



ReInHerit

Redefining the Future of Cultural Heritage, through a disruptive model of sustainability



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Acronyms and abbreviations

European Commission	EC
Research Executive Agency	REA
Grant Agreement	GA
Consortium Agreement	CA
Description of Action	DoA
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Executive Summary

D3.2 presents the Toolkit Strategy for apps and tools development based on existing commercially available or open-source platforms and frameworks, basic technologies, and frameworks in the fields of AI, IoT. This public report is developed according to the qualitative and quantitative analysis of the data collected from the primary research (D2.1, D2.3, D2.4), the results of the secondary research (D2.2), CH Management Guidelines (D2.5, D2.6) and National Surveys Report on the current ICT tools employed in Cultural Heritage (D3.1) The Strategy aims to address and to identify the digital tools (interactive and mobile applications for education - game based & AI for adults & kids) to be developed and shared as resources in the Digital Hub and related guidelines that will be delivered in the context of WP3 tasks. All the strategic issues will be useful in selecting the next training topics (aimed at professionals) for webinars, mobility/professional training, and a workshop that addresses the needs of all stakeholders. The D3.2 provides also valuable material to the consortium to feed and shape the next WPs of ReInHerit project (Digital Hub-WP4, Travelling and Digital Exhibitions WP6 – WP5, and Dissemination, Exploitation and Communication activities-WP7).

1. Introduction

The following introduction aims to describe and characterize WP3 “Toolkit Strategy” and its strategic role in the overall ReInHerit project. Additionally, it will be shown in which way the WP3 core team and the results of the other WPs have influenced the process and the progress (e.g. tasks, objectives) of WP3 already.

It must be noted that all sections within this introduction refer to the predefined objectives and tasks in the GA and its Annexes. However, the results of the work carried out in the first year as well as the needs of the WP3 group and the partners have had its impact on these predefined parameters.

In order to examine WP3 and its process from the very beginning (M1) up to the present time (M15), it can be divided into three phases:

- **Phase I - Preparatory Work Phase** (M1-M11, before WP3 officially started):

The initial phase included the team building process and brainstorming on the digital strategy on ICT technologies. During these sessions, the team discussed competencies and the digital set-up as well as their roles in the ReInHerit project. They shared ideas on digital tools for user interaction in museums and CH sites and for triggering visitors' emotions. At this stage, in the context of the interdisciplinary training "Emotional Museums" organized by UNIFI in Florence, the ReInHerit project was presented and shared with participants in order to begin a promotional activity with a community of possible interested professionals to be involved in the different phases of the project. Not only in the activities related to WP3 but also in the preliminary activities of the various WPs and in particular for the users' needs analysis and dissemination of questionnaires carried out in the context of WP2.

- **Phase II - Kick-off & Prototyping Phase** (M12, official start of WP3): The WP3 core team shared all information, ideas, and possible technology solutions and digital tools in the kick-off meeting and in sessions with partners. The ideas and suggested proposals were shared firstly in the ReInHerit Consortium Meeting. Secondly, by organizing an online internal Consortium Workshop on computer vision and artificial intelligence tools for cultural heritage. Finally, by organizing an onsite thematic workshop in collaboration with some partners to discuss synergies between the Digital Toolkit (WP3) digital exhibitions (WP6) and the Digital Hub infrastructure (WP4).
- **Phase III - Concept and Final Phase** (M15): Based on the results the National Survey (D3.1) and according to the ReInHerit guidelines on users' needs identified in primary/secondary research (WP2), the Toolkit Strategy was designed selecting innovative ICT tools primarily focused on a playful engagement and users' interactions with artworks and collections, planning also activities to test them in a real context and with a participative community. The basic idea is not only to produce finished and commercial tools but also to identify and produce a dynamic and interdisciplinary process of co-creating, to

share open-source and reusable digital solutions for museums and CH sites, and to provide related training addressed to CH professionals. During this phase a ReInHerit technical committee has been formed, to assess the viability of the tools. The committee will continue its activity during the development phase, with the help of newly appointed Innovation Manager, Tech Manager and Sustainability Manager.

A list of meetings and workshops carried out during these phases is listed in the Appendix.

In the following subsections of this introduction, the **Scope & Tasks** (1.1) of the ReInHerit pilot phase are defined and described. It is pointed out which main requirements of the GA and Annexes have to be considered for the Toolkit Strategy and which tasks derive from them directly.

In subsection 1.2 **Problem Statement**, general challenges and goals are described to give an idea of the decisions made for the strategy.

Subsection 1.3 **Objectives** is dedicated to the objectives of the pilot phase itself as well as those of this strategy report

1.1 Scope and tasks

According to the overall objective of WP3 in developing innovative methods and tools of communication & collaboration between museums and cultural heritage sites, the Toolkit Strategy (D3.2) aims to identify apps and tools *“based on existing commercially available or open source platforms and frameworks, basic technologies and frameworks in the fields of AI, IoT, webinars and mobile development for CH management”* (DoA, PartA, p. 25).

