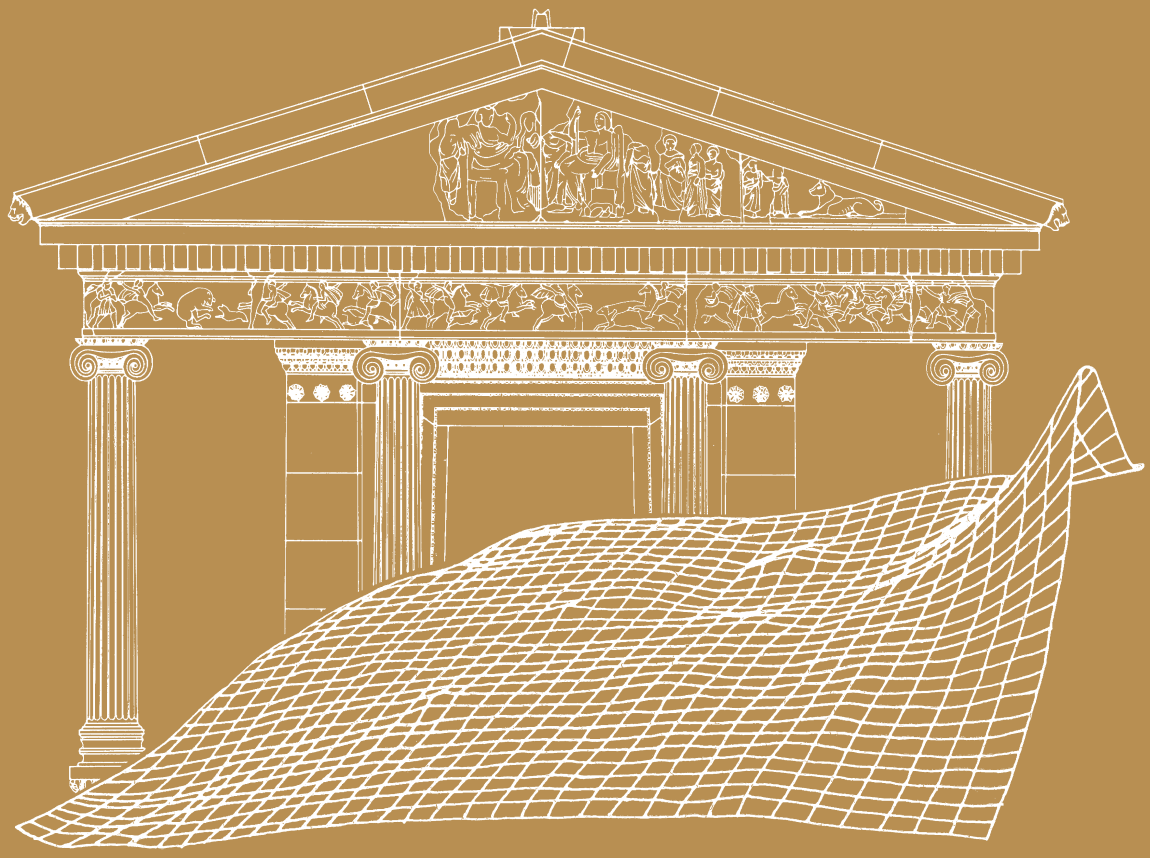

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ARCHEOFOSS 2022
PROCEEDINGS OF THE 16TH INTERNATIONAL CONFERENCE ON OPEN SOFTWARE, HARDWARE, PROCESSES, DATA AND FORMATS IN ARCHAEOLOGICAL RESEARCH (ROME, 22-23 SEPTEMBER 2022)

edited by
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MASPAG & PYARCHINIT, THE NEWBORN COLLABORATION OF SAPIENZA AND ADARTE IN THE SULTANATE OF OMAN

1. Introduction

MASPAG, which stands for Missione Archeologica della Sapienza nella Penisola Arabica e nel Golfo (Archaeological Expedition of Sapienza in the Arabian Peninsula and the Gulf), is a new multidisciplinary archaeological project financed by Sapienza Great Athenaeum Excavation program since 2019 (Ramazzotti 2021a), recognized and supported by Italian Ministry of Foreign Affairs and International Cooperation since 2022. The project focuses on the Italian long-lasting archaeological tradition of research in Western Asia, in the South-Eastern Arabian Peninsula and especially in the Sultanate of Oman (Frenez, Cattani 2019). MASPAG aims to study the ways of life of the ancient communities that inhabited the Arabian Peninsula and the Gulf, which were in direct contact with the most renowned ancient empires (Ramazzotti 2022). Indeed, Ancient Eastern Arabia became the framework of a unique development of social relationships, based on tribal alliances and human mobility rather than kingship and bureaucracy (Tosi 1986; Cleuziou 2009; Bortolini, Tosi 2011).

