eNCATC
EUROPEAN JOURNAL OF CULTURAL MANAGEMENT AND POLICY

TYPE Original Research
PUBLISHED 12 August 2025
DOI 10.3389/ejcmp.2025.14963

OPEN ACCESS

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RECEIVED 26 May 2025
ACCEPTED 22 July 2025
PUBLISHED 12 August 2025

CITATION
Rizzi G and Casciani D (2025) Scouting emerging AI applications in fashion heritage and archival practices. *Eur. J. Cult. Manag. Policy* 15:14963. doi: 10.3389/ejcmp.2025.14963

Scouting emerging AI applications in fashion heritage and archival practices

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Artificial intelligence (AI) increasingly influences the Cultural and Creative Industries (CCIs), offering new ways to support and enhance the sector. In the field of cultural heritage, AI has proven valuable across various disciplines, assisting in restoration, reconstruction, and the enrichment of historical knowledge. This paradigm opens new perspectives for fashion heritage, where AI technologies contribute to the preservation, reinterpretation, and dissemination of digitised archival materials, including garments, textiles, sketches, and photographs. This article investigates how AI is being integrated into fashion heritage practices by combining academic literature with practice-based evidence. Through an integrative review, it identifies three main trajectories of application: Conservation, Reinterpretation, and Exploration. These clusters highlight how AI is reshaping archival workflows, expanding access, and supporting new creative and curatorial approaches. The intersections between the trajectories give rise to the Creative Recovery, Heritage Imaginaries, and Augmented Access, which enable hybrid practices in current AI applications. The study concludes with a critical reflection on the main ethical concerns, including legal issues, economic implications, and concerns about data representation. These reflections are accompanied by a broader reconsideration of how memory is constructed and mediated in the contemporary context, increasingly shaped by human–AI collaboration.

KEYWORDS

fashion design, fashion archive, artificial intelligence, fashion cultural heritage, digitalisation

Introduction

Over the last few decades, interest in conservation practices in museums and archives concerning fashion and its related materials has intensified, recognising their high value as manifestations of culture, both in their tangible form as artefacts and in their intangible nature, encompassing techniques, processes, and cultural meanings embedded in their physical form (Vacca and Vandi, 2023). They enable the construction of narratives that position them as barometers of collective social change and as witnesses to shifting modes of expression of individual identities (Peirson-Smith and Peirson-Smith, 2020). This material dimension remains central to how fashion heritage is interpreted and communicated. When we think of fashion, our perception primarily falls on its visible

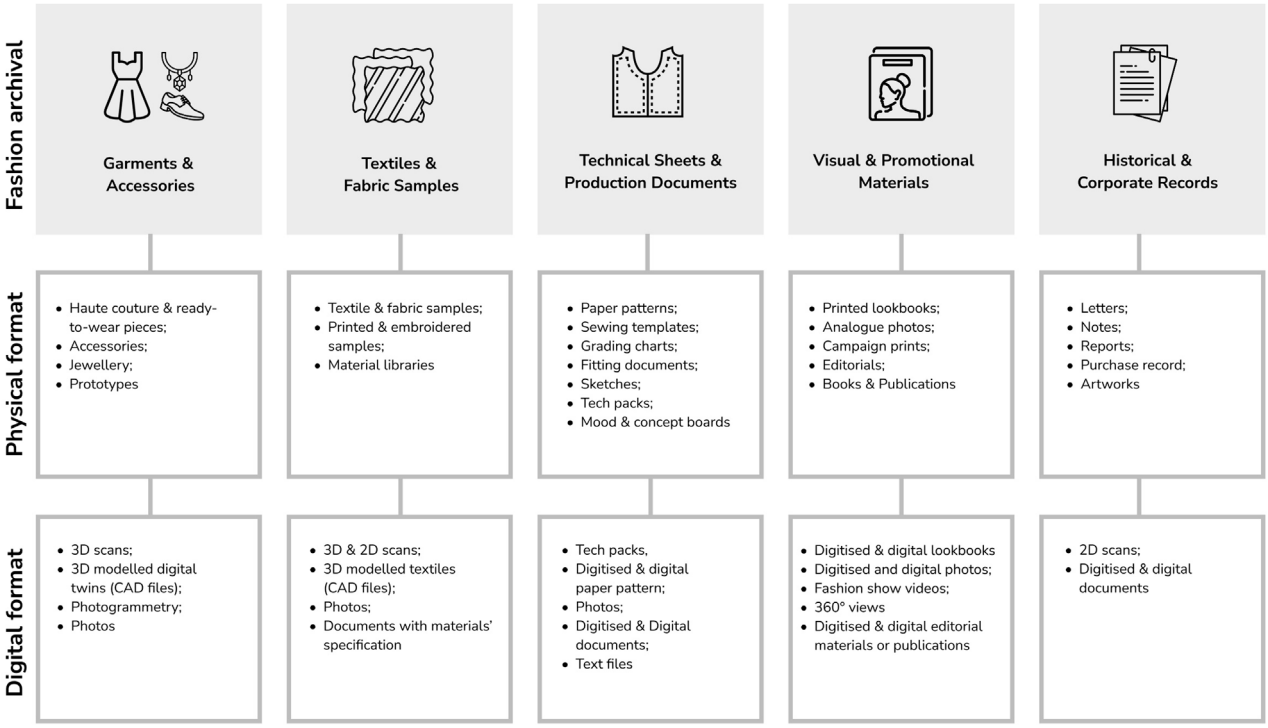


FIGURE 1
Taxonomy of fashion physical and digital format of archival items. Source: Authors.

form, materialised in the garment. From there, the communication of its cultural value is propagated through various assets, such as sketches, photographs, written documents, promotional media and materials, historical and corporate records, all of which contribute to contextualising and conveying the cultural significance of fashion heritage (Vandi, 2023).

In the current landscape, the inherently digital nature of fashion, driven by the diffusion of Industry 4.0 technologies, has transformed design practices through the adoption of digital tools, resulting in fashion materials that are natively digital and redefining the discipline across both physical and virtual realms (Särmäkari, 2023). This shift in how fashion is created and experienced also has direct implications within archival practices, which now require approaches that adapt to the new nature of fashion materials and their evolving modes of presentation and communication (Peirson-Smith and Peirson-Smith, 2020). Consequently, in the process of fashion heritagization, digital fashion is legitimised and rendered visible in both its contemporary and historical forms, enabling its dissemination beyond the material confines of the museum. From this perspective, digital fashion is increasingly treated as equivalent to material fashion, archived and granted a new form of permanence. It becomes an act of "past-presencing," where curated stories become accessible on a large scale thanks to their new digital form (MacDonald, 2013; Melchior, 2019). While archival practices traditionally focused on preserving physical artefacts, today they are being reimagined to embrace more inclusive approaches that bridge past and present, physical and digital, the tangible and intangible value of artefacts through hybrid models representative of digital cultural heritage (Mason and Vavoula, 2021). These strategies reflect broader digital transformation trends in heritage practices (Brennen and Kreiss, 2016; Münster et al., 2024).

Since the 1990s, digitisation efforts have led to the expansion of archival content into digital formats (Colavizza et al., 2021). As a result, the concept of the archive is being redefined to integrate technologies enabling new strategies for acquiring and reorganising materials, redefining curatorial practices operating between digital and physical realms in hybrid narratives, and using digital devices that enhance and expand access to artefacts' multifaceted nature (Vandi, 2023). This digitally driven transformation enables a renewed vision of knowledge, emerging from new relationships between archival elements (Martin and Vacca, 2018). This process unfolds through the connection between existing physical materials and augmented forms of knowledge, fostering hybrid explorations across different languages and media by combining data analysis with the cultural meanings embedded in the materials. Reflecting this evolving notion of the archive,

Figure 1 offers a conceptual mapping of the core asset types that constitute fashion heritage in both physical and digital forms. This framework, informed by the authors' prior research and theoretical literature on fashion archives and documentation practices, serves as a basis for the following analysis on how AI technologies interact with the various components of fashion cultural heritage.