As described in the GA and its Annexes, an important and useful trend and needs to be considered is the user-personalization, *“viewed as a factor in enabling museums to change from “talking to the visitor” to “talking with the visitors”, turning a monologue to a dialogue, co-creation of content with users stimulates their participation and creativity, creating wider connections with new audiences, solutions that help to create users collaborative narratives allow to follow the “Visitor Journey theory”, according to which the experience of the visit begins before visitors cross the museum entrance and goes on after they exit.”* (DoA, PartA, p. 22)

The first deliverable planned in WP3 is the key report *“National Surveys on current state-of-the-art tools”* (D3.1), and it is associated with the main goal to aggregate data resulting from the quantitative method of surveys on the current ICT tools employed in Cultural Heritage (T3.1). In the GA and its Annexes (doA, PartA, p. 49), the task is pointed out as follows: *“The aim is to gather an up-to-date analysis of technologies that involve AI, computer vision, Internet-of-things, cloud-, fog-, edge- and mobile application development (...) Particular attention will be devoted to the availability of open source frameworks and tools, as well as to commercial tools that have been proved to be commercially and technologically viable. As mentioned in the objectives section of this WP, the aim is to select tools that allow to create personalized visits, allow user interaction and learning-by-doing or by gamification.”*

Overall, the defined tasks of WP3 are the following:

- T3.1 National Surveys on current state-of-the-art tools
- T3.2 Consolidated Report on ICT in CH Management
- T3.3 ReInHerit Toolkit Strategy
- T3.4 Mobile-based Applications
- T3.5: Story based game development
- T3.6: Training curriculum development

1.2 Problem Statement

The overall objective of Redefining the future of cultural heritage, through a disruptive model of sustainability (ReInHerit)" project is to create a model of sustainable heritage management, which will foster a digital dynamic European network of heritage stakeholders. This model is based on a digital cultural heritage ecosystem in which all the stakeholders (museums, heritage sites, policy makers, professionals and communities) will be provided with the tools and resources to communicate, experiment, innovate and disseminate European cultural heritage. (DoA , part B p.2) The Horizon 2020 project "ReInHerit" focuses on current challenges in the heritage sector across Europe (e.g. climate protection and sustainability, digital transformation and digital engagement, integrated experiences across sites and museums) and aims to foster further communication and exchange opportunities between actors of the cultural heritage sector (especially museums, cultural heritage managers and policy experts, tourism industries, heritage audiences, and citizens) by developing solutions, guidelines and tools, which are accessible for everyone.

To achieve this, a ReInHerit Digital Hub will be created: its innovative technological solutions will facilitate the development of a European cultural heritage network, open to all stakeholders, enabling collaboration within the sector. The Digital Hub will be structured to serve two user segments: cultural heritage professionals and visitors of museums and heritage sites. In the Digital Hub, all actors of the cultural heritage sector will have a chance to make the future of cultural heritage their own - either by connecting, communicating and sharing with other peers or by getting to know new ways and technologies for cultural heritage management and distribution. The hub will include Toolkit on the use of digital technologies in museums and cultural heritage sites. Specifically, the Toolkit will provide guidelines, prototypes for developing technology-assisted immersive performances, digital exhibitions, and educational and smart tourism applications, and training webinars. The ReInHerit project will develop a set of innovative tools & practices that will disrupt the current status quo of museums-cultural heritage sites communication and collaboration. The core element of ReInHerit is digital innovation: cooperation is taking place within an open-ended design space in the form of a Digital Hub that will sustain a digital ecosystem of cultural heritage stakeholders. Workshops have been organized to analyze the requirements for toolkit development with respect to the functionalities offered by the Digital Hub; these are presented in D4.1 Requirement Analysis Report, in particular in section 6.3 and in D4.2 in sect. 4.4 and 5.4 regarding the maintenance of the open source code of the toolkit. (Fig .1)

