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Artificial Intelligence and its Field of Application in the Study of History an Archaeology

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Abstract

Artificial intelligence is a highly topical subject today, particularly because its use helps save time and effort. It can be applied in the fields of history and archaeology through the creation of historical databases and their analysis using artificial intelligence algorithms. In addition, it enables the development of simulation models for historical events. Virtual and augmented reality can also be used to revive heritage and ancient civilizations, and these technologies have been utilized in education and teaching.

Keywords: Simulation; Algorithms; Artificial Intelligence; Archaeology; History.

1. Introduction:

The ambition of artificial intelligence is not a coincidence; rather, it is the result of accumulated knowledge preceded by continuous improvements and developments. Artificial intelligence is defined as the ability to design intelligent machines that exhibit human-like intelligent behavior. In recent years, the field of artificial intelligence has witnessed tremendous advancements that have expanded its applications to include many domains, including the humanities and social sciences.

From this, we raise the following problem:

“How can we protect archaeological civilizations and heritage using artificial intelligence?”

Archaeological sites and human heritage have, throughout history, been a living witness to the development of humanity. They reflect the values, practices, and traditions upon which our societies have been built. However, today these civilizations face major challenges such as environmental changes, natural deterioration, wars, and sometimes neglect.

In the modern era, technologies especially artificial intelligence have emerged as powerful tools that can be used to protect heritage. Artificial intelligence is a crucial component of modern information technology and has proven its impact on modern archaeology. Archaeologists have been attracted to it due to its limitless potential. Unlike many other aspects of archaeology that involve specialized procedures, the importance of artificial intelligence lies in its integration into multiple areas, from discovering archaeological sites, restoring and examining mummies, and disseminating knowledge about archaeology and history, to the creation of virtual museums and archaeological sites.

The concept of artificial intelligence has evolved alongside industrial development since the 1950s, aiming toward the emergence of intelligent systems. One of the most notable contributions is the book *The Sciences of the Artificial* by Herbert Simon, one of the pioneers of the AI revolution.

Artificial intelligence can be a powerful ally in this field through several key applications, such as:

- Analyzing texts and extracting information from manuscripts and historical documents.
- Machine translation of ancient languages and historical texts using deep learning (Appendix 3).
- Intelligent search in large databases and archives.
- Classification and analysis of artifacts and excavations using computer vision (Appendix 4).
- Modeling human societal behaviors and decision-making processes.

Thus, artificial intelligence contributes to accelerating research and discovering new knowledge in the humanities and social sciences by employing modern technologies to collect data, analyze it, and derive conclusions.

2. Fields of Artificial Intelligence Applications include:

- **Historical data analysis:** extracting information from ancient manuscripts and aerial imagery.
- **Virtual reconstruction:** designing 3D models of buildings and archaeological sites.
- **Digital preservation:** digitizing rare documents and artifacts to make them available for future generations.
- **Awareness and promotion:** using virtual and augmented reality technologies to enhance awareness of the importance of heritage.

All these technologies have contributed to preserving heritage and archaeological cities.

Cultural and archaeological sites represent the physical memory of peoples, preserving important historical evidence that reflects human civilizations and their development over time. With technological advancement in the modern era, artificial intelligence has emerged as a powerful tool that can significantly contribute to studying and analyzing these sites and maximizing the benefits of cultural heritage.

Integrating history and archaeological sites with artificial intelligence to achieve innovative results in preserving, exploring, and deeply understanding heritage requires multiple approaches through study and implementation. Algeria, for example, possesses a vast amount of urban heritage that surpasses that of many countries, yet much of it remains unstudied or unverified—this is the core issue today. However, integrating this cultural and archaeological heritage with modern technology may offer a solution.

This can be achieved by using computers in this field an approach adopted by artificial intelligence experts for over a decade in the humanities and social sciences to develop programs capable of accurately processing urban heritage and historical texts, transforming them from traditional historical formats into digital forms, and making them accessible for knowledge and research.

Following the example of several countries that have contributed to heritage preservation using artificial intelligence, Qatar Foundation stands out. Its experts work on projects aimed at integrating technological innovation with the preservation of cultural and historical heritage. This is achieved through advanced technologies such as machine learning and natural language processing, as well as the development of tools and software that enable effective and

comprehensive monitoring and documentation of heritage, thereby contributing to its protection and transmission to future generations in the best possible way.

One of the most significant efforts in the field of digitization concerning historical and cultural heritage is the development of a digital biography of the Prophet Muhammad (peace be upon him). This Qatari institution has reflected its commitment by supporting initiatives and projects that serve the noble Prophetic biography, aiming to make it active and influential in people's lives. The Prophet (peace be upon him) is a role model for all people—Muslims and non-Muslims alike—and these efforts help individuals embody Prophetic morals in their daily lives.

Another prominent contribution in cultural history comes from a model developed by one of the research centers affiliated with Hamad Bin Khalifa University in Qatar. Experts at the Qatar Computing Research Institute use artificial intelligence technologies to preserve linguistic and Arab cultural heritage, as well as to teach the Arabic language and local dialects in a comprehensive and effective manner.

3. Projects we aim to implement in the field of artificial intelligence:

3.1 Artificial Intelligence in the Service of Archaeology:

Information technology should be highly appealing to archaeology, as it mediates between many activities related to archaeology and archaeologists. It enables connections across electronic field recording, offices, email communication, and even virtual conferences, extending to AI-powered museums. Information technology has become more accessible and powerful, and modern AI tools are capable of bringing new life to ancient artifacts. Many traditional tools used by field archaeologists now have digital counterparts, which are extensively used to analyze and present archaeological perspectives, as well as to record three-dimensional data of archaeological sectors and excavations.

There are numerous case studies that demonstrate how artificial intelligence can be applied in archaeology, including:

- Using machine learning to analyze and classify hundreds of thousands of ancient artifacts according to time periods and styles.
- Applying computer vision algorithms to examine aerial images and detect potential archaeological sites. In particular, computer vision helps archaeologists analyze images to identify artifacts and create accurate maps of ancient sites. Image analysis can also reveal hidden patterns in landscapes or even help reconstruct broken artifacts, thereby accelerating discoveries and preserving the finest details of our history and culture. Archaeologists are discovering new AI-driven methods to explore the past faster, more accurately, and with deeper insight than ever before.

- Employing artificial intelligence to scan and digitize manuscripts.
- Using robots in archaeological excavation for documentation and protection of artifacts.
- Restoring broken artifacts using deep learning techniques (Appendix 1).
- Building three-dimensional models of buildings and archaeological sites based on available data and images.

Artificial intelligence is now being used to reconstruct accurate virtual models of buildings and archaeological sites that have been damaged or destroyed.

Example: In Syria, artificial intelligence technologies have been used to reconstruct 3D models of the ancient city of Palmyra after it was damaged due to armed conflicts (Appendix 2).

Thus, artificial intelligence has contributed to accelerating archaeological work and improving its accuracy through the automation of certain tasks and the use of advanced technologies in collecting and analyzing archaeological data.

This may lead to what is known as a digital illustrated lexicon—that is, the electronic documentation of archaeological images for historical and tourism purposes across different regions. This facilitates the study of history for students, especially in archaeology. The Ministry of Culture has contributed by launching an initiative in cooperation with the U.S. Embassy to inventory existing cultural heritage; however, this effort still requires further enrichment and organization.

1.2 Virtual and Augmented Reality

Virtual reality technologies allow visitors to take virtual tours inside archaeological sites as they were in the past.

Global example: Google collaborated with 80 museums around the world to provide 3D virtual visits to archaeological sites such as Petra in Jordan and the Temple of Tutankhamun in Egypt. Algeria has not yet contributed to such initiatives.

Hologram technology: This technology creates three-dimensional visual representations of people in exhibitions and conferences.

As for artificial intelligence and machine learning, machines have reached levels where they surpass humans in many fields. This raises the question: how can we employ artificial intelligence to protect our heritage?

We can study the use of artificial intelligence in preserving our heritage through two aspects:

- A **theoretical aspect**, which involves data.

- A **practical aspect**, which involves implementation.

For example, to study a civilization, we can convert images into three-dimensional models and then materialize them into a virtual museum.

1.3 Employing Artificial Intelligence in Analyzing Archaeological Sites

Artificial intelligence can analyze aerial images and satellite data to discover potential archaeological sites, especially those hidden underground.

Example: Research teams at Harvard University used artificial intelligence to analyze satellite data in Egypt, leading to the discovery of dozens of previously unknown buried archaeological sites.

One of the latest technologies is the Metaverse, which connects the real world we live in with virtual reality. Many developed countries are working on creating companies within virtual environments. This technology also allows people to attend meetings virtually from home.

From a cultural perspective, this can be beneficial through virtual 3D field trips anywhere in the world. For example, in 2021, NVIDIA, a technology company, developed an infrastructure project that enables developers worldwide to collaborate in real time and allows students to explore ancient civilizations and architectural heritage. Through such technology, there is no need to travel physically—for instance, to Tunisia to see Carthage, to Iran to explore Persian civilization, or to Cairo to visit the pyramids. These places can be visited virtually using specialized headsets. The key advancement here is the sense of interaction or “touch,” achieved through simulation systems.

1.4 Simulation Models of Historical Events Using Artificial Intelligence

Artificial intelligence can be used to build simulation models for various historical events and processes, contributing to a deeper understanding of how events unfolded and evolved.

Examples include:

- Simulating historical battles and wars, such as the Battle of the Pyramids or battles between Saladin and the Crusaders.
- Modeling the emergence and spread of historical epidemics such as the Black Death.
- Simulating the rise and development of ancient civilizations like Mesopotamia.

- Modeling the collapse of major empires such as the Roman or Ottoman Empires.
- Simulating major human migrations and their impact on cultural diffusion.
- Modeling the impact of technological innovations such as printing or the compass on the course of history.
- Simulating revolutions and social and political transformations throughout history.

These simulation models help test different hypotheses about historical events and study the effects of various factors on their development.

Modern technologies, especially artificial intelligence, are among the most important tools that can play a major role in preserving heritage and enhancing cultural interaction among different peoples and cultures. Through a combination of technology and human creativity, artificial intelligence can open new horizons for exploring, understanding, and documenting heritage, making the human experience with history and culture richer and more dynamic.

Artificial intelligence plays an effective role in preserving heritage and presenting it to people in a systematic and organized manner. There is also another level of AI applications: making heritage active in our lives. This means not only collecting and organizing heritage but moving to a deeper level where heritage becomes integrated into daily life and reinforces its value in education and training.

Today, we can preserve heritage and history in ways never seen before. Historically, heritage was preserved orally, then recorded by scribes in manuscripts, later developed into printed books after the invention of the printing press in the 18th century. Today, we have moved to a more advanced level—artificial intelligence—which offers vast capabilities for preserving heritage in all its forms, whether written, material, or otherwise.

Based on this, several ideas have been proposed on how to employ artificial intelligence applications in the study and protection of archaeological cultural centers in Algeria across different historical periods, as they represent an important cultural heritage.

We can use historical data analysis to determine the impact of cultural centers in Algeria by applying artificial intelligence techniques to analyze old maps and aerial images. We can also use virtual reality technologies to revive archaeological sites such as Timgad and the Beni Hammad Fort, providing detailed virtual tours.

In addition, Geographic Information Systems (GIS) allow us to analyze the geographical distribution of cultural centers, while machine learning techniques provide the ability to build accurate three-dimensional models of archaeological sites. In the field of digital restoration, artificial intelligence can be used to preserve and digitize artifacts. On the other hand, AI-

powered robots can play a significant role in exploring undiscovered archaeological sites, and natural language processing tools can be used to analyze ancient texts and historical documents.

Automatic classification applications also contribute to identifying and classifying discovered artifacts, helping to preserve this historical heritage for future generations.

Examples include:

2. Artificial Intelligence in Analyzing Historical and Archaeological Data:

History is not merely a collection of past events; it is a complex network of information that requires precise analysis to understand the relationships between events, people, and places. Artificial intelligence can play a fundamental role in analyzing ancient historical texts, such as manuscripts and inscriptions, to extract information that is not visible to the human eye.

- **Machine learning and text analysis:** Using techniques such as deep learning, artificial intelligence can assist historians in analyzing ancient manuscripts and damaged or missing texts, helping recover unknown historical information.
- **Historical modeling:** Artificial intelligence can be used to build complex historical models that simulate the development of societies and civilizations, enabling researchers to examine different scenarios about how and why certain historical events occurred.

2. Artificial Intelligence in Discovering and Analyzing Archaeological Sites:

Archaeological sites are cultural treasures that must be preserved and studied carefully. Here, artificial intelligence plays a role in enhancing discovery processes and preserving these sites.

- **Remote sensing and image analysis:** Using satellites and drones equipped with AI technologies, new archaeological sites can be discovered. These tools can analyze images faster and more accurately than traditional methods, identifying geometric or structural patterns that indicate the presence of buried remains.
- **Intelligent robots in excavation:** Advanced robots powered by artificial intelligence can be used to explore complex or hard-to-reach archaeological sites. These robots can efficiently collect data, facilitating the work of archaeologists.
- **Artificial intelligence in heritage preservation:** In the context of preserving cultural heritage, AI can contribute to restoring damaged artifacts. Through techniques such as deep learning, digital reconstructions of damaged artifacts can be created, or parts of historical buildings can be rebuilt based on collected data from original sites.

3. Artificial Intelligence in Creating Interactive Visitor Experiences:

Modern technologies supported by artificial intelligence enable cultural institutions and museums to enhance visitor experiences. In archaeological contexts, AI can help develop interactive experiences that increase engagement with history.

- **Smart interactive tours:** Using augmented reality (AR) and virtual reality (VR), visitors can take virtual tours of ancient archaeological sites. For example, they can explore a historical city as it existed in the past, enriching their experience and deepening their connection to history.
- **Intelligent guidance:** AI-powered mobile applications can provide personalized experiences for visitors by delivering accurate and engaging historical information tailored to their interests during their visit to archaeological sites.

Challenges and Future Opportunities:

Despite the significant potential of artificial intelligence in archaeology and history, there are challenges that must be addressed:

- **Technical challenges:** AI requires advanced tools and precise data processing to achieve effective results. Additionally, machines need to be trained to understand complex historical and cultural patterns.
- **Preserving cultural authenticity and privacy:** Some modern AI technologies may raise concerns regarding cultural privacy, so they must be used carefully to avoid negatively impacting or damaging cultural heritage.
- **Future opportunities:** In the future, AI technologies can contribute to creating more accurate models of the development of ancient civilizations, improving excavation methods, and expanding access to cultural heritage in faster and more comprehensive ways.

2.2 Applications of Virtual and Augmented Reality in Reviving Heritage and Ancient Civilizations:

In recent years, the world has witnessed a major revolution in artificial intelligence and scientific research, and its impact has become evident across most areas of life. The use of AI applications has become essential in many fields such as medicine, engineering, space sciences, and others.

Regarding the use of artificial intelligence in archaeological exploration and excavation, it has developed a distinct role. AI has enabled scientists and researchers to analyze large datasets and extract valuable information. It plays a crucial role in identifying archaeological sites and discovering artifacts.

AI systems, trained through advanced algorithms, can recognize and predict the locations of archaeological sites and the types of artifacts present by processing vast amounts of data quickly and identifying patterns and relationships that may be difficult for humans to detect.

Thus, AI has become particularly useful in analyzing aerial imagery and remote sensing data to identify key indicators and clues for locating potential archaeological sites—especially in inaccessible areas or regions affected by conflict. AI can also analyze historical and geographical data to provide accurate estimations of underwater or hidden sites. Additionally, it can contribute to protecting archaeological sites by predicting the impact of environmental changes and enabling preventive measures.

However, artificial intelligence cannot replace human experts in archaeology; rather, it serves as a supportive tool that enhances their capabilities and improves their work.

The aim of studying AI in archaeology is to highlight its role, benefits, and applications, and to demonstrate the effectiveness of its techniques in analyzing large datasets and extracting critical information for identifying archaeological sites and uncovering artifacts. AI should be seen not as a substitute for archaeologists, but as an assistant that strengthens their analytical and research abilities.

From this, we conclude that AI technologies play a vital role in archaeological exploration and excavation. Intelligent models can analyze physical and stored archaeological data to guide field operations efficiently and identify the most promising locations for discoveries. AI can also help protect archaeological sites by predicting environmental impacts and enabling preventive strategies.

We can summarize the role of **virtual and augmented reality technologies** in reviving and highlighting heritage and ancient civilizations as follows:

- Reconstructing archaeological sites and buildings in 3D based on historical records and excavations.
- Enabling virtual tours inside museums that display artifacts and remains of ancient civilizations, such as the Egyptian Museum.
- Using augmented reality at archaeological sites to display digital content related to the location as it exists today.

- Reviving important historical figures and events through virtual reality.
- Creating virtual museums that gather 3D models of artifacts scattered across the world.
- Developing interactive applications and educational games based on historical and civilizational elements.
- Publishing 3D visual content that helps understand lifestyles and cultures of ancient civilizations.

These technologies provide new and innovative ways to explore and interact with human heritage.

2.3 How Artificial Intelligence Can Help Analyze and Understand Historical Sources and Texts:

Artificial intelligence can assist in analyzing and understanding historical sources and texts through several methods:

- **Optical Character Recognition (OCR):** converting scanned texts into digital formats that machines can read and analyze.
- **Machine translation:** translating ancient or obscure languages into more widely used languages using deep learning techniques.
- **Text summarization:** condensing long historical texts into concise summaries while preserving key meanings.
- **Named entity recognition:** identifying entities mentioned in texts (people, places, organizations) and extracting relationships between them.
- **Content classification:** organizing texts into categories and thematic topics.
- **Linking documents:** connecting historical documents that refer to the same events or figures.
- **Timeline extraction:** identifying chronological sequences and major events from historical narratives.
- **Question answering:** responding to queries based on the content of historical texts.
- **Structured summarization:** organizing information in a clear and accessible format for easier understanding.

Thus, artificial intelligence can process vast amounts of historical textual data quickly and accurately, extracting key ideas, relationships, and patterns that support deeper understanding and analysis of these texts.

2.4 Presentation of Real Models and Applications of Artificial Intelligence in the Field of History:

There are many real models and applications of artificial intelligence in the field of history, including:

- A project to translate ancient papyrus texts in Greek and Coptic in Egypt using deep learning.
- The use of machine learning algorithms to classify and analyze hundreds of thousands of ancient Greek pottery artifacts.
- The application of the Dutch Institute for Digital Humanities, which uses artificial intelligence to analyze historical texts.
- The *Parse* project, which uses computing technologies to link historical figures with places and events within a large database.
- Optical Character Recognition (OCR) systems to convert historical books and documents into digital texts.
- Virtual reality applications to reconstruct three-dimensional archaeological sites.
- The use of neural networks to restore damaged artifacts.

These are examples of how artificial intelligence technologies can be integrated into historical research to achieve new results and discoveries.

3. Discussions and Panels on the Future of Artificial Intelligence in Historical Studies:

Discussions and panel sessions can be organized حول (around) the future of artificial intelligence in the field of history, focusing on the following points:

- The readiness and willingness of historians to adopt AI technologies and integrate them into their research and studies.
- The challenges facing the adoption of AI in historical research and ways to overcome them.
- The most promising future applications and uses of AI in serving historical studies.

- The impact of AI on the nature and methodology of historical research.
- Ethical considerations in the use of artificial intelligence in historical studies.
- The role of governments and research institutions in supporting the adoption of AI in history.
- How to build the human capacities necessary to activate the role of AI in supporting historians and researchers.

Such discussions can contribute to a better understanding of the impact of artificial intelligence and help shape its future use in a way that maximizes its benefits for the field of history.

4. Conclusion:

The integration of artificial intelligence with history and archaeological sites represents a step toward the future, as this technology can play a central role in preserving cultural heritage, exploring it, and analyzing it in new ways. By combining technological innovation with historical research, humanity can preserve its memory and deepen its understanding of past civilizations.

Preserving our cultural and civilizational heritage is a collective responsibility that requires cooperation between governments, academic institutions, and technological organizations. With the advancement of artificial intelligence, we now have more powerful tools to protect heritage—not only for current generations but also for future ones.

Artificial intelligence has transformed the field of archaeology, making it faster, more accurate, and more accessible. By analyzing large volumes of data, discovering hidden sites, and restoring ancient artifacts, AI improves how we explore and understand the past. Its ability to process information quickly and accurately allows archaeologists to achieve discoveries that previously took years using traditional methods.

As artificial intelligence continues to evolve, its potential to uncover more about our history is virtually unlimited. The future of archaeology appears promising, with AI playing a major role in preserving our cultural heritage and deepening our understanding of ancient civilizations.

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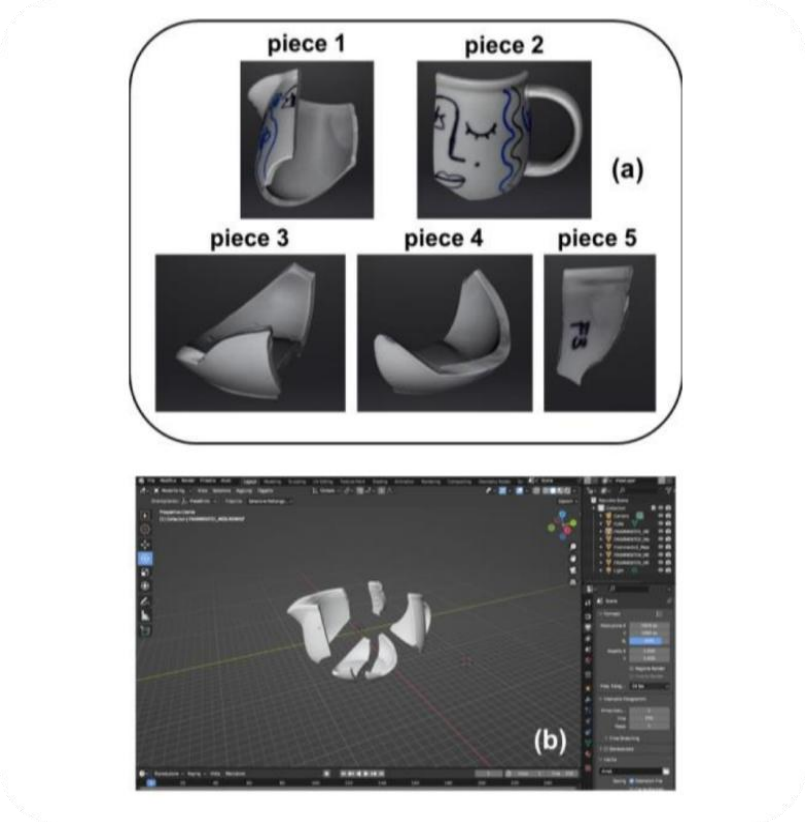
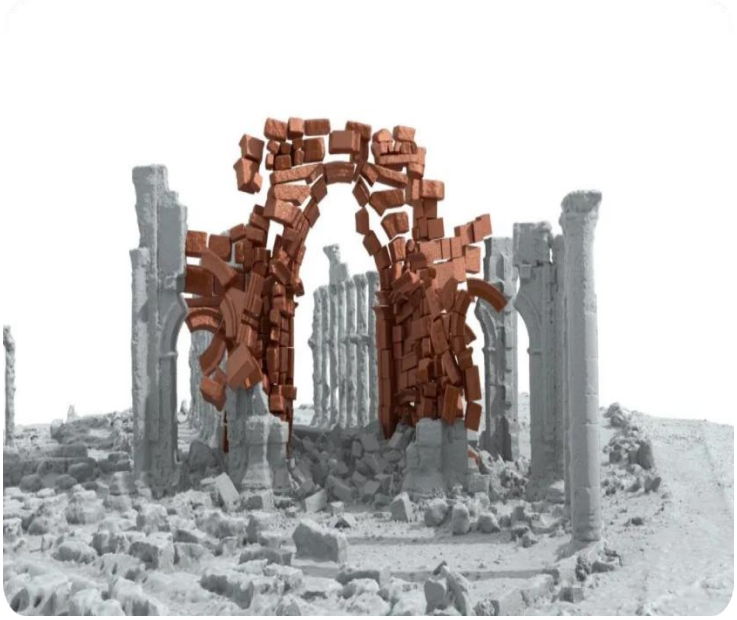
5. Appendices:

Appendix No. 1:



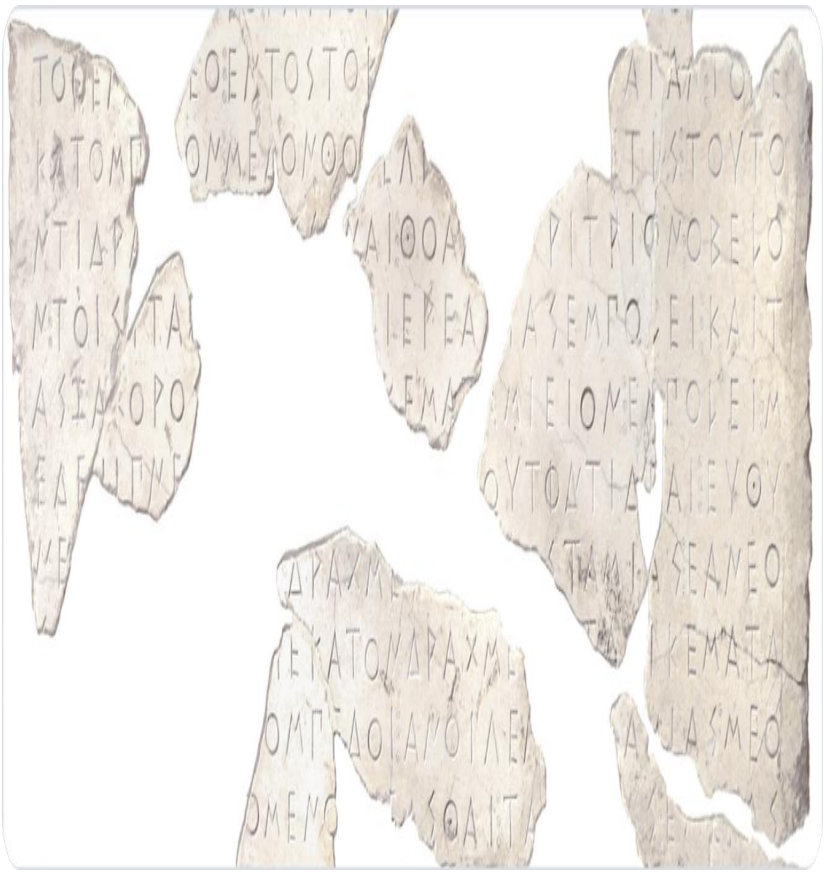
3D reconstruction of fragments using a three-dimensional model to carry out the restoration process.

Appendix No. 2:



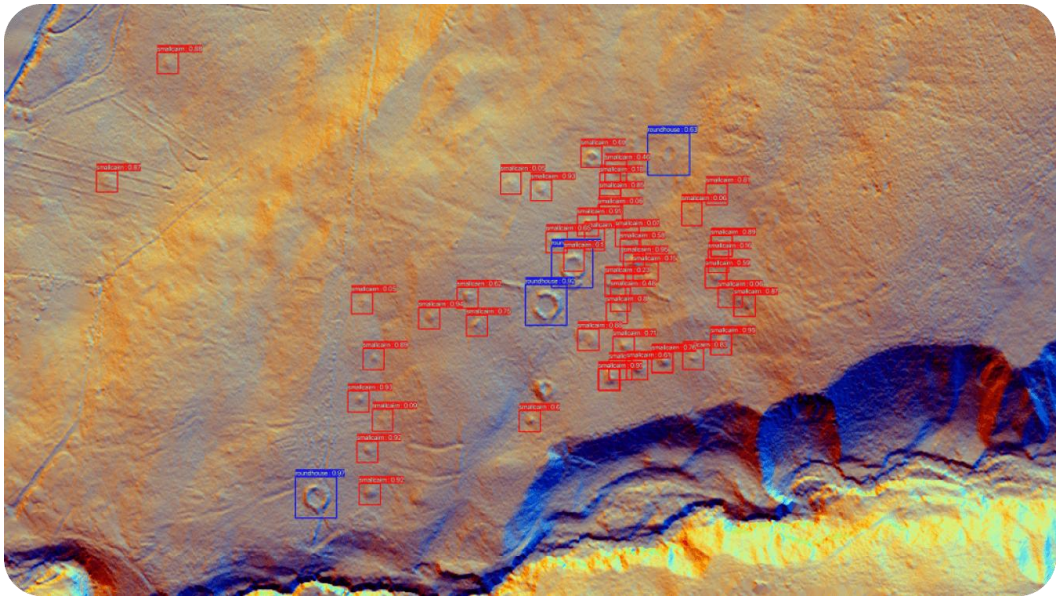
A 3D Iconem model of Palmyra, Syria, before its destruction in 2015.

Appendix No. 3:



The use of artificial intelligence to read ancient texts — a text dating back to 485 BC.

Appendix No. 4:



The use of artificial intelligence to identify excavation sites.