Field activities focus on the conclusion of the stratigraphic investigation of the large collective burial LCG-2 in the monumental funerary complex of Daba al-Bayah, in the governorate of Musandam, Sultanate of Oman (Genchi 2019, 2020; Genchi *et al.* 2018, 2022; De Cataldo *et al.* 2020). In 2021, the Sapienza archaeological mission decided to extend its archaeological investigation by setting the foundations for a new landscape investigation project, in agreement with the Ministry of Heritage and Tourism of the Sultanate of Oman and the Italian Ministry of Foreign Affairs. The first step was to identify the survey area, which had to meet certain logistical as well as scientific requirements. Clearly, the first and fundamental point was the absence of pre-existing archaeological investigations or activities, in order to have an unexplored landscape to document and study, a georeferenced ecotope to analyse through computational and digital modelling as an Artificial Adaptive System (Ramazzotti 2014, 2021b; Ramazzotti *et al.* 2020).

Located in the al Batinah South Governorate of Oman, in the provinces of Nakhal, al-Awabi and Wadi al-Ma'awil (Fig. 1), the surveyed area offered the ideal context to start a new landscape project, which would lead to explore the complexity of human mobility and social organisations at the core of the so-called Land of Magan (Potts 2000). The geomatic mapping of the archaeological landscape was structured in two main operations. First, an in-depth

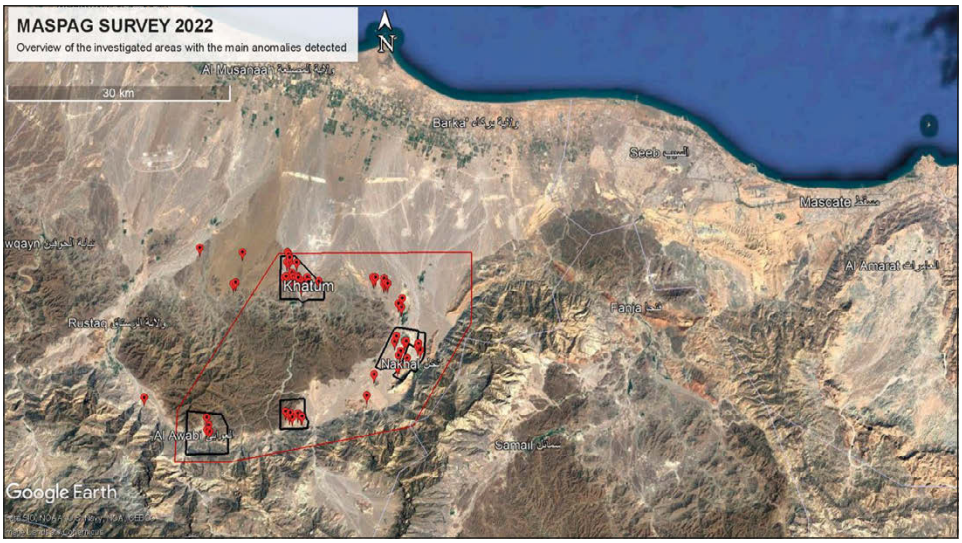

Fig. 1 – Overview of the investigated area.

remote-sensed based examination of satellite images of the area was carried out, with the aim of recognising anomalies or rather clusters of anomalies that could indicate the presence of archaeological areas (November 2021-January 2022).

The analysis of satellite images by Google Earth Pro has proven its effectiveness in landscape archaeology and this approach has also been proposed in Oman, particularly in the framework of the Wadi Andam archaeological project (al-Jahwari, Kennet 2010; Deadman 2012a). The absence of pre-existing works on the selected area made the remote sensing approach the first step in discovering and understanding the survey landscape. Before starting the satellite survey, the literature was reviewed to identify and classify the specific morphologies of archaeological features in the Omani landscape (Giraud, Cleuziou 2009; Deadman 2012b; Condoluci, Esposti, Phillips 2014; Thornton, Cable, Possehl 2016; Döpper 2018; Döpper, Schmidt 2020; Düring 2022; Swerida 2022).

