Abstracts

Machine Learning and AI

AI in times of COVID Creating quality pottery shape simulations for pre-training Machine Learning Pottery Image Classifiers: processes in the Arch-I-Scan project

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The Arch-I-Scan project aims to develop a Machine Learning Image Classifier for sherds of Roman terra sigillata fine ware, to aid the recording and collation of large datasets of Roman pottery, ultimately to facilitate greater use of this material in the study of eating and drinking habits across the Roman world. In early 2020, we were in the early stages of data gathering when the COVID pandemic stopped life on earth as we knew it. According to our original programmed timetable, we would by now have gathered tens of thousands of photos of Roman terra sigillata sherds, engaging members of the public to assist recording using mobile phones. With no opportunity to gather these photographs, we have turned to experimenting with simulated terra sigillata shapes to pre-train the classifier.

Having initially focussed on getting the classifier to work with rough shapes, we later focussed on the impact that the quality of the simulation has on the accuracy of the classifier. In this paper we present the Arch-I-Scan project as initially envisioned and the results of these early simulation experiments.

Gaze and Body Orientation in Ancient Images. New Approaches for Estimating Relationships via Computer Vision

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Understanding the images of past societies is a key aspect of Classical and Christian Archaeology. Since 2019, the interdisciplinary research project "Iconographics" tackles the problem of developing methods and models to digitally support the analysis of complex compositional and semantic structures in historic artworks with computer vision and deep learning. As a part of this, gaze and body directions of depicted figures are central elements for the narrative of an image, but suitable applications are missing that automatically recognize these in pre-modern artworks.

In ancient images, gaze direction and foot alignment are crucial for determining the interaction of the figures and thereby to define the overall action that is taking place. For example, in addition to the general composition, the eye contact between a warrior and a woman in the schematic depictions on Attic black-figured vases separates the two main protagonists from minor figures. Additionally, in combination with the eventual bodily contact, the direction of the feet determines the kind of action that is depicted – from "facing" or "seizing" to "guiding" and "leading". Also, in early Christian and Byzantine depictions of the Annunciation to Mary, the gaze and feet directions of Gabriel suggest an interaction between him and Mary, even if Mary's pose and gaze do not indicate an interaction at first.

State-of-the-art [SOTA] methods in computer vision often fail when tested on images due to varying styles, genres and periods. Hence, we reformulate the problem of estimating head-gaze-feet orientations and body contact as an object detection problem to leverage the existing object detection capabilities for better understanding and analysis. We can improve this further by styled transfer learning in terms of predictions and performance.

Keywords: Classical Archaeology, Christian Archaeology, Digital Humanities, Computer Vision

Patterns of Trauma - Employing AI and ML in bioarchaeological trauma research

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The applicability of Machine Learning (ML) and Artificial Intelligence (AI) has made a profound impact on archaeological research questions. Its power to extract patterns invisible to the human eye is makes it one of the most powerful – although dangerous – tools of modern science.

Our study starts at the fundamental core of ML, in pattern extraction. Injury patterns are time and culture specific not only offering insights into personal lives but further, the presence, occurrence, and sanction of violence within a society. Distinguishable by specialists, interpersonal violence can separate from accidental injuries, especially in cases of sharp force or projectile trauma. However, most fractures are hard to interpret in bioarchaeology and even many forensic cases. Pathognomonic fractures of small scale, non war related, interpersonal violence are extremely rare and their interpretation will and should always involve expert opinions. The study uses a tagged bioarchaeological dataset for training and generates models based on the location of the fractures, their lethality, biological sex, age, and burial place of the individuals. It increases in sensitivity through iterations predicts more accurately with time.

This talks presents a proof of concept to use AI based models on published archaeological and modern cases to replicate the divide between accidental injuries and lethal interpersonal violence. We hope to explore the potential of these methods with a critical view on their mechanics and how they can aid to explore new hypotheses, especially considering the vast record of bioarchaeological human remains for population studies. The project aims to expand its transdisciplinary research to the distinction of patterns of interpersonal violence in the future.