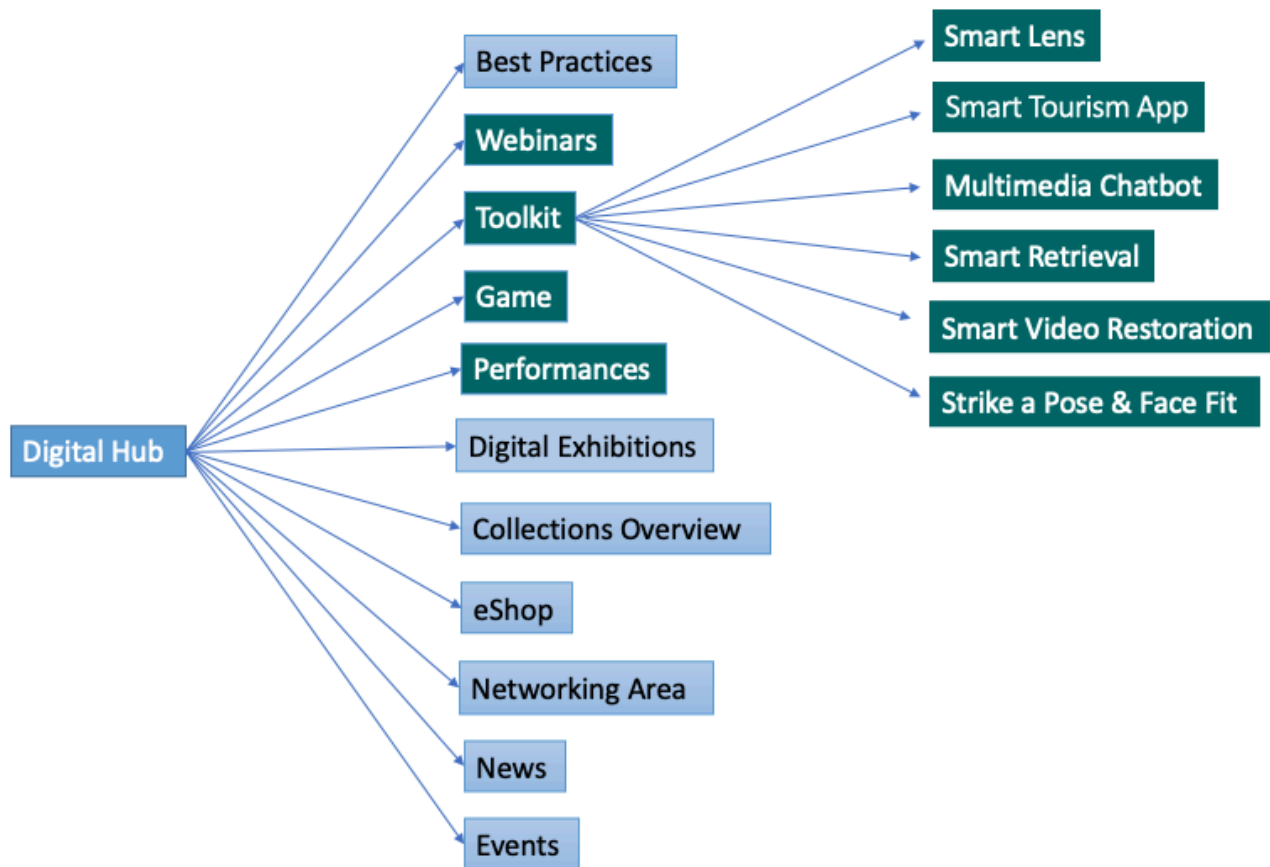


Fig .1: Digital Hub & Toolkit - tree summary

The problem statement of the Toolkit Strategy is to identify the cultural heritage sector audiences to be targeted, based on the CH needs analysis conducted and the aggregate data resulting from the quantitative survey method of ICT tools currently in use by cultural heritage institutions. The following sections describe the methods identified to reach different audiences, and the emerging digital tools that can enable active participation and user interaction in museums and CH sites. Parameters such as the types of CH audiences to focus on. In addition, trends, barriers and opportunities to actively engage them in cultural heritage. The most innovative and necessary technologies to reach the identified targets, motivate them in educational activities, and engage them in active participation. Also including emerging digital technologies for CH management and planning.

1.3 Objectives

The ReInHerit Toolkit Strategy, built on the results of T3.1 and T3.2, aims to develop a sustainable method for app and tools development, based on existing commercially available or open-source platforms and frameworks, as well as core technologies and frameworks in the fields of AI, IoT, webinars, and mobile development.

The goal of the WP3 is developing digital tools and mobile applications for user interaction (game based & AI for adults & kids) and CH management to achieve technological and commercial sustainability of the applications developed in T3.4 and T3.5 and to be deployed in the ReInHerit project's Digital Hub.

The Toolkit strategy considers the implementation process of the tools on the Digital Hub (WP4), the creation of a multidisciplinary team of experts (archaeologists, museologists, historians, technologists) with the purpose of designing interdisciplinary webinars and curricula on the main technologies, practical guidelines and best-practices. (T3.6).

As a result of the preliminary workshop and study visit conducted in collaboration with the WP3 and WP4 partners, a test framework was designed so that the tools will be tested in the "Digital and Traveling Exhibitions" (WP6) and in accordance with the pilot strategy (D6.1). This pilot tool will be a sustainable "use case" that will follow a "bottom-up" approach by providing additional workshops and hackathons with users and various stakeholders in cultural heritage (museums, heritage sites, researchers, policy makers and communities). A way to co-create cultural contents and re-design the tools in a collaborative and interdisciplinary working method based on "design thinking" (Objective 1,5 - DoA, PartB). Also providing training courses (online and physical) on the use of digital tools developed and about other topics identified in the context of WP2 analysis (governance, conservation, finance, technology, copyright, community). With the purpose to increase innovation potentials of small and medium-sized cultural heritage organizations, through digital experimentation in cultural practices, collaboration and training (Objective 2, 6 - DoA, PartB).

2. Theoretical & Conceptual Framework

2.1 Results of WP2

In this section, the theoretical and conceptual framework for WP3 is presented. As indicated in the GA and its Annexes (doA, PartA, p. 49), WP3 activity was *"driven by the outcome of Tasks 2.1 – 2.3, to align the analysis for the current and future needs of the cultural heritage sector with the scientific and technological state-of-the-art."* The results of WP2 "Needs Analysis and Guidelines of the ReInHerit Project" were aligned with the analysis conducted in D3.1 on the National Survey, and these outcomes are the framework of the toolkit strategy. The initial goal was to identify the needs of cultural professionals and different institutions from the primary and secondary research results, also comparing them with the needs of users, diversifying them by age, cultural and educational background etc... In order to select the most useful type of digital tools to be developed, and consider them from an innovative and sustainable perspective. This analysis, of course, was aligned with important references and innovative trends in museum, cultural and technological context.