By examining the historical images, it was possible to observe the archaeological evidence before and after the excavation activities, recognising how they appear in the pristine landscape. In this way, the morphologies and positioning of the major archaeological features in the landscape were identified, so that they could be pinpointed as anomalies and anomalies' clusters to be verified on site. Once the most promising areas were identified, fieldwork was initiated for ground verification of the anomalies and for the documentation of the landscape (February 2022).

The aim was to highlight the archaeological potential of the area and to set up a remote sensing and ground truthing methodology by integrating the analysis of satellite images with targeted field surveys. Exploiting the potential offered by modern application of remote sensing and Geographical Information Systems (Ramazzotti 2013a, 2013b; Casana 2020; Montagnetti, Guarino 2021), an unexplored multi-millennial landscape was charted, highlighting the relationship with the high density and variability of archaeological features and modern anthropic activities.

Approaching a landscape yet undocumented by scientific literature, one of the ambitions of the survey was to create a cartographic basis for future exploration and to define a workflow protocol for the documentation of all archaeological data. For these reasons, and in anticipation of the opening of stratigraphic excavations, new possible GIS solutions were researched with the aim of developing a comprehensive documentation management system. The exploration of these solutions was the drive and meeting point between MASPAG and pyArchInit.

2. Objectives

The collaboration between MASPAG and adArte srl (developer of pyArchInit, see below) was founded with a clear objective: to digitally enhance the archaeological documentation apparatus of the archaeological field activities of Sapienza in the Sultanate of Oman. This intent took the form of a PhD student application for funding from Sapienza University of Rome for Research Initiation Projects (Progetti per Avvio alla Ricerca - Tipo 1). The proposal had as its objective the development, in collaboration with dedicated programmers, of a geodatabase to manage information and data of the archaeological landscape of MASPAG's area of interest.

Involving experienced professionals in both standardised computer language for relational databases (Structured Query Language, SQL) and sciences of antiquities would have allowed the creation of a highly performing dedicated product, optimising research time and promoting a metadisciplinary approach that could become the basis for future research and collaborations. This project would also make it possible to create an online platform to which the raw geographical and archaeological data of other research groups active in the area could be redirected, projecting towards dissemination in Open Access format and research communication.

The funding of the Sapienza's Research Initiation Project made it possible to institutionally start the collaboration between MASPAG and the developers of pyArchInit open sources plugin for QGIS (Mandolesi 2009; Mandolesi, Cocca 2013; Cocca, Mandolesi 2016; Montagnetti, Mandolesi 2019). As a first step, it was mandatory to clarify the objectives in order to plan a

strategy to achieve them and overcome the main challenges, thus an early assessment was necessary. The project "pyArchInit - Open Source Platform for Archaeology" (https://pyarchinit.org/), is being developed since 2005 with the purpose of building a Python plugin for the open source software QGIS, specifically for the management of archaeological data (Mandolesi 2009).

Over time, pyArchInit has become a working and interaction model, a sequence of procedures that are gradually being developed and codified in order to achieve real data management in both research and heritage preservation (Mandolesi, Cocca 2013; Guarino, Rosati 2021). In its current state, the plugin workflow allows maximum portability and compatibility of the system, and the complete management of stratigraphic data and archaeological and anthropological materials, by systematically integrating and putting together alphanumeric cartographic and multimedia data (Montagnetti, Mandolesi 2019).

Given these premises, the potential of adopting the plugin in MASPAG's documentation system was obvious: to obtain an archaeological specific geodatabase documentation platform with a clearly operational workflow and a direct contact with its developers, themselves being professional archaeologists. Only one element had to be developed and integrated into the system to precisely answer the proposal presented in the Research Initiation Project, and thus meeting the scientific expectation of MASPAG: the archaeological landscape, its decomposition and documentation.

Pointing out the need to expand the existing pyArchInit system was extremely well received by its developers, embracing the principle of keeping the system always open for adding new features and functionalities (Mandolesi 2009, 209-210). The foundations were laid for a long-lasting partnership across multiple topics and branches of archaeological research: training in the management of geo databases and advanced use of GIS for archaeology with pyArchInit, the development of a dedicated geodatabase platform for the documentation of the archaeological landscape and its issues, challenges and stakes.

The ultimate long-term goal we expect to achieve in the next years is the development of an open source GIS solution for archaeological investigation, from stratigraphy to landscape, integrating the structure developed for the MASPAG 2022 survey within the pyArchInit system. Achieving these ambitions will lead to a twofold objective: the developer team by adArte will be able to extend the reach of the pyArchInit platform with a landscape documentation tool, while at the same time, the Sapienza team will have the pyArchInit platform available for all scientific documentation, from survey to excavation.

3. First results

The last year saw the first results of the newborn collaboration between Sapienza and adArte: advanced training in the management and use of

geodatabase in a GIS environment (QGIS and pyArchInit), and the development and field application of a dedicated structure for documenting the MASPAG survey. The training, financed by Sapienza Great Excavation to adArte, included a 24-hour course in October 2021 covering the theoretical and practical aspects of building, managing and applying geodatabases (mainly Spatialite and PostgresSQL). Specific classes followed on the use of the pyArchInit plugin: installation on QGIS and the organisation of datasets; digitisation of stratigraphic units (SU), plans and sections; management of stratigraphic relationships and Harris matrix generation; export of phase plans, cards and lists for SU and archaeological materials.

The result of this phase was the development of the relational geodatabase structure on QGIS for the documentation of the first survey season planned for February 2022. The aim is to fully integrate into the pyArchInit system this beta version, which was positively tested by the survey team (Mandolesi 2009, 212-213). The entities of the archaeological survey were separated (transects, collection areas, archaeological features, view points) and associated with geographical and environmental features and entities (provinces, land use, topographical units, building sites) (Montagnetti, Mandolesi 2019).

The core element of the system is the relationship between Topographical Unit (TU) and archaeological features (documented and digitised as points,

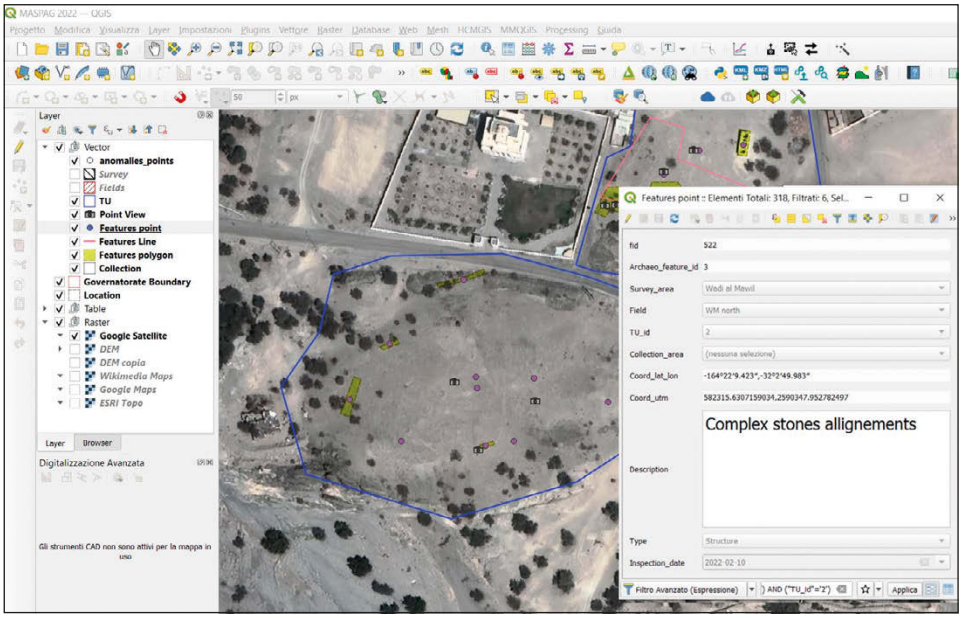

Fig. 2 – Screenshot of the QGIS project, on the left the vector layers represent the decomposition of the archaeological information.

Fig. 3 – QField in action, on site digital data acquisition directly feeding the database with points as well as pictures.

lines and polygon layers). The TU table is organised in attributes that allow its geographical description and positioning in the larger ecotope, together with the human activities observed in the field and the archaeological activities carried out. Digitised as a polygon, the TU layer becomes the container for the archaeological features identified in it (Fig. 2). The archaeological features themselves are described by an open list of categories (e.g. structure, shred concentration, stone alignments, etc.) in order to account for the very high variability expected in the archaeological landscape.

The intention to separate description from interpretation has justified this choice, reinforced above all by the high volume of photographic documentation via a dedicated point-view layer. With this structure organised in a QGIS project, we were ready to start the survey and document the landscape. QField plugin was used to enter data directly in the field (Fig. 3). This open source software synchronises a QGIS desktop project to an Android mobile device, used to draw geo-referenced archaeological features on the spot. With the application of this workflow, 25 TUs distributed along 5 Field Areas and a total of 313 archaeological features were documented during the month of fieldwork (Fig. 4).

The most prominent documented features are the about 249 funerary monuments. These last are concentrated in two main areas: Khatum West has 89 graves spread across 5 topographical units, from the rocky jebels (KTW.TU.9) to their foothills (KTW.TU.6), and to low natural rocky plateaus that are 3-4 m above ground level (KTW.TU.2 and KTW.TU.3). In contrast, the Wadi al Ma'awil South area has 152 tombs arranged more coherently in a single long series of interconnected low ridges and small plateaus that span about 3.5 kilometres in a SW direction (WMS.TU.1).

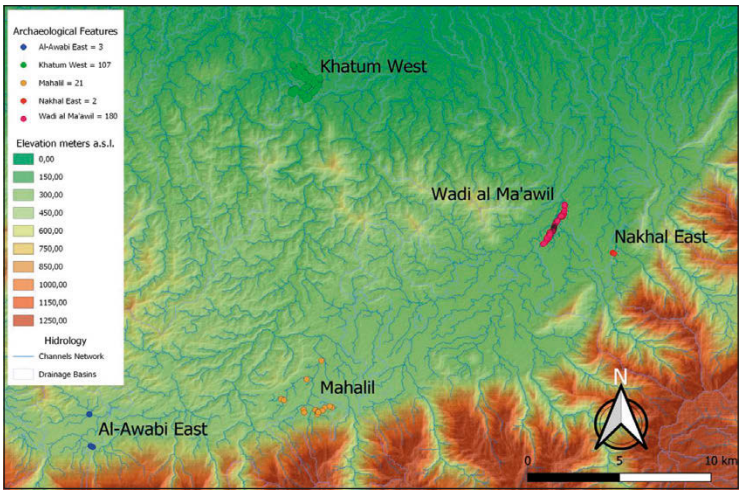

Fig. 4 – Final map showing the archaeological features documented in the landscape.

Besides the 249 tombs, there are 37 other features linked to settlement contexts (such as stone alignments, pottery clusters, lithic, etc.), 10 individual features (collected diagnostic elements such as metal slags, stone tools, and diagnostic pottery), and 17 anomalous features (such as regular soil discoloration or vegetation growth completely separate from the surrounding environment). In addition, several trigonometric points were surveyed to document and study the relationship between the archaeological landscape and modern activity, enabling us to reconstruct the recent history of the landscape's human impact.

Through this data acquisition process of the archaeological landscape, we were able to make a preliminary projection of the archaeological risk and potential of each documented Topographical Unit (TU), and thus create an Atlas of the surveyed area. Each entry of the Atlas retrieves and lays out the information related to the TUs, from its coordinates and administrative positioning to the archaeological features with their proposed chronology, up to the modalities of land exploitation today and the evaluation of the archaeological impact, the latter assessed on the based on the relationship between archaeological evidence and modern anthropic activities observed on site.

The production of the Atlas allowed us to provide the specific cartographic documentation directly during fieldwork, and our close collaboration with the Ministry of Heritage and Tourism of the Sultanate of Oman allowed us to communicate with the department of housing in order to raise awareness on the implications and importance of an archaeological assessment.

4. Future perspective

As highlighted above, both the training in the use of geo databases and the new QGIS documentation tool for MASPAG's survey were successful. Thus, we structured the advancement of the partnership, bringing us closer to the final goal envisioned since the beginning, i.e. the full integration of pyArchInit into MASPAG's documentation system. The promising start to this second phase was the renewal of the Research Initiation Projects (Progetti per Avvio alla Ricerca - Tipo 1), which will make it possible to develop and expand the skills and experience gained and to concretely start thinking about the scientific ramifications and possibilities that such a system can offer.

Combined with the future launch of an *ex-novo* stratigraphic investigation of selected archaeological sites, settlements and seasonal occupations while continuing field, aerial and satellite surveys activities in parallel, the preconditions are in place to enhancing pyArchInit plugin to integrate in one innovative platform the documentation of both stratigraphic excavation and archaeological landscape. The primary objective of this phase of the work is therefore to develop the integration of the structure created for the survey into the pyArchInit platform, which will enable digital management of all scientific documentation produced, from the landscape to the stratigraphic unit.

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ABSTRACT

During the fieldwork season in November 2021-March 2022, the 'Missione Archeologica della Sapienza nella Penisola Arabica e nel Golfo' (MASPAG), as part of the research activities supported and financed by the Great Excavations of Sapienza since 2019 and MAECI since 2022, planned and launched a new landscape archaeological project in the Sultanate of Oman. The first survey was carried out in an area of the Al Batinah South Governorate unknown to archaeology, combining remote-sensing and ground verification activities. This operation also saw the first result of the collaboration between the MASPAG research group and adArte srl, developer of pyArchInit open source plugin for QGIS. The first season of the survey not only made it possible to estimate the archaeological potential of the study area, but also served as a workshop, opening a dialogue between universities and private companies, to discuss open source solutions in archaeology.

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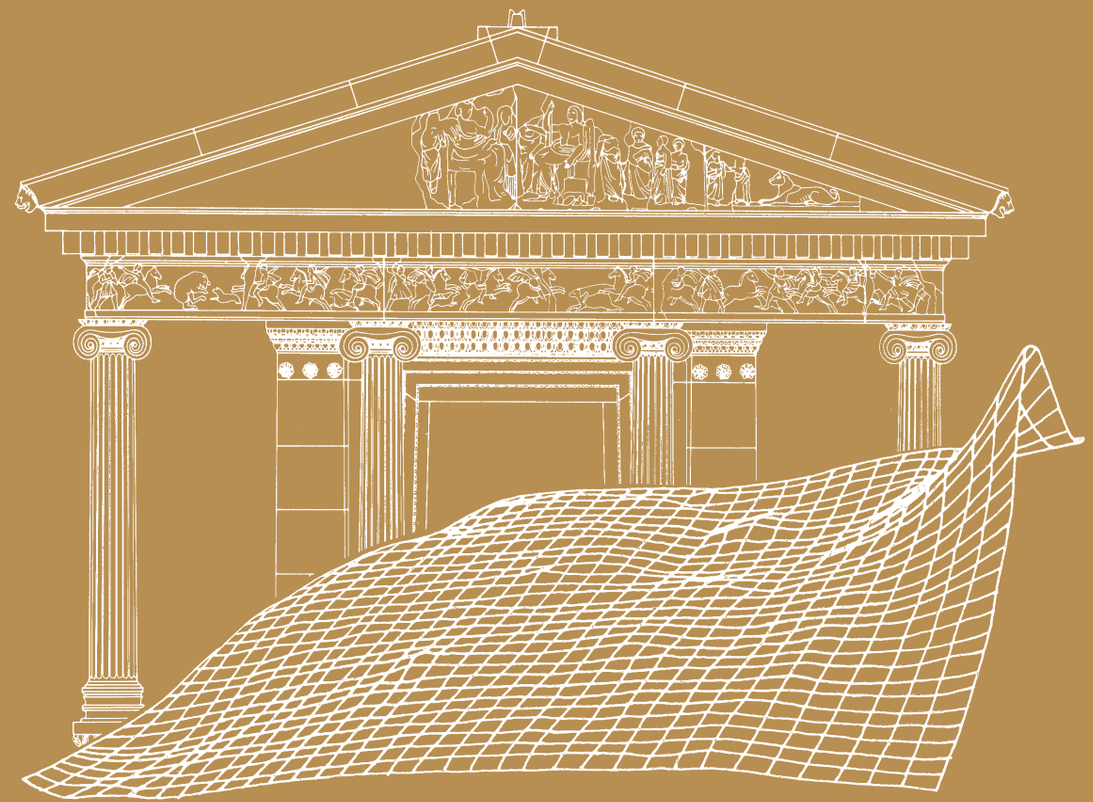

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