

Advancing Education and Cultural Heritage through Innovative AI Techniques: A Bibliometric Analysis

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Abstract— AI powered educational tools have the potential to transform teaching methods and create adaptable learning experiences. These tools can analyze student data, automate administrative tasks. Contribute to making education more inclusive and engaging. Moreover AI technologies can significantly impact the preservation and promotion of heritage. They offer solutions, for documentation, analysis and sharing by facilitating digitization cataloging, virtual simulations and interpretation of texts. To gain insights into the intersection of AI, education and cultural heritage a bibliometric analysis was conducted. This analysis examined trends in research related to AI techniques for cultural heritage outreach. The dataset revealed an increase in publications within this field with an annual growth rate of 7.34%. The documents analyzed were relatively recent with an age of 4.11 years indicating advancements in this domain. Impressively each document received an average of 5.328 citations reflecting their impact on the field. Furthermore the analysis highlighted variations in citation counts across years. While some years had no citations all others witnessed higher recognition and influence in terms of scholarly output. Notably the year 2020 emerged as influential for research output within this subject area. The main objectives of this study is to identify research areas within AI education and cultural heritage outreach well as recognize most influential countries and gaps in the area. It offers information, about the condition of research areas where further investigation is needed and new developments that can inform stakeholders about research collaborations, allocation of resources and policy formulation.

Keywords— *Innovative AI Techniques, Artificial Intelligence, AI, Cultural Heritage, Education, Immersive Learning*

I. INTRODUCTION

In recent years, Artificial Intelligence (AI) has made progress and has become a part of various fields, including education and cultural heritage. The introduction of AI techniques has sparked interest, in exploring how they can benefit these domains by creating opportunities for learning, preserving knowledge and sharing it with others. This study aims to conduct an analysis of published works to examine the trends, patterns and impact of research at the intersection of AI, education and cultural heritage.

Education plays a role in shaping societies and promoting development. Traditional educational methods often rely on curricula and teaching approaches. However the emergence of AI technologies has opened up possibilities for adaptable learning experiences. Educational tools powered by AI can analyze individual student data identify learning patterns and

provide customized interventions to improve learning outcomes [1]. These tools can offer feedback, intelligent tutoring systems and virtual simulations that allow students to engage in interactive learning experiences. Additionally AI can assist educators by automating tasks such, as grading assignments while providing real time insights into student performance [2]. Integrating AI into education has the potential to revolutionize teaching practices by making learning more engaging, efficient and inclusive [3].

Cultural heritage encompasses both the intangible aspects that define a society's identity. This includes things, like artifacts, historical sites, traditions, languages and practices. Preserving and promoting heritage is incredibly important because it helps maintain diversity fosters unity and enriches our understanding of the past [4]. AI technologies can play a role in this preservation and promotion by offering tools for documentation, analysis and sharing. For example AI powered image recognition and natural language processing techniques can assist in digitizing and cataloging artifacts efficiently. This allows for storage, retrieval and analysis of objects. Additionally virtual reality (VR) and augmented reality (AR) applications powered by AI can create experiences where individuals can virtually explore sites and interact with cultural artifacts [5]. Furthermore AI algorithms can aid in interpreting texts well as translating or transcribing ancient languages. These advancements make cultural heritage more accessible to an audience. To fully understand the state of research in education and cultural heritage fields it is crucial to gain insights, through analysis. Such an approach provides an examination of scholarly publications while also identifying trends and assessing the impact of research studies.

Through the analysis of a collection of literature this study seeks to uncover significant research themes, influential authors, highly cited papers and collaborative efforts, within the realm of AI applied to education and cultural heritage.

The objectives of this study can be summarized in three aspects. Firstly it aims to explore the intersection of AI, education and cultural heritage by examining publications titles, abstracts and keywords. Through this analysis we will gain an understanding of the topics and themes discussed in the literature. Secondly we aim to identify the authors and institutions that contribute to this field. By studying authorship patterns and affiliations we can uncover networks and expertise, within the community. Lastly we strive to assess the impact of research in this domain by analyzing citation patterns and identifying papers. This analysis will offer insights into how AI has contributed to education and cultural heritage. The results of this research will have implications for researchers, practitioners well as policymakers involved in AI, education and cultural heritage domains. It will provide an overview of research status while highlighting any research gaps that exist.

Additionally it will identify emerging trends and directions for investigations. The findings from our analysis will inform stakeholders about studies and researchers in this field so that they can make well informed decisions regarding research collaborations, resource allocation, as well, as policy development.

II. LITERATURE REVIEW

AI techniques present both challenges and opportunities, in the fields of education and cultural heritage. When it comes to education the high cost often prevents individuals from accessing quality education. However AI offers solutions to address these challenges by tackling issues such as diversity, security and privacy [6]. Professionals working in Cultural Heritage Institutions (CHIs) encounter their set of obstacles including professional expertise, collection specific complexities, and staff related concerns and limited AI/Machine Learning (ML) resources [7]. To overcome these limitations implementing a strategy for AI/ML in CHIs along with knowledge sharing among institutions could prove beneficial. Furthermore leveraging AI and advanced machine learning techniques can assist in identifying objects captured in photography such as architectural monuments, within the realm of cultural heritage.

Ardissono et al. (2022) delved into the development of tools using Information and Communications Technology (ICT) to curate explore and appreciate heritage. The author discussed the challenges and opportunities presented by the intangible aspects of cultural heritage in this context [6]. The focus of the research paper lies in how AI and HCI methods to tackle these challenges and leverage the opportunities. Key findings highlighted the significance of utilizing AI technologies to curate explore and appreciate heritage while emphasizing the need, for user centered design approaches when developing ICT tools for this purpose. The study underscores how AI and HCI methods have potential in enhancing accessibility, preservation and comprehension of heritage. In summary this paper offers insights into applying AI and HCI techniques within the realm of cultural heritage curation, exploration and appreciation by shedding light on both its advantages as well as inherent challenges.

Sethi et al. (2020) conducted a study examining how artificial intelligence can address cultural challenges in education while emphasizing its role in education technology [7]. The research paper underscores that education plays a role in fostering an understanding of values, alongside cultural norms to help individuals become valuable members of society. AI tools have been identified as having an impact, on research enabling access to literature from around the world and presenting solutions to social issues such as diversity, security and privacy. The study also acknowledged the influence of AI in areas, like media, communication and technology.

In a study conducted by Cozzani et al. (2017) they delve into the significance of technology, in safeguarding and educating people about heritage (ICH) through the i Treasures project, which was supported by funding from the European Community [8]. Their research focuses on creating a platform that offers features and hands on learning experiences to users interested in ICH education. The authors emphasized how innovative technologies play a role in enabling users to learn and practice forms of dance or singing while receiving valuable feedback thereby enhancing the overall learning

process. The evaluation of the i Treasures platform demonstrated its effectiveness in preserving and passing on ICH making it a valuable resource, for organizations, schools and institutions dedicated to promoting expressions of ICH. Additionally the paper suggests an assessment method that utilizes equation modeling to measure the performance of the platform and enhance its various components. All the i Treasures project serves as an excellent example of how groundbreaking technologies can contribute to safeguarding and educating about intangible cultural heritage providing novel ways for users to engage with it while deepening their understanding and appreciation.

Guan et al. (2020) delved into the use of intelligence (AI) and deep learning (DL) techniques, in teaching and learning over a period of twenty years. Their study involves analyzing than 400 research articles from leading journals to understand how AI and DL research themes have evolved in education [9]. By examining the keywords associated with AI powered pedagogical adaptation research in each decade they uncover shifts and emerging trends in research. The findings showcase a decline in technology based instructional design studies while highlighting the growth of student profiling models and learning analytics. Ultimately the paper aims to shed light on the opportunities and challenges presented by AI and DL for adaptation sparking conversations, within the education community.

Yan and Li (2023) explored the practice of innovation, in the field of heritage education at universities focusing on the creative preservation of intangible cultural heritage crafts [10]. The study comprises two stages. In the stage they examine approaches to heritage education in higher education institutions through case studies of "She costumes culture" and "Quanzhou traditional embroidery skills." The second stage involves a survey questionnaire that explores products and activities related to aspects of intangible cultural heritage. By employing analysis using Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS) they identify 26 indicators and six dimensions; heritage education, significance of heritage, cultural participation, cultural identity, integration between culture and tourism and reflection on culture. The study reveals a covariant relationship between tourism integration and heritage education emphasizing their importance. It underscores the need for governments and local communities to define their roles in preserving heritage for intangible cultural heritage education. Moreover the paper highlights that citizens play a role in transforming inherited values while inheritors must strive for sustainable protection of intangible cultural heritage, through self-management.

Ye, J. (2022) explored the use of AI technologies, in the field of Digital Humanities with a focus on Dunhuang culture. The research delves into the methodology behind applying AI in Digital Humanities [11]. Proposes approaches to preserving, developing and innovating traditional culture. The author suggests leveraging Smart Data to obtain structured and visually appealing heritage utilizing Cross media Intelligence to reconstruct and disseminate culture and employing Human machine Association for renovating and recreating treasures.

The study also examines how these methodologies can be applied to Dunhuang culture, including analyzing natural language patterns using Smart Data for transferring image styles creating museums through VR and AR technologies

well as restoring murals in Mogao caves using Human machine Association. Furthermore the study discusses the impact of these techniques on cultural heritage preservation. Outlines development strategies. The author emphasizes the significance of integrating humanities research with computer technologies, AI systems to enhance humanities studies. Ultimately this research highlights the potential of AI technologies in safeguarding, preserving and advancing heritage with a special emphasis on Dunhuang's rich cultural legacies. It is suggested that AI can simulate real life scenarios during restoration, in Dunhuang caves thereby minimizing chances of failure. The study also discusses the evolution of humanities computing throughout history which began with the integration, classification and indexing of text and later expanded to include the use of computers, in research within the humanities. The author acknowledges the establishment of programs and principles that have been created to cater to the requirements of scholars, in this field.

Ranaldi and Zanzotto (2021) delved into the application of intelligence (AI), in preserving heritage. They highlighted the limitations of AI technologies, which heavily rely on learning and non-symbolic representations [12]. The authors proposed investigating the KERMIT system as a meeting point between learning theories. They put forth a perspective on knowledge within AI models emphasizing the combination of rules, learning and human expertise. The paper also delves into the divide between empiricist theories. How it influences the representation of the world in AI systems. According to the authors argument effective knowledge representation necessitates a blend of symbols and experiential understanding. Notably they emphasize the importance of gaining insights into AI models while exploring possibilities, for knowledge systems that integrate both symbols and experience.

III. METHODOLOGY

The main aim of this research is to examine the literature on how AI techniques can contribute to the advancement of education and cultural heritage. Through an analysis we will identify research trends, influential authors and institutions as well, as key publications in this field. To achieve this goal we conducted an analysis of scholarly articles and conference papers. Bibliometric analysis is a recognized and rigorous method for examining scientific data. For our study we focused on articles published between 2006 and 2023. It is crucial to select a database that contains bibliographic data when conducting bibliometric analysis. Different databases may vary in terms of coverage, scope, quality and accessibility which can impact the outcomes and conclusions of the analysis. Therefore we have chosen the Scopus database as our information source due to its collection of citations and abstracts for peer reviewed literature. The data was extracted from Scopus on September 01 2023. Our search criteria include terms, like "Innovative AI Techniques". Artificial Intelligence". AI" AND "Cultural Heritage" AND "Education" OR "Immersive Learning". We found a total of 61 papers, in the Scopus database related to the search term. We then analyzed these articles using R studio and various bibliometric techniques.

IV. RESULTS

These studies emphasize how AI and machine learning methods can improve accessibility, preservation and understanding of heritage. They also address cultural

challenges in education. The key findings of these studies include the importance of designing ICT tools for heritage with users in mind. They also highlight the need for a strategy for AI/ML in cultural heritage institutions and knowledge sharing among institutions. Moreover these studies explore how innovative technologies can enhance the learning experience by allowing users to practice forms of dancing or singing and receive feedback on their performance. However these reviews also acknowledge that modern AI technologies have limitations calling for an understanding of AI models and exploring knowledge systems that integrate symbols and experience. Overall these literature reviews provide insights, into how AI techniques can be applied to education and cultural heritage while highlighting both their benefits and challenges.

The findings of data extracted from Scopus are as following:

A. Information about the data:

TABLE I. INFORMATION ABOUT DATA (Source: Scopus)

Information about data	
Timespan	2006:2023
Sources (Journals, Books, etc)	44
Documents	61
Annual Growth Rate %	7.34
Document Average Age	4.11
Average citations per doc	5.328
References	1529
Document Types	
article	21
book chapter	3
conference paper	30
conference review	6
review	1

The table-I presents findings from an analysis of a dataset that contains information, about publications in the field of using AI techniques for cultural heritage outreach. The dataset covers the period from 2006 to 2023. Includes 44 sources such as journals, books and other types of documents. In this study a total of 61 documents were examined. One notable discovery is the growth rate of these publications, which is calculated to be 7.34%. This indicates an increase in the number of publications over the years showing the growing interest and research activity at the intersection of AI and heritage. The average age of these documents is reported to be 4.11 years suggesting that they are recent publications that demonstrate active progress in this field in recent times. Furthermore each document receives a citation count of 5.328 indicating their impact and influence as they have been widely recognized and referenced by other scholars in this field. These findings suggest that AI techniques for cultural heritage outreach are experiencing growth with an increasing number of publications and significant citation counts, per document. The prevalence of conference papers and articles, as the types of documents suggests the significance of conferences and journals, in disseminating research findings within this field. The relatively young average age of the documents points towards recent advancements and ongoing research in this field.

B. Annual Scientific Production

TABLE II. ANNUAL SCIENTIFIC PRODUCTION (Source: Scopus)

Year	Articles	Year	Articles	Year	Articles
2006	3	2013	1	2020	7
2007	2	2014	1	2021	7
2008	1	2015	1	2022	16
2009	1	2016	1	2023	10
2010	0	2017	1		
2011	0	2018	5		
2012	1	2019	3		

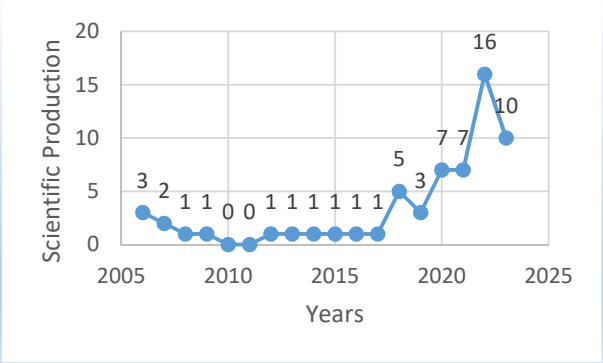


Fig. 1. Annual Scientific Production

The information provided in Table II gives us insights, into the output within the realm of AI techniques for promoting cultural heritage. It showcases the number of articles published annually from 2006 to 2023. Upon analyzing the table we can observe a growth in output over time specifically in the field of Innovative AI techniques for Advancing Education and Cultural Heritage. While there were publications in years research activity has significantly increased since 2018 with a particularly notable surge in 2021 and 2022. These findings indicate a growing interest and commitment towards advancing AI techniques for cultural heritage promotion in years. As of now ten articles have been published in 2023 indicating a level of productivity.

C. Annual Citations per Year

TABLE III. ANNUAL CITATION PER YEAR (Source: Scopus)

Year	Average Citation per Year	Year	Average Citation per Year	Year	Average Citation per Year
2006	0.07	2014	0.4	2020	6.75
2007	0.03	2015	0.67	2021	2.05
2008	0	2016	0	2022	0.84
2009	0	2017	1	2023	0.3
2012	2	2018	0.33		
2013	0	2019	0.47		

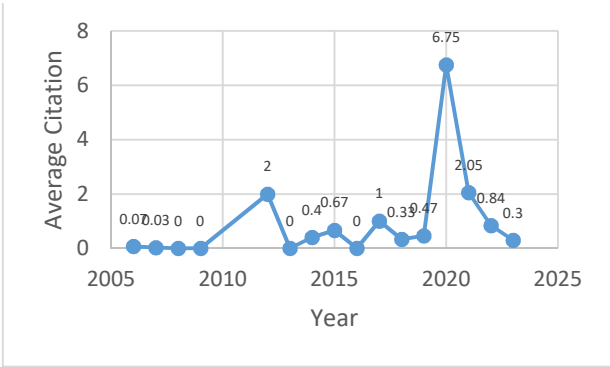


Fig. 2. Average Citation per year

Table III analysis reveals variations in citation counts per year for articles related to Innovative AI Techniques for Advancing Education and Cultural Heritage. From 2006 to 2009 citation counts were generally low with some years having no citations all. This suggests that early publications did not receive attention or recognition from researchers in terms of citations. However there are increases, during years indicating greater recognition and impact achieved by those articles. The high number of citations, in 2020 indicates that it was a year of influence, in the field of research. These findings show the variations in degrees of attention and recognition received by publications in different years. It also highlights the impact and influence of research within the field of AI techniques for cultural heritage outreach.

D. Top 10 Countries with Highest Scientific Production

TABLE IV. TOP 10 COUNTRIES WITH HIGHEST SCIENTIFIC PRODUCTION (Source: Scopus)

Country	Freq.	Country	Freq.
China	52	India	13
Italy	26	France	10
Greece	24	Spain	9
South Korea	15	Ireland	6
UK	15	Portugal	4

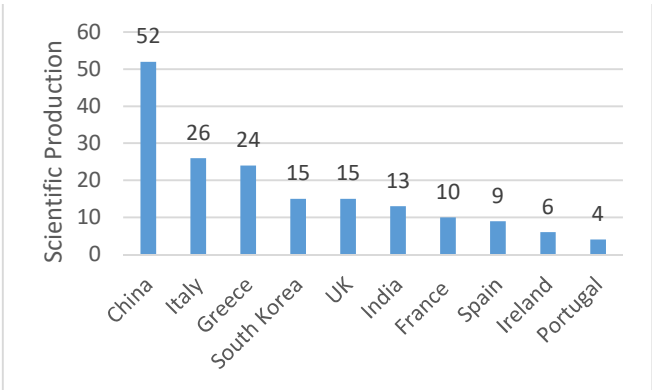


Fig. 3. Top 10 countries with highest scientific production

The analysis of the table reveals the top 10 countries with the highest scientific production in the field of Advancing Education and Cultural Heritage through Innovative AI Techniques. China, Italy, and Greece emerge as the leading contributors, while other countries, such as South Korea, the UK, India, France, Spain, Ireland, and Portugal, also

demonstrate significant research output in this field. These findings highlight the global nature of research and collaboration in advancing AI techniques for cultural heritage outreach, with numerous countries actively participating and contributing to the scientific literature.

E. Top 5 Countries with Highest Citations

TABLE V. TOP 5 COUNTRIES WITH HIGHEST CITATIONS (Source: Scopus)

Country	TC
Greece	213
Italy	23
China	20
Morocco	10
Spain	5

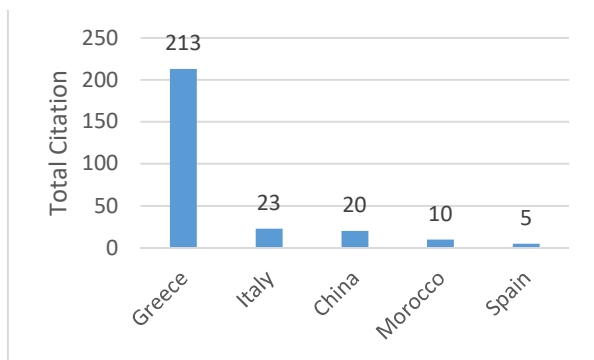


Fig. 4. Top 5 Countries with Highest Citations

Based on the table –V analysis, it becomes evident that there are countries, at the forefront of research in Advancing Education and Cultural Heritage through Innovative AI Techniques. Notably China, Italy and Greece stand out as the contributors. However other countries like South Korea, the UK, India, France, Spain, Ireland and Portugal also show research output in this field. These findings emphasize the nature of research and collaboration when it comes to advancing AI techniques for cultural heritage outreach. It's encouraging to see numerous countries actively participating in and contributing to the literature in this area.

F. Most Influential Sources

TABLE VI. MOST INFLUENTIAL SOURCES (Source: Scopus)

Sources	Rank	Freq.
LECTURE NOTES IN COMPUTER SCIENCE (INCLUDING SUBSERIES LECTURE NOTES IN ARTIFICIAL INTELLIGENCE AND LECTURE NOTES IN BIOINFORMATICS)	1	10
INTERNATIONAL ARCHIVES OF THE PHOTOGRAMMETRY, REMOTE SENSING AND SPATIAL INFORMATION SCIENCES - ISPRS ARCHIVES	2	3
ACM INTERNATIONAL CONFERENCE PROCEEDING SERIES	3	2
CEUR WORKSHOP PROCEEDINGS	4	2

COMMUNICATIONS IN COMPUTER AND INFORMATION SCIENCE	5	2
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The analysis of the provided table- reveals the most influential sources in the field of machine learning for spatial analysis in urban areas. The leading source is Lecture Notes in Computer Science, which covers aspects of computer science, including intelligence and bioinformatics. Another influential publication is the International Archives of the Photogrammetry Remote Sensing and Spatial Information Sciences a journal within this field. Additionally the ACM International Conference Proceeding Series, CEUR Workshop Proceedings and Communications in Computer and Information Science also hold sway in this domain. These sources indicate a research community dedicated to exploring machine learning and spatial analysis in areas offering valuable resources for researchers and practitioners seeking advancements and insights.

G. Most Influential Authors

TABLE VII. MOST INFLUENTIAL AUTHORS (Source: Scopus)

Element	h index	g index	m index	TC
ADAMOPOULOU E	1	1	0.25	188
AKHGAR B	1	1	0.0588235	1
ALBINO-PIRES N	1	1	0.5	5
ALLISON- BURBANK JD	1	1	1	2
AN P	1	1	0.2	7
BARRA S	1	1	0.3333333	17
BEN AHMED M	1	1	0.5	10
BENALI A	1	1	0.5	5
BISOJNI C	1	1	0.3333333	17
BONCI A	1	1	0.1666667	6

The analysis of the table-VII provides an overview of the authors who specialize in AI techniques for cultural heritage outreach. Although all these authors have an h index and g index of 1 (indicating levels of recognition) their m index and TC values reveal differences, in their impact and citation counts. These metrics collectively highlight the varying degrees of influence received by these authors within their field.

H. Top 5 Most Influential Affiliations

TABLE VIII. MOST INFLUENTIAL AFFILIATIONS (Source: Scopus)

Affiliation	Articles
BEIJING CITY UNIVERSITY	5
INFORMATION AND COMMUNICATIONS UNIVERSITY	5
HUNAN UNIVERSITY	4
POLYTECHNIC UNIVERSITY OF MARCHE	4
SANGMYUNG UNIVERSITY	4

According to the analysis of table VIII the top five affiliations that have had the impact based on the number of articles published are Beijing City University, Information and Communications University, Hunan University, Polytechnic University of Marche and Sangmyung University. These affiliations have made contributions in their fields through a substantial number of academic publications.

approaches and information systems advancements. These topics reflect the focus areas and advancements, within this field.

I. Top Trending Topics

TABLE IX. TRENDING TOPICS (Source: Scopus)

Terms	Frequency
artificial intelligence	28
cultural heritages	25
virtual reality	9
deep learning	7
education	7
engineering education	7
chatbots	6
intangible cultural heritages	6
information systems	5



Fig. 5. Trending topics

The analysis of the table -IX also highlights the current trending topics in AI techniques for cultural heritage outreach. These topics include intelligence, cultural heritages preservation efforts, virtual reality applications deep learning methods education initiatives related to engineering and catboats implementation. Additionally intangible cultural heritages and information systems play a role in this field. These findings indicate the range of applications and advancements within AI techniques, for cultural heritage outreach.

V. CONCLUSION

Based on the analysis of data and literature reviews it can be concluded that AI techniques have shown promise in the domains of education and cultural heritage. These techniques offer opportunities to improve accessibility, preservation and understanding of our heritage while also addressing challenges. The examination of the Scopus dataset reveals a growing interest and research activity, in using AI techniques to promote heritage with an increasing number of publications and citations in years. This underscores the significance of user design when developing ICT tools for heritage purposes well as the need for a well thought out strategy for integrating AI/ML technologies into cultural heritage institutions to enhance learning experiences. However it is important to acknowledge the limitations of AI technologies and recognize the role played by symbols and personal experiences in knowledge systems. Notably countries such as China, Italy, Greece, South Korea and the UK have made contributions to production in the field through global research collaborations. The analysis also highlights sources and authors that researchers and practitioners may find valuable.

The popular topics related to using AI techniques for cultural heritage outreach include intelligence itself virtual reality applications, deep learning methods, education

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