The various subsections of section 2.1 provide an overview of the literature reports, focus groups, questionnaires, and reports that constitute the core of the toolkit strategy, and which led to the identification of some example on ICT tools in cultural context as "Digital Tools & State of the Art Examples" presented in section 2.2. These examples of tools, along with reference studies and networks, were inspirational during the brain-storming phase and will be useful for creating connections with WP4 and WP6.

2.1.1 State of the Art Report: Literature

The WP2 “State-of-the-Art-Report: Literature Review” is an analysis on cultural heritage management and “*will assist the ReInHerit consortium to fulfill its aim of developing tools and resources that will allow European cultural heritage stakeholders to communicate, experiment and innovate through a dynamic ecosystem fostered by a Digital Hub.*” (D.2.2 State of the Art Report - Literature Review)

The report itself is structured in seven main sections with their subtopics: a) Basic Premises for and Basic Notions of Cultural Heritage Management, b) Museum and other Cultural Institutions’ Collections, c) Intellectual Property (IP) Management, d) Audience and Local Communities’ Engagement, e) Environmental Concerns and Climate Change, f) New ‘Business’ Models and Financing, and g) Marketing and Branding.

The most interesting and relevant topics identified “*as the key challenges facing the Cultural Heritage sector today*” (D.2.2 State of the Art Report - Literature Review), are sustainability, digitization, digital technology and transformation, inclusion, communities and audience development. Among all these themes, those related to digital tools and technological innovation in the museum and cultural field were selected in the WP3 work activities. These references were useful in giving a guideline for the strategy and its development. Therefore, in the preliminary phase, partners were involved in summarizing and identifying the main themes to be used as important milestones in relation to WP3 tasks and in the process of tools development.

The starting point is the human-centered approach, because the role of the museums has changed in the last few years. Being and staying relevant for their audience and for the people in general has become a central objective for many CH institutions. One strategy for reaching this goal is democratization of knowledge and an inclusive and a “human centered approach”. A new mindset is needed, paying attention to people, stories and ways of living, to a new vision of dynamic and liquid museums, with an “open-minded” and “out of the box” vision, focused on complexity, multiplicity, diversity, inclusion, aiming at bridging the gaps between people of art and nations. An interdisciplinary and digital network of heritage stakeholders, crossing the boundaries of many disciplines and fields and engaging communities with cultural heritage. A new vision to transform the “conventional approach” into a “human” and “integrated” approach. A co-creative and participatory process, providing practices and tools for the development of cultural heritage by building a sustainable ground for the well-being of humanity. The new needs and emerging trends are well summarized as follows in the schema (Fig. 2) from D2.5 “The CH Management Guidelines”.



Fig. 2: Summary of the Secondary Research – (D2.5 p. 26)

Concerning this human centered approach, the literature review report points out that a new way of designing cultural experiences is focusing from collections and artifacts to the users' interactions. New **experiences** are **mixed**, **extended**, and **emotional**, especially using digital tools. It is highlighted that *"the new museum exhibits and cultural heritage site layouts are recently designed to enhance extended and mixed experiences, centered on 'multi-tasking' visitors, immersed simultaneously in the physical and digital dimensions. It uses digital tools to interact with museum collections and contents and to create new narratives, during, after, and before the visit. Digital technology combined with effective scenography offer the opportunity to expand the modes of visitor engagements, creating an emotional relationship between collections, museum and visitors. A new trend of the 'emotional museum' is focusing on integrated multidisciplinary practice that excites audience as well as the various professional actors, who contribute to its design, implementation and management"* (D.2.2 State of the Art Report - Literature Review p.53)

In this regard, effective audience development is of central importance for any museum and other cultural institution or site, so that it can respond to the challenges and possibilities of a new era. In terms of the main reasons for potential visitors to visit a museum, the environment and interaction with the collection rather than the quality of the collection are highlighted as key factors. Therefore, the digital toolkit strategy needs to be centered on **visitor interaction** in order to meet different needs and achieve greater visitor satisfaction. The literature emphasizes the need to clearly understand the target audience and its needs in order to effectively use new technologies and digital media. Technologies have changed audience behavior rapidly and radically, and people are not passive recipients of cultural offerings.

According to literature (D.2.2 pp. 134-135), some of the main **goals** and **benefits** to be considered on the use of **modern technologies** by museums and other cultural institutions and sites are as follows:

- create a sense of **'playfulness'** and exploration
- inspire **creativity**
- avoid offering a rigid didactic experience
- offer **multiple voices** from informal to authoritative
- exploit the tactile nature of the device.

