Introduction to the Special Issue on Extended Intelligence for Cultural Engagement

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New curatorial practices have emerged in the last decade to increase the engagement of citizens in cultural heritage, ranging from visitors' experiential feedback to exhibitions and cultural artifacts, to digitally mediated forms of interaction, such as social media and games. Within this context, citizen curation is proposed as a methodology for eliciting, producing, collecting, interpreting, and archiving people's responses to cultural objects in interactive and immersive environments. This special issue provides a comprehensive exploration of the challenges and opportunities posed by artificial intelligence and interactive technologies for citizen curation by presenting a diverse set of case studies that range from museums to heritage sites.

CCS Concepts: • **Human-centered computing** → **Interaction design**; **Mixed / augmented reality**; **Virtual reality**; **Interaction design**; **Mixed / augmented reality**; • **Computing methodologies** → *Artificial intelligence*; *Artificial intelligence*.

Additional Key Words and Phrases: Citizen curation, Extended reality, Empathic interaction, Cultural engagement, AI for cultural computing

1 INTRODUCTION

In recent years new forms of citizen participation in cultural heritage have emerged, producing a wealth of material relevant to curatorial practices, spanning from visitors' experiential feedback to exhibitions and cultural artifacts, to digitally mediated forms of interaction, e.g. on social media. A key contribution to a clearer definition of Citizen curation has been provided by the European project SPICE (Social Participation, Cohesion, and Inclusion through Cultural Engagement)[1], where Citizen Curation is intended as a methodology for eliciting, producing, collecting, interpreting, and archiving people's responses to cultural objects. By leveraging the new ways for interacting with the digital world, such as virtual and augmented reality, Citizen curation can complement traditional expertise and favor the emergence of multiple perspectives that motivate users and memory institutions to reflect upon artworks, negotiating their identity along the process.

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[1]https://spice-h2020.eu/

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Following the path set by SPICE, the papers in this special issue address open questions on how digital innovation can influence and support the new ways of engaging with cultural heritage enabled by AI and technologies. These include how to engage audiences that are not the common "museum goers" including teenagers and young adults as well as minority groups, how to encourage interaction and opinion sharing between different groups in XR contexts, and how to promote the acceptance of diverse opinions.

With domains spanning from heritage sites to old media, the papers in this special issue provide a comprehensive exploration of the challenges and opportunities posed by artificial intelligence and technologies for citizen curation, ranging from the use of XR for fostering perspective taking and immersion into cultural heritage to the development of inclusive environments and dedicated infrastructures for Citizen Curation.

In the following, we briefly describe the papers included in the special issue by gathering them according to their common traits, from span from education and citizen science to emotional and empathic engagement in immersive environments, without neglecting infrastructural aspects.

2 THE MULTIFOLD FACES OF CITIZEN CURATION BETWEEN TECHNOLOGY AND INTERACTION

Citizen curation for educational purposes is explored by a group of works where Gaming, Citizen Science and Storytelling are repurposed to engage visitors in museums and open areas.

"Exploring the Impact of an IoT-based Game on the Experience of Visitors at a Natural Science Museum" explores the impact of an Internet of Things (IoT)-based game called "Magic Torch" on museum visitors' experiences. Conducted at the University of Bari's Museum of Natural Sciences, the study involved 18 young participants who played the game following a guided tour. Using a combination of quantitative and qualitative methods, the research assessed how the game influences emotions, workload, and overall user experience. Results show that the IoT game enhances visitor engagement and emotional response compared to a traditional guided tour, although it also increases workload. The findings suggest that IoT games can offer enjoyable, interactive, and educational experiences in cultural heritage contexts, enhancing visitor satisfaction and engagement.

"Digitising the Deep Past: Machine Learning for Rock Art Motif Classification in an Educational Citizen Science Application" explores the application of Machine Learning for classifying Indigenous rock art motifs, focusing on educational and cultural heritage objectives. This interdisciplinary project by Griffith University involves Indigenous students in a citizen science application, merging cultural preservation with digital education. The students assist in tagging rock art images, which trains ML models for motif classification.

The initiative not only aids cultural preservation but also enriches Indigenous students' educational experiences in STEAM (Science, Technology, Engineering, Arts, and Mathematics), showcasing how technology can bridge cultural and educational gaps. This research highlights potential expansions, including broader dataset development and applications in other cultural heritage areas.

"Augmented Reality Book Design for Teaching and Learning Architectural Heritage: Educational Heritage in Hong Kong Central and Western District" The teaching and learning of architectural heritage can engage students with their cultural background and identity. Augmented Reality (AR) has clearly a role when it comes to face challenges such as limited access to heritage sites and engaging less motivated students. The article presents an AR book that combines pop-up 3D models with a dedicated mobile app to showcase the architectural heritage of Hong Kong's Central and Western Districts. An evaluative study utilized a mixed-methods approach assessed the AR book's usability by surveying 80 heritage education undergraduates and conducting semi-structured interviews with a subset of participants.

"An Extended Reality Platform for Cultural Gaming: Enabling Interactive Narratives in Spatial Contexts" documents work realized in the UNESCO World Heritage City of Evora, Portugal. Here extended reality approaches have been developed with the objective of achieving a revalorisation of the Historical Soundscape Heritage. Valued soundscape elements such as the sounds of church bells, running water, and the music of church choirs are brought together with cartographic artifacts and gamification techniques to enable exploration, recognition, and engagement with selected local narratives.

"HeritageSite AR: Design and Evaluation of A Mobile Augmented Reality Exploration Game for a Chinese Heritage Site" provides an accurate and detailed documentation about the design and evaluation process of an exploration game for a Chinese heritage site. The evaluation study reported in the paper shows positive feedback about the impact of the game, designed according to an iterative, holistic approach aimed a mapping the technical means to the requirements of the cultural application, collected with the involvement of domain experts and user, to obtain a playful, engaging interaction.

The development of immersive environments that break the boundaries between individuals and groups to promote empathetic involvement with CH is the topic of a cluster of works which put VR at the service of perspective taking.

In "A Polyvocal Approach to Virtual Heritage: An Immersive Case Study" contextualisation and the presentation of multiple perspectives are essential properties of emerging CH applications, and there is need of research investigating effective strategies for achieving these objectives. Virtual Reality (VR) has the potential to foster empathy, emotional regulation, and social skills by allowing users to experience and interact with different perspectives. The article presents a VR application designed to investigate *polyvocality* (i.e. highlighting multiple perspectives on a given subject matter). The participants were invited to interact with 3D objects which revolved around the topic of the experiment (i.e. the Suriname flag and the history behind its symbolism). The authors measured how polyvocality was acknowledged in each participant before and after the experiment via questionnaires, quantitatively. In addition, a qualitative analysis of the recordings of the experiments is also discussed.

the work presented by "Virtual Empathy: Usability and Immersivity of a VR System for Enhancing Social Cohesion through Cultural Heritage" tackles the assessment of potentially conflicting poles - namely usability and immersivity - in a VR environment that promotes encounters with other visitors' narratives as a way to promote empathy.

Immersivity is the key to engage the audience with traditional media in the project described by "The Biograph Scope: Exploring Early Cinema in an Immersive Environment", which presents the initial results of a project which designed and implemented a computer-based application/installation that offers an immersive experience of digital restoration of silent films. The article makes a substantial contribution to the current knowledge regarding the use of digital technologies in the restoration of audio-visual heritage media such as film. The text covers a lot of ground, including topics related to embodiment, visualization, immersion as well as current trends in the use of AI techniques for restoration as well as a basic evaluation of user experience.

Last, but not least, the special issue acknowledges the need for dedicated technological and knowledge infrastructures to enable CC for cultural institutions make it inclusive.

"Integrating Citizen Experiences in Cultural Heritage Archives with a Linked non-Open Data Hub" This paper introduces a Linked non-Open Data Hub (LDH) designed to support citizen curation in cultural heritage archives. The authors present findings from the EU-funded SPICE project, which explores social participation and inclusion in cultural engagement. The LDH integrates museum collections and user-generated content to empower institutions like the Irish Museum of Modern Art to foster diverse perspectives on art. It addresses challenges in privacy, data control, and rights management, enabling citizens and museums to collaboratively shape and

interpret cultural heritage. This system offers enhanced access control, content monitoring, and customizable data management for museums and curators.

"An Ontology Network for Citizen Curation" focuses on documenting processes and tasks entailed in the creation of a complex online information processing environment (Spice Ontology Network, SON) that, in order to support the activity of Citizen Curation, brings together multiple ontology varieties including those used for narrative description, emotional engagement and iconographic expression, among others. The essay provides a very interesting and important account in how it depicts the challenges that entail building bridges between users communities in both physical and virtual worlds.

The paper"Multivocal Exhibition: Exploring Cultural Perspectives through User-Curated Art Exhibitions" focuses on the interpretation of cultural symbolism as a way to enrich users' understanding of diverse cultures. Using the Multivocal Exhibition application, which relies on the cultural symbolism knowledge graph called "HyperReal", users can curate their own art exhibition by selecting a preferred theme and a set of cultural contexts for its interpretation. The app creates a 3D environment featuring artworks symbolically related with the chosen theme from the perspective of the selected cultural contexts, thus allowing the user to explore serendipitously the multivocal interpretation of cultural symbols across different contexts.

"Interpretable Clusters for Representing Citizens' Sense of Belonging through Interaction with Cultural Heritage" describes how the technical tools developed as part of the SPICE EU project were integrated into a platform and can be combined to guide and facilitate the processes of interpretation and reflection on cultural heritage artifacts. Following the central ideas of SPICE, namely the sense of belonging and the Interpretation-Reflection loop, the underlying aim was to support citizens' participation and inclusion for social cohesion. A clustering algorithm was designed to create meaningful communities from content provided by citizens and iterates until all clusters are explainable. The authors claim that the algorithm is valuable for understanding and organizing complex data in cultural heritage contexts and illustrate the approach by considering different attributes of individual citizens and citizen groups in the GAM (Galleria Civica d'Arte Moderna e Contemporanea) case study while visualizing the clustering results using the VISIR tool that enables the users to explore and unveil connections between citizens and communities, bringing together the citizen space and the cultural heritage space.

3 CONCLUSION

The Special Issue gathers in one place a variety of approaches that, by creating inclusive, interactive and immersive environments, engage visitors in Citizen Curation and promote participation with Cultural Heritage in a measurable way. The works in this special issue share the use of intelligent components to support immersion and interactivity, with the ultimate goal of allowing visitors and collections to reveal, share and exchange their stories. In this manner, this special issue gives evidence of the vitality of this research area.

In summary, the special issued provides a palette of technological and conceptual tools that can be expanded and reused to create new citizen-inclusive applications, building tomorrow's citizen curation upon their multi-faceted experiences.