of objects and their component parts is absolutely fundamental, and an area where automated approaches present a direct challenge to archaeologists to unambiguously define how they see what they see. Such processes are key to choosing the most productive trajectories for development, built on a shared and clear understanding of founding principles and therefore of what outputs mean in 'real

world' terms. With this approach in mind, the paper aims to introduce the session ‘Automation is here to stay!’ and contextualise current developments in the field of object detection in archaeological remote sensing, providing the basis for further discussion and illustrating trialled approaches.

Analyzing Trophic Networks among the Ancestral Pueblo

Crabtree, Stefani (Washington State University And Université De Franche-Comté)

This paper uses the novel approach of trophic network modeling (food webs) to understand how Ancestral Pueblo people connected themselves into a greater environmental web. I examine key prey species in archaeological assemblages, arguing that changing species composition would have had cascading effects on the environment. This, coupled with natural climatic fluctuations and anthropogenic environmental change increasingly made the Four Corners area of the U.S. Southwest less productive for farming and wild-game procurement. I combine a diachronic examination of multiple archaeological assemblages with a database of every modern non-invasive species and their feeding links in a 4,600 square kilometer area of southwestern Colorado. Common network analyses are employed to examine how humans placed themselves in foodwebs, and how this changed through time. This study is not without its assumptions. I augment the piecemeal data of multiple midden assemblages with data from the modern four-corners region. This assumes that past species and modern species are the same. I explore why these data were substituted. This study is built upon research already completed within my dissertation, but has added in at least 8 additional sites to the data, allowing for more nuanced analyses of common network properties. The data from the four-corners will be compared to datasets compiled in other regions, including the Martu of Australia and the Tlingit of the Northwest Coast, showcasing the comparative abilities of food web analyses.

An Introduction to Modeling

Crabtree, Stefani (Washington State University And Université De Franche-Comté)

In this paper I introduce the original research papers that follow within our session, allowing for a cohesive format for our session.

Communicating Archaeological Research to the Press and the Public

Crabtree, Stefani (Washington State University And Université De Franche-Comté)

Archaeology as a field is interesting to everyone. How many times have you been on an airplane, told your seat-mate you're an archaeologist, and they want to talk to you for hours about your job? Computational archaeology also holds the possibility of relaying incredibly important findings to the public... Yet we are awful at talking to the press. This topic will force us to consider how to boil down our details to talk to a non-specialist, how to advocate for ourselves to approach the press, and why it matters to communicate our results to the public at large.

Unravelling Urban Religious Landscapes: Modelling Processions at Ostia

Crawford, Katherine (University Of Southampton)

Roman religion pervaded the ancient city in terms of its temples, statues, inscriptions, and rituals, all of which helped to construct an urban religious landscape. This landscape, in part, was shaped by the ritual activity of processions that effectively connected religious and urban spaces across the ancient city. The ways in which we can study processions is complicated by their lack of documentation within the archaeological record coupled with fragmented literary and epigraphic accounts. The nuances of how a procession traversed a city's streets and it urban impact are not easily discerned based on existing sources of information. This paper considers Ostia, Rome's ancient port, as a case study to question the ways in which computer modelling can help inform our interpretations of urban processional routes. The application of network and visibility analysis presents one method to study the movement patterns of processions as a dynamic event that engaged both a city's inhabitants and the built environment. Moving beyond trying to reconstruct specific routes, possible variables that affected processional movement are applied within the study to question how religion was disseminated across Ostia's cityscape. The ways in which these models help inform our interpretation of religious landscapes and their challenges will be addressed.

A Landscape-Based Approach Assessing Hominin Occupation and Dispersal in Lower-Middle Pleistocene Central Asia

Cuthbertson, Patrick (University Of Oxford)

The current study addresses issues of hominin occupation and dispersal in Central Asia with a novel landscape-based approach. The study region contains few Lower-Middle Pleistocene dated sites, and the majority of sites identified as Lower Palaeolithic are surface sites. This provides numerous challenges for assessing the position of Central Asia in discussions of Pleistocene hominin dispersal within Asia. Building on Burg's (2013) concept of 'total paleo-landscapes', this study maps the distribution of a variety of resources and resource-proxies across the study region, such as raw material outcrops, groundwater potential, and the

palaeohydrology of the Caspian and Aral seas. In mapping and discussing these resources in combination, and in relation to known sites, this study aims to overcome the limitations of the dataset to provide a framework for understanding the archaeology of the study region in relation to its broader landscape. Results from these analyses are already demonstrating a strong relationship between Central Asian sites and raw material sources, but are also revealing a more complex picture that includes other resources, such as drinkable water. These results provide an important source of information for an area that tends to be neglected in wider discussions of Asian Pleistocene dispersal, but has enormous research potential. This study also aims to provide a scaffold for further research in the area. Burg, M.B., 2013. Reconstructing "total" paleo-landscapes for archaeological investigation: an example from the central Netherlands. Journal of Archaeological Science, 40(5), pp.2308-2320.

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iDAI.field 2.0 - A Modern & Open Framework for Field Recording

Cuy, Sebastian (German Archaeological Institute)
Jan Wieners (University Of Cologne)
Daniel De Oliveira (German Archaeological Institute)

Accompanying and supporting an excavation practically by collecting and persisting excavation data is – concerning the vast diversity of the research subject matter – a challenge which the German Archaeological Institute faces with its software application „iDAI.field". Developed since 2005 as a modular database system, „iDAI.field 1" supported the excavation work in over 35 projects with varying research methods but quickly showed its limits: By grounding its interface, storage and retrieval mechanisms on a proprietary solution, the initial version of iDAI.field isn't able to respond to growing challenges and increased archaeological needs in documenting excavations. In this paper, we present „iDAI.field 2", an ongoing effort to develop a non-proprietary software which enables archaeologists to extensively document their field work. "iDAI.field 2" is based on a highly configurable data model and provides a geographical information system as its main interface to locate and describe excavation artefacts in a comfortable and contemporary way. The application already supports offline editing and server-syncing functionality and aims to establish different data entry and curation workflows by implementing peer-to-peer syncing. Based on standard web-technology it can be run on most modern desktop and mobile platforms and will be available for anyone interested under an open source licence.

Curation at the Sensor's Gaze: Connecting Representation and Performance in Archaeological Visualization

Dallas, Costis (Faculty Of Information, University Of Toronto & Digital Curation Unit-IMIS, Athena R.C)

Archaeological visualization covers a wider span than the photorealistic 3D representation of archaeological sites and landscapes: it encompasses data-enriched maps and plans, diagrammatic models of artefact types, seriations, typologies and stratigraphic sequences, and a diversity of graphic conceptual models of sociocultural phenomena revealed through archaeological investigation. Visualization has been from the outset – as early as Winckelmann, Worsaae and Thomsen – an objectual epistemic practice not an act of display. Viewed as information objects, archaeological visualizations connect different layers of the interpetation ladder, from captured traits of sense data to middle-range theories, and act as boundary objects between compilations and explanations, J.-C. Gardin's two kinds of archaeological constructs. The emergence of pervasive digital curation practice in archaeology is manifested in the increasing colonization of archaeological work by ubiquitous mobile devices, global networked infrastructures, and an expanded digital sensorium for capturing the archaeological record. Its advent brings about new forms of archaeological visualization and marginalizes others. But, given the interactive potential of digital objects, and the rising overlap between data collection and interpretation in digital archaeological work, it also calls for a turn from conceiving archaeological visualizations and associated (meta- , para-)data as 'actuarial records' of what the sensor saw to understanding them as 'epistemic contracts' for scholarly knowledge and cultural meaning-making. I will outline this theorization and assess its implications on the construction of data models and metadata schemas for archaeological visualization, as well as on their affordances for research, scholarly communication and public interpretation.

Making Sense of the Surface: Using Spatial Simulation to Understand Stone Artifact Scatters

Davies, Benjamin (The University Of Auckland)
Simon Holdaway (The University Of Auckland)

Stone artifacts are often used in archaeological interpretations of past human mobility. Proxies that directly reflect movement require an understanding of how their emergent patterning over time relates to movements in the past. This study uses spatial simulation to explore how different combinations of reduction, selection, transport, and discard of lithic artifacts generate patterning in the geometric attributes of surface scatters of stone artifacts, with the aim of developing expectations about human movement and surface record formation. In the simulation, computational agents manufacture simplified versions of cores and flakes, while correlated random walks are used to model different degrees of movement tortuosity between discard events, generating simulated assemblages. Drawing on a case study from arid Australia for comparison, outcomes are assessed using the Cortex Ratio, a geometric proxy used to demonstrate movement at the assemblage level. Results of the initial exploration show that redundancy in movement between discards reduces variability in Cortex Ratios among assemblages, while mean assemblage values can be attributed the relative proportion of artifacts carried into the population versus those carried out. These results suggest that the availability of raw

material is a potentially crucial factor in determining what kinds of movement is visible in surface scatters, and these findings are being used to guide future fieldwork.

The Interpretive Potential of Geophysical Landscape Archaeology: An Electromagnetic Perspective.

De Smedt, Philippe (Department Of Soil Management Ghent University)

Geophysical prospection methods are coming of age as a standard part of the archeological toolkit. Archaeologists, especially in Europe, are more reliant on geophysical data in both developer-led and research archaeology. More recently, archaeological geophysics is bridging the gap between site and landscape through mobile survey strategies. This upscaling renders unprecedented insight into buried archaeological landscapes, but also highlights a number of methodological difficulties inherent to geophysical prospecting. Issues related to the intrinsic natural and anthropogenic palimpsest that determine the observed geophysical responses need to be considered before and after prospecting, and each applied geophysical method has its own interpretive potential and limitation. In this presentation, the interpretive framework that can be provided by geophysical landscape archaeology will be addressed. Starting point will be both small and large scale electromagnetic induction datasets that, through their multi parameter potential (i.e. by recording electrical and magnetic soil properties), offer a good basis to evaluate the level of archaeologically relevant information that can be deduced from geophysical survey results. Through addressing different case studies, the potential and pitfalls of such data are addressed. Finally, it is explored how landscape scale geophysical prospection is shaping the interpretive archaeological framework for future generations

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Applied Technological Approaches in Heritage and Heritage Management: the Black Butte River Mapping Project

Denham, Brian (Sonoma State University)

This research presents the framework of applied technological approaches and highlights the ability of technology to provide solutions to contemporary problems in heritage based research and heritage management. I present the Black Butte River Mapping Project as a case study in mapping in the Mendocino National Forest, in northern California. I will provide a critique of cultural heritage mapping in the project area, and discuss how theoretical perspectives in anthropology have been visually represented in earlier mapping endeavors. These visually represented theoretical perspectives have continued to affect both visual and textual interpretations of sites within the Black Butte River watershed under a prehistoric/historic

dichotomy. Thus, visual interpretations have acted as a catalyst in separating time and space into arbitrary categories, successfully inhibiting interpretations of Native American cultural heritage within the historic era.

Ethics? Ethics? Anyone?

Dennis, L. Meghan (University Of York)

Though (many of) the major professional societies of the archaeological community have determined general standards of acceptable ethical behavior, those standards have not been translated into practical guidelines or implementable policies for digital archaeology. This has left a void in our pursuit of best practices as digital archaeologists, allowing the discipline to grow without critical examinations of the ethical ramifications of our methodological, theoretical, and technological choices.

Data Description and Integrated Study of Ancient Near Eastern Works of Art: The Potential of Cylinder Seals

Di Ludovico, Alessandro (Sapienza Università Di Roma)

The problem of documenting and systematically describing the material witnesses of the artistic cultures of the Ancient Near East is especially urgent, considering the increasing endangerment of the heritage in Wester Asiatic regions. As shown in experiments carried out in the 1960s and the 1970s, there are many factors, which make the task a very challenging one (if not almost impossible) even if one focuses exclusively on specific fields.Despite of this, some sub-categories of Western Asiatic artistic products could be represented and described in open archives in a formal way that would be sufficient for the largest part of the investigations and needs of scholars. The core of this contribution is a wide discussion about the exemplary potential of cylinder seals in this field. Textual encodings, on one hand, and different kinds of presence/absence ones, on the other hand, can be used, as will be shown here, to develop descriptions, classifications, interpretations, and comparisons concerning the representations depicted on cylinder seals. The use of such encodings on specific glyptic categories, like “presentation scenes”, will serve as a concrete example, through experiments in statistical analyses (correspondence analyses and hierarchical classification), and Artificial Neural Networks (SOM, Auto-CM). In these experiments, encoding strategies were preliminary to the data processing, but they have also been the starting point for the systematic description and representation of both the basic data (the artifacts) and the outcomes from quantitative investigations on them.

3D Mapping and Visualizing the Galerie de paléontologie et d'anatomie comparée at the Muséum national d'histoire naturelle, Paris

Du Vernay, Jeffrey (University Of South Florida -- Center For Virtualization And Applied Spatial Technologies (CVAST))

In early 2016 CVAST partnered with the Muséum national d'histoire naturelle, Paris to 3D document the Galerie de paléontologie et d'anatomie comparée with the objective of creating highly accurate and detailed 3D visual representations and maps of the gallery floors and their hundreds of mounted skeletal specimens. To these ends, CVAST captured imagery for photogrammetry model generation and simultaneously utilized two FARO Focus3D X330 terrestrial laser scanners to collect the 3D coordinate data needed to meet these objectives. The complex museum floorplans and the presence of glass and other highly reflective surfaces associated with many of the museum exhibits posed challenges to the 3D documentation effort. This poster details the 3D data collection and processing workflow developed and executed for this project and discusses some of the various challenges that were presented and the ways they were addressed. Additionally, the poster showcases the various 3D-derived products that were created from the collected gallery data, including gallery maps, floorplans, and cross-sections, point cloud animations, point cloud and 3D model representations of individual gallery skeletal specimens and exhibit cabinets, and associated metadata.
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Evaluation and Enhancement of the Virtual Experience: The Case Study of the "Reviving Karanis in 3D" Project

Elgewely, Eiman (Faculty Of Fine Arts , Alexandria University, Alexandria, Egypt.)

The core objective of the "Reviving Karanis in 3D" project, which started in 2013, was reflecting on the spirit of the place and time of the ancient Greco-Roman town of Karanis as a model of coexistence and interference between Egyptian, Greek, and Roman arts and cultures. Positive results were achieved by the project due to utilizing state-of-the-art digital visualization tools and incorporating various sources of information accumulated through decades of research in an integrated virtual 3D model thanks to the open-source culture, especially in light of working with a minimal research budget. Enabling the project for evaluation by random users drew attention to some drawbacks that are currently being developed to achieve a more successful virtual experience, which is the main focus of this paper. Computer games have become part of the culture of our time, leading to a high level of user expectations from the virtual environments regarding realism, immersion, and interaction. Among the issues discussed here are the contrast in the degree of photorealism between the "hand-made" 3D modeled architectural environments and the photogrammetric

3D models of archaeological finds, the missing connection between the built structures and the urban and environmental surroundings, the inconsistency between the data from the old archaeological recording and the recent digital surveys and 3D documentations, and the absence of the representation of non-tangible elements that help to engage more senses such as hearing and smelling.

ArchaeoSTOR: A User-friendly Archaeological Database

Elliott Smith, Rosemary (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)
Taylor Harman (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)
Carolyn Breeze (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)
Thomas Levy (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)

Cultural heritage sites around the world are under threat; it is vital that these sites, their history, and their artifacts be preserved for future generations. In this paper we describe a newly developed digital curation tool: ArchaeoSTOR. ArchaeoSTOR is a web-based database for the storage of cultural heritage data. Designed as a research tool, ArchaeoSTOR allows for the secure storage and analysis of artifact metadata, location data, photographs, and even point cloud data. First developed in 2013, recent enhancements of ArchaeoSTOR funded by the University of California (UC) Office of the President's Research Catalyst Award have focused on improving the usability of the application, aiming to make it streamlined for efficient use in research. This database has the capability to function in the field as an independent server, making it a versatile tool for data collection in remote areas. Further, as ArchaeoSTOR is being developed for use by multiple UC campuses and their unique projects , it is an exploration into the adaptability of SQL databases to archaeology—a discipline in which standardization in documentation methods has remained elusive.

3D Modeling to Reconstruct a Paleontological Site: Museum of Casal de' Pazzi in Rome

Empler, Tommaso (Sapienza University Of Rome, Department Of History, Representation And Restoration In Architecture)

Today, 3D modeling allows to perform sophisticated reconstructions in the field of Paleontology: until not long ago, these could only be obtained by means of traditional techniques and drawings made by hand. An interesting methodological application was employed for the Museum of Casal de' Pazzi in Rome; 3D modeling enabled to reconstruct, starting from the discovery of some bones, a copy of the "ancient elephant ", "Uro" and "Neanderthal"'s man. Modelling is performed with the help of scientific data and with the expertise of Paleontology and Anthropology experts and teachers. 3D models are completed with the "sculptured surfaces" technique; in addition to allow an improved image of the shape and appearance of animals that lived

there, models are subsequently used for multimedia and interactive communication, describing the history of the place on which the Museum is located.

Epigraphic Interoperability in/of Encoded Ancient Texts: Some Principals and Deliverables at the Current State of our Encoding Schemes Based on an Encoding of Quadrilingual Vase of Darius I and Some Prospects for the Future

Eraslan, Doğu (École Pratique Des Hautes Études)

The current panaroma of encoding schemes for ancient languages being rather diverse, we begin by emphasizing the problems arousing from this diversity for ancient historians working on multilingual documents. The principal problem is the incapacity to incorporate the same level of interpretation represented by the encoding regarding the physical document. Though in theory encoding schemes represent the text by using the most elementary unit as their starting point, most of the time their most elementary unit doesn't correspond to the same entity in the physical document. From a purely philological standpoint this may not be considered as an issue, but from an epigraphic standpoint this creates a serious obstacle for handling the multilingual documents or multilingual corpora in a unified way in the long run. What are our options then to ensure this interoperability ? A unified encoding grammar for ancient languages, i.e. Epidoc or something based on it. What are the current deliverables provided by the use of Epidoc on multilingual documents? Capturing syntaxical influences of languages on each other, unified prosopography for important persona, unified data structure for facilitating theme based research. What are some of the prospects to ensure epigraphic interoperability? Instead of trying to encode the "text/word/letter/sign" we should concentrate on trying to encode the "line", the elementary measurable unit of that which is participating to the constitution of a geometric interpretable entity.

3D-models in Archaeology

Eriksen, Kristin (NTNU University Museum)

I want to discuss everything that is wrong with the use of 3D-models during and after archaeological excavations. 3D-models just for fun, or why are we making them?

3D Ground Truth: Integrating Above Ground Photogrammetry, Ground Penetrating Radar, and Subsurface Laser Scans of a Medieval Tunnel, Mourjou, France

Ernenwein, Eileen (East Tennessee State University)
Jeremy Menzer (University Of Arkansas)

The term “ground truth” is often used in geophysics to imply that excavating an “anomaly” will reveal the ultimate truth about what produced it. What is actually found is often less satisfying than anticipated. The Chestnut House site in the Cantal region of France provided an opportunity to truly ground truth GPR data. Two medieval tunnels were discovered there in 1998. Both tunnels are largely inaccessible due to modern collapse, but one can still be partially accessed from the surface. Ground penetrating radar and electromagnetic induction were used to more precisely map and identify the extent of the tunnel system. Photogrammetry was used to map surface relief, which was used to topographically correct the GPR data. In addition, a portion of one tunnel that is still accessible was scanned with a Leica C10 laser scanner. The topographically corrected GPR data were compared to the tunnel scan to evaluate how it was detected, or not, by GPR. Additional unknown tunnels in the survey area were also discovered.

Implicit Gender Bias? What’s that?

Ernenwein, Eileen (East Tennessee State University)

According to the Gender Bias Learning Project (genderbiasbingo.com), there are four patterns of gender bias: (1) “Prove it again!,” in which women holding historically male jobs must prove their competence over and over again, whereas men are presumed to be competent simply by their title; (2) The “maternal wall,” a belief that mothers are less committed to their job and should take on a motherly, service-oriented role in the workplace; (3) “gender wars”, where women who conform to gender stereotypes are pitted against women who fill traditional male roles and thus break that mold, and (4) the “double bind,” where women have to between being liked and being respected, but can rarely be both. Gender bias persists among women and men in American culture. It has been suggested that gender imbalance is in the process of working itself out because more women than men are getting college and graduate degrees, but this will not automatically solve the problem because women are just as likely as men to be gender biased. The problem is cultural, and the solution is education and outreach. Implicit (unintentional) gender bias is pervasive among students, faculty, and professionals in the sciences and more broadly, but awareness and repeated reminders go a long way.

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10 Years of Online Archaeological Databases - Revolution, Convolution, Evolution

Eve, Stuart (L - P : Archaeology)
Guy Hunt (L - P : Archaeology)
Michael Johnson (L - P : Archaeology)

Jessica Ogden (L - P : Archaeology)
John Layt (L - P : Archaeology)

10 years ago at CAA in Berlin we introduced the Archaeological Recording Kit (http://proceedings.caaconference.org/paper/09_eve_hunt_caa2007/). When we first started work on ARK the Web was a very different place. Our revolutionary ideas for our new system envisioned an openness and transparency that would adapt to archaeologists needs and become a community platform, in many ways this has been a great success. Over the years as ARK has continually developed to keep up with web technologies that constantly come and go, the back- and front-ends have in some cases become convoluted and over-complicated with necessary short-cuts and code forks to make a 2006 code-base work on the 2017 web. The same story is true for many online archaeological projects over the past decade. We have now begun work on ARKv2 - our attempt to completely re-factor the ARK database onto a modern framework with the aim of drastically improving database performance, ease of maintenance, the introduction of an API allowing development of tools external to ARK on multiple platforms. We give an overview of how this process has been managed to maintain both the core ARK premise alongside the necessity for a radically more rigorous and agile database implementation. We compare ARK to to other long-running archaeological databases and track the revolutions, convolutions and evolutions and how the lessons learned can be used to change and improve digital archaeological recording.

How Waterloo was Won

Eve, Stuart (L - P : Archaeology)

The Battle of Waterloo (1815) as well as being the turning point in a huge European struggle has been the subject of a number of computer games. These range from the innovative turn-based mechanics of Mirrorsoft's Amiga game - Waterloo (1989) to the sophisticated and highly graphically appealing Napoleon:Total War with a vast number in between. However, none of these games allow for a detailed examination of the individual parts of the highly complex battle, mostly focusing on the wider strategy of the day. The charity Waterloo Uncovered is currently excavating at the battlefield in Belgium and uncovering new information every year about the minute details of the day of the battle. Our current focus is the struggle for Hougoumont Farm and we are discovering how the micro-topography, architectural structures and even the types of plants in the gardens would have affected the soldiers and how they moved and fought on the day. We would like to see how a gaming engine and game mechanics could be used to investigate this - charting the fall of musketballs (and comparing them with the recovered remains), simulating the visual and physical impact of hedges and ditches, and even modelling the build-up of dead bodies on the field and how they would have affected movement, morale and the will to continue the fight.

Least Cost Path Modelling: Computing Functional Correlations in Chacoan Road Systems

Field, Sean (University Of Nebraska-Lincoln (MA Student))

The road systems that connect Great Houses throughout the larger Chacoan landscape (U.S. Southwest) have been postulated as both phenomenological and functional pathways. Pathway modelling, specifically Least Cost Path Analysis (LCPA) is employed here to assess functional components of roadways throughout the Chacoan landscape. Two methods are employed to identify ancient roads: 1) modern high resolution imagery supplied by a NASA DEVELOPER project and 2) photogrammetric models generated from high altitude aerial imagery taken in the 1990s by pilot Jacob Smith III. These imaging sources are also employed to create higher resolution DEM's to increase accuracy for the modelling procedures. LCPA's are applied on multiple scales, comparing short segment near distance travel between proximal Great Houses, and long distance travel between Chaco proper and the peripheral communities. Discrepancies between these modelled paths and the actual road locations, as well as their contribution to our understanding of functional facilitation of the roadways, are examined. Further, I will discuss and analyze the benefits of re-writing Tobler's algorithms to model the portage of roofing timbers to better represent ancient human movement practices in the Chaco region. The archaeological (or anthropological) significance of these results are considered in relation to theoretical issues in modelling efficient human movement, and the applicability (or lack thereof) of computationally representing actions that may not have been primary considerations to past populations.

Drawing, Survey, Measure to Analyzing the Reliability of Photomodelling for Cultural Heritage

Filippucci, Marco (University Of Study Of Perugia)
Fabio Bianconi (University Of Study Of Perugia)
Sofia Catalucci (University Of Study Of Perugia)
Gianluca Rossi (University Of Study Of Perugia)

Many measurements techniques have been proposed and used for the "digitalization of things": laser scanner, high resolution camera, depth cam, thermal-cam, structured light 3D scanner, hyper-spectral sensor, multi-spectral cam, … Since the adoption of the European Agenda for Culture in 2007, heritage has been a priority for the Council's work plans for culture, and cooperation at European level has advanced through the Open Method of Coordination. Political interest at EU level has steadily grown cultural and heritage stakeholders recently highlighted in the Declaration on a New Narrative for Europe: "Europe as a political body needs to recognise the value of cultural heritage". Photomodelling is one of the contemporary frontiers of research applied to the conservation and promotion of cultural heritage, an extremely economical technique for the expeditious restitution of reality, which leads to the creation of three-dimensional models starting from the

simple acquisition of photographs. Aim of the research is to understand the full potential offered by these instruments, analysing the reliability of each software, with particular attention to freeware ones, and results. An analytical comparison between photomodelling and laser scanner, tested in the relief of the "Doccione di fontana" of Galleria Nazionale dell'Umbria, guarantees a first measure of the reliability of instruments. The comparison of the models is explained using two different criteria, a spatial one and a surface one, comparing the reference mesh and extrapolating the data relating to the distribution of deviations between elements that compose models.

Models and Parameterization of the Five Orders of Architecture

Filippucci, Marco (University Of Study Of Perugia)
Fabio Bianconi (University Of Study Of Perugia)
Federica Magi Meconi ()

The architectural orders have always occupied a key role in architectural doctrine. During the Renaissance, after the rediscovery of the Vitruvian text, all of the most famous architects gave their own interpretation about the Orders composition and proportion. By a careful analysis of some of main Orders treaties, in particular the works of Vitruvius, Alberti, Vignola and Palladio, it was necessary to determine a unified interpretation of the Orders genesis and to create a digital single model that could be declinable in various versions. By the most advanced digital techniques it was possible to generate a representative algorithms like a basic structure that could be modified using different parameters. Therefore, the Classical Order can be analysed studying the geometry and the measure, then the symmetry in the classical meaning of proportion relations. The results achieved are related to the relief and knowledge scope, they are also important for the direct comparison between authors. The algorithms may also support accurate representations and interpretation of the actual artifacts form, useful to hypothesize the author's style by a comparing with the classical manuals and, in case of restoration, to operate in a consistent way. The applications of the results are many and open to the field of virtual reconstructions that could be very useful for the archaeological study: indeed the theme could be extended to the constructional and architectural rules of classical offices, to create probable digital versions of classic building from the remains.

A "Digital Divide": Working to Close the Gender Gap

Fischer, Lisa (Jamestown Rediscovery Foundation)

CAA has always been a very welcoming organization as is demonstrated by its commitment to encouraging participation among students and young scholars. Yet a majority of the leadership roles, at least over the past decade and likely longer than that, have been occupied by men. As a woman who has been on the CAA

steering committee in both the role as a conference organizer and as a chair of a national chapter, I do not believe this gender gap reflects an active attempt to exclude women from leadership positions within the organization. Instead it is indicative of fewer women being available or volunteering for consideration. This position paper will seek to examine some of the reasons why women are less likely than their male colleagues to take on these roles. It will also discuss ways to encourage more women not only to join the organization, but to be more actively involved in CAA at both the national and international levels.

KORA: A Digital Repository for Cultural Heritage Collections

Foley, Catherine (Michigan State University)

For the past two years, a team of archaeologists, a digital librarian, a web designer, and programmers has collaborated on the Archaeological Resource Cataloging System (ARCS). ARCS, funded by the National Endowment for the Humanities, is a project to develop an online collaborative workspace to organize and use digitized archaeological documentation. The Michigan State University based ARCS team, under the leadership of co-Principal Investigators Drs. Jon Frey and Ethan Watrall, has leveraged open source digital tools to create the ARCS workspace. This paper focuses on one of these tools, KORA, a digital repository application built by MATRIX: Center for Digital Humanities and Social Sciences at MSU. MATRIX uses KORA to store and deliver digital files and metadata and to curate online exhibits. The paper will provide an overview of KORA, describing its architecture, flexible metadata capacity, and tools that promote the creation of complex digital objects. The paper will also examine several digital archives that use KORA to support collection development, resource description, and public access to cultural heritage materials.

A 3D Visualization of Ceramic Materials form Gabii, Italy

Follett, Forrest (University Of Arkansas)
Kyle Urquhart (University Of Arkansas)

Embodied visualization of archaeological data is a topic of interest that has been growing significantly in recent years. Most of the work in this area, however, seems to center around an emphasis on reconstruction or cultural preservation. This paper presents findings of a pilot project that seeks to use these virtual environments to display quantitative data in a way that can aid interpretation. Using the Unity game engine, we combine photogrammetric models of contexts across the site, as well as linking a geodatabase of finds data. Using Unity's particle system module, we are able to visually represent artifact distributions across the site, such that the photomodels provide a visual frame of reference. Analogous to the heat map used for 2D visualization of distribution data, the particle system has a distinct advantage of being able to display multiple classes or datasets simultaneously which is a result of its use of particles rather than 2d color gradients. This

method, when combined with more common methods of architectural reconstruction, can offer evidence for interpretations of use areas across the site.

The Colour Out of Space: Digital Media as Mouthpieces for Material Agency

Foreman, Penelope (Bournemouth University)

Colour is a fundamental human experience – though not a universally constant one. There are, after all, individuals who are colour-blind to various degrees, or even those that see extra colours. However, there is something about the perception and categorisation of colour that is near uniform across humanity, as evidenced by Berlin and Kay's Basic Color Terms (Berlin and Kay, 1969) and studies into the key mechanisms of colour vision (Hurvich and Jameson, 1957; Jameson 2010). Deeper still, it seems to be the case that specific colours re-appear in human art, iconography, ritual and folklore as a leitmotif running through our cultural evolution; that is, the colours red, white, and black (Turner 1967, Gage 1999, Petru 2006, Hemming 2012). Evidence for this significant triad, as well as other colours showing repeated and deliberate selection, is to be gathered an analysed. The main aim of this research is to survey a wide sample of Neolithic monuments across Atlantic Europe, and see if there are any commonalities, significant patterns, and demonstrable signs of specific colour selection that may hint at colour being an important part of Neolithic cosmology – regionally, locally, or culturally. Recording these colours using a digital tool rather than the human eye achieves two things: namely, to compensate for the fallibility of the human visual cortex, and to provide a vector for the material properties to speak without being interpreted by a human intermediary. This paper shall discuss the main methodology and the theoretical concerns it highlights.

"Well, actually...": The Othering of Women in the Computing and Programming Communities and its Effects on Digital Archaeology

Foreman, Penelope (Bournemouth University)

Despite the preponderance of women programmers during the early advances of computer technology, the current demographic for those involved in the field is notably male-orientated. Not only does this lead to the known issues of all male conference panels, a higher percentage of male senior academics in the field, and the associated higher rate of pay for such technical roles, it also has a deleterious effect on the way women are treated by "the digital community". Those seeking advice or support online are often subject to hostility, sexist or even degrading remarks, and constant questioning of their "worthiness" to be part of the community by self-appointed gatekeepers. Thus, the cycle of lack of female engagement continues. This paper presents a case study of the experiences of several women in digital archaeology, and gives constructive direction as to how

those involved in the field can work towards making changes that will make the environment more open and inclusive, and in turn, ensure that digital archaeology does not lose promising practitioners that could benefit future developments and advances in the field.

Vulci3000 Project - A Digital Challenge

Forte, Maurizio (Duke University, Dept. Of Classical Studies, Art, Art History And Visual Studies)
Nevio Danelon (Duke University)
David Johnston (Duke University, Nicholas School)
Katherine McCusker (Duke University, Dept/ Of Art, Art History And Visual Studies)
Everett Newton ()

The interpretation of Etruscan cities and pre-roman urbanism is very much related to the concept of City-State and its organization, which is reflected in the spatial organization, in architectural transformations and in social-political changes. The Vulci3000 Project, directed by Duke University, started in 2014 with the goal to investigate the Etruscan and Roman city of Vulci (Viterbo, Italy) since its early development to the final transformation into a Roman city. The project is a multidisciplinary example of digital integrated technologies: 3D photogrammetry, GPR, drone remote sensing, virtual reality, web GIS and 3D repository. At macro-scale level, the research is focused on the archaeological landscape, at micro-scale on the archaeological excavation of the Western Forum. The superimposition of Etruscan and Roman buildings in a public space can give new insights about the urban transformation and the conceptualization of social and political city-models.

The Dig@Lab at Duke University

Forte, Maurizio (Duke University, Dept. Of Classical Studies, Art, Art History And Visual Studies)

The future of human knowledge will be mostly digital. A transition from the linear growth of human knowledge to the exponential growth of human knowledge has taken place. According to researchers dealing with this information, vastly more complex software, shareability, and virtual multisensorial environments are needed. The world is moving rapidly towards ubiquitous connectivity that will further change how and where people associate, gather, share and consume media. In archaeology and in the field of the digital humanities we produce hundreds of times the amount of data we were able to generate just a few years ago. This jump in volume became possible through the use of digital integrated technologies such as 3D laser scanners, remote sensing systems, image modeling, virtual reality, and immersive systems. Research labs, universities, and research centers record and interpret large quantities of data in different formats and sizes. Much of these data involve 3D analysis and scientific visualization of complex models whose use and interpretation depend

on human interaction and processing (hardware and software). Open data formats and conversion tools are becoming more widespread. The quality of the hardware and software, in tandem, deeply influence the user's experience, feedback, interpretation and digital knowledge/transmission. Unfortunately most digital data have little or no circulation and almost no public access outside the digital labs that produced and stored them. For example, data digitally born in a university lab frequently remains in that lab with little or no circulation or public access. This is very disappointing if we estimate the large investment of human and financial resources for data production and management. On the contrary, the dissemination of this kind of information is essential for the future of human knowledge but also for increasing the chance to be studied worldwide. The Dig@Lab is one of the IT leaders of the CMAS initiative at Duke (Computational Media, Art and Science), at the intersection of digital humanities, digital archaeology, cyber-archaeology and new media. The main goal is to create a digital infrastructure for big data, after the standardization of the digital workflow, from the field to the server. Currently spatial data are optimized for Geonode, an open source web-GIS platform, while 3D models are implemented for Dig@iT (based on Unity 3D), a software running on Oculus Rift and immersive CAVEs (DiVE, Duke Immersive Virtual Environment). A pilot project of 3D repository will use web-GL applications.

The Trajan's Forum Project: Dig@lab and the Framework of Big Data.

Forte, Maurizio (Duke University)
Nevio Danelon (Duke University)
Julia Liu (Duke University)

Big Data labs like Duke University's Dig@lab provide unique cross junctions for interdisciplinary research and design. The Trajan Forum project is an expansive and extensive investigation into archeological fragments from Trajan's Forum in Rome to reconstruct and assemble a multimedia multi-platform public exhibit. Our case study focuses on the digital recontextualization of potentially 40,000 architectural fragments, which are remainders from the Basilica Ulpia of Trajan's Forum. This talk will explore considerations within the design process, from the collection and collation of information, to the analysis and synthesis thereof, to the final design and dissemination process. When considering big data, we must cast our net beyond quantitative parameters to include the rhizomatic web of hyperdimensional qualifications. For example, metadata allows for organization of objects with multiple taxonomies; temporal, spatial, emotional, iconographic and many more attributes. Our talk considers methodological approaches for organizing a panoply of threads. Our approach covers multiple strata of holographic topologies, haptic exploration, and immersive narrative design. At each step, we take micro and macro scale dissemination into consideration to produce both individualized and collective experiences. Our methodological approach and narrative presentation augments and contextualizes ancient artifacts to bring them into the digital era.

Collision Detection: Reflections on Gender from Game Space to Other Spaces

Fredrick, David (University Of Arkansas)

Over the past two decades, 3D technologies have transformed how archaeologists capture and interpret data for the scholarly community and the public. This transformation has been accompanied by persistent concerns about the scientific validity of 3D representations, concerns closely linked to their rhetorical power to immerse and persuade. At their core, these concerns involve 1) democratized access: as the barriers to its creation drop, how to police the resulting explosion of sophisticated 3D content? and 2) modality of representation: unlike a still render or a video, a real-time walkthrough invites game-style interaction, raising the specter of the archaeological site as video game. Democratized access and embodied, game-like modalities challenge the ideal, both phallo- and ocular-centric, of what Susan Bordo has called "the view from nowhere," the detached, apparently objective appraisal of evidence by a bodiless researcher. As Bordo emphasizes, this view is grounded in culturally specific, gendered assumptions about just who gets to transcend their body to attain this rarified perspective. At the same time, the Cartesian coordinate system of a game engine carries its own culturally specific, gendered baggage, which is not evaded by simply adding colliders and a first-person camera. As game engines become more widespread in archaeological practice, the onus is on archaeological teams to challenge the given of 3D game engine space to better explore the other spaces of past cultures, a practice that will hopefully redraw the limits of "scientific validity" in our own 21st-century discipline.

Project Archaeology: Assessing Paper and Digital Approaches to Online Learning

Freeman, Mark (University Of Tennessee)
Jeanne Moe (Bureau Of Land Management)

Project Archaeology is a comprehensive national archaeology education program, jointly sponsored by the Bureau of Land Management and Montana State University, which uses archaeological inquiry to foster understanding of past and present cultures; improve social studies and science education; and enhance citizenship education to help preserve our archaeological legacy. To date it has reached more than 15,000 educators with curriculum guides, activity guides, and professional development. These educators reach an estimated 300,000 learners each year in classrooms and informal settings. Since 2003 the Investigating Shelter units - teacher-led and designed for upper elementary to middle school students - have been available both as online and printed materials. The units present both archaeological practice and discoveries through different types of shelter – a Tipi, a slave cabin, and an Earthlodge. The online version allowed for the addition of interactive elements and media, potentially supporting different learning styles. Based on classroom research, and situated in a broader literature, this paper will discuss the comparative strengths and

weaknesses of the digital component as models for teaching archaeology and digital literacy, and consider plans for future assessment.

From Analog to Digital in Archaeological Archives

Frey, Jon (Michigan State University)

Over the past few decades, the increased affordability of digital hardware combined with innovative software solutions have vastly simplified the task of analyzing, storing and sharing newly acquired archaeological data. At the same time, this digital revolution has left many archaeological projects with long histories but short budgets at a disadvantage as they search for the best way to "go digital" without losing the vast stores of analog legacy data in their archaeological repositories. Thus, in conjunction with Michigan State University's MATRIX Center for Digital Humanities and Social Sciences, archaeologists at the Ohio State University Excavations at Isthmia have developed the Archaeological Resource Cataloging System (ARCS). This open source software solution, which is based upon the KORA Digital Repository and Publishing Platform, allows archaeologists to organize and share digitized copies of field journals, photographs, and other forms of traditional documentation in a format that respects the unique nature of these legacy materials. Moreover, through the use its ARCSCore metadata schema, ARCS enables researchers to make these documents "machine searchable" without resorting to simple transcriptions of content into raw text. In this way, ARCS bridges the gap between the analog past and digital future of archaeological recording systems.

Digitizing Sculpture: Where We've Been, Where We're Going

Frischer, Bernard (Indiana University)

This paper will give an overview of the history of 3D digitization of works of sculpture from the 1990s until today. The case will be made that developments since 2011 such as robust photogrammetric software for data capture and modeling as well as WebGL for data visualization online have caused a sea change. After two decades of intermittent experimentation, digitization of 3D objects such as works of sculpture has reached the take-off point. The future bodes well for seeing large online catalogues of sculpture with interactive 3D models accompanied by appropriate metadata and paradata. As state models become routine, restoration models will become more and more important. New opportunities in the next five years will lie in the development of AR and VR applications exploiting 3D state and restoration models of sculpture.

Treatment of Lime Stone Colored with Egyptian Blue Pigment Using Different Techniques of Documentation

Gad, Moataz (Documentation Specialist Ministry Of Antiquities)
Yasmin Mohamed (Conservator Specialist Ministry Of Antiquities)

Given the importance of Egyptian blue and rarity in ancient period, also its use in decoration and superficial inscriptions and exposed the stone peaces colored with Egyptian blue for along times to many of the deterioration phenomenon, To the extent that most of the blue color grain turn to green color, Therefore, it was necessary to study these phenomenon to develop the appropriate treatment plane, In trying to retrieve the Egyptian blue to the preliminary nature and treat the stone surface from degradations. Reflectance Transformation Imaging (RTI), the result is akin to looking at the real object—only better, because the lighting can be controlled and moved around the target with a precision not otherwise possible. Multispectral imaging: Ultra Violet (UV) _ Infra-Red (IR), Multispectral imaging is the procedure used to observe an object using selected ranges of wavelengths in the electromagnetic spectrum that include and extend beyond the capabilities of the human eye. HH X-Ray Florescence Spectrometry (XRF) Portable or hand-held X-ray fluorescence has been used intermittently in archaeological science on artifacts in museums. Elements are identified from their unique set of fluorescent X-ray energies and composition can be deduced from their relative abundance in the XRF spectrum under the experimental condition. Also Stereo microscope investigation, SEM examination, biological wipes was undertaken to achieve the best treatments.

How to Maintain an A-Game!: The Importance of Continued Education for Women in Technical Fields.

Gale, Sara (New South Associates, Inc.)

There is an overall lack of continuing education opportunities in technical fields that go beyond introducing archaeologists to the fundamentals of a method or approach. Developing technical skill sets is important for men and women, but for women, who still face challenges being viewed as technical experts, the importance of quality and in-depth training is elevated. This carries beyond the CAA fields to any specialty, area of focus, or even, management acumen. But the CAA, and similar conferences, may provide a unique opportunity as it brings together experts capable of providing advanced training or workshops. Where does the responsibility lie for providing advanced and in-depth continuing education opportunities? Should we target women or minorities when developing training, workshops, or classes? If we're all to be considered "Technical Experts" without hesitancy, then we need to maintain a focus on advanced continuing education and skills sharing.

3D Models and Interactive Comunication for Archaeology. The Nymphaeum Ponari in Cassino

Gallozzi, Arturo (UNICLAM, University Of Cassino And South Latium - DART, Laboratorio Di Documentazione, Analisi, Rilievo Dell'Architettura E Del Territorio – DICeM, Dipartimento Di Ingegneria Civile E Meccanica- DICeM)
Leonardo Paris (Sapienza University Of Rome; Department Of History, Representation And Restoration Of Architecture)
Wissam Wahbeh (FHNW University Of Applied Sciences And Arts Northwestern Switzerland)

Not far from the archaeological core of Casinum was found in the half of '900, a nymphaeum dating from the second half of the first century B.C. The Nymphaeum Ponari is part of a Roman villa stilltoday completely buried. The excavations that have occurred overtime have gradually unearthed a well-preserved environmentconsists of a rectangular hall with niches, covered by a barrelvault. On the walls are visible pieces of original frescoes withgeometric shapes and a pseudo perspective cornice. In some areasthey are also evident some plaster layers with traces of mosaictiles and other mixed techniques. In subsequent excavations it has been brought to light a courtyardwith a central water tank, also this one with well-preserved finish. The court was a filter between the Nymphaeum Ponari and the Roman villa, whose first newly found remains foreshadow the existence of a major domus. The metric data acquired in a recent digital survey have allowedthe development of new drawings, and then update ones madeduring previous excavations, and to realize some representative3D models of the place with a particular attention to the decorative study and coatings. This allowed us to also develop a virtual model reconstruction ofthe Nymphaeum and design an interactive communication system on site and off site linked to the nearby museum complex presentinto the archaeological site of Cassino in South Latium, Italy.

Virtual Viewing: Engaging Audiences with the African Rock Art Digital Collection at The British Museum

Galvin, Elizabeth (The British Museum)
Jennifer Wexler (The British Museum)

The African Rock Art Image Project (britishmuseum.org/africanrockart) launched at the British Museum in 2013 to document and disseminate c.25,000 digital images of rock art from throughout the continent. It is one of the first born-digital collections to be registered and accessioned as objects into the British Museum. Open access and expanding engagement with rock art is one of the project's key aims. As an entirely digital collection, this presented new opportunities and challenges for engaging audiences both online and in the Museum. One such example of this was a digital event held at The British Museum. By stitching together

images (from the collection and from partners in Africa), and using inexpensive devises, such as standard smart phones and Google cardboard, visitors were able to take an interactive 360 tour of the famous rock art site, 'Game Pass', in South Africa. This site is often referred to as the Rosetta Stone of San/Bushman rock art as it lead to theories and interpretations of the rock art of one of the last communities to practice it in Africa. Born-digital objects are expanding and changing the way curators and museum professionals are able to inform and educate the general public in archaeology, as well as how the audience can interact with heritage.

Public Engagement in Compulsory-age Education with MOOCs: A Case Study from the Italian and English Context

Gandolfi, Eleonora (Archaeological Computing Research Group, University Of Southampton)

In the last couple of years, MOOCs have become prominent in the Higher Education market. Increasingly, Universities are offering a greater variety of courses to increase their attraction to prospective students and promote their research to the public. Specifically to the Heritage context, a few MOOCs have focused on making archaeological content accessible globally to a wider audience. In 2014, the University of Southampton and FutureLearn ran a MOOC on the archaeological work in progress at the Roman site of Portus. The course has engaged thousands of learners contributing with comments, ideas and questions, and build upon Portus Project's previous work to share the results of funded research via the BBC documentary Rome's Lost Empire and the website/blog. At the same time, the Italian government has developed a series of articles (Law n. 107, 13/7/15; "La Buona Scuola") and policies (eg. Strategic Plan by TDLab) to develop global citizens skills among new generations and develop Italian tourism. In this talk I will examine the opportunities for linking the course and its materials to Italian secondary education, and for building educational links between Italian and British children will be examined. I will also consider the role that the course plays in building local, national and international communities around the site of Portus.

Assessing the Impact of Parametric Uncertainty in a Simple Model of a Social-ecological Network

Gauthier, Nicolas (Arizona State University)

I present a simple mathematical model of a network of human settlements and natural ecosystems, adapted from urban studies, and assess the impact of parametric uncertainty on our understanding of the dynamics of archaeological networks. The model resembles the well-studied Lotka-Volterra predator-prey system, extended to include the nontrivial consumer-resource connectivity structures and nonlinear returns to scale that characterize real-world social-ecological networks. I explore how uncertainty in the parameters

governing scaling and connectivity impact the behavior of the model, and how similar uncertainties impact our understanding of empirical social-ecological networks derived from archaeological proxy records. I conclude by outlining how future empirical efforts can help to reduce these conceptual uncertainties and refine our thinking about past network dynamics.

A Methodology for Architectural Heritage's Digital Reconstructions. Lisbon Religious Houses as Case Study

Gil, Ana (CERIS, IST, Universidade De Lisboa)

Lisbon religious houses represent a vast architectural heritage that marked and still mark the city's image. Considering that there isn't a global perception of its importance, it is essential to study and disseminate the past and present-day reality to better preserve and protect it. It was prepared digital reconstructions, based on the London's Charter and the Principles of Seville, which are intended to enable the study, preservation and dissemination of architectural heritage. Such an approach required a broader study, going from the city scale to the building scale. Regarding the production of graphical data, it stands out by the development of three-dimensional models that evolve together with the research phase and the life of the building. So, it has been developed a cyclical methodology, with parametric and associative geometry - BIM models -, based on the development of digital models, allowing to at any time add information to the model. Recent advanced photogrammetry and laser scanner survey technics were used for model development, including analysis in some stages of the methodology. It is intended, with the present communication, to present and discuss the methodology used for digital architectural reconstructions, introducing the existent old convent spaces on extinction date in a digital form, and show how these models can be important in an interdisciplinary way.

Centrality Measurements and their Application to Archaeological Data

Gjesfjeld, Erik (University Of California, Los Angeles)

The concepts and measurement of centrality is fundamental to nearly all applications of network analysis. Unfortunately, the use of centrality measures with archaeological data creates challenges in both the interpretation and reliability of centrality measurements. This research will present two previously published methods for evaluating the stability of centrality measures using bootstrap simulation and sensitivity analysis. Using these approaches, I will explore the variability of different centrality measures across a range of network types that differ in their size, density and degree of centralization.The goal of this research is to highlight network structures and centrality measures that might be strongly influenced by common

limitations of archaeological data. This research also aims to investigate the potential of alternative centrality measurements, such as edge centrality, that might be useful in archaeological research.

Historical Contingency in Network Data: Examples from Museum Collections Research

Golitko, Mark (University Of Notre Dame)

Museum collections are rich repositories of archaeological and ethnographic data that can be utilized in network studies, however, these collections are palimpsests reflecting collector bias, changes in museum practice, and changing standards of data collection. This talk explores the missing data problem inherent in using legacy datasets via a study of bone daggers from New Guinea housed in several ethnological museums, and collected between about 1890 and 2000. This project seeks to examine how material cultural patterning relates to likely patterns of interaction as well as language distribution as a test of common archaeological assumptions about human biocultural diversity. I explore several aspects of missing data in this study, including historical biases in data collection and reporting, the impact of variable sample size across inferred networks, and the potentials for using spatial autocorrelation between datasets to impute missing values. It is argued that modelling is both a means of dealing with missing data and a way of making statistical and anthropological inferences from material cultural datasets, which are intrinsically incomplete representations of social process.

The Use and Reuse of 3D Scanned Lithic Refits

Golubiewski-Davis, Kristina (Middlebury College)
Samantha Porter (University Of Minnesota)
Matt Edling (University Of Minnesota)
John Soderberg (Ohio State University)
Gilbert Tostevin (University Of Minnesota)

The study of stone tools requires an understanding of complex geometries. This can be difficult to comprehend from 2D representations, and actual archaeological sequences are hard to come by. To address this problem, in 2006 we 3D scanned four experimental refit sequences to use in our teaching. Here, we discuss how our use of these digital resources developed over the past decade in response to changes in technology and student feedback. Initially, these refits were presented as animations showing each flake being removed in sequence. Next, we created interactive flash movies, which gave students the ability to rotate individual flake models in time with the animation. These videos eventually suffered from problems with browser integration and were replaced with 3D PDFs. Our most recent project uses 3D prints fitted with magnets, which allow students to disassemble and reassemble the sequence. This aids the teaching of both

lithic technology and lithic refitting. The 3d prints increase student engagement and have been well received during public outreach events. Throughout the project, we integrated student feedback to improve the way we used new advances in 3D technologies to enrich the students' exposure to the artifactual past.

Toward an Argument Evaluation System on Cultural Heritage Based on Anchoring Inference Theory

Gonzalez-Perez, Cesar (Institute Of Heritage Sciences (Incipit), Spanish National Research Council (CSIC))
Martin Pereira-Fariña (Department Of Philosophy And Anthropology University Of Santiago De Compostela)
Chris Reed (Centre For Argument Technology University Of Dundee)

Research on cultural heritage works within a research framework different to the well-known hypothetic-deductive method. This means that the conclusions or claims resulting from research work must be supported by good and sound arguments rather than unquestionable proofs. To the best of our knowledge, the current methodological approaches to archaeology in particular, and cultural heritage in general, lack a well-defined framework for argument evaluation. In order to establish the foundations for this, we propose to use Inference Anchoring Theory (IAT). This is a conceptual tool to annotate and represent arguments in the form of graphs, which allow us to connect dialogical structures or texts with argumentative ones, as well as the entities in the world that the discourse refers to. AIT is supported by computational tools, such as OVA (http://ova.arg-tech.org/), and can be combined with Argumentation Schemes theory, which provide us solid grounds for an argument evaluation system. In this paper we describe an initial proposal for an AIT-based framework combined with the CHARM reference model (www.charminfo.org) for the evaluation of archaeological arguments and their linking to the entities it refers to, and illustrate it with some examples taken from archaeological reports and published papers.

Cyberfeminist Perspectives on the Future of Digital Archaeology

Gonzalez-Tennant, Edward (University Of Florida)

This paper draws on Cyberfeminist ideas to examine the future of digital archaeology, particularly as it pertains to difference and equity in the make-up of its practitioners. In feminist technoscience, feminist technologies are those which are good for the oppressed. Many techniques being explored by digital archaeologists are such technologies. A central question cyberfeminists ask of such technologies is their value in challenging entrenched systems of domination and hierarchy. After a brief review of how hierarchical thinking is embedded in some familiar technologies, I examine the possibilities digital technologies hold for

creating experiences and narratives which challenge dichotomous and hierarchical views of the past. New technologies allow us to interact with past landscapes, inhabit the bodies of others, and explore the surface of new worlds. Will these technologies support hierarchical tendencies, or can we affect a new paradigm? Digital archaeology can help shape the use of these technologies as they relate to heritage, community, and identity. In order to realize this goal, our discipline needs to resist the devaluing of women's contribution to digital archaeology. I end the paper with a frank discussion of how our discipline can avoid maligning technological methodologists. This includes drawing inspiration from potentially surprising places, including the intersection of video games and popular culture.

Modeling Acoustics in Ancient Maya Cities: Moving Towards a Synesthetic Experience Using 3D Simulation

Goodwin, Graham (University Of Nebraska-Lincoln)
Heather Richards-Rissetto (University Of Nebraska-Lincoln)

Urban landscapes are often designed to intentionally invoke synesthetic experiences. Among the ancient Maya, the senses—sight, sound, taste, touch, and smell—worked in concert to create ritually-charged atmospheres. Ancient Maya architecture served not only as backdrops for ritual events, but also shaped the experiences of participants and audience. Several archaeological analyses of urban dynamics have successfully employed 2D and 3D tools to develop computational methods that measure vision and movement within urban environments. Virtual reality (VR) environments are now enabling archaeologists to also measure the acoustics of ancient spaces. In this paper, we employ GIS, 3D modeling, and VR to measure reverberation of sound in the Acropolis at the ancient Maya city of Cópan. Together with archaeological, iconographic, and epigraphic data, acoustic measures help us to (1) identify potential locations of ritual performance and (2) determine the spatial placement of participants in these events. To move toward an understanding of the role synesthetic experience might have played in shaping interaction in ancient Maya cities, we employ proxemics as a bridging framework for computational analysis and humanistic perspective because it situates sound and sight in relation to embodied experience.

Everything Wrong with Bots: On Algorithmic Madness

Graham, Shawn (Carleton University)

In 'Weapons of Math Destruction', Cathy O'Neil describes ways in which the unintended consequences of algorithms ruin lives, spoil society, and generally are not being paid attention to. In this presentation, I want

to consider how some simple algorithms - Twitter Bots - can both ruin and enrich digital public archaeology. And what happens when one's bots start talking to one another.

Wetware: Analog Simulation of Roman Socio-Economics

Graham, Shawn (Carleton University)

Sometimes, the fastest route to developing a working simulation that encompasses one's understanding of the past and simulates a phenomenon well enough to generate insight, is to use wetware. That is to say, play it out with a bunch of humans. In this paper, we describe a computational simulation of Roman socio-economics as they play out over a network representation of the Roman economy, realized as an analog simulation. You might even call it a board game.

Big Geophysics with Small Tools: Looking for the Big Picture One Step at a Time at Tel Shimron

Grap, Rachel (East Tennessee State University)
Eileen Ernenwein (East Tennessee State University)

A tel is a mound site that has been occupied by multiple civilizations over time with each civilization building upon the remains of the previous civilization. It's common for archaeologists to dig in one location on the tel for decades, making it possible to document successively older occupations tens of meters below the surface. Choosing an excavation location is therefore a high stakes decision, because the entire project will unfold from there. Geophysical survey can improve this situation by (1) gaining a better understanding of the archaeological deposits in the uppermost strata, and (2) informing excavation area selection. The 15 hectare site had obstacles such as steep slopes, partial tree-cover, concrete slabs, and modern trash piles. Additionally, excavations were planned for summer 2017, leaving only one field season to conduct the survey. Use of large carts was ruled out because of the obstacles. Our solution was to train a group of students during the academic year by way of a one-week geophysics workshop, and then collect data on foot in the summer of 2016. The team worked in shifts to collect six hectares of GPR and nine hectares of magnetometry data and process it in real time. This paper will include a summary of these results and a discussion of the pros and cons of this type of strategy.

Using an ABM to Evaluate the Impact of Missing Links on our Interpretation of Social Networks

Gravel-Miguel, Claudine (Arizona State University)

For this project, I use an agent-based model (ABM) to reproduce the social networks created between groups of Southwest European hunter-gatherers facing the Late Glacial climate changes. In the model, agents living in different sites interact with one another when in need of resources, and transmit some form of cultural knowledge that is recorded as numerical values. These values are then analyzed statistically to reproduce the networks created between sites from the bottom-up, as if they represented a perfect archaeological assemblage. Using an ABM has the advantage of providing a perfect rendition of the networks created, with all links documented. In this presentation, I demonstrate how going from a complete to an incomplete data record impacts our interpretations of the archaeological social networks. I use the numerical values outputted by the model to reconstruct the networks statistically, and show the impact of removing data on the results. I attempt to answer the questions "At which percentage of missing data do we start interpreting the results incorrectly?" and "How can we use this information to improve our interpretation of the incomplete archaeological record?"

Information Systems and Ad Hoc Workflow Models as Viable Applications to Improve the Pre-excavation Detection of Characteristic Human Interments

Green, Ashely (Faculty Of Science And Technology, Bournemouth University, Poole, Dorset BH12 5BB)
Paul Cheetham (Faculty Of Science And Technology, Bournemouth University, Poole, Dorset BH12 5BB)
Timothy Darvill (Faculty Of Science And Technology, Bournemouth University, Poole, Dorset BH12 5BB)

The detection of large targets (e.g., field boundaries, agricultural systems, and settlements) by geophysical survey and remote sensing is relatively uncomplicated in comparison to detecting human interments. This research aims to produce an information system to automatically or semi-automatically detect signatures characteristic of archetypical human interments, thereby increasing the confidence of obtaining true positive and true negative results. By developing an ad hoc workflow model to determine the appropriate technical survey parameters while accounting for environmental factors, it is hoped to offer the highest probability of detecting burial(s) in a given survey with respect to environmental factors and the nature of the target. The information system will employ algorithms adapted from pattern recognition approaches for geological and seismic surveys, Hough Transforms, and additional linear feature extraction methods where applicable, and a key based on data collected from sample geophysical and remote sensing surveys of medieval and experimental interments in southwest England and Ireland and archived data. Results to date of this ongoing doctoral research project are to be presented, with the characterised 'signatures' being: amplitude, magnitude, and top- and side-view morphologies. By detecting human internments during the pre-excavation stage of an investigation, archaeologists are able to maximise the recovery potential of any human remains while also informing excavation and post-excavation strategies.

Geospatial Analysis, Predictive Modelling and Modern Clandestine Burials

Groen, Mike (Netherlands Forensic Institute)

The use of geospatial analysis and predictive modelling, with the aim of discovering new sites through the use of previously known patterns, is widely applied within archaeology. However, these methods are sparsely known, and hardly used, within the police and judicial contexts. This paper presents a pioneering study of modern clandestine burials in the Netherlands between the period 1960 and 2016. The dataset comes from known clandestine burial sites and integrates spatiotemporal patterns, offender and victim characteristics and Bayes' theorem to predict where, given a certain forensic scenario, an unknown clandestine burial site could be found. The study demonstrates that modern clandestine grave locations are patterned and quantifiable and that geospatial analysis and predictive modelling can be used to help locate missing and presumably clandestinely buried individuals.

Continuity and Discontinuity in Transport Networks of the Dutch Limes Zone

Groenhuijzen, Mark (CLUE+ Research Institute For Culture, History And Heritage Faculty Of Humanities VU University Amsterdam)
Philip Verhagen (CLUE+ Research Institute For Culture, History And Heritage Faculty Of Humanities VU University Amsterdam)

In this paper, we investigate continuity and change within transport networks in the Roman Dutch limes zone and the effects of chronological uncertainty on transport network analysis. Local supply of the Roman military garrisons in the Lower Rhine region between 12 BC and AD 270 gave rise to transport networks on an unprecedented scale. Yet, it remains largely unknown how goods were being moved from the local population to the military, largely owing to the lack of material evidence for transport. In previous research, we have applied least-cost path modelling and network analysis to construct networks of local transport and investigate the role of individual sites within these networks. However, this approach is inherently dependent on the quality of the archaeological datasets. One of the key issues is site chronology. Sites dated with various levels of detail or incorrect dating have the potential to drastically alter the outcome of analyses. We have developed a method to deal with chronological uncertainty in a more formalized and flexible way, by simulating the probability of the archaeological finds of a site belonging to a certain time period. We present the results of applying this method to investigate in greater detail continuity and discontinuity in transport networks, and how the analysis of transport networks and sites within those networks can be affected by chronological uncertainty.

Challenges in Analysing Sensitive or Uncertain Data in a Semantic Web Environment

Gruber, Ethan (American Numismatic Society)

Over the last few years, more than 135,000 Greek and Roman coins have been aggregated into Nomisma.org following the principles of Linked Open Data. The majority of these coins have come from museum databases, but an increasing number are from archaeological or finds databases, such as the Portable Antiquities Scheme. The precise coordinates of finds are sensitive; the release of such information may encourage looting. As a result, findspot coordinates are published to the web on the level of the parish. While this is useful for the study of coin circulation and ancient trade on a broad scale, it prohibits more sophisticated analysis or visualisation on a local level, e. g., to show the distribution of coinage found within a certain distance of a Roman road, a query that would be very useful for analysing patterns of population movement in periods of economic or social upheaval. This is one of a number of challenges that we face in building query and visualisation interfaces for numismatics: how can we make sensitive or uncertain data available to researchers (and the general public) through web-based tools on Nomisma.org without giving them direct access to precise coordinates? Or, at worst, how do we document the limitations in our own data and information systems in a way that makes it clear to researchers that there may be shortcomings in the accuracy of highly-localised geographic queries?

Best Practices and Metrological Issues in Massive 3D Digitization of Sculptures

Guidi, Gabriele (Politecnico Di Milano)
Umair Malik (Politecnico Di Milano)

In the past five years several initiatives for 3D digitization of archeological artifacts have been started in important museums worldwide. Between 2012 and 2015 the first massive digitization initiative was financed by the EU Commission through the project 3DICONS. The purpose of this project was to generate 3000 new 3D models of artifacts and structures of the European Heritage, to be published through the EUROPEANA portal. During the course of this project, some significant actions were completed, such as the digitization of the whole patrimony of the Archeological Museum of Milan (500+ models). On the basis of such experiences this year a new project was started by Indiana University, in cooperation with Politecnico di Milano and University of Florence, aiming at digitizing the entire patrimony of roman sculptures of the Uffizi Museum in Florence (Italy). The principal technique involved, in both 3DICONS and Uffizi projects, was automatic photogrammetry. The authors have experienced a variety of different issues in museums, ranging from working with the natural lighting conditions to the different ways for posing the camera on the scene. That involved specific technical choices for reducing the digitization time and costs, still maintaining a high coherence between the physical artifact and its digital counterpart, fundamental for making such models

suitable for different purposes (virtual visits, technical documentation, 3D data bases). The paper discusses these issues and the related post-processing needs, in a framework where the purpose is massively digitizing complex artifacts in their original setting by minimizing impact on the museum.

A Novel Pipeline for the Structural Analysis of 3D Digitized Cultural Heritage

Guidi, Gabriele (Politecnico Di Milano Milan, Italy)
Sara Gonizzi Barsanti (Politecnico Di Milano Milan, Italy)

The use of Finite Elements Methods (FEM) for the mechanical analysis of ancient structures and artifacts has recently shown great potentialities. However, the typical workflow of such analysis involves the use of CAD models made by mathematic surfaces, representing the ideal shape of the object to be simulated. This might be appropriate when the physical element to be simulated is very close to its ideal drawing. But, for Cultural Heritage objects, often altered by the time passed since their original creation, the models are generated with 3D capturing methods producing high resolution meshes, often made by millions of polygons and for this reason not suitable to be directly processed with a FEM package. The focus of this paper is the study of the most accurate 3D representation of a real artifact/scenario in order to get a 3D surface suitable to be transformed in a volumetric 3D model as close as possible to the physical reality, minimizing in the same time the number of nodes defining its shape. The approach that is going to be experimented is based on a wise use of retopology procedures, coupled with a transformation of a simplified and retopologized model to a mathematical model made by NURBS surfaces, as close as possible to the real shape, but suitable to be transformed in reasonably complex volumetric 3D models through standard FEM packages. Such approach will be demonstrated on the 3D model of the sculpture “Patroclo e Menelao” belonging to the Uffizi Museum in Florence.

Diachronic 3D Reconstruction of Historical Sites in Urban Context

Guidi, Gabriele (Politecnico Di Milano)
Laura Micoli (Politecnico Di Milano)
Sara Gonizzi Barsanti (Politecnico Di Milano)

This paper presents a methodology for the three-dimensional diachronic reconstruction of a site in an urban context with the nearly total absence of remains to be surveyed, uncertainty of sources, difficulty to correlate documents and data to a three-dimensional representation. The case study is the Milan’s Roman circus, built in the era when the city was the capital of the Western Roman Empire, under Maximian (284-305 A.D.). Although the circus of Milan was one of the most important of the empire, today there are only few visible traces: a tower of the Carceres reused as a bell tower and some sections of the foundations hidden in

buildings of private properties. Historical sources report the existence of the circus until Longobard's era, then, as happened to other monuments in Milan, the materials that formed it were used to build other buildings and the area was densely urbanized. Archaeological studies were conducted mostly at the beginning of the '900 and after World War II, when during the reconstruction of some buildings and public works it was possible to see the remains. Many questions are still open about the building's development elevation and its relation to the surrounding works: the imperial palace and the town fortification walls. This work shows how all sources (maps, drawings, archaeological reports, archaeological restrictions decrees, photographs, etc) has been integrated to hypothesize a reconstruction of the area by georeferencing such documents to that specific location of the city and by and interpreting them as a whole.

Archaeological Field Data Collection Using Ruggedized Android Tablets and Free and Open Source Software

Gunn, Scott (University Of New Mexico Office Of Contract Archeology)

Open Data Kit (ODK) is a free and open source (FOSS) mobile data collection toolkit utilized by a wide range of users around the world. Using ruggedized Android tablets with ODK, archaeologists with the Office of Contract Archeology at the University of New Mexico recently spent 20 days in the Bandelier Wilderness documenting impacts to cultural resources from the 2011 Las Conchas fire. Data collected from the project were successfully incorporated into pre-existing spatial databases and used to populate state and federal PDF forms using Python and a variety of FOSS tools. Additionally, using ODK and the ODK Aggregate server, tabular and spatial data collected in the field can be uploaded remotely, providing project managers with the ability to monitor ongoing fieldwork projects while in the office. This presentation will provide details into this approach, including the setup of ODK forms, ODK Aggregate server, Bluetooth GPS pairing, the integration of field data into both FOSS and COTS spatial databases, and PDF form generation. We'll also examine the problems and pitfalls encountered with the approach and discuss possible solutions.

Geographic Visualisation as Knowledge Generation in Archaeology

Gupta, Neha (Memorial University Of Newfoundland)
Rodolphe Devillers (Memorial University Of Newfoundland)

Geographic information systems (GIS) and other geovisualisation tools have been successfully used in archaeology to produce maps that can communicate archaeological information. The ability to use geographic visualisations to generate new knowledge however, has been largely neglected and offers immense perspectives for a field that deals with large amounts of complex data. We re-conceptualise maps in a

representational model and argue that geographic visualization encourages the use of our cognitive abilities to process information and to generate new knowledge. In this context, we present MINA | Map Indian Archaeology (dngupta.github.io/mina.github.io), a Web-based platform built on the Leaflet library as a visualization tool that promotes data exploration and encourages questions about potentially unknown spatial patterns and relationships in Indian archaeology. The Leaflet libraries enable user interaction with archaeological data and facilitate meaningful graphical summaries of spatial information, which in turn, can promote new empirical research in archaeology. The web map supports knowledge discovery through data exploration, showing, for instance, a striking pattern and distribution of archaeological investigations throughout India during the 1950s. This simple prototype provides a proof of concept and shows that greater efforts in developing advanced visualisation tools appropriate for archaeological data can promote the generation of new knowledge in archaeology.

Inferring Influence Networks of Grapheme Innovation in Classic Maya Hieroglyphic Writing

Habiba, Habiba (University Of Konstanz)
Viviana Amati (University Of Konstanz)
Jessica Munson (Lycoming College)
Jonathan Scholnick (University Of California, Davis)
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Martha Macri (UC Davis)

Classic Maya hieroglyphic writing is one of the best-documented and thoroughly deciphered scripts in prehispanic Mesoamerica, yet we still know remarkably little about how this writing system evolved. Specifically, when and how did novel graphemes – the discrete and most basic units of text – spread across the Maya region? A major challenge to inferring influence is that who—influences—whom network is largely an intangible and unobservable phenomenon. Moreover, the underlying network of interactions through which influence potentially propagates is, at best, partially observable in most cases. Taking into consideration these challenges, we devise a probabilistic framework for building networks of grapheme innovation using the observed dates of grapheme inscription and the geographic positions of archaeological sites. We use the Susceptible-Infected (SI) transmission model from mathematical epidemiology as the basis of our proposed method. The inferred influence networks of grapheme innovation are validated by comparing them with the sociopolitical ties documented in the written texts. These influence networks facilitate the identification of sites that stood out as innovators at various points during the Classic period. The proposed probabilistic model is applicable to a wide range of archaeological network inference problems and opens up further questions about co-evolution, replacements, and the discontinuation of graphemes through time.

Classifying the Surfaces of Virtual Cuneiform Tablet Fragments

Hanes, Laurence (University Of Birmingham)
Tim Collins (University Of Birmingham)
Sandra Woolley (University Of Birmingham)

The reconstruction of fragmented cuneiform tablets has long been a challenging problem of historical significance. The large numbers of fragments as well as their geographical separation makes manual reconstruction intractable and motivates research into the reconstruction of 3D mesh representations of fragments in virtual environments. A key step in the automated reconstruction methodology is to identify the broken and intact surfaces on each fragment, as well as the cuneiform inscriptions. However, approaches in the literature are dependent upon high precision scans of fragments, which introduces a significant hardware and expertise cost. Here we present a methodology that is able to identify the different surfaces of fragment meshes captured with lower precision scanners, for which existing approaches fail. We develop a new method for identifying smooth intact surfaces based on global fragment convexity as well as local surface curvature. We identify written surfaces by detecting the periodic nature of cuneiform inscriptions. The surface identification results can then be easily used in either user-assisted or fully automated reconstruction environments. By reducing the hardware requirement for scanning fragments, our results will allow a greater number of fragments to be scanned and contribute to reconstruction efforts for a lower financial and time investment.

Understanding Urban Pattern of Silk Road Oasis-Cities Using Archival Aerial Images.

Hanus, Kasper (Adam Mickiewicz University In Poznań)

Researchers are devoting more and more attention to the archaeology of early cities. This interest is reflected in a growing number of publications on the topic. An attempt at creating a city, especially in relation to non-European cultures, has outgrown the framework set by the attributes listed by V. Gordon Childe. Most contemporary definitions of the phenomenon of the city are based on its demographic or functional features. The authors of this paper suggest an approach through the prism of landscape, where the cityscape can be understood as physical (material) space with all the human-made landscape modifications visible in the archaeological material, as well as social space, where particular landscape elements (including cityscape) have a meaning given to them by the bygone societies that inhabited that space. While the earlier research on early city forms in Asia focused mostly on „ticking off" points from the list of city features based on Eurocentric interpretation of the phenomenon of the city, the following article is an attempt at looking at the material and social aspects of the city with the consideration of the local urbanization processes which could

have had a different course than in Europe and the Mediterranean. The research hypothesis put forward in this article assumes that although the urban centers which developed on the southern branch of the Silk Road in Tarim Basin (Xinjiang, western China) significantly differ in terms of morphology from the dense, compact cityscapes of Europe, from the functional point of view they functioned as cities in the landscape. In our view the urban centres we discuss are characterized by features of dispersed, agrarian-based urbanism, and we shall verify the correctness of our approach through an analysis of the features of low density urbanism, as suggested by Roland Fetcher. In my poster I would like to present how the archival aerial images, mostly Corona clichés, can provide data needed to understand the urban pattern of Silk Road Oasis-Cities.

Mapping and 3D Modeling at the Household, Neighborhood, and Regional Levels Using UAVs, Photogrammetry, and LiDAR

Hare, Timothy (Sociology, Social Work, & Criminology Morehead State University)

Using unmanned aerial vehicles (UAVs/drones) to carry photographic equipment and photogrammetric processing of resulting data simplifies and accelerates mapping, 3D modeling, and environmental reconstruction. Construction and expansion of highways through Mayapán and the surrounding region are destroying valuable archaeological remains and environmental features. The 2016 field season targeted these areas for rapid recording and depended on UAV photography and photogrammetric processing for site and excavation photos as well as production of 3D modeling of archaeological remains and excavation units. In this presentation, I outline the technology used, the data processing workflow, and the resulting products including oblique photos, orthorectified aerial photo mosaics, digital elevation models, 3D models, and data layers for use in geographical information systems. I conclude with an example of implementing UAV-borne LiDAR and multispectral cameras into archaeological mapping and modeling of Maya house groups and urban neighborhoods.

Mobilizing a Salvage Archaeology Dataset to Build a 3D Interpretive Visualization

Harrison, Laura (University Of South Florida)

Many discussions of digitization in archaeology foreground projects with substantial financial resources and highly trained technical specialists. While essential in driving methodological innovations that inform best practices in digital heritage, these high-end projects offer few practical insights for archaeological projects lacking a predetermined digitization strategy. These constraints are particularly acute in salvage archaeology contexts, where substantial time and budgetary constraints are the norm rather than the exception. This paper

presents a case study from the salvage excavation of Seyitömer Höyük, an Early Bronze Age urban settlement in Turkey, to demonstrate how to mobilize an extant archaeological dataset for the creation of a low-cost, data-rich 3D model by means of hand modeling. The result is a useful research tool that concisely synthesizes multiple classes of data in a coherent visual framework, and contributes to digital heritage objectives without taxing limited project resources.

TrowelBlazers: Raising Horizons for a Diverse Digital Archaeology

Hassett, Brenna ()
Suzanne Pilaar Birch (University Of Georgia)
Victoria Herridge (Natural History Museum, London)
Rebecca Wragg Sykes (University Of Bordeaux)

Pith helmets, fedoras, and...bonnets? Although the persona of the archaeologist is often imagined as male, women have been active in the field and lab since the early 1800s and today make up a majority of students in the discipline. However, they often suffer from historical erasure or else are lauded as an intrepid individual in a man's world, and are less likely to hold positions of leadership in the field. Even less visible in the discipline, historically and today, are women of color, including local and indigenous women working in colonial settings. Three years ago, through the launch of TrowelBlazers, a blog and social media collective, we have been sharing women's stories in the fields of archaeology, geology and palaeontology. By far the most rewarding aspect has been the uncovering of robust research networks that existed amongst women in these fields throughout the 20th and even 19th centuries, as well as the growth and development of our own online community intersecting with public events, outreach, and academic research.

2D and 3D Electrical Resistivity Tomography Imaging of Archaeological Structures - Case Studies from Romania

Hegyi, Alexandru (West University Of Timisoara)
Petru Urdea (West University Of Timisoara)

In the last decade electrical methods have been important for archaeologist because of their ability to detect the shape of the archaeological structure and, more important, the actual depth. Nevertheless, due to the slow process of data acquisition, the ERT method hasn’t surpassed in importance other techniques like geomagnetic measurements (magnetometry). Even so, in the light of recent studies, ERT measurements provide a large amount of information about the site itself but, moreover, about the particular structures and soil pattern condition. Withal, depending of electrodes geometry settings, a series of geomorphological insides

as lithology, water resources, soil markers and others can also light up important things for the research. The aim of this study is to present a few methodologies of using the ERT method in some various archaeological sites from Romania. The different way of data acquisition and the morphology of the sites allowed us to diversify the interpolation for a better 3D visualization. The presentation of the analogies between data and comparison with some archaeological excavation and drillings represent another purpose of our approach. In the end, as a personal remark, we consider this method to have an enormous potential for archaeology because of its versatile application – in addition to data representation which is often asked by archaeologist, the method can also be used for quantification analyses.

Decolonizing an Archive of Archives?

Heitman, Carrie (University Of Nebraska-Lincoln)

In the case of cultural heritage resources, the stakeholders invested in digital archival resources can be difficult to gauge and engage due to historical, economic, religious, political, ethical and legislative issues. Over the last 12 years, the Chaco Research Archive (CRA) has encountered (and continues to encounter) evolving ethical challenges as well as new opportunities to help work against the colonial context of legacy excavation data. In this paper, I present the CRA as a case study profiling these complexities: an archive of historic data on the cultural heritage of a Native American sacred ancestral site known today as "Chaco Canyon" (located in northwest New Mexico, U.S.). I discuss some of the mistakes we have made and our ongoing efforts to reconsider aspects of design and data reuse to help decolonize an archive of archives.

Hydrologic Design in Three Maya cities: Using Regional Topographic Data, Hydrologic Analysis in GIS and Archaeology for a Comparative Analysis of Palenque, Tikal, and El Peru

Hermitt, Elijah (The Pennsylvania State University)
Erika Maxson (Bloomsburg University)
Kirk French (The Pennsylvania State University)
Damien Marken (Bloomsburg University)
Derek Shaffer (The Pennsylvania State University)
Timothy Murtha (The Pennsylvania State University)

Evidence for hydrologic design of ancient cities and presence of water management features are increasingly documented throughout the Maya lowlands. They are far from uniform in that the form, distribution and function of these systems vary regionally. Palenque in modern-day Chiapas, Mexico, Tikal and El Peru in El

Petén region of Guatemala offer three regional case studies of water adaptation, through hydrologic city design and management features. Palenque has a perennial excess of water that, in order to avoid flooding and to maximize plaza space, must be diverted to underground aqueducts. Conversely, Tikal boasts a network of bajos and reservoirs for the purpose of conveying and collecting water to sustain through an intense dry season. El Peru, on the other hand, exhibits characteristics of both. Utilizing the hydrology toolset in ArcGIS sinks in the terrain were filled and flow direction and accumulation were determined to document and describe the hydrological structure and form of the region surrounding these cities. The results are spatially compared to site and regional samples of archaeological settlement patterns. In this paper we not only detail how regional hydrology is expressed in the design and planning of these three cities, but also compare how global topographic data like ASTER and SRTM influence the hydrologic analysis.

What to do with Ambiguous Anomalies?

Herrmann, Jason (Institut Für Die Kulturen Des Alten Orients Eberhard Karls Universität Tübingen)

In the best-case scenario, data from archaeo-geophysical surveys are striking and clear, revealing traces of human activity preserved in the near subsurface in vivid color. Other times, ambiguous anomalies dominate the results or lurk in the background of otherwise compelling images. Several case studies from the US, Europe, and the Middle East will be discussed in order to explore how we present and publish these ambiguous anomalies. When should we err on the side of caution and emphasize uncertainty? When should we confidently forge ahead with tentative interpretations in the hope of developing testable hypotheses? What are the competing pressures in our discipline that push us toward one or another solution? Discussion from the audience and fellow speakers will be welcomed.

Non-destructive Techniques for the Structural Health Assessment of Historic Buildings

Hess, Michael (University Of California, San Diego)

The proliferation of digital techniques applied to the documentation of cultural heritage has generated an abundance of data sets which can enable meaningful quantitative analysis of the most culturally significant structures in the world. Presented here is an example of how the data generated through digital documentation can enable structural health assessment of historical structures. Until now, many of the heritage digitization efforts have served to provide visually stunning presentations or qualitative interpretations. This work explores the diagnostic value of terrestrial laser scanning for quantitative structural health assessment and demonstrates how important these assessments can be to life-cycle management of heritage structures. A case study at the Baptistery di San Giovanni in Florence, Italy was conducted, wherein multiple 2D and 3D non-destructive techniques were used to digitally document the monument in order to

study its construction. Terrestrial laser scanning was used to measure trusted, accurate, high-resolution geometry throughout the structure. Portions of the data have been analyzed in order to quantify and visualize the effects of centuries of structural changes and aging. The laser scanning geometry can also be used to register thermal imaging, photogrammetry, and geo-radar data which aid in additional analysis beyond geometric calculations.

Human Scale and its Impact on Location Modelling

Higginbottom, Gail (Australian National University)
Roger Clay (University Of Adelaide)

Traditional archaeological location modelling, whilst very informative about spatial patterns across a 2D spectrum, can be limited in its contribution to understanding human choice about location. On the other hand, projects combining statistical tests with models influenced by individual immersion techniques have a far better chance of understanding the choices people made in regards to place and confirming the likelihood of these apparent choices. Our work uses theoretical ideologies based on Husserl's notions of 'humans as the centre of their World'. Amongst other things, this has inspired the creation of an in-house developed program that recreates contexts from an individual's field of view, a human scale. The program, Horizon, uses topographic, astronomic, and atmospheric data, along with information on human vision and 3D-rendering techniques, where a change in time and/or location accurately alters what can be seen astronomically and/or in terms of landscape, such as the shape of the horizon. Accessing the asci horizon data created by this program, for instance, allows it to be used in quantitative assessments about landscape choices through time within or across regions and can be used to test whether the locations or other aspects of the monuments were random or not. The creations of the 3D models at numerous sites allow for the comparison and seeking of possible land-sky-scape patterns in terms of detailed visible topography and astronomy that are often not apparent, even if we visit all these sites ourselves. New statistical tests along with test and new model outcomes will be presented.

Place: the Physical Embodiment of Collective Information

Higginbottom, Gail (Australian National University)
Vincent Mom (DPP Foundation)

Abstract We argue that many classic Landscape Archaeology studies still tend to use GIS tools to create a 'god's-eye' perspective, where the images they produce are views from above the landscape looking down, like 2D-maps or viewsheds. This 'god's-eye' perspective assumes all agents or individuals have complete spatial information and are situated in a global frame-of-reference. By contrast, this project is inspired by 'individual

immersion models' and has a tool that recreates contexts from an individual's field of view (Higginbottom in press). It is, therefore, an investigative aid for examining archaeological problems about people (Herman 2008) rather than just "illustrating knowledge already gained once serious scientific investigations ha(ve) been concluded" (Forte 2008, 22). Specifically, this powerful tool allows us to visualise how the sky and landscape appeared together by people in the past, viewed from any chosen point in a real landscape. The tool, whilst not VR, uses topographic data and 3D-rendering techniques to create landscape views with visual depth. Using the actual program developed by Andrew G.K. Smith called Horizon as our slide, we will demonstrate land-sky-scapes seen as day and night views with the paths taken by celestial bodies across the visual field, demonstrating that the situating of monuments in prehistory encompasses a complex frame-of-reference for collective cultural knowledge. The night views have never been presented previously. We apply this approach to new case-study sites recently visited in Scotland on the isle of Mull and the mainland of Argyll.

Low Cost, High Accuracy Drone Survey Methods

Hill, Austin (Dartmouth College)

In the last few years Unpiloted Aerial Vehicles (UAVs), or drones, have been widely adopted by archaeologists as an important tool for archaeological survey, excavation recording, and heritage site management. As technologies have improved and costs have plummeted, it has become possible to record increasingly large areas at high resolution. Now that drones are a common part of the archaeological toolkit, there is increasing interest in low cost ways to improve accuracy and survey efficiency in the field. This paper will present quantifiable results, comparing multiple data collection workflows, from local site tests in New Hampshire. This data demonstrates that using DIY (Do it yourself)-style drones and low cost PPK (Post Processed Kinematic) GPS tools for survey work can both improve georeferencing and decrease field time and equipment requirements. These will be critical improvements for archaeologists working with limited budgets or with limited access to sites for documenting damage.

Designing and Using Game Environments as Historical Learning Contexts

Hiriart, Juan (University Of Salford School Of Arts And Media)

The virtual presentation of landscapes in games, thanks to the exponential increase of representational power of digital technologies, has been progressively challenging the capacity of gaming audiences to distinguish virtual environments from real-world referents. This spectacular growth, however, has not been mirrored by a comparable progress in the simulation of the natural and social processes from real environments. Although highly realistic, game landscapes in most commercial titles still remain as inert theatrical scenery, devoid of

any capacity to reflect the effects of human life agency and the inextricable nature of social and natural processes. In this presentation, I would like to demonstrate a historical game prototype that I have been developing as part of a PhD research, with the purpose of investigating possible design solutions to the problem of creating game environments capable of transmitting the inherent complexity of historical landscapes. The game reconstructs Early Medieval Britain, focusing on the micro-histories of everyday life instead of more stereotypical forms of gameplay centred on the simulation of violent conflicts. Currently in its final version, the game has been iteratively produced in cycles of development and play-testing sessions with the participation of archaeologists, historians, and educators who have given valuable feedback about its design, direction, and potential use.

Designing Locational Models to Test Settlement Theory

Hobbs, Elizabeth (Minnesota Department Of Transportation)
Michael Bergervoet (Minnesota Department Of Transportation)

Archaeological locational modeling is premised on the assumption that archaeological site locations (the dependent variable) can be predicted by a suite of independent, mostly environmental, variables. Settlement theory informs which site populations and environmental variables we choose to model, but how do we design our models to best test that theory? Many publications in this field have focused on the selection of the appropriate statistical test for representing the relationship between sites and their environment. In this paper we examine the selection of both dependent and independent variables to best represent the prehistoric patterned behaviours we wish to understand. We draw examples from our experience developing models for the state of Minnesota (MnModel) 20 years ago and from the actions we have taken since then to improve those models and the insights they can provide about prehistoric settlement in Minnesota. In particular, we discuss the importance of how well independent variables depict aspects of the prehistoric landscape thought to be important for hunter-gatherer economies and the separation of economic from cultural constraints on site location.

MorgantinaVR: Cityscale Handheld AR and Cross-platform VR for Visulizaing Georeferenced Datasets as a Part of a Microservices Software Architecture

Hollis, Luke (Archimedes Digital Classical Language ToolKit)

As the first wave of generally available virtual reality devices has emerged, Archimedes Digital has focused on cross platform VR/AR/MR applications to provide interpretive materials for archaeological sites as well as visualization tools for researchers. Working with the Contrada Agnese Project at Morgantina (Sicily), our

applications visualize historically-accurate architectural reconstructions and datasets alongside georeferenced photogrammetry to connect users to ancient greco-roman culture onsite and enable archaeological researchers to interpret excavation data. The georeferenced datasets may also be viewed in a web portal that offers 2d and 3d interfaces for visualizing the Contrada Agnese Project's data. While onsite at Morgantina, using a smartphone or Project Tango-enabled device, users can explore the monuments in the agora where currently only foundations of ancient structures are visible. The smartphone application uses the device GPS and compass for localization with about 1-6 meter accuracy, and the Project Tango tablets offer much finer spatial awareness and motion tracking through use of the Project Tango software's area description files. Users who aren't onsite at Morgantina can explore the agora reconstruction in VR with HTC Vive, GearVR, Hololens, and Google Cardboard to tour the agora throughout the course of the centuries of its growth and decline and explore buildings that have been backfilled or lost. Similarly in VR, site researchers are able to browse a day-by-day recreation of trench models and 3d rendering of the museum and geospatial teams datasets.

Modeling Resource-driven Out of Africa Hypotheses – Potential and Challenges

Hölzchen, Ericson (Senckenberg Research Institute, ROCEEH, Senckenberganlage 25, 60325 Frankfurt Am Main, Germany ROCEEH, Heidelberg Academy Of Sciences, Karlstraße 4, 69117 Heidelberg, Germany)
Christine Hertler (Senckenberg Research Institute, ROCEEH, Senckenberganlage 25, 60325 Frankfurt Am Main, Germany ROCEEH, Heidelberg Academy Of Sciences, Karlstraße 4, 69117 Heidelberg, Germany)

The earliest hominins originated in Africa and from there dispersed across Eurasia. At least two different hominin dispersals out of the African continent can be distinguished. We refer to "Out of Africa 1" as the dispersals of early hominins before modern humans and "Out of Africa 2" as the dispersal of modern humans. It is currently debated how intensive the interactions among different early hominin species were and where they took place. Knowing the past dispersal routes allows us to identify potential regions of interaction. However, the mechanisms of early hominin dispersal are not clarified. Among various factors, distribution and acquisition of resources are proposed as main drivers in early hominin dispersals. However, we do not know to what extent. Here, we used agent-based modeling to assess the impact of different resource types on early hominin dispersal patterns and to identify the capability and limitations of input data and modeling abstractions. The resources of various types are represented on a world map. The agents represent hominin groups who disperse by reproducing into neighboring patches, whereby patches with a higher amount of resources provide a higher chance of survival. We compare dispersal patterns to quantify the impact of specific resource types on the dispersal. The results of the first runs of the model tests will be introduced and future challenges will be summarized.

Developing a Standardized Workflow for Digital Preservation and Analysis of Archaeological Ceramics

Howland, Matthew (Department Of Anthropology University Of California San Diego)

The digital revolution in archaeology has opened up a new avenue of archaeological preservation: digital documentation and storage. Adding a digital record of excavated artifacts can preserve the original, excavated form of artifacts against both physical deterioration over time and destructive sampling of objects. A digital record of artifacts can also allow for techniques of digital shape/volume analysis not possible through analog methods. These advantages of digital recording and analysis are dependent on a consistent, quality data acquisition strategy to ensure comparability between different artifacts or even datasets. To that end, this poster describes the creation of a standardized Structure from Motion and morphological and typological analysis program applied to ceramics recovered by the Edom Lowlands Regional Archaeology Project, as well as the creation of a systematic digital database for the results of modeling and analysis. 3D modeling is done using Agisoft Photoscan, while form analysis is performed using the Pottery Informatics Database, developed by Dr. Neil Smith. This work is part of a larger ceramics study, the full extent of which is beyond the scope of this poster.

Continuous Interactivity in Archaeological Visualisation

Huggett, Jeremy (Archaeology School Of Humanities University Of Glasgow)

Along with the growth in 3D environments, VR, AR, mixed reality, etc. has come a corresponding requirement for interactivity as an increasingly essential aspect of our visualisation. But what do we mean by interactivity? What are we actually interacting with? Should we be capturing and modelling our interactions? Is there such a thing as inappropriate interactivity? Can there be too much / too little interactivity? What do we learn from interactivity? Does an interactivity encapsulated within a 21st century technical environment have any real value for our understanding of the past? This provocation seeks to lay down a challenge for future visualisations in archaeology, based on approaches such as activity theory, the extended mind and related theories, which in combination offer the potential to apply a radically different perspective to the critique.

Everything Wrong With … Digital Archaeology

Huggett, Jeremy (Archaeology School Of Humanities University Of Glasgow)

Despite the deliberate provocation in the title, there's a serious debate to be had: that we often forget about – even ignore – the digital in our pursuit of the archaeology. The implications of this are far-reaching given the extent to which we are increasingly entangled in a digital world. The proposal here will be that we need to develop an archaeology of the digital that sits within Digital Archaeology. [Given the scope of the topic (!!) I'd lean towards the 10 minutes rather than 5 if at all possible ...]

Context and Community: Accountable, Open Presentation of Digital Archaeology

Huntsman, Theresa (Sardis Expedition, Harvard Art Museums)
Eric Kansa (Open Context)

In archaeology, context is everything. Context is multi-dimensional, simultaneously physical, social, cultural, and intellectual. Therefore, digital archaeological initiatives, especially those highlighting war and ideologically-motivated destruction of cultural heritage, must respectfully engage these different contextual dimensions. Unfortunately, several digital initiatives have failed to include any contextual engagement, and as a result the 24-hour news cycle has only fetishized ancient replicas and their technology. The high-profile reconstruction of the Palmyra arch represents a watershed moment for digital archaeology. Will digital archaeology offer effective, accurate, and respectful approaches to contextualizing the past? Or will the fetishizing of technology overshadow the tragic human dimension of the war and its effect on Syria's historical legacy? ISIS's destruction of monuments is just the tip of the iceberg, and the trauma inflicted on the Syrian people represents the gravest threat to Syria's cultural heritage. After all, people and communities, especially those that live in and around archaeological sites, are the key actors in stewardship; they have been entirely left out of the presentation of 3D models. This paper argues that digital archaeology can be done well with more accountability and attention to context via richer, open web presentation of information. We must work with a wider community to unite vast collections of digital data, along with cross references, so that collections can enrich and add context to each other. The key to make this work is the community aspect, enriching and expanding those communities across institutional, linguistic, and cultural boundaries.

Tradition and Innovation: From Worksite Plans to Digital Models

Inglese, Carlo ("Sapienza" University Of Rome)
Carlo Bianchini ("Sapienza" University Of Rome)
Alfonso Ippolito ("Sapienza" University Of Rome)
Martina Attenni ("Sapienza" University Of Rome)
Valeria Caniglia ("Sapienza" University Of Rome)

The study and analysis of archaeological elements often ranges from very big sites to small objects. This difference in size and type is also present during survey and representation. This idea sparked the proposed study of worksite plans representing the only firm link between historical architecture (designed, analysed and theorised) and its representation. The objective is to develop a new interpretation of worksite plans based on the enormous options provided by the merger of massive acquisition technologies and digital representation. When combined it is possible to build extremely detailed, ideal models with which to acquire extensive, in-depth knowledge (Descartes) of the studied object. The topic is part of the studies on the origins of architectural drawing based on the interdisciplinary union between architecture and archaeology. The objective is to critically interpret worksite plans in order to establish and classify a study method that can lead to an efficient cataloguing of geometric/formal, theoretical/ideal and metric/constructive issues. Based on these premises we examined the key relationship exists between the metric/formal construction of a two-dimensional drawing (plan) with a three-dimensional drawing (ideal model). The study is part of the now consolidated drawing/survey/design process which, based on objective/real drawings leads to a three-dimensional/ideal model. Geometric/constructive tests alternate with tests between ideal models and real models as part of the debate on the relationship between sign and model and between what is real and what is virtual.

Quantity vs Quality: Advantages and Disadvantages of Imaged Based Modelling

Ippolito, Alfonso ("Sapienza" University Of Rome)
Carlo Inglese ("Sapienza" University Of Rome)
Martina Attenni ("Sapienza" University Of Rome)
Valeria Caniglia ("Sapienza" University Of Rome)

In the last years, survey has changed radically thanks to progress in the field of 3D massive acquisition methods. A variety of data acquisition modes are increasingly easy to access and use to document Cultural Heritage. The scientific debate focuses on the control over data quality, in terms of metric accuracy, by comparing 3D image-based acquisition methods with consolidated methods. The term “digital building recording technologies” may infer collection of accurate and efficient dimensional data, but in actuality a building’s size is often not the only focus for the knowledge, preservation or conservation. Collecting, interpreting and filing a large amount of information helps to define a system we can use to understand our Cultural Heritage. The system has to be based on scientific process used to achieve a dual objective: to document acquisition using a heterogeneous set of data and metadata to guarantee repeatability; to ensure data quality during data capture and processing of 2D and 3D models. These contain heterogeneous information that may be equally important in the context of preserving or conserving an Cultural Heritage. They include cultural resource data: dimension, information on construction, evidence of architectural modification; material characteristics, color; etc. The case of study, the Abbey of Santa Maria della Matina,

focuses on the shift from quantitative data, acquired in a semi-automatic manner, to qualitative data, meticulously controlled as regards uncertainty. In this framework, all branches of the Science of Representation ensure metric, spatial and formal control of the built models.

Supporting Community Annotation with Recogito 2

Isaksen, Leif (Lancaster University)
Rainer Simon (AIT: Austrian Institute Of Technology)
Elton Barker (The Open University)
Valeria Vitale (Institute Of Classical Studies, School Of Advanced Study)
Rebecca Kahn (Humboldt Institute For Internet And Society)

Recogito is a tool developed by the Pelagios Commons initiative in order to facilitate the semantic annotation of place references in texts, tables and imagery. Originally designed to annotate place references in early geographic documents, the tool has seen uptake by practitioners across the digital humanities, and these in turn began to highlight some of its limitations. These included: - a single workspace for all registered users, leading to inflexible and centralised document management - support for only a narrow range of file formats - lack of integration with other mainstream DH technologies. Consequently Pelagios Commons has redeveloped Recogito from the ground up, in order to support a fully multi-tenanted online annotation platform that a) allows users to upload, annotate and share content with other members of the community, b) supports major standards including the Text Encoding Initiative (TEI) and the International Image Interoperability Framework (IIIF), and c) offers a wider range of input and output formats so as to provide maximum flexibility across its stakeholder group. This presentation will describe the latest developments for Recogito, and situate them within a broader series of activities within Pelagios Commons intended to increase decentralisation while ensuring sustainability.

Context as Theory: Towards Unification of Computer Applications and Quantitative Methods in Archaeology

James, Vivian (University At Albany, State University Of New York)

There are three problems in archaeology that a GIS-based solution can improve or resolve: archaeologically theorizing computer applications for archaeology; research detachment – geographically, linguistically, and physically; and curation alternatives. Context in archaeology is a theory of inclusion, which differs from context in computer science and other fields where context is a theory of exclusion (i.e., context is everything except whatever is being studied). Context is everything in archaeology – the research context (the

conditions under which research is conducted), the geographical context, the archaeological context, the environmental context, the taphonomical context, the social context, the institutional context, the hermeneutical or interpretive context, the curation context – each of which is embedded and overlapping in multiple scales, constituting the dimensionality of archaeological research. Context as theory organizes this multidimensionality and is ontologically based in the site, subsite, feature(s), assemblage(s), artifact(s), and the detail(s) of the artifact – literally, everything! GIS layering and sequencing enable modeling and analysis of the multidimensionality of context. Database hyperlinks and multimedia within the GIS provide synergistic opportunity for alternative curation, (e.g., digital), and (re)connects detached research. A multidimensional perspective of context as theory crosscuts themes and archaeological settings to unify what only appears to be the fractured character of computer applications and quantitative methods in archaeology.

Semantically Enhanced 3D: Introducing a Web-based Platform for Spatial Integration of Excavation Documentation

Jensen, Peter (Aarhus University)

The promise and premise of 3D photogrammetric field recording is currently out of alignment with archaeological practice. The reality-proximate, photorealistic, and geometrically accurate representation of excavation situations advanced by technologies such as Structure From Motion, has the potential to strengthen the post-excavation interpretation process, as it becomes increasingly easy to share the observed archaeology with other researchers. However, the spatial representation is paradoxically lacking in its ability to convey archaeological interpretation, as existing solutions usually only provide surface geometry and texture, and are limited to proprietary desktop solutions. The advent of HTML5 and WebGL means that JavaScript enabled browsers may interactively render and manipulate 3D content client-side.This paper demonstrates how a web-based 3D platform is able to facilitate the collaborative exchange of 3D excavation content almost instantaneously. The platform is based on a philosophy of integrating all spatial and attribute data into one common data model, effectively storing all geometry as Well Known Text in an Open Source Data Management System. Focusing particularly on how we may use custom algorithms to enhance the semantic value of 3D models by segmenting the geometry, the paper demonstrates a framework for interactive 3D models, which includes attributed classification correlated with traditional raster, vector and textual data. Rather than enforcing new standards for 3D content, the paper seeks to emphasize the focus on developing tools for analysis and management of 3D content as well as building infrastructures for the purpose of cross-disciplinary collaboration, research and knowledge exchange.

Application of a 3D Morphing Technique to Analyze the Style of Archaeological Models

Jiménez-Badillo, Diego (INAH: National Institute Of Anthropology And History, Mexico)
Salvador Ruíz-Correa (Center For Mobile Life Studies Insitituto Potosino De Investigación Científica Y Tecnológica)
Mario Canul-Ku (Centro De Investigación En Matemáticas, A.C.)
Rogelio Hasimoto-Beltrán (Centro De Investigación En Matemáticas, A.C.)

Thanks to recent advances in scanning technologies there has been an increase in the number of methods developed for digitizing archaeological artefacts. Many of the resulting 3D models are used for visualization or archiving purposes. Unfortunately, there are still few projects oriented to gain archaeological knowledge from point clouds and triangular meshes. In this paper we present some results of an ongoing project focused on analyzing the shape of artefacts, focusing specifically on a new method to analyze variations of styles in archaeological artefacts. Such method is based on a 3D morphing algorithm that analyzes two objects whose shapes represent the canonical extremes of a continuum, that is, two objects that belong probably to two different "styles" within a cultural tradition. The purpose of the algorithm is taking these two extreme shapes as input in order to extract several 3D virtual models whose shape or "style" lies in-between. This is useful in situations where archaeologists need to decide to which extreme a real artefact is closer or how far its shape is to each extreme. We apply the method to rank shape similarities in a collection of archaeological stone masks from Mexico. This includes masks belonging to several well-defined styles, but it also includes many others that cannot be positioned within a specific style because they share features of two or more canonic styles.

Building Web-based Integration from Data Model through Tablet Data Collection to Analysis

Johnson, Ian (University Of Sydney)

This paper addresses the theme of the session through a case study of the FAIMS Android data collection app and its integration with the Heurist web-based data modeling, management and analysis tool. The workflow encourages de-facto standardisation, without prescription, through Heurist's ability to publish and share elements of existing data models. These elements can be subsequently combined, extended and customised for a specific project. The resulting data model can be used to generate a FAIMS configuration, allowing field data collection with full spatial functions (including GPS, total station and georeferenced image integration) and seamless data synchronisation across multiple tablets. Heurist ingests FAIMS-generated field data, rich legacy spreadsheets and file-based resources, providing an integrated web-based data manager. It provides filtering, basic mapping, crosstabulation and network visualisation, and flexible output for external analysis, web publishing and archive packages. Heurist and FAIMS are Open Source and model-agnostic, and can be adapted, largely without programming, to many kinds of survey and excavation fieldwork, environmental monitoring and historical research. The session abstract asks whether a single all-encompassing platform is

the best solution. We will argue that an integrated but highly customisable environment provides significant advantages over separate tools or a bespoke system, up to the point of preliminary analysis and visualisation (including summary statistics and mapping). More in-depth analysis should be delegated to appropriate tools, so an integrated environment should have the ability to filter and repackage data as required, in order to drive analysis tools and web publishing platforms.

Social Network Analysis of Ancient Families: Exploring the Effects of Known Unknowns using Phenotypic Data from Documented Collections of Human Skeletal Remains

Johnson, Kent (School Of Human Evolution And Social Change Arizona State University)

Recent research suggests social network analysis of phenotypic data is a viable method for investigating genetic relatedness, population history, and population structure in archaeological skeletal samples. However, bioarchaeological applications of social network analysis face unique challenges inherent in phenotypic data drawn from human skeletal remains. This paper evaluates the effects of two known unknowns on the ability to identify biological family networks within cemetery samples using social network analysis of phenotypic data: unknown heritability estimates for the phenotypic traits analyzed and the lack of established criteria for differentiating biological relatives from non-relatives. Dental morphological and metric data were collected from dental casts taken from over 400 individuals from a single population of Gullah, an African American community from St. James Island in the Outer Banks of South Carolina, for which genealogical data are available. Two adjacency matrices are created using Gower's similarity coefficients: one based on phenotypic traits weighted by observed heritability estimates and one weighted using generic heritability estimates. The effects of using generic heritability estimates for phenotypic traits to create social networks are evaluated using network visualization, network and node measures, and network structure. Distributions of Gower's similarity coefficients are generated and used to identify informed breakpoints for differentiating close relatives from non-relatives when heritability is known and unknown.

The ASOR Cultural Heritage Initiative-TerraWatchers Collaborative: Crowd-Sourced Monitoring of At Risk Cultural Heritage Sites in the Middle East

Johnson, Andrew (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)
Steve Savage (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)
Tom Levy (Center For Cyber-Archaeology And Sustainability, University Of California San Diego)

The Middle East is home to over 40,000 different archaeological sites dating from the Neolithic to modern times. With such a major concentration of sites, the Middle East provides archaeologists and historians with a

record of thousands of years of history through its material culture and written texts. Today the countries of the Middle East are at war, and Islamist extremist groups such as ISIS, other militant groups, and civilians, as well as environmental processes, are putting these cultural heritage sites at risk of destruction. Partnering with the American Schools of Oriental Research (ASOR) and funded by a University of California (UC) Office of the President's Research Catalyst Award, UC San Diego started a research project in March 2016 to monitor at risk sites in the Holy Land using crowd-sourced observations of satellite imagery. Locations of 12,000 at-risk sites in Syria and Iraq have been provided by ASOR and uploaded into a web-based application called TerraWatchers. TerraWatchers runs satellite imagery through Google Earth and Digital Globe. UC students were recruited to record observations of 14 different kinds of damage to these at-risk sites including looting, refugee camp impacts, explosive damage, and erosion. Results show that thousands of sites in the Middle East have incurred significant damage. Further, while crowd-sourcing is an extremely useful method for sifting through massive amounts of data quickly, proper training is required to ensure accurate observations.

Shifting Stones and Data Points: Using Terrestrial Laser Scanning to Assess Damage to Monumental Architecture in Hawai`i

Johnson, Adam (Southern Methodist University)

The use of 3-D technologies in archaeological practice has grown significantly within the last decade. In this paper I present a case study of traditional temples (heiau) located within the boundaries of Pu`ukoholā Heiau National Historic Site on Hawai'i Island to address two questions raised by this trend: are there significant differences between volumetric data collected from TLS and other techniques? And, what impact can high-definition documentation have on determining labor estimates for ancient architecture? This paper highlights how total station and TLS techniques were applied to better understand the effects of natural disasters on monumental temple sites built from dry-set basalt stone on the Big Island of Hawai`i. Major structural damaged occurred to two major temple sites (Pu`ukoholā and Mailekini Heiau) in 2006. Total station and terrestrial laser scanning (TLS) survey methods were employed to record damaged and repaired conditions and solid meshes created from post-processed data was used to quantify the scale of structural failure. Volume measurements derived from total station and TLS were statistically evaluated using paired T-tests to determine if there were significant differences in the volume measured by each technique. Volume was of particular interest since volume of stone is a common proxy for labor inputs in the construction of Hawaiian architecture. The results suggest that there are merits to a combination of survey techniques and that construction labor estimates can vary depending upon a number underlying assumptions.

3D User Interfaces at the Nexus of Technical Processing and Creative Design in Digital Archaeology

Johnson, Tyler (University Of Michigan)

Structure-from motion-photogrammetry (SFM) represents a cost-effective way of acquiring 3D field data. SFM facilitates the creation of high resolution 3D models of archaeological features, complete with detailed textures and "georeferenced" positional data. While this method of documentation is efficient, no standard practice currently exists for packaging sets of models into a format which is publishable or useful for analysis and research. SFM has been an integral part of the Gabii Project's field documentation strategy for several seasons, and the excavation has committed to a program of publishing its field reports in a web-based format, featuring an interactive, game engine-based visualization of its SFM models. This paper provides an overview of the technical challenges our team has faced as we have developed this workflow. The solutions we have settled upon involve the retopology of SFM models (a process of transferring the weighty 3D resolution of meshes to a more manageable, texture-based format), their insertion into an interactive, game engine-based environment, and the design of a user interface for exploring the models in a contextualized, engaging virtual setting. I will make the case that in addition to technical processing, creative interface design is a key aspect of analysing and publishing 3D field data, outlining some of the challenges we have faced in attempting to design an archaeological user experience for a web-based publication.

How Can Something so Small Cost so Much? Cost- and Time-Efficiency in Microartifact Analysis

Johnson, Phyllis (Vanderbilt University Department Of Anthropology)

Microartifacts (measuring less than 1/4-inch) can provide robust and complementary information to that of macroartifacts by discerning site integrity, spatial organization, lithic reduction strategies, and site formation processes. As beneficial as microartifact analysis can be to archaeologists, the time commitment and resulting costs of these analyses make them impractical for most projects. As such, I suggest an experimental machine-learning methodology for reducing the time and costs required to complete these analyses.

Campus Archaeology and Digital Mapping: Urban space and Commerce in Lincoln Nebraska, 1870-1920s.

Juckette, Cole (University Of Nebraska Lincoln (UNL))
Effie Athanassopoulos (University Of Nebraska Lincoln)

Aaron Pattee (Heidelberg University)
Kami Ahrens (University Of Nebraska Lincoln)

This presentation showcases the application of GIS techniques to excavations on the University of Nebraska-Lincoln (UNL) campus. The project combines historic maps of Lincoln and 3D models of excavated artifacts, traces Lincoln's development at the turn of the 20th century as the university expanded into residential areas, and preserves a now 'invisible" portion of Lincoln's developmental history Throughout the past century, the majority of Lincoln's early buildings were demolished and its material culture lost. Excavations of these former areas were conducted in the 1990s and early 2000s, though the excavated artifacts were stored away and only recently rediscovered. The archaeological collections are diverse and in excellent condition, drawn mainly from former local residences, a cistern located under the UNL student union, and a privy near the university theatre. They consist of glass bottles, ceramics, metal tools, and utensils. Using ESRI ArcMap, each map layer will represent new phases in land use, the initial growth of residential neighborhoods, and their subsequent contraction as the university expanded. The data on urban expansion and development will be determined by cross-referencing the historic Sanborn Insurance maps and bird's-eye drawings commissioned by the state. 3D photogrammetric models of artifacts excavated from the various sites will be geo-referenced to their respective locations within the maps, allowing researchers to visualize their positions, manufacture, and distribution in ArcScene. The maps will be essential in the development of a digital resource, integrating digitized primary sources, 2D images, and 3D models generated by the UNL Campus Archaeology project.

Contextualizing Cultural Heritage – the Cupola of the Torres de las Damas in the Alhambra

Kai-Browne, Arie (University Of Applied Sciences Berlin)
Thomas Bremer (University Of Applied Sciences Berlin)
Kay Kohlmeyer (University Of Applied Sciences Berlin)
Julia Gonnella (Museum For Islamic Art Berlin (SMB))
Sebastian Plesch (University Of Applied Sciences Berlin)
Susanne Brandhorst (University Of Applied Sciences Berlin)

Nowadays, 3D scanning technology and image based modeling can be considered as established methods for the highly accurate documentation of cultural monuments. In many cases the technology is applied as a beneficial substitute for classic approaches of cultural heritage documentation, where the derivatives serve as basis for architectural research, restoration/ conservation, art history etc. Nonetheless 3D documentation can offer a much wider range of interesting applications to help enhance the understanding of our cultural heritage. In the past years, a team of researchers at the University of Applied Sciences Berlin has been using 3D technology for contextualizing cultural monuments and applying various methods for an immersive interaction with complex 3D-data. In the current case study, the cupola of the Torres de las Damas of the

Palacio del Partal in the Alhambra, which was brought to the Museum for Islamic Arts Berlin in the beginning of the 20th century, has been documented using a 3D sensor-fused based approach. Additionally, the original tower room as well as the entire building was recorded. Through the use of VR as well as AR technology these highly accurate and detailed data-sets will enable laymen as well as researches to interactively view the re-contextualized architectural parts for the first time since its original removal.

The More the Merrier? Two Conflicting Stances on Multi-Array Sensors

Kalayci, Tuna (Laboratory Of Geophysical - Satellite Remote Sensing & Archaeo-Environment Foundation For Research & Technology, Hellas (F.O.R.T.H.))
Meropi Manataki (Laboratory Of Geophysical - Satellite Remote Sensing & Archaeo-Environment Foundation For Research & Technology, Hellas (F.O.R.T.H.))
Apostolos Sarris (Laboratory Of Geophysical - Satellite Remote Sensing & Archaeo-Environment Foundation For Research & Technology, Hellas (F.O.R.T.H.))

This paper reveals two opposing experiences with two different multi-array systems within the Mediterranean context. A multi-array geomagnetic sensor has been successfully deployed in numerous field surveys and has revealed invaluable archaeological and paleogeographic information over extensive areas, both in land and marine environments. Thanks to the advancement of this instrumentation, it has been truly possible to conduct geomagnetic prospection following a landscape archaeology approach and to address research questions at multiple scales in tandem. An imaging radar array, however, proved to be inefficient in the same research context. Prospection mostly failed due to logistical reasons as well as high signal-to-noise ratio. Single sensor GPR revealed better results during data collection and processing. The imaging radar array performed better only in specific environments. Following some prime results from GPR and geomagnetic prospection we address issues like; cost and benefit analyses, emerging possibilities due to flexibility of multiple carrier setups, new processing techniques, and the impact of sensor designs on survey strategies. As a result, we welcome and favor the use of multi-array sensors in archaeology –with reservations.

The Volume of Ancient Movement: A Satellite Remote Sensing Approach

Kalayci, Tuna (Laboratory Of Geophysical - Satellite Remote Sensing & Archaeo-Environment Foundation For Research & Technology, Hellas (F.O.R.T.H.) Institute For Mediterranean Studies (I.M.S.))

Ancient paths reflect the motivation behind movement. Therefore, they provide a glimpse of daily lives of individuals as well as embedded rules and societal norms. Despite their significance in the archaeological record, studies on ancient paths and roads remain static due to the nature of available data. In particular, scholars provide a layout of the movement, but fall short in explaining the traffic –as the prime agent of road

making. This study focuses on Early Bronze Age roads network in Upper Mesopotamia. It has been shown that the movement embedded within production economies contributed to the formation of the network. In pursuit of this phenomenon, the study explores a typology of roads. It is hypothesized that variations in the ancient traffic differentially changed soil physical characteristics (e.g. soil compaction/moisture) so that past variation in traffic is still detectable on satellite data. As for the methodology, the road system is indecisively visible on CORONA imagery. Thanks to this historic satellite system, it is possible to map the road network in its entirety. Likewise, multispectral datasets (e.g. Landsat) reveals clues for the locations of past movement. In particular, time dependency of spectral visibility offers the potential for classifying roads under climatic stress; i.e. vegetation growth over ancient roads is intrinsically related to the character of deposition. Therefore, variations in vegetation health may be used as a classification schema. Finally, the impact of post-depositional processes are nullified by cross-comparing proxy remote sensing variables collected over the roads and from their immediate surroundings; under the assumption areas with close proximity had witnessed same surface processes. The results do not provide a direct estimation of ancient traffic (i.e. the number of moving agents). However, some inferences can be made in regards to which roads might have been used more frequently than others.

Digital Digestion: Roman Food and Digital Objects at Corinium Museum

Kamash, Zena (Royal Holloway, University Of London)

This paper will present the results of the 'Digesting the Romans at Corinium Museum' project. The project has laser-scanned and 3D printed a selection of objects from Corinium Museum's collections that relate to food; some of these objects have also had poems written about them by Dan Simpson as part of the same project (http://coriniummuseum.org/corinium-poetry/). These scans, prints and poems were used in a series of focus groups with different user groups, in which we discussed the future of these technologies and approaches in museums, encouraging discussion and debate on a range of questions. As well as sharing the results of the focus groups in this paper, the scans, prints and poetry will be made available to the session participants, so that we can continue the discussion over key issues that have arisen in the focus groups, including: - do people feel that the 'real' objects, the 'digital' objects and the poems offer different experiences of the same object? - Do people feel that the laser-scans and the 3D prints are the same as the original object? Or do we now have two different objects? - Would the provision of more digital 3D objects online and/or poetry encourage more people to come into a museum to see the 'real' objects?

'Postcard to Palmyra': Exploring Visitor Responses to the Replica of the Triumphal Arch from Palmyra in Trafalgar Square, London

Kamash, Zena (Royal Holloway, University Of London)

This paper will present the results of analysis of responses gathered on postcards during a three-day event (19th-21st April 2016) in Trafalgar Square, London that saw the installation of a replica of part of the triumphal arch from the archaeological site of Palmyra, Syria. A team from the Department of Classics at Royal Holloway, University of London (who were not involved in the creation of the arch by the Institute of Digital Archaeology) invited visitors to write postcards on which they were able to share any memories of the site and any thoughts, hopes and fears for its future, including whether it should be reconstructed or not. Over 340 postcards were gathered and included responses from Syrians and Iraqis, as well as many other visitors to the installation. As such this collection represents an excellent opportunity to gain an understanding of how local communities and non-specialists felt about the arch and their thoughts and hopes about the future of Palmyra and archaeological sites in the Middle East more generally. The postcards provide us with a vital insight into various issues concerning colonialism, ethics and the politics surrounding the creation of the replica arch.

Feasibility Study of Consumer Electronic Scanning Devices for Pottery Documentation

Kampel, Martin (Vienna University Of Technology)
Juraj Sarkisjan ()

In the recent years, 3D scanning has become an integral part of any archaeological documentation where the extraction and description of shape of certain findings is of importance. Besides software advancements for aligning views and generating virtual models, 3D scanning devices have gained a tremendous progress in various requirements like high geometric accuracy, capturing all details, photo-realism, full automation, low cost, portability, flexibility in applications, and efficiency in model size. In this paper, we compare latest available scanning devices with the purpose of acquiring 3D data from archaeological findings. We want to acquire 3D representations of fractured objects like ceramics and other small findings. 3D scanning devices like the IPAD/Kinect structure are now part of consumer electronics. The usability of these devices has increased dramatically. And the prize has reached a range, that personal 3D scanners are feasible. We want to investigate whether these novel devices together with the attached reconstruction software fulfill archaeological requirements for proper documentation. We have a close look at the acquisition process, the registration and reconstruction task as well as the possibilities to scale up 3D modelling for large quantities of archaeological findings. All steps of the whole reconstruction pipeline are evaluated with calibrated as well archaeological objects.

A Reality Check: The Impact of Open data in Archaeology

Kansa, Eric (OpenContext.Org)
Anne Austin (Stanford University)
Ixchel Faniel (OCLC Research)
Sarah Kansa (Open Context, Alexandria Archive Institute)
Ran Boynter (Institute For Field Research)
Jennifer Jacobs (Consulting Ethnographer, Alexandria Archive Institute)
Phoebe France (University Of Hawaii)

This paper presents a recently launched study funded by the National Endowment for the Humanities (NEH) to investigate how to better align field data creation with future reuse and synthesis. Public policy governing research increasingly emphasizes the importance of research data management. Digital repositories now offer critically needed data archiving services. However, such repositories, though necessary, are not sufficient conditions for ensuring access to intelligible and useful data. The data now preserved in repositories still usually result from ad hoc, idiosyncratic, and error-prone collection practices. Teams working with such practices can face difficulties using even their own data. Furthermore, such practices can also compound the costs and difficulties of data reuse, impeding future data analysis, integration, and interpretation. Even in ideal circumstances when reusing archived data, researchers face methodological and sampling variability, different semantic models and levels of data-granularity, different formats, as well as scale and complexity challenges. Navigating these challenges requires consideration of data flows throughout each stage of the research lifecycle. In order to open new research opportunities for ourselves and future generations, intellectually and methodologically rigorous approaches toward data management must underpin each stage of archaeological research, from a project's initial planning to its conclusion. Will top-down bureaucratically mandated "data management plans" be sufficient to motivate improvements in practice? What else stands in the way of improving field practices so that data sharing and archiving makes meaningful contributions to knowledge?

Visualizing and Navigating Chronology in Large Digital Collections

Kansa, Eric (OpenContext.Org)
Neha Gupta (Memorial University Of Newfoundland)

Digital archaeological data are increasingly disseminated through data repositories and publishers. Archaeological data are scalar, ranging from individual objects to macro phenomena that span millennia and continents, which presents a key challenge for the discovery and visualization of relevant digital data. The nested (quad-tree) indexing strategy that is widely used for Web-based maps offers an efficient way to index and aggregate spatial data and enable faceted search applications. While fruitful, quad-tree indexing has not yet been adequately developed for chronological information. Chronological information in archaeology is often expressed as time spans, with early and late dates bracketing the duration (and uncertainty) of ancient events and processes. Early and late date estimates can be used to define a two-dimensional space that can be

recursively represented in a quad-tree index. Using quad-tree indexing for both time and space metadata, we present a customized user-interface integrated in Open Context (https://opencontext.org) that can facilitate visualization of spatial and temporal components of archaeological data. We offer the underlying open-source code on GitHub (https://github.com/dngupta/datavis) to encourage further work on developing tools to visualize space and time in archaeology. Greater efforts in developing visualization tools appropriate for archaeology can enable the discovery of unknown patterns and relationships in digital archaeological data.

What do Web-based Platforms Mean for the Ambitions of Archaeology?

Karenowska, Alexy (University Of Oxford Department Of Physics And Institute For Digital Archaeology)

There is consensus that web-based platforms are changing the face of archaeology. These changes come not only in the form of new tools which can contribute to tackling traditional archaeological problems like, for example, documentation and identification of archaeological finds, but also in the form of a profound expansion in the scope of the field. In short, we are seeing a rapid web-driven evolution in the kinds of activities that constitute archaeology. Against this background, there is much discussion about the specific enabling qualities of, for example, web-based collaborative tools in the context of traditional archaeological practices. So far, however, there is much less dialogue about the more general question of how the availability of such tools might impact on the goals of the activities themselves. In this talk, we consider how the opportunities offered by web-based platforms impact on the ambitions of modern archaeology. We shall make the observation that these ambitions necessarily serve, and indeed, emerge from, different constituencies — academics, museums professionals, and members of the public, for example — and explore the extent to which the roles of these different groups are influenced by new web-driven interactions between them. We shall further put forward the idea that an important effect of the injection of web-based technologies into archaeology is a blurring of the boundaries between traditional roles and ask what this might mean for the future of the discipline.

3D Maya Music: Use of 3D Models for the Creation of Typologies and for Public Outreach

Katz, Jared (University Of California, Riverside)

The largest challenge facing the study of ancient Maya music is the inaccessibility of the musical artifacts, which are housed in archaeological laboratories and museums around Mesoamerica and the U.S. To resolve this problem, I have been creating a database of musical instruments consisting of photographs, contextual information, audio recordings, and 3D models of the artifacts. The 3D models are particularly crucial for the

establishment of typologies of instruments from across the Maya area, as they allow for side-by-side analyses of instruments that are housed in different institutions. This database will be placed online, thus allowing scholars and any interested people to study ancient Maya music. In addition to using the 3D models for academic endeavors, I have created and run an outreach program called the Maya Music Program that uses playable 3D printed replicas of ancient Maya instruments and Google Cardboards to teach people about ancient Maya culture. This program was extremely successful, as it allowed people to experience the past in a very tactile way. 3D printing has created new interactive ways of informing the public about archaeological research. Music was a crucial aspect of ancient Maya culture, and new 3D technologies allow for the subject to be studied more effectively. This talk will discuss how the use of 3D models of ancient Maya instruments is helping to expand the field by allowing for the creation of typologies of musical artifacts and by using playable 3D printed instruments to encourage more people to study ancient Maya culture.

Modeling Human-Environment Interaction in Sub-Saharan Africa: Archaeological Data, Ecological Questions

Kay, Andrea (University Of Lausanne)
Jed Kaplan (University Of Lausanne)

The African Iron Age transition is characterized by a shift from nomadic hunting and gathering societies to food-production, ferrous metallurgy, and centralized states and empires across most of the continent. Because the transition occurred episodically and at different times in different regions, and because large parts of Africa are poorly studied archaeologically, unambiguous evidence for human influence on the environment is lacking in large parts of the continent. In order to better understand the process, pattern and impact of anthropogenic activities on the environment over the African Iron Age, we are developing a continental-scale quantitative model of human-environment interactions. This model will be informed by a synthesis of archaeological, archaeobotanical, linguistic, ethnohistorical, and physical environmental data. The model simulates the area that is used for human habitation and the procurement of food and fuel, which varies based on population, subsistence strategy, technology available to a society, and the intensity with which the land is used. Our model results show how land use in turn has widely varying effects on landscape with respect to indigenous flora and fauna, biogeochemical cycling, and physical properties. While large data gaps still exist, our method demonstrates the potential of using archaeological information for large-scale quantitative modeling.

Sound and Vision of Cup-marked Stones in Rebala Heritage Reserve, Estonia

Kimber, Andres (Institute Of History And Archaeology, University Of Tartu, Estonia)

Perception and interpretation of archaeological sites by acknowledging their acoustic properties has become more and more popular. Although as abundant as cup-marked stones are in Estonia, their possible sonic significance has not been studied until recently. In this paper, intentionality and importance of sound of cup mark pecking is studied. For this, results from experiments are employed to visualize and analyze sound propagation of multiple cup-marked stones using GIS tools. Due to their nature and location in open fields no special effects, such as reverberation or echos, cannot be studied in any resultant manner. Therefore attention is directed at the quantity of cup marks and the relationship between other stones, stone graves, natural landscape and its visual properties. The intentional use of sound in prehistoric communities is oftentimes revealed as some form of pattern. In this respect, preliminary results suggest that sound might have been considered when choosing a stone to make cup marks on. In almost every case, pecking of a cup mark is hearable to at least one other cup-marked stone. In addition, stone graves are not in the range or just on the border areas of hearing the making of cup marks on cup-marked stones. It seems that sound might not be the primary factor explaining the location of cup-marked stones, but definitely one worth considering.

Discerning the Urban Morphology of Angkor Using a Semi-Supervised Algorithm for Manifold Learning

Klassen, Sarah (Arizona State University)
Jonathan Weed (Massachusetts Institute Of Technology)
Damian Evans (École Française D'Extrême-Orient (EFEO))

This paper discusses recent advances using computational and quantitative methods to understand the urban development of Angkor, Cambodia. Members of the Greater Angkor Project have been using aerial mapping and other remote sensing for decades to map the area surrounding Angkor Wat. This work was complemented by a light detection and ranging, or lidar, mission in 2012 that revealed an additional 19,000 features, that have since been digitized. However, the features are both too numerous and too difficult to date using traditional archaeological methods, which presents a serious impediment to diachronic analyses of urban morphology. In this paper, we combine this mapping work with several sets of disparate data to better understand the urban morphology of Angkor. We use a mathematical model to combine temples, reservoirs, and rice fields into plan units based on azimuths, alignments, proximity, and known historical relationships. These plan units are then placed in time by using a semi-supervised algorithm for manifold learning, which uses known date information from inscriptions for some units along with a similarity measure between plan units to infer dates for the remainder of the sites.

The Key to Creating a GREAT Model from Laser Scanning and Photogrammetry

Kleinkemper, Larry (AIA)

You spent the budget on 3D Laser scanning your site, and bought the best camera for photogrammetry...now what? This talk goes through the best and worst practices for getting great reference data, and then what you can do with it. We will review key requirements for a technical model vs visualization model. We will touch on standards you should require when contracting out the service. We will explore a variety of uses for the data once translated into a computer model.

Best Practices for Mobile GIS and Information Technology in the Field

Knoop, Peter (University Of Michigan)

The increasing availability and power of mobile information technology in the field is enabling new and innovative applications of GIS from archaeology to zoology. We present an overview of emerging best practices derived from field-based research and courses that leverage GIS, focusing on archaeology, and related examples from geology, environmental sciences, and ecology. There are several key factors to consider in developing a mobile GIS strategy: power, ergonomics, networking, and data management. For instance, can one rely on an electrical grid or on-site power generation, and are batteries required to transport power to where it is needed? Using a tablet at the office or home is a very different experience than holding one all-day in the field, so ergonomic considerations, such as hand-straps or shoulder harnesses, as well as durability, are important. Often fieldwork represents a significant investment of time and money, so a reliable back-up strategy is a key part of the mobile GIS workflow, and designing one for a field site usually means dealing with a lack of Internet access. It is also important to remember that gathering and using data in the field is typically just the first step of working with information in GIS. Data schemas and workflows should be designed to help maximize productivity in the field, however, they also need to accommodate data-sharing and continued analysis at home. While information technology continues to evolve, these emerging best practices can provide guidance for successful application of GIS in field research and teaching.

Auralizing Ancient Spaces: Sonic Re-Presentation from Architectural Models, In-Situ Measurements, and Experimental Analogues

Kolar, Miriam (Weatherhead Fellow, School For Advanced Research (SAR) & Five College Associate)
José Cruzado Coronel ()

Sound is spatial and physical, whether heard or felt. Beyond sensory engagement of ancient sites, archaeoacoustical reconstructions of spatial sonic dynamics reveal environmental characteristics that influence human behavior. Archaeological auralization––the re-sounding of instruments and spaces from past life––is a

reconstructive and re-presentational interpretive process that benefits from site-contextualized analyses of data and careful analogical consideration, as well as adequately curated presentation to its audiences. For example, to reconstruct acoustics of the partially intact Circular Plaza at the Andean Formative ceremonial center at Chavín de Huántar, Perú, we have collected architectural and acoustical data from in-situ measurements, considered prior research, and incorporated comparative findings from experimental measurements and perceptual observations of an analogical extant structure. Because the computational platforms and technologies for sonic reproduction determine underlying parameters for these virtual re-presentations, we pose a framework for exploring how such work may be understood and interrogated by archaeological practitioners and public audiences.

Multi-Sensory Landscape Analysis of Spanish Mission Building Practices in the Philippines

Koller, Jared (Department Of Archaeology, Boston University)

This paper explores the social and religious ramifications of Spanish settlement-building in the Philippines (1521-1898) by examining the relationship between visual and acoustic information in and around plaza complexes. By inviting acoustic information into archaeological analysis, I hypothesize that multi-sensorial investigations will lead to a fuller understanding of cultural and religious mixing practices in the Philippines during Spanish contact. I test this hypothesis by demonstrating how the geometry and materiality of plaza complexes expanded the audible range of church-bell ringing that emanated from poblaciones (Spanish Colonial towns), which interfered with indigenous musical performances and rituals that were important to local identity and social organization. Multiple visual and audio scenes are created through a combination of ray-tracing analysis and visual modelling that are based on survey and excavation data, environmental reconstructions, and acoustic measurements. The resultant scenes aim to address questions about the relationship of Spanish deforestation efforts in the Philippines to trajectories of audible information within a culturally-specific landscape and how that information is received by individuals who inhabit that space.

Synergistic Collaboration between Data Visualization Experts and Historians in Developing a Geodatabase of Forced Resettlement in the Colonial Andes

Kondo, Yasuhisa (Research Institute For Humanity And Nature)
Akira Saito (National Museum Of Ethnology)
Nozomi Mizota (Doshisha University)
Tomoko Koyama (Kwansei Gakuin University)

This paper reports on an ongoing synergistic collaboration between data visualisation experts and historians in developing a geodatabase of resettlement (reducción) in the colonial Andes (Peru and Bolivia) in order to understand the historical process and the implications of the resettlement of indigenous people in the Andean region after the general inspections of viceroy Francisco de Toledo between 1570 and 1575. As the first step, the database structure was carefully designed through a dialogue between database experts and historians, with Resource Description Framework (RDF) applied as an ontological framework. Then, historians compiled tables of 69 administrative units (corregimientos), 530 and more taxation units (repartimientos), and 870 and more settlements (reducciones) from taxation records (AGI, Lima 464). The Linked Open Gazetteer in the Andean Region (LOGAR; http://logarandes.org/), released from Vanderbilt University, USA, in September 2016 (Wernke and Mumford 2016) was consulted for the location of settlements, which was supplemented by the project team on a real-time basis by using a cloud-based GIS (ArcGIS Online). Further synergistic developments in digital humanities may occur when this geodatabase is published online as a linked open data.

Best Practices and Challenges in Promoting Open Science in Archaeology: Two Narratives from Japan

Kondo, Yasuhisa (Research Institute For Humanity And Nature)
Atsushi Noguchi (The University Of Tokyo)

Open science refers to efforts to make outputs from publicly funded research more widely accessible in digital format (OECD, 2015) and is expected to accelerate social innovation by recycling open research data and resources. In practise, open science can only be promoted by accumulating successful use cases. Two narratives from our ongoing challenges to promote open archaeological data in Japan are shared here with an international audience. The first best practice example deals with open archaeological data from the 'Palaeolithic Sites in the Japanese Islands' database. This database was published online in May 2016 by the Japanese Palaeolithic Research Association to promote wider use beyond the original community, and the first outreach meeting was held in November 2016 with the attendance of ecologists, chronologists, and data scientists other than archaeologists. The second example represented a challenge to open access archaeological data from the 'Replacement of Neanderthals by Modern Humans' project. In this case, a database of Pleistocene archaeological sites in the Old World (Neander DB) was not disclosed because team members were reluctant to release information prior to publication. Nevertheless, progress of open science may save this database, as it has been inherited by the PaleoAsia project and plans are afoot to publish it as open data online in five years.

The Gordian Knot Project: An Integrated Approach for Rock Art Visualization

Kotoula, Eleni (University Of Central Lancashire)
David Robinson (University Of Central Lancashire)
Matthew Baker (University Of Strathclyde)
Clare Bedford (University Of Central Lancashire)
Devlin Gandy (University Of California, Berkeley)
David Wheatley (University Of Southampton)
James Miles (University Of Southampton / Archaeovision)
Jennifer Perry (California State University, Channel Islands)

This presentation discusses the ongoing research for the analysis of Pleito cave pictographs in the Chumash site of San Emigdio, California, with a particular emphasis on the use of visualization techniques. It sets out the proposed methodology for investigating the painting sequence of multi-layered polychrome compositions. It presents the contribution of reflectance transformation imaging (RTI) in synergy with decorrelation stretch (DStretch) and multispectral imaging, as well as 3D digitization and virtual RTIs, towards the analysis of assemblages of paintings with complex biographies, low surface detail, large size and irregular shape in an overall complex geometry under restricted accessibility. • The enhanced perception of the surface morphology provided by RTI emphasizes the dominant paint features and the paint application characteristics. • The integrated RTI and image enhancement approach in the form of DStretch RTI is key for revealing not only fugitive or exfoliated paintings but also their texture. • MS and FCMS imaging assist in initial materials characterization, followed by the application of analytical techniques, such as XRF, FTIR and Raman Spectroscopy. • Virtual RTIs offer the opportunity to capture views of the pictographs, which would have been impossible following mainstream methodologies due to the geometric complexity of the cave.

Incorporating Texture in the Retrieval Process of 3D Models Exploiting Spatial-consistency of Texture Maps

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Georgios- Alexis Ioannakis (Faculty Of Electrical And Computer Engineering, Democritus University Of Thrace, Xanthi 67100, Greece)
Christodoulos Chamzas (Faculty Of Electrical And Computer Engineering, Democritus University Of Thrace, Xanthi 67100, Greece)

The aim of this work is to extend the way 3D content-based retrieval is usually being performed and hence proposes the utilisation of the texture information. To achieve this, it proposes the generation of a spatially-consistent UV map by exploiting computational geometry and planar mesh parameterisation. The 3D objects are parameterised onto a unit-square plane, independently of their genus, by implementing an iterative cutting procedure. The planar mesh is then associated with its texture coordinates and thus a spatial-consistent texture map is produced. Having the texture of a 3D object depicted on a completely 2-

dimensional structure and without inconsistencies, enables us to exploit well-known algorithms derived from the image processing domain and apply them on the object's texture map. We attempt to exploit the texture information in order to detect similarities among 3D objects and objectively evaluate the retrieval performance of different types of 2D features in terms of robustness and relevance accuracy. We apply our methodology on a ground truth dataset that is composed by textured 3D replicas of ancient Greek vessels.

Creating a Future for Automation by Targeting Models to their End-users.

Kramer, Iris (University Of Southampton)

Even though the discussion on automation has balanced towards the believers, the available methods that have been published over the years are yet to be generally adopted by researchers and national mapping projects. There are various possible reasons for this such as the required technical skills (and lack of practical guides) but also the accuracy and the transferability of a final model. As it is now a given that we are able to create successful models it seems fair to shift the focus from displaying possible applications towards discussing the creation of long term solutions for both academia and national mapping projects. This paper will focus on project planning that puts the emphasis on the end-user for creating durable models. In this approach the project should be very aware of the wishes of their end-user (e.g. academic or commercial) for whom they are creating the product. The initiators should be aware of the targeted accuracy but also of the requirements for the final product to be user-friendly. By considering these product requirements there is a standard to meet and the outcome of the model could be assessed accordingly. This approach will be exemplified with the design of a model for a national mapping agency that will eventually have to meet the requirements of the end-user in both accuracy (effectiveness to verify the results in the field) and in user-friendliness (updating the model with newly acquired site or remote sensing data).

One Stone, Two Men, Three Methods: Different Methods – Different Data? Rockart Analysis Testing RTI, Photogrammetry and Laserscan

Kristensen, Steinar (Museum Of Cultural History, University Of Oslo, Norway)
Magne Samdal (Museum Of Cultural History, University Of Oslo, Norway)

Digital 3D-documentation of rock carvings has become an alternative to the traditional analogue 2D-documentation. The discovery of a stone with rock carvings in a burial mound in Vestfold, Norway gave the opportunity to compare three methods of 3D-documentation; Reflectance Transformation Imaging (RTI), photogrammetry and laser scanning. The stone was scanned in controlled conditions at the museum, and the methods were compared with regards to time use and precision. One aspect of traditional rock carving

documentation has been whether to do an interpretation of the rock carving directly in the field or to document as objectively as possible in the field. The successful 3D-documentation can give an exact digital version of the surface that can be studied and interpreted later. The documentation will be done for a certain purpose – it can be done to present the images to a museum audience, for research or for preservation. This paper presents the results of the comparative study and compares the methods in light of the purpose of the documentation.

One Size Does Not Fit All: A Comparison of 3D Data Capture

Krohn, Anna (Brandeis University)
Miriam Clinton (Rhodes College)
Ian Roy (Brandeis University)

The technologies for capturing 3D data are rapidly developing and becoming increasingly accessible for non-technical users; we are at an opportune moment, therefore, to educate our fellow archaeologists on the responsible application of technology. As a new project focused on applying the best technology for each use case, the Mouliana Project had the luxury of testing three different methods of data collection on a set of less than 50 artifacts. Methods included LiDAR (DotProduct 8-SR), high-end photogrammetry (Nikon D800), and structured light scanning (Artec3D), all backed up by traditional methods of measurement and illustration. Although no workflow for the project was uniquely created in-house, the application of existing workflows to this field and their combination is cutting edge and required new adaptation of techniques not originally designed for archaeological material. The application of multiple methodologies on our limited set of objects often revealed unexpected advantages and disadvantages of the technologies, in addition to confirming some expectations. This initial testing has informed our plans for future seasons, when we will expand our scope to include architectural features and landscapes. We present the results of our first season, comparing the benefits and drawbacks of the various technologies, our plans for future use, and potential applications for other projects.

Spatial Pressure on Alpine Settlements? An Equation Based Case Study in the Silvretta Massif (Switzerland, Canton of Grisons)

Kruse, Kristin (Canton Grisons, Switzerland)

The Alpine Region has been populated from the beginning of the Bronze Age until today. Thereby a solid economic system with settlements in the valleys and seasonally used alpine pastures has developed. The theory states that the limited productive land around the settlements forced people to outsource their animal

husbandry onto alpine pastures. Since 2007, the Swiss Research project "Rückwege" (way back) has been looking for the prehistoric origin of these economic systems. The latest contribution is a land use model considering two neighbouring settlements and an alpine pasture site from the Iron Age. Unfortunately, the sites don't allow conclusions regarding their original size – therefore, the site catchment was chosen as starting point for the model. An equation based subsistence model was developed and fed with variables from archaeological, physiological und agricultural research. By considering the spatial requirements of agriculture and animal husbandry, it became possible to estimate the boundaries of population and herd size for each settlement. Interestingly, our model doesn't show economic or ecological pressure. In both settlements, it would be possible to maintain agriculture and animal husbandry inside the site catchment for up to 200 people. This seems to indicated that alpine pasture was not done out of spatial pressure, but was a very deliberate choice.

3D Models of Architecture Remains in Archaeological Context. Visualization as a Tool in Interdisciplinary Research of Polish Archaeological Mission in Kato Paphos on Cyprus.

Kubicka, Anna (Wroclaw University Of Science And Technology)
Aleksandra Brzozowska-Jawornicka (Wroclaw University Of Science And Technology)

The aim of the paper is to present the usage of different methods for obtaining 3D virtual models in order to document and better understand features of various kinds of data collected during excavations of the Polish Archaeological Mission of the University of Warsaw at Kato Paphos in Cyprus. During several recent seasons of excavations we tested a few methods of generating 3D spatial data, among others the image-based modelling and the structured light 3D scanner. As an interdisciplinary group of architects and archaeologists we used them for different kinds of objects: from relatively small pieces of architectural details and sculpture (e.g. fragments of columns, cornices, altars, etc.), through archaeological trenches to fragments of bigger structures and edifices. Most of the objects, independently of their size and scale, belonged to architectural remains. The comparison of methods and workflows with spatial data on the field helped us to find the best solution for multidisciplinary studies on the archaeological site of the Greek and Roman residential settlement in Kato Paphos. The cooperation of different specialists on our site, results in various methods of documentation. The creation of the 3D models allows us to coordinate their work and obtain the most complex yet very precise effects. In our presentation we would like to focus on the results of different aspects of the visualization usage. E.g. simultaneously to the archaeological exploration, 3D models of different layers and structures were created which allowed us to analyse and interpret the stratigraphy of different tranches combined together with the general plan of the site. Furthermore, the usage of the 3D models resulted from the need to document very specific pieces of the architectural detail. The so-called block-out or Nabatean capitals may serve as a good example for the application of this technique. Although they seem to be quite simple, their form is rather complex geometrically, which is very difficult to document by traditional methods.

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The Metrological Research of Machu Picchu Settlement. Application of a Cosine Quantogram Method for 3D Laser Data.

Kubicka, Anna (Wroclaw University Of Science And Technology)

The purpose of the research is to look for a basic unit or units of measure (quantum), multiplication of which would help delineate the outline of Inca settlements : Machu Picchu. Anthropometric measurement system predominant in the Inca Empire limits the search area for quantum, nevertheless, it does not preordains its functioning. The questions and problems of research concerning the existence and usage of base unit or units of measure are formed on the foregoing assumptions pertaining to current phenomenon of outlining and measuring Inca urban planning. By making use of the statistic method developed by D.G Kendall: cosine quantogram when dealing with data acquired through 3D laser scanning we can answer the question: Did the Inca abided by the imperial measurement systems and construction rules in their urban planning or, quite the contrary, the ethnic diversity of people working on the Machu Picchu construction resulted in various metrological systems being used, which were based on the local traditions of those ethnic groups. The measurement data were collected from 3D point cloud gathered form terrestrial 3D laser scanning of Machu Picchu. The results of the study are based on dimensions between niches and windows which arranged interior of each building. Verification of the archived results was conducted with the Monte

Carlo method in order to depict the phenomenon in statistical terms. Chosen method of collecting data was dictated trapezoidal shape of Inca building plan and elevation where general dimensions of buildings changed on different section's height. Small measurements such as every dressed stone in masonry wall also required a great number of measured points. Concerning these features of Inca masonry's and buildings construction 3D laser scanning method is much faster and is not so time consuming in comparison to tachometry methods e.g. Totalstation Cosine quantogram method developed by D.G Kendall in 1974 was wildly used by scholars (e.g. Jari Pakkanen 2001, Susan Margueritte Cox 2006, F. H. C. Marriott 1979, J. J. Coulton 1975) with a success to analyze architecture of ancient Greece and medieval urbanism. So far these method have not been applyed in Pre Columbian architecture where there is no written sources which confirmed existence of measurement standard. It seems that combination of Inca architecture theory and statistical methods implemented originally in computer environment for a purpose of these research gives an answer confirming the existence of measure system in Inca Empire.

Giga-Point Rendering for 3D VR

Kuester, Falko (Center Of Interdisciplinary Science For Art, Architecture And Archaeology (CISA3) University Of California San Diego (UCSD))
Vid Petrovic (Center Of Interdisciplinary Science For Art, Architecture And Archaeology (CISA3) University Of California San Diego (UCSD))

The rapid adoption of diagnostic imaging as well as analytical diagnostics techniques is setting the foundation for the creation of ever more detailed digital surrogates, capturing site and artifact geometry at the surface, subsurface and volumetric level, in combination with material characteristics. While improved resolution and precision of exceedingly more complex surveys should increase the diagnostic value, the proverbial digital data avalanche, has created unique challenges for data visualization, analysis and diagnostics. This paper presents a visual analytics technique that enables the collaborative and fully interactive and immersive visualization, annotation and exploration of massive point-based data assets from field surveys that may bring together surface data assets being acquired via light detection and ranging, photography, photogrammetry, ground penetrating radar and X-ray fluorescence imaging.

Tracking in 3D

Kulhanek, Karin (Friedrich-Alexander Universität, Erlangen)
Andreas Pastoors (Neanderthal Museum, Mettmann Andreas Pastoors Is One Of The Initiators Of The Project "Tracking In Caves". He Supervises My Master Thesis About The Pech Merle Scans That Were Taken Within This Study.)

Human hand- and footprints are rare momentary to find in archaeology, yet latter category got relatively little attention. While handprints can be interpreted as intentional remains - especially in context of parietal art - footprints are rather unwary, subconscious traces. These fragile impressions in soft clay can be found e.g. in Pech Merle, France, where they had been carefully examined by three Ju/'hoan San tracker within the project "Tracking in Caves". While former approach focused on morphometric acquisition of data, the specialized knowledge of reading various footprints could be directly applied during the project. Exceptional was the narrative topology of the tracker: In example of Pech Merle the known footprints could be extended to 18 impressions. But instead of documenting 18 single imprints it was possible to track five individuals out of the "dispersed" seeming assemblage, so that certain paths can be traced. As further personalization it was possible to draw inferences from imprints about body height, weight and gender. Based on 3D scans of the ground we can examine the tracks within the framework of the indigenous knowledge in a non intrusive way to understand this way of reading. Characteristic features of an individual path can be picked out and the indicators can be compared. One indicator could surely be the different size or shape of the feet; another may be the different pace of the individuals, which can be shown by the modeling of pressure contours of the imprints.

The Dimensions of Settlement Choice

Kvamme, Kenneth (University Of Arkansas)

Revelation of the fundamental dimensions underlying settlement choices is necessary to a growth in understanding of human location behavior and the development of settlement theory. A non-traditional form of Principal Components Analysis that focuses on environmental properties that minimize variance in settlement location may offer a tool for accomplishing these goals. Results offer important theoretical implications because the dimensions revealed indicate elements of the social and physical environments important to location choices as revealed by the settlements themselves. A case study of rural farming settlements from historic Northwest Arkansas, USA, defines dimensions related to terrain form, the hydrologic system, soils, and the social network of roads, all of which may be mapped and visualized through GIS. If the mean on any respective dimension can be regarded as “most ideal” for settlement, then as one moves away from the mean places become less ideal. This idea can be expanded into a multivariate context by considering all dimensions simultaneously through Mahalanobis D2 and its chi-square transformation where the multidimensional mean represents an “ideal settlement space” and D2 can be viewed as a multidimensional z-score that quantifies deviations from the ideal. Besides offering (1) a view of key settlement dimensions and (2) location choices that “make sense” with respect to a (multivariate) normal model, this methodology also yields a form of archaeological location model (ALM) that may be mapped regionally through GIS, permitting (3) ready visualization of settlement preferences.

A Small Private Online Course on 'Modelling and Simulation in Archaeology' at Leiden University

Lambers, Karsten (Leiden University)
Fulco Scherjon (Leiden University)
Iza Romanowska (University Of Southampton)

A Small Private Online Course on 'Modelling and Simulation in Archaeology' at Leiden University Fulco Scherjon1, Iza Romanowska2, Karsten Lambers1* 1Leiden University, 2University of Southampton, *Corresponding author, k.lambers@arch.leidenuniv.nl Keywords: E-learning, modelling, simulation This paper introduces a new online graduate course on 'Modelling and Simulation in Archaeology' at Leiden University. In September 2016, the Faculty of Archaeology at Leiden University launched the new MSc track 'Digital Archaeology' (60 ECTS) within the existing master's programme 'Archaeological Sciences'. As part of the core curriculum of this programme, the course 'Computational Methods in Archaeology' is intended to offer students in-depth training in one of the subfields of Digital Archaeology. 'Modelling and Simulation' was an obvious choice of subject for this course, given the increasing importance and potential of these techniques within archaeology. Supported by Leiden University's Learning Lab, we developed a new online format for this course: a Small Private Online Course (SPOC). Compared to Massive Open Online courses (MOOCs), SPOCs are developed for smaller and more dedicated target groups. E-learning is especially suited for our purpose, as it allows the course to be offered to graduate students of archaeology and related fields at both universities involved (Leiden and Southampton) and external participants. In addition, because of the practical nature of the course we make ample use of online resources for teaching. In this paper we will introduce the content and format of the course and share details on the construction and first experiences gained during the teaching of the course in spring 2017.

Integrated Digital Methods for Investigating a Hidden Cityscape: The Case of Ancient Hermion

Landeschi, Giacomo (Lund University)
Stefan Lindgren (Lund University)
Jesper Blid Kullberg (Stockholm University)
Henrik Gerding (Lund University)
Alcestis Papadimitriou (Ephorate Of Antiquities Of Argolida)
Jenny Wallensten (Swedish Institute At Athens)
Nicolò Dell'Unto (Lund University)
Angeliki Kossiva (Ephorate Of Antiquities Of Argolida)

Recent advances in digital technology dramatically affected the practice of landscape and site documentation. The combination of Image-based 3D modelling techniques (IBM), Unmanned Aerial Vehicles (UAVs) and Geographical Information Systems (GIS) provided archaeologists with unprecedented opportunities that allowed improving the quality of data representation and analysis. In the course of a research project recently developed by Lund University in collaboration with the Swedish Institute in Athens and the Ephorate of Antiquities of Argolid (Greece), the ancient city of Hermion has been investigated with a combination of integrated methods. Different acquisition techniques have been thus complemented in order to provide an entirely-3D representation which included the still visible archaeological features along with a high-resolution Digital Terrain Model (DTM) of the modern city. The whole dataset has been subsequently imported into a GIS platform where all the 3D models could be spatially related and more sophisticated analysis carried out. In particular, physical relationships between still visible archaeological features such as city walls, embankments, and temple foundations can be detected and mapped in a multi-scalar and multi-temporal perspective. This could significantly help archaeologists in answering questions about the multiple phases of inhabitation of Hermion, location and orientation of the main sacred buildings and the function connected to the different areas of the city. In this respect, the availability of an entirely-3D dataset is an essential prerequisite to perform any valuable analysis. As an example, the precise height of terrace walls, stone blocks and temple architectural elements can allow to better understand their reciprocal topographical relationship so as to determine different chronological phases of inhabitation. Additionally, the possibility to remove all the modern structures and leave only the original architectural remains within the virtual space might allow to simulate the visual prominence of buildings and structures in relation to the topographic settings of the landscape by taking into account of a line-of-sight approach in which entirely-3D elements can increase the accuracy of the reconstruction and consequently, the reliability of the modelling process. This could significantly contribute in increasing our understanding of the social significance of the ancient space of the city.

A 3D Web-aided Resource for Pompeian Studies (3D WARPS)

Landeschi, Giacomo (Lund University)
Danilo Marco Campanaro (Lund University)
Nicolò Dell'Unto (Lund University)

Danilo Marco Campanaro*, Giacomo Landeschi*, Nicoló Dell'Unto* *=Department of Archaeology and Ancient History, Lund University In the last decade the rise of Web Graphic Library (WebGL), a Java based Application Program Interface (API), with its potential to render interactive 3D web computer graphics without the need of any browser-plugin component, has rapidly change the picture of web-based applications promptly affecting a wide array of fields, from entertainment to education and research. The project "3D WARPS", exploiting the technology of 3DHOP (3D Heritage Online Presenter) an open-source software

package for the creation of interactive Web presentations of high-resolution 3D models, aims at the creation of a 3D web-based research facility where a thorough mathematical replica of the actual state of an entire city-block of Pompeii is openly offered to scholars from every part of the world. Built in the framework of the Swedish Pompeii project, this platform allows users to easily navigate, by means of a reference map, between different high-resolution 3D colored models - each one aggregating two or more rooms as archaeologically meaningful units- and perform a wide range of relevant analytical tasks. The presented web-based 3D research platform is undergoing a constant process of development and amelioration and has already shown to be an invaluable tool to address specific questions connected with - otherwise arduous to tackle- archaeological and architectural issues, both off-site and an on-site

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Spacialist – A Virtual Research Environment for the Spatial Humanities

Lang, Matthias (EScience-Center, University Of Tübingen)
Michael Derntl (EScience-Center, University Of Tübingen)

Matthias Lang, Michael Derntl, Benjamin Glissmann, Vinzenz Rosenkranz, Karsten Schmidt, Dirk Seidensticker eScience-Center, University of Tübingen, Germany matthias.lang@uni-tuebingen.de Many archaeological research projects generate data and tools that are abandoned after the project funding ends. Moreover, research data handling and the deployed tools are often highly specific for single projects. This insustainable practice leads to solutions that are incompatible with other tools, projects and infrastructures, and they often do not rely on accepted standards. To close this gap, the project Spacialist was tasked to create a modular virtual research environment that offers an integrated, web-based user interface to record, browse, analyze, and visualize all spatial, graphical, textual and statistical data from archaeological or cultural heritage research projects. To address the highly heterogeneous requirements of such projects, Spacialist is developed as a software platform that is instantiated, customized and deployed for each research project. Spacialist uses project-specific controlled vocabularies (thesauri) based on the SKOS-XML standard, thus facilitating data analysis and interoperability with other projects and infrastructures. The development of Spacialist is driven by an interdisplinary team of software developers, geographers, ethnologists, archaeologists and librarians in collaboration with pilot projects in various areas like mediterranean archaeology and cultural herigtage preservation in the Sultanate of Oman and Japan. Spacialist is developed and released as open source software. To support the full research project lifecycle, the platform is integrated with our University's research data archive, which guarantees the long-term availability and reusability of project data.

Cultural Heritage Monitoring using Time-Sequenced Satellite Imagery: A Case Study from the Syrian Civil War

Laugier, Elise (Dartmouth College)
Jesse Casana (Dartmouth College)

As a collaborative effort with the U.S. Department of State, ASOR's Cultural Heritage Initiative (CHI) seeks to monitor and assess damage to archaeological and heritage sites across Middle Eastern conflict zones. As part of this larger effort, our research has sought to develop a comprehensive assessment protocol for monitoring looting and war-related damage via time-sequenced, high-resolution DigitalGlobe satellite imagery. Leveraging a database containing thousands of sites across Syria and Iraq, we have instituted a methodology to catalog cultural heritage assessments in a manner that facilitates spatial and temporal queries and efficiently generates reportable results. Having completed assessments at more than 5000 archaeological sites, results reveal previously unrecognized patterns in the timing, severity, and distribution of looting and other forms of damage. This presentation offers a summary of our database design, our approach to remote sensing-based damage assessments, and an overview of key findings to date.

Open Source: You're Doing it all Wrong

Layt, John (L~P : Archaeology)

Open Source in Archaeology has largely failed. While many of us are consumers, there are few producers and fewer still collaborators. Too much effort and money is wasted reinventing wheels in bit-rotting projects that fail to advance the art or industry, largely due to parochial academic and commercial mind-sets. The speaker will share his experiences as a 15 year veteran of one of the worlds largest open source communities to try throw light on what we need to do to remedy our failure.

High-frequency GPR for Real-time 'Digital Bisection' of Archaeological Features

Leach, Peter (Geophysical Survey Systems, Inc.; University Of Connecticut Department Of Anthropology)
Richard Boisvert (New Hampshire Division Of Historical Resources)

Ground-penetrating radar is an efficient means for non-invasive archaeological mapping. Archaeologists generally use low frequency antennas (200MHz—900MHz) across expansive project areas. Delineation of features is common, but resolving detailed internal characteristics is not. During excavation, interpretation of features is often complicated by their variable size and nature and similarities to naturally occurring disturbances. Traditional field methods often require manual (and destructive) bisection to distinguish natural from cultural origins. We therefore have been experimenting with high-frequency GPR data (2.0GHz—2.6GHz) across newly-exposed features. Our goal is to develop a means of "digital bisection" with GPR that will allow field workers to remotely characterize features prior to manual bisection and complete excavation.

The benefits of a streamlined digital bisection method include: 1) the ability to differentiate between natural and cultural features and provide enhanced mission planning for feature investigation; 2) collection of a gridded GPR dataset that produces a digital archive of a feature, effectively 'preserving' it digitally. In this presentation we discuss recent high-frequency GPR experiments at multiple sites and across numerous types of features. We are beginning to refine the method, and are working to fine-tune real-time interpretations, identify ideal GPR frequencies, and establish best practices for grid spacing and data density.

Leveraging the UC Merced WAVE and Pacific Research Platform to Create At-Risk Global Cultural Heritage Networks

Lercari, Nicola (University Of California Merced)
Jeffrey Weekley (University Of California Merced)

The UC Merced Wide-Area Visualization Environment (WAVE) is a cutting-edge visualisation facility that was built in 2016 under a collaboration agreement between the University of California Merced and Qualcomm Institute at the University of California San Diego. The main purpose of this facility is for visualization of research-derived content, performance and collaboration, but it can also be used for outreach and education. The WAVE is an interactive virtual reality space made of twenty 4K 3D displays mounted in a half-pipe configuration, resulting in an array of 160 Mega pixels, the highest-resolution virtual environment of its kind in the world. The WAVE is part of the NSF-funded Pacific Research Platform (PRP), a "West Coast Big Data Freeway System" which links Caltech, NASA Ames Research Center and the NASA Research and Engineering Network (NREN), San Diego State University, San Diego Supercomputer Center, Stanford, the ten University of California campuses, USC, and the University of Washington over the CENIC and ESnet networks at speeds up to 100Gb/s. Leveraging the WAVE and PRP our team is taking part in the UC President's Research Catalyst grant titled "3D-Digital Preservation of At-Risk Global Cultural Heritage", led by Tom Levy at UCSD, with the goal to develop a multi-campus network of archaeological heritage data visualisation and interpretation facilities across California

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Patterns of Urbanism in Bactria: Reevaluating a Paradigm Through Remote Sensing

Levine, Evan (Brown University, Joukowsky Institute For Archaeology And The Ancient World)
Daniel Plekhov ()

Bactria, a region comprising parts of modern-day Uzbekistan, Afghanistan, and Tajikistan, has long been described—by ancient and modern scholars alike—as existing at the end of the proverbial world. Pronounced by Strabo as the land of a thousand cities, periods of political instability in the region over the last half-

decade have prevented more rigorous archaeological investigation of Bactrian urban development. Drawing on a wide array of publicly available satellite imagery datasets, as well as data from the handful of published archaeological surveys in the region, we seek to address the question of urban development in this region from the 4th century BCE to the modern day. We then evaluate the spatial distribution of urban sites through time with respect to local and external factors. In so doing, we highlight the extent to which political, environmental, or topographic variables influenced the development of settlement in Bactria, and how these patterns of urban development change over time. Simultaneously, this study explores the potential of engaging with "big data" in an archaeological context, drawing from large-scale, publicly available datasets to conduct research on a regional scale. Finally, we hope to highlight the usefulness of this methodology for regional studies whose subjects span multiple contemporary countries or within whom fieldwork opportunities are limited.

The UC San Diego Center for Cyber-Archaeology and Sustainability

Levy, Thomas (Center For Cyber-Archaeology Qualcomm Institute And Department Of Anthropology University Of California, San Diego)
Margie Burton (Center For Cyber-Archaeology Qualcomm Institute And Department Of Anthropology University Of California, San Diego)

The UC San Diego Center for Cyber-Archaeology and Sustainability (CCAS) is a partnership of the Division of Social Sciences and the Qualcomm Institute at the University of California San Diego. Established in 2015, CCAS aims to explore new digital approaches to research, conservation and teaching for world cultural heritage through development of innovative data capture, curation, analysis, and dissemination including scientific visualization facilities. Student-oriented and research-focused, CCAS collaborates with organizations conducting cultural heritage research around the world to study the relationship between human behavior, material culture, and the environment along deep-time trajectories. CCAS currently includes 44 faculty, staff, researchers, and students from 13 campuses and other organizations. The foundational project for CCAS is "At-Risk World Heritage and the Digital Humanities", a $1.06 million, two-year UC President's Research Catalyst Award from the University of California (UC) Office of the President to a consortium of archaeologists and information technologists on four UC campuses: UC San Diego, UCLA, UC Berkeley and UC Merced. Starting January 2016, the project team has taken steps toward: • Confronting the problem of 'Big Cultural Heritage Data' (BCHD), its movement and curation; • Melding state-of-the-art 3D scientific visualization with top-end immersive virtual reality (VR) platforms for museums and public places in addition to serving inexpensive personal VR devices; • Developing citizen-science crowdsourcing programs using a unique opportunity to access high-resolution satellite imagery from Digital Globe to monitor and model endangered archaeological sites and their environments; and • Providing unique learning opportunities to prepare UC students to use new information-technology tools to enhance their career paths.

Think Different! - Why "Model Thinking“ Shaped the Archaeological Thought Beyond the Hype on ABM

Linde, Lennart (Goethe-Universität Frankfurt)

During their "hype phase“ Agent Based Models (ABM) were perceived as an almost magical "wundertool“ which is to be fed with research data and somehow comes up with an accurate picture of our past. ABMs had to inevitably fail these exaggerated expectations. I would argue that ABMs, despite the declining hype and leveled expectations, are still a widely misunderstood but concurrently heavy underestimated tool in the archaeological toolbox. This is owed, among other things, through their introduction of "model thinking“ to archeology.In parts the often emotional critique voiced against ABMs seems almost surreal. Given the fact that a lot of our perceptions of the past are rather based on narratives than on research data. For instance the widespread term "elite“ is rarely connected to falsifiable facts. The very core of ABMs is to make quantifiable statements by expressing a tightly defined ruleset. Yes, it is easy to criticize any of those rules. But that is exactly what makes "model thinking“ such a powerful tool. Especially in contrast to purely narrative approaches to interpret the remains of our past. My contribution to the table would therefore plead for a better integration of ABMs in the various archeological curricula. In which emphasis is put to modeling as a way of archaeological thinking which not necessarily aims on its transfer into a computational system. I would love to take my views to your table for discussion, extension and refinement.

Blur the Lines – Games as Tools for Archaeological Research

Linde, Lennart (Goethe-Universität Frankfurt)

In the past decade, Agent Based Models (ABM's) have become a functional part of the archaeologist's toolbox. Many ABM's include elements of game theory in their ruleset, which is the foundation of a working model. The line between a purely scientific ABM and a video game from the simulation genre is already thin, but why not blur the line further and blend an ABM into a full-blown game experience? The use of games as tools of research is the next logical step. Instead of formalizing our theories in a ruleset for an ABM, we could design a game based on them. Where the player makes choices through gameplay and be monitored exploring various strategies! This talk will investigate the potential of the given approach, based on a fictive open-world game, set in the European Bronze Age. The players will have to manage resources and tackle the spatial organization of a village. They are also bound to make decisions on the social organization of their village. There is no direct interaction with the inhabitants of the game world as they act as agents. The collected datasets will be analyzed with emphasis on the correlation between certain forms of social organization and the rise of warfare, as well as on connections between wealth distribution and tensions

within the tribe. Archaeogaming does not need to be limited to the research of games anymore; we can try to take a step forward and do research through games.

Running on Autopilot: Testing Google Earth Engine for the Automatic Identification of Archaeological Features in Satellite Imagery

Liss, Brady (University Of California, San Diego)
Matthew Howland (University Of California, San Diego)
Thomas Levy (University Of California, San Diego)

Google Earth Engine (GEE) is an in-development, cloud-based platform for analyzing satellite imagery with access to petabytes of data (Google Earth Engine Team 2015). Combining this massive database with the computing power of Google's cyber infrastructure facilitates quick and easy analysis of satellite imagery on any scale (including planetary). Moreover, GEE provides readily available tools to investigate and manipulate satellite imagery, but users are also free to create custom scripts particular to specific research questions. As such, GEE affords a unique opportunity for innovative methodologies involving satellite imagery. This paper evaluates the potential contribution of GEE in archaeological research. To do so, GEE was employed/tested for the rapid and automatic identification of particular archaeological features in the Faynan region of Southern Jordan. Specifically, GEE was used for supervised classification, a method of machine learning by which GEE can be trained to detect specific features in satellite imagery based on its unique spectral signature. In this case study, GEE was provided with known locations of ancient metallurgical waste (slag) mounds at a single archaeological site in the form of polygons, and in following, GEE quickly and automatically located additional slag mounds (by searching for pixels with similar spectral signatures) across an area of approximately 135 square kilometers. Through this case study, GEE proved to be a viable tool for archaeological research with significant potential to supplement traditional forms of archaeological survey.

From Scan to Sculpture: Ensuring Quality Control in Digital Restoration.

Liu, Julia (Duke University)
Adam Spring (Duke University)

Digital technologies have significantly improved workflows and reduced production time. This amelioration through automation is still in its' adolescence and we as practitioners must be on the lookout for common best practice techniques in order to navigate its' obstacles. In this talk, we will demonstrate an abridged walk-through of a digital restoration workflow for a fragment from a Dacian pillar on the facade of the Basilica Ulpia of Trajan's forum. The demonstration will be divided into two parts, pre-production and acquisition of

digital scans and the production process of digital sculpting. We shall start with an initial scan offering tips and pointers towards best practices in lighting and scanner setup. Then we will walk through the process of preparing the mesh for digital sculpting by focusing on the capturing high fidelity surface detail. The production section consists of a walk-through for digital sculpting in Z-brush. From the organizational workflow of setting up simultaneous references along orthogonal views, to the preservation and masking of individual elements to the digital translation of an analogue art form. Our demonstration will conclude with a discussion of best practice techniques working across multiple subdivision levels to maintain quality assurance for higher fidelity detail, while allowing for ease of manipulation and speed in processing at lower subdivisions for large shapes and objects. Finally we will briefly discuss and demonstrate post-production output considerations in re-topology and decimation and open the floor for discussion to questions from the audience.

Flippin' R

Lockyear, Kris (Institute Of Archaeology, UCL)

Many archaeologists dislike statistics at best, and at worst are frankly scared by them. The perception that one has to be “good at maths” in order to apply such methods is hard to shake. And yet, archaeology is a subject which generates large, complex data sets which require good sampling strategies and careful analysis to make the most of them. In reality, the ability to use appropriate software and construct basic code is arguably more important than a detailed understanding of the underlying maths. This paper describes the way in which the author teaches an undergraduate core course entitled Research and presentation skills. The course mixes “flipped” lectures, where recorded lectures are made available online and class time is used to answer questions about those lectures, with practical classes undertaking an analysis of a simulated cemetery data set using the R statistical software system.

Augmented History – A Virtual “Window to the Past”

Löwenborg, Daniel (Department Of Archaeology And Ancient History, Uppsala University)
John Ljungkvist (Department Of Archaeology And Ancient History, Uppsala University)
Daniel Westergren (Disir Productions)
Sebastian Wiberg (Tinker)
Staffan Hagberg (Tinker)

The old (Gamla) Uppsala was an important center during the Late Iron Age in Sweden, and the site is mentioned as a mythical royal place in historical sources. With increasing research and archaeological excavations in the area during later years, our factual knowledge has increased, and it is now possible to

understand more about the royal manor at the site and how the landscape has been manipulated throughout history to transform the site. The archaeological research project has used different technologies to disseminate the results, though Web-GIS applications and 3D models. With the project Augmented History, this is taken to a new level, where we have created an iOS app that allows the user to freely explore the area through a detailed 3D reconstruction of what the site might have looked like in the mid 6th century, with building, graves and animated characters. Using the GPS of mobile devices for positioning, the user can move around in the landscape and in the virtual world simultaneously. This provides an immersive experience, that is complemented with interactive elements that combine game like interfaces with textual descriptions of artifacts and environments. Within the project we combine high quality 3D reconstructions with 3D scans of objects, buildings and environments to create compelling graphics. Interactive elements and storytelling based aspects are used to ensure that the needs and requirements of different user groups are met, and that the experience can be adjusted to different historical sites with different stories to tell.

Technical Women in Cultural Resource Management: Amplifying the Importance of Non-Traditional Skill Sets in Modern Archaeology

Lowry, Sarah (New South Associates, Inc.)

Cultural resource management (CRM) archaeology is evolving and becoming more technical and computer based. Historically, CRM is male dominated and great value has been placed on traditional expressions of masculinity. As work continues to transition to a more technical sphere, this is an opportunity for women already working in this space to amplify our value and those around us whose skills may have been overlooked. We can show the value that technical based skills can bring to grow a new business environment. Technical and computer based skills figure heavily into the future of CRM archaeology and digital archaeology is a burgeoning field. As women in the field we can use the tools of amplification to draw attention to the growth of computer centered archaeology. This includes making sure that our voices and the voices of our peers are promoted and heard.

Mississippian Villages in East Tennessee: Geophysical Case Studies at Five Sites to Examine Community Layout and Land Use

Lowry, Sarah (New South Associates, Inc.)
Shawn Patch (New South Associates, Inc.)

This paper compares five large-scale geophysical surveys collected along the Tennessee River and its tributaries in the southeastern United States. The results from this work represent a series of projects where

ground penetrating radar (GPR) and magnetic gradiometer data collection were done on Mississippian village sites owned by the Tennessee Valley Authority (TVA) that had been excavated in some capacity during the early twentieth century. Present-day geophysical data collected at these sites and the early 20th century archaeological notes and reports were used to build a comparative data set of South Appalachian Mississippian sites where a specific interpretations about community layout and land use could be made, including village size, occupation density, and architectural variation.

Scientific Database and the Big Data Approach for the Bronze Age of China

Lu, Qin-Qin (University Of Science And Technology Of China)
Zhengyao Jin (University Of Science And Technology Of China)

Chinese bronze is remarkable in its variety, scale and intricacy, yet Chinese Bronze Age still poses major and fascinating questions, including the origin and dispersion of technologies and materials. Archaeologists over the world have analyzed large amount of bronze artefacts. However, certain factors have hindered further inter-regional studies: discrepancies in the formats and precisions of these accumulated data, an academic gap between field archaeologists, archeometrists and geochemists, and the language barrier between Chinese and Western scholars. We propose to develop a comprehensive database for China's ancient bronze artefacts, for the remains from ancient mines and smelting works, and for relevant mineral deposits. This would require collecting and collating chemical, isotopic, chronological and GIS data for bronze artifacts, as well as geological and geochemical data for mineral deposits. To address the aforementioned challenges, we plan to extract data from published Chinese and Western literature and to take measurements to obtain new data when necessary, after which we will categorize, assess and verify the obtained data to ensure reliability. Drawing from our highly interdisciplinary experiences, efforts will be made to actively involve potential contributors and users as well as wider audience during the course of database development to bridge the gaps between different research communities. This database will be designed with expandability, efficiency and usability, and will facilitate international collaboration by acquiring data and sharing data both on a global scale. Combining available data with analytic tools, we will also carry out analysis on macro-scale topics such as provenance, cultural diffusion and technological evolution.

Digital Surveying and Ideal Reconstruction for Total Hybrid Model. The Case of Fort Presanella in Val di Sole.

Luce, Fabio (Università Degli Studi Di Trento)

Describing the ruined architecture has always been a challenge both to the restitution issues of the existing forms in order to synthesize their visual appearance and to the ideal reconstruction aimed to show their geometry after the construction. These considerations are particularly suitable when you consider the several military architectures built in Trentino during the Great War: buildings with clearly defined shapes, heavily integrated into their landscape but profoundly transformed by the conflict or by abandonment. The research aims to describe the procedural steps used for the construction of a total 3D digital model that collects the informations from surveying operations and those deriving from the ideal reconstruction. The study-case of this research is the fort Presanella, a military structure built by the Austro-Hungarian Empire between 1908 and 1912, part of the defensive line of Val di Sole. In particular it will show the digital procedure result of the restitution of image-based survey data and it will explain the procedure followed for the construction of an overall 3D model that is the result of vectorization of design drawings made by the Austrian military engineering. The outcome of these procedures will be an integrated hybrid model designed to show the fort virtual reconstruction, considered as a testimony of past and present state, for an analytical-descriptive and tourist-informative purposes.

Integrated Surveying Techniques for Analysis of Archaeological Artifact

Mancini, Matteo Flavio (Roma Tre University, Department Of Architecture)
Leonardo Baglioni (Sapienza University Of Rome, Department Of History, Representation And Restoration Of Architecture)

The Conical Sundial preserved in the depository of the National Archaeological Museum of Naples presents an opportunity to highlight the experimental potentiality of integrated surveying techniques applied to archaeology. The sundial (about 2nd century BCE) is a marble sculpture with dedicatory inscriptions, reliefs and solar paths traced on the generatrixes of the conical surface which preserve red deposits of particular importance for the correct interpretation of the sundial itself. The survey was primarily aimed to create a cast copy of the original piece suitable for different aims, ranging from the documentation and dissemination to the opportunity of sharing data between scientists of different fields, also enabling the study of the sundial without having to act directly on the original. Therefore the survey had to ensure the accuracy of both morphological and chromatic data to achieve a correct interpretation of the geometrical operating principle of the sundial. In order to achieve these results the survey was performed by means of both short range laser acquisition and structure from motion techniques. The processing phase of the experimental data focused on highlighting the characteristics of the two acquisition techniques in order to obtain an accurate fusion between the two mentioned models.

Revealing Degraded Script in High Resolution 3D Measurement Data with GigaMesh

Mara, Hubert (IWR, FCGL - Heidelberg University)

Motivated by the demand for analysis of damaged objects we are developing new methods for filtering triangular meshes provided by high resolution 3D-scanners. This work began with improving the readability of cuneiform tablets, which are one of the oldest and largest sources for human history used throughout four millenia before Christ. These tablets are made from clay and inscribed with a rectangular stylus leaving wedges shaped markings. Hence they are named after the Latin word cuneus. As these tablets are easily made with almost no cost, archaeologists have unearthed tremendous amounts of this wedge-shaped Script in 3D, which features the challenges known from the domain of handwritten documents. This lead to the development of filtering algorithms using Multi-Scale Integral Invariants (MSIIs), which are core methods in our Open Source based GigaMesh software framework. In a first step we compute high contrast visualizations of 3D-models of cuneiform tablets with these robust MSII filters allowing for a dramatically improved visibility of cuneiform characters. It was even possible to visualize small details like sealings and fingerprints left on the clay tablets. In a second step we compute and extract line tracings of the characters stored as Scalable Vector Graphics (SVGs) files. These files are processed using a word-spotting inspired approach to make digital drawings of tablets searchable. In general we can process all other types of objects with Script in 3D. Examples will be shown for weathered medieval tombstones made from sandstone and a lead plate buried with Gisela of Swabia.

How to Integrate and Illustrate Aspects of Landscape Evolution and Human Evolution

Märker, Michael (Deparment Of Geography, University Of Tübingen)
Volker Hochschild (University Of Tübingen, Germany)
Christian Sommer (University Of Tübingen)

The acceptance of a database related to early human expansion studies depend very much on the capabilities to explore and visualize the data and to results in a dynamic way. Thus, different levels of interaction must be provided with the system in order to fulfill the manifold user requests. In the recent past data base systems providing information on early humans and their environment are becoming more and more important and increase rapidly in number. The main aim of the Heidelberg Academy of Sciences and Humanities project entitled “The role of culture in early human expansions (ROCEEH)" is to assess the spreading "out of Africa" in a spatial, cultural and biological context. Implicitly we suppose as working hypothesis that the influence of changing environmental conditions decreased as the importance of cultural and technological innovations grew. The ROCEEH project deals with a variety of variables and formats from geology, geomorphology, palaeontology and archaeology in vector, raster as well as text formats. To achieve the general objectives a georelational spatial information system was developed and implemented. The system is called “The ROCEEH Out of Africa Database (ROAD)”. In this paper we focus especially on the infrastructure to visualize

landscape features like geomorphology and soils as well as their evolution together with palaeontological and archaeological data.

Assessment of Subsurface Neolithic/ Palaeolithic Sites in the Southern Gargano Area, Apulia, Italy

Märker, Michael (University Of Pavia, Italy)
Ivano Rellini (University Of Genoa)
Luigi Mucerino (University Of Genoa)
Volker Hochschild (University Of Tübingen)

The stratigraphic reconstruction of cave's deposits combined with the study of the archaeological and biological contents provides an excellent record of the climatic changes that happened in the cave and its surroundings and also offers information about landscape evolution. Our study area is close to Manfredonia, Southern Gargano, Italy and characterized by important archaeological sites (i.e., Occhiopinto Cave). The aim of the study was to assess the spatial distribution of underground cavities. We used a parallel setting of transects in order to perform a 3D model of the underground structures. Therefore three different arrays were tested, Dipol-Dipol; Wenner and Schlumberger. The utilized electrode spacing for the surface transects was 2m. In order to calibrate and validate the analysis we made 2 core drillings yielding information on the stratigraphy and cavities in the underground. With the given value ranges and the respective electric resistivity arrays we were able to identify the location and depth of the major cavities in 3D for a ca. 25 ha test plot area.

Educational Experiences in Archaeological Information Modelling with the Mind Maps and Object-oriented Paradigms

Martin-Rodilla, Patricia (Institute Of Heritage Sciences (Incipit) Spanish National Research Council (CSIC))
Cesar Gonzalez-Perez (Institute Of Heritage Sciences (Incipit) Spanish National Research Council (CSIC))

Information modelling in archaeology has produced important advances in ontologies or methodologies which have led to progress in archaeological information conceptualization, processing, integration and reuse. To perform these tasks, specific skills are required, including recognition of archaeological entities and their relationships. Despite the vital importance of information modelling skills in archaeology, we find that these aspects are undertreated in most university courses, either because there are no specific courses, or because existing ones are commonly instrumentalized towards specific software tools, lacking a comprehensive approach to teach information modelling skills regardless of information scope,capturing method, its final

goal or the tools employed. In order to identify useful paradigms to be taught in archaeological information modelling postgraduate courses, we have conducted an empirical study within the yearly "Archaeological Information Modelling" course that we teach at the University of Santiago de Compostela. Students were asked to answer comprehension questions and create information models from two archaeological case studies, using one of two modelling paradigms (mind maps and object-orientation) for each case study. We analyzed intuitions and basic modelling skills, attempting to identify potential problems regarding the assimilation of the more structured paradigm (OO) versus the less structured one (mind maps). We present here the empirical study design as well as the quantitative and qualitative results obtained over two years. The results give us initial responses about students' intuitions in archaeological information modelling, the existing learning curve of both paradigms, and the need for such approaches in course plans for future archaeologists training.

CVAST: The USF Center for Virtualization and Applied Spatial Technologies

Maschner, Herbert (University Of South Florida Center For Virtualization And Applied Spatial Technologies)

The University of South Florida Center for Virtualization and Applied Spatial Technologies (CVAST) is a multidisciplinary research and teaching unit dedicated to digital technologies in the humanities, social sciences, and natural sciences. Its mission is to document, preserve, and protect the world's cultural and natural heritage through the use of digital visualization, geospatial technologies, informatics and 3D virtualization. Central to this mission is the democratization of science and the facilitation of scientific research, collaboration, and education by delivering digital data and heritage resources to the global community. With field projects in Spain and Italy, and museum projects in Paris, Tampa, London, and the Arctic, we are creating online content for a digital research infrastructure. Here our global academic partnerships are reviewed, our recent research projects are highlighted, and our long-term goals for data preservation and distribution are presented.

Challenges in Processing, Delivering, and Archiving Large Amounts of 3D Data

Massari, Lauren (Institute For Advanced Technology In The Humanities, University Of Virginia)
William Rourk (University Of Virginia Library)
Shayne Brandon (Institute For Advanced Technology In The Humanities, University Of Virginia)
Jama Coartney (University Of Virginia Library)
Worthy Martin (Institute For Advanced Technology In The Humanities, University Of Virginia)
Chip German (Academic Preservation Trust And University Of Virginia Library)

For the past two years, an interdisciplinary group at the University of Virginia has been gathering 3D data through laser scanning and photogrammetry to document the cultural heritage of the University and surrounding historic landmarks, both as a historical record and as a useful tool for architects, preservationists, students, and others. The group will discuss the challenges of processing large amounts of data into a usable format, the tools explored for delivering the resulting 3D content via the web, and the desire to archive the entire process in a way so that the data will be preserved and usable in the future. Network clustered processing of large datasets, particularly photogrammetric data collected by terrestrial and aerial methods, is necessary for ensuring the integrity of resolution of data necessary for scholarly use. Presentation strategies for 3D data include WebGL-based technologies and immersive visualization technologies such as virtual reality. Library asset archives such as Academic Preservation Trust (APTrust) and open data archive access in such forms as the UVA Library's Libra repository for data, which uses Dataverse, are being explored as platforms for preserving cultural heritage data. We are particularly interested in a discussion with other session participants about the feasibility of a cross-institutional 3D repository.

Adding the Aerial Multi-spectral Perspective: A Holistic View of Vulci through Multi-layered Data Sets

McCusker, Katherine (Duke University, Art, Art History, And Visual Studies Dig@Lab)
Maurizio Forte (Duke University, Classical Studies And Art, Art History And Visual Studies Dig@Lab)
David Johnston (Duke University Duke Marine Lab Marine Robotics And Remote Sensing Facility)
Everette Newton (Duke University Duke Marine Lab Marine Robotics And Remote Sensing Facility)

This paper presents the preliminary results of the multi-layered digital methodology of Vulci3000, an interdisciplinary archaeology project, with a focus on fine scale aerial remote sensing data, collected during the summer of 2016 at Vulci, Italy. The Vulci3000 project combines a variety of remote sensing and geospatial data, including ground penetrating radar, LiDAR, aerial photography, and 3D photogrammetry. The objective of this multi-layered approach is to offer a holistic analysis of the city and its process of urbanization through a fusion of large data sets. This presentation will focus on the first stage of this objective: the collection of broad to meso-scale digital archaeological data required and the infrastructure used to organize and analyze the data sets. In order to more effectively illustrate this process, this paper focuses on the collection of aerial photographs (RGB, red edge, and near infrared wavelength) through autonomous flights of an eBee drone. The initial results of our data fusion provides insights into the utility of drone-based remote sensing at Vulci, how remote sensing data sets can be most effectively combined in archaeological studies and the inherent challenges that occur when working with a multiplicity of data types.

A Glimpse at Site Formation Processes from 3D Laser Scanning Ceramic Sherds in East Texas

McKee, Arlo (The University Of Texas At Dallas)

Excavations at the Murvaul Creek Site (41PN175), located in Panola County, Texas, recovered a Caddo ceramic assemblage that was contained within both colluvial deposits and a buried soil. Although the site is situated on the edge of a relatively flat sandy upland, the colluvial deposits on the site suggested that slope processes played a significant role in the burial and preservation of at least a portion of the assemblage. However, it was not readily apparent from the ceramic macroscopic analysis whether artifacts in the colluvium were redeposited through slope processes or whether they were moved through the profile through bioturbation. This presentation will focus on a 3D laser scanning study that was conducted to help identify the degree of micro-abrasion on sherd edges. Instead of scanning and presenting 3D data of whole sherds, the study focused on identifying the best methods, sample sizes, and required data resolution to identify very subtle abrasion. Through a combination of automated analysis in Matlab and R, as well as GIS analysis, the study ultimately proved to be a novel way to identify the portion of the collection that had been redeposited on the site rather than in primary context.

Three-Dimensional Documentation and Examination of a Medieval Period Cistern at Alarcos in the Castilla-La Mancha Region of Spain

McLeod, James (University Of South Florida - Center For Virtualization And Applied Spatial Technologies)

Abstract: Traditional methods of survey are useful for providing spatial information about topography, archaeological landscapes, and site features, but often these methods fail to capture the detailed information that extends beyond general geometry leaving the documentation of detailed archaeological data to high – resolution photography techniques and hand sketches. Advances in laser scanner design and improvements in processing software are now making it possible to efficiently map and produce high-resolution data of complicated environments that would otherwise be difficult to document with traditional methods. In October 2016 the Center for Virtualization and Applied Spatial Technology at the University of South Florida (CVAST) conducted a 3D mapping project of the Castillo de Alarcos in the Castilla-La Mancha region of Spain. As part of this survey, a publically inaccessible semi-intact cistern with significant looter damage was documented using a Faro Focus3D x330 terrestrial laser scanner resulting in a highly-representative point cloud of the cistern. This poster reviews the methodology and challenges of laser scanning confined spaces and presents ways the laser scanner output data was used to produce high-resolution orthographic, color enhanced, and photo-realistic images that provide information about the construction and as-is condition of the cistern not possible with traditional documentation techniques.

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Augmenting Art History: AR in the Survey Classroom

McMichael, A.L. (Michigan State University)
Jon Frey (Michigan State University)
Tommy Truong (Michigan State University)
Eric Martin (Michigan State University)

In spite of recent advances in digital technology, the typical university-level art history lecture remains rooted in a PowerPoint-based pedagogical model that recalls the era of the lantern-slide. While it is possible to point to a strong sense of tradition in the profession, this lack of innovation also signals practical limitations. Thus, even though the number of freely accessible virtual models and environments continues to increase, many academic programs cannot afford the necessary hardware to utilize them. Likewise, the use of equipment like virtual reality (VR) headsets often prohibits the type of group interactions that are essential to learning in the classroom. In this paper, we report on our ongoing effort to utilize augmented reality (AR) technology to teach students about ancient material culture in a survey course. Using Unity 3D software to create a mobile app for smart devices, we present virtual objects in a classroom setting that strikes a balance between the needs of an instructor to direct the lesson and a student to engage in independent exploration. We ask students to critically engage with media in the context of historical research to increase both visual and digital literacy. The resulting classroom experience more closely matches the learning experiences that are found in museum study programs.

From Air to Model- A Workflow for Automated UAV Surveying, Data Transmission and Rapid Cloud Distributed Photogrammetry Processing

Meyer, Dominique (Undergraduate Physics Student At The University Of California, San Diego; Researcher At CHEI, UCSD)
Eric Lo (CHEI, UCSD)
Thomas Wypych (CHEI, UCSD)
Dominique Rissolo (CHEI, UCSD)
Falko Kuester (CHEI, UCSD)

Although UAVs have demonstrated their effectiveness in collecting aerial imagery to document archaeological sites, current workflows to acquire, process, and archive data consist of disjoint stages requiring significant

human intervention. The challenge is that comprehensive and complete data acquisition has to be ensured when perishable data is being collected. As such, the ability to rapidly create and validate a digital surrogate for a cultural heritage site is indispensable. We present an integrated data-driven workflow consisting of automated data acquisition (including takeoff, flight path generation and landing), realtime transmission, and processing, culminating in a rapid preview of orthomosaics and 3D models. For data acquisition, a compute module is paired with a machine vision camera to acquire image data, complemented with inertial measurements and location data from an IMU and RTK GPS which collects data while the UAV autonomously flies over a select environment. An LTE modem in turn communicates with a custom LTE base station for the transmission of data which is either processed locally, or redistributed to a networked compute cluster. The synchronized capture of imagery and pose metadata allows for the accurate generation of orthorectified image mosaics in realtime, as well as more efficiently deriving 3D point cloud data in the field. By streamlining the process from capture to model preview, actionable analysis can be performed on site to inform decision making on at risk archaeological sites.

Evaluating Photogrammetric Reconstructions of Faunal and Lithic Artifacts Compared to Traditional Microscopic Observation, Structured Light Imaging, Laser Scanning, Magnetic Resonance Imaging and Computerized Tomography Scanning

Meyer, Dominique (Undergraduate Physics Student At The University Of California, San Diego; Researcher At CHEI, UCSD)
Danielle Mercure (UC Denver)
Eric Lo (CHEI, UCSD)
Jamie Hodgkins (UC Denver)
Dominique Rissolo (CHEI, UCSD)
Falko Kuester (CHEI, UCSD)

Photogrammetry techniques and in particular structure from motion extraction have emerged as popular and powerful tools for artifact and site recording. While photogrammetry has proven successful at deriving geometry from a set of images, its effectiveness must be evaluated in terms of resolution, geometric accuracy, and completeness. This study evaluates the diagnostic value of digital artifacts versus the original, physical artifacts. When considering the effectiveness of photogrammetry, we compare the surface geometries, volume geometries, and the surface texture to measurements obtained through other techniques. We provide a test setup which evaluates the effectiveness of readily available 3D reconstruction methods to digitize and analyze faunal and lithic artifacts. Being able to identify surface features such as cut and percussion marks in fauna or flake scars in lithics, is invaluable in taphonomy and lithic analysis, supporting the need of good digital models for analysis. While some technologies excel in surface-level acquisition, others such as MRI and CT scanning provide subsurface and volumetric information. The photogrammetry acquisitions are done in two

ways: a handheld reconstruction using a mirrorless camera with a macro lens; and an integrated, automated computer vision camera scanning system, with intelligent focus-stacking and lighting control. The quantitative comparison validates the performance of the photogrammetry, and a qualitative evaluation compared to traditional microscopic observation is done by qualified zoo-archaeologists. The overall goal of this study is to assess the diagnostic value of a purely photogrammetric approach for field and laboratory usage in comparison to other imaging technologies.

Comparing Measured Frequency Responses of the Third Tower of San Marino to Simulation Derived Frequency Responses from a Photogrammetry and LIDAR Acquired 3D Model

Meyer, Dominique (Undergraduate Physics Student At The University Of California, San Diego; Researcher At CHEI, UCSD)
Gianmarco Guerra (Università Degli Studi Della Repubblica Di San Marino)
Eric Lo (CHEI, UCSD)
Michael Hess (CHEI, UCSD)
Davide Forcellini (Università Degli Studi Della Repubblica Di San Marino)
Falko Kuester (CHEI, UCSD)

Ancient cultural heritage sites frequently contain structures exposed to erosion, aging, natural disasters and human conflict, which together with the lack in construction knowledge result in an unknown structural integrity that has to be evaluated for the preservation of the structure and to protect the surroundings. The ridge of Mount Titano and the San Marino Historic Centre town was included in UNESCO world heritage list in 2008, his historical center contains three towers built between the 13th and 14th century, all of which have gone through renovations and have unknown structural resistance to earthquakes and other external processes. High resolution aerial and ground based photogrammetry, together with LIDAR scanning have enabled us to generate a millimeter accuracy 3D surrogate as the basis for numerical simulation.We evaluated a way to numerically approximate the frequency response from finite element 3D models of varying resolution and geometric accuracy. Comparing the numerical simulation results to physical measurements of the physical response allows us to evaluate the extent to which geometric details in 3D model are required for a good structural evaluation of the structure.

Saving the Nubian Temples: The Study of the History through Digital Tools

Mezzano, Michela (Politecnico Di Torino)
Noemi Mafrici (Politecnico Di Torino)

The proposed presentation focuses on the use of digital tools, 3D modelling and Virtual Reality, starting from a historical research on the UNESCO rescue campaign of the Nubia temples in the 1960s. At that time, the Egyptian government promoted the "pharaonic" project for the construction of the Lake Nasser, dammed by the impressive Aswan High Dam. The effects of this work would have destroyed several temples and consequently the historical memory of this area between Egypt and Sudan. The rescue campaign was a unique work both for the coordination between the States involved and for the technology used for the storage of archaeological sites. However, even if the UNESCO international campaign to safeguard the Nubian region has succeeded in preserve a large number of temples, the landscape suffered an irreversible transformation. The purpose of this project is to study the territory and the history through the analysis and the digitalization of traditional historical sources through digital technologies as 3D modelling and Virtual Reality with the aim of promoting, enhancing and communicating the historical and cultural values of this World Heritage Site. The research is conducted by a team composed by members from Politecnico di Torino and from UCLA University of California Los Angeles.

Landscape and Economics: A GIS Location Analysis of Middle Age water mills from Banat Region (Romania)

Micle, Dorel (West University Of Timisoara, Romania)

Banat Region is a historical province located in south-western Romania. The region soundings were drain by several rivers, playing an important role from economically point of view. Due to the high flow rate of those rivers many water mills were built during the middle age period. The historical maps, satellite images and aerial photographs analysis allow us to identify the location of old water mills even if some of them are missing today. In this order, we carried out a series of GIS analyses. Diachronic analysis of the landscape shows some massive man-made interventions in few areas of Banat (during the 18th, 19th, and 20th centuries), changing the rivers flow direction, the flow rate and the depths of the water beds. This proves that the economics of medieval villages have been completely different comparing to modern times. So, the water mills along certain rivers were exploited by remote human communities, fact which brings new insights on people mobility, inter-community relationships, merchandise circulation or craft specialisation. In this study we try to demonstrate that the presence of water mills along certain rivers indicate an extraordinary landscape adaptation and some powerful skills in the large domain of resources management. In conclusion, the medieval communities of Banat region practiced some different economic activities which can be explained through geomorphological and historical context. Finally, this study will bring up a series of spatial analyses used to fulfill our purposes. In this order, we will use some raster reclassifications (slope, exposition, hydrology) to determine the cost analyses and also the rivers dynamics (rate, flooding susceptibility) and others. All of these will pop up some interesting aspects regarding the relation between the millstone and settlements nearby.

The Potential of Structural Analysis in Archaeological Simulation and Interpretation: A Case Study of Medieval Winchester Cathedral Close

Miles, James (Archaeovision)

Following my 2012 session on structural analysis, and my subsequent 2014 paper on the potential of the method within archaeology, the paper presented in Atlanta will highlight the work completed within my PhD research at Winchester Cathedral, which focuses on using structural analysis as a validation tool within interpretations of standing and ruined remains. The understanding of the past, based on limited information, cannot be representative and decisions have to be made interpreting the data available. In order to create three-dimensional models of the past within virtual archaeology and analyse them correctly, the adaptation of newer technologies is needed. Focus, however, must be maintained to emphasise the modelling of physical structures, thus staying faithful to the original intentions of virtual archaeology Investigations as to whether reconstructed buildings can withstand the gravitational loads form the foundation of an additional layer of validation of the models produced. This layered approach allows for greater scrutiny and scientific rigour, creating a tool that is able to review the models produced. Using structural analysis, through the examination of a model's physical properties, allows for not only a critique of its form, but through wider structural tools, possible functions can be clarified and questioned with a greater certainty than is currently available. The introduction of structural analysis as a validation tool has been completed through the research conducted at Winchester Cathedral, and its integration within the modelling process will be discussed.

Old or new? Human Impact and the Mapping of Ancient Nea Paphos

Miszk, Łukasz (Jagiellonian University In Kraków)
Martina Seifert (Hamburg University)
Nikola Babucic (Hamburg University)
Ewdoksia Papuci-Władyka (Jagiellonian University In Kraków)

The mapping of the Archaeological Park in Nea Paphos, one of the most important ancient urban centers of the eastern Mediterranean, is currently under development. Geophysical prospections, remote sensing methods, geological investigations and confirming excavations, conducted by an international team of experts, allow a thorough analysis of the area. This research is carried out under difficult topographical and infrastructural conditions. A dense vegetation in a nature reserve as well as several natural and artificial obstacles on the entire site, limit mobile prospecting devices. First geomagnetic test measurements were conducted in 2015 by a team from both universities on an area restricted to the agora and its immediate surroundings and provided successful results, later confirmed by trial pits. In 2016 surveying was continued

in the northern part of the Park on a larger scale. The obtained promising results comply with the former road network and urban layout. Still the generated data revealed various issues. A main problem will be to generate an extensive plan of modern disturbances to distinguish them from the ancient structures in order to avoid interpretational errors. The lecture is going to show how these studies allow a preliminary outlining of the main architectural structures in the urban layout and how they will affect our future surveys.

Urban sprawl vs. Archaeological Site. A View from Paphos.

Miszk, Łukasz (Jagiellonian University In Kraków)
Wojciech Ostrowski (Warsaw University Of Technology)
Weronika Winiarska (Jagiellonian University In Kraków)

Recent rapid development of the urban sprawl is considered as the most dangerous factor for the cultural heritage protection of the ancient archaeological sites. This is notably the case for Paphos – one of the most important touristic center on Cyprus, which is located directly on the ruins of its ancient predecessor. In spite of the fact that since the 80s 75 percent of the ancient city has been isolated from the infrastructure activity, the rest of it is still being degraded by the urban development. The aim of this paper is to present both the workflow and the data which give the possibility to look into recent past of this kind of archaeological sites. Critical study of the data which are available for free (satellite images) as well as commercial data (archival aerial images, satellite images) for the research area was complemented by the proposition of workflow which gives a possibility of full utilization of the information. The available image data were evaluated as a source of data for two purposes: planning archaeological excavation and management of the cultural heritage. Consistent GIS for the whole research area provide an easy way of integrating the past view of site with other data, like geophysical prospection or documentation for the recent excavation as well as outer data, such as city zoning maps.

Analytical Study and Conservation Processes of Scribe Box from Old Kingdom

Mohamed, Mohamed (Conservator In The Grand Egyptian Museum)

The scribe box under study dates back to the Old Kingdom. It was excavated by the Italian expedition in Qena (1935-1937). The box consists of 2 pieces, a lid and a body. The inner side of the lid is decorated with ancient Egyptian inscriptions written with a black pigment. The box was made using several panels assembled together by wooden dowels and secured with plant ropes. The entire box is covered with a red pigment. This study aims to use analytical techniques to identify the box components. The authors were significantly interested in using (RTI-IR) as a computer technique to improve the hidden inscriptions on the lid. 3D and 2D programs were used to illustrate wood joint techniques. Optical microscopy (OM),X-ray diffraction

(XRD),X-ray fluorescence (XRF) and Fourier Transform Infrared spectroscopy (FTIR) were used in this study in order to identify wood species, remains of insects bodies, red pigment, fibers plant and previous conservation adhesives. The analysis results proved that wooden panels were identified as Acacia nilotica, wooden rail was Salix sp. the insects were identified as Lasioderma serricorne and Gibbium psylloids, the red pigment was Hematite, while the fiber plants were linen, previous adhesive was cellulose nitrate. After transportation to Grand Egyptian Museum Conservation Center, conservation techniques were applied with high accuracy including cleaning, consolidating of friable pigments, removal of previous adhesive and reassembly. Finally the conservation processes were effective for this box which became ready for display or storage in (GEM-CC).

Today's Surveys and Tomorrow's Inversions: GPR Attribute Analysis

Morris, Isabel (Heritage Structures Lab Department Of Civil And Environmental Engineering Princeton University)

Ironically, two fields primarily concerned with the conservation of valuable cultural heritage sites (archaeology and materials science) are inherently destructive. Ground Penetrating Radar (GPR), a promising, non-invasive tool, has yet to reach its full potential. The information contained in a set of GPR data is usually enhanced by applying a variety of standard post-processing techniques and filters. One of these techniques, attribute analysis, is an effective and relatively simple set of methods that can reveal additional information from a survey without engaging in physical excavation or the technical complexities of waveform inversion. Here I present the results of GPR attribute analysis that attempts to distinguish between buried concrete samples with known and variable mechanical properties. The main aims and outcomes of this work are twofold: (1) to explore material specific signatures of different concrete mixes in GPR data, probing empirical relationships between the electromagnetic properties of the material and the mechanical properties; and (2) to validate the capacity of waveform inversion to identify variations in materials. This work is immediately applicable in both the practical quotidian analysis of GPR data and in proving that broader research in GPR waveform inversion can be used to identify mechanical properties.

Challenges and Insights from the Photogrammetric Capture of a Large-scale Diego Rivera Fresco

Mudge, Mark (Cultural Heritage Imaging)
Carla Schroer (Cultural Heritage Imaging)

This paper will share our experience capturing the fine surface details of a 6.7 by 22.5 meters (~ 151 square meters) 1940 fresco by Diego Rivera. The project had multiple motivations: to produce benchmark historic documentation of the current state of the mural; provide details of the mural's surface for conservation and restoration planning; promote awareness and research of the mural iconography and the brushwork of the artist. Several aspects of the project will be highlighted including: the determination and achievement of the resolution and precision requirements; the metadata strategy for the imaging data; and considerations for viable outputs for the web and other distribution channels. Because the fresco surface is so subtle, a high-resolution (submillimeter) capture was required. Approximately1500 overlapping 50MP images were collected following a rule-based, data acquisition error minimization and software independent capture methodology. Another key goal of the work was to acquire appropriate metadata about the imaging project to aide in data reuse and scholarship. We employed a novel metadata acquisition approach using newly developed software tools that produce CIDOC Conceptual Reference Model (CRM) mapped Linked Open Data (LOD) describing the capture context and data validity. The tools use a natural language interface to collect relevant information about the subject, people, project, and equipment. The user needs no CRM or LOD experience to produce this rich metadata result.

Computational Photography, Scientific Imaging, and the Preservation of 3D Digital Representations

Mudge, Mark (Cultural Heritage Imaging)

This 5-minute paper is proposed for the topic Sustainability, Preservation, and Forward Migration. The paper will discuss the advantages of image-based systems for sustainability and long-term preservation of 3D models. When a photographer follows a scientific rule-based methodology, and captures a well-executed sequence of images for use with computational photography technologies such as Reflectance Transformation Imaging (RTI) or photogrammetry, these images can be used to create 3D models with quantifiable measurement precision for use by others both now and in the future. The rigor of scientific imaging requires a record of the means and circumstances surrounding the photographic capture event and any subsequent processing. This record is the equivalent of a scientist's "lab notebook." Our current work to develop advanced metadata collection software records this context metadata in a "Digital Lab Notebook" (DLN). These image sets along with their associated DLN permit qualitative evaluation of a 3D representation built from these images and the information's informed reuse. The captured photographic sequences and the DLN metadata contain all the information needed to regenerate advanced 2D and 3D digital representations, such as 3D models with texture, and a scientific account of their measurement precision at any time. As this 3D information can be reconstituted as needed, computational photography also has an advantage for the long-term preservation of 3D information. Archiving images and metadata is a well-understood practice.

Diffusion Networks and the Transmission of Dynastic Rituals in Classic Maya Society

Munson, Jessica (Lycoming College)
Viviana Amati (University Of Konstanz)
Habiba Habiba (University Of Konstanz)
Jonathan Scholnick (University Of California Davis)
Matthew Looper (California State University, Chico)
Yuriy Polyukhovych (Maya Hieroglyphic Database Project)
Martha Macri (University Of California Davis)

The simple dyadic structure of a network is the basis for studying a wide variety of entities and their relationships. Here, we investigate whether network ties facilitated the flow of information in past complex societies. Inscriptions on Classic Maya monuments offer a unique dataset to evaluate the degree to which sociopolitical network ties were conduits for the diffusion of specialized ritual knowledge between ancient Maya cities. Given that some of the largest Maya sites shared a significant proportion of inscribed ritual practices, we apply network diffusion models to test whether specific sites were more or less likely to adopt a ritual based on their network position and geographical location. Although these hieroglyphic texts provide detailed historical records about the specific rituals performed by Maya rulers, as well as when, where, and with whom they battled and reigned over, several challenges are posed by this analysis. Due to the preservation of the monuments, the data are affected by missing information, which might bias the model estimates. Furthermore, several assumptions about the rate at which rituals are adopted need to be formulated. Deviations from these assumptions might seriously affect inferences from the data. After discussing probabilistic methods to reduce the impact of missing data, we investigate the robustness of network diffusion models comparing parametric and non-parametric approaches.

Practical Applications of Underwater Laser Scanning in Maritime Archaeology Compared to Micro-bathymetry Sonar and Photogrammetry

Murray, Michael (University Of Southampton And Biscayne National Park)

Advances in multi-beam sonar have produced high density (and in the case of photogrammetry) textured, photo-realistic results of various underwater archaeological sites by rapidly capturing information in areas that are difficult or otherwise inaccessible to diving. In recent years, these technologies have been accompanied by underwater scanning, a method, which offers a step change in resolution, and consequently, significant interpretative potential. However, each method has inherently different sources of uncertainty across various conditions where effectively gauging their performance remains elusive. This paper proposes a new methodology through the results of case studies for verifying accuracy through an easily deployable 3D

scale and quantifies these technological differences while considering their implications of use within archaeology. Future work, including the potential use of ROVs for deep water applications will also be discussed.

Digital Workflow for Structural Analysis of Discontinuous Media

Napolitano, Rebecca (Princeton University)
Branko Glisic (Princeton University)

Heritage structures are an integral and tangible part of cultural legacy. Holistic analysis of these buildings can lead to a better understanding of their meaning, construction, and the people who built them, as well as indicate how they can be best preserved, monitored, or enhanced. An important part of holistic analysis is the availability of a fast and accurate means of evaluating structural integrity. Furthermore, it is imperative that analytical models accurately reflect the current conditions on-site including cracks, defects, and other types of damage. We have developed a digital workflow which facilitates the fast generation of an analytical model, from either a two-dimensional photograph or three-dimensional model obtained by photogrammetry. Furthermore, we use a distinct element model to simulate structural response to a variety of scenarios, including gravity, lateral, and seismic loading. Important properties of distinct element models are the assumption of a discontinuous medium as well as the use of an explicit time-step. These numerical properties allow for jointed structures to be properly simulated, as is true for masonry, where the stones are mechanically much stronger than the mortar joints. Allowing for modifications on the fly, our digital workflow enables us to quickly compare the structural analysis results with and without hypothetical structural features, including cracks, supports, or other missing elements, leading to a deeper understanding of heritage structures.

A Geographically based Ripley's Function to Assess Settlement Patterning

Negre, Joan (Quantitative Archaeology Laboratory Autonomous University Of Barcelona)

In the statistical analysis of spatial point patterns, it is assumed the correlation between the elements of a spatial distribution is a function of the Euclidean distance between them. This framework has been vastly used in Spatial Analysis to describe settlement processes, taking into account a homogenous and undifferentiated surface, without movement constraints, easy to generalise. Our approach assumes instead some kind of spatial heterogeneity, this is a topographical dependence of settlement patterns, because it is not as difficult to travel between two points when they are in a flat and firm area as when the path must pass through a very hilly mountainous area. A methodological R-coded approach is proposed in order to implement a spatial homogeneity descriptor, based on a geographical modification of the standard Ripley's K-

function, allowing the researchers to describe the degree of spatial overdispersion in a more reliable way. Social processes tend to act over settlement patterns and consequently, the transformations shown by these can be formally analysed as a result of a series of historical and political decisions. They are, therefore, precise indicators of social change. A remarkable theoretical model of rural settlement was made by John C. Hudson at the end of the sixties in these terms. We use it in a case study from the northeast Iberian Peninsula regarding its medieval settlement expansion process, comparing the results of both traditional and modified Ripley's K function.

Turning the Ship without Rocking the Boat: Establishing Archaeological GIS within an Undergraduate Experience

Newhard, James (College Of Charleston)

The use of GIS and other informatic tools is no longer a novelty but a necessity for the proper collection, management, analysis, and communication of our work; yet these skills are often disparately found within the curricula of US institutions and rarely required for the pursuit of a degree in archaeology or its cognate disciplines. This presentation will discuss the implementation of archaeological GIS within an undergraduate institution to discuss broader factors within higher education that perhaps underlie the fragmented manner by which this disciplinary need is often met and directions for successful resolution.

Whose (maritime) Archaeology is It Anyway?

Ni Chiobhain Enqvist, Delia (Linnaeus University Bohusläns Museum)

Access to cultural heritage is both recommended by and is the basis of many conventions on cultural heritage. In the case of submerged cultural heritage the 2001 UNESCO Convention on the Protection of Protection of the Underwater Cultural Heritage highlights the importance of access, while also recommending in situ preservation, setting the tone for the discipline of maritime archaeology’s current dominant practice. The current challenge for development-led archaeology to present archaeological results in such a way that they are of relevance and benefit to society is thus amplified when this type of heritage is located in an environment accessible only by the expert few. Those who create visual narratives are heavily influenced by both personal and discipline-wide biases and research agendas, culminating in an unbalanced and excluding picture of the past delivered to society. The adoption of digital documentation techniques by archaeologists working underwater has resulted in many older methodologies simply turning digital, circumnavigating any critical analysis of the methodologies themselves, what precisely they are communicating and to whom the information is to be conveyed. This is resulting in a failure to realise the full potential of the multiple ways

that this particular kind of heritage can be experienced and narrated, as well as the full potential of these technologies for visualisation purposes.

Good Photogrammetry, Good Data, Good Science

Noble, Tommy (TN Photogrammetry LLC)
Neffra Matthews (United States Department Of The Interior, Bureau Of Land Management)

Traditional photogrammetry has been greatly enhanced by the development and proliferation of automatic image matching or Structure from Motion (SfM) algorithms and techniques. Along with huge advances in compute speed and graphics processing power, it is quite easy to produce visually stunning 3D output from nothing but a few images. In some cases nothing more than visualization or virtual interaction with a 3D representation of a subject may be all that is desired. However, if the resulting 3D model is intended to support good science there is a need for understanding, modeling, and minimizing the sources of error in the photogrammetric process. With very little additional time or cost, image data can be both visually stunning and scientifically accurate, reliable and statistically supportable. Presented will be techniques and procedures for image capture, analysis and camera calibration refinement to meet accurate data requirement needs. In addition, some discussion and examples of error that can and does exist in photogrammetry projects - created without proper image capture, lens calibration, and error minimization - will be included.

How We Measure Shape

Opitz, Rachel (Center For Virtualization And Applied Spatial Technologies And Department Of Anthropology, University Of South Florida)

The study of use wear on ceramics has primarily been carried out on the basis of visual assessment. Through ongoing work in the "CALCRome Project" we are exploring the use of 3D scans of vessels to support a more quantitative approach to measuring and characterizing different types of wear. In trying to tell apart, quantitatively and robustly, wear from production, use and deposition, we are having to think quite hard about the shapes that characterize each type of wear. New morphological descriptors and metrics are needed to characterize each type of wear. Shape similarity metrics that work well for irregular shapes and are pose invariant are also needed. In short, in order to make good use of 3D digital models of ceramics in use wear analysis, we have to improve the way we measure and characterize shapes. This paper lays out the challenges for characterizing shape and our projects approach to the problem.

Publishers and Archives as Fieldwork Collaborators

Opitz, Rachel (Center For Virtualization And Applied Spatial Technologies, University Of South Florida)

The ultimate goal of a research excavation, beyond the excitement of discovery during the dig, and the intellectual accomplishments of analysis and study, is the publication and dissemination of the results and the creation of an archive. This session challenges us to consider, “how to effectively integrate digital technologies in day-to-day fieldwork practice, and which infrastructures we should develop to favour the 'digital turn' in archaeological recording on site”. This paper discusses how planning for digital publication and archiving is affecting our daily field recording strategies at the Gabii Project, and looks at some of the infrastructure and approaches that can help us to better link these stages of the process. I argue that explicitly planning and preparing for narrative publication, data publication and archiving as part of the fieldwork process encourages the ‘digital turn’, in particular because it tightens the links between recording in the field and the published interpretation and record. At the same time, challenges are posed, in particular by the requirement for early and flexible collaboration with potential archives and publishers, and by the need to adapt to multiple platforms to study, store and disseminate complex digital data generated by many excavations today.

Enhancing Collaboration between Digital Assyriology Projects Through Open Access Practices

Pagé-Perron, Émilie (University Of Toronto)
Terhi Nurmikko-Fuller (Australian National University)
Vanessa Juloux (Ecole Pratique Des Hautes Etudes Paris Sciences Et Lettres (PSL) Research University)

Assyriology is a small discipline[1] and digital corpus analysis is a niche domain within it. Many independent online projects have emerged (e.g. CDLI, OCHE, ORACC, ArchiBab), resulting in a fragmented cluster of resources containing rarely connected but complementary data, published according to different standards. Collaborations are often restricted to models that do not foster Open Access (OA). In this paper, we argue the need for greater dissemination of agreed upon standards, increased interoperability, and further linking between resources. Proposed solutions include shared standards for encoding data and adherence to Linked Open Data[2] to bridge complementary assyriological corpora with each other, and other relevant information published online, without extensive restructuring or duplication of labour. Information becomes more readily discoverable and available for use by researchers in new ways (statistical analysis, comparative evaluations). It will also prepare data for future machine-based inferencing. This paper will also foster discussion on defining new ways of collaborating toward this goal. [1] The International Association of Assyriology members’ list has around 500 members http://iaassyriology.org/members-list/ [2] https://www.w3.org/standards/semanticweb/data

An Inclusive Archaeology: Being Able in Archaeology

Pageau, Hanna (University At Albany)

An often underrepresented, group even amongst underrepresented groups, are those suffering from (usually) invisible illnesses. This is a particularly harsh thing to talk about in academia, even more so amongst the field sciences, given that the significant boundaries set in place by the environment it creates that often push those with any negative notions of health back out the door as soon as they step inside. The idea that to be a field scientist you have to be strong and healthy is a damaging one that contributes to silence from those affected on a daily basis, and perpetuates the idea that science is for the able. Digital Archaeology is not only a boon for those who are financially unable to make it out to the field – but Digital Archaeology and digitalization of collections in particular, opens up the doors for inclusivity at a new level for those who are more physically unable – whether permanently or temporarily – to continue work within the field of archaeology. This paper will discuss the need for this level of inclusivity and call for a shift in thinking of the idea of what being able means, in order to counter the common elitist field science narrative that digital archaeology is 'fluff' and not 'real' archaeology.

How Can We Trace Translocated Boulders with Petroglyphs at the Riverbank?

Pakhunov, Alexander (Institute Of Archaeology Russian Academy Of Sciences)
Ekaterina Devlet (Institute Of Archaeology Russian Academy Of Sciences)
Alexander Popov ()

Boulders with carvings evidently seem to be stable, immovable and that is true in almost all cases. But there are some exceptions – one may be found at Amur riverbank (Russian Far East). At Sikachi-Alyan rock art site boulders at the riverbank are often shifted by icedrift, they also may be influences by a strong flooding, so, petroglyphs may appear and disappear. Sikachi-Alyan is an important site in the UNESCO Tentative List, local rock art tradition is dated back as far as to 14,000BP and survived till medieval period. In order to trace the current positions of translocated stones, and to provide new methods for the monitoring of the site we make detailed photogrammetric models of the major locations using a NikonD800 camera with 20mm lens at a 4-meter pole. In order to estimate the sensitivity of the method we experimented with the intentional shifting of one stone without petroglyphs, and tracing its position before and after translocation. The comparison of two points clouds in CloudCompare software allowed to detect the shifted stone and also a number of small ones (

Campus Archaeology and 3D Modeling: An Archaeological Collection of Historic Artifacts from the University of Nebraska-Lincoln

Pattee, Aaron (Heidelberg University And University Of Nebraska-Lincoln)
Effie Athanassopoulos (University Of Nebraska-Lincoln)
Kami Ahrens (University Of Nebraska-Lincoln)
Cole Juckette (University Of Nebraska-Lincoln)

This presentation explores the application of 3D modeling procedures for laser-scanning and photogrammetric recording methods. The combination of both methods allows for precise recordings of artifacts and generations of high resolution models. The case study is site 25LC86—a cistern once located under the student union at the University of Nebraska-Lincoln. The artifacts are representative of a late nineteenth and early twentieth century Lincoln residential area, before it became part of the university campus. The archaeological collection is diverse and in excellent condition, including a large number of glass bottles (many of them medicinal); metal artifacts such as nails, padlocks, and eating utensils; faunal remains; personal items, such as pocket watches and fragments of pipes; and a wide variety of ceramics, including utilitarian pottery from the former Lincoln Pottery Works factory, whitewares, stoneware, and porcelain. Many of the objects required an unconventional modeling procedure due to shiny/reflective surfaces in which the camera was rotated around the objects. This procedure yielded high resolution models with minimal glare and textures rivaling 2D photographs. The collection is instrumental in understanding domestic life on the Great Plains at the turn of the century. This knowledge will be disseminated through an online project hosted on the interface Scalar integrating research, 2D images, digitized primary resources, and the 3D models. The assemblage offers a unique insight into the social structure of Lincoln at the end of the nineteenth century and provides an opportunity to explore the methods for presenting historical/archaeological knowledge in a digital format.

Analyzing the Medieval Landscape of the Pfalz—Castles in the Area of Kaiserslautern

Pattee, Aaron (Heidelberg University)

This study explores the integration of various methods including photogrammetry, laser-scanning, GIS, and textual analysis creating a more holistic and anthropological understanding of the medieval landscape of the Pfalz in the area of Kaiserslautern, Germany. The case study is composed of several ruined castles, surrounding the former royal palace (Königspfalz) in Kaiserslautern, which served as key components to a larger network of fortresses built throughout the Pfalz from 1050-1300 A.D. The project is divided into a visual component and textual component. The objectives of the visual component are to merge the measuring strength of terrestrial laser-scanning with the high resolution textures of photogrammetry—both necessary

for architectural analyses. Access to high resolution models of the structures without being physically present at the sites is a significant advantage for both researching the architecture of the structures and for their digital preservation. The merged models will be geo-referenced in GIS and a variety of GIS functions will be performed in order to postulate the reasoning for the placement of the castles and their designs in relation to their environment. The textual component of the project consists of historical documents including letters, archaeological excavation reports, maps, drawings/etchings, and histories of the castles from which information will be derived and incorporated into GIS. The documents provide the means to contextualize the project within the framework of the medieval culture. Creating a digital landscape in GIS, integrating 3D models and historical documents, will preserve these sites and allow for new interpretations of the area's past.

History Erased and History Recovered: (Re)Creating the Rohwer Japanese Interment Camp

Payne, Angie (Center For Advanced Spatial Technologies)
Vance Green ()
Fred Limp ()

The Rohwer Reconstructed project is an interactive historic visualization that allows visitors to virtually explore and experience the Japanese American internment at Rohwer Arkansas as it was during WWII. The site today is a farm field – the site has been literally erased. The project's objective is to show the details of daily life in an immersive walkthrough of a single block within the camp. Throughout this project, we have encountered numerous challenges some of which are common visualization considerations and others that are specific to handling culturally sensitive content associated with Rohwer. For example, a primary consideration of this project has been striking a balance between making the space "look lived" while respecting the level of maintenance and craftsmanship that the internees exhibited in caring for their homes and gardens. In this paper, we will discuss how we are achieving that balance by receiving critical feedback from internees that actually lived at the camp. With input from previous internees, we have also had to reevaluate the underlying story or content that is presented in the visualization. Whose story is it? And how effectively is that story told throughout the visualization? Finally, we will also discuss important user interface considerations that include designing for multiple skill levels and how different tour options affect the end-user experience.

Bootstrap Methods for Assessing Variability in Archaeological Networks

Peeples, Matthew (Arizona State University)
John Roberts (University Of Wisconsin, Milwaukee; Department Of Sociology)

A long-standing criticism of traditional graph-theoretic measures in network analysis is the lack of assessment of sampling variability or uncertainty more generally. For instance, the classic measures of network actors' centrality do not include confidence intervals for calculated node or graph level scores. Even if one is not interested in, say, testing for a "statistically significant" difference between two actors' centrality scores, some assessment of sampling variability would be helpful in making substantive interpretations. This concern is particularly relevant for the most common types of archaeological data that have been used to generate formal networks. In particular, archaeological networks based on co-occurrence or similarity created from artifact frequency data are subject to a number of potential sources of variation due to sampling error, missing data, and the vagaries of artifact classification schemes among others. Resampling (bootstrap) methods are a natural approach to this problem; in these methods, measures can be calculated in a large number of "replications" resampled from the observed data, and sampling variability in observed measure assessed by its variability across replications. In this paper, we build and test a set of formal tools for evaluating uncertainty in archaeological network datasets based on this resampling approach using examples from a large regional dataset from the U.S. Southwest.

The Use of GIS to Understand the Circulation of Metal in the Prehistoric Alps.

Perucchetti, Laura (University Of Oxford)
Peter Bray (University Of Oxford)
Mark Pollard (University Of Oxford)

Most scientific metallurgical projects on prehistoric artefacts focus on the provenance of the material, such as simplistic matches between mines and finished objects. This paper outlines new GIS-based approaches that instead explore metal technology and circulation in the Circum-Alpine Region in the Copper Age and Early Bronze Age (c. 3600-1600 BC). Through this time span many cultures followed one other, on both sides of the Alps. This paper aims to explore how these societies interacted with metal, their production processes and how circulation patterns changed over time. We feel that this attempt to see how metallurgy operated in the social context of a dramatic, mountainous landscape is a more interesting approach than applying old models of scientific provenance. We created a database with information on metal artefacts that captured as wide a range of data, blending the archaeological (typology, deposition context) and scientific (chemical analysis). These data have been analysed with a number of geostatistical approaches, including cost surfaces and Anselin Local Moran's I. Other bespoke tools were developed to interpret the distribution of metal compositions through ubiquity analysis. The results indicate that increased metal production at the transition between the Copper Age and the Early Bronze Age does not imply socio-cultural changes, such as the establishment of centralised production and distribution. Instead, in both periods, metal moved through short-distance exchange between proximal communities, with recycling and mixing of material. Topographical features can be statistically demonstrated to be less influential than cultural choices on this flow of metal.

Using Inscribed Stone Surfaces To Examine Low Cost 3D imaging

Peters, Caradoc (University Of Plymouth, Truro College)

Inscribed stones located throughout South Western Britain will be used to examine low cost 3D imaging solutions. The presentation builds upon research outlined in Developing a low cost 3D imaging solution for inscribed stone surface analysis - comparing results generated from a mobile or cell phone and DSLR camera. The fundamentals of photogrammetry will be considered in the examples used. That is, in order to show why metric accuracy is important when dealing with artifacts where subjective interpretation can be a problem. The following are also considered; interior and exterior orientation; how scale is added to a scene and what the information generated is ultimately being used for.

Accessing the Inaccessible: Detailed 'Off-Site' Archaeological Survey using Satellite Imagery and GIS at the Hatnub Travertine Quarries, Egypt

Pethen, Hannah (University Of Liverpool.)

Complete sites and anthropogenic damage, as well as hollow-roads, radial trails and long-distance routes have previously been traced using remote-sensing, but the investigation of an entire landscape requires detailed survey of much smaller features than these. This paper describes the successful 'off-site' archaeological survey of features across the Hatnub desert quarrying region, including particularly small huts and shelters. High (0.4m) resolution pan-sharpened satellite imagery was used to create a detailed vector plan of a 100km square pilot area in ArcGIS 10.4 Geographic Information System software. As with a project recording roads from remotely sensed imagery at Deir el-Bersha, spectral content and filtering was found to be of less importance in feature detection, but enhancement techniques such as histogram stretching were effective in obscured areas. The high proportion of archaeological features recorded in the 'off-site' survey that were also present in field-survey data demonstrated that the process was generally accurate, except for features that had been badly damaged in recent years. The resulting digital plans provide a permanent record of an imperilled landscape at a level of detail that has not previously been attempted using 'off-site' survey. This method offers improved access to inaccessible areas, will ensure fieldwork is targeted at important remains and can be combined with mobile recording techniques that modify 'off-site' survey data during 'on-site' fieldwork.

Determining Spatial Relationships Between Domestic Sites and Cemeteries of the Central Peloponnese

Pihokker, Matthew (Joukowsky Institute For Archaeology And The Ancient World, Brown University)

The Late Bronze Age in mainland Greece is often characterized by mass migration and population movement stemming from the collapse of regional Mycenaean urban centers and their consolidated systems of organization. Decentralization of power spurred an increase in the prevalence of rural domestic sites and cemeteries as people moved away from cities and settled in remote areas. This well-established dynamic is documented in many regions of the mountainous central Peloponnese, long understood to be a natural refuge. Yet, archaeological material indicates a number of distinct burial centers throughout the territory with little or no evidence for nearby domestic sites as one would expect. This paper will address the seemingly disparity for certain burial centers in the central Peloponnese that lack evidence for established or emergent domestic sites during the Late Helladic III period, and seeks to offer answers as to their probable locations and relationship to the landscape. Larger trends in Mycenaean burial practice will also be explored. Survey and remotely-sensed data, as well as GIS-based analyses will be considered, specifically Normalized Difference Vegetation Index (NDVI) analysis.

Augmented Reality (AR) and Digital Photogrammetry as a Way of Preserving and Popularization of Archeological Collections

Pikov, Nikita (Siberian Federal University)

Exponential growth in IT provides new ways to digitize and present archeological research and has influenced the popularization and preservation of cultural heritage. Digital photogrammetry is an optimal method to digitize archeological objects that does not require any special equipment and provides accuracy, objectivity, and a high level of data performance. Augmented Reality (AR) allows a user to study ancient materials through an ability to examine the objects from any angle. Since 2014, we have been developing projects aimed at preserving and popularizing archeological collections using digital photogrammetry and AR. In 2015, we developed a PC app representing a collection of Okunev culture petroglyphs from the State Hermitage Museum. It included 3D visualized petroglyphs, animation, and audio. Since 2016, we have been working on a project including a printed dictionary of archeological terms and an AR mobile app for iOS and Android. We have developed a “Virtual Archaeology” mobile app as supporting information for the “Ancient Cultures of Mongolia, Baikalian Siberia and Northern Area of China” conference. The app is on the App Store and Google Play in a reduced functionality mode. Photogrammetric digitization and AR visualization are practical for archaeological collections. Students can benefit from AR using 3d models as supplemental materials to course books, so a student can refer to an archaeological artifact with his/her mobile device. However, using AR in mobile devices restricts textures' resolution and variety and requires optimization of 3d objects. These aspects along with lighting used during photogrammetric digitization may lead to certain distortion of images.

Graphic Analysis of Historic Documents, Architectural Survey, Applied Geophysics in Support of Archaeological Investigation. The Urban Wall of Cagliari (Sardinia, Italy)

Pirinu, Andrea (DICAAR, Faculty Of Engineering And Architecture, University Of Cagliari)

This paper shows the results of a multidisciplinary investigation applied to the historical city of Cagliari, where relevant portions of both the medieval and the modern defensive lines are presently hidden below the street level and / or incorporated within the existing buildings. In fact, the study area is among those which have suffered major transformations between the Middle Ages and the Modern age, and maintains important traces of military architecture. The research has included a first phase dedicated to the study of historical maps that represent the fortress of Cagliari as it was in the past. A second phase has concerned an additional step with the reliefs of the existing structures. The architectural and archaeological methods have been integrated by means of geophysical surveys with electromagnetic and seismic methods; the combined use of GPR (ground penetrating radar) and seismic tomography proved to be a useful tool for the understanding of the complex building systems characterizing the study area. The results deriving from the above integrated approach lead to a single multidimensional model structured in a G.I.S. project.

3D Digital Modelling and Digital Urban History: A Methodology for Studying the Processes of Transformation of Nubian Temples and Landscape in the Site of Lake Nasser.

Piumatti, Paolo (Politecnico Di Torino)
Rosa Tamborrino (Politecnico Di Torino)

3D digital models are powerful tools for the study and comprehension of historical sites and buildings. 3D virtual reality is a common practice for investigating the state of a building; in addition to such state description, 3D models can be used for a process description, which is fundamental in order to investigate how an historical building or site was conceived, used, modified, ruined, reconstructed, in other words the physical and cultural phenomena underlying its life. This paper illustrates the first results and the issues about the use of 3D digital models to study the transformations of the sites along the river Nile now submerged by the waters of the Lake Nasser. The research is conducted by a team from Politecnico di Torino and from the Department of Near Eastern Languages and Cultures of UCLA University of California Los Angeles. In this research 3D models are used as a tool to digitally collect, organize and visualize data starting from heterogeneous historical documents. In particular 3D models are conceived and used to study the transformations of the landscape, urban settlements and temples before and after the construction of the Big Assuan Dam. The first results show that the discrepancy between the homogeneity of data required to build

the 3D model and the non-homogeneity of historical documents is at the same time the weakness and the strength of the method, since it forces researchers to explore new hypothesis and students to understand and manage the reliability of historical data.

The Microcosm of Tiberius's Cave in Sperlonga: Analysis, Investigation and Digital Reconstruction of the Ancient "Sculpture's Theatre"

Porfiri, Francesca ("Sapienza", University Of Rome)
Carlo Bianchini ("Sapienza", University Of Rome)

The Tiberius's Cave is an example of rare merging between landscape and architecture, set in Sperlonga, a unique reality where architectural and environmental values coexist. The emperor Tiberius's villa, built in the first century A.D., was composed by several buildings laid out on terracing towards the sea and by a wide natural cave with a fish pond in front of it, that hosted inside a caenatio, extending its morphology under the cave through a round pool. The Tiberius's Cave showed inside a flowing succession of scenography settings, thanks to the presence of many sculpture's group, dedicated to Ulysses's myth – that's why the cave was so called "the sculpture's theatre" – but especially with the help of sea colour mosaic decorations, or marble fragments along the surfaces of the cave. Nowadays sculptures and decoration's fragments are preserved in Sperlonga's Museum. This study aims to approach a digital 3D-reconstruction of the ancient "sculpture's theatre" with its original elements and decorations by using a previously executed accurate analysis and a combination of different architectural survey techniques. It is possible to obtain a 3D model in which the surfaces are portrayed in high definition, with greater morphological accuracy including their material and chromatic appearance, by integrating the textured mesh model of sculptures and decorations (provided by photomodelling) with the points cloud of the cave (from 3D laser scanning). The goal is to bring back its perceptive power through the computer graphic technology to promote an appropriate preservation of archaeological heritage.

A Comparative Analysis of Châtelperronian and Protoaurignacian Blade Core Technology Using Data Derived from 3D Models

Porter, Samantha (University Of Minnesota, Twin Cities)
Morgan Roussel (Leiden University)
Marie Soressi (Leiden University)

This study uses data extracted from 3D models to compare the Châtelperronian and Protoaurignacian stone tool industries, which are at the center of the debate surrounding the nature and extent of interactions

between Neanderthals and anatomically modern humans (AMHs) approximately 40,000 years ago. Our data are derived from 3D scans of 149 blade cores associated with one Protoaurignacian and two Châtelperronian assemblages from two archaeological sites (Roc-de-Combe and Les Cottés). We will use these data to test hypotheses about technological similarities and differences between these two entities by making statistical comparisons of artifact attributes, which are either difficult or impossible to quantify using traditional methods. We will examine the utility of different approaches including the digital measurement of edge angles, and the characterization of artifact shape using elliptical fourier analysis. We will interpret our results within the framework of previous qualitative observations made about these technologies, as well as the larger research question of if and how Neanderthals and AMHs may have exchanged technological knowledge. This presentation will also touch on larger issues including the use of close-range photogrammetry for morphological analyses of artifacts, the pros and cons of using 3D-derived data compared to traditional methods, and the quality of data required to conduct a study of this kind.

A Tale of Two Projects: The Role of Web-GIS in Collaborative Research

Pouncett, John (School Of Archaeology, University Of Oxford)
Chris Green (School Of Archaeology, University Of Oxford)
Chris Gosden (School Of Archaeology, University Of Oxford)
Mark Pollard (School Of Archaeology, University Of Oxford)

This paper compares the contrasting roles that Web-GIS plays in two ERC funded projects based at the University of Oxford – Flow of Ancient Metals across Eurasia (FLAME) which has just begun and English Landscapes and Identities (EngLaID) which is currently drawing to a close. Both projects: 1) seek to integrate and synthesise large quantities of data from a wide variety of sources; 2) operate at a broad range of spatial and temporal scales; 3) bring together a diverse group of specialists with differing areas of research and skill sets; 4) utilise datasets that have access constraints and cannot be published in full. All of these elements present challenges, not least finding a common platform that will enable sharing of data and tools both internally within the core project teams and externally with project partners and the wider community. Problems encountered include reporting restrictions on spatial precision and interpretations of fair academic use, solved using spatial bins and traffic-light encoding respectively. Both projects have addressed these challenges using Web-GIS, but have done so in different ways. The strengths and weaknesses of the approaches adopted by the two projects will be discussed critically with a view to best practice for similar projects in the future.

Comparing Network Models for the Evolution of Terrestrial Connections in Central Italy (950—500 BC ca)

Prignano, Luce (Universitat De Barcelona)
Sergi Lozano (IPHES (Institut Català De Paleocologia I Evoluciò Social))
Ignacio Morer (Universitat De Barcelona)
Francesca Fulminante (Università "Roma Tre")

The period between the Late Bronze Age and the Archaic Age is a time of change and development in the Italian Peninsula, which led to the creation of regional ethnic and political groups and to the formation of the first city-states. In this study, we focused on the Tyrrhenian regions of Latium vetus and Southern Etruria, by analyzing the evolution of the network of terrestrial routes as they have been hypothesized by scholars from archaeological evidences. Our goal was twofold: 1) To explore the mechanisms that shaped the overall structure of these past communication infrastructures; 2) To figure out whether they changed or stayed the same throughout the considered time framework. To this end, we designed network models corresponding to three competing hypotheses about the dominant mechanism underlying the creation of new connections. Then, in order to compare the synthetic networks generated by those models with the corresponding empirical systems, we considered several global topological measures. In particular, we focused on features that are not sensitive to missing links and, therefore, are appropriate to data-sets with a certain degree of incompleteness. This comparative analysis led to different outcomes for each of the two regions. In the case of Southern Etruria, the model simulating a simple form of cooperation was able to accurately reproduce all the relevant features of the network for the whole period under study. On the contrary, for Latium vetus, each model could reproduce only some of the features at some of the ages. However, if we add a “rich get richer” bias to the cooperative model, its performance improves significantly. These results suggest that coordinated decision-making was the main mechanism for both regions. In the case of Southern Etruria the polities could be regarded as peers, while unbalanced power characterized the context in Latium vetus.

Digital Philology in the Ras Shamra Tablet Inventory Project: Text Curation through Computational Intelligence

Prosser, Miller (OCHRE Data Service Oriental Institute University Of Chicago)

The Ras Shamra Tablet Inventory (http://ods.uchicago.edu/rsti/) is a research project at the Oriental Institute of the University of Chicago. Co-directed by Miller Prosser and Dennis Pardee, a primary goal of the project is to create reliable digital editions of the texts in the Ras Shamra-Ugarit corpus. Using OCHRE (the Online Cultural and Historical Research Environment), we are currently in the process of importing and curating data with the help of various workflow wizards. The data ingestion process accepts a standard text transliteration—from a Microsoft Word or other common document format—and uses intelligent functions to atomize the linear transcription into individual signs or letters. As part of this process, the database validates these signs and letters against an internal sign list that includes all possible readings of all possible signs in the Ugaritic and Sumero-Akkadian writing systems. Once the text is added to the database, analytical wizards

guide the user through the tasks of finding words in project dictionaries, parsing words for grammar, and identifying people and places in the texts. The importation and curation steps both employ intelligent processes developed specifically for the task of knowledge representation of philological data. The outcome is textual data that is highly granular, well-organized, and ready to be shared online or used in various types of analyses.

Processes of Urban Development Among the Ancient Maya of Uxbenká and Ix Kuku'il, Southern Belize

Prufer, Keith (Department Of Anthropology, University Of New Mexico)
Amy Thompson (Department Of Anthropology, University Of New Mexico)

This paper examines low-density urbanism through the use of LiDAR derived data and excavated materials at two Classic Period (AD 300-800) Maya communities, Uxbenká and Ix Kuku'il, located in the southern foothills of the Maya Mountains, Toledo District, Belize. While the settlement typologies based on architectural forms and volumetric analyses suggest general similarities in these settlement systems, geospatial and statistical analyses indicate differences in the distributions of households across the landscapes of Uxbenká and Ix Kuku'il. Using high-precision radiocarbon dates and ceramic sequences from household contexts of varying social status across the sites, the gradual growth and development of Uxbenká and Ix Kuku'il are compared to understand the expression of low-density urbanism in contemporary communities. We utilize a human behavioral ecology (HBE) theoretical framework to consider the social and ecological factors that influenced human decision-making dynamics in regards to settlement location and how these changed over time with shifting political atmospheres. This paper explores how and why low-density urban communities manifest in seemingly similar yet different ways through comparison of urban development in southern Belize.

Acoustics of the South Theatre at Hadrian's Villa: A Preliminary Study using I-Simpa

Puglisi, Julia (Indiana University, Bloomington)

Today, the acoustics of the South Theatre at Hadrian's Villa in Italy are lost under stratified layers of debris and cannot be tested in situ. The field of acoustics and 3D modeling permits a richer understanding of ancient theatre construction by "reviving" these once functional structures in the virtual realm. By utilising a three-dimensional sound propagation software called I-Simpa, we were able to test the accuracy of the theatre's architectural plans proposed by the 19th-century architect Hermann Winnefeld. We used I-Simpa to

simulate the aural experience of the South Theatre, to test varying levels of intelligibility throughout the cavea, and to disprove Winnefeld's claim of an "imperial box" at the top of the cavea.

In Search of Common Ground: Time, Tradition, and Temporal Reconciliation in PeriodO 2

Rabinowitz, Adam (The University Of Texas At Austin)
Ryan Shaw (The University Of North Carolina, Chapel Hill)
Patrick Golden (The University Of North Carolina, Chapel Hill)
Elijah Fleming (The University Of Texas At Austin)
Lorraine Haricombe (The University Of Texas At Austin)

PeriodO is a Linked Data gazetteer of authoritative spatiotemporal definitions of archaeological, historical, art-historical, literary and geological periods. Unlike thesauri that treat periods as abstract entities, PeriodO is intended to document specific instances of usage where a scholar or project has defined spatial and temporal boundaries for a particular period concept; model those instances in such a way that their boundaries are clearly expressed for both human and machine readers; and give each definition a globally-unique persistent identifier. This approach captures usage across a range of traditions, disciplines, places, and times, providing a way for data managers to transparently define the usage of period terms in their own datasets. In the first phase of the project, we collected more than 2700 period definitions and created a browser-based client for viewing and input. The goal of PeriodO 2 is to put the gazetteer to use among a broader group of humanities-focused partners. In this phase, we will develop reconciliation tools that allow data managers to match their terms to PeriodO definitions, and improve the client's visualization options to enhance gazetteer usability. At the end of this phase, we will explore the use of the gazetteer for probabilistic temporal text-parsing.

Landscape Archaeology and Artificial Intelligence: The Neural Hypersurface of the Mesopotamian Urban Revolution

Ramazzotti, Marco (La Sapienza)

Today, there is unceasing talk of Computer Semiotics as a discipline aiming at establishing the function of the logical operators of programming on the basis of structured and complex semantic units, but the semiotic analysis is also one of the main trends in Computer Science. In particular, the Computer Science is interested in constructing nodes or cells composing many of the artificial models of the Artificial Adaptive Systems' class. Given these basic coordinates, it seems clear that simulating the behavior of the high variability of the

cultural factors in networks thus conceived equals tracking down, selecting and recreating a wide variety of functions associating variables, inferences controlling their semantic structure, and causes producing their transformation. The paper will thus mainly focus on the development of a neural computational method for the multifactorial analysis of the the archaeological records collected from the area surveyed between Uruk and Eridu (Lower Mesopotamia). The records have been coded in three macro-classes of variables. The n-dimensional matrix simulated through the AAS can be considered a synthetic formalization of the most ancient southern Mesopotamian settlement system, between the end of the Fifth and the end of the third millennium BC. In this specific approach, the application of Artificial Intelligence models to the Mesopotamian Urban Revolution landscape recreates a possible world of other associations of meaning from the body of lacking sources and dispersed information, exhibits the nuances and complex interrelations and, furthermore, helps the researcher to codify other - unforeseen - interrelations.

Extraction of Linear Structures from LIDAR Images Using a Machine Learning Approach

Ramel, Jean-Yves (Laboratoire Informatique De Tours, Université François Rabelais De Tours)
Clément Laplaige (UMR 7324 CITERES - LAT, Université François Rabelais De Tours)
Xavier Rodier (UMR 7324 CITERES – LAT, Université François Rabelais De Tours, CNRS)
Shuo Bai (Laboratoire Informatique De Tours, Université François Rabelais De Tours)

LiDAR technology makes it possible to generate highly accurate elevation models from the ground whatever the nature of the plant cover. Lidar elevation models have multiplied during the past decade, delivering an unprecedented amount of original archaeological finds in the forest. These features correspond to habitat, agricultural or funeral structures before the existence of forest cover but also archaeological micro-structures directly linked to past forest economy. The SOLiDAR program is dedicated to the diachronic study of land use in a geographic area of 270 km² around Blois and Chambord (Loir-et-Cher, France). In this program we study, among others, the linear shapes that reveal landscapes prior to forest. Recently, the rapid supply of large-scale LiDAR data by the National Geographic Institute is now giving us lot of data at very high resolution on surfaces of several thousand km². Manual digitizing of these remains is a time-consuming activity and does not guarantee an exhaustive recognition of features. In the context of this project, after trying to use classical image processing techniques, we propose to reflect on elements to be integrated in Machine Learning approaches for a better and a more flexible extraction and characterization of archeological structures discovered in the LiDAR datasets. This communication will be the occasion to present: - the identified characteristics/discriminant features of searched objects in this study - the architecture of the proposed machine learning framework - the results of the first tests - how the data will be processed in the near future.

Optimizing Long Run Energy Harvesting Strategies in Central Asian Nomadic Pastoralists

Reynolds, Adam (Emory University)
Paul Hooper (Emory University)
Stefani Crabtree (Pennsylvania State University)
Julia Clark (American Center For Mongolian Studies)

Optimality models derived from behavioral ecology have been applied with remarkable success toward understanding the behavior of human foragers, including diet breadth, work effort, mobility, and technological investment. Despite the historical importance and modern day resilience of pastoralism – economic production based on domestic animal herds – few models rooted in evolutionary theory have been developed to understand the constraints and decision problems inherent to pastoralist subsistence strategies. To address this lacuna, we present a new behavioral ecological model and operationalize it with recent ethno-archaeological data, aiming to derive new insight into adaptation by central Asian nomad societies. This evolutionary model characterizes optimal strategies for maximizing long run benefits of herds by balancing tradeoffs affecting rates of animal breeding, slaughter, and market sales at the level of residential groups. We test predictions from the model using data collected through ethno-archaeological fieldwork with nomadic pastoralists in Mongolia and southern Siberia. We emphasize the role of economic and life history tradeoffs to explain variation in energy harvesting strategies between residential groups. The model offers a new perspective on pastoral adaptation and can contribute a behavioral basis for understanding broader social and political transitions observed in the archaeological record.

Not all Data are Born Digital: Workflows to facilitate Data Integration and Rapid 3D Visualization of Landscapes

Richards-Rissetto, Heather (University Of Lincoln-Nebraska)
Zachary Day (University Of Kansas)
Shane Bolan (University Of Nebraska-Lincoln)

Born digital data are increasing in archaeology. RTK GPS and 3D surveying techniques such as laser scanning and photogrammetry allow “instantaneous” acquisition of high-resolution data of extant archaeological features. Digital tools such as GIS, 3DStudioMax, and Unity3D enable archaeologists to employ modeling and visualization as archaeological investigation. However, such archaeological investigation requires that we be able to efficiently integrate born digital field data with “digitized” legacy data such as architectural drawings, site maps, field notes, excavation profiles, or photographs. The problem is that digitized legacy data often come in a hodge-podge of file formats, generated without standards or according to best practices because

they were created at different points in time using different software and to achieve diverse objectives. These various, and often incompatible formats, make data integration and interchange difficult, particularly for re-use purposes such as analysis and visualization. The MayaCityBuilder Project is creating a procedural modeling kit and digital lexicon of 2D and 3D data for ancient Maya architecture and workflows that will allow users to "rapidly" create 3D buildings in georeferenced landscapes in a web-based environment. In this paper, we present three workflows we have developed to export/import 3D models derived from different formats and various sources.

Challenges of Peer-review: Where Does 3D Archaeological Scholarship Fall Under the Umbrella of Digital Humanities Scholarship?

Richards-Rissetto, Heather (University Of Lincoln-Nebraska)

Peer-review of digital scholarship is an on-going struggle. Most scholars transform their digital projects to more traditional formats such as monographs, articles, or book chapters. This transformation is necessary because there is a lack of infrastructure, standards, and/or best practices to peer-review digital scholarship in its native format. Within archaeology, such challenges are growing exponentially as 3D technologies become integral to our toolkits—not only as acquisition and visualization tools but importantly as tools for data analysis and the formulation of scholarly interpretations. The process of 3D modeling is research, but we struggle with how to publish our 3D scholarship on dynamic, interactive platforms that simultaneously allow us to link associated archaeological data. Critical to 3D modeling is paradata, that is, the interpretative decisions we make in the process of modeling alongside our data sources. While many scholars support digital scholarship, they are wary of the absence of peer-review. A positive move, many organizations are now including digital scholarship in tenure and promotion guidelines; however, scholars are still in the dark as to how to actualize proposed guidelines. In this "flash" paper, I situate the challenges that face peer-review of 3D scholarship under the larger umbrella of peer-review challenges for the broader digital humanities to lay a foundation for further round table discussion.

Digital Archaeology and Digital Inequalities: A View from a Sociology Department

Richardson, Lorna-Jane (Department Of Sociology Umeå University Sweden)

Huggett (2015: 89) has called for “a form of introspective or more self-aware Digital Archaeology, one which consciously seeks to understand the underlying processes and behaviours that sit behind the tools, technologies, and methodologies applied”. To answer this call, this paper will discuss classic as well as modern sociological theories, which can be brought to bear on the interactions and social dimensions of the use of

digital media by both professional archaeologists and the non-professional, and attempt to lend digital archaeology some of this critical and social introspection in relationship to diversity and inequality in digital practice.

Quantitative Analysis Based on 3D data - Examples

Rieke-Zapp, Dirk (AICON 3D Systems)

In recent years a lot of attention has been given towards the methodology of 3D data acquisition and basic scanning applications. Today, the knowledge about the basic technology is readily available and most institutions have access to 3D data acquisition tools. This contribution will provide several examples on how to make best use of available digitization tools for quantitative comparison of cultural heritage artefacts. Examples include a study Attic productions of pouring vases, a comparison of different casts located in museums as well a predictive scanning application for matchmaking of 3D scan data to catalogue objects including shape prediction.

Experiments in Modelling Environmental Impact: A Case Study of Post-Contact Piaroa (Wothuha) Land Use Patterns

Riris, Phil (Institute Of Archaeology, UCL)

Shifting cultivation in tropical forests is one of the primary means by which many indigenous groups support their population. Importantly in many South American contexts, the historical, as opposed to pre-historic, roots of documented shifting cultivation strategies have begun to come to light. Studies of Amerindian land use in the present have tended to focus on a relatively narrow range of characteristics under varying conditions: yields of specific crops, sustainability, and the role played by indigenes in regional biodiversity. Although the mechanics of swidden farming practices in the present are well-documented by anthropologists and conservationists, the local and regional impacts of these systems over the long term have nonetheless received comparatively little attention. In order to explore one of many potential historical frameworks, this case study presents an agent-based simulation of Piaroa (Wothuha) household swidden activity. The aim is to understand the potential range of changes effected in the four centuries since European contact using simple behavioural rules gleaned from extensive ethnographic data on Piaroa settlement patterns in the Upper Orinoco. The simulation explores the extent to which households that seasonally manage swidden plots effect structural changes to the vegetation within a landscape, and evaluates their scale and consequences. The implications of the modelling experiments are framed with reference to current debates on the historicity of shifting agriculture in lowland South America.

“Twitter is Actually Stupid” - @fart

Riris, Phil (Institute Of Archaeology, UCL)

I propose that social media use at conferences does not contribute significantly to the experience or outcome, and in fact, might detract from them. As an investment by organisers, it’s a waste; as a practice by participants, it’s a distraction; and finally, it has little demonstrable long-term impact.

Preliminary Structural Assessment of a Unique Maya Building Platform at Oxkintok, Yucatan

Rissolo, Dominique (University Of California, San Diego)
Michael Hess (University Of California, San Diego)
Jose Huchim Herrera (Instituto Nacional De Antropologia E Historia, Mexico)
Eric Lo (University Of California, San Diego)
Vid Petrovic (University Of California, San Diego)
Dominique Meyer (University Of California, San Diego)
Falko Kuester (University Of California, San Diego)
Fabio Amador (National Geographic Society)

The Labyrinth of Oxkintok, also known at Satunsat, is one of the most enigmatic ancient structures in the northern Maya lowlands. Inside this otherwise unremarkable terraced building platform is a series of interconnected vaulted passageways that span three levels. In addition to functioning as an observatory, Satunsat has also been interpreted as a symbolic or “architectural” cave. Of particular interest is the remarkable ability of the irregular, corbelled vaults and relatively narrow spine walls to distribute and bear the overlying mass of the structure. The earlier slab style of Satunsat’s masonry vaults differs significantly from the veneer and concreted core technique characteristic of later Puuc vaulted architecture. Also noteworthy is the relationship between the plaza, the structure’s masonry components, and its bedrock foundation. Recent 3D documentation enables researchers to better examine the complex morphology of Satunsat while making possible a more accurate structural health assessment.

The Modeling of Urban Spatial Dynamics in Long Time Spans

Rivals, Cécile (Docteur Associé, Laboratoire TRACES UMR 5608, Équipe Terrae, Université Toulouse 2 Jean Jaurès, France)

Medieval and modern tax sources are usually used to study landscapes, but historians and archaeologists also know their limits regarding the reconstruction of ancient plots. Compoix and terriers, which are fiscal documents without maps, describe precisely the landscape. They can be considering as cadastre's ancestors. These lists of properties, sorted by owners or locality, appeared in south of France during the second part of middle Ages. To study the plots dynamics in long time spans with these documents, it is necessary to divert of classical representations. That's why the contiguity of plots is considered as links of a network. Thus, it is possible to use the topological attributes of the documents for modelling landscape with the help of graph theory. This approach leads us to understand the evolution of urban or rural landscape and of the society which created it. The CAA 2017 could be an opportunity to present the treatment of spatial information contained in fiscal sources of a small medieval town in south of France.

F*ck Public Archaeology

Rocks-Macqueen, Doug (Landward Research Ltd., Archaeology Scotland)

We are not very reflective when it comes to community engagement and this paper will attempt to do just that. (Title altered from talk given by Jaime Almansa-Sánchez on the importance of Public Archaeology)

The Last of the Publishers

Rocks-Macqueen, Doug (Landward Research Ltd., Archaeology Scotland)

The changes to the publishing landscape have been breadth taking. When I presented work on openaccessarchaeology.org at the CAA in Southampton it was a struggle for people to understand the concept or to separate out peer review from Open Access. 'I can't publish Open Access, I need to have my work peer reviewed', was a common statement among archaeologists only a few years ago. Great strides have been made but has publishing changed or been improved because of it? With Open Source Software such as Open Journal Systems we should see more people publishing— instead there are far fewer publishers than there was a decade ago. Open Access promises to be cheaper but all indications are that publishing costs continue to outstrip inflation. This paper looks at the political component involved in publishing. It will ask the question — even if we could greatly improve publishing through new methods, like linked data, or publishing formats would it make a difference?

Is Equality Enough?

Rocks-Macqueen, Doug (Landward Research Ltd.)

In many countries there are now as many women as there are men in professional archaeology, in some countries more (see http://www.discovering-archaeologists.eu/). This phenomenon has raised questions about if women are getting paid the same as their male counterparts. This paper will examine the countries where data is available on gender pay in archaeology (UK, USA, Norway, etc.) and demonstrate that, at least in those countries, there is no pay gap. However, it will also demonstrate that while women get paid the same as men there is still gender inequalities when it comes to distribution of high paying jobs. It will show that while women are paid the same for the same positions they are heavily underrepresented in higher paying roles e.g. academic positions in the UK. The paper will show that even if roles are filled with an equal number of men and women that, without sweeping changes, it will still be decades before the profession actually finds a balance. Which raises the question, how willing are we to radically alter how we conduct professional archaeology? Are we willing to institute reverse discrimination or are we content to wait three more decades to achieve equality?

The Long Road Ahead for Simulations in Archaeology

Rocks-Macqueen, Doug (Landward Research Ltd.)

This paper provides a position paper to kick start some discussion at the workshop-A reoccurring narrative in archaeological simulation is that it keeps going through the 'hype' cycle. First it was the initial interest in the 1970s followed by the doldrums of the 1980s. Simulation was reignited in the 1990s with more powerful computing only to fade. In the last few years there have been a flurry of papers leading some to suspect a renaissance is upon us. However, as will be demonstrated briefly in this position paper, archaeology has grown so much that even a significant increase in publications means that simulation is further behind now than in the 1970s. Raising the question what does establishing simulation in the mainstream of archaeological practice look like and how far do we have to go to get there?

How to Combine Archaeological Archives, Linked Open Data and Academic Publication, a French Experience

Rodier, Xavier (CITERES, CNRS/University François-Rabelais Of Tours)
Olivier Marlet (CITERES, CNRS/University François-Rabelais Of Tours)

The principles of academic publication are largely accepted by the archaeological community but the new terms offered by digital publishing allow to reconsider the issue. The developing movement of open publishing s opens new prospects associated with the issue of data sharing. Its apprehension is different and less unanimous depending on diverse practices in each country. In France, the issue of archaeological

publication is an old debate that, despite successive observations, is not really tracking changes. The open data is far from common. However, the group MASA, the French consortium on archaeological archives of the Very Large research infrastructure for digital humanities (TGIR Huma-Num) has been working for four years to disseminate better practices on interoperability of archaeological information systems and data sharing. It relies on long term work and aims to contribute to put on line some archaeological data in the Linked Open Data. One purpose is to change the relationship between the necessary publication of primary data and synthetic papers. Of course, this is not new but the challenge is to break with the descriptive model which links raw data and monographic papers. The major challenge is certainly the opportunity to combine data and synthetic paper to ensure the administration of proof and highlight the interpretation and reasoning. Experiments based on such a proposal ensure the robustness of this scientific approach in order to make possible to renew the experience from the primary data recorded during excavation.

Hominin Dispersal, Environmental Change and the Evolution of Behavioural Plasticity

Romanowska, Iza (Institute For Complex Systems Simulation Centre For The Archaeology Of Human Origins University Of Southampton)

The Variability Selection Hypothesis argues that rapid environmental fluctuations during the last 6 million years produced strong selection pressure on adapting to change rather than any particular set of environmental conditions. This promoted behavioural plasticity and the evolution of organisms which can be described as 'versatilists', such as early hominins. Here we present a computational model testing the impact of rapid climatic fluctuations on the process of dispersal. A heterogenous population consisting of organisms with different adaptation patterns (specialists, generalists, versatilists) is modelled following simple demographic and genetic principles. The composition (proportion of individuals with each type of adaptation) is then recorded at different points during the dispersal, for example before and after an environmental barrier. The results shed light on the possible mechanisms behind the 'Out of Africa' dispersals especially the spatial structuring of the dispersal wave or the role of the initial conditions. Finally, the study raises doubts over a number of widely accepted assumptions and conceptual models.

Everything Wrong with Archaeological Models

Romanowska, Iza (Institute For Complex Systems Simulation Centre For The Archaeology Of Human Origins University Of Southampton)

Few remarks on how we construct models in archaeology, what do we expect from them and why we do not seem to be keen on learning from other disciplines. My rant should not exceed 5 minutes.

Geometry as Matrix of Construction of Roman Stone Bridges. The Augustus Bridge in Narni.

Rossi, Maria Laura (Sapienza University Of Rome; Department Of History, Representation And Restoration Of Architecture)
Carlo Inglese (Sapienza University Of Rome; Department Of History, Representation And Restoration Of Architecture)
Antonio Pizzo (Instituto De Arqueología-CSIC)
Leonardo Paris (Sapienza University Of Rome; Department Of History, Representation And Restoration Of Architecture)

The roman stone bridges, the remains of which are scattered anywhere in romanized territories, are a concrete testimony of the technical level achieved by Romans in the fine art of construction. Many of these, especially if for infrastructure, have considerable size. They have been realized in different orographic conditions and with local materials often by different mechanical properties. The arc is the most used structural element. There are interesting geometric implications in the subdivision of the blocks and in the respective stone cutting project; this is an aspect that precedes of many centuries the birth of stereotomy. Realization of blocks also has implications in the organization of the construction site and in the management of operations related to the specialization of workforce. Studying the Augustus Bridge in Narni, of which a digital survey was recently done, we have obtained several representative models of the above mentioned problems. It still retains an integral span and pieces of spans; the collapsed central span measured 30 m in diameter, one of the largest in Europe; one span presents a different technique by rings, that poses interesting questions of dating. Processing 3D models, between the current state and the original one, regards also an application of parametric modeling, as transformation of basic geometric elements that, starting from a simple block of stone, have become then the structural blocks of the arc.

Do All Roads Really Lead to Rome? Modelling Mobility in the Ager Veientanus and the Sangro Valley, Italy

Rothenberg, Miriam (Brown University)

Least-cost path analysis has long been lauded for its broad applicability in modelling routes of movement through various landscapes and for its ability to incorporate both static data and experiential parameters. Building on Bell, Wilson, and Wickham's (2002) method for creating road networks by summing least-cost paths, this paper demonstrates how ancient road systems changed through time in two Italian valleys—the Ager Veientanus (Tiber) and the Sangro. Road systems have here been iteratively modelled for several historical periods using regional field survey data and satellite-derived elevation models. The resulting

weighted path networks are compared with one another to demonstrate the persistence of highly-trafficked routes across multiple periods. The proximity of these modeled systems to the recorded locations of Etruscan and Roman roads is also evaluated in order to ascertain the relationship between the generated paths and the material evidence of ancient roads. These diachronic models demonstrate how road systems and settlement patterns are mutually constituted, and how both are shaped by natural topography and social relationships. Specifically, in the Ager Veientanus, changes in network shape reveal how the region transitioned from a landscape of competing Etruscan city-states to a highly productive Roman hinterland. The use of summative cost path analysis on such large datasets exposes some of the technique's limitations, including edge effects, algorithmic constraints, and prohibitive processing times. Yet the overall success of the study nevertheless demonstrates the potential of such an approach to answer questions of inter-site mobility and diachronic route change.

What is Open Data in an Archaeological Context?

Roued-Cunliffe, Henriette (University Of Copenhagen)
Peter Jensen (Aarhus University)

This paper will examine the concept of open data and data sharing in an archaeological context. The Open Knowledge Foundation [1] states that: "Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness),". In a cultural context the OpenGLAM initiative has worked on principles that are championed by OpenGLAM [2] institutions [3], including how they should engage with the public about the reuse of their open data. As we can see the focus is very much on openness for all and for all purposes and for archaeological data we must remember to ask: Who is it open for? What is it open for? And how open is open. In order to discuss this I have formulated five questions that can be used to assess how open an archaeological dataset is: Is the material published online, with metadata so that it can be searched and found? Is the material published with an open license or in the public domain and is this clearly communicated in conjunction with the material? Does the creator actively encourage reuse of the material and provide support for anyone who wishes to reuse it, free of charge? Is the material available in an open machine readable format, that anyone can export/download? Is the material available through a well-described web service or API (Application Programming Interface), that anyone has access to? [1] http://opendefinition.org [2] http://openglam.org/principles/ [3] GLAM: Galleries, Libraries, Archives and Museums

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Cultural Heritage Data Synthesis for Architectural History Field Methods

Rourk, Will (University Of Virginia Library)
Andrew Johnston (University Of Virginia, Architectural History)
Lauren Massari (Institute For Advanced Technology In The Humanities (IATH), University Of Virginia)
Shayne Brandon (Institute For Advanced Technology In The Humanities (IATH), University Of Virginia)
Arin Bennett (University Of Virginia Library)
Jama Coartney (University Of Virginia Library)
Worthy Martin (Director, Institute For Advanced Technology In The Humanities (IATH))

Documentation methods of historic sites have traditionally involved manual processes of measuring and recording with tape measure, pencil and paper. Metrological technologies such as laser scanning, photogrammetry and ground penetrating radar (GPR) are revolutionizing field documentation by providing tools that collect high resolution measured data at the scales of both artifact and architecture with millimeter range accuracy. Students at the University of Virginia are being taught skills in applying these technologies as a part of their curriculum in Architectural History Field Methods classes. Specialists from within the University of Virginia Library aligned with UVA's Institute for Advanced Technology in the Humanities (IATH) are embedded within these classes to help students laser scan artifacts and architectural sites, collect high altitude photographs and photogrammetric data using quad-copters and capture data from GPR. Students process the data using industry grade software to help them make scholarly use of cultural heritage data. Interactive modes of digital analysis and representation are developed using this data and presented via a Drupal-driven website embedded with web-3d digital models, interactive GIS maps, video and panoramic photography. The pedagogical goal is the interlinked process of the collection, analysis, interpretation, and representation of data for the purpose of assessing the interrelationships of data collection and historical interpretation.

Combined Method of 3D Model of Archaeological Objects Optimization for a Mobile App.

Rudov, Ivan (Siberian Federal University)

Digitalization of an archaeological object aims to accurately represent its topology and texture. Photogrammetric digitalization of small models with a volume up to 20 cm3 is only of acceptable quality if the number of polys is 300k or more and resolution of diffuse textures is more than 8k. Objects having such characteristics occupy minimum 30Mb of disc space and have some restrictions on use. In fact, such models can be used for static but not real-time visualization in mobile app since they require much computational resources. That is why we examined methods of both automatic and manual optimization and then came up with a combined method. Initially hipoly models exported from Agisoft Photoscan (file format is *.fbx, 8 bit *.png texture) were automatically optimized with MeshLab through a quadric edge collapse decimation algorithm that reduced the number of polys by 80-95% so we got draft lowpoly models. They were processed

with 3Ds Max to refine topology on basis of hipoly versions of models with graphite modeling tools. Then albedo, normal and ambient occlusion maps were baked in HandPlaneBaker in order to add the topology features lost while optimization. The textures were then combined in Quixel Suite and the process of optimization had been completed. As a result, we got the realistic models with approximately 4.5k polys and 2k texture resolution.

Considerations for Modeling Mobility and Cultural Interaction Among Maritime Communities

Safi, Kristin (Oak Ridge National Laboratory)

Understanding how maritime communities interacted requires considerations for how one traveled across a changeable surface where material traces of movement are rarely preserved (e.g., docks). Reconstructing travel routes across a maritime environment computationally presents its own set of challenges, not least of which is that traditional pathfinding models rely on changes in elevation as the basis for movement calculations. In this paper, I discuss the limitations of current path modeling solutions in identifying realistic or testable networks of movement among maritime populations. I then highlight considerations for modeling travel networks across open water. Drawing on the archaeological record of the Coast Salish communities of British Columbia, I present one computational approach that implements potential solutions to some of the modeling constraints found in typical pathfinding methods when applied to maritime cultures. I analyze how moving from a terrain based (DEM) movement model to a water based movement landscape that routes across an ocean currents dataset built specifically for that region can better inform how social and economic networks in this region may have been spatially enacted. This method utilizes a series of custom 8-band rasters to calculate optimized movement based on the direction and speed of currents at a particular time of day, that "update" as the travel day continues, and that vary diurnally depending on starting area. Pathways are calculated by starting zone to all other sites in the region, to a sampling grid of coastal landing points, or to contemporaneous sites. The resulting "high traffic" routes are contextualized within a discussion of data types that may allow us to empirically evaluate these models, such as through ethnohistoric records, and how travel corridors may have altered through time as population densities changed, sea levels shifted the occupiable landscape, and cultural material cues of social shifts and community alliances spread around the coast.

Using Technology to Increase Skill Development, Problem Solving, and Collaboration among Women in the CAA

Safi, Kristin (Oak Ridge National Laboratory)

Women in computational archaeology are often highly skilled individuals who, often through a lack of numbers and networked relationships, are unaware of other specialists with whom they could collaborate and advance archaeological science. One way in which those networks and collaborations can be built is by leveraging online conferencing and collaboration tools to host technical seminars, specialized methods roundtables (e.g., object detection improvements, simulating complex systems within particular computational environments), and "hackathon" style collaborations where in-person and/or remote conferencing enables women to build a tool, model, or computational solution in short but intense problem oriented sessions. Through such activities, members of the CAA can strengthen their networks with other women in the field, both those practicing similar techniques and those with complementary skills. Unlike other women's networking opportunities (Facebook groups, twitter lists, conference happy hours, etc.) that are geared more toward sharing information or enabling increased name recognition among other women, this technological strategy emphasizes skill development and research output among computational archaeologists. Broadening how one can "participate" in a CAA Women's Group and the means by which members can engage may help advance the role of women in this organization and advance our research within the broader field. I propose discussing ways in which we can capitalize on existing collaboration enabling tools to promote more than friendly meetings among the women of the CAA.

The Integration of Multiple 3D Documentation Methodologies in the Modeling and Analysis of an American Civil War Submarine.

Scafuri, Michael (Clemson University)

The H.L. Hunley submarine is currently undergoing conservation treatment and archaeological analysis at the Warren Lasch Conservation Center in Charleston, South Carolina. Throughout the conservation process, the archaeological team has employed a number of 3D documentation methodologies to collect data from the H.L. Hunley and its artifact assemblage. Much of this documentation was conducted using a structured-light system in order to record accurate geometry and high-resolution surface details. However, the limitations of this system in terms of large-volume data capture and operational distances led the WLCC to begin complimenting this data collection strategy with both laser scanning and photogrammetry. This paper will discuss some of challenges of data acquisition on the H.L. Hunley and the necessary use of multiple 3D documentation strategies. Overcoming the problems inherent in the confined and restricted nature of the submarine, and capturing data from wet iron artifacts, required a multifaceted approach. The author will discuss the implementation of different data acquisition methodologies and where these methodologies were or were not useful in terms of collecting specific data necessary for the projects research goals. The author will also address the integration and post-processing of data from multiple sources and the development of an overall site plan as an analytical and visualization tool. The results of these varied data collection techniques

will be compared, with some comments about the viability of each technique and their applicability in addressing our larger research questions.

Analyzing Reasons for Different Datings of Periods using the ChronOntology Time Gazetteer

Schmidle, Wolfgang (German Archaeological Institute, Berlin)
Sebastian Cuy (German Archaeological Institute, Berlin)
Nathalie Kallas (FU Berlin, German Archaeological Institute, Berlin)
Florian Thiery (University Of Applied Sciences Mainz)
Jan Wieners (Uni Köln)

In the ChronOntology project we are developing a web-based time gazetteer (http://chronontology.dainst.org/) that strictly distinguishes between the definition of a temporal concept or cultural period and any dating information about it. The data model is based on CIDOC CRM and Doerr et al. (2006), Thesauri of Historical Periods (http://www.ics.forth.gr/isl/publications/paperlink/CIDOCpaper1_Doerr.pdf) and extends it to cope with large amounts of data from different sources. In this talk we analyze the reasons that may lead to different datings, such as different meanings or definitions of the same term and arbitrary choices of events to mark the beginning or end of a period, and on the other hand we analyze the relationships between these meanings, definitions and marker events. We describe some concrete use cases, for example the meanings of the term Augustan with different spatial and temporal extents and the periods of the Aegean Bronze Age. The system currently has a focus on archaeology but will be user-driven and can be applied to the whole Digital Humanities, for example as a repository for named entities from the primary literature.

Digital Lab Notebook Creation for Computational Photography

Schroer, Carla (Cultural Heritage Imaging)
Mark Mudge (Cultural Heritage Imaging)

Scientific digital documentation of cultural heritage and natural subjects can be a powerful tool supporting e-science and citizen scholarship. For centuries, the scientific method has required the recording of empirical data collection contexts and subsequent processing in a lab notebook, which provides informational transparency and enables informed reuse. This talk will introduce two new, metadata and knowledge management software tools for scientific digital documentation of cultural heritage. This methodology is designed for digital representations that are built with computational photography technologies. They are

called Digital Lab Notebook:Capture Context (DLN:CC) and Digital Lab Notebook: Inspector (DLN:Inspector). These applications are user-friendly and, nearly automatically, record the contexts in which the original photographic sets of empirical data were acquired. The software then inspects these photographic datasets to identify any potential problems before their subsequent advanced processing. Here's how it works. First, the DLN:CC uses pre-organized templates of user entered data to automatically map information about the project, people, imaging subject, location, and equipment to the CIDOC/CRM ontology. Users determine the amount of included information. Next the captured photosets are validated by DLN:Inspector which produces a user-friendly report of potential errors and problems. The metadata information in the DLN is then published as both XML, and Research Description Framework (RDF) Linked Open Data files. These open source DLN tools enable future evaluation of digital surrogate reliability, and improve prospects for long-term archiving.

Interpreting Shell Middens through Physics Simulation

Schubert, Lutz (University Of Ulm)
Keith Jeffery ()

The characteristic shell heaps of middens in e.g. the Orkneys follow continuous shapes and immediately invoke associations with natural shaping processes. Middens are generally considered garbage heaps – a byproduct of the eating habits. However, burials and finds in such middens, as well as embedded structures hint at more complexity and potential intentionality by the occupants. We describe a means to simulate the deposition behavior of Mesolithic people in shell middens to identify how likely a purely incidental layout is or whether the local conditions would lead to a different shape of the deposits. Such a simulation would normally try to reproduce the deposition behavior (casting away food remnants) from likely sitting arrangements given wind conditions at the time. However, since these types of environments are open world chaotic systems, reproduction leading to the same shape is near impossible and trying to reproduce all potential layouts and compare them against the actual finds would require infinite time and resources. We instead promote a different approach which investigates the likelihood of the layout given conditions that would indicate purely incidental accumulation. To this end we try to derive whether trajectories exist from the given layout to the likely sitting arrangement under the wind conditions at the time. The paper will demonstrate how such models can be used to argue over incidental and intentional accumulations. The results link to our work presented at CAA2016.

Training with Free and Open-Source Photogrammetric Softwares : One of the Answers to Rectify the Situation?

Seguin, Maxime (Inrap)

The French National Institute for Preventive Archaeological Research (Inrap) gathers about two thousand archaeologists. The institute is present throughout the french territory with more than forty research centers. It is the major player in preventive archaeology with more than two thousand field operations realised each year. It has to deal with two main goals : the detection and study of archaeological sites threatened by infrastructural works, and the diffusion of the research results within the scientific community and the general public. As eslsewhere in the archaeological community, production of 3D models with low cost image-based commercial solution is the very latest thing. The software Agisoft Photoscan has led archaeologists to believe that they can produce accurate models without any photogrammetric notions. In fact, they often produce a visually pleasing meshed model without any information about quality assurance. In this context, the institute began considering the need of training sessions to stop the anarchic pratice of pseudo photogrammetric recording. Since then, it has launched a programme to train archaeologists in the best practices and to promote the use of MicMac software. It is a software suite, developed by the French National Institute of Cartography (IGN), dedicated to scientific purpose and is distributed under a free and open-source license. In the short term, the institute hope to move towards a better practice of photogrammetric surveys and a spread of the MicMac professional software suite.

New Methodologies for Knowledge and Valorization: The Digital Survey Made by Remote-controlled Mobile Platform. The Case Study of the Roman Casinum City

Senatore, Luca (University Of Cassino E Del Lazio Meridionale)
Michela Cigola (University Of Cassino E Del Lazio Meridionale)
Arturo Gallozzi (University Of Cassino E Del Lazio Meridionale)

The use of digital survey technology and representation techniques for the documentation of archaeological sites or historic buildings, has grown significantly in recent years. The contribution focuses on digital survey tools able to return point clouds, applied to remote-controlled mobile platforms. Through a wireless control system, the mobile platforms equipped with XYZ or RGB data acquisition sensors are able to overcome some physical limits up to now not solvable by making use of traditional instruments. The gat for the logistical reasons, rather hazard inherent in the quality of the structures could be exceeded using this kind of tools. All this in order to complete the gaps in the traditional survey and increase the level of knowledge of architectural and archaeological artifacts. This research has been made by the Laboratory of the University of Cassino DART, with the aim of making light on the current level of technology and the ever more with a consistent perspective to realize itself a prototype able to survey, artifacts Architectural making use of non-contact technologies. Through a series of examples and direct field trials made on the Casinum Archaeological area, will define the state of art of this subject that it connects indissolubly knowledge and experimental technology.

General Discussion Outline

Seymour, Brian (Michael Baker Engineering)

As limits on physical archive and curation spaces become greater and greater, it seems that digital archiving, in-situ preservation, and non-invasive investigations are likely to become more and more "the norm" for archaeological research. As such, questions regarding the modern-day archaeologist's use of digital technologies, and regulatory agency willingness to accept digital material will be explored in this panel lead discussion. The organizers envision a brief (ca. 5 min) introduction to the issue at hand (ie. the lag between the academic acceptance and use of digital technologies as a tool for archaeological investigation, research, and reporting, etc., and its acceptance by professional and governmental/regulatory institutions as the same). This introduction will be followed by another brief (5-10 min) exposition of the various actions that regulatory and professional consulting agencies HAVE taken to try and employ these various digital technologies in their respective tool-kits. These examples will mostly come from the US and Canada, where the panel leaders have had the most experience. Once the discussion opens to the floor, we look to hear from other conference participants about the practices and regulations in place in the myriad countries represented at CAA. Having gone through the various examples, the discussion will open to questions like whether or not we should be pushing regulators to start including more digital data-sets, models, and the like as part of the permitting process, and if so, what is the best way to start making those efforts. Ca. 1 hour total

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Sites, Landscapes, and LiDAR in the Maya Lowlands: Leveraging high resolution regional LiDAR for improved predictive models.

Shaffer, Derek (The Pennsylvania State University)
Timothy Murtha (The Pennsylvania State University)
Charles Golden (Brandeis University)
Bruce Cook (NASA)
Elijah Hermitt (The Pennsylvania State University)

Despite advancements in the methods and theory of landscape and settlement patterns in many archaeological regions, including the lowland Maya region of Mexico and Central America, archaeology remains focused on site-centered inquiries and sampling strategies. Even the sampling strategies used with LiDAR and other modern remote-sensing technologies are commonly defined in relation to monumental sites, belying the full interpretive potential of these technologies, and presenting a challenge to the development of truly regional understandings of land use and landscape. In this paper we examine the potential to move beyond sites to a more completely landscape focused research paradigm using a combination of predictive modeling and a

regionally extensive sample of LiDAR originally collected to better measure above-ground carbon stocks in southern Mexico. First, by relying on macro-scale site location and environmental data, we describe and discuss the results of a maximum entropy model for site location probability in the lowlands. We then investigate a sample of 610 LiDAR images using the G-LiHT system of NASA's Goddard Space Flight Center of low probability areas. Employing both the maximum entropy model and these new data we will evaluate how macro-regional archaeological site location and environmental data can be best used in the lowlands for predictive modeling, and also explore how such approaches can better inform landscape archaeology in regions like the Maya lowlands, where a tradition of site focused archaeology remains dominant.

Testing the 'Small-Site' Approach with Multivariate Spatial Statistical and Archaeological Network Analysis

Sharp, Kayeleigh (Southern Illinois University, Carbondale)

Recent research at the Songoy-Cojal site complex in the mid-Zaña Valley, north coast Peru, has offered an intriguing glimpse of quotidian life in small-scale urban contexts. Although regional settlement pattern survey and the analysis of large-scale monumental centers have long been the primary means of archaeological investigation and cultural assessment in Peru, the complementary investigation of smaller-scale quotidian spaces allows us to test the fundamental premise that individuals (or groups) carry out quotidian practices in patterned ways, as practice theory suggests. Such are the foundations of A.L. Kroeber's 1963 'small-site method', which posits that smaller-scale sites can be used as touchstones for understanding materials observed at large-scale centers. While fundamentally sound, the original approach was limited by inadequacy of computational tools to effectively study differing relationships between materials and behaviors observed in and/or absent from archaeological settings of differing scale. In addition, relationships between phenomena observed in large-scale urban centers which may be inconsistent with those observed in small-scale urban settings has never been properly tested. Combining multivariate spatial statistical and archaeological network analysis to segregate out similarities and differences observed in well studied small-scale (Songoy-Cojal) and large-scale (Pampa Grande) urban contexts, this paper tests the adequacy of the small-site approach for elucidating patterns that characterize first-millennium urban lifeways in the Lambayeque-Zaña intervalley zone and within in the broader Lambayeque region despite data that are missing, imprecise and vague.

Accessing Archaeology: Creating an Open-Access Heritage Database for the Endangered Archaeology in the Middle East & North Africa (EAMENA) Project

Sheldrick, Nichole (University Of Oxford)

The EAMENA Project has developed a database to record sites and track damage and threats to the archaeological heritage of the MENA region. Our primary sources include satellite imagery available through free platforms such as Google Earth, aerial photography, survey reports, and collaborations with projects working on the ground. Our goal is to create a useful open-access resource for a wide network of partners across the MENA region to support the protection and management of the region's rich heritage, to be launched in 2017. Throughout development, however, we have been faced with many important questions surrounding how best to record and present these data, and in particular, the ethics and implications of making our database open-access, which is a requirement of our funding. Who decides, and how, what information should or should not be public, particularly when that data comes from open-access sources in the first place? How do we manage differing and sometimes conflicting expectations of partners in various countries regarding the use and dissemination of archaeological data? What steps are we taking to ensure that our database respects heritage policies across several different countries? In this paper, I will discuss the EAMENA Project's approach to these issues and the challenges of creating a practical and accessible database for users across the MENA region and beyond.

High-throughput Computing for Large-scale Digitization

Sherman, William (Indiana University)

A collaboration between high-performance computing practitioners with digital humanities researchers is expanding the use of HPC (high performance computing) systems typically oriented toward the physical sciences for use within archeology and other non-traditional computing fields. Efforts to digitize hundreds of artifacts from within a single museum, each of which requires hundreds of photographs to produce a quality model. Using the technique of high-throughput computing on large HPC ("big-iron") servers allows digitization to be parallelized on a macro-scale on the artifacts as well as a micro-scale on the structure-from-motion (SfM) algorithms. Our method takes advantage of a trusted commercial software package with built-in scripting capabilities for a semi-automated process with limited but focused human intervention.

The Effect of Gridiron Street Pattern on the Urban Growth of Adriatic and Ionian Coastal Cities 1800-2010

Shpuza, Ermal (Department Of Architecture Kennesaw State University)

The study addresses the evolution of Adriatic and Ionian coastal cities during the last two centuries. The region manifests the ambivalent role of the sea channel as divider and unifier over the centuries. Urban expansion according to gridiron street pattern was a defining urban planning event that followed the spread

of Napoleonic influence in Italy, and the de-Ottomanization of cities in Greece. The application of gridiron streets in the 19th century underlies the strongest bifurcation in urban evolution patterns in the region: while it occurred in almost all Italian and Greek cities, it was not adopted elsewhere in the region. The study inquires the effect of gridiron street patterns on the displacement of the urban center and the extent to which the original set of inter-city roads maintains its role as the foreground network during growth. The study is supported by an extensive research of historical maps and aerial photographs from more than twenty archives. Street networks in seventy cities and towns in the littoral region are studied according space syntax representations of three growth stages: 19th century, WW2, and present. Cities are analyzed according to axial maps where the longest and the fewest segments that cover streets and open public space are represented as graph nodes, and intersections between them as graph links. The study combines the heuristic examination of the transition of urban center and change of foreground network over time with the statistical analysis of subsamples of cities with and without gridiron patterns.

That Was Not OK. Now What?

Simon, Katie (Center For Advanced Spatial Technologies, University Of Arkansas)

From our first field schools to directing our first projects, as women in these fields we have a number of challenging experiences that men do not have and/or may unintentionally be blind to. Many are common experiences for women in general and many are specific to the nature of using a range of tools that are traditionally considered to belong within the male domain. From minor annoyances to assault the severity level of these experiences are commonly classified as minor non-issues while significant violations frequently go unreported due to the potential consequences of speaking out. Rather than risk being identified as complainers or weak we quietly compartmentalize and move on because above all else we have work to do. Our ability to do this has become part the pride we take in our strength and ability to successfully navigate endlessly challenging environments in the office and in the field. By following this comfortable path are we validating and reproducing professional environments that are harmful to us, our female colleagues, or future generations of female researchers? This position paper explores our power to identify these occurrences as “not ok” and the opportunity to take simple actions to counteract institutionalized sexism. It also explores alternative paths that may enable constructive identification and elimination of these unfortunate obstructions while promoting our full potential and professional productivity.

Seafaring with Mental Sign Posts: Connecting Materials with Canoe Routes in the Archaic Age Northern Lesser Antilles

Slayton, Emma (Leiden University, NWO Island Networks Project)
Jan Athenstädt (University Of Konstanz, ERC NEXUS 1492)
Corinne Hofman (University Of Leiden, NWO Island Networks And ERC NEXUS 1492)
Jan Hildenbrand (University Of Konstanz)

Modeling voyages between Archaic Age (2000 BC – 400 BC) sites in the Northern Lesser Antilles can help to inform the existence of seasonal rhythms. These seasonal rhythms were integral to several aspects associated with journeys, not only in terms of underlying environmental factors that pushed the canoes along but also in terms of terrestrial resources that flourished at different times of year. For example, evidence of exploitation of bird populations on Saba from February to July may have some relationship to the placement of pathways to and from the island during these months. Similarly, the availability and production of specific materials could help pinpoint the location of sites. For example, places associated with lithic procurement and canoe construction can be considered as background knowledge to layout and sustain the placement of pathways. Working with experimental archaeology can also help to define social factors that may have dictated certain limitations on voyages, affecting the possible reach and territory expanse of these communities. Finally, when balanced with ethnohistorical accounts of canoe usage, the functionality of these vessels can be judged against a framework of modeled routes. These models, much like a sign post or road marker, can help to define the trajectories of these seasonal connections as they are modeled using an isochrone least-cost pathway method.

Locations in Experience: Visibility, Seafaring, and the Placement of Pembrokeshire's Iron Age Coastal Promontory Forts

Smith, Karl (University Of Oxford)

This project assesses the visual prominence of Iron Age promontory forts in Pembrokeshire by developing a novel methodology that builds on recent theoretical and methodological developments, including 3D GIS tools, visual affordances, and the integration of visibility and movement modelling into more comprehensive approaches. For a set of observer points derived from a least-cost path representing a boat's progress along the Pembrokeshire coast, this analysis (1) generates a projective array for each point, (2) intersects rays with 3D features representing targets and a terrain surface, and (3) generates diachronic visibility profiles based on the number of unobstructed rays from each observer to each target. This methodology determines a feature's extent in an observer's field of view more precisely than previous approaches, which have described that extent in terms of minimum/maximum angles defined by observer and target. This precision is useful in analysing sites that do not appear as rectangular shapes – such as Pembrokeshire's promontory forts. Lack of excavation, scarce material culture, and erosion at these sites makes it difficult to substantiate claims about these sites' duration, whether they were integrated into sea-trade, or even whether they constitute

settlements. The results of this analysis address this uncertainty by critiquing interpretative narratives in which Pembrokeshire has been included, and evaluating site typologies within the region.

The Center for Cyber-Archaeology and Sustainability (CCAS): Pedagogy and Student Engagement in At-Risk World Heritage Initiatives

Smitheram, Craig (1. Department Of Anthropology, University Of California, San Diego 2. Center For Cyber-Archaeology And Sustainability, Qualcomm Institute, University Of California, San Diego)
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As part of the University of California (UC) Office of the President's Research Catalyst Award, the Center for Cyber-Archaeology and Sustainability (CCAS) at UC San Diego has undertaken research programs and public outreach projects worldwide concerning at-risk cultural heritage and the digital humanities. At the CCAS, a volunteer group consisting of undergraduates and members of the public has been formed through which active-learning, peer instruction and community involvement are fundamental to the learning experience and project goals. This paper will address pedagogic methods used in various digital tools and applications of cyber-archaeology data creation and analysis. In addition, a discussion of preliminary results, the dissemination of knowledge for research and public consumption, and experiences of members of the volunteering group will be shared to promote new paths forward in understanding and engagement in multi-scalar cultural heritage initiatives.

Enhancing Archaeological Material Provenance Studies by Manipulating Isoscapes

Sonnemann, Till (University Of Bamberg)
Jason Laffoon (Leiden University)
Termeh Shafie (University Of Konstanz)

The availability of worldwide isotope variation data offers a new possibility to spatially display the likely origin of archaeological finds. Isoscapes, developed from these data sets, differ for each element, being dependent on particular attributes such as geology, distance from water, altitude and latitude, to name a few. The variation provides a particular opportunity, to narrow down the origin of potentially non-local material by correlating the distribution of (initially two) different isotopes. Originally applied in ecology to understand bird migration by sampling feathers, two approaches were tried to develop and test more standardized and quantitative approaches in archaeology. An exclusionary approach uses a defined range of fixed isotopic variation per location, removing any area in which one of the isotope measurements are not

within the error range; and a probabilistic assignment approach, using univariate and bivariate probability density functions, to present likelihoods of provenance. First tests were conducted from results of 87Sr/86Sr and δ18O samples retrieved from modern and archaeological enamel, the hard mineralized tooth surface. The tests show both its potential and limitations. The dual-, and in future studies multi-isotope, approach in combination with continuously improving isoscape maps offer a possibility to better geo provenance archaeological samples.

Solutions in Photogrammetric Selectivity. Optimizing High Fidelity Meshes from Casual Photography. The Trajan's Forum Project Examples

Spring, Adam (Department Of Archaeology University Of Plymouth Truro College College Road Truro TR1 3XX)

The Dig@Lab at Duke University uses the example of a decorative sphinx, which was once part of Trajan's Forum in Rome, in order to demonstrate how 3D imaging and modeling is both an art form and science. In terms of big data, the case study considers what the heritage practitioner or academic now faces when creating digital content or using computer based tools. We consider how the digital production process is shaped by the application presented, and why it is important to develop a workflow based around the conditions in place. Photo in ReCap was chosen over PhotoScan because of the speed and resolution at which it could generate a high resolution 3D mesh. Overall, the 3D imaging workflow outlined in this presentation was determined by the type of 3D imaging employed, how scale was added to the scene generated, establishing meshes were geared toward 3D printing and digital sculpting, and scene reconstruction based on features within the environment photographed. These directly affected which software's or services we could use to inform the digital sculpting of the sphinx.

Bronze Age Tell or Not? Research Methods for Revealing the Internal Habitation Pattern of Alioş – „Valea Alioşu" site, Timiş County, Romania

Stavilă, Andrei (West University Of Timişoara)

Almost unknown in the scientific literature, Alioș - "Valea Alioșu" site proved to be, after some field surveys, one of the most representative Middle Bronze Age site from northern Banat region of Romania. The main issue is related to the habitation type of the site. Is this representing a tell, a tell-like, or simply a short-term habitation? To answer this question we tried to recreate the internal pattern of the habitation by collecting information about the spatial layout of the archaeological features and general reconstruction of the site stratigraphy. Also, another purpose was to individualize some particular archaeological features as dwellings

or the fortification ramparts/ditches using electrical resistivity tomography. Some additional methods were used to complete the results. Thereby, a series of magnetic prospection, drillings, field surveys and topographical work were carried out. This work was about mapping the above ground and underground patterns inside the archaeological site of „Valea Alioşu".

Ground-Penetrating Radar in Chaco Canyon, New Mexico: 40 years of Mapping Chaco's Buried Past

Sturm, Jennie (University Of New Mexico And TAG Research By Sturm, Inc.)

The first documented application of ground-penetrating radar (GPR) in American archaeology was in Chaco Canyon, New Mexico in 1976. At the time these surveys were largely experimental, but represented pioneering efforts to apply GPR to archaeological sites in a research-driven way. 40 years later, advancements in computer power, data collection strategies, and processing methods have made GPR an indispensable method for mapping Chaco's buried landscapes. However, making sure these GPR data can be used to interpret past behavior has required persistence, both in how the method is applied and how the data are processed. This presentation will highlight the history of GPR use in the canyon, and the developments in data collection and integration with other geospatial methods that have allowed more robust interpretations of cultural activity in the canyon.

Women in Business in the CAA fields

Sturm, Jennie (University Of New Mexico And TAG Research By Sturm, Inc.)

Many of us are aware of the statistics reflecting the number of businesses owned and led by women in the U.S. The percentage of small businesses owned by women hovers somewhere around 30%, though "ownership" does not always translate into leadership positions. Despite substantial progress over the past several years, there are still challenges women face when trying to start a business or move into a business leadership position. In the CAA fields, such challenges may include mentorship, access to resources, or the problem of "being taken seriously." Addressing these challenges begins by acknowledging them. This position paper will explore some of these issues while emphasizing the qualities that make women effective business leaders in the CAA fields. Such qualities, such as conviction and inclusiveness, are particularly beneficial for the CAA fields, where technical work often necessitates a collaborative and creative approach. Therefore, encouraging women to enter into business in the CAA fields goes far beyond simply trying to achieve equality or gender balance. Rather, women are in a unique position to offer innovative leadership solutions in ways

that can create jobs, generate creative products and strategies, and offer mentorship within the CAA disciplines that benefit everyone.

Learning Through Objects: 3D Digital Imaging, 3D Printing and Haptic Technology for Public Outreach in Archaeology

Tanasi, Davide (University Of South Florida)

Archaeological museums are often perceived as repositories of relics, entrusted to preserve ancient material culture in perpetuity but at the same time committed to making it accessible. The fear of deterioration often denies access or imposes limits on the interactions between visitors and artefacts. This contribution will present the results of three projects about archaeological heritage which has limited access and is not properly shared and communicated with the public: The Karam Collection of the University of South Florida, the Maltese prehistoric collection at the Museum of Siracusa (Sicily) and the Kouros of Leontinoi, scattered between two Sicilian museums. 164 objects were 3D scanned and the digital models were shared with the public using Sketchfab and the augmented reality app Augment. It is clear that digital renderings cannot replace real objects. Though they lack an existence in the real world, they make up for it by being available for experimentation and manipulation. In order to overcome the obvious limitations on tactile interaction with digital media, an alternative system was used, employing realistic 3D printed copies and haptic devices to afford the participation of members of the public with visual impairments.

Integrating Accurate Interactive Acoustics, Music and Soundscapes into Interactive 3D Models of Archaeological Sites and Landscapes

Till, Rupert (University Of Huddersfield)

This paper discusses issues raised during the creation of 3D models of three different World Heritage Sites, for the European Union funded European Music Archaeology Project exhibition Archaeomusica. For this exhibition an audio-visual installation called the Interactive Soundgate was created. Digital models of the landscape and architecture of archaeological sites were built in Unreal Engine 4 computer game engine, and a soundscape that was as authentic as possible was integrated into the interactive model, sound changing as one virtually navigates the space. Stonehenge was modelled using data from English Heritage, in four phases of its development, each phase presented in daylight, evening and at night. The Hellenistic Paphos Theatre in Cyprus was modelled with 3D data from the Cyprus Institute. Five caves that are part of the Cave of Altamira and Paleolithic Cave Art of Northern Spain World Heritage Site were modelled using photogrammetric data from the Songs of the Caves research project. The paper describes and illustrates the

construction of the acoustic ecology of these sites, creating an environmental soundscape, sourcing recordings of music instruments appropriate to the context, and processing soundscapes through digitally modelled convolution reverberation using impulse responses that accurately reproduce the acoustics of the space.

Improving Data Quality by Rules – A Numismatic example

Tolle, Karsten (University Of Frankfurt)
David Wigg-Wolf (Römisch-Germanische Kommission)

The archaeological data we deal with in our database solution Antike Fundmünzen Europa (AFE), which records finds of ancient coins, is entered by humans. Based on the Linked Open Data approach, we link our data to Nomima.org concepts and to resources such as Online Coins of the Roman Empire (OCRE), a digital type corpus based on Roman Imperial Coinage (RIC). Since for each single coin we record information such denomination, material, etc., this information should be identical for coins of the same type. Unfortunately, this is not always the case, in most cases due to human error. Based on rules we implemented in a rules system called Drools, we could use this redundant information to detect possible errors within AFE, and even correct errors in Nomimsa.org. The Drools approach has the weakness that we needed to transform the data into an internal data model. In a second step we therefore developed our rules within the Linked Open Data world as SWRL rules. These now can be applied to all datasets uploaded to Nomisma.org. We believe that such ways of improving the data quality of individual databases like AFE, but also across different data sources and up to higher levels such as OCRE and Nomisma.org, is mandatory in order to increase trust in them, especially when the data is exchanged within a network. Similarly for uncertain information, rules can help indicate impossible entries based on other certain information.

Recontextualizing Decades-old Excavation Materials Through 3D Visualization

Triplett, Edward (Duke University)
Emma Buckingham (University Of North Carolina)

While undoubtedly useful, 3D visualizations have the ability to create an unintentional break between pre and post-digital excavation periods at sites that were dug over many decades. Moreover, earlier excavations (such as those in the 1950s) were so much larger than projects today, with multiple trenches running simultaneously, that the volume of material produced naturally led to a "quantify and store" method that adds even more distance between the excavated materials and their interpretation. In this paper, our group will describe a method for using photogrammetry to digitally recontextualize large collections of pottery excavated over the last sixty years at the archaic settlement at Morgantina in Sicily. The method we devised is relatively simple. First, we used an available tabletop in our storage facility to act as a common surface for

strewing pottery that had previously been divided into context-specific containers on shelves. Then we shot between thirty and fifty photographs around the tabletop and processed the artefacts into a 3D model with Agisoft Photoscan. In the final stage, we layered the tabletops spatially in 3D and added a visual reference to the location, shape and size of the trench where the objects were found. To make the 3D strata easier to analyze in their native 3D form, we built a prototype using the Sketchfab WebGL viewer. In addition to process, we will also describe the consequences of this method for analysis with specific reference to the implications of layering object-scale and site-scale 3D data in a single system.

Complexity of Mesolithic Settlements in Northeastern Bulgaria

Tsonev, Tsoni (National Institute Of Archaeology And Museum - Bulgarian Academy Of Sciences)

The present study explores the Mesolithic settlement pattern in the Dikilitash (Raised Stones) area of northeastern Bulgaria. On small sandy areas there are overlapping concentrations of Mesolithic flint artefacts. The stone columns on these areas are geological formations which are empty inside and part of them are able to produce sound by the passing wind or when hit with stone. My analysis of this phenomenon is based on considering the nature of sacred space where knowledge has a discrete nature: inner mental predicates and outer cognitive artefacts that in the process of knowledge formation, the first take the form of cognitive states and the second may be situated both in concrete and abstract space. I examine them as constitutive elements of the process of language formation that provide the deterministic part of this emergent social dynamic. Illustrative of the possibilities of this approach is the similarity between the Mesolithic settlement pattern and the areas of intensive sales of corn in Atlanta, Indiana, USA. I explain the similarity of these emerging patterns on the qualities of pattern formation: the power of the farming symbolic and the local interaction of farming and foraging symbolic. The complex spatial characteristics of this formal deterministic expression turn the sites of the so-called 'Sandy Mesolithic' in Europe from marginal to central places that played a key role in introduction of sedentism and farming.

Display matters? Enhanced Visualization for Unique Aspects of Norwegian Stone Age Site Distribution

Uleberg, Espen (Museum Of Cultural History, University Of Oslo)
Mieko Matsumoto (Museum Of Cultural History, University Of Oslo)

This paper explores effective ways of visualization of Stone Age site distribution in South-Eastern Norway for researchers and the general public, using the Norwegian University Museum database. Our project Dynamic Distributions has over the last years utilised the metadata from the database to show the distribution patters

of single finds from diverse landscape types with valleys and agricultural areas. The analyses have targeted both the coastal area where the landscape are affected by the landrise after the last Ice Age and the high mountain where the tree limit has consequential impact on the vertical distribution of both single finds and occupational sites. The geotagged artefacts are annotated with different precision levels ranging from site over cadastral unit to municipality and county. The precision levels are decisive when choosing objects to include in analyses with landscape types to answer archaeological research questions. The present paper applies the concept of system attractors to larger archaeological sites and activity areas, weighing the single dot on the distribution map against the find volume. Contents, volumes, and contexts of lithic material are studied to display a more holistic view on the Stone Age landscape use. The artefacts were originally distributed in time and space, so the visualization includes an ordering in time/space entities to reveal patterns inherent in the distribution.

3D Digital Models and Bioarchaeology: Challenges and Proposals for Practice

Ulguim, Priscilla (Teesside University)

3D digital technology is increasingly accessible and being rapidly integrated into archaeological excavation and post-excavation workflows. This includes the digitisation, analysis, archiving and sharing of funerary features and human remains, presenting significant opportunities and challenges for bioarchaeologists. The ability to present complex data in 3D and share information about individuals in the past has great potential for research and outreach. This enables analysis, digital data integration, remote or even crowdsourced interpretation, and engaging learning possibilities. However, challenges are associated with creating and curating digital data: reusability, contextualisation, licencing and long term storage, and specifically for human remains: ethical considerations consent and use models. Using case studies of in-situ funerary context 3D recording, and data on sharing 3D bioarchaeology via online platforms such as SketchFab, this paper compares manifestations of challenges and opportunities and ways in which they are addressed. This emphasises the continued development of infrastructure to support advances in technology and exponential growth in applications, including proposals for best practices on 3D GIS integration, bioarchaeology metadata and paradata storage, supporting interactivity and ethical considerations for sharing. Although the visual interactivity of 3D digital models means they are often discussed individually, the paper takes a broader perspective of creation and curation of different types of digital bioarchaeological data, proposing a flexible framework to approach this issue.

Completing the Loop: Model-component Coupling and Bidirectional Feedback.

Ullah, Isaac (San Diego State University)

Simulation models are explicit descriptions of the components and interactions of a system, made dynamic in software. To achieve dynamism, we typically include stochastic processes that can be amplified by feedbacks between coupled model sub-components. In archaeology, the coupling between social and natural systems is a major feedback of interest that is investigated through simulation modeling. This is often achieved by conducting controlled simulation experiments, in which key socio-ecological parameters are varied, and changes to system-level dynamics are observed over time. However, it is increasingly apparent that nature of the sub-component feedback loops are at least as important drivers of dynamics as are the values of the key components being modeled. In this paper, I present the results of some initial experiments into the effects of different feedback processes on model dynamics. Using a dynamic simulation model of Neolithic agro-pastoralism, I systematically vary the style of coupling between the human and natural sub-components of the model, keeping all other variables the same. The changes in dynamics observed in the outcome of the different model-runs shows the effect of different kinds of feedback between model sub-components.

Arpilleras and Ayni: Roleplaying Reciprocity

Underberg-Goode, Natalie (University Of Central Florida)

The project is based on the work of Peruvian arpillera (appliqué) artist Flora Zárate, whose three dimensional "story cloths" narrate cultural stories both of people from her native Peru and of immigrants in the United States. Although not created in the ancient past, these works illustrate very old and persistent themes found in Quechua-language (the language of the Incas) mythology and folktales such as the concept of ayni, or reciprocity, expressed in such activities as cooperative labor. In addition to identifying key themes in Andean mythology, we consider how elements of mythic thinking and Andean worldview that figure in Quechua folktales--such as the presence of religious syncretism, the relation between time and space in Andean thought, and the conception of gender complementarity and dependence--could be integrated into the design of the interactive experience based on exploration of an arpillera reimagined as board game prototype. Throughout the game, the main character will have to make choices that relate to Andean culture, including understanding and demonstrating the importance of reciprocity or, “today for me, tomorrow for you.” We will present a paper prototype using materials including paper, blocks, dice, and index cards, identifying the presence of these recurring Andean cultural themes in the arpilleras, addressing how the design is intended to present characters whose roles relate to corresponding knowledge and tasks, and how objects are linked to culturally-relevant potential uses. Participants will be invited to play through the prototype, giving feedback and making design suggestions.

Frontier Networks: Cultural Transmission and Multiple Relations at the Intersection of Mississippian and Oneota Worlds

Upton, Andrew (Michigan State University And The Graduate School University Of Cincinnati)

Archaeologists have long recognized the potential of technological characterizations of material culture for assessing interactions, relational social ties, and cultural origins. In this presentation, I demonstrate the application of a multiple relations, or multiplex, network approach for the analysis of networks derived from technological attribute data that connected frontier communities of Mississippian and Oneota ceramic artisans in the Late Prehistoric central Illinois River valley (1200-1450 AD). Relational data is obtained from technological characterizations of pottery through the application of a quantitative cultural transmission model focused on differentiating between variation in artifact attributes mainly affected by engineering constraints ("functional") from those affected mainly by social constraints ("stylistic signaling" or social information bearing). Networks are constructed from each assemblage-based type-attribute mainly affected by social constraints. Indicators for influences and overlaps between these type-attribute networks are calculated prior to and post-dating the circa 1300 AD Oneota in-migration to demonstrate the restructuring of indigenous Mississippian networks. Because these different networks connect the same set of nodes (settlements), they are integrated into a single multiplex network. The multiplexity of this aggregate layer is argued to provide both a more robust identification of relational interaction and is a means to overcome the often substantial amounts of missing data inherent in technological characterizations of archaeological materials.

Virtual Reality as a Tool for Spatial Analysis at Cerro Maya, Belize (Cerros)

Vadala, Jeffrey (University Of Florida)
Brian Denham (California State University Sonoma)

This presentation discusses a virtual reality spatial analysis of the architectural landscape at the ancient Maya site of Cerro Maya, Belize (formerly known as Cerros). Virtual reality can be used as an applied technological approach because it has the potential to represent complex spatial archaeological data in highly critical, affective, and accessible ways. We demonstrate the potential of our approach by discussing the evolution of the architectural landscape at Cerro Maya. More specifically, our analysis focuses on the changing social and functional capacities of the monumental architecture that developed in relation to emerging hierarchal social orders. The social capacities of the ancient architecture are measured using Erving Goffman's spatial concepts of "copresence" and "front/back space" and Pierre Bourdieu's sociological concept of the "social field." We found that our virtual reality approach provides interpretive insights into ancient Maya ritual, heritage, astronomy, and social structure.

The Dynamics of Brazilian Rock Art Landscape: An Agent-based Modelling Approach to Theories

Van Havre, Grégoire (Department Of Archaeology, Federal University Of Piauí, Brazil.)

Historically, Brazilian rock art has been studied from a variety of theoretical perspectives. The first attempts endeavored to synthesize the diversity of sites and the graphical manifestations, which involved a certain amount of environmental determinism. As a consequence, the supposed marginality of most areas of Central and Northeast Brazil restricted the research to site descriptions. At the same time, the concept of tradition was introduced in the 1960 to link cultural proximity and stylistic similarity. This research proposes an agent-based model may be able to verify the possible effects of theoretical perspectives on the landscape. This model uses a number of hunters moving randomly and a set of shelters where they can make new paintings according to simple rules. Three different mechanisms can be modified: exogenous force (by nature, some shelters are fit for painting and not others), endogenous (by culture, some shelters are preferred and not others) and cumulative (shelters with paintings are more attractive). The results can then be compared to the archaeological context and used breach the distance between the environmental determinist model and the tradition model of interpretation to give a more nuanced understanding of the cultural and environmental forces that created these sites. In conclusion, this model allows us to analyze effective mechanisms behind theoretical formula.

Networks as a Theoretical Framework for Rock Art Studies in Northeast Brazil

Van Havre, Grégoire (Archaeology Department, Federal University Of Piauí, Brazil.)

Rock art in north-east Brazil is generally associated with the famous Serra da Capivara National Park, in the state of Piauí. Since the 1980s, the park has attracted much of the attention and energy of the Brazilian archaeological community. While it certainly remains one of the largest and most beautiful examples of rock paintings sites in the Americas, two other regions in the neighbouring states are particularly interesting: the Seridó (Paraíba) and the Chapada Diamantina (Bahia). Research developed in these regions in the last decade has showed the close relationship between these three areas. Despite up to a thousand kilometers distances between the areas, the same figurative styles are recurrent, and a series of scenes indicate an important cultural and material proximity. With the identification of these interactions for what they are, cultural contacts, and not just a stylistic similarity, the intermediary zones located between these three hubs mostly empty of archaeological evidence, this area must receive a renewed attention. We propose to study how, by crossing the results of network analysis with geographical information systems, we can look for new lines to orientate archaeological research and prospection in the region.

Digitizing Ancient Sculpture at the Michael C. Carlos Museum, Emory University

Varner, Eric (Emory University)

This paper will present the project to digitize African, Egyptian, Nubian, Greek and Roman sculpture in the Michael C. Carlos Museum of Emory University. The project will provide free access to the collection of ancient sculpture. The Carlos Museum has already made over 1,000 high resolution images of objects in the museum available online. The project, in close collaboration with the Virtual World Heritage Laboratory of Indiana University, will create 3D digital models of important works of sculpture in the Carlos collections using photogrammetry and make them freely available online with appropriate metadata and scholarly interpretation. Graduate students in Emory's Art History Department, as well as in History and other disciplines will also be able to propose 3D reconstructions of sculptures, including reuniting an over life-sized head of the emperor Tiberius with his long lost body. In this paper, we will discuss the goals and methods of the project as well as present some of the early results.

A Quantitative Approach Using 3D Models for a Typo-technological and Manufacturing Study of Terracotta Statuettes. The Case Study of the Ayia Irini (Cyprus) Small Figurines.

Vassallo, Valentina (The Cyprus Institute/Lund University)
Nicolò Dell'Unto (Lund University)
Sorin Hermon (The Cyprus Institute)

The Ayia Irini terracotta figurines are part of a collection found by a Swedish excavation in a sanctuary in the north of Cyprus at the beginning of the 20th century. It consists of a large number of statues different in size and in form: human figures, animals, chariots and minotaurs. Coroplastic study and in general archaeological descriptions are traditionally based on qualitative assessment of morphologies or on the use of linear basic measurement in order to differentiate the archaeological artefacts morphologically, typologically and stylistically. The doctoral research aims at enhancing traditional studies and at exploring the range of variation that occurs in figurines form and size through the use of 3D models, potentially contributing to statuettes manufacturing taxonomy. Specifically, the study is applied on a set of the Ayia Irini human figures, grouped according to similar forms. The methodological approach for their documentation includes the use and integration of 3D scanning and image based 3D modelling. The resulting 3D models and their constituting parts are then metrically compared to quantify and statistically analyse the objects. This will allow to evaluate the morphological similarity and dissimilarity between the sampled items, enhancing the understanding of manufacturing techniques and procedures in an artisan environment. The paper will also discuss the technologies used for 3D data capture, their integration, the issues encountered, the use of further

techniques for a complete study of the material (e.g. non-invasive chemical analysis) and the metadata structure supporting the data information.

To Boldly go where No One has Gone Before: Integrating Socio-cultural, Environmental and Temporal Factors in Site Location Analysis and Predictive Modelling

Verhagen, Philip (VU University Amsterdam, Faculty Of Humanities)
Antonin Nüsslein (École Pratique Des Hautes Études, Paris)
Laure Nuninger (Chrono-Environnement UMR 6249, Besançon)

Over the years, predictive modelling has been characterized as being environmentally deterministic, a-temporal, or even as a way of 'effectively de-humanising the past'. During the past ten years, however, spatial analysis of settlement patterns has progressed substantially, paying much more attention to the role of socio-cultural factors and the analysis of settlement pattern dynamics. In this paper, we will present an approach to site location analysis and predictive modelling that can be characterized as essentially data driven, yet is very much theoretically informed, and which has focused primarily on facilitating comparisons between various chrono-cultural contexts. Our experiments, that have been carried out since 2010, have mainly used data from the Roman period in various regions of France, but the general ideas and workflow can easily be transferred to other settings. However, when it comes to including both socio-cultural and temporal factors, we are still very much dependent on the characteristics of the archaeological data sets at our disposal, and the interpretations derived thereof. We will demonstrate this with a case study carried out in the north-east of France, where several new ideas were tested to understand the role of settlement hierarchy and its influence on the subsequent development and structuring of settlement patterns.

Making Virtual Reality Real: What Can We Learn by Bringing Together Virtual Reality and Visual Attention Analysis?

Vurpillot, Damien (Chrono-Environnement Laboratory (UMR 6249) University Of Bourgogne Franche-Comté)

The potential of virtual reality has been anticipated for decades, but the experience – it seems – has never quite lived up to the hype. However, over the past two years, immersive technologies – notably headsets – have begun to open new possibilities for truly immersive reconstructions of past landscapes. Taking advantage of these improvements in immersive technologies, we investigate the possibility that a careful analysis of visual attention and patterns of movement in virtual environments can provide essential new information and lead toward a better understanding of symbolic space. This paper presents the example of an experiment in

visual perception in the reconstructed landscape of a Gallo-Roman sanctuary in Eastern France. The aim of the experiment was to study the spatial composition of this landscape and how it was originally intended to be seen and perceived, through the application of low level visual attention metrics to views of the realistically reconstructed landscape, as seen by a user moving through it. Participant behavior was recorded during a series of interactive scenarios. This experiment serves as a starting point for a discussion of methodological developments that can improve the use of virtual reality as a real research tool. Successes and challenges of the experiment are outlined and possible improvements to the method and new research directions are suggested.

Exploring Massive Point Clouds: How to Make the Most Out of Available Digital Material

Vurpillot, Damien (Chrono-Environnement Laboratory (UMR 6249) University Of Bourgogne Franche-Comté)

Whether it is airborne laser scanning, terrestrial laser scanning, structured-light 3D scanning or photogrammetry, high density survey technologies produce point clouds as a basic digital output. In recent years, the industry has seen a tenfold increase in point cloud density: datasets with hundreds of millions or even billions of points are not rare. These new products require a change in practice. We have a reached a point where the basic digital material, the point cloud, should not be regarded as an intermediate product, used solely for the purpose of producing what is still seen as the real finished product: a DTM, mesh, orthophoto, etc. Rather, these point clouds are so massive that they have become a viable visualization medium by themselves, both for cultural heritage projects and remote sensing analyses. In this poster, we present innovative tools for the exploration of massive point clouds. We will be focusing on the open source point cloud webgl viewer Potree and a new tech demo from nvidia's Applied Engineering Department to render massive point cloud visualizations in virtual reality.

Increasing Academic Approaches to CAA

Wallrodt, John (University Of Cincinnati)

There are many vectors for creating cross-sectional analyses of the members of the archaeological community. Gendered participation in archaeology is one, gendered participation in the archaeological sciences is another, but this panel is concerned about gendered participation in the CAA in particular, that is, the intersection of computer science specifically to archaeology. This paper will look at the trends in academic departments which contribute the majority of archaeologists, and the declining numbers of females

in the computer sciences. It will also offer suggestions for increasing the participation of females in the CAA by marketing the organization to students and scholars with an interest in archaeological science who can learn from, and contribute to, the fields that forms the core of the CAA organization (computational analysis, statistical analysis, etc.) without necessarily an absolute focus on the academic construct of Computer Sciences.

The Aura as Metadata, The Aura of Metadata

Walthew, Jessica (Bard Graduate Center/American Museum Of Natural History)

We will focus on the conceptualization of digital models in cultural heritage, examining issues of "aura" and how both digitization and 3D documentation raise problems for the preservation and interpretation of artifacts in museum collections and archaeological sites. Standardizing metadata for 3D models continues to be a huge challenge for practitioners in CH fields. Interoperability is perhaps the greater challenge for the future of open access data. Beyond the technological, there are philosophical issues that need to be addressed. This work comes out of our experience in the fields of heritage conservation (Jessica Walthew) and computer graphics (Will Field). We would require 10 minutes to present.

Building Scholars and Communities of Practice in Digital Heritage and Archaeology

Watrall, Ethan (Department Of Anthropology MATRIX: The Center For Digital Humanities & Social Sciences Michigan State University)

As digital methods have become more ubiquitous in archaeology, the challenge of teaching those methods has become important. Beyond the question of how and what we teach, however, there is an equally important challenge - how do we build communities of practice populated by scholars who are connected through a shared perspective on both the methods and the thoughtful application of those methods. It is within this context that this paper will explore an approach developed at Michigan State University that speaks to both teaching (and learning) digital methods and the development of communities of practice in which those methods are relevant. The approach itself is informed by the activities in three separate venues: The Cultural Heritage Informatics Graduate Fellowship Program, the MSU Department of Anthropology Digital Heritage Fieldschool, and the National Endowment for the Humanities funded Institute for Digital Archaeology Method & Practice. Ultimately, the goal of this talk is not just to discuss the Michigan State University approach, but to suggest a series of best practices for building capacity and community among students and scholars in digital heritage and archaeology that could be adapted and adopted in a wide variety of institutional, professional, or scholarly settings.

MATRIX: The Center for Digital Humanities & Social Sciences

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Founded in 1995 at Michigan State University, MATRIX: The Center for Digital Humanities and Social Sciences is one of the oldest research centers in North America focusing on the application of digital tools and methods to cultural heritage materials, questions, and challenges. While MATRIX's work is incredibly diverse, the center is particularly well known for cultural heritage software development, building large scale digital libraries that preserve and provide access to endangered heritage materials, and initiatives that serve to build capacity in digital heritage methods among scholars, professionals, communities, and institutions. In addition, MATRIX has long been deeply commitment to working with African collaborators (both individual and institutional) on digital project that relate to African heritage, history, and culture. This paper will focus on the history, structure, administration, organization, workflow, and current trajectory of MATRIX. Special emphasis will be placed on exploring the critical strategic decisions made over MATRIX's more than 20 year history that allowed it to evolve into a mature, stable research center that is widely considered to be a leader in the domain of digital heritage and culture.

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mbira: A Platform to Build, Serve, and Manage Mobile Heritage Experiences

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The spaces we inhabit and interact with on a daily basis are made up of layers of cultural activity that are, quite literally, built up over time. While museum exhibits, archaeological narratives, and public archaeology programs communicate this heritage, they do not generally allow for interactive, place-based, and individually driven exploration by the public. In recent years, mobile and augmented reality applications have offered both platforms and models for mobile heritage experiences that partially address these issue. Unfortunately, the bar for developing mobile heritage applications is getting increasingly more difficult to reach for many heritage institutions and projects. Quite simply, building robust mobile applications is too technically complicated and specialized for many in the heritage community. It is within this context that this paper will introduce and explore mbira. Currently being developed at Michigan State University, mbira is an open source platform that empowers cultural heritage institutions, archaeological projects, and heritage landscapes to create, serve, manage, and sustain engaging mobile heritage experiences. Special attention will be paid to the design metaphor of "space and place as museum" that is woven into the fabric of mbira. In addition the paper will explore mbira's features that support multivocality and public discourse.

Military Markets in Moesia Inferior: Using Location Analysis and Comparative Modelling to Identify Market Places on Rome's Lower Danubian Frontier

Weaverdyck, Eli (University Of Michigan)

Comparative modeling of settlement-centered landscapes allows for the investigation of processes that are hugely consequential but leave little trace in the archaeological record. This project analyzes rural settlement patterns in the Lower Danubian Plain in order to investigate agricultural intensification and marketing in antiquity. Landscape archaeology and the theory of affordances undergird this inductive analysis of the relationships between settlements and their surroundings. Data collected from published and semi-published archaeological investigations in northern Bulgaria are employed to compare the productive potential of the areas surrounding settlements to randomly distributed areas of the same size in order to find evidence for intensive cultivation. Meanwhile, comparative, multivariate logistic regression analysis provides insights into rural marketing systems: first, the accessibility of marketing opportunites—"market potential"—from any given location is calculated using different hypothesized marketing systems; then a series of logistic regression models is created using environmental variables and one market potential variable. By comparing the goodness of fit of these models to one that excludes market potential altogether it is possible to determine whether marketing opportunities influenced rural settlement and, if they did, which places served as markets. In this way, computational modeling of settlement patterns reveals ancient people's relationships to the land and to each other.

Bringing out the Best: Mentoring Women in Digital Archaeology

Wendrich, Willeke (UCLA, Cotsen Institute Of Archaeology)

In spite of several feminist waves the position of women, and the subconscious consideration of women as top candidates in academia still lags demonstrably behind. In archaeology the majority of students, in programs and in field schools is female, but this is not reflected in academic positions. One solution to enhance diversity in CAA is through the stimulation of mentoring relationships. Mentoring, when done right, provides direction and a support structure, but most importantly it gives women a chance to speak freely and get candid advice.

3DVR Caveats and Accomplishments - Introduction

Wendrich, Willeke (UCLA, Cotsen Institute Of Archaeology)

3D virtual environments are persuasive and convey strong messages. Unless a critical approach is taken to what the models present, what they are based on and who they represent, the virtual environments can inadvertently express prejudices that result in racist or sexist messages. At best they will result in naive representations of history. The theoretical approach taken in archaeology needs to be fully employed in virtually representing information based on archaeological data. The accountability of the creators of 3DVR models includes giving access to the full range of data underlying the virtual environment as well as a justification for all decisions that were taken along the way. Many of the reconstructions that are not supported by actual information reflect a high degree of speculation. Adding "atmospheric" details such as dramatic clouds, bright sunlight, wavy grass, birds in the air and shady paths may create impressions that are actually false representations of the experiential part of a virtual environment (such as flowerbeds near slave barracks, which may give the impression that "life was not so bad").

On the Dynamics of Interactive Exploration over Animation as Methods of Experiential Simulation in the Sanctuary of the Great Gods on Samothrace

Wescoat, Bonna (Emory University)
Arya Basu (Emory University)

The Greek island of Samothrace was famed in antiquity for its mystery cult of the Great Gods, whose secret rites promised protection at sea and the opportunity for moral improvement. The rites remain secret and the complex archaeological record raises more questions than it answers regarding the experience of initiation. 3D modeling and computer graphics, however, allow us to explore another aspect of the site, the physical environment and the bodily actions and perceptions of pilgrims moving through it, and to communicate how the nexus of terrain, buildings, and movement heightened the experience of initiation. For the first three generations of our digital model, we worked in a static (quasi-dynamic) environment (first Lightwave, then 3dsMax) from which we produced animations. We privileged texture, detail, lighting, and control of the pilgrim's passage over interactive real-time exploration. We have now also moved the virtual landscape into a game engine platform, Unity3D, for its greater flexibility as a diagnostic tool using real-time interactivity and for its potential to enhance public scholarship and cross-platform publication. In this paper we assess our experience with both approaches, offering a cost/benefit analysis from the perspective of expertise, time, expense, complexity, research value, educational benefits, and broader dissemination.

Blurring the Lines Between Prediction and Interpretation: Some Thoughts on the Contributions of Energetics, Mobility, and 3D Models to Settlement Theory.

Whitley, Thomas (Sonoma State University)

Recently, archaeologists (myself included) have had this tendency to begin papers or session abstracts with an introduction that extolls a 'new' technology or approach that is changing, or has the potential to change, the way we do archaeology. Given the way that computers 'evolve' on an almost daily basis, we can forever be extolling 'new' techniques until the robotic cows (to be introduced by Google no doubt) come home. Yet, we never actually get any closer to the people in the past, and I would venture to say that new technology, in practice, does very little to alter the nature of archaeological theory. Computational modeling is, at its heart, an experimental process; not a theoretical framework. This does not mean that it should be devoid of, or make no contribution to, theory however. Here I will address some of the experimental processes that I have employed in the GIS modeling of human energetics, examinations of mobility, and creating 3D photorealistic models to find a balance between predicting settlement locations and interpreting human behavior. These objectives are often surprisingly at odds with each other and they frequently say much more about what our motivations are today, rather than how people lived in the past. Examples will be used from efforts to model the past, and future, effects of climate change on three continents.

Open Science, e-Science and Geospatial Data Management to Support Research in Archaeology

Willmes, Christian (Institute Of Geography, University Of Cologne)
Daniel Becker (Institute Of Geography, University Of Cologne)
Yasa Yener (Institute Of Geography, University Of Cologne)
Olaf Bubenzer (Institute Of Geography, University Of Cologne)
Georg Bareth (Institute Of Geography, University Of Cologne)

In this presentation we will present the Open Science approach on which the infrastructure design of the CRC806-Database (crc806db.uni-koeln.de) was founded and implemented. The system is built completely on the basis of open source software and implements the principles of open science (including open data, open access and open standards) as far as possible. A community peer-review process for the PaleoMaps data published through the CRC806-Database is in development, first results of this research will be presented and discussed during the talk. The talk will address current developments and new features of the infrastructure. An example for a new notable feature of the presented CRC806-Database is the Research Sites application, which organizes and relates research sites of concern to the CRC 806 (www.sfb806.de) to data and publication resources that are published through the platform. Due to the facilitation of open standards, integration with other data infrastructures, that also implement these standards, is possible. We will also talk about ongoing data integration and exchange projects with the ROCEEH ROAD database and with the NESPOS database. Additionally, we show some example applications of the database, as the basis for qualitative and quantitative applications like Agent Based Modeling, based on the PaleoMaps paleoenvironmental GIS data collection, that was presented last year at CAA Oslo.

Seismic Response of Geologic and Heritage Structures: Geometry Acquisition, Numerical Modeling, and Probabilistic Interpretation

Wittich, Christine (Department Of Civil Engineering University Of Nebraska-Lincoln)
Tara Hutchinson (Department Of Structural Engineering University Of California, San Diego)

The seismic response of cultural heritage and archaeological structures is of particular interest with respect to both preservation efforts and historical context. However, traditional structural analysis methods may not be ideal given the potential for complex geometries, atypical boundary conditions, and uncertainties in earthquake characteristics. These issues may be further exacerbated by the sensitive nature of these structures and the subsequent need for non-contact and non-destructive studies. Combinations of terrestrial light detection and ranging scanning (LiDAR) as well as structure-from-motion (SfM) techniques can be used in an effort to maximize accuracy and minimize occlusion for particularly complex structures. This high-accuracy and high-resolution geometry can then be utilized to predict the response of the structure to seismic excitation through finite element analysis for restrained, or attached, systems as well as through robust contact modeling for systems of unattached components. In this work, the geometric data acquisition, processing, and subsequent seismic response analysis of two representative systems is presented, including 1) restrained statue-pedestal systems in a museum, and 2) systems of unattached rocks in the field. The resultant response data for these systems is then interpreted in a probabilistic framework in an effort to account for uncertainties in earthquake excitation and modeling parameters.

Photogrammetric Feature Documentation and Cave Modelling

Wolter, Thomas (University Of Cologne CRC 806)

During the 2014 and 2015 CRC806/B1 archaeological field campaigns in Albania was a rash of caves in the space of a karstic system in the Dibrës region investigated. Within this system particular focus on 3D-documentation necessity was set on Keputa cave. There are 19 feature situations with a particular quality of large concentrations, fireplaces, charcoal remains at the wall and traces of animal activity. The priority object of our work inside the cave was to establish an as precise as possible copy of the whole cave ground. The setting for this plan was covering 1500m² of cave floor with overlapping ground spots and with strategic focus on feature concentrations. Almost 8000 photos in 47 sets were collected and processed with Agisoft Photoscan and afterwards linked to each other. From archaeological perspective all finds on the surface were single measured and collected for contextual information. A second focus is now on publication and the possibility to present the 3D-model and the contextual data of archaeological research. One of the most important points within this workflow is data management and reproducibility. Now we have to evaluate if

our accomplishments answer our own research questions. Furthermore if the connection of underlying single measurement data within the 3D model and additional scans of single finds will be an valuable support for future research. As we understand this is also a matter of cultural heritage conservation.

Lidar Damage Evaluation of Historic Temple after the 2015 Gorkha Earthquake

Wood, Richard (University Of Nebraska, Lincoln Department Of Civil Engineering Structures Group)
M. Ebrahim Mohammadi (University Of Nebraska, Lincoln Department Of Civil Engineering)

Damage evaluation of a historic structures following an extreme event introduces many challenges in comparison to a contemporary, engineered structures. Structural engineers typically create finite element models (FEM) of the structure of interest in which numerous model parameters require calibration to simulate the response and confirm damage mechanisms. This information may include structural plan details (geometry), material characteristics (strength and stiffness parameters), as well as observed damage patterns (cracks, spalling, etc.). Lidar scans contain the ability to rapidly capture dimensionally accurate point clouds of the structure or facility of interest. Within these point clouds, information can be extracted to guide the geometry as well as the objectively determined damage patterns. Localization and quantification of damage can serve to update the FEM with high level of certainty within forensic investigations as well as estimate the remaining capacity or safety of the structure. In this work, a case study will be demonstrated on the Nyatapola Temple, the largest five-story temple in Nepal that sustained significant damage after the 2015 Gorkha Earthquake.

One Size does not Fit All: Reflections on Online Research Infrastructures

Wright, Holly (Archaeology Data Service University Of York)

The Archaeology Data Service (ADS) is a data archive working at a national level in the UK, to ensure archaeologists have access to high quality and dependable digital resources, including openly licensed legacy data for re-use. ADS also acts as a metadata aggregator for archaeological data held by larger heritage agencies, and smaller, regional organisations. It holds an extensive library of Unpublished Fieldwork Reports representing work ranging from large commercial field units to individual contractors. ADS also participates in international aggregation infrastructure projects like Europeana and ARIADNE, which allow users to access resources held in many countries from a single interface. All of these situations reflect the fact that making data available for re-use in a sustainable way is often more dependent upon building complex relationships and active collaborations, rather than technical solutions. This paper will reflect on issues surrounding creating collaborative online research infrastructures for archaeological data, including lessons

learned, challenges and opportunities, and thoughts for the future from the perspective of the ADS, a data archive now in its 20th year.

Adapting to the Problem at Hand: Image Registration and Object Detection for Automatic WW2 Aerial Photograph Processing

Zambanini, Sebastian (Computer Vision Lab, TU Wien)
Simon Brenner (Computer Vision Lab, TU Wien)
Robert Sablatnig (Computer Vision Lab, TU Wien)

This paper addresses the problem of automatically analyzing aerial photos taken during World War II air strikes. The goal of this work is to locate unexploded ordnances (UXOs) for risk assessments, enabled by the registration of the historical air photos to modern-day satellite images and the detection of military objects (e.g. bomb craters or trenches). The work is part of the DeVisOR project which aims at supporting the tedious task of creating UXO surveys in a semi-automatic manner by means of powerful image analysis methods and interactive visualization techniques. In this talk, we give an update on the project progress focusing on the problems of automatic georeferencing by historical-modern image registration as well as military object localization by the analysis of sliding windows on the image data. For image registration, we propose a regularization of keypoint matching by combining global and local estimations. To this end, a hybrid voting mechanism for transformation parameters is presented where local correspondences as well as global image similarities are used to identify the transformation parameters with the highest support from the data. As both voting schemes are optimized for our problem, this methodology provides a statistically profound basis to identify the final correct correspondences. For object detection, we present and discuss results achieved by convolutional neural nets trained on image samples of military objects.

Building a Heritage Management Platform for Endangered Archaeology in the Middle East and North Africa

Zerbini, Andrea (Endangered Archaeology In The Middle East And North Africa, University Of Oxford)

This paper addresses the role of web-based heritage management platforms as tools for the analysis of archaeological sites and their changing condition through time. The Endangered Archaeology in the Middle East and North Africa (EAMENA) project has adapted the open-source Arches 3 platform for recording more than 100,000 cultural heritage sites in the MENA region. Most of this dataset has been collected by analysing satellite imagery and aerial photographs. Data has been structured in accordance with the CIDOC CRM to achieve integration with other cultural heritage mapping projects. Moreover, a data sharing protocol

has been established to incorporate pre-existing and newly-acquired field data onto this platform. The international scope of the EAMENA project, which covers more than 20 countries, makes this platform an ideal tool to promote collaborative archaeological research in the Middle East and North Africa. At the same time, this platform may also serve as a template for the development of customised Historic Environment Records (HERs) at a national level. Starting in 2017, EAMENA will allow access to its platform for as many people as possible via the website eamena.org. However, this raises ethical and professional issues about the extent of data visualisation and what should and should not be shared publicly. For this reason, this paper will also discuss the sets of restrictions that EAMENA intends to put in place to prevent the illicit use of heritage data (particularly geographic data).

Possible Strategy of Land Use by the Przeworsk Culture People in Widawa Basin (South-Western Poland) and the Probable Settlement Processes

Zipser, Jan (Freie Universität Berlin, Excellence Cluster Topoi)

Even though it is possible to describe overall dynamics of the settlement phenomena of the Przeworsk culture in Widawa Basin (pre-Roman Iron Age to the early Migration period), it is important to answer a question about the reasons for this dynamic and the accompanying changes in the occurrence of Przeworsk culture settlements in Widawa Basin. It is also possible to presume a key role of environmental conditions, which shaped the strategy of land use by the Przeworsk culture people and the detailed course of the settlement system's expansion. The shape of the Widawa group settlement system very strongly corresponds to the spatial distribution of a dense river system in the said area. It seems possible to propose a bold assumption that due to the economic use of bog iron present only in the vicinity of watercourses and wetlands, watercourses played a major role in the Przeworsk culture people's settlement process and strategy for further use of the Widawa basin. The paper presents selected results of the research project aiming at recreation of the Przeworsk culture settlement emergence and expansion in the Widawa basin by means of simulation models (primarily the Shifting Model, based on the "intervening opportunities" idea).

Introduction

Simon, Katie ()