Using CarcassonNet to automatically detect and trace hollow roads in LiDAR data

Wouter B Verschoof-van der Vaart (Leiden University)*; Jürgen Landauer (Porsche)

Convolutional Neural Networks (CNNs) are becoming the state-of-the-art object detection method for LiDAR data in landscape archaeology. Detection rates are now exceeding 80% for compact, localized objects such as barrows and charcoal kilns. However, little research has been done on the detection of more complex landscape objects such as hollow roads. While CNN-based methods have successfully been applied to modern road detection, they do not translate well to the archaeological domain: hollow roads are only partially preserved, dissected by modern landscape objects, and contain multiple overlaps between tracks.

Therefore, we present a novel approach to automatically detect hollow roads in LiDAR data by combining a CNN and image processing algorithms. We call this approach CarcassonNet as its key ideas were inspired by the well-known board game “Carcassonne”. There, a medieval road network is constructed by laying square-shaped tiles to construct road networks of almost arbitrary shapes. Likewise, we divide the LiDAR data from the research area (the Dutch Veluwe) into 64x64 pixel tiles. This method makes it much more cost-effective to create a sufficient dataset to successfully train a CNN. Furthermore, the CNN is only used for image classification, a relatively simple task, instead of more complicated tasks such as segmentation.

The tiles are used as to transfer-learn a pre-trained ResNet34 CNN. Subsequently, the trained model is used to detect hollow roads in new data from different areas. The results of the classification are converted into geospatial vectors (polygons and lines) with different Image and GIS processing algorithms. Experiments conducted with CarcassonNet have shown that it is able to detect and trace hollow roads in LiDAR data, with an accuracy of 89%. The results of this research can be used for the reconstruction of these vanished and abandoned routes and answer archaeological questions about human-landscape interactions.

Remote sensing and geophysics

Searching for the Dutch castle landscape

Nancy de Jong-Lambregts (PhD)*; Ferry van den Oever (Saricon BV)

An interdisciplinary approach with a variety of non-destructive (geophysical) techniques

Research into Dutch castles has suffered from an outdated approach solely focused on the object and not its surroundings. Research into the immediate environment leads to a better insight into the function of a castle in medieval society. Castles are part of an extensive infrastructure consisting of outer wards, artisanal buildings, defensive structures, ports and farmsteads: The Castle Landscape. In the Netherlands, a research backlog is evident in this area. This abstract highlights a part of a PhD study on Dutch castles in the 13th century and particularly the research on the castle and it's landscape.

From an international point of view, the Netherlands are lagging when it comes to using near-surface geophysics. When used at all in the Netherlands, it concerns mainly solitary cases using just one technique.

In this study, the geophysics expert will interpret the data (of a combination of techniques) together with the archaeologist/building historian, supported by aerial WOII photography, Lidar images and historical sources.

Only then, geophysical research is optimally utilized.

In the past 2 years we have already researched four castle terrains and would like to show the results you can achieve when using this complementary approach. The study will expand on this approach, refining and assessing it and will contribute to an improved implementation and adaptation of existing Guidelines for the use of geophysics in Dutch archaeology and the approach on castle archaeology in general.

We will present our approach and some of the remarkable first results of this study such as the discovery of a unknown pre-13th century fortification in Alkmaar with help of WOII aerial photography and the discovery of a unknown 13th century castle in Heemskerk with use of geophysics.

It will be a duo-presentation

The tumultuous Marriage between Mrs. Archaeology and Mr. Geophysics

Joep Orbons (ArcheoPro)*

Once upon a time there were mister Geophysics and miss Archaeology. He was a technician, loved electrodes and digital numbers. She was more into humanities, loved the people and their relations. They fell in love but their relationship is characterized by disorderly commotion and emotional agitation. He produced graphs she didn't understand and she formulated questions he could not put into his machines. Marriage counselling was brought in. They found out they enriched each other, given the right way of thinking.

