Global Journal of Environmental Planning and Architectural Heritage
https://www.eurekajournals.com/GJEPAH.html
ISSN: 2581-4192

Applications Artificial Intelligence in Archaeological Discovery

Prof. Dr. Badawi Mohamed Ismail[1]

[1]Dean of Faculty of Archaeology -Luxor University, Consultant at the National Museum of Egyptian Civilization

Abstract

Archaeological research that reveals artifacts is of extreme importance since ruins and objects are the only way to deal with the history of the city. AI techniques can support archaeologists to manually discover remains that are difficult to identify because they must be searched over a vast area or because they are hidden from direct observation. Here we present an original methodology that integrates deep learning and computer vision techniques to identify the remnants of Centuriation, an ancient Roman system of territorial division.

The applications of artificial intelligence in the social sciences and humanities, among the areas in which techniques and artificial intelligence are used, is archaeological excavation and imaging, which is carried out in different ways than before. Techniques are also used during exhibitions in museums and is used to access what cannot be accessed by humans, as well as artificial intelligence is used in insurance against fire and theft, and there are some devices that are used in history.

This article focuses on the application of artificial intelligence in archeology and its potential in this field. Although some may consider this topic outside their primary interest, not knowing the basic points about this topic can be devastating.why? Archaeologists use AI in many ways, from creating 3D models of historical scenes to scanning areas with laser radar to find ancient tombs. Moreover, new methods have recently been tested and are almost ready for implementation in practice. The article helps explore an area of study where the past and present work together. Another point is that AI helps archaeologists conduct excavations and makes artifacts and cultural property more accessible to people. Scientists assume that in the near future they will be able to please the public by presenting archaeological values

Keywords: Artificial Intelligence, Archaeological, Deciphering the Ancient, Mysteries.

Introduction

Artificial intelligence (AI), due to its increasingly powerful predictive capabilities, is showing an increasing trend in gaining widespread interest in many sciences. Archaeologists can now fully utilize knowledge from a large amount of archaeological data using artificial intelligence in a way to make decisions about appropriate strategies for the preservation and protection of archaeological items, as well as to decide on the most ideal point excavation in a complex cultural landscape.

The Future and Transformations of High-Tech Artificial Intelligence

In the past, human interactions were the main driver of international politics, but recently artificial intelligence has played a prominent role in political life and has become a major actor in the global economy and international wars. Cinema and science fiction novels have worked-on several occasions-to portray the relationship between humans and artificial intelligence in the future as war and controversy, ignoring the positives achieved by technology in several areas, such as public health, medicine, and law.

To confirm the American leadership in shaping the future and transformations of these high technologies for artificial intelligence, the Massachusetts Institute of Science and Technology announced in mid-October the largest financial investment in this field, worth one billion dollars, to establish a new college that combines its specialties.

In this regard, a report issued by Chatham House (Royal Institute of International Affairs) in June 2018, co-authored by five specialists, entitled "Artificial Intelligence and International Affairs: The Upcoming Turmoil", attempts to measure the effects of artificial intelligence on international policies in the short and medium term. In addition to its effects on global security, and in various fields such as military affairs, economic and human security.

Influences in World Politics

On the effects of intelligence technology in the political field, which is characterized by a high degree of complexity of human relations, the report indicates that it is difficult to imagine that it will replace executives in decision-making in the short term, but that technology plays the role of aid to decision makers in making decisions in a rapid and effective manner. The mechanism of the work of artificial intelligence technology lies in its ability to structure many data, and to keep it in a way that surpasses the human mind, but it may malfunction if there is something unfamiliar with what it has been programmed to, unlike the human mind, so each works as a complement to the other.

The Report Points to Three Main Roles for Artificial Intelligence in Global Politics, as Follows

First-the analytical role: by analyzing the databases and producing results that are in line with the models that have been programmed on it, such as monitoring the implementation of treaties on the control of nuclear or chemical weapons. As a result of the increase in current data, whether commercial or industrial, artificial intelligence will contribute to its

crystallization and analysis to give it to the decision maker to take the appropriate decision.

Second-the predictive role: Artificial intelligence can provide decision makers with possible outcomes in the future, according to the data it has analyzed. For example, through certain types of applications, the decision maker in international affairs can come up with models for complex negotiations, and then build on them the positions and actions of other actors. With the accumulation of knowledge, and the further development of application programming, AI can make predictions more accurate.

Third-Operational Role: Modern logistics applications play an undeniable role in international politics. In the arms sector, unmanned pilots are widespread, and in the commercial markets there are self-driving cars, and everything that has previously resonated with the path of global politics and economy, whether morally or in terms of speed of deployment and response to risks.

The report clarifies the agreements signed to ensure an ethical and legal framework for the spread of artificial intelligence and its applications, including the "Toronto" Declaration in May 2018, which calls for ensuring the widespread learning of autonomous technology systems that integrate the human mind and artificial intelligence.

Features of Similarities and Differences

The report indicates the need to differentiate between automated systems and autonomous systems in artificial intelligence. The first will produce the same results every time you enter specific data because it works according to certain operational structures, while the second will produce different results because it works like the human mind with several steps starting from perception through sensors, then knowledge, and information analysis, to take out the appropriate and sound decision.

However, the report indicates that there is a fundamental difference between the human mind and artificial intelligence, which is that the former requires a simple effort to understand what it is around and determines its actions according to its experiences and momentary awareness, which responds to it quickly, even if it is surprising. On the contrary, it is artificial intelligence, which needs to be constantly updated to adapt to the developments in the surrounding environment. The report's authors give an example of this with drones, which are easier to operate than driverless cars that may travel in a crowded environment with a proportion of humans and organisms; Thus, artificial intelligence may not be able to perceive the risks around it, as it is designed to work according to a safe environment that operates with a high degree of accuracy, which contradicts reality in many places. In addition to the above, there are ethics. For example, in the case of self-use weapons, the decision to kill a human being requires human intervention to resolve it. It is not possible to put all possibilities in the hands of robots.

- **Military Effect**

And on the impact of artificial intelligence at the military level, the report indicated that it

depends on the extent to which engineers can design independent systems capable of producing outputs based on knowledge and experience, and that are not controlled by humans even remotely, which is what is currently being worked on in developed countries such as the United States and China. and Europe, but it faces many difficulties due to its high cost, and the difficulty of accessing these highly independent technologies.

As a result of the high cost of developing artificial intelligence, the competition of the military sectors in the areas of development has declined, leaving the field to the commercial sectors that have huge investments in that field. The report cited several examples of this, including unmanned aircraft and self-driving cars. It indicated the beginning of interest in developing self-driving cars in 2004, and the project developed significantly until it was marketed in the commercial markets. On the contrary, military vehicles have not received the same amount of attention because of the inability of the military sector to compete with the commercial sector and develop self-operating programs, while spending on developing the information and communication sector and the self-driving car sector occupies the first place in the priorities of the commercial sector, due to the high competitiveness in the commercial market.

In this context, the report referred to companies such as "Google", "Apple", "Facebook" and "Amazon" that spend huge amounts of money on developing artificial intelligence in the information and communications sector, self-driving cars and drones.

Accordingly, it is difficult to judge the development of the future of wars in the short term due to the weak performance of the military sector in the development of artificial intelligence, in addition to the control of commercial companies, as terrorists can buy self-driving cars or drones before the armed forces can obtain them. The example is developing a network of drones to transport passengers, and there are several companies around the world that are following suit.

- **Strengthening Human Security**

After the end of the Cold War, external threats to human security decreased, and internal threats increased, and according to Microsoft projections, by 2025, about 4.7 billion people will use the Internet, including 75% of those within emerging countries, which will generate more data and information that will be an engine Effective persuasion, development, and coercion at the same time. These will enter new economic markets, facing changes in labor markets, climatic, demographic, and political changes, which will multiply the need to develop artificial intelligence applications to support human security and reduce violence, and the responsibility for achieving it lies with governments, civil society organizations and international organizations. As a result of the lack of coordination between them in the field of information and communications, or the pursuit of funding from different parties, goals, and interest's conflict.

The report identifies three main obstacles that affect human security: the inability to foresee threats early, the inability to develop plans to address these threats, and the lack of an effective response to disempowering real stakeholders.

To meet these challenges, the report indicates a set of steps through which artificial intelligence can protect human security, which are:

First-"knowledge": that is generated from the analysis and crystallization of the data collected. By categorizing this data, it is possible to predict the occurrence of certain social phenomena before they occur, and there are several systems that work in this vein, such as "EMBERS", which uses the data available on Google and various social networking sites and predicts the occurrence of some social phenomena about eight days before, with an accuracy of 94%.

Second-"Planning": It is the next step for data analysis, and it is done through the development of artificial intelligence applications to measure the degree of risks, crises, and emergency response, know the consequences, and then draw the best scenarios to reduce losses, whether material or human, and be more effective in the case of civil society organizations and non-governmental for low rate of bureaucracy and quick decision-making.

Third-"Empowerment": By using artificial intelligence applications, decision makers can make the best decisions, and with the same applications, all human beings are enabled to access all rights and services, to eliminate racism or camaraderie against a particular group of people.

Fourth-"Justice, Transparency and Accountability": By setting rules to protect the data used by artificial intelligence applications, so that it does not fall into the hands of the elite without the rest of the masses and is used to achieve harmful purposes such as political repression and fraud, so that all individuals have the right to know the reason and extent of the use of private data them.[1]

Economic Effects

- ***According to the Authors of the Report, Artificial Intelligence Will Have a Great Impact on Three Economic Aspects***

First- Production: Artificial intelligence applications will play a major role in increasing production and reducing its costs. In 2017, a McKinsey study expected that artificial intelligence would increase the global production rate from 0.8% to 1.4% per year, and in 2016 a report issued by Accenture expected that its use would double the rate of economic growth. For many developed countries by 2035. Most of the profits will come from health care services, financial markets, retail companies and transportation services.

On the other hand, artificial intelligence applications may contribute to reducing GDP; This is due to the availability of free services that replace the paid ones, so spending on those services decreases and thus production decreases, such as Google Translate, which may replace translation offices.

Second-the labor market: Economic studies point to the contribution of artificial intelligence to raising the global unemployment rate, and some economists even demand the need for countries to intervene to redistribute the profits earned by companies from artificial intelligence to unemployed individuals. But there are other economists who believe that

technology reduces jobs, not work, and thus creates new jobs that did not exist before.

According to a study by PWC, By 2030, about 30% of jobs in Britain will be subject to automation, while that proportion ranges from 35% to 38% in the United States of America and Germany, and decreases in Japan to reach about 21%. The fear is that eliminating jobs will be faster than creating new ones, and human emotions remain the dilemma that is difficult to reach through artificial intelligence, which exists in many professions that are subject to automation, such as law and medicine.

Third-International Trade and Development: Artificial intelligence will leave a large gap between developed and developing countries, as the first has highly skilled labor and high wages, and has made strides in development, so the effects of artificial intelligence will be to generate pressures on employment and the state, while the second is severely affected by intelligence. It has low-skilled labor, and perhaps its opportunity is to contract companies with foreign investors who pledge to allocate ratios for training labor, improving state productivity, and transferring technology, and the competition race will be based primarily between China and America.

In terms of international trade,the development of artificial intelligence will contribute to reducing the cost of production within developed countries, and thus less reliance on manufacturing in developing countries, and the need for expatriate labor will decrease, and the remittances of workers abroad to their countries will decrease, and the national product of countries will decrease.

- ***The Report Concludes with a Set of Recommendations for Governments and Decision Makers That Can Be Summarized in the Following***

1. Working on developing education and infrastructure so that countries can catch up with advanced artificial intelligence, so that technological dominance does not remain in the hands of a small group of countries.
2. Governments, companies, and international organizations allocate funding sources for artificial intelligence in the humanitarian fields to mitigate risks for poor nations.
3. Not limiting technological knowledge to technological experts and working to circulate it to ensure benefit from it.
4. Supporting the links of relations between the governmental and commercial sectors, to ensure a technological balance between the two sides and to benefit from each other's successes.
5. Setting regulating frameworks for the use of artificial intelligence and ensuring the achievement of the principle of inclusion for its use.
6. Regulating the relationship between artificial intelligence and the human element to avoid any future clash.
7. In conclusion, it can be said that artificial intelligence is a double-edged sword, and the international community must be careful and prepare appropriately for the effects that will inflict on global societies and economies from it. It is necessary to maintain the link between him and the human being.

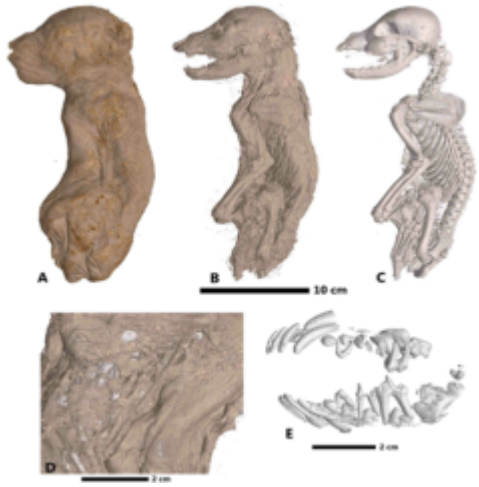
More accurate images of Egyptian animal mummies using artificial intelligence

It helps archaeologists to segment images of mummified animal remains automatically. It provides more accurate information on the origins of historical and archaeological mummies in a short time.

For at least a decade, archaeologists have been applying new techniques to better understand our past, and synchrotron-radiation microscopy has been the gold standard for getting to the interior of archaeological remains without destroying them.

Synchrotron radiation microscopy is a very successful technique in the examination of fossils, because fossils vary widely in preserving their size, shape and density, and it is characterized as a non-destructive scanning technique, and it allows researchers to visualize the exact structure of bones in 3D, in addition to examining the amount of bone tissue In each sample, it is based on scanning fossils using synchrotron radiation, which is electromagnetic radiation that arises when charged particles are accelerated (or accelerated) to speeds close to the speed of light, and are under the influence of a strong magnetic field.

More accurate images of Egyptian animal mummies using artificial intelligence



Source: Data designed by the researcher

Figure 1: Egyptian animal mummies using artificial intelligence

Figure 2: Egyptian animal mummies using artificial intelligence

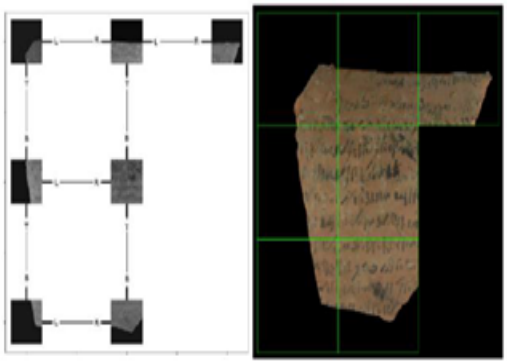


Figure 3: Egyptian animal mummies using artificial intelligence

Examples of ostraka with the scale bar below.

An example of global reconstruction with its graph: each edge keeps track of the spatial arrangement of the fragments with concerning the others.

But this process is long and complex and requires weeks of great human effort, especially for biological samples such as animal mummies that require manual division of the images taken.

Hence the importance of the role played by artificial intelligence in significantly reducing that effort and reducing the expected time to complete the processes of dividing and fragmenting images to a few hours depending on the size and complexity of the image, according to a study published in the journal PLOS ONE and conducted by a French research team- common maltese; With the aim of developing a mechanism for segmenting images of fossils using machine learning.

Johan Priva, associate professor in the Department of Communication, Computer and Engineering at the University of Malta, and the study's principal investigator, told Al-Alam: The software we developed is freely available for use, and relies on machine learning to model materials that are manually divided. This model is used to segment and segment the entire image, for example, the European Synchrotron Radiation Facility currently generates massive amounts of human organ data of up to 2 terabytes (a unit of measurement for computer storage capacity) for a single scan, and only AI methods can segment this data and segmentation. In computer language, image segmentation is an important step in providing inputs to understanding the image, by dividing the image into meaningful regions.

Archaeological Studies of Mummified Animal Remain

Priva adds: During the study, this technique was applied to archaeological studies of mummified animal remains dating back to the Ptolemaic and Roman periods in ancient Egypt (around the third century BC to the fourth century AD), which makes it easier for archaeologists to work on examining these images.

And “Priva” explained that the samples obtained by the researchers from the holdings of the “Museum of Natural History” in Grenoble, France, and the “Museum of Grenoble” in France, adding: Like many other animal mummies preserved in museums, we know very little about

the origins of these historical and archaeological mummies. minute.

He continues: We performed virtual autopsies, which helped us obtain information about the life and death of animals in past civilizations, and the technique used to examine a group of four samples from ancient Egyptian animal mummies achieved an overall accuracy of between 94 to 98% when compared to the slides that were examined. Divide them manually, and the accuracy increased to between 97 to 99% when using deep learning (a form of artificial intelligence, derived from machine learning), which confirms the importance of using AI techniques to obtain accurate results.

But the study revealed-on the other hand-that this new technology has some flaws; It is only suitable for dividing and segmenting elements with high contrast or well-defined edges, for example, this method did not distinguish between soft tissues, bones, and teeth inside the mummy after the process of accurate data imaging and reconstruction, which requires further study, according to "Priva".

Artificial Intelligence Decodes the Mysteries of Ancient Peoples

Artificial intelligence technology helps archaeologists decipher the symbols and writings of the languages of ancient peoples that were difficult to decipher.

The use of AI technology is no longer limited to dealing with many problems and areas of the modern world, but AI algorithms will also play a prominent role in deciphering and ambiguously deciphering the lives of ancient civilizations and peoples that inhabited the earth thousands of years ago.

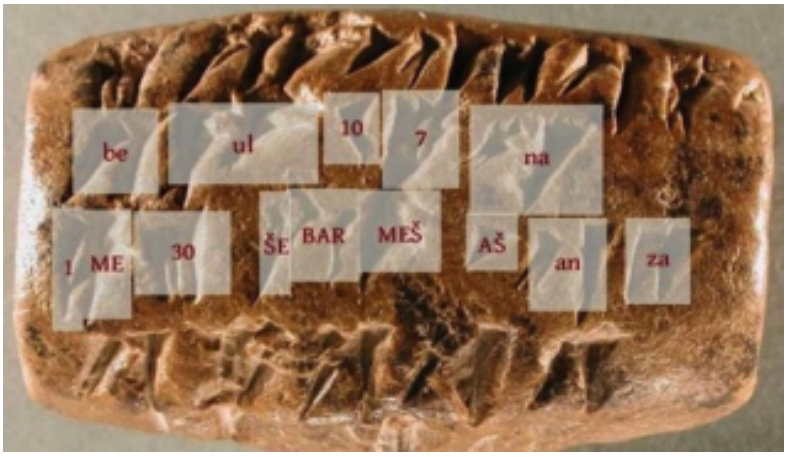
According to digitaltrends.com, a research team made up of scientists specialized in computer science and AI technology at the University of Chicago, America, has created highly advanced algorithms that support AI technology to help archaeologists decipher archaeological fossils and clay tablets dating back 2,500 years belonging to the Achaemenid Empire. in Persia.

The US Army is hiring game developers to produce warplanes

130 million home service robots sold in two years

Sanjay Krishnan, head of the research team and assistant professor in the Department of Computer Science, explained that the team from the Chicago group has built an artificial intelligence AI neural network capable of reading and analyzing codes. This will make the task of archaeologists easier for the first time to analyze and decipher the ancient clay tablets that were discovered in Iran in 1933.

Artificial Intelligence Technology in Deciphering the Symbols and Writings of the Languages of Ancient Peoples



Source: Data designed by the researcher

Figure 4: Artificial Intelligence Technology in Deciphering the Symbols and Writings of the Languages of Ancient Peoples

For her part, Susan Paulos, assistant professor specializing in Assyriology for the study of the history of the civilization of Mesopotamia, Persia and the cuneiform language, including the writings and languages emanating from it, such as Sumerian, Akkadian and Byte, confirmed that the new technology is capable of translating signs and symbols of the cuneiform language with an accuracy of 80% with the possibility of increasing the percentage of The efficiency of the accuracy of the technology in the near future, which will make archaeologists focus their efforts more on focusing on difficult tasks, leaving the secondary matters to artificial intelligence technology.

Artificial intelligence technology in deciphering the symbols and writings of the languages of ancient peoples

Source: Data designed by the researcher

Figure 5: Artificial intelligence technology in deciphering the symbols and writings of the languages of ancient peoples

"Paulos" explained that what makes the ancient cuneiform clay tablets difficult to translate is the complex system that they are characterized by because they are written on wet clay and contain hundreds of signs and symbols with close meanings. Knit and often worn out.

Artificial intelligence technology in deciphering the ancient peoples' languages and writings

Source: Data designed by the researcher

Figure 6: Artificial Intelligence Technology in Deciphering the Symbols and Writings of the Languages of Ancient Peoples

The role of artificial intelligence in archeology and unraveling the mysteries of ancient civilizations

The use of artificial intelligence has entered all areas of life around us. The use of this technology is no longer limited to dealing with many problems and areas of the modern world only, but that artificial intelligence will play a prominent role in decoding the mysteries and ambiguities of the lives of ancient civilizations and peoples, which inhabited the earth thousands of years ago. the years. Deciphering Greek inscriptions In 2019, researchers from the University of Oxford, British, were able to adapt deep learning techniques to decipher ancient languages, by developing an artificial intelligence system that can guess the missing letters from Greek inscriptions. According to the "New Scientist" website, which specializes in the field of science: "During the tests conducted to decode 2,949 damaged historical inscriptions, experts were able to reach 30% of the unclear symbols, and the electronic system was able to decode 50 inscriptions in just two hours."

The role of artificial intelligence in archeology and unraveling the mysteries of ancient civilizations

Source: Data designed by the researcher

Figure 7: The role of artificial intelligence in archeology and unraveling the mysteries of ancient civilizations

Deciphering the Achaemenid Empire A research team consisting of specialized scientists, in the field of computer science and artificial intelligence technology belonging to the American University of Chicago, succeeded in devising highly advanced algorithms that support artificial intelligence technology AI, in order to help archaeologists decipher archaeological fossils and clay tablets, dating back to To 2,500 years belonging to the Achaemenid Empire in Persia, according to the "Digital Trend" website.

Deciphering the Ancient Babylonian Tablets

Archaeologists have used artificial intelligence technology to help decipher the ancient Babylonian tablets and the secrets within them, as historians from two Israeli universities have relied on artificial intelligence technology to recover the decoded words written in the Akkadian language. The Akkadian language is an extinct language that was spoken in the ancient Mesopotamian empires of Babylon and Assyria, from about 2500 BC until about 600 BC. It is the oldest known Semitic language and predates Aramaic, Hebrew, and Arabic. Archaeologists from Ariel University-Department of Israeli Heritage and Bar-Ilan University are studying the language on clay tablets engraved with cuneiform script, but the clay tablets are incomplete because ancient artifacts are fragile, and they often break while finding them.

That is why researchers are going through the process of digitizing the tablets, using a tool called the “Babylonian Engine”, where digital texts are analyzed and studied by machine learning algorithms, to reveal the secrets of the ancient Persian Empire in the sixth and fourth centuries B.C. To create an artificial intelligence capable of recovering damaged texts, by knowing the appropriate words and using them in the missing sections.

The applications of artificial intelligence have spread to almost every scientific field, including archaeology.

Most of us grew up watching archeology-themed movies like The Mummy or Indiana Jones. While today's digital technologies such as artificial intelligence cannot break a whip like Harrison Ford at Indiana Jones, they certainly bring significant impetus to the technological side of this science.

For example, deep learning is already solving problems in computer vision and has practical applications in many areas. Today, it also helps analyze airborne data to detect archaeological artifacts.

Archaic, a startup, is de-risking the construction industry by using artificial intelligence to automatically detect archaeology on Earth observation data. Archaic, founded by Iris Kramer, an archaeologist turned computer scientist, aims to lower the cost of construction, and ensure the preservation of vital historical sites. It achieves this by using deep learning to discover where archeology is located during the early planning stages. This allows accurate estimates of the time and cost involved in obtaining planning permission and greatly reduces the risk of unexpected archaeology being discovered during construction.

Archaeologists, Gabriele Gattiglia and Francesca Anicini, of the University of Pisa in Italy,

have developed the ArchAIDE project, a digital tool that allows archaeologists to image and identify a piece of pottery in the field through convolutional neural networks.

Even by taking advantage of computer vision algorithms, archaeologists analyze satellite images and data from drones. It also helps in automating the process of detecting potential archaeological sites in them. Last year, a team of researchers from Binghamton University developed an automated algorithm to identify the large earthen and scalloped mounds built by the indigenous peoples of Southeast America.

Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Source: Data designed by the researcher

Figure 8: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

According to the published research paper, many existing, but unknown, archaeological mound features still avoid detection due to the dense forest canopies that occupy large areas of the area, making pedestrian surveys difficult and preventing aerial observation. This challenge inspired the team to use Object-Based Image Analysis (OBIA) to analyze light, radar, and LiDAR data (3D laser scanning technology). Using publicly available lidar data from Beaufort County, South Carolina, and an OBIA approach that incorporates morphometric classification and statistical template matching, the team can identify more than 160 previously undiscovered features.[2]

Aside from finding ruins during the excavation process, linguistic anthropologists also use artificial intelligence to track the evolution of different languages. For example, Google's DeepMind used a deep neural network called PYTHIA to recreate inscriptions lost in ancient Greek from damaged surfaces of objects made of stone or ceramic.

Last year, two Israeli universities, Ariel University, the Department of Israeli Heritage and Bar Ilan University, used artificial intelligence to retrieve broken words written in the Akkadian language. The Akkadian language is considered an extinct language that was spoken in the ancient Mesopotamian empires of Babylon and Assyria about 2,500 years before the birth of Christ, until about 600 BC. It is the oldest known Semitic language and

predates Aramaic, Hebrew, and Arabic. The team of researchers from these two universities digitized the clay tablets inscribed with cuneiform (a writing system made of wedge-shaped impressions), using a tool called the Babylonian engine. Then the digital texts were analyzed and studied by machine learning algorithms to reveal the secrets of the ancient Persian Empire-VI-IV centuries BC. This method helped in recovering damaged texts by knowing the right words to use in the missing sections.

Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

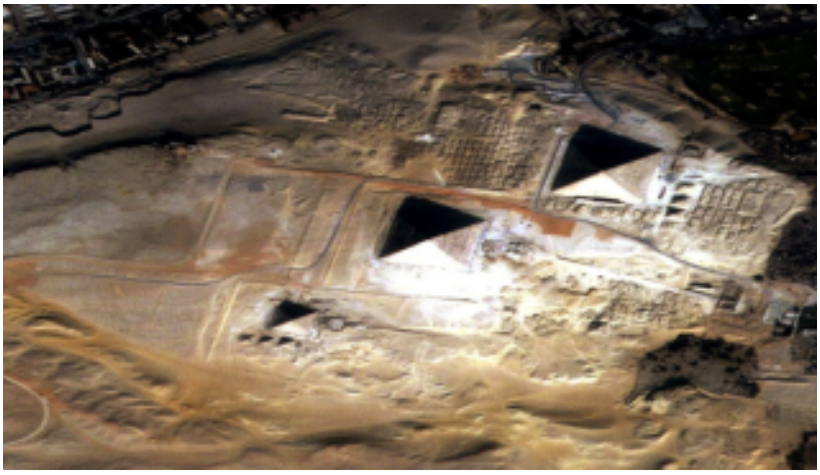
Source: Data designed by the researcher

Figure 9: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

AI technologies are also helping archaeologists and paleontologists discover and study the behavior of early humans. A study team from the Centro Nacional de Investigación Sobre la Evolución Humana (CENIEH) used artificial intelligence at the Navalmaíllo Rock Shelter site in Madrid, which shows the activity of Neanderthal groups in breaking the bones of medium-sized animals for later consumption of marrow.. The Navalmaíllo Rock Shelter, which is about 76,000 years old, provides one of the few great windows into Neanderthal behavior within the Iberian Meseta.

Artificial intelligence has also proven to be a vital tool in mapping ancient civilizations. Machine learning algorithms have enabled researchers at Institut Català d'Arqueologia Classica (ICAC) to reconstruct more than 20,000 kilometers of ancient rivers along the Indus Valley Civilization.

Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations



Source: Data designed by the researcher

Figure 10: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Also, although in traditional research settings, information retrieved from many archaeological sites may not be sufficient to reach an objective conclusion. Hence, researchers take advantage of machine learning to determine the accuracy and relevance of their archaeological finds. For example, a team of Mexican archaeologists and the University of Marburg are taking advantage of machine learning models to determine whether the source materials required to make the obsidian artifacts, discovered in Jalasco, came from local sources, or obtained from other remote areas.

While AI helps extract ancient information about ancient ruins and human civilization, it is not a panacea! It will not replace humans because it lacks the subjective expertise of a human archaeologist. So, while it helps address many of the challenges faced by human experts, it is a far cry from Indiana Jones yet!

Artificial intelligence is dramatically changing archeology, discovering new sites and artifacts.

Artificial intelligence is being used to help archaeologists find new excavation sites and new discoveries, significantly increasing the pace of archaeological research. As reported by Singularity Hub, artificial intelligence and computer vision algorithms are used to analyze satellite image data and automate the process of discovering potential archaeological sites in them.

Thanks to the proliferation of aerial image data collected by satellites, aircraft, and drones, archaeologists can examine areas of the Earth for potential archaeological sites without visiting the area themselves. However, manually analyzing thousands of landscape photos can be a tedious and time-consuming task. Artificial intelligence algorithms can automate this process, making it faster and more efficient.

As Dylan Davis, a doctoral candidate in Penn State University's Department of Anthropology, explained to SingularityHub, archaeology has greatly expanded its use of artificial intelligence over the past few years. The use of artificial intelligence by archaeologists has led to some exciting new discoveries in recent years. This includes the discovery of the historical settlements in Madagascar and the earthen mounds established by prehistoric North Americans. Davis himself developed predictive algorithms that were able to locate these locations.[3]

AI systems use a variety of techniques to distinguish structures and objects of interest to archaeologists. The AI algorithm designed by Davis used LiDAR technology to generate pulses of light that are interpreted by AI to create maps of geographical areas. The LiDAR pulses mapped the forest floor containing information regarding the floor texture, size, shape, and slope. The AI has been trained on this data to enable it to identify potential sites of interest. According to Davies, automation saved himself and his colleagues several years of work. As Davis explained, the AI model was able to help his research team find archaeological sites in Madagascar. Over the course of a year, AI was able to identify more than 70 confirmed sites across an area of more than 1,000 square kilometers.

Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Source: Data designed by the researcher

Figure 11: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Archaeologists are constantly looking for new ways to speed up the identification of archaeological sites. Many potential archaeological finds are being destroyed by sea level rise and other effects of climate change, deforestation, construction, or other human activities. The traditional methods archaeologists use to find potential sites can take months or years. This is one of the main reasons why machine learning is useful for archaeological research, according to Davies.

Artificial intelligence models developed to enhance archaeological research have applications beyond learning more about the culture and history of ancient civilizations. Studying the

technologies used by historical civilizations can help modern governments deal with long-term challenges such as managing water resources. For example, researchers from the Instituto Català d'Arqueologia Classica (ICAC) used an artificial intelligence model to reconstruct the features of thousands of miles of ancient rivers across modern-day India and Pakistan. The set of data provided by the model can help governments discover smart ways to use water resources.

In addition to the previously mentioned use cases, AI can enhance the search for archaeologists in several different ways. Artificial intelligence techniques are being used to help researchers determine the chemical composition of ceramics, pottery, and other artefacts. By analyzing the chemical components of the artifact, researchers can get better ideas about the source of the materials used to make the artifact. Linguistic anthropologists have recently used machine learning techniques to model how different languages appeared in different parts of the world, and last year inscriptions on damaged Greek artifacts were recreated with the help of a deep neural network developed by Google DeepMind. In the past year, more than 65 artifacts have been published that have benefited from machine learning in some way, and this number is likely to continue to grow in the future. [4]

Artificial Intelligence in Digital Archeology

Talking about "artificial intelligence" in archeology might be a little too close. We have machine learning in the service of archaeology (neural networks for taxonomic purposes, for example), and there is a well-established working body in terms of simulation that could fall under the heading of “artificial intelligence.”

Then why use the term? We think it is still useful to use the term because it reminds us that by using the computational power of simulation or image classification, we dump some of our experiences and abilities into a non-human actor. In the case of machine learning and neural networks, we can't see what's inside the "black box". But we can examine the training data, because in the selection of the training data we introduce biases or agendas into the computation. By thinking of the machine in this case as something non-human, we hope to remind you not to blindly accept the results or methods of AI in archaeology, as if the machine were not capable of racist or colonial outcomes.

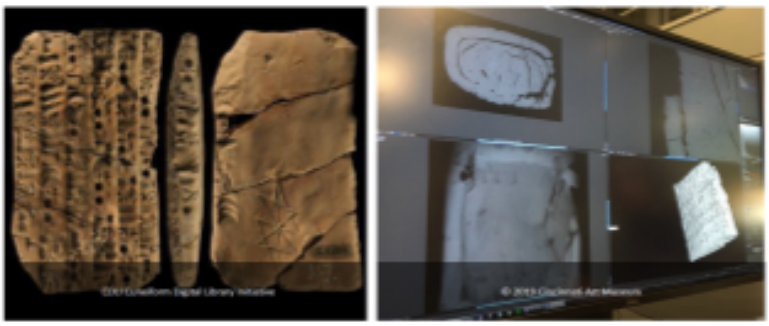


Figure 12: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Machine learning: A series of techniques that seek to train a computer program to identify and classify data according to some predetermined value. In this chapter, we will discuss image recognition using a Google-trained neural network model, the Inception3 model, which we will query using the TensorFlow package.

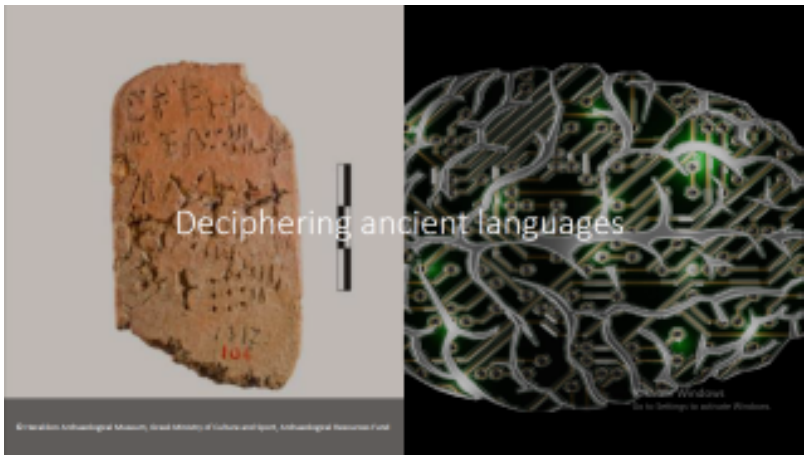


Figure 13: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Agent-based simulation: A series of technologies that create a set of programmed software "agents" according to contextual rules (eg, if that happens, then do so) that govern the behavior of individual agents. The context can be in terms of the simulated environment (GIS data, for example) or the social environment (social relations as a network). Simulation experiments are repeated over multiple sets of parameter values, the 'behavior space'. The investigator then uses the simulation results to explain a "real world" phenomenon as an emergency of a group of agents following a set of rules under certain situations.

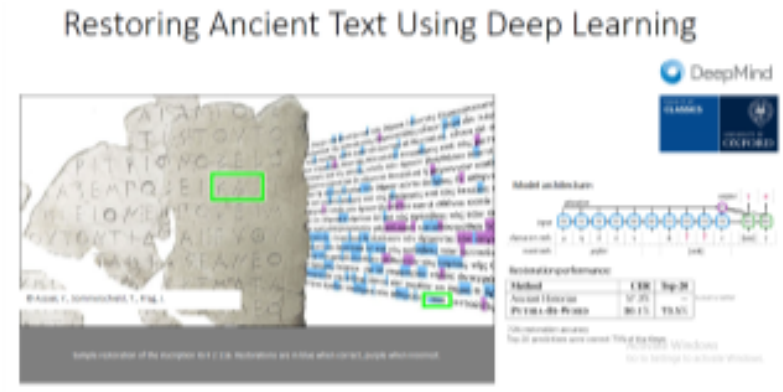


Figure 14: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

The value of machine learning makes us think carefully about what we are looking for in the first place; Hence it can be scaled widely.

The value of agent-based modeling: it forces us to think so hard about what we believe happened in the past so that it can be expressed as a series of contextual rules of behavior, operating under certain conditions.

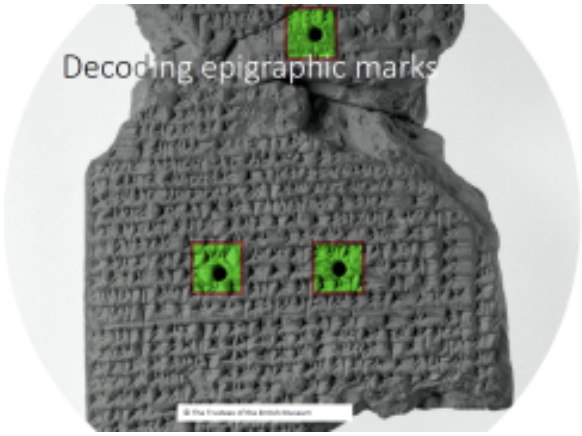


Figure 15: Archeology and unraveling the mysteries of ancient civilizations

Agent Based Modeling (ABM)

This section is an overview of agent-based modeling (ABM), as it is used in archaeology, anthropology, and the behavioral sciences. Before addressing "agent-based", we begin with a brief introduction to what "modeling" means. To put ABM in a bigger picture, we present the reader with multiple dimensions of simulation model diversity. We describe the necessary and optional parts for ABM models, including the distinct element type, i.e. the agent. At this point, the student should be aware that simulations in our context involve computer code (they are numerical) and repetitive operations (they are dynamic). [5]

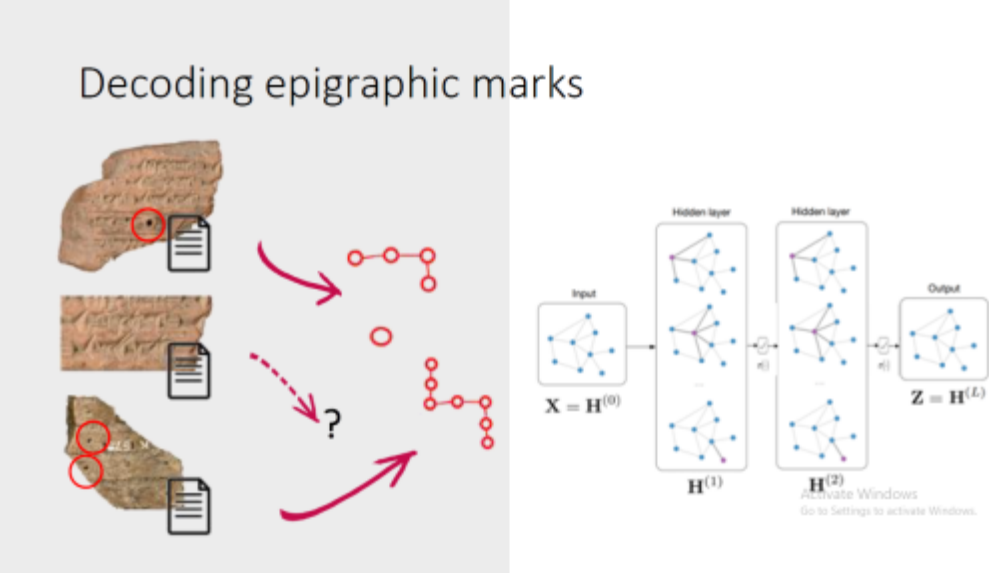


Figure 16: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

After defining ABM, we describe the process of creating a model or formalizing an informal model. This process can be divided into seven stages: definition, design, implementation, verification, verification, understanding and documentation. In explaining all modeling tasks, we aim to keep the instructions general enough to be valid for most curriculum, theoretical backgrounds, platforms, or programming languages. Finally, we present a set of exercises to introduce the practical aspects involved in creating and using ABM models.

Figure 17: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

During this section, many concepts will likely seem strange to most students of history and archeology; And some may remain vague long after this lesson has been completed. In addition to any practical application, ABM has strong roots in mathematics and logic. Don't panic! Most ABM modelers do not go through formal introductions and are well versed in algebra and calculus. As in most digital curriculum in the humanities and social sciences, ABM is mostly carried out by self-taught scientific experts with mixed and curvy academic profiles. Also, because ABM modelers in archaeology are often not computer scientists, the community lacks agreements on how to communicate models and simulation results, although there are proposals (eg, ODD document, see Grimm et al. 2006; Grimm et al. 2010; Muller). et al. 2013). Disclaimer: The modeling strategy described here places great emphasis on theory building (general, exploratory), not hypothesis testing and prediction (specific, data driven). In this sense, the content of this section should not be considered the norm among the ABM archaeological community. [6]

Figure 18: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

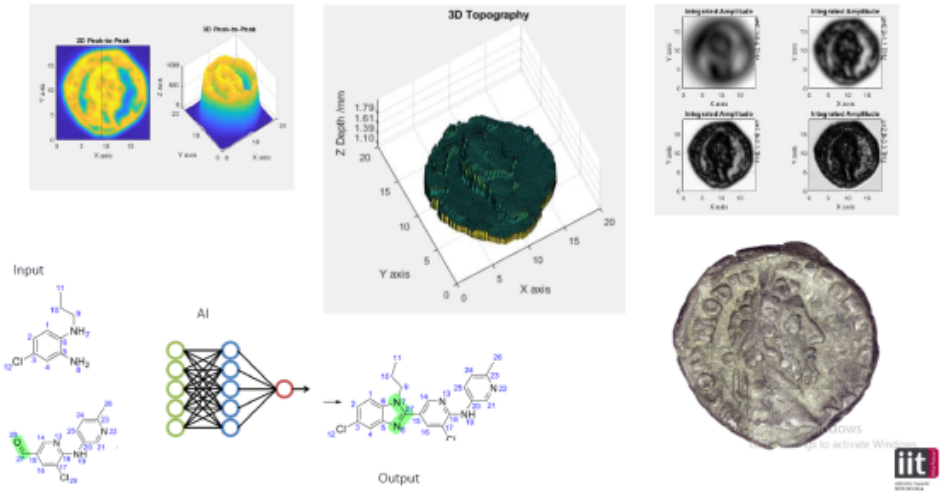


Figure 19: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

So far, there is no easy way to start an ABM business. We encourage students to get involved in modeling the faster, the better, by following our exercises, and other tutorials, or trying to develop their interests, research questions, and creative fears. A full understanding of ABM will require years of practice and interdisciplinary reading; Definitely, greater mastery in programming.

Although ABM is scarce in mainstream history and archeology approaches, there are many publications that provide introductions to ABM in archaeology, written by authors from different backgrounds and perspectives (eg, Breitenecker, Bicher, and Wurzer 2015; Cegielski and Rogers 2016 Romanowska 2015); Also visit The ABM in Archeology Bibliography, for an extensive and frequently updated bibliography. As a source of examples and past experiences, the student can find a variety of articles related to Archeology/ABM in academic journals such as Journal of Archaeological Method and Theory, Ecological Modeling, Journal of Artificial Societies and Social Simulation (OPEN), Proceedings of the National Academy of Sciences (OPEN), Journal of Archaeological Sciences, Journal of Anthropological Archeology, Structure and Dynamics, Human Biology. [7]

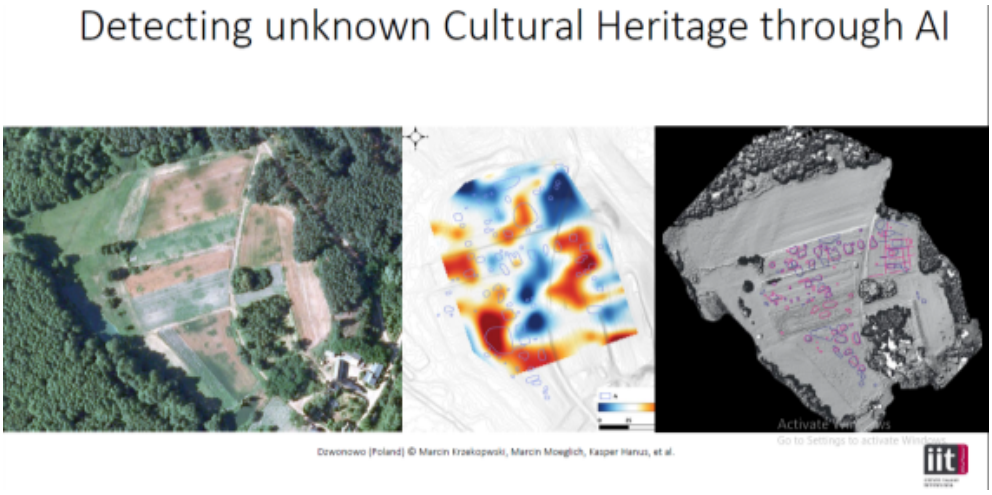


Figure 20: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Algorithms of artificial intelligence for the identification of archeological sites

Over the millennia man has always changed the soil: to build houses or to harness the waters the ground has been continuously excavated to create trenches, pits, canals, or simple holes which have affected the surface of the soil altering its shape. But since the most remote antiquity man has dug the ground also to look for the materials necessary for its subsistence: the clay to produce the vases, the minerals to extract the metal necessary for the tools and the stones to build buildings.[8]

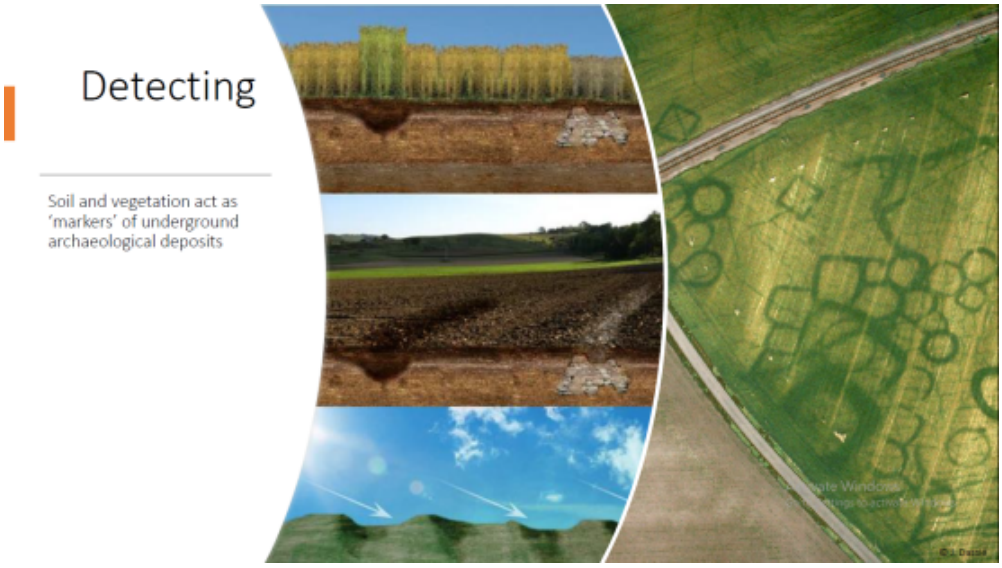


Figure 21: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

Subsequently, the interest of seeking in the ground also extended to what man himself had placed there: the earth has been enriched with "treasures" that have become part of our collective imagination. The very concept of "treasure" has gradually changed over time, also based on the different value that the various civilizations have attributed from time to time to certain objects. For example, in Eastern civilizations the rediscovery of ancient palaces and dynastic sanctuaries served to consolidate and increase the importance of the genealogical tree from which the sovereign descended, in Greece the rediscovery of the tombs and weapons of heroes was a symbol of worship and re-enactment of the past. During the Middle Ages, churches were embellished with ancient artefacts recovered and purified with prayers specially dedicated "to the vases discovered in ancient places". The land, however, was not yet seen as a potential custodian of a historical tale. [9]

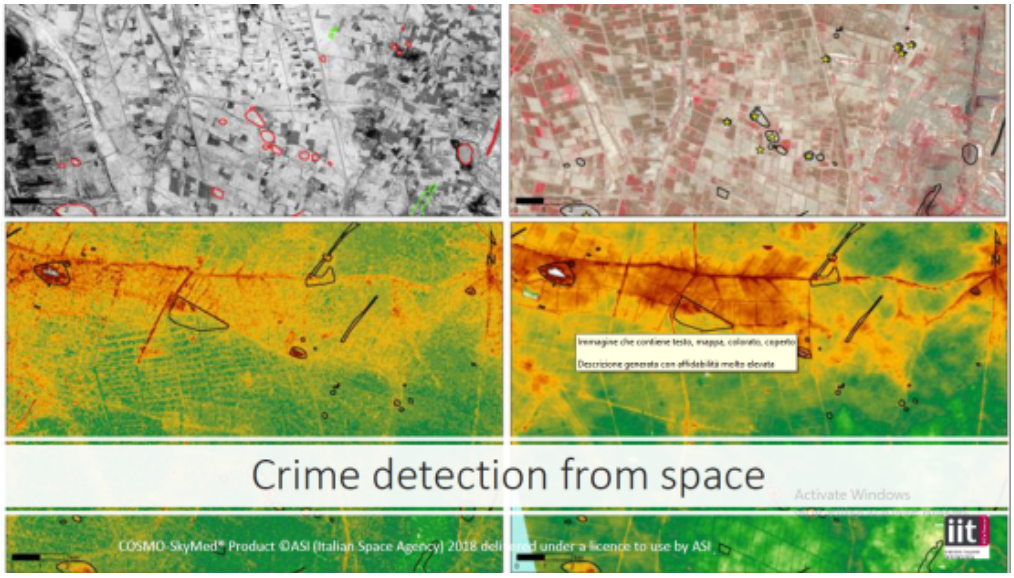


Figure 22: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

If the search for precious objects has therefore been a habit long cultivated by man, archeological excavation can be considered one of the most recent forms of this trend. The rise of the archeological excavation, as we understand it today, occurs in the nineteenth century with archaeology intended as historical science. The first archeologist to exhibit his practical method of excavation was Boni in a famous essay of 1901. The method was applied for the first time in the excavations of the Roman Forum and consisted in the execution of stratigraphic surveys aimed at recognizing the stratifications and in the removal of the individual layers "according to their natural deposit". The historical interpretations that Boni said of his excavations show that, at the turn of the twentieth century, the fundamental concepts of the stratigraphic investigation of the terrain were now acquired and could also be applied in the practice of monumental excavation.

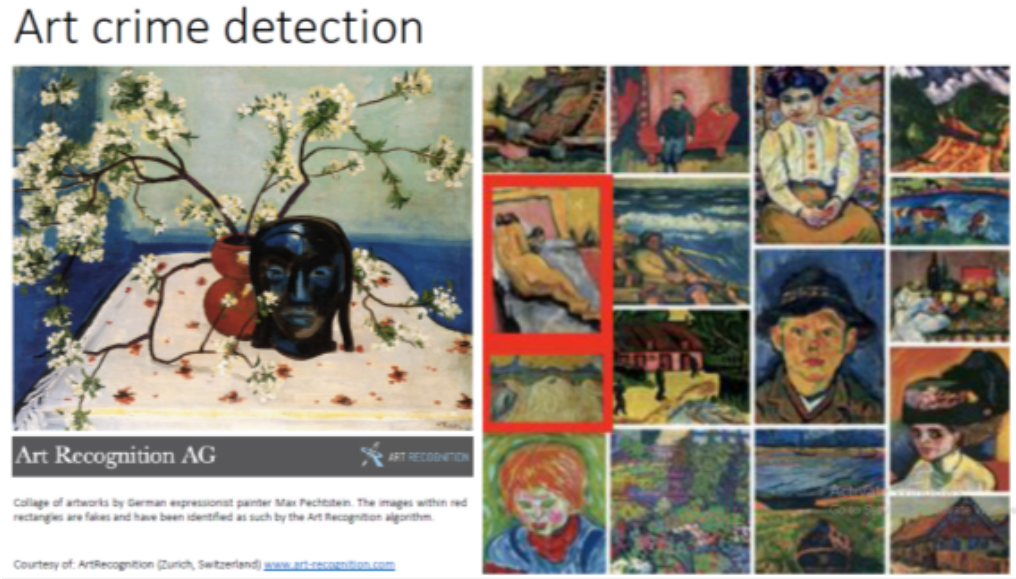


Figure 23: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

In addition to all the traditional methods of detecting archeological and excavation sites, some based on artificial intelligence have recently been developed relating to archeological sites not only terrestrial, but also marine. The following will analyze the artificial intelligence techniques used in the search for archaeological sites in Brandenburg, the "princely" tombs in the Eurasian steppe, the urban area of the ancient city of Falerii Novi, the monumental site of Kuelap in Peru and the exploration of marine archaeological sites.

Identification of terrestrial archeological sites

Archaeological predictive modelling (APM) deals with developing methods suitable for the identification of potential archaeological sites in geographic space, using regression and classification techniques, spatial statistics, and heuristic approaches.

system (GIS) is a fundamental part of the APM because it provides tools for the storage and analysis of spatial variables as well as the interface between geo-archaeological information and advanced numerical processing at the base of all archaeological predictive models. For this type of operation, it is assumed that the settlements have environmental characteristics: characteristics of the conformation of the soil (height, slope and aspect angle), the distance from surface waters, the level of groundwater, the structure and the quality of the soil.[10]

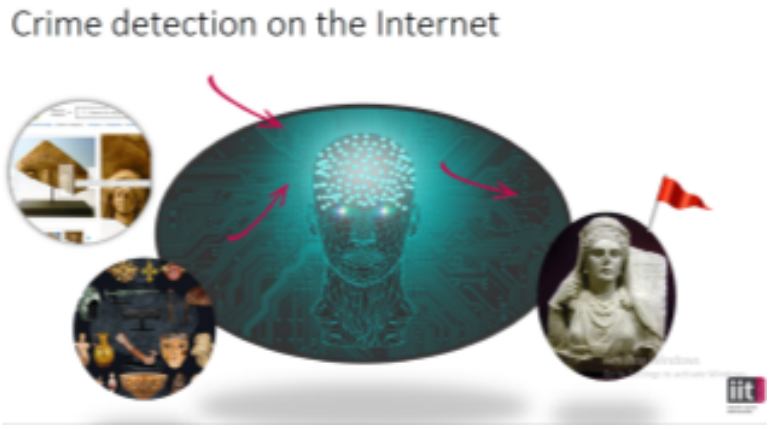


Figure 24: Artificial intelligence technology in archeology and unraveling the mysteries of ancient civilizations

The artificial intelligence technique used for this purpose is the Artificial Neural Networks (ANNs). The artificial intelligence technique used for this purpose is the Artificial Neural Networks (ANNs). ANNs are a computational model consisting of artificial "neurons" and are inspired by a biological neural network; they are often used for classification problems. In the context of APM, ANNs are widely used, thanks to their robustness and their training and testing method, because they effectively manage the most serious problems that usually afflict archaeological data: missing or incomplete data, noisy data (for example in this case data that do not refer mainly to environmental factors, but to political, religious or social reasons that led to the settlement in that place) and finally to the non-linear relationships between the data. The most used ANNs variants are:

1. Multilayer Perceptron Network (MLP) is one of the basic architectures of the ANNs. It consists of multiple layers of nodes (an input layer, 1 or more hidden layers and an output

layer), in which each layer is completely connected to the next. This network provides a supervised learning technique called backpropagation: during the training, the values of the connections are updated until the optimal value is found. In the case of APM, the input consists of a vector containing the environmental characteristics described above, while the output will consist of two nodes: “site present” and “no site present”.

2. Probabilistic Neural Network (PNN) [11] is a special architecture of ANNs with a kernel density estimation, a statistical method that uses functions to approximate the behavior of a sampling distribution [12]; for this reason the network can estimate the true probability function according to the input data. In a PNN, the operations are organized in a multilayer feedforward network with four levels: an input layer, a model layer, a summation layer and finally an output layer. In this case the only probability that there is a site can be output.

3. Convolutional Neural Network (CNN) [13] (Figure 24) is a family of neural networks widely used in the field of computer vision and, more generally, with data that have spatial relationships. It is a feedforward ANN in which the way neurons are connected is very reminiscent of the organization of the animal visual cortex. The structure of a CNN is organized in layers of three different types: the convolutional layer, the pooling layer and finally the fully connected one. They accept input data like a grid or that can be treated as such, for example images.

References

[1]Barceló, J. A. (2010). Visual analysis in archaeology. An artificial intelligence approach. In Morphometrics for Nonmorphometricians (pp. 93-156). Springer, Berlin, Heidelberg.

[2]Barceló, J. A. (2010). Visual analysis in archaeology. An artificial intelligence approach. In Morphometrics for Nonmorphometricians (pp. 93-156). Springer, Berlin, Heidelberg.

[3]Barceló, J. A. (2010). Visual analysis in archaeology. An artificial intelligence approach. In Morphometrics for Nonmorphometricians (pp. 93-156). Springer, Berlin, Heidelberg.

[4]Barceló, J. A. (2010). Visual analysis in archaeology. An artificial intelligence approach. In Morphometrics for Nonmorphometricians (pp. 93-156). Springer, Berlin, Heidelberg.

[5]Barceló, J. A. (2010). Visual analysis in archaeology. An artificial intelligence approach. In Morphometrics for Nonmorphometricians (pp. 93-156). Springer, Berlin, Heidelberg.

[6]Lazar, A. (2002). Heuristic knowledge discovery for archaeological data using genetic algorithms and rough sets. In Heuristic and optimization for knowledge discovery (pp. 263-278). IGI Global.

[7]M. L. Cummings, Heather M. Roff, Kenneth Cukier, Jacob Parakilas and Hannah Bryce, “Artificial intelligence and international affairs: disruption anticipated”, Chatham House report, June 2018.

[8]Mantovan, L., & Nanni, L. (2020). The computerization of archaeology: survey on artificial intelligence techniques. SN Computer Science, 1(5), 1-32.

[9]Martín-Perea, D. M., Courtenay, L. A., Domingo, M. S., & Morales, J. (2020). Application

of artificially intelligent systems for the identification of discrete fossiliferous levels. PeerJ, 8, e8767.

[10]Martín-Perea, D. M., Courtenay, L. A., Domingo, M. S., & Morales, J. (2020). Application of artificially intelligent systems for the identification of discrete fossiliferous levels. PeerJ, 8, e8767.

[11]Puyol-Gruart, J. (1999). Computer science, artificial intelligence and archaeology. BAR International Series, 757, 19-28.

[12]Rathnayake, P. (2013). Using Artificial Intelligent Applications in Archaeology.

[13]Richards, J., Tudhope, D., & Vlachidis, A. (2015). Text mining in archaeology: Extracting information from archaeological reports. Mathematics and archaeology, 240-254.