The incorporation of new technologies into museum practices marked what Pruulmann-Vengerfeldt (2013) defines as the "digital turn" (Pruulmann-Vengerfeldt et al., 2013), directly affecting the relationship between cultural institutions and the public. Although integrated technologies were initially intended primarily to support administrative functions, their role has gradually expanded into a broader digitalisation process, leading to the complete conversion of fashion collections and related materials into digital formats. Starting with image digitisation, the growing complexity and efficiency of technological tools have led to the development of immersive virtual reality environments featuring 360° visualisations and detailed 3D reproductions (Pecorari, 2019), unlocking a new layer of interaction between users and archival repositories, a type of narrative that is still evolving. Moreover, with the exponential growth of data volumes and the emergence of born-digital records, traditional conservation practices have been progressively supported by the contribution of AI (Colavizza et al., 2021). However, this research does not explicitly address fashion archives. While AI was initially introduced in the digital cultural heritage domain to support broader archival operations, such as data and metadata analysis through the deployment of Machine Learning (ML) techniques, the development of more sophisticated Deep Learning (DL) algorithms has led to its use for cultural data enrichment, addressing challenges related to the curation and reconstruction of cultural assets (Belhi et al., 2023). Such evolution in the integration of AI in archival practices redefines the traditional notion of an archive by transforming its interpretation from a historical repository into a dynamic resource, a collection of data from which algorithms extract information to inspire new creations. Past imaginaries are reframed in a way that allows their significance, primarily manifested through their outward appearance, to be remixed and reinterpreted, beyond the hierarchies of cultural value through infinite visual variations (Meyer et al., 2023). In this context, with the support of AI, the concept of style that is particularly central to fashion emerges as a powerful source for generating new meanings and attributing cultural significance. (Meyer et al., 2023), which can be transmitted to the public in an augmented manner. New directions are therefore emerging, enabled by AI to promote the conservation and communication of fashion heritage, allowing for the creative reinterpretation of historical materials, while seeking to safeguard the cultural significance and value of artefacts. While scientific literature has increasingly explored the potential of AI in the cultural heritage domain, particularly focusing on fields such as archaeology, fine arts, and linguistics, most studies in these areas have concentrated on the application of AI solutions (e.g., ML, DL, and generative AI models) to support the conservation, restoration, and enhancement of archival material. Moreover, Hajahmadi et al. (2024) explore AI's role in virtual retail environments, discussing the incorporation of historical elements and brand heritage into virtual retail environments but not fully exploring the potential of AI in reimagining fashion archives. The existing academic literature on the application of AI to fashion cultural heritage remains scant and predominantly concentrates on specific areas, such as image restoration and inpainting techniques. In contrast, this article hypothesises that the growing adoption of generative AI is expanding the scope of practices in this field, fostering more creative and diverse applications. This study aims to explore emerging uses of AI in fashion cultural heritage, moving beyond the narrow focus of current research. In parallel, the article also reflects the ontological and epistemological implications of this integration, particularly how AI challenges the traditional notion of memory and knowledge production in the cultural domain.

As part of a broader PhD research project on the intersection between fashion and AI, this article explores the integration of AI technologies within fashion heritage practices, identifying key trajectories and their implications for both material and immaterial cultural assets. It highlights emerging approaches with the potential to enhance the tangible and intangible dimensions of fashion heritage. It addresses key challenges such as the restoration of archival materials, the exploration of their creative and cultural significance, and the broader dissemination of fashion heritage. Section *Materials and Methods* outlines the methodological approach and tools used to frame the research and ensure its replicability. Section *Results*, provide the results of the analyses about the contribution of AI to the *Conservation, Reinterpretation,* and *Exploration* of archival content, highlighting its impact on archival processing, data management, enhancement of stored materials, narrative development, the augmentation of historical knowledge, and the enablement of new interaction strategies between users and both physical and digital archival environments. Section *Discussion* discusses the impacts of the presented trajectories of AI application in fashion cultural heritage, offering reflections on the technical, ethical, and epistemological challenges of AI integration. These include legal issues related to its use, economic implications for the cultural heritage sector, and concerns about dataset creation, knowledge curation, and representation.

Materials and methods

This study seeks to explore the evolving intersection of AI and fashion heritage by identifying and analysing emerging

modes of engagement, with the objective of uncovering how generative AI technologies are reshaping preservation, interpretation, and dissemination practices across both material and immaterial dimensions of fashion culture. To fill this gap, a literature search of academic contributions in the form of articles, book chapters, and conference papers was initially conducted in the Scopus database between January and April 2025, using a combination of keywords and Boolean operators across three main areas of investigation: the technological dimension of AI systems, their functional application to cultural heritage practices, and the specific disciplinary context of fashion-related cultural materials. These were explored through the following sets of terms related to (i) AI technologies: "Artificial Intelligence," "Generative Artificial Intelligence," "Generative Models," "Machine Learning," "Deep Learning," "Algorithms," "Image Generation," "3D Generation"; (ii) application objectives in cultural heritage: "Cultural Heritage", "Reconstruction," "Restoration," "Recovery," "Recreation," "Inpainting," "Infilling," "Preservation," "Conservation," "Documentation"; and (iii) application context: "Fashion," "Clothing," "Textile," "Garments," "Craftsmanship," "Techniques," "Folk Costumes," "Historical Fabric," "Embroidery," "Silk Heritage."

Due to the limited number of results specifically addressing the intersection of the previously delineated investigation areas, the review was extended through a snowballing method and supplemented with targeted searches on Google Scholar. As a result of this methodological choice, this article adopts an integrative review approach (Snyder, 2019), combining academic literature with practice-based evidence, exploiting grey literature sources, thus including company reports, websites, and interviews accessible via Google search related to fashion design projects, fashion brand initiatives, and cultural institutional programs. These cases were selected based on the following criteria: (i) connection to fashion cultural heritage and related topics, understood in broader terms to include experimental projects developed within research and innovation from academia, companies, or cultural institutions, as well as projects already implemented within the fashion industry; (ii) explicit integration of AI technologies, intended as tools and models, applied to the projects, whether used in relation to collections, garments, or garment-specific aspects (such as fabrics or decorative patterns), in either their material or digitised forms; (iii) availability, traceability, credibility and depth of information, by evaluating the legitimacy of channels where the sources are located, the purpose of the publication to exclude the evidently promotional or market-driven contents to select verifiable, detailed, and balanced ones substantiated by data. They were retrieved using Google search engines through the following keywords: "AI fashion archive," "AI fashion cultural heritage," "generative AI fashion design," "fashion museums AI," "digital restoration fashion garments," "AI exhibitions fashion," "AI textile heritage," and "AI fashion heritage."

The resulting cases include fashion heritage materials understood in broader terms, encompassing garments, accessories, and textiles, both in digital and physical forms. It also considers fashion collection–related repositories, such as sketches and drawings, photographs, technical information, historical documents, and pictorial records, such as ancient paintings. The cross-analysis of academic literature and practice-based industry sources offers a comprehensive examination of the evolving integration of AI within the fashion cultural heritage sector. Employing a thematic clustering approach (Saldaña, 2013), the analysis reveals both the technological dimensions of AI adoption and broader patterns of use across the field. This dual-level reading highlights, on one hand, the current role of AI in cultural heritage practices, addressing the technological evolution, its affordances, and limitations and, on the other, identifies three principal trajectories shaping its application: *AI for the Conservation* of Fashion Cultural Heritage; *AI for the Reinterpretation* of Fashion Cultural Heritage; and *AI for the Exploration* of Fashion Cultural Heritage. Furthermore, three key intersections emerged from the analysis: Creative recovery, Heritage imaginaries, and Augmented access.

The selected case studies are summarised in Table 1, organised by source type (academic or practice-based), AI model used, and their placement within the three main trajectories, also specifying the type of application within each trajectory and the orientation towards overlapping areas. This classification resulted from an iterative and interpretative process grounded in qualitative analysis, with Table 1 and Figure 2 developed in parallel to ensure coherence with the thematic clustering that informs the analysis in the following sections.

Results

The role of AI in cultural heritage practices

The contribution that AI can make to the CCIs, and in particular to the cultural heritage sector, has also been acknowledged at the level of European policy and EU funding programs. AI is valued not only for its potential economic impact but also for its role in preserving and promoting the cultural diversity of European heritage, contributing to democratising access to cultural resources and supporting creativity. According to the European Parliamentary Research Service (EPRS) and the European Commission, the integration of AI into the cultural heritage and museum sectors can generate positive impacts across three main areas (EPRS, 2023; European Commission, 2022).

TABLE 1 Synoptic table of the academic and practice-based industrial case studies selected in the contribution.

Source type	Project/Case and year	AI technologies	Trajectory	Trajectory subcategory	Area of intersection*(If applicable)*	Source
Academic Sources	Luo Coat Restoration, 2023	GANs, image inpainting	Conservation	Digital restoration and enhancement	Creative Recovery	Ding and Liang (2024)
	Ancient Textile Restoration, 2024	GANs, image inpainting	Conservation	Digital restoration and enhancement	Creative Recovery	Sha et al. (2024)
	Textura by SEDDI, 2024	CNNs, high-res image analysis, textile property extraction	Conservation	Digital reconstruction and simulation		Youn et al. (2024)
	Metadata Enrichment, 2024	NLP, word embeddings	Conservation	Archival cataloguing	Augmented Access	McIrvin et al. (2024)
	DeepKnit, 2020	GANs, knit code synthesis, visual style learning	Reinterpretation	Creative augmentation		Scheidt et al. (2020)
	Museum Learning Experience, 2024	Multimodal AI, emotion recognition	Exploration	Immersive and interactive environments		Fominska, et al. (2024)
	Hand-i-craft Bot, 2024	Domain-specific chatbot, NLP model, recommendation engine	Exploration	Interactive archival dialogues		Chai-Arayalert, et al. (2024)
	FabricNet, 2021	CNNs	Conservation	Archival cataloguing		Ohi et al. (2021)
	Zhang Xuan's Painting – Ramming and Washing Silk, 2025	Image inpainting, enhancement, vectorisation, 3D asset generation	Conservation	Digital reconstruction and simulation	Creative Recovery	Zhu et al. (2025)
	SilkNow Project, 2018–2021	Neural networks, Semantic web knowledge graphs, NLP	Conservation	Archival cataloguing	Augmented Access	Alba et al., 2021 https://silknow.eu/
	Miao Batik Culture, 2024	Knowledge Graphs, NLP, Improved ResNet34 DL Model	Conservation	Digital reconstruction and simulation		Quan et al. (2024)
	Co-creative dialogue with the archive, 2025	AI and ML, Interactive display	Exploration	Interactive archival dialogues	Augmented Access	Besana et al. (2025)
Practice-based industrial sources	Adidas AI Archive, 2023	Custom diffusion model, text-to-image generation, parametric design control	Reinterpretation	Heritage-based training; Creative augmentation	Creative Recovery	Suessmuth et al. (2023)
	Norma Kamali AI System, 2024	Stable diffusion, metadata-enhanced training	Reinterpretation	Heritage-based training; Creative augmentation	Creative Recovery	MIT News https://news.mit.edu/2025/norma-kamali-transforming-future-fashion-ai-0422
	Burberry AI Animation, 2025	Generative image animation	Reinterpretation	Heritage reformulations	Heritage Imaginaries	Burberry: https://row.burberry.com/c/burberry-world/campaigns/its-always-burberry-weather-trench-campaign/
	Lanvin Sport Campaign, 2025	Generative image animation	Reinterpretation	Heritage reformulations	Heritage Imaginaries	Ryder (2024)

(Continued on following page)

TABLE 1 (*Continued*) Synoptic table of the academic and practice-based industrial case studies selected in the contribution.

Source type	Project/Case and year	AI technologies	Trajectory	Trajectory subcategory	Area of intersection*(If applicable)*	Source
	Tatreez Garden – Future Archives, 2025	Custom generative model trained	Reinterpretation	Heritage reformulations	Heritage Imaginaries	Kawash, A. (2025) https://ameerakawash.com/tatreez-garden
	Chat with Natalie – Met Museum, 2024	LLM (GPT-based), curated training dataset	Exploration	Interactive archival dialogues	Heritage Imaginaries	Metropolitan Museum of Art https://chatnataliepotter.metmuseum.org/
	A.B.C. – Automating Blender Code, 2024–2025	Segment Anything, HuggingFace (semantic), Blender (3D generation)	Conservation	Digital reconstruction and simulation	Creative Recovery	Europeana, 2025. https://pro.europeana.eu/post/how-ai-is-transforming-digital-cultural-heritage

1. Conservation: AI supports cataloguing, organisation, and information management through ML algorithms, including artefact classification and analysis via computer vision, text interpretation, and automated processing of textual materials, as well as digital restoration assisted by DL technologies.
2. Research and Curation: AI facilitates the analysis, clustering, and identification of new connections between objects and data, expanding conventional applications of ML by leveraging both computational and interpretative capabilities.
3. Engagement: AI enhances cultural experiences and audience interaction through immersive and personalised access modalities, such as interactive exhibitions and reinterpretations of archival content; in addition, AI could support the management of visitor experiences via predictive analysis of attendance data and qualitative assessment of user engagement.

Prior research in the wider cultural heritage domain has highlighted advanced AI technologies' growing and pervasive applications. This article proposes to examine the adoption of AI within the context of fashion heritage, drawing parallels with the classification frameworks proposed by the EU. About area (1), key applications involve the analysis and restoration of material culture through automated reconstruction techniques, as seen in archaeological research (Altaweel et al., 2024); the recognition and classification of physical objects, and the application of AI models for certifying artefact authenticity (Varshney et al., 2023). AI has contributed to analysing and verifying the authenticity of ancient inscriptions, where AI-enabled authorship and geographic attribution even in cases of partial deterioration (Sommerschield et al., 2023). Additionally, AI supports the organisation and indexing of cultural content across archives (European Commission, 2022). Regarding area (2), AI supports the renewed historical-cultural exploration, enabling the recovery and reinterpretation of aspects of fashion heritage through innovative approaches (Münster et al., 2024; Spennemann, 2024). Regarding area (3), some of the most promising approaches involve integrating multiple technological solutions, where AI contributes to curating more personalised experiences. By combining AI with interactive and immersive tools such as virtual and augmented reality, the storytelling of archival materials and cultural values becomes more engaging, guiding visitors through the exploration of museums and archives (Münster et al., 2024).

A brief overview of AI technologies in cultural heritage

Drawing from the literature review, a synthesis of the most referenced AI systems used in archival and curatorial practices of fashion cultural heritage was established. AI can be broadly defined as a machine-based system capable of influencing its environment by producing outputs, such as predictions, recommendations, or decisions, based on human-provided input data, while operating with a certain degree of autonomy (European Commission, 2022). This definition allows for a wide range of applications, reflecting the flexibility and adaptability of AI technologies. Within this broader field, ML represents a key branch focused on using statistical models to analyse large datasets and predict phenomena (Yüksel et al., 2023). DL, a subset of ML, employs complex neural network architectures and is widely applied in domains such as computer vision, speech recognition, machine translation, and Natural Language Processing (NLP), the latter referring to systems capable of understanding and generating human language (European Commission, 2022). These technologies support many of the digital solutions currently being integrated into the cultural heritage sector.

Besides the ability to process textual content, which is particularly relevant for enhancing accessibility and interactivity, visual data are central in fashion archival materials. For this reason, computer vision techniques take

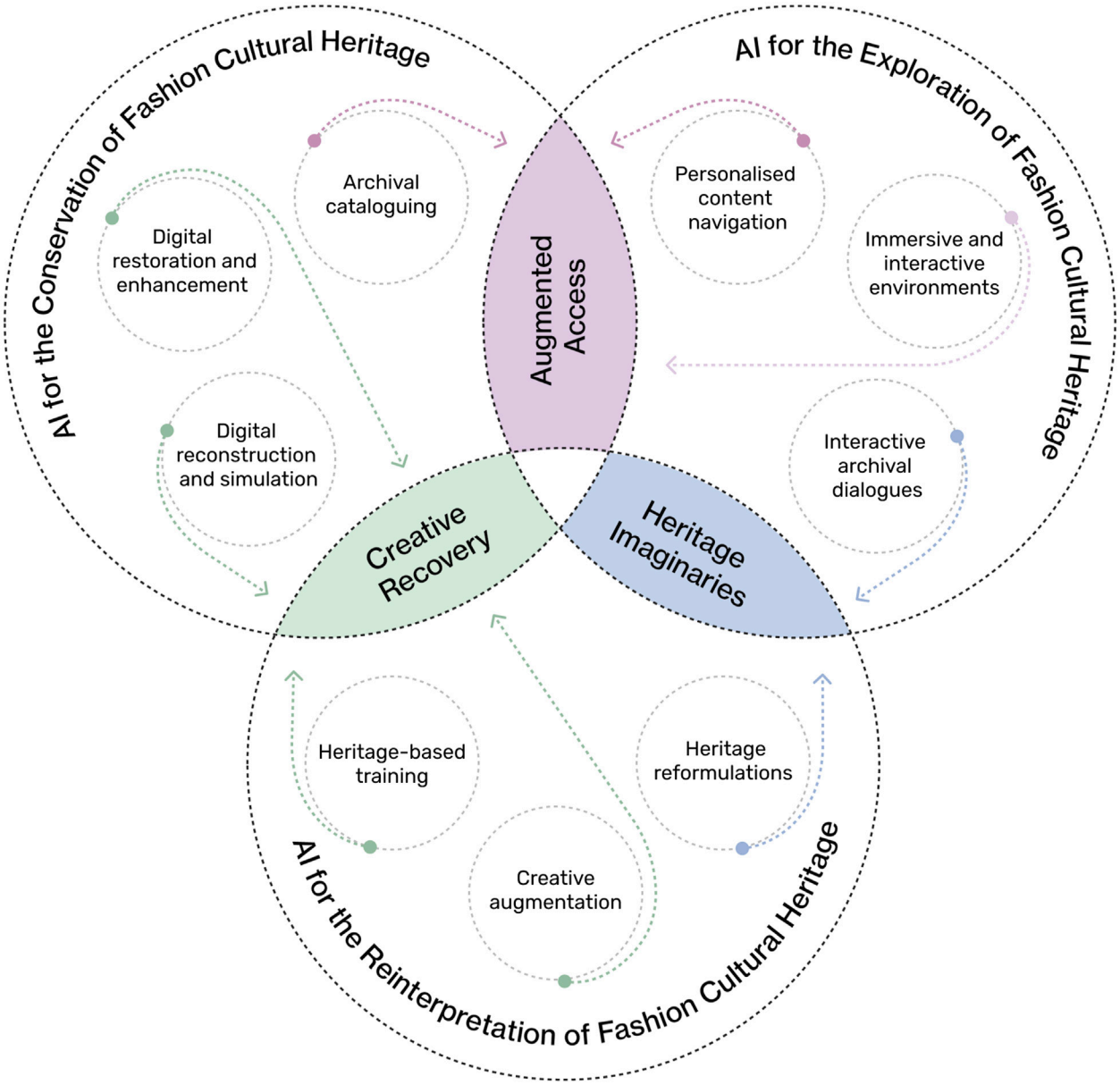


FIGURE 2
Overview of the three AI trajectories in fashion cultural heritage, including subcategories and areas of intersection.

on a critical role, as they enable machines to extract and interpret information from images and videos. Specific methods include image recognition, content-based image retrieval, semantic segmentation, object detection, and image enhancement or restoration through inpainting and super-resolution (Gîrbacia, 2024). Classical ML approaches are also applied to tasks such as metadata classification and artefact cataloguing (Münster et al., 2024). Furthermore, many of the most innovative applications in the fashion heritage sector involve deep generative models, particularly Generative Adversarial Networks (GANs) (Kahng et al., 2019) and Diffusion Models (DM) (Croitoru et al., 2023), which enable both image synthesis and restoration. These models are part of a broader category of AI that includes multimodal systems, capable of processing and generating different types of data, such as text, images, and audio. This consists of the integration of Large Language Models (LLMs), such as Generative Pre-trained Transformer (GPT), with computer vision systems, enabling new forms of interactive storytelling and immersive experiences (Münster et al., 2024).

Exploring the three trajectories of AI in fashion cultural heritage

The three trajectories proposed in this article, *AI for the Conservation, AI for the Reinterpretation, and AI for the Exploration* of Fashion Cultural Heritage, constitute an interpretative model derived from the analysis of the frameworks outlined by the European Commission regarding the application of AI in the cultural heritage sector (European Commission, 2022; EPRS, 2023). They discuss a targeted understanding of how AI is being used in the context of fashion, cultural heritage, within archival, curatorial, design, communication, and experiential practices, dealing with both physical and digital artefacts. Based on the analysis and thematic clustering of both academic and practice-based cases, the trajectories should be understood not as fixed structures, but as dynamic, interconnected, and mutually influencing pathways, where the sub-trajectories of *Augmented Access, Creative Recovery,* and *Heritage Imaginaries* stem from the intersections among the main areas of application (Figure 2).

AI for the Conservation of Fashion Cultural Heritage addresses the integration of AI in preservation strategies, supporting documentation, classification, and archiving of fashion heritage through ML, DL, computer vision, and NLP, while also activating restoration, enhancement, and metadata generation. In this sense, the trajectory develops in three main applicative directions: the enhancement of classification and cataloguing workflows through AI-assisted systems (Archival cataloguing); the visual improvement of archival materials via digital restoration techniques (Digital restoration and enhancement); and the simulation or reconstruction of lost items through generative models (Digital reconstruction and simulation).

AI for the Reinterpretation of Fashion Cultural Heritage explores the creative use of AI to reimagine fashion heritage, enabling new interpretations and the generation of artefacts through models such as GANs, DMs, and LLMs, expanding the expressive potential of historical data (Gîrbacia, 2024). Within this trajectory, three primary applicative directions can be identified: the training of generative models on fashion heritage datasets to ensure stylistic and semantic coherence with historical references (Heritage-based training); the support and enrichment of the designer's creative process through AI-assisted systems and co-creation workflows (Creative augmentation); and the reconfiguration of visual languages and stylistic codes through reinterpretative transformations of existing archival content (Heritage reformulations).

AI for the Exploration of Fashion Cultural Heritage focuses on how AI improves interaction with heritage materials, shaping both access and engagement through recommendation systems, behavioural tracking, multimodal inputs, and immersive or conversational technologies. Within this trajectory, three main areas of application emerge: the development of AI systems for adaptive and user-driven exploration of cultural content (Personalised content navigation); the design of interactive interfaces enabling dialogue with archival materials through natural language exchanges (Interactive Archival Dialogues); and the creation of immersive environments that foster deep engagement with digital artefacts and heritage narratives (Immersive and interactive environments).

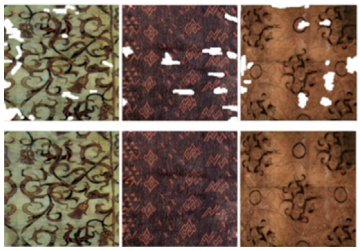
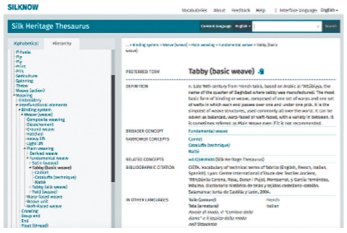
In addition to this, three key intersections between the trajectories can be identified. Between *Conservation* and *Reinterpretation, Creative Recovery* emerges, exploring how AI can be integrated to restore fashion archival items. In the absence of complete materials, generative reconfigurations can be enacted, blending conservation approaches with reinterpretative strategies to produce synthetic reproductions of historical artefacts. From the intersection between *Reinterpretation* and *Exploration*, *Heritage Imaginaries* emerge, in which reinterpreted archival content becomes the starting point for speculative storytelling. Rather than conveying historical facts, these AI-assisted experiences activate imaginative reinterpretations to foster engagement with cultural and creative content. The bridging between *Conservation* and *Exploration* gives rise to *Augmented Access*, where AI application enables more intuitive and customised modes of accessing and navigating fashion heritage materials in both digital and physical contexts.

For each trajectory, a detailed discussion will follow based on the identified case studies presented in Table 1, focusing on: (i) the most frequently used AI technologies; (ii) the types of intervention enabled by AI integration; and (iii) the nature of the archival materials involved (whether digital or physical).

AI for the conservation of fashion cultural heritage

In recent years, there has been growing interest in conserving, preserving, and restoring fashion heritage, addressing both the tangible nature of artefacts and the intangible body of knowledge, techniques, and craft processes that guided their design and creation (Vandi, 2023; Casciani and Vandi, 2022). However, several challenges emerge: the conservation of intangible aspects poses challenges due to their intrinsic ineffability. At the same time, direct intervention on physical artefacts presents critical issues, as restoration processes can cause further damage to already fragile items. To overcome these challenges, the experimentation with digital approaches supported by advanced AI techniques has emerged to offer less invasive ways of approaching tangible heritage, reducing risk of permanent damage, to activate the opportunity of recording and archiving more intangible knowledge, thus, also to expand opportunities to access and share cultural heritage knowledge globally. In this context, two main areas of application can be identified: Digital restoration and enhancement and Digital reconstruction and simulation, whose application varies depending on the nature of the

TABLE 2 Examples of case studies applying AI models within the Conservation trajectory, illustrating: (a) Digital restoration and enhancement, (b) Digital reconstruction and simulation, and (c) Archival cataloguing.

