



Applying Synthetic Intelligence and Data Science to Contemporary Challenges of Archaeology, Art History, and Historical Forensics

The Work of Exploration, Discovery, Recovery, Reconstructive Modeling, and Restoration

New Approaches in the scientific search for lost missing structures and artifacts

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One of the objectives in archaeology is to understand how remaining artifacts fit together both physically and functionally. We aspire to recreate how settlements ranging from short-term occupancy nomadic habitations to centuries-plus and millennia-occupied towns and cities were physically structured, modified, often severely destroyed by natural or human actions, and also, very significantly, how the structures and objects found in those locations were used. What were they for, who used them, in what ways, for what purposes.

In historical times there are firm records of many artifacts that have disappeared through a combination of cataclysms, thefts, and other acts of both human-induced and natural causes. Such losses include books, manuscripts, paintings, jewelry, and a host of other objects d'art and valuables which demonstrate historical, cultural, and monetary value.

The challenges to scientists, explorers, and experts in all of the pertinent fields are immense because of many uncertainties, most of which are glaring open questions due to scarcity of reliable, verifiable knowledge. Did the place or artifact actually exist, ever? Was it destroyed through any number of actions in ancient or modern history? Was some artifact stolen, or found and then concealed, and

placed in some form of secret location, and perhaps forgotten with no clear record of its location now accessible or existing?

Of those objects, small and large, and places, of which the latter were often large edifices or urbanized communities with multiple buildings and human-developed areas, what are the possibilities of discovery in this 21st century? Manuscripts and many artifacts easily decompose. Many objects of any type of composition may have been used and thereby destroyed, by people over a period of centuries and even millennia. What are the ways in which scientists, explorers, curators, and forensic investigators can effectively, and efficiently, proceed to identify those things in our missing past and present which are most likely to exist, most likely to be traceable, (re)discoverable, and acquirable, in our 21st century? What types of tools do we have at our disposal that can make such tasks easier and more practical from all points of view including time and finance for exploratory work, be it in the laboratory or library, or in the field, in regions that are often difficult and expensive in which to conduct any type of fieldwork due to nature and human factors?

Our position is that there are some valuable technologies now at our disposal, and many of these involve mature and increasingly mature applications deriving from signal and image processing, geospatial informatics, the broad field of data science including VLDB (very large database) analytics, and particularly what we term SI – synthetic intelligence – the broad field of computational methods generally known as artificial intelligence, neural networks, probabilistic reasoning, deep learning, and several other contemporary terms.

The SI “treasure chest” provides a mature and growing repertoire of mathematical and computational resources that may be used by investigators and explorers, whether they are interested principally in archaeology, anthropology, or particular subject-areas of specialization relating to arts, crafts, agriculture, or many other disciplines. They may be invaluable in tracing the pathways of different objects and the likelihood of objects or places being in specific accessible (or potentially accessible) regions of the world. They may be very useful for specialists in the art, archaeology, anthropology and law enforcement domains for tracking the locations of known, presumed, or probable stolen objects. Some of these resources have developed and matured most strikingly in recent years within other fields, notably medicine, agriculture, geological exploration for use in the mining and petroleum industries, and within military applications as will be no surprise.

We concentrate our attention here, in this paper and in our long-standing research, upon two principal technology domains:

signal processing (including image restoration and analysis) deriving from aerial, satellite, and marine sources including the use of robotic devices, and upon machine learning, the “AI”, what comprises the broad field of SI, and particularly upon work in patterns both physical and logical, including detection, error-correction, matching, fitting, differentiation, and recognition.

In this brief introductory and exploratory paper, we consider a hypothetical use of several mature technologies that can be summarized under the heading of synthetic intelligence. We employ this term as a distinction from the older, traditional and “industry-accepted” term of artificial intelligence, in order to draw a distinction between systems that model, mimic and in some arguable cases surpass conventional and unaided (by computing) human intelligence (“AI”) and systems (“SI”) that potentially go beyond the limits of detection, correction, recognition and declarative action in machines and which implement, or at least show qualitatively different promise and potential, for imagination, invention, innovation, departure from the norm of established algorithms, and even self-awareness in some form.

We consider how these types of computational resources can aid in tasks that have historically proven to be challenging if not unsurmountable, to date, in the study of ancient historical life and the history of objects known or believed to have existed in the past but which are missing, lost or destroyed in our contemporary times. We examine how SI can assist in our attempts to rediscover habitations and other physical structures, and unique artifacts including sculptures and objects, especially such as have been associated with religion and sociopolitical power. We aim to present a path forward for using these technologies in the context of exploration and discovery. We want to make progress in a new methodology for learning about what humans have constructed, hundreds or thousands of years ago, and which are in difficult states of ruin and decomposition, or lost forever. We aim to assist scholars and students in the tasks of reducing uncertainty, doubt and often disbelief regarding how to interpret the surviving evidence, and to help answer questions regarding whether or not there had been something that existed in the very first place.

Did it exist and does it exist today and can we find it, and what special new understanding will the answers to these questions provide to us as we continue in our very innately human quest to understand Ourselves – that is how we want to apply the mathematics and the computations.

[end of Introduction]

Annotations to the Map on the first page:

This map provides markers that indicate possible locations of some artifacts of interest, and also possible locations of what may be important information, such as books and manuscripts that give references, also perhaps physical maps as well.

This is only a collection of pointers to places – in some cases specific sites, in most cases only cities, towns, regions, where it may be valuable to explore further.

Further explanations are in the other notes and databases.

Note that the locations of attention and interest are not associated with many specific sites that have been heavily explored and/or popularized. The majority of locations indicated on this map pertain to possible locations where there may be information in the form of books, manuscripts, maps, and other records, that can indicate likely locations of various objects of interest, or the impossibility of finding such objects due to their destruction in the past. There is value in ascertaining the non-existence of certain things, and also in tracing the historical routes by which both objects and knowledge (such as ancient scientific and technical knowledge) may have moved during the ancient past.

Thus, the work of ArkhēIntel is very much like investigating “cold cases” and involves a great deal of “connecting the dots”. But the first tasks ahead are to identify the correct dots and to learn how they may in fact be logically and historically connectable!

These markers on the map include:

- (red) Locations where there may be artifacts or structures of interest that are hidden and not yet discovered.
- (orange) Locations where there may be artifacts that have been retrieved and are in some form of hidden storage, either intentional or forgotten over a period of centuries – including objects that have been stolen from known locations such as museums and galleries.
- (yellow) Locations of the latter type but which are or have been specifically religious monasteries or centres under the control of specific monastic-type orders (at present or in the recent historical past).



In the main document that is in preparation (for which this text, above, is an introduction), there is explanation and further details regarding these locations.