- Offer the ability to engage audience within the organization's wall or beyond
- Provide users with high learning value (**participatory learning**)
- Provide a truly **immersive experience** for all, including users with disabilities, minorities, young and old people, people from an immigration background, people who are unemployed, people who are economically or geographically disadvantaged, etc.
- **Promote dialogue** between the user and the organization (a new relationship based on **collaborative** and **strong interaction**)
- Foster promotion and distribution of cultural content, products and activities online
- provide **personalized** services

The recent **digital tools** identified in the literature are (D2.2 p. 136):

- Personalization/Wearable Devices (create a more powerful connection between the visitor and the story)
- Augmented Reality/Virtual Reality/Mixed reality (bringing exhibits and artifacts to life in new and immersive ways creating multisensory and multimodal experience)
- Gesture Technology/Non-touch Interactives (In the post COVID-19 era touchless technologies and proximity sensors will likely gain popularity)
- Haptic technologies
- Internet of Things (IoT) technology
- Mobile Technologies (web and hybrid Wi-Fi apps, mobile apps, tour-based apps that enrich the exhibit content, mobile ticketing technology, etc.)
- Indoor GPS tracking systems (track movement within the facility, which allows them to confirm how well a storyline works)
- Artificial Intelligence
- LED/Laser Projection Technologies (creating powerful, immersive museum environments)
- Virtual Touring
- Holographic representations
- Flexible Technology Exhibit Platforms (developing software and designing exhibits that can not only accommodate content flexibility but also allow exhibits to easily change)
- Augmented Reality Selfie-Moments

Modern literature emphasizes the importance of interacting with visitors in dynamic and powerful ways by offering transformative learning experiences, during the entire visitor's journey. **Playful and immersive experiences** are used to inspire creativity not in rigid didactic way but based on informal and participatory learning. The new audiences are young people and the local communities, using different digital tools and instruments capable of **involving** and **motivating** them in experiencing, **enjoying, participating**. In a way to reflect the diversity of stories within museum collections and all around them and using digital tools and **participative storytelling** to promote social inclusion. Always considering that technology is not a goal itself, but it is a way to make the visitor understand and learn more.

All of these outcomes were extremely important and useful in choosing the digital tools to be developed, the audiences to be reached, and the needs to be met.

2.1.2 Focus Group 1 Report

The “Focus Group Report” was a deliverable (D2.1) of WP2 with the aim “to conduct primary research in the form of focus group interviews and tailor made questionnaires in order to develop a Needs Analysis Report based on mapping of the current state of the affairs in the management of the Cultural Heritage (CH) sector.” (D2.1 Focus Group Report Phase I). Five focus group interviews were conducted with a total of 34 professionals working in the cultural heritage management sector from 12 countries in Europe.

The main FGS1 outcomes were also summarized in D2.5 (“2.1.1 Focus Group Phase 1” pp 7-12). Regarding the **Digital Toolkit strategy**, the following are some **challenges** to consider:

REACHING YOUNG PEOPLE – visitors under 35 years of age are difficult to reach. The main challenges identified for museums and cultural centers were broadening the target audience and attracting younger visitors. Younger audiences view museums and cultural centers as less attractive sites, although they are interested in arts and culture. Collaboration of museums and cultural centers with schools and youth, the introduction of **gamification and digital tools** that offer useful insights into the target audience can help make cultural heritage and more relevant

REACHING LOCAL AUDIENCE - Another challenge for museums and CHS is to attract local communities. Museums and CHS need to become more accessible and attractive for museums and CHS to attract more locals and become less dependent on tourism. This could become possible through introduction of locally significant themes, collaboration with policy makers and introduction of a **participatory approach** fostering collaboration with locals through the organization of workshops and artistic activities such as performances.

RELEVANCE - Museums and CHS need to remain relevant to their target audience. For museums and CHS to increase their relevance, they need to be radical and experiment while they translate interest in cultural heritage into appealing products and services. It is important to anticipate the educational needs of society in the future and adapt services offered to these needs. And there is a need to appeal to all types of audiences. The concept of the understanding and **participatory museum** with a **horizontal approach** to interaction was mentioned as a recommendation. Moreover, it is recommended using **digital tools** to find out what is **important to the audience**. To Promote activities from the creative sectors and themes from everyday life. To use an horizontal approach to interaction to foster dialogue with the society’s needs.

EFFECTS OF THE PANDEMIC OF COVID-19 - The pandemic was viewed by the focus group participants not only as a challenge but also as an opportunity to create new tools and forms of action and incentivized the cultural heritage sector to appreciate the value of new technologies, including 3D experiences and improvement of sensory aspects for remote visitors. Service, design, and **storytelling tools** as well as **hybrid models of experience** can cater to different visitors’ needs and increase their engagement with the cultural sector.

DIGITALIZATION - There is a need to reinvent the idea of the **museum online**, to define the museum in the digital space and to engage with a variety of communities digitally. It is important to highlight the wish to do more research on the **combination** of the **digital and physical** and on how audiences perceive this connection. The digital space can contribute towards ensuring that there is a real connection with people, Introducing **gamification** and technological tools.

DIGITAL HUB - Digital platform needs to be an interactive and **user-friendly platform**. The most frequently mentioned requirement seems to be **networking**. The platform will connect professionals and will foster the exchange of knowledge and **good practices** as well as the sharing of information, experiences and **innovative tools**.

TOOLS - Training was the tool most mentioned by focus group participants. Apart from training, **gaming tools** were also mentioned with the collaboration of gaming experts, **community creation** and **connection** with the **social media** and “treasure hunt” systems. Digital tools that are **easy to use** and accessible from anywhere and by all.