AI for the conservation of fashion cultural heritage		
Digital restoration and enhancement (Creative Recovery)	**Digital reconstruction and simulation (Creative Recovery)**	**Archival cataloguing (Augmented Access)**
		
a: https://media.springernature.com/lw1200/springer-static/image/art%3A10.1007%2Fs44196-023-00381-9/MediaObjects/44196_2023_381_Fig13_HTML.png	b: https://pub.mdpi-res.com/electronics/electronics-14-01139/article_deploy/html/images/electronics-14-01139-g009.png?1741942522	c: https://metode.org/issues/monographs/weaving-the-past-into-to-the-future.html

available material and the intended purpose of the material digitalisation process (Ding and Liang, 2024).

Digital restoration and enhancement refer to the simulated visual and aesthetic enhancement of an artefact and are sometimes used to preview the potential results of a physical restoration prior to its physical execution (Nencini and Maino, 2011). In the domain of fashion cultural heritage, it primarily focuses on the visual recovery of damaged images, ancient textile fragments, or visual representations of garments. Early approaches to digital restoration relied on geometry-based and patch-based inpainting methods, which aimed to recover missing visual information using contextual cues. These methods have been complemented with advanced DL models, including GANs, which enable more accurate and context-sensitive digital restoration and recovery of damaged or incomplete areas. An example is the restoration of the Luo coat from the Southern Song dynasty, where GANs were used to reconstruct missing sections of the textile decoration (Table 2, a). The process included data augmentation and normalisation to achieve a plausible visual outcome, which was later integrated into a workflow involving virtual fitting and 3D modelling techniques for the creation of a digital twin of the ancient garment (Chen et al., 2023), offering a more comprehensive overview of the historical clothing piece. A similar technique has also been applied to restore, revive, and enhance structural elements and decorative patterns in ancient textile artefacts, allowing for the recovery of visual details that would otherwise be permanently lost (Sha et al., 2024). Beyond their contribution to visual enhancement, these examples illustrate how restoration practices can intersect with the *Reinterpretation* trajectory, placing them within the *Creative Recovery applicative dimensions*.

Digital reconstruction and simulation, on the other hand, is typically employed in cases where historical artefacts are no longer physically preserved, have been irreversibly lost, or are presented in formats that limit interaction, such as two-dimensional documentation or static display settings, often due to conservation requirements. Within fashion cultural heritage, this approach is particularly relevant for garments that are absent from physical collections or are exhibited in protective environments. The reconstruction process generally begins with archival images and involves the analysis of style, fabric, colours, decorative patterns, and garment structure through parameterisation and mathematical modelling. This is followed by the creation of a pattern block, in which 3D shapes are flattened into 2D representations, and subsequently converted into new 3D models using dedicated modelling software (Moskvin et al., 2019). This approach allows the generation of digital data such as 3D digital representations related to absent or inaccessible artefacts that can activate more audience participation and immersive involvement in experiencing the fashion cultural heritage, thus allowing *Augmented Access* applicative dimensions, where conservation, restoration, and exploration converge.

In Zhang Xuan's painting Ramming & Washing Silk, AI models were used for inpainting, enlargement, and digital cleaning of the garments' decorative patterns, as well as for their vectorisation and conversion into 3D assets (Zhu et al., 2025) (Table 2, b). These procedures are particularly important for documenting disappeared fashion items whose visual identity survives only through written or pictorial historical records. In such cases, reconstruction relies on the interpretation of available evidence, aiming to deduce approximately fabric type, construction geometries, colours, and other types of details, often complex to model precisely using traditional prototyping software (Ding and Liang, 2024). Emerging research is exploring strategies and developing AI tools to create fully automated workflows for 3D garment reconstruction from 2D images.

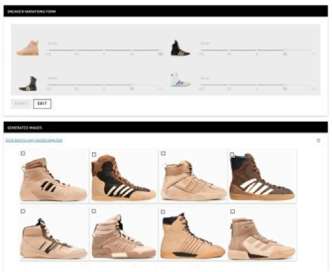
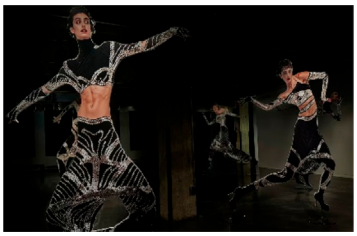
The A.B.C. (Automating Blender Code) project, developed within the Europeana AI4Culture initiative, investigates the use of open-source tools to convert static images into 3D models. The pipeline integrates the Segment Anything model for shape extraction, HuggingFace models for semantic interpretation, and the 3D software Blender to refine the final visual output, demonstrating a possible AI-assisted workflow for this type of application (McIrvin et al., 2024; Europeana, 2025). The discussed AI solutions aiming at reconstructing missing archival information can be positioned within the *Conservation* trajectory. However, their reliance on generative reconstruction brings them closer to the applicative direction of Creative Recovery.

In addition, *Digital reconstruction and simulation* techniques are employed to support the digitisation of specific fashion archival items, in particular surface, textures, structural characteristics, and detailed geometries of fibres and fabrics, captured through non-invasive methods to prevent damage to the original fragile textiles (Ilies et al., 2022). 3D scanning technologies, while invaluable for digitising cultural heritage artefacts, encounter notable limitations when applied to textiles and fabrics. Challenges such as capturing intricate surface details, accurately representing complex geometries, and dealing with materials that have varying reflectivity, or translucency can affect the fidelity of the digital models produced. These limitations are particularly pronounced in the context of historical garments, where precise replication of textures and structures, along with specific information about their mechanical, physical, and chemical features, is crucial for conservation and study. For instance, studies have highlighted difficulties in scanning materials with complex geometries and fine details, which are common in textile artefacts (Żyła et al., 2021; Montusiewicz et al., 2021). To address these challenges, AI offers promising solutions to enhance the quality and accuracy of 3D scans by filling in missing data, correcting inaccuracies, and providing deeper insights into the structural composition of textiles. Textura system developed by SEDDI applies CNNs to analyse high-definition images, extract mechanical properties, and simulate fabric behaviour in virtual environments (Youn et al., 2024). Using knowledge graphs, NPL, and DL, researchers have developed a dual-channel mechanism integrating semantic and visual information to protect the Miao batik culture in Guizhou Province, China. The study enabled a structured access to symbolic, historical, and contextual information about batik patterns, while high accuracy in identifying and understanding the cultural connotations of batik patterns, thus creating a reliable create a dynamic, interactive, and searchable digital archive, effectively bridging traditional cultural knowledge with modern AI tools (Quan et al., 2024). To address these challenges, AI offers promising solutions to enhance the quality and accuracy of 3D scans by filling in missing data, correcting inaccuracies, and providing deeper insights into the structural composition of textiles. Textura system developed by SEDDI applies CNNs to analyse high-definition images, extract mechanical properties, and simulate fabric behaviour in virtual environments (Youn et al., 2024). Using knowledge graphs, NPL, and DL, researchers have developed a dual-channel mechanism integrating semantic and visual information to protect the Miao batik culture in Guizhou Province, China. The study enabled a structured access to symbolic, historical, and contextual information about batik patterns, while high accuracy in identifying and understanding the cultural connotations of batik patterns, thus creating a reliable create a dynamic, interactive, and searchable digital archive, effectively bridging traditional cultural knowledge with modern AI tools (Quan et al., 2024).

Alongside restoration and reconstruction, AI also contributes to *Archival cataloguing* through NLP techniques and image classification, enhancing the searchability and accessibility of archival data and materials, from textiles to full garments and all correlated digital materials. An example is the project at the Fashion Merchandising and Design department at Virginia Tech, which demonstrated how word embedding can generate additional descriptive metadata, improving the discoverability of fashion artefacts. The approach, validated through a human-in-the-loop process, enhanced the descriptive quality of the Oris Glisson Historic Costume and Textile Collection and improved interoperability and data exchange across collections (McIrvin et al., 2024), thus supporting archival practice. Also, the SILKNOW project leverages AI technologies such as neural networks for image classification, semantic web knowledge graphs for data integration, and NLP for multilingual standardisation to enhance the accessibility and conservation of European silk heritage (Table 2, c). These AI-driven tools enabled the development of advanced search capabilities, but also the creation of a Virtual Loom for simulating historical weaving techniques, and the production of detailed 3D models, thus facilitating richer conservation, but also aiding exploration and dissemination of archival silk textiles of the 15th-19th century (Alba et al., 2021). Therefore, improved access and navigability across collections and deeper into collections' digital materials can, in turn, support strategies aimed at engaging audiences in the deeper exploration of archival materials, thereby contributing to the applicative direction of *Augmented Access.*

In addition, AI has contributed to verify the authenticity of heritage fabrics, developing a deep metric learning model to classify six types of traditional handloom textiles from Assam, India, distinguish authentic handloom products from machine-made imitations, thereby supporting the conservation of cultural heritage and the economic wellbeing of indigenous weavers (Das et al., 2024). Recent research has applied deep learning models, including CNNs and autoencoders, to classify textiles via near-infrared hyperspectral imaging (Kainz et al., 2024). This approach offers robust generalisation under varying conditions, highlighting the potential of AI in textile analysis

TABLE 3 Examples of case studies applying AI models within the Reinterpretation trajectory, illustrating: (d) Heritage-based training, (e) Creative augmentation, and (f) Heritage reformulation.

AI for the reinterpretation of fashion cultural heritage		
Heritage-based training (Creative Recovery)	**Creative augmentation (Creative Recovery)**	**Heritage reformulations (Heritage Imaginaries)**
		
d: https://dl.acm.org/doi/fullHtml/10.1145/3587421.3595416	e: https://www.businessoffashion.com/articles/technology/after-months-of-designing-with-ai-norma-kamali-isnt-looking-back/	f: https://www.instagram.com/reel/DE14RMxgg-g/?hl=en

and conservation. Examples of applications include FabricNet, an AI architecture designed for textile fibre recognition through image analysis, employing CNNs to identify various fibre types based on surface images of fabrics, streamlining the classification process through textile digitisation efforts (Ohi et al., 2021).

AI for the reinterpretation of fashion cultural heritage

Researching historical sources for inspiration is recognised as a core activity in fashion design. It supports both the consolidation of brand identity and the development of coherent visual narratives, stimulating a dialogue between past and present, and promoting the renewal of traditions through a contemporary lens (Murphy, 2011). Traditionally, fashion historical research has taken place in museums and archives, informed by catalogues, libraries, and heritage databases, to contribute to the creation of new designs through visual recombination of shapes, materials, and motifs. Many renowned fashion houses, including Chanel and Dior, have institutionalised this approach by establishing dedicated brand archives, reinforcing their identity and acknowledging the cultural value embedded in fashion (Jane and Maughan, 2020).

Until recently, this practice primarily relied on physical archives, which were only gradually digitised. In such research processes, the archivist plays a key role, guiding designers through visual repositories by linking catalogues, images, and textual descriptions with heritage references, offering individual expertise to align findings with the designer's stylistic vision (Britt and Stephen-Cran, 2014). Today, generative AI is increasingly taking on a central role in this process, performing a hybrid function that can be described as "creative archivist", that both explores fashion archives toward a *heritage-based training* and generates reinterpretations of the retrieved materials *toward the creative augmentation* in design workflows. Therefore, AI technologies support designers in the development of new fashion products by drawing on augmented archival inspirations where the archive is no longer seen as a repository of records, but as a dynamic resource for contemporary creation, where heritage serves as a foundation for design innovation (Almond, 2020), and is reactivated within design processes, positioning AI as a co-creator assistant in the making of new collections and fashion items (Rizzi and Vandi, 2023).

One example of these applicative directions is AI ARCHIVE (Table 3, d), a generative AI tool Adidas developed that activates *heritage-based training and creative augmentation.* Based on a custom diffusion model trained on over 160,000 side-view images of the brand's sneakers, the system shifts design conceptualisation beyond the sole imagination of the designer. It generates a wide range of design options within seconds, allowing for a new form of interaction with cultural heritage sources. Designers collaborate with AI as a creative partner, drawing on textual descriptions, reference images, and parameter controls to shape customised outputs (Suessmuth et al., 2023). Similarly, Maison Meta developed an AI tool for the fashion designer Norma Kamali, aimed at preserving and transmitting her creative legacy through a proprietary generative AI system (Table 3, e). The model was based on a customised version of Stable Diffusion, further integrated with the open-source tool Focus, and was trained on 57 years of collected brand imagery. Metadata labelling was applied to associate visual data with design attributes such as garment geometries, fabric types, and construction details. The resulting system supports Kamali's creative process by offering heritage-consistent design suggestions in response to textual prompts. This collaboration highlights the potential of fashion designer-AI co-creation paradigms to ensure both style continuity and innovation (MIT News, 2025; Smith, 2024). These examples show how

fashion archives support creative augmentation and reinterpretation within *Creative Recovery*.

Generative AI models can also support more technical applications in the production stages, allowing for *creative augmentation* by gathering information from a digital archived dataset. For instance, in the field of knit pattern generation, a generative AI model trained on a dataset of machine-readable code and historical knit pattern images was able to produce new design variants compatible with digital knitting systems. The model successfully imitates the visual characteristics of the training data without directly replicating them, generating reinterpretations consistent with the style of historical pattern libraries. The tool enables users to define a general stylistic direction and generate multiple alternatives, even without specific knowledge of machine code (Scheidt et al., 2020). Although the project demonstrated a promising application of AI in knitting design practices, an iterative process involving generation, validation, and correction remains necessary, as automatic generation can still introduce errors. This underscores the importance of collaborative workflows between human expertise and AI capabilities in the design process, taking advantage of hybrid intelligence teaming (Mao et al., 2023) for expanding their creative potential (Jin et al., 2024).

Within *Creative augmentation applications, AI can move from product-oriented efforts to communication strategies that draw on archival heritage*. For instance, luxury fashion brands such as Burberry and Lanvin have used AI-powered animation to bring historical imagery to life in advertising content. In January 2025, Burberry animated a 1980 photograph by Lord Lichfield, showing a couple dressed in classic Burberry clothing, and shared it on Instagram (Table 3, f) (Burberry, n.d.). Similarly, Lanvin applied generative AI to animate archival illustrations from the 1920s for a campaign promoting its Sport line, renewing interest in the brand's heritage through visually innovative approaches (Ryder, 2024). This case offers a meaningful example of how the reinterpretation of archival material can foster public engagement by drawing attention to cultural values. In doing so, it positions itself within the *Heritage Imaginaries* applicative direction, where heritage content is reactivated as a medium for storytelling.

Beyond branding strategies, generative AI is also being employed in critical and speculative projects that engage with forgotten, imagined, or undocumented fashion heritage towards *heritage reformulations*. A case study is the work of researcher and artist Ameera Kawash, whose project *Future Archives* investigates how AI can address representational gaps and challenge dominant narratives shaped by models predominantly trained on data from the Global North. Kawash's initiatives merge generative AI with archival content to explore future-oriented representations grounded in data, while also prompting reflection on practices of visual recovery for traditions that have faded over time (Kawash, 2025). Tatreez Garden is her AI image generator trained on a dataset of Palestinian embroidery known as Tatreez, a traditional form of wearable art rooted in Palestinian women's cultural identity and memory. The platform generates new embroidery patterns aligned with the collective memory of the practice, sustaining and reimagining its cultural significance (Kawash, 2025). Reimagining cultural practices at risk of disappearance also contributes to developing *Heritage Imaginaries* that challenge dominant cultural frameworks and foster reflection on underrepresented traditions.

AI for the exploration of fashion cultural heritage

This trajectory takes the perspective of AI fostering meaningful connections between heritage artefacts and their audiences, both in physical and digital environments, exploring AI applications integrated into the strategies of cultural institutions and museum exhibitions to activate new participatory modalities for experiencing fashion cultural heritage. This evolution is further driven by a growing interest in textile and clothing exhibitions, promoted through interdisciplinary collaborations among artists, artisans, designers, fashion companies, and educational institutions. These initiatives have repositioned museums as key actors within the broader fashion (eco)system and central figures in the process of fashion heritagisation, enhancing the cultural value of fashion and reinforcing their role as gatekeepers for the public (Murzyn-Kupisz et al., 2024). Within this trajectory, digital technologies, including virtual and augmented reality, and AI play a crucial role in enhancing user engagement by enabling immersive interactions with displayed artefacts and narratives (Andò et al., 2023).

Engaging people in history requires creating *immersive and interactive experiences* that enable deeper, personalised exploration of curated content, allowing users to connect directly with their interests in responsive, emotionally resonant ways that go beyond passive visual observation and foster sensorial, participatory involvement.

Interactive archival dialogues are one example of AI enhancing interactivity with fashion heritage through chatbots, facilitating direct dialogue between users and cultural content. This is the case of *Hand-i-craft Bot*, a domain-specific chatbot designed for digital exhibitions of hand-woven fabrics. It was trained on and directly connected to the Museum of Namuensri Textiles database, which preserves traditional hand-weaving practices. The chatbot addressed the previous lack of real-time multimedia access and intuitive navigation for exploring the digital library. It also integrates selected external sources, offering contextualised responses to visitors through NLP models and providing them with personalised virtual tour suggestions based on their preferences. These features significantly improved both the accessibility and engagement of the archival browsing experience (Chai-Arayalert et al., 2024). The integration of tools based on NLP solutions is becoming

TABLE 4 Example of a case study applying AI models within the Exploration trajectory, illustrating: (g) Interactive archival dialogues.

AI for the Exploration of Fashion Cultural Heritage
Interactive archival dialogues (Heritage Imaginaries)

g: https://www.wsj.com/articles/openai-brings-custom-tech-to-this-years-met-gala-exhibition-b858af4d

central to enhancing accessibility and connection with cultural content, as demonstrated by the collaboration between OpenAI and the Metropolitan Museum of Art's Costume Institute for the 2024 exhibition "Sleeping Beauties: Reawakening Fashion". At the centre of this initiative was a custom chatbot called "Chat with Natalie", designed to digitally bring to life Natalie Potter, a New York socialite from the early 20th century, using her 1931 wedding dress as a portal to her personal experiences. Visitors could engage in personalised conversations with the AI-generated character, exploring her biography, memories, and the broader historical context of her time (Table 4, g). The chatbot's dataset was curated with the museum's team, drawing on letters, newspaper articles, and archival documents to ensure the AI's responses were authentic and historically grounded (Metropolitan Museum of Art, 2024). By rematerialising a figure from the past through an AI model specifically trained on archival documents, this case study intersects with the area of *Heritage Imaginaries*, as it seeks to reinterpret archival contents through new forms of storytelling.

In addition to this, Besana et al. (2025) propose a scenario where users such as visitors are allowed to interact with the driven archive to "recreate" fashion contents by retracing the fashion designer's creative journey but also to support new avenues of content generation inspired by that journey in a co-creative activity process between humans and AI (Besana et al., 2025). This transforms the archive into a responsive system that can act as a representative of the fashion designer, adaptively conveying their principles, values, and stylistic logic in response to user interaction. Integrating AI-enabled functionalities with a user-centred interface design allows for more proactive engagement, thus contributing to intersecting the practice with the *Augmented Access* applicative directions.

Although AI adoption in fashion museums remains limited, personalised *content navigation* extends beyond interactive installations. Initial attempts to integrate AI into visitor experiences have explored multimodal human–machine interaction systems with emotion recognition. These systems analyse emotional responses through facial recognition, voice analysis, or wearable IoT devices monitoring physiological signals, contributing to the domain of *Augmented Access*. However, such innovations raise critical ethical concerns related to privacy, informed consent, and the potential for emotional manipulation (Fominska et al., 2024), and their implementation still needs to be tested within the context of fashion exhibitions.

Challenges and gaps in AI integration across the three trajectories

Although the presented framework outlines promising directions for AI applications in fashion cultural heritage, the analysis of case studies also reveals several limitations specific to each trajectory. In the *Conservation* trajectory, the integration of AI within complete restoration pipelines remains partial: current models often struggle to move from 2D reconstruction to high-fidelity 3D digital materialisation, highlighting a technical gap and a potential direction for future research. Additionally, limitations persist in the accuracy of pattern recognition, material simulation, and the standardisation of scanning protocols for fragile textile artefacts. In the *Reinterpretation* trajectory, ethical concerns are particularly prominent, notably in relation to copyright, data ownership, and the use of archival content for training custom generative models. The risk of aesthetic homogenisation in AI-generated outputs, combined with the reliance on iterative corrections to address generative inaccuracies, highlights the need for more robust validation processes and deeper critical engagement with questions of authorship and creative agency. The *Exploration* trajectory is the least developed within fashion heritage, with few concrete applications so far. Despite its potential for audience engagement and multimodal interaction, it raises concerns about user protection, particularly in relation to personal data tracking. Moreover, its integration into institutional practices remains limited, revealing infrastructural and organisational gaps that hinder wider adoption.

Discussion

This study advances the understanding of how AI technologies are transforming the field of fashion cultural heritage by presenting a framework that encompasses both the technical implementations and conceptual implications of current practices. Grounded in a literature review and analysis

of selected case studies, it positions AI as an active agent in managing cultural knowledge across conservation, research, curation, and public engagement. Also, expanding the EU definition related to the general cultural heritage definitions also provides a framework for the fashion heritage applicative domain through trajectories and directions that highlight emerging applicative approaches in supporting creativity, augmenting access, and advancing the narrative of fashion cultural heritage.

The classification proposed in this section identifies three main trajectories of *Conservation, Reinterpretation,* and *Exploration*, informed by the application areas outlined by the EU (European Commission, 2022) and reframed to reflect the specificities of the fashion heritage sector. These trajectories illustrate distinct yet complementary applications of AI, all aimed at enriching and supporting archival and curatorial processes while enhancing the communication of fashion's cultural value to broader audiences.

The integrative literature review highlighted a predominance of research and documentation focused on Conservation, while the Reinterpretation and Exploration trajectories appear to have been explored less in academic discussions. This suggests a strong potential for these areas to open up critical discussions on the role of AI in both the reinterpretation and broader communication of cultural heritage. Moreover, the analysis showed that AI applications do not always align neatly with a single trajectory. In many cases, hybrid practices emerge, giving rise to more transversal and layered forms of intervention. This convergence identified three interpretative areas: *Creative Recovery, Heritage Imaginaries,* and *Augmented Access*. These intersections reflect how the interplay between different trajectories fosters more integrated approaches to managing and disseminating fashion heritage. At the same time, they invite critical reflection on the limitations and ethical implications of deploying AI within cultural contexts.

This study presents several limitations that suggest valuable directions for future inquiry. First, the article adopts a predominantly European perspective on AI regulations and cultural heritage frameworks, while a number of the case studies examined are rooted in Eastern contexts, particularly involving Chinese cultural archives. This geographical imbalance limits the generalizability of the findings across global contexts. Future research could address this by incorporating a more diverse range of regional perspectives, allowing for comparative analysis and broader applicability of the proposed framework. Secondly, the case studies are restricted to a timeframe between 2018 and 2025, which, while capturing recent developments, may not fully reflect the rapidly evolving landscape of AI applications in fashion cultural heritage. As new technologies emerge, additional cases could enrich the identified trajectories and potentially confirm the framework while also generating new trajectories and directions. Furthermore, using grey literature to select case studies may introduce bias, particularly in the optimistic portrayal of technological outcomes. However, this limitation has been mitigated through a critical discussion of ethical, economic, and cultural implications in the following paragraphs, aiming to balance the prevailing techno-positive narratives and present further research opportunities.

Therefore, the resulting discussion and the proposed framework should be understood as part of an ongoing PhD research project investigating the integration of AI solutions within the fashion industry and cultural heritage. This contribution is to be interpreted as a theoretical investigation into the current state of the art across these overlapping domains, laying the foundation for future explorations and experimental applications to be developed in the context of the PhD research.

Ethical implications of AI integration in fashion cultural heritage

As explored throughout this article, AI is gradually being integrated into cultural heritage practices, demonstrating its potential to address challenges related to the deterioration of artefacts, the complexity of digitalisation processes, the storage and accessibility of digital materials, and the exploration and dissemination of their tangible and intangible cultural values. Although the described trajectories presented open, promising prospects regarding the potential of computational systems for such applications, further reflection is needed on the implications of the intersection between cultural heritage and advanced technologies, raising critical questions that cut across all three trajectories. These implications, situated within the broader context of CCIs, underscore the wider impact of AI integration into established organisational structures, economic systems, and their associated value chains, branching into the protection of fundamental principles, investigating legal issues related to human rights in the use of AI such as authenticity and intellectual property rights; the economic impact in terms of business model transformation and employment; and the cultural representation in available data and datasets (Council of Europe, 2024).

The protection of fundamental principles involves concerns about the authenticity and accuracy of AI-generated content, alongside issues of bias and fairness that may result in misleading or discriminatory outputs. Intellectual property rights are also significant, especially concerning the intrinsic value of human creativity, the potential erosion of human expertise, and the use of archival materials as training datasets for AI models. Additionally, matters of transparency and AI-related processes explainability remain central, with growing attention directed toward making AI decision-making more accessible and understandable to users (Benbya et al., 2024; European Commission, 2022). Finally, privacy and data security issues remain highly pertinent, encompassing the protection of personal data and rights of professionals working with AI in

archival settings and users engaging with AI-enabled technologies in cultural heritage contexts (Zlateva et al., 2024).

The *economic impact* of AI on the cultural and creative economy across the entire value chain includes effects on the structural organisation of institutions working in the field, the creation of new market concentrations that may limit the cultural offer, and the marginalisation of smaller organisations unable to access or afford AI tools. These dynamics also affect the job market, including potential job displacement and growing dependency on automated systems (Council of Europe, 2024). In parallel, structural limitations are linked to institutional resources and skill sets. Many organisations lack the financial capacity to invest in specialised personnel or external consultancy, and there is often a shortage of professionals capable of bridging archival, humanistic, and technological expertise. This gap complicates the formation of interdisciplinary teams that can develop meaningful AI applications in cultural contexts. Furthermore, from a social perspective, this *a priori* scepticism often inhibits a broader understanding of how AI could enhance internal workflows, expand public engagement, and support the dissemination of cultural heritage to more diverse audiences (European Commission, 2022).

Future research could delve more deeply into the challenges outlined in this discussion, particularly by exploring co-design practices for AI-assisted tools within fashion cultural heritage. Such investigations should be embedded in interdisciplinary frameworks that bring together fashion heritage professionals, AI developers, and ethicists, fostering the development of more contextually grounded and ethically informed AI models.

The *cultural representation in available datasets* reveals data usage criticalities regarding how AI models are trained, such as the risk of inadvertently reinforcing biases embedded in historical data or their representations, potentially leading to historical and cultural misinterpretations. The predominance of data in specific languages and cultures may further marginalise underrepresented groups and create barriers to heterogeneity, sensitivity, and data quality. There are also widespread concerns regarding the homogeneity of curatorial outputs and the potential narrowing of cultural narratives, especially when dealing with content of high symbolic and historical value (Council of Europe, 2024). This challenge is linked to the low level of digitisation and the inconsistent metadata quality across many cultural heritage collections. Numerous archives contain either undigitised or only partially digitised materials, while the available data are often incomplete, poorly standardised, or not optimised for machine processing. These limitations significantly hinder the applicability and effectiveness of AI systems, ultimately impeding efforts in conserving and disseminating cultural heritage (European Commission, 2022; EPRS, 2023).

Future research should focus on developing inclusive, multilingual, and culturally sensitive digitisation and digitalisation frameworks for fashion archives, addressing existing data gaps and biases to ensure broader accessibility, representational diversity, and effective AI integration for the preservation and dynamic dissemination of fashion heritage.

In response to these challenges, the EU is activating strategies and guidelines aimed at promoting a more sustainable application of AI systems to ensure prosperity and social wellbeing across the CCIs. These policies focus first on improving access to AI through developing digital literacy and skills, adapting education curricula to reflect new job requirements and emerging professional profiles. This is paralleled by initiatives to raise awareness around the potential of AI in enhancing the cultural sector's value chain. A key step in this direction involves creating standardised procedures for digitising archival materials, ensuring that documentation practices are interoperable and retrievable in a transparent way. It is also relevant to promote trust in AI systems, with legal frameworks addressing the protection of authenticity and copyright in cultural content. These have implications for both end users and developers, particularly regarding data training and the creation of more explainable and transparent systems (Schoenherr et al., 2023). Moreover, more inclusive AI ecosystems need to be promoted to build trust and propensity for adoption. This includes promoting decentralised AI development to prevent market monopolisation and ensure greater diversity in how tools are designed and trained, fostering a more pluralistic cultural expression. The need to address the risk of AI reinforcing existing cultural biases is closely linked to this. Regarding this point, a more substantial involvement of cultural, creative, and heritage actors in the design and implementation of AI tools is necessary, along with monitoring and evaluation mechanisms to mitigate these risks. Finally, greater interdisciplinarity and cooperation are needed, as a closer dialogue between AI developers and professionals in the cultural heritage field, including creative practitioners, archivists, and researchers, toward AI tools that are tailored to the sector's needs and workflows (Council of Europe, 2024). This will contribute to a more balanced collaboration between human skills and machine capabilities, enabling the development of AI solutions that can assist humans without replacing their skills. Beyond the policy frameworks and guidelines currently being developed to promote more sustainable AI implementation (Council of Europe, 2024), there is a growing need to refine and design AI systems to make them more human-centred (Auernhammer, 2020). This must be matched by educational initiatives to promote technological awareness and digital literacy among professionals in the cultural and creative sectors, enabling more effective collaboration between human expertise and technological potential, and promoting the synergistic integration of AI into existing workflows.

From analysis to synthesis: towards hybrid cultural knowledge

Beyond its technical applications within CCIs and the cultural sector, the integration of AI invites a broader epistemological

reflection on the role it is gradually assuming in cultural processes, as the boundaries between human and computational agents become increasingly blurred. The use of AI in the preservation, reinterpretation, and exploration of cultural materials exemplifies a growing reliance on machine-assisted processes, in which AI plays an active role in creating new knowledge. In this paradigm, knowledge is no longer shaped solely by human reasoning. However, it is increasingly co-produced through human and AI collaboration (Peeters et al., 2021), moving toward collective intelligence models that attribute sense-making functions to AI.

In cultural domains and digital humanities, the role of hermeneutics has long been a point of tension, oscillating between two approaches: a data-driven, quantitative logic rooted in pattern recognition and statistical modelling, and a humanistic, interpretive model focused on meaning-making and semantics (Van Zundert, 2015). Computational methods are often associated with the former positivist-structuralist frameworks, which risk reducing cultural complexity to measurable regularities and overlooking the variability inherent in cultural expression. However, recent advances in AI suggest the emergence of systems capable of generating machine-made histories, acquiring the status of artificial history makers (Hughes-Warrington, 2022). From this perspective, AI shifts from an assistive archival tool with "enhanced mnemonic capabilities" to an active agent: a co-author in producing historical knowledge, as also demonstrated through the analysis of its role in heritage *conservation, reinterpretation, and exploration.* What has been previously discussed exemplifies how a hybrid model is emerging. This model does not displace traditional hermeneutics or reduce culture to computation but instead integrates both strengths to enrich cultural heritage research and enable novel forms of analysis and reinterpretation (Van Zundert, 2015). Even so, the role of AI in shaping collective and cultural memory (Gensburger and Clavert, 2024) needs to be critically discussed.

In the evolution of archival practices, the process of fashion heritagization has shown how archiving procedures preserve artefacts and reconfigure their value, both historical and contemporary, activating narratives that structure history through archival organisation (Franceschini, 2019). The digital turn, as described by Pruulmann-Vengerfeldt et al. (2013), marked the shift from analogue to digital in the cultural sector. Today, this transition is acquiring renewed significance (Mandolessi, 2023). Digitisation has introduced new dynamics. While it facilitates access and dissemination, it also enables subjective and decentralised interpretations, first by humans and now increasingly by machines (Franceschini, 2019). As Hoskins (2018) notes, digital memory has become a memory of the multitude, characterised by participation, dynamism, and constant reinterpretation. In contexts lacking documentation, AI can even generate speculative yet plausible reconstructions of the past, described as a synthetic past (Hoskins, 2024). This ability to artificially extend memory redefines how individuals relate to historical knowledge and materials. AI is thus positioning itself as a historical agent, recombining vast cultural archives into new representations of the past. This process signals a paradigmatic shift from analysis to synthesis. Whereas analysis seeks meaning through the breakdown of components, in this case fragments of history, synthesis involves the creation of new configurations from existing parts (Simon, 2008). In this sense, artificial objects mimic natural facts but lack full authenticity. Their meaning must be constructed retrospectively by humans, who remain responsible for assigning significance to the stochastic outputs of these systems (Twomey, 2023). In this process, history is synthesised by machines, yet still analysed by humans, who project their knowledge and interpretations toward co-generated knowledge.

Therefore, further research activities should investigate how AI is reshaping fashion archival practices from static preservation to dynamic synthesis, exploring its role as a historical agent capable of generating new, participatory narratives, aiming to develop ethical frameworks and co-curation tools that ensure inclusive, critical engagement with machine-generated interpretations of fashion heritage.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

Conceptualisation, DC and GR; Methodology, DC and GR; Analysis, DC and GR; Writing and original draft preparation, GR; Writing, review, and editing, DC and GR; Visualisation, GR. All authors contributed to the article and approved the submitted version.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Acknowledgments

The authors would like to thank the editors and the reviewers for their work and contribution.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Generative AI was used in the creation of this manuscript. The author(s) declare that Generative AI was used in the creation of this manuscript. Not being native English speakers, ChatGPT was adopted for sentence reformulation and syntax improvement, as well as for simple English spell-checking.

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