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Emerging Technologies and the Digital Transformation of Museums and Heritage Sites

First International Conference, RISE IMET 2021
Nicosia, Cyprus, June 2–4, 2021
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Preface

The RISE IMET International Conference on Emerging Technologies and the Digital Transformation of Museums and Heritage Sites was conducted online during June 2–4, 2021. The conference was organized by the CYENS Centre of Excellence (formerly known as RISE), which constitutes a joint venture between the three public universities of Cyprus (University of Cyprus, Cyprus University of Technology, and Open University of Cyprus), the Municipality of Nicosia, the Max Planck Institute for Informatics (Germany) and University College London (UK). This was the first conference in a series of CYENS conferences focusing on Interactive Media, Smart Systems, and Emerging Technologies (IMET).

The first RISE IMET conference was dedicated to Emerging Technologies and the Digital Transformation of Museums and Heritage Sites. In particular, the conference was dedicated to the exploration of current practices in the use of emerging and interactive technologies such as augmented, mixed or virtual reality, holographic models, 3D models, artificial intelligence, sensors, and gamification in museums and heritage sites. The aim of this conference was to promote critical and interdisciplinary approaches and conversations between participants from diverse fields and to encourage dialogue between academics and professionals from various backgrounds on digital advances, innovation, and their impact on the field of cultural heritage. Thus, the conference was addressed to academics and professionals from the fields of museum studies, cultural heritage, computer science, heritage management, artificial intelligence, visual arts, and cognitive science, amongst others, and it aimed to provide an interdisciplinary platform to discuss state-of-the-art developments in academia and industry, as well as opportunities for networking and collaboration through a series of keynote addresses and presentations.

The conference offered a variety of themes, focusing on many different types of technologies as well as different key discussions, such as the advantages, challenges and limitations of emerging technologies, current theoretical and practical approaches in digital heritage, emerging trends in the digital presentation, interpretation and management of cultural heritage, issues of immersion and authenticity, and the application of emerging technologies in specialized areas of cultural heritage (e.g. contested heritage, cultural tourism, education and museum pedagogy, participatory practices, etc).

A total of 119 submissions were received from authors in more than 27 countries, including the USA, the UK, the Philippines, Estonia, Austria, Greece, France, Australia, Cyprus, Spain, Norway, Finland, the Netherlands, China, Sweden, Germany, Argentina, Israel, Russia, Mexico and Italy, amongst others. All submissions went through a rigorous review process to ensure that the best quality papers were selected for presentation.

This volume includes 23 selected papers from the conference. All full papers went through a rigorous double blind review process involving at least three independent

reviewers. The Scientific Committee made a tremendous effort to ensure fairness and consistency throughout the review process.

The volume is structured around six main themes: Digital curation and visitor engagement in museums and heritage sites; VR, AR, MR, mobile applications, and gamification in museums and heritage sites; Digital storytelling and embodied characters for the interpretation of cultural heritage; Emerging technologies, difficult heritage, and affective practices; Participatory approaches, crowdsourcing, and new technologies; Digitization, documentation, and digital representation of cultural heritage. Through these themes, the proceedings volume covers many aspects of different applications of emerging technologies in museums and heritage sites, offering insights on both the technical aspects and challenges faced and the interpretive aspects of the museum experience, as well as on the visitor/user experience. The papers also cover and discuss a variety of different technologies such as VR, AR, MR, gamification, virtual humans (avatars), projections and holograms, 3D scanning and photogrammetry, digital archival practices and digitization tools, NKRL (Narrative Knowledge Representation Language) tools, and sonic practices, amongst others.

The collection of papers comes from authors from universities, research centres, and museums and heritage organizations, showcasing case studies and collaborative research amongst various actors and countries, and presenting different approaches and challenges found in different parts of the world. The selected papers are also indicative of the interdisciplinary nature of the conference, since many author groups consist of a mixture of collaborating scientists (coming from the fields of technology or computer science, museums and heritage, and digital humanities) showcasing interdisciplinary endeavors and research, which was the main aim of RISE IMET.

RISE IMET 2021 offered a virtual platform for its participants to share their experiences, knowledge, and insights and to exchange ideas on the future of emerging technologies in museums and heritage sites. The conference also included five keynote speeches from distinguished academics and professionals: Alan Chalmers (WMG, University of Warwick), Sarah Kenderdine (Laboratory for Experimental Museology, eM+, École Polytechnique Fédérale de Lausanne), Jenny Kidd (Cardiff University), Nancy Proctor (Director, The Peale Center for Baltimore History and Architecture), and Roberto Scopigno (Director, ISTI-CNR, Italy). We would like to extend our gratitude to our keynote speakers for their contribution in the conference. We are also extremely grateful to our Scientific Committee for the valuable reviews and the time they invested in producing high-quality reviews and ensuring the high academic standard of all accepted papers. Their expertise and support constituted a bedrock for the success of this conference. We would also like to thank Springer for supporting us in the production of these proceedings and for providing us with the opportunity to publish the RISE IMET proceedings in their CCIS series.

Last but not least, the editors would like to take this opportunity to thank all conference participants for supporting and trusting RISE IMET, especially through the organizational difficulties faced because of the COVID-19 pandemic. Their

high-quality contributions and vivid participation allowed RISE IMET to achieve the academic and public outreach goals set at the beginning of this journey.

June 2021

Maria Shehade
Theopisti Stylianou-Lambert

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Computational Archives for Experimental Museology

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Abstract. This article addresses the potential for computational practises within archival and museological domains by charting a positional shift occurring in digital archives; from working with an object orientation and containment – to computing with a dimension orientation, segmentation, analytics and visualization. Computational museology allows us to conceive new trajectories that link all forms of cultural materiality: objects, knowledge systems, representation and participation. Following key definitions, the authors: outline state of the art in archival access and museological engagement through a series of examples; examine advances in the computational analysis of archives exploring forward-looking trends for massive digital cultural archives; and introduce an upcoming project, *Narratives from the long tail: transforming access to audiovisual archives*.

Keywords: Museology · Audiovisual archives · Curatorial analytics · Visualization · Interaction · Immersion

1 Introduction

1.1 Definition

Experimental museology sited within cultural heritage emerges from the delicate interstices of technologies and interfaces, human interaction and experience, and culture and social spaces. As a fulcrum for translation experimental museology traces epistemic patterns of abstraction, documentation and reformulation of cultural heritage; and the systemic transitions of the archive and cultural interaction with the archive [1].

1.2 Computational Archives

A positional shift is occurring in digital archives; from working with an object orientation and containment delineated in documentation and high-level archival ontologies – to computing with a dimension orientation, segmentation and analytics. New semantics arising out of this systemic shift are yet to be grounded, interpreted, abstracted and formalised as informatics in cultural heritage documentation. Computational archives are new terrain upon which curators will reckon with heritage materiality and calculate and define new fine-grained archival ontologies and narratives [2]. Large-scale curated

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video archives serve as important social contexts for difficult questions arising in data science and computer science to be asked and answered—and also connect diverse audiences with their multimedia cultural heritage. Video archives can be oriented to enabling novel exploitation of new, curated, diverse and large data assets, for the purposes of public engagement e.g., examining the rules of cinematography [3] through computation and analytics.

An interdisciplinary approach to working with computational archives will aid with testing technological and epistemological assumptions underlying computer vision, audio-visual, archival, and media studies; and new media research [4, 5]. By harnessing the push for transparency in the reuse of scientific research methods to transform big cultural datasets into computational archives this can also serve as "…an open process of scrutiny [and] is one of the pillars of scholarship and, in the end, scholarship's claim to social legitimacy" [6, p. 75].

It is timely for a wide range of research disciplines and archivists that work with video, to work with computer scientists, to examine how this mix of disciplines and research methodologies can be effectively drawn together to deliver value to different industries and sectors – and – wider community. Work has already been undertaken to detect and identify notable figures in footage drawn from more homogenous video archives for the purposes of refinement and testing techniques [7] in laboratory settings to meet an organisation goal, monographic narratives and national agenda [8]. Multimodal computational methodologies are yet to be applied to heterogenous curated cultural video archives, across a multitude of cultures, periods, events, experiences, storylines and genre. Experimental museology aids with expanding, testing and linking together the work undertaken in research labs as scholarly labs and in museums as labs for civic engagement with scholarship and curatorship.

1.3 Experimental Museology

This essay focuses on the work of the Laboratory for Experimental Museology (eM+) at EPFL. Within its broad remit from computational imaging through to immersive visualization, part of its research is based on new modalities of access to digital archives. Bridging academia, archives, museums and society, eM+ focuses on the contemporary challenges of public access to the principal mnemonic records of the 20th and 21st centuries: large-scale audiovisual archives and the large-scale cultural datasets that are the foundation of museological archives. Through computational processes, eM+ sets out to address and resolve the gap between digital archives and the embodied, participatory world of museological experience encompassing machine learning, visual analytics, digital museology, and archival science. Taking a 'systems thinking' approach to incorporate all aspects of its dynamic structure, 'computational museology' builds upon digital archiving through interlocking methods that will allow audiences to meaningfully explore the semantically rich 'long tail' of audiovisual memory [9].

Computational museology lies at the intersection of artificial intelligence, data curation, experimental and speculative visualization and performative archives. It is grounded in novel approaches to digital museology and digital archives in conjunction with the application of participatory museology. The domain undertakes to innovate

'narrative visualization', where narrative is widely understood to arise from a rich philosophical background in time-based media (cinema, media art, gaming) and interactive visualization. The approaches taken in the examples in this essay, provide systematic attempts to solve the challenges of narrative coherence for visualization through its computationally enabled data mining, analytic and interactive visualization approach. As we attempt to address an interdisciplinary description, it is evident that some disciplinary boundaries overlap, while others are siloed. This summary reading underscores the challenges of our topic, as well as highlighting why these fields have to date been independently unable to resolve the impasse of public access to the 'long tail' of audiovisual archives.

2 Massive Cultural Data

2.1 Audiovisual Archives

Audiovisual archives face an impasse with multiple implications for culture, public history and society. The pressure for these repositories to be 'open' has increased with European Commission strategies of inclusiveness, accessibility to and reuse of public information. This is underscored in the promotion of research and innovation, through FAIR and Open Access policies, and the notion of shared value as invested in 'the Commons' [10]. For the world's moving image and sound archives, preservation and access are twofold aims with sometimes conflicting values: digital preservation seeking to safeguard collections, while access prioritizes societal and economic impact. Closed collections also entail perpetual high-cost maintenance yet have little civic value [11, p. 10, 22]. Archival scholars, such Fossati, have pointed to these distinctions; highlighting dichotomies of preservation versus the reuse of film archives, and the need for engagement with new performative frameworks [12], to provide a genesis for both archival practices and museological approaches.

In response, broadcast institutions, notably the Netherlands Institute for Sound and Vision (NISV), have been at the forefront of pioneering policy and research [13]. Indicating the nature of the challenge, with an investment of 100 + million euro, the Eye Filmmuseum and NISV project, Images for the Future (2007–2014) resulted in 20% of the Filmmuseum's collection being digitized. However, due to copyright restrictions, only 2% was made public [14, p. 48]. Several similar investments have been made including by EU Screen portal [15], the BFI's 'Unlocking Film Heritage' program [16, 17] and Europeana [18].

2.2 Curatorial Analytics

Archival practices are relitigated and reworked by the introduction of computation and operationalization [19]. Digital archives have long been managed as collections of objects with database and search as efficient functional mechanisms that use Cartesian documentation methodologies and information retrieval methods. Archives are containers for objects – and – a social construction of all that they signify and obscure. That is, disrespect or respect du fonds, arrangement and description—how archives are

grouped, defined and represented; and appraisal and elision—what is retained and interpreted and why. Archival theory is freighted with social observation and practices of control asserting socio-political and semantic boundaries. Archives exist in multiverses [20] and are "deeply implicated in webs of affective relations" [21, p. 7].

Operationalizing the archive in a museological context triggers three significant positional shifts in archival theory and practice: (1) the archive moves out from sphere of object containment and archival system retrieval and into the social sphere of immersed experience; (2) the archivist moves into a new cultural mediation mode enabled by interdisciplinary dialogue with museology and media specialists and computer scientists; and (3) the multitude of cultural features embedded in the digital archive are reified in new spatiotemporal, social, affective and aesthetic semantics that enable new abstractions, political restructuring and narrative reimagining.

A computational archive is a continuation of the functional definitions of and interactions with the archive, but as "data source" rather than object store. The use of computer vision (as analytic tool) is a new approach yet to be embedded in archival practice and cultural heritage informatics. Operationalization of the archive as "data source" exposes the need for an end-to-end data flow from institutional metadata and content stores to new data repositories [22, 23]. Acts of data integration, transformation and restructuring in the generation of cultural analytics will also involve curatorial interpretation of archival objects, their dimensions, relationships and contexts. A "dimension" view of archival data as valent and affective, is a continuation of the precept that cultural signifiers emerge "from the archive" regardless of their material presence or absence, or promotion or elision. A computational archive is a refactoring not just of digital archives but also of curatorial practices of authority and interpretation and the philosophical and positional shifts required in digital transformation. A curatorial approach to selecting and formalizing analytics aligned with museological and archival interpretation and documentation and paratext practices can encompass multiple perspectives and explanations.

Curatorial analytics will build on cultural analytics (as material deconstruction of the archive through computation and generalization) [24] by maintaining a focus on semantic refinements, variation, contextualization and significance.

3 Archival Access in Museums

Museums have experimented with new technological forms and formats to enhance public engagement. Digital museology has been at the forefront of this trajectory more than a decade [25]. Within this field, a distinct approach of experimental museology has been taken by the Laboratory for Experimental Museology at EPFL to innovate at the intersection of immersive visualization technologies, visual analytics, aesthetics and cultural data. This area of research has advanced theoretical frameworks emerging from new museology since the early 1990s, redefining the boundaries of public and exhibitionary space. Through its tripartite speculative, applied and theoretical research, experimental museology engenders new modes of knowledge production arising from digital cultural archives, doing so through a participatory model focused on situating audiences and their experiences at the center of knowledge creation [26].

Significant to this latter pursuit is the overlooked role of 'embodiment' in creating meaningful museum experiences, specifically by amalgamating cultural heritage archives with interactive cinema to foster novel forms of embodied narrative [27, 28]. Experimental museology thus nurtures new forms of interpretation based on phenomenological and cognitive encounters as they emerge in relation to immersive, interactive visualization technologies [29]. Important theoretical shifts due to the impact of digital technologies on spectatorship and perception inform the experimental framework of eM+, among them the concepts of immediacy and remediation [30], interactive narrative, aesthetic transcription [31, p. 10], and modes of performance and creative reuse as a means of generating new narrative and memory.

In order to address the gap between audiovisual repositories and the public sphere, it is necessary to augment the data curation lifecycle at a systemic level [32] in a dual method that implements novel computational approaches to the archival collections themselves [33] in tandem with novel forms of in situ engagement for narrative making. We propose a major research effort to enable these new forms of expressive media through computational methods and analytics, thus enabling the enormous untapped potential for public 'history making' and promoting sustainable futures for audiovisual memories [34].

3.1 Narrative and Visualization

Kenderdine and her collaborators have been at the forefront of a major research trajectory in the creation of narrative through interactive systems and information visualization for cultural heritage materials (i.e., sites, objects and archives). The pioneers of this field have also conceived powerful interactive visualization environments, endowed with omnispatial and omnidirectional capacities in which participants are mobile and are able to look in any direction in the three-dimensional 360-degree virtual environments [35, 36]. Crucial to this present research, immersive framing notably helps to resolve problems of data occlusion and distribute the mass of data analysis in networked sequences revealing patterns, hierarchies, and interconnectedness, and data fusion [37] while hybrid approaches to data representation allow for the development of audio strategies to augment the interpretation of search results [38]. For instance, Panorama+, the 360-3D platform that is the basis of the experimental setting that has been shown to enhance cognitive exploration and interrogation of high-dimensional data, essential for big data while also providing powerful spaces akin to the real world for simulation [39].

A seminal media artwork in this domain is T_Visionarium II [31, 40] developed among other iterations between 2006 and 2014 (see, Fig. 1. and video at https://vimeo.com/2832411). Situated in a panoramic environment, its source material is a collection of 24 h of free-to-air broadcast TV footage from 7 Australian channels. Computationally segmented according to changes (i.e., edits or to camera angle cuts), and analyzed to assign these to metadata categories of emotion, expression, physicality and scene structure, and metatags such as speed, gender, color, in the final visualization, the viewer can both search and recombine 500 simultaneously looping video streams of 4 s each. The system is highly responsive: when one image is selected, all the other semantically similar clips flock to the opposite side, 180 of the 360-degree display

screen. The entire search matrix can be weighted in favor of specific metatags chosen by the viewer, and the clips can be recombined to create a new filmic episode. This early experiment in spatialized video montage reveals the affordances of empowering the viewer to engage in actively re-conceptualizing a moving image collection. The dynamic re-sequencing of segments allows the user to create an emergent or 'transnarrative' version (i.e., traversing individual narratives).

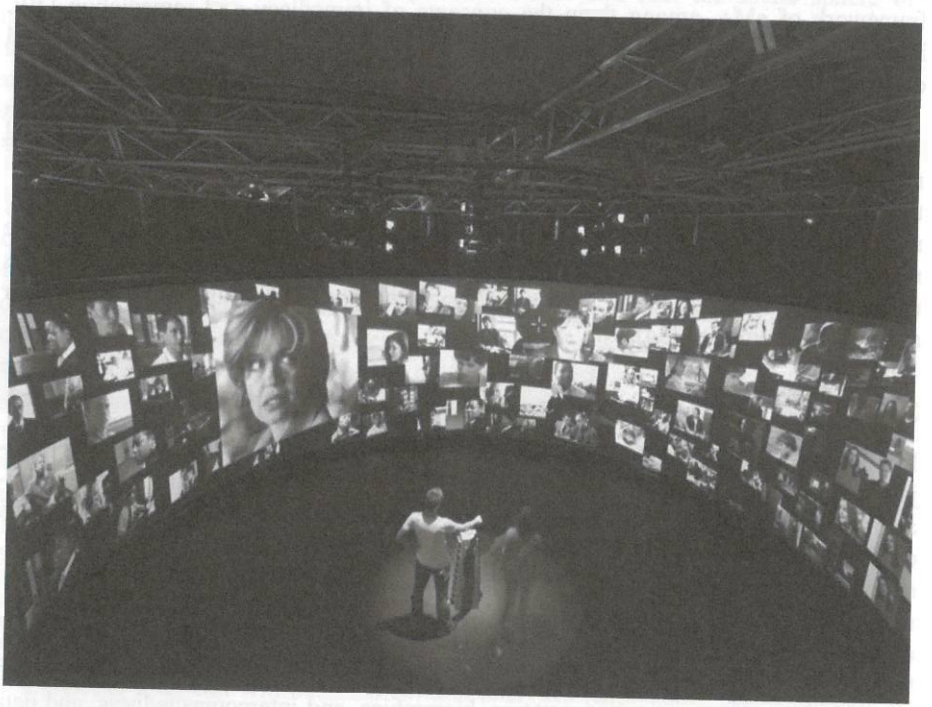

Fig. 1. *T-Visionarium II*, iCinema Centre, UNSW 2009. Photo: iCinema, UNSW.

ECLOUD WWI is an interactive spatial browser for the exploration of cultural data collected in the Europeana 1914–1918 archive (Fig. 2). Presented in a 3D custom designed 9 m by 3 m projection screen, the installation contains more than 40,000 images of war memorabilia ascribed to 2,500 individual stories collected across Europe between 2009 and 2013 in an ongoing Europeana crowdsourcing project [103].

The installation instantaneously aggregates the digital imagery and its associative metadata to provide an immersive viewing experience. Museum visitors use an iPad tablet to navigate and direct the data that is displayed on the panoramic arc of its screen. Six satiric European maps of the period are entry points into the archive via specific images that represent particular stories chosen by the curators of Europeana. Selecting one of these images brings up its description and related articles, artifacts and objects. This story group then becomes the portal to other metadata-associated image groups that appear as 'clouds' of images rendered on a rotating 3-D cylinder. Selecting any

image from this cylindrical cloud causes the picture, along with its description and associated themes and metadata, to expand, and this in turn provides the viewer with the opportunity to link to other such clouds of images with different themes [41].

With 40,000 images and 15 keywords, the contents of this Europeana digital archive can be dynamically recombined for extended non-linear exploration by the viewer. The visualization strategies engaged in ECLOUD WWI signal opportunities for new curatorial practices and embodied museography by redeploying Internet data in a situated museum setting. ECLOUD WWI applies an integrative pluralist approach to the juxtaposition of image and memory that signals a shift from traditional classification and organization to a newer search-and-remix paradigm; the emphasis here is on personal affective engagement with cultural memory and on interface.

Fig. 2. *eCloud WWI*, Applied Laboratory Interactive Visualization and Embodiment, 2012. Photo: Jeffrey Shaw.

Counter to the notion that databases and narratives are natural enemies [42], the dynamic segmentation and recombination of data has the potential to open up new realms of narrative coherence for participants, while also challenging conventions of meaning making. The world's first immersive 360-degree interactive data browser for museum collections *mArchive* (Fig. 3) was the result of an experimental application designed to develop emergent narrative arising from a museum collection. This research project was focused on 100,000 heterogenous image records from Museum

Victoria (with a total collection of 16 million items). The application uses extant collection metadata as the basis for an active interface to create the equivalent of a 'real-time curating machine'. It has been installed since 2015 in the Museum's visualization system, where it is available for up to 30 visitors at one time.

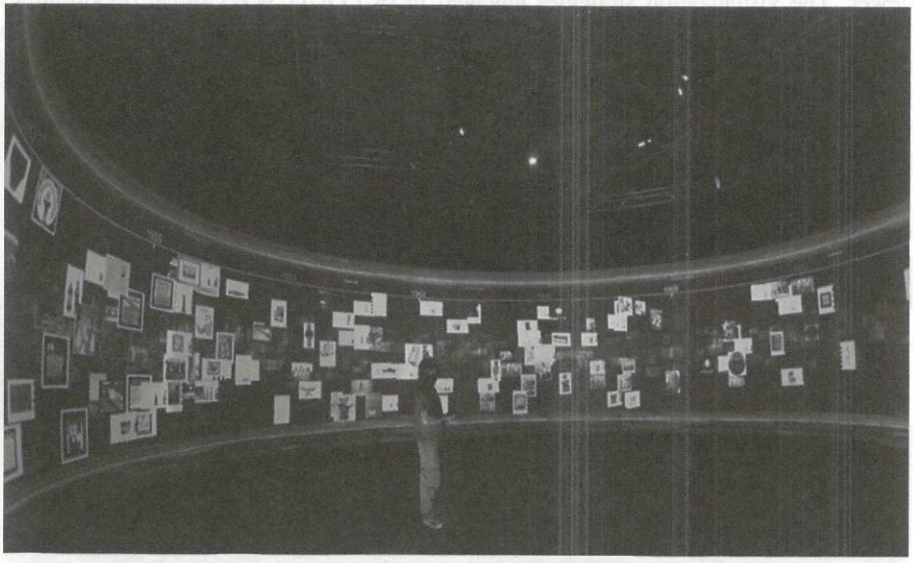

Fig. 3. *mArchive,* Museum Victoria, 2015. 100,000 objects distributed across a 360-degree 3D screen. Note: no text-based search engine is provided. Photo: Volker Kuckelmeister.

More recently, *Jazz Luminaries* (2019; Fig. 4, see video at https://vimeo.com/414654196, password: jazz), transforms the Montreux Jazz Festival archive into an interactive installation. Combining extant metadata and novel visualization, Jazz Luminaries enables viewers to cut, remix and replay over 13,000 videos of the 5,400 jazz greats recorded in the archive. Each musician is represented by a node, which is interconnected to other Festival artists based on their historic collaboration over the years. This interaction is enabled through a unique multimodal interface, under a fulldome where participants generate an experience of their own, illustrating the shift from a linear classification of objects within inventories to their remix, recollection, regeneration and reworking, interaction and serendipitous discovery [43].

3.2 Visualization – Searching Collections

A shift in the 'grammar' of the visual occurred from the end of the 1990s, as graphic and computational techniques were applied to visually represent and generate alternate insights into complex and large-scale collections of information [44]. Often referred to as the 'diagrammatic turn' [45], these new forms of information visualization, or InfoViz, are based on the notion that graphical representation can harness and augment

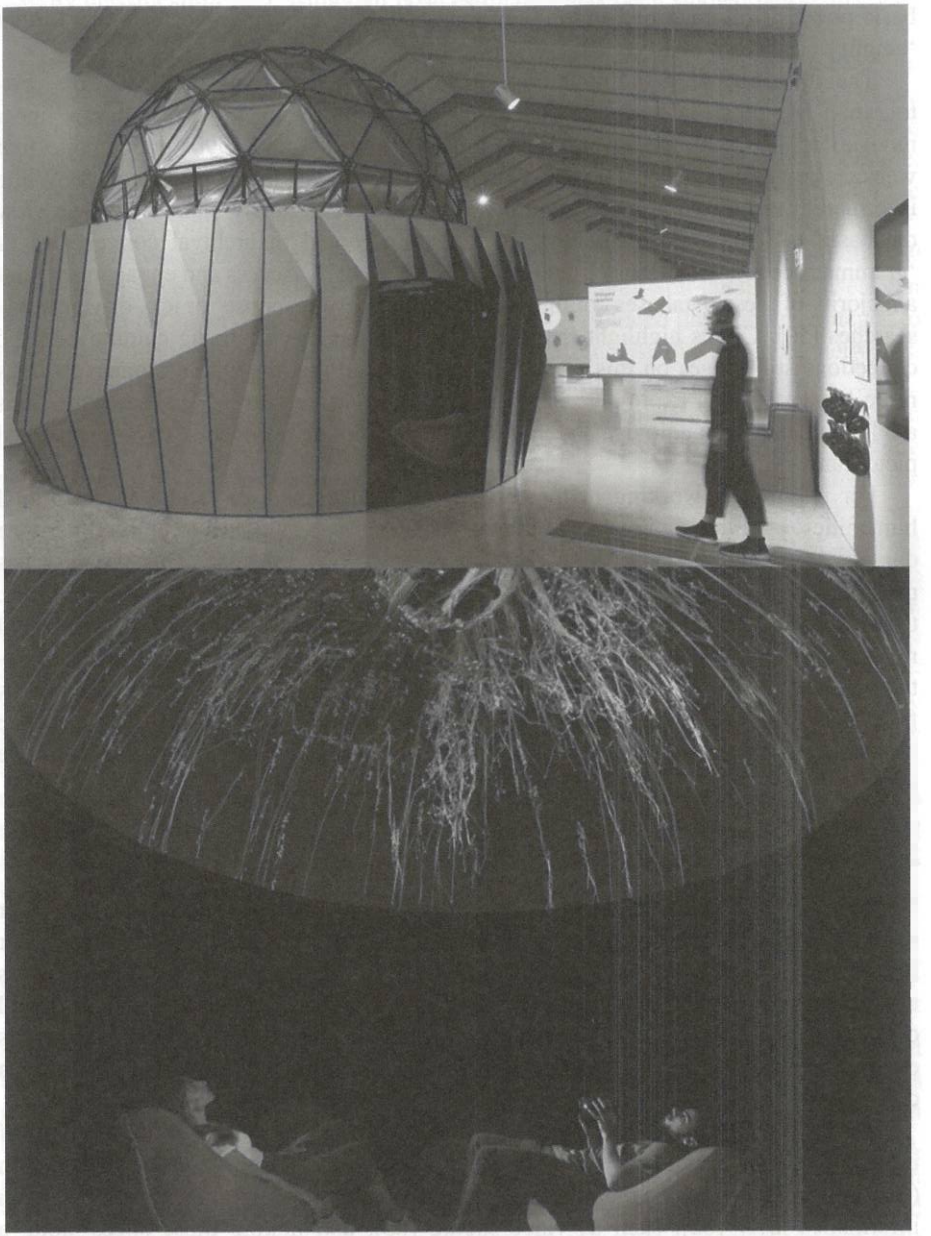

Fig. 4. *Jazz Luminaries* by eM+, *Infinity Room 2*, ArtLab EPFL 2019. Viewers reclined under the eM+ dome, navigating a social network constellation of the jazz greats in the Montreux Jazz Archive. Photos: Catherine Leutenegger/Sarah Kenderdine

basic powers of human perception, and that visual representations of data can further 'amplify cognition' [46].

The influence of data-driven visualization on search tools (i.e. networks, histograms) is evident in the consistent graphic and informatic logic of flatness, linear navigation [47]. With the advent of the Internet, from the mid-1990s public collection websites could have become a virtual counterpart for the in-situ, located archive. While information visualization and 'cultural analytics' have arguably altered how we view databases [48] tools for searching them remain rooted in archival conventions of 'grammato-centristic notions of data storage' [50, p. 117]. Access and engagement with a majority of these databases continues to rely on 'query-response' or text-driven single searches [50]. Critics highlight that the state-of-the-art in visualizing cultural heritage collections still hinges on this database paradigm and that the whole domain requires more 'generous' and expressive interfaces for in-situ access [51–53]. These questions are fundamental for audiovisual archives, which cannot be resolved in two-dimensional pictograms.

For researchers working in the recently defined domain of 'audio visual digital humanities' [54] the application of digital visualization techniques to cultural heritage datasets is a new and innovative research methodology [55, 56]. This progress has prompted a turn away from the tools made for textual digital humanities studies, towards new approaches for access, discovery and study of moving image and sound materials. There is also an awareness of the need to shift this research from an institutional framework, to address the crisis of public access [57]. Other research in this field has concerned how interaction and user creativity can be harnessed to enhance browsing environments, such as multimodal browsing or searching along multiple threads [58, 59].

3.3 Advances in Computational Video Analysis

Video retrieval, or the content-based retrieval of digital moving images in the computer vision research domain, has been a significant field for 20 years, see TRECVIC, for instance [60]. Central to online video platforms (YouTube, Vimeo) video retrieval is also one of the key tools that large moving image archives use to make their digital collections searchable online. Recent work on information retrieval and data analytics enabled by machine learning research has made an impact on broadcasting production discoverability [3, 61].

Advances in the visualization of video data, which began with visual abstractions of images in video as keyframes and evolved to incorporate different semantic information (features from text and sound), have also evolved to incorporate features into an informatics layer [62], such as video-slicing [63], and linking those slices along a timeline to connect features in space and time [64]. Visual analytics research has begun to refine methodologies through which the semantics derived from 'deep architectures to capture complex relationships among multimodal features', including gesture and emotion recognition [65]. Computer vision has seen noted breakthroughs since 2012 in convolutional neural networks – a deep learning technique that can detect objects in images with almost human-level accuracy [66]. There has been intense work on new neural network architectures for various perception tasks such as human detection, and

activity classification [67]. Although pose estimation has been studied before the deep learning era, it is a significant cornerstone in the new work of Wei et al. [68].

In summary, a curatorial focus on data is maturing in computer vision research, to delineate datasets as fit for different tasks (instead of 'one size fits all'). There is also a growing interest in the evaluation of video data for the purpose of developing and testing algorithms, however the sources for this research is usually web accessible, camera or sensor imaging (readily available), or it is orchestrated and generated for the purpose of experimentation. Computer vision research using video has vastly diversified like its datasets, in tandem with machine learning techniques. Datasets with few or no labels have been used for unsupervised learning, and well-labelled datasets can also be used for supervised learning. The visualization of video data, however, tends to repeat the functional and illustrative forms of scientific visualization (i.e., networks, histograms, the use of snippets or derivatives are used to visualize features).

There is, to date, no discussion on data science challenges associated with video visualization for the purpose of engagement and this is the subject of an upcoming project *Narratives from the long tail: transforming access to audiovisual archives*, funded by the Swiss National Science Fund as a Sinergia grant (2021–2025) in collaboration with: EPFL, University of Zürich, University of Amsterdam and the archives of the International Olympics Committee (Olympics Museum), Montreux Jazz Archives, Swiss Television and Radio and the Eye Museum in the Netherlands. *Narratives* will transcend state-of-the-art across all its fields to initiate a groundbreaking visualization framework for interactively (re)discovering hundreds of thousands of hours of audiovisual materials. This is achieved through *Narratives*' highly novel 360-degree 3D Narrative Visualization Engine, that will dynamically reveal the spatial, temporal, social, affective and aesthetic patterns, phenomena and processes of archival collections, and ensure 'narrative coherence' for audiences as they navigate them. This scalable and participatory engagement model aims to situate audiences and their experiences at the center of knowledge production while also stimulating innovation in archival practices [69].

4 Conclusion

Artificial intelligence and computational video archives are already operationalized in broadcasting, film production and professional sports. Computational methodologies and visualization technologies, techniques, and analytics from industry that are taken up, translated and reworked with cultural heritage practice will impact on curation, pedagogy, aesthetics and the design of public exhibitions. Constraints and issues in computer and data science include a slow transition from machine learning enabled experimentation into the uptake and refinement of computational methods and their application in different loci. New challenges around data quality, scale, and accessibility, and the exposure of bias in data, algorithms, analytics and visualization methods have emerged and pose collective challenges. There is a call for more transparency, explainability and interpretability in data science, computational and AI methods and practices [70]. Multiple disciplinary interests are converging and opening out questions that expose issues with big data curation, human-computer interaction, ethics and social

impact, visualization, and knowledge transfer [71]. Diverse perspectives are needed to challenge and critically evaluate computational methodologies and the use of artificial intelligence in cultural and social contexts, including museums.

The rise of audiovisual analytics addresses a need to get through content quickly and to search through databases for content and as a specialism has already positively impacted several domains e.g., broadcasting, sport, commerce, and science [72]. Video analytics, computational archives and AI however will all need to be critically evaluated, reinterpreted and potentially reconfigured to become a part of curatorial practice in cultural heritage. In a public space curatorial intention and public response involve social and dynamic human-machine interaction and dialogue, so multiple perspectives can be drawn together in the interpretation and representation of cultural and social knowledge [73]. Experimental museology contends very differently with the challenge of high dimensional data that contains a myriad of variables and correlations and multiple historiographic explanations and reinterpretations of cause, effect and consequence. Experimental museology is a driving force for diverse narrative and analytics and visualization that embrace curatorial determinations of cultural significance, individual and communal reassessments and redefinitions, variation and uncertainty [74].

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