The aim of this paper is to make the marriage between archaeology and geophysics work. A roadmap of logical steps will result in better understanding and better results.

Starting with a thorough desktop study and proper archaeological questions. These are then translated to the geophysical technical world into terms of physical contrast, measurement noise and structural patterns. These translated physical parameters determine the type of geophysical instruments to be used.

A prediction can then be made of the archaeological result. Will it be hopeless? Wil it be a nice clear result or is a trial needed? All this information can then be used to set up field planning. It is only after these steps that the fieldwork can be carried out.

The technical geophysical report is translated back into archaeological answers. The beautiful picture is not the goal, the goal is to answer the archaeological questions.

To any archaeologist, this process should sound familiar, the same goes for trial trenches, augering campaigns, C14 dating and excavations. These research methods are a tool in the archaeologists toolkit. Geophysics is one other tool.

The necessity to pass information to the next research step is obvious. A proper feedback to learn from what was picked and what was missed is often forgotten.

Mrs Archaeology and Mr Geophysics lived happily ever after.

Drone thermography for archaeological applications

Jitte Waagen (Universiteit van Amsterdam)*

Drone thermography is a newly developing field in aerial remote sensing techniques. By measuring and imaging infrared radiation it is possible to distinguish between material types, which can lead to detection of archaeological features on- and under the ground. Thermal cameras and thermograms collected by e.g. satellites have been available for a long time, but drones hugely improve on their usefulness because of their operational flexibility. Especially the collection of thermal imagery relatively close to the ground creates the potential to pick up thermal signals of buried archaeology. Whereas there have been successful applications in various parts of the world, the optimal conditions and workflow are still being researched (cf. Casana 2017, Cool 2018, Hill et al. 2020). This paper presents some preliminary insights into the matter based on still ongoing case studies in The Netherlands (Westerbork, Siegerswoude), Italy (Satricum), Turkey (Troy) and Greece (Halos).

Gaming, AR and VR

Augmented Blended Learning: providing immersive content to augment the museum environment

Markus H Stoffer (University of Amsterdam)*

Making historical VRs, lessons learned from two case-studies: the commanders house at Westerbork and the former Jewish neighbourhood Vlooienburg, Amsterdam.

Tijm Lanjouw (UvA)*; Jitte Waagen (Universiteit van Amsterdam)

Over the last two years the 4D Research Lab of the University of Amsterdam was involved in the creation of two (unrelated) historical VR's to be used in museum exhibits. The VRs differ completely in functionality, visuals, technology, narrative style, historical epoch and collaborating groups. But they share a single element: a learning curve. For us as a lab these were the first steps in the world of VR creation, so clearly, we learnt important lessons from these projects. Not only in terms of technical knowledge and skills, but also about conceptual and functional design, communication with collaborators and project planning. In my talk I will give a life demonstration of both 'apps': the layered commanders house at Westerbork with its complex of layered narratives, and the multi-period historical-architectural reconstruction of the former Jewish neighbourhoods Vlooienburg and Valkenburg, Amsterdam.

Archaeogaming - Reflections on Code and the Playability of the Past

Sophie C. Schmidt (Deutsches Archäologisches Institut)*; Tine Rassalle (University of North Carolina at Chapel Hill)

Since Andrew Reinhard's definition of archaeogaming as the intersection of archaeology and video games as an academic research field (Reinhard 2013), a number of scholarly subjects surrounding video games have been explored. In this presentation, we will discuss how many 'historical games' (that is, games that are set in a specific historical period) create game worlds that might seem realistic and accurate at first sight, but in reality, only offer certain generated interactions that can skew how players see and think of the past. At the base of every digital game is code, and within this code, choices are made. Technology trees, strengths and advantages of different units or characters, possibilities of interactions, which action will create which reaction within the game – everything visualized and all 'rules' implemented in the game are in fact technically determined by game developers. Drawing on Jeremiah McCalls Historical Problem Space Framework (McCall 2020) and the works by Tuur Ghys (2012) as well as Felix Zimmermann (2018) and Wolterink (2017), we will discuss how historical games are not simulations, but actually new creations of the past. However, since they relay an atmosphere of authenticity, they influence a player's perception of the depicted time period. Games oversimplify and abstract the past, making the player believe that certain historical events were much more straightforward than they actually were. In this paper, we hope to encourage critical reflection on the medium "game" and stimulate archaeologists and historians to get more involved in the production of video games, in order to make them useful tools for public outreach and teaching.

Ship Shapes: Digitising 17th and 18th century Dutch ships

John McCarthy (Flinders University)*

This presentation describes the outcomes of a recently completed PhD study on the power of technological advances to shift the gaze of maritime archaeologists beyond individual ships towards broader trends in vessel use, design and modification over long periods. The sheer logistical burden of investigating a shipwreck and the romantic nature of the material has discouraged maritime archaeologists from attempting the kind of typological and longitudinal studies that underpin research into most other types of archaeological site. However, digital techniques have the power to capture and combining very different types of source material and allow for tracing of trends in the archaeological record which can be liked to significant social and technological changes. A suite of novel techniques has been applied to the rich evidence base for seventeenth- and eighteenth-century Dutch merchant ships, including digital scans of in situ and recovered shipwreck remains, contemporary scale models, shipwreck material, and other sources such as paintings, manuscripts and charters. A substantial digital library was built up through diving in Iceland and Australia, and scanning of contemporary ship models in museums in The Netherlands, Belgium, Norway, the UK and the USA. Detailed analysis of dimensions and scale, typology, and hull form has provided a much richer understanding of this material. Beyond its relevance to Dutch ships, the methodology developed is proposed as a model for discipline-wide collaborative development of 3D libraries which could have a transformative impact on ship studies and, in turn, maritime archaeological practice.

Tools, statistics and little Minions

Linked Open Samian Ware - Unveiling the hidden Data Dragons and uncovering temporal vagueness with the help of Little Minions

Florian Thiery (RGZM)*; Allard Mees (RGZM); Dennis Gottwald (Johannes Gutenberg-Universität Mainz)

The relevance of LOD and the Semantic Web in archaeology has increased substantially, resulting in the establishing of a CAA Special Interest Group on Semantics and LOUD in Archaeology (SIG Data Dragon). There is - usually beyond our current known horizon - a considerable amount of unknown but qualified data, which is essentially available but hardly findable: the modern unknown data dragons (datadragon.link). They are hidden in their lairs and we are trying to lure them out. As an example, we use the online relational database `Samian Research` with its quarter of a million finds of potters' stamps, placed by thousands of potters on Terra Sigillata, from all over Europe. South Gaulish potters' stamps may occur on different sections of the Limes in different parts of Europe, allowing for a) comparison and b) temporal reasoning between the Limes sections of the 1st and 2nd centuries AD. As a result, Terra Sigillata is regarded as a dating instrument in archaeology. We are bringing the dragons into the open and transforming the resource into LOD as part of the LOD cloud. In the first part of our presentation, we will present this transformation process and its results.

With all these data, assisted by two Little Minions - Alligator and AMT, introduced at CAA Kraków – we apply multivariate analysis combined with the use of the Alligator algorithm and AMT reasoning by using Linked Data techniques. In the second part of our presentation, we will then present interpretations resulting from analyses and visualisations of the dependencies within the dating arguments for individual sections of the Limes that rely on the evidence of Terra Sigillata data with the help of the Little Minions. This is a fundamental contribution for further methodological discussions as to what extent Sigillata can be considered as a dating instrument at all."

geoCore - QGIS plugin to construct a graphical representation of petrographic drilling profiles

Moritz Mennenga (Lower Saxony Institute for Historical Coastal Research)*; Gerrit Bette (T-Systems on site services GmbH)

One of the main problems with displaying core data is the individual layout and definition not only through different disciplines but also between institutions or even single researchers. To solve this problem the Lower Saxony Institute for historical Coastal Research and the T-Systems-on-site-services-gmbh developed a QGIS-Plugin to provide a very flexible open source tool. This geoCore-Plugin is implemented in the QGIS environment and gives the user the opportunity to customize the layout of the profiles, which are drawn based on the stratigraphic information. In the talk the functionality and the customization possibilities will be shown using a practical example.

The track graph: a heuristic tool for reconstructing past movement systems

Philip Verhagen (Vrije Universiteit Amsterdam)*; Laure Nuninger (UMR 6249 Laboratoire Chrono-Environnement, University of Bourgogne Franche-Comté)

The rapid acquisition of observational data and creation of digital data over the past 10 years has led to an archaeological “information explosion” that is calling for new approaches to knowledge creation from (digital) data. In this paper, we propose such an approach for the study of movement, designed for the present data-rich research context. We illustrate how the breakdown of implicit conceptual references into explicit, logical chains of reasoning, describing basic entities and their relationships, allows the use of these constituent elements to reconstruct, analyse, and compare movement practices from the bottom up. We then introduce a new heuristic tool based on this ontological reasoning, the “track graph”, to record observed material features in a neutral form which can be employed to reconstruct the trajectories of journeys which follow different logics of movement. We also present a first application of its use in the context of network analysis and simulation modelling.

Handmade pottery and the mystery of volume: how to calculate capacity in an accurate way

Vasiliki - Lagari (Leiden University)*

During my research, I tried to tackle the problem of calculating the capacity (interior volume) of ceramic vessels, to understand how 3D models contribute to this field and if they help evolve the archaeological study of ceramics. Having the Bevelled Rim Bowls and the “Flower pots” of Jebel Around (Mesopotamia, Uruk period, 4th millennium B.C.E.) as a case study, I tried to create a specific workflow that could deliver the most accurate results regarding their capacity. Their non-standardized character enabled me to compare the potentials of different methods (manual measurements, calculations by following the profile of the objects, and calculations by 3D models created with photogrammetry) and by doing that to add some more insights about their ancient use and the possibility of a standardized metric system.

The Fractal Dimension of Stone Tools

Florian Linsel (University of Cologne)*

The history of studying complexity theory and fractal geometry started back in the early 20th century and its influence has been tremendously increasing since the 1980’s. A fractal is any pattern that gains a higher complexity when it is magnified.

The investigation of ridges and scars of stone tools showed in the past, that these features are present due to the three main stages of preparation - decortication, shaping and sharpening. The assumption of this research is that these structural patterns of ridges and scars could potentially behave like fractals and these fractal distributions could be further described by the Fractal- (Hausdorff-) Dimension. One important precipice for the existence of this dispute was the article “The Fractal Dimensions of Lithic Reduction“ written by Clifford T. Brown. Brown focused on the debitage classification of several sites in the area of Wetherington Island Site. Brown classified size-frequency distributions of the according to their fractal dimension. He could distinguish different stages of reduction. If a site could be described with the method, then every object may be describable with this method, too.

For analysing these Fractal Dimensions potentially enclosed in Lower and Middle Palaeolithic artefacts, a Python Code for image analysis was developed. By photogrammetrically generating a DEM of the artefacts and applying the Python Code it was possible to automatically detect the scars on the surface of these objects.

The analysis of 30 artefacts results in a display of fractal characteristics. The lithic items analysed possess fractal properties and present potential indications on the specialisation of the individual objects as well as their techno-complexes. The heterogenic in shape, technique and chronological setting of stone tools (c. 1,000 – 40 ka BP) was used to check the applicability of this method.