2.1.3 Questionnaires Report

The “Questionnaires Report” (D2.3) was part of Task 2.1. In the framework of WP2, the second phase of T2.1 consisted of primary research conducted through two online surveys: one designed for cultural heritage professionals and one for museum and CHS visitors, the two user segments that will be served by the Digital Hub of the ReInHerit project. The survey was conducted online and remained open for 19 weeks in October-December 2021. 2481 responses were collected from questionnaires filled out by visitors and 890 by cultural heritage professionals from 37 countries. The main aim of the survey was to conduct primary research through tailor-made questionnaires that would lead to the development of a Needs Analysis Report on the Cultural Heritage Management Sector. The results included in the current report informed the design of ReInHerit the digital tools and digital hub.

Surveys Useful outcomes was summarized in D2.5 (2.1.2 “Questionnaires Report” pp 14-18) and in relation to the **Toolkit Strategy** these are the main points to consider:

- **younger visitors (18-29)** are more **likely to be interested in the tools** that will be created by the ReInHerit project in the museum environment. *“they are more likely to use the digital tools the ReInHerit project is offering, but within this category of young users we can also include 30-44 year olds when it comes to the use of digital tools (D2.3).* The **younger** the visitor, the **more likely that this person will use a digital game** in a museum or CHS. Younger people show greater interest in taking part in technology-assisted experiences in museums and CHS.
- Most of the people in the **“65+” age group are not at all interested** in using a **digital game** in a museum. Most people find **virtual exhibitions** and **tours** useful although the proportion of people in the age group of “65+” that finds such tours and exhibitions “very useful” is significantly lower.
- Using **QR codes** during a visit to a museum or CHS is popular **across all age groups**.
- **Smaller or medium sized organizations have less capacity to use the digital services** in the cultural heritage management sector therefore they will be **less interested** in the digital tools of the ReInHerit project and the Digital Hub. **Smaller organizations (10 – 50 employees)** mentioned that they **require more technical guidance** on how to implement the digital exhibitions rather than a ready-made package.
- **Larger organizations (50 – 250 employees)** seem to **require less technical guidance** than smaller ones in developing digital exhibitions but a high proportion of larger organizations suggested that they would need **a ready-made package** to set up their digital exhibitions. It is more likely for larger organizations to have offered a digital game in the past as **they have the infrastructure and capacity** to offer digital games.

The results indicate that **younger** respondents are more positively inclined towards the use of **digital tools** mentioned in the survey in a museum or CHS environment and it is likely that

they have used such tools in the past and find them useful. Therefore, it can be assumed that young museum visitors aged **18-29 years old** are more likely to use the **digital tools** the **ReInHerit project** is offering.

The Survey's results indicated that larger organizations had experience of organizing and offering **technology assisted immersive experiences** and **digital games**. All organizations had an interest both in the digital game and the immersive experience, however the smaller the organization the **more technical assistance they would require**, either in the form of guidance and or technical instructions or a ready-made package which they could implement. This indicates that small and medium size organizations **are less likely to adopt digital tools unless they are provided with support and guidance**.

These results are mainly interesting for WP3 Toolkit but also regarding the "Digital and Traveling Exhibitions Pilot Phase Strategy" (D6.1) and possible correlations. As it is stated in this WP6 Strategy "*when it comes to **digital exhibitions** that should also **include playful** (e.g. gamification) and **interactive** or **activating parts**. When designing and implementing **digital tools**, elements, or models and offering them on the hub as **reusable open-source tools** to interested museums and CH sites, there needs to be some **educational material** (information and **guidance material**, "how to use it").* (D6.1 p. 31)

In addition and regarding the Toolkit implementation (WP4) , "*The results of the surveys indicate that in the **digital hub** it is important to include **webinars** that guide museums and cultural heritage sites in **technical issues** related to **the use of the digital tools** we will be offering, as well as promoting these tools so as to reach a wide audience base. Small- and medium size organizations seldom have the in-house resources to maintain digital tools, so the start-up packages we will be offering should be all inclusive and have clear use **instructions**.* (D2.3)

2.1.4 Focus Group 2 Report

In the framework of WP2 on CH Needs Analysis & Guidelines of the ReInHerit project, five additional focus groups were conducted with museum/heritage site professionals, academic researchers, officers from public authorities/NGOs and ICT professionals. Participants included members of the consortium. The activity was in line with the criteria set in the GA and it considered their professional capacity and the type of organization they work in.

Identification of tools currently used in the CH sector inspired the **Toolkit Strategy** and led to the selection of **tools** that allow **personalized visits, learning by doing, user interaction** or **gamification**.

The results collected in the report D2.5 (2.1.3 Focus Groups Phase 2 pp 19-25) concern Processes and Outcomes of Digital Innovation, summarizing motivation mechanisms, technical barriers, enablers and methodologies for designing digital tools that are crucial in the collaboration between museums and heritage sites in digital innovation.

Professionals identified different issues of innovative tools for museums and CH sites. The following are key factors identified in designing an effective Toolkit Strategy, relevant to current needs and trends.

- **Digital tools** improve **hybrid models of interaction** with users and reach new **audiences, especially younger**, motivating **online /onsite** educational activities. Educational digital tools make more **attractive, inclusive, and**

playful training opportunities to younger audiences, engaging in a **storytelling** approach and inspiring their interest to learn more.

- **Digital tools** create **stronger emotional bonds** between museums and CHS and visitors, enhancing visitor experience as **multisensory engagement** and **triggering emotions**, before, during and after the visit.
- **Digital tools** provide **different stories** and interpretations of objects, introducing different layers of realities such as **immersive experiences**. Moreover, they can contribute through promotion of non-exhibited objects, focus on context and promotion of multiple interpretations, **inclusivity**, **cultural mediation**, and **new narratives**.
- **ICT and AI based tools** adapt information to the **needs**. AI and VR combined are useful to know **interests of visitors** and **personalize** narratives and interaction according to their preferences. They can track **behavioral patterns** of museum audiences and AI can offer an **enriched, live visitor experience**. They are used as a **guidance for the visitor** providing additional and appropriate information for different age groups.
- **Multisensory tools, gamification** and **Immersive** solutions (smart apps, mobile and wearable devices, sensor networks, multimedia augmented realities) help to design an **emotional museum** that uses new technologies to create, play, learn and desire to learn more.

FGs2 results also concern recommendations on the digital innovation **process**. Emphasis was placed on the life-cycle of digital tools , considering it in all its phases: *Product, Design, Development, Maintenance, Improvement*. Moreover, for small and medium-sized cultural organizations it is difficult to maintain digital tools throughout the lifetime. Therefore, it is suggested to have some “**open-source platforms**’ to develop reusable tools, find documentation, tutorials, examples, guidelines and updates.

- CH professionals require a **collaborative** and **multidisciplinary Digital Platform** for sharing tools and training. In order to create a common language between technical and cultural sectors. Such a digital space would really help museums to understand what technology is and how to use it.
- It is necessary to **involve communities in the creative process**, through workshops and hackathons. Use design-thinking methods to empathize with the audiences, understanding their needs, defining the problem, ideating solutions, and testing the prototypes.
- Professionals remarked that the **change of operational mindset** in cultural heritage organizations is a matter of power and decision-making. First, this dialogue needs to take place within cultural heritage organizations - from artifacts to visitor-centered - and then with the audiences. Digital tools help in this direction.

2.2. Digital Tools & State of the Art Examples

Looking at the results of the analysis conducted in WP2 and in relation to the use of digital tools in CH sectors, research strategy was done on examples and best practices in order to

design and implement relevant digital tools. Therefore, examples of ICT tools and Toolkits were researched and presented to partners through dedicated workshops and focused on AI/CV tools for Cultural Heritage. We also considered possible connections with WP6 in the context of digital and traveling exhibitions.

First of all, we started from the principle that digital interactivity is a key aspect of innovative user-centered exhibits. The digital interactivity is to be considered not like an end itself but as a medium for a participatory and inclusive process, increasing the level of user involvement and enhancing the educational and learning process itself. As also indicated in the WP6 Strategy report on traveling exhibition design, inspired by Nina Simon's *“The Participatory Museum”* method, the following five key values are fundamental in museum and CH exhibitions: relevant, inclusive, interactive, collaborative and educational (Fig.3). These values are defined as follows in D6.1 (p. 24):

- **Relevance** in an exhibition can derive from various elements in exhibitions, e.g. the topic itself, the way it is narrated, how it is contextualized, through new methods and inventive forms of presentation.
- **Inclusive** (in terms of open): The exhibitions are accessible in terms of physical/digital space and content. They offer multi-perspective views, multi-sensory designs, different levels of interaction and explanations/text.
- **Collaborative**: We want to try out more participatory approaches and open up a collaborative process to the audience and CH professionals for contribution, or maybe even enable co-creation.
- **Interactive**: The visitors get involved in a playful way. They are enabled to interact with the exhibition content (e.g. direct feedback/perspectives from audience and live-visualization) along the project’s claim “make it your own”.
- **Educational**: The audience is invited to learn something which they try and work out on their own.

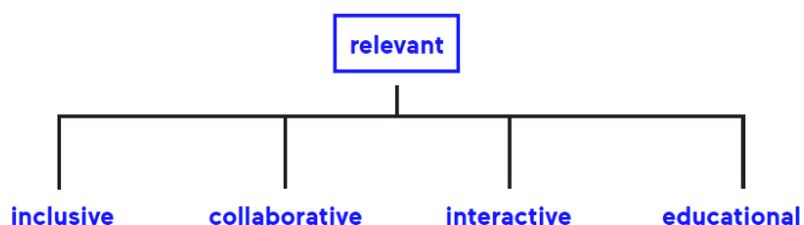


Fig. 3: Mapping of the key values of the WP6 team for the exhibitions

Interactive approaches, web-based communities, and bottom-up capacity building are the most effective way to create an innovation-driven economy and society. As also reported in GA and its Annex, Digital Technologies for Culture 3.0 are based on active cultural participation and interaction. *“The production of meaning through the active interaction of different users and heritage institutions in digital platforms, is considered one of the most important changes brought by digital media. End-users use their skills to contribute in the heritage the process of cultural content creation: i.e. not only they hear music but play music; not only they read text but they write them etc. In doing so, individuals re-negotiate their expectations/beliefs, reshape their own social – identity; this behavioural dynamic is a knowledge-intensive form of the capability building process.”* (DoA Part B, p. 9).

An important and significant example of interactive technology in museum environments highly referenced by literature is the **GalleryOne - ArtLens Exhibition at the Cleveland Museum of Art (CMA)**. The development of Gallery One and Art Lens represents a true and equal collaboration among the curatorial, information management and technology services, education and interpretation, and design departments at the Cleveland Museum of Art. Composed of six "interactive lenses", Gallery One invites museum visitors to explore pieces from the permanent collection in a more active or kinesthetic form. It welcomes visitors into an interactive and participative space where art and technology provide a dynamic environment for visitor exploration. Gallery One's innovative blend of art and technology invites visitors to connect actively with the art on view through exploration and creativity. Designed for visitors of all ages, the digital tools inspire visitors to see art with greater depth and understanding, sparking experiences across the spectrum from close looking to active making and sharing. A clever use of gamification creates a completely new experiential atmosphere within a traditional art institution.

In the **"Strike a pose" [lens]**, visitors are asked to imitate the pose of a sculpture, and they are provided with feedback relating to the accuracy of their pose. Visitors were able to share their poses and view others' poses, in addition to trying another pose. **"Make a Face" [lens]**, in real time, facial recognition software matches a visitor's facial expression to artworks within CMA's collection. Visitors can share their interactive experiences and see other visitors' ones.

The following aspects of Interactive experience at CMA are close to the idea of the Toolkit we are going to develop. [Alexander, Barton, and Goeser 2013]

- *Create a nexus of interpretation, learning, and audience development*
- *Build audiences—including families, youth, school groups, and occasional visitors—by providing a fun and engaging environment for visitors with all levels of knowledge about art.*
- *Highlight featured artworks in a visitor-centered and -layered interpretive manner, thereby bringing those artworks to the Greater Cleveland community and the world.*
- *Propel visitors into the primary galleries with greater enthusiasm, understanding, and excitement about the collection .*
- *Develop and galvanize visitor interest, bringing visitors back to the museum again and again .*
- *Feel empowered to browse, explore, and create personal meanings about the museum's collection*
- *Enjoy an organic, visitor-driven experience in the space without feeling like the experience is haphazard*
- *Employ engaging interactives, both technological and hands on, that use investigative methods and tools for critical observation to develop an engagement with the collection and interpretive concepts about the collection*
- *Create a personalized profile driven by their interests*

This is a significant example of a tool that aspires to engage visitors with art in meaningful and interactive ways, leading to some sort of transformative experience or understanding of the museum and cultural context. An exciting and emotional experience, which as such will remain more imprinted in visitors' takeaways for an extended period. As the outcomes show,

“Gallery One expands the Cleveland Museum of Art’s abilities to reach and accommodate visitors. According to the Museums and the Web 2014, in the first year of the atrium opening, the museum attendance increased by 39%, groups with children increased by 25%, and during the first half of the fiscal year donations increased by 80% Cleveland Museum of Art took the initiative to re-invent the museum experience through the aid of technology (...) Technology use is a trend that is not going to go away and is becoming more difficult for cultural institutions to shy away. (...) This rapid growth shows that people are adapting and using technology in everyday life. Therefore, incorporating technology – and even cellphone use – in a museum can be a natural and positive addition.” [Murphy 2015]

The ReInHerit toolkit comprises, among the tools, two applications related to the CMA “Strike a pose” and “Make a face” lenses, that build upon those experiences changing the technological approach and the interaction. In particular, the lenses proposed by CMA are designed using Microsoft Kinect devices to recognize expressions and poses; this limits the maintainability of the system, linking it to the availability (Kinect was discontinued in 2017) and to the computer vision capabilities of such devices. The strategy used to develop the ReInHerit toolkit is to use a software-based approach to computer vision, so as to ease the maintenance of the systems and their longevity since they are not linked to specific hardware. This approach further allows to deploy the systems on a larger variety of devices, from mobile ones to PCs.

D3.2 Toolkit Strategy was inspired by this interactive and digital exhibit, reinterpreting it with CV/IA-based tools, addressing mainly to small and medium-sized museums that often lack the funds and technological skills to develop such high-level tools. Regarding the use of Computer Vision and Artificial Intelligence technology in museums, it is interesting to note that *“Museum Innovation Barometer 2021”*¹, one of the most important annual reports on technology in museums produced by Museum Booster, highlights the topic of CV/AI in museums among its best 4 smart tools. The report introduced the **“AI: A Museum Planning Toolkit”**² edited by “The Museum & AI Network”. A Network founded in 2019 by Dr. Oonagh Murphy, Goldsmiths, University of London and Dr. Elena Villaespesa, School of Information, Pratt Institute, with the aim to examine current practices, challenges, and the potential of AI application in the museum field. The goal of The Museum & AI Network is to explore the possibilities and challenges of Big Data and AI technologies by sharing experiences, events, and workshops with the participation of professