Can stones be made (artificially) intelligent? Understanding people from patterns and similarities of architectural decoration in Roman Asia Minor —Julie Verlinden, Toon Goedemé, Arjan Zuiderhoek

The disciplines of History, Archaeology and Computer Vision have each stimulated the development and use of diverse digital tools within their own domain. But what if we dare to ask a research question positioned right at the crossroad of these fields, necessitating the analysis of people's past via ancient texts and monuments (in casu thousands of legacy photographs of decorated buildings)? And what if, in addition, the expertise and data on the latter was locked into a silo due to its language barrier, hermetic and outdated scientific traditions and single-sided research finality? In this paper we return to dawn of our era (1st century BCE - 3rd CE) in the historical region of Asia Minor (roughly modern-day Turkey) to put this to the test. With the help of a Nodegoat relational database and pattern recognition AI-techniques we attempt to break down this silo and unlock its data's true historical potential.

Our starting point is a simple, yet significant observation about the Roman empire: archaeologists and ancient historians encounter a remarkable degree of similarity in the material culture and architecture of its many studied provincial cities[1]. Focusing on buildings, we observe that, despite differences of detail, constructions look remarkably similar, also in Asia Minor. What processes explain this similarity in an empire where the central government was bureaucratically minimalist and local communities enjoyed a lot of autonomy? A pivotal dataset had been overlooked so far: that of architectural decoration. The canon of geometrical and vegetal designs found on a building has no structural function, yet is present on nearly every monument with some grandeur in the empire. And, it is prone to fashions, changing over time and space, yet displaying the above-mentioned similarities (fig.1). Especially in Asia Minor, many monuments are also linked to surviving inscriptions. These provide information on who commissions or pays for these buildings; who sets trends or copies them; who plays which role in the game of social status. These texts, in other words, connect the buildings and their decorations to the people behind the stones: the elite protagonists who built their lives in these ornamented cities.

In sum, we investigate if the similarities identified in the ornaments match with other (un)known forms of connectivity (institutional, cultural, social, religious) between the same cities and their elites, known from written sources. At the DH Benelux 2024 congress, we would like to present our workflow which consists of a Nodegoat database & pattern recognition AI-techniques. In this way, we argue, ornamental patterns of (dis)similarity within and between cities can be discerned on an unprecedented scale, as well as the structure of the communities and social networks responsible for these buildings, whose actions might explain the sameness in the decoration.

Fig.1: two decorated building blocks, from Perge (left) and Sagalassos (right), illustrating the similarity in Roman urban culture in Asia Minor that forms the core of this paper. Both exhibit the same selection of canonized ornaments (1: bead-and-reel, 2: egg-and-dart, 3: anthemion frieze, 4: scroll) yet in a slightly different fashion.

[1] Van Oyen-Pitts eds. Materialising Roman Histories. Oxford, 2017.

For the Nodegoat database[2], we have so far designed a new data structure in which the individual ornamental patterns are linked to their ancient buildings, in detailed statements of place and time, and connected to our bibliography in Zotero. Thus, the legacy data is brought into motion and enters the DH era, forming the first digital compendium on the subject ever. We likewise invest in the principles of linked data, currently integrating existing gazetteers (Digital Atlas of the Roman Empire), unique identifiers (Arachne ID, TM person ID) and ontologies (Chronontology). In a next step, controlled vocabularies will be set up bridging the ornaments' terminology in different languages and unique IDs will be generated for each block, transcending the different excavations projects' conventions. With this approach, we take the first steps towards breaking down the silo architectural decoration was locked into. To date, the field had solely established urban chronologies, leaving its potential to answer broader socio-historical questions unexplored. Moreover, the field had become alienated from mainstream ancient history and classical archaeology as it relied on only a handful of expert scholars in the 1970/80-early 2000's, publishing lengthy descriptive manuscripts (mostly in German) with catalogues of black-and-white analogue photos. In addition, the info on these buildings and benefactors was until now fragmented (scattered throughout different epigraphic corpora, excavation reports by different projects/institutions, in different languages) and incomplete (not every stone had a unique identification).

The opportunity for computer vision techniques pertains to the quantity and granularity of detail to be captured. At this stage, the compendium is estimated at over 5,000 images of decorated blocks from roughly 600 monuments on nearly 30 archaeological sites. Since every block typically exhibits multiple different designs, mapping and comparing these manually is mission impossible. Hence, AI-based automatic pattern recognition techniques are indispensable, placing architectural decoration studies on an exciting and innovative new footing. So far, we have scanned the existing repeating pattern detection algorithms to identify the most apt one for our first WP: isolating the different patterns as identified in the specialist literature from all photographs. The one from Pelosin e.a.[3] fits best as it is the most optimized state-of-the-art algorithm that can detect multiple patterns unsupervised and is open source. Deploying the Canny algorithm, DAISY and SLIC techniques, it cuts out the periodically repeating unit of each decorative element, yielding a large image data set of pattern snippets. Next, we plan to classify the different ornamental design classes in this digital library according to the taxonomy described in the literature. Noteworthy is that modern AI-techniques can then be deployed, enabling comparing the pattern snippets at an unprecedented granularity. Only by using high-performance embeddings (e.g. SimCLR) we will unveil subtle differences between patterns within a class, offering the crucial yet previously invisible cues for our novel historical analysis.

[2] Thanks to Prof. Julie Birkholz and Hans Blomme (Ghent Centre for Digital Humanities) for their help.

[3] F. Pelosin, A. Gasparetto, A. Albarelli, and A. Torsello, "Unsupervised semantic discovery through visual patterns detection," arXiv (Cornell University), Feb. 2021, doi:10.48550/arxiv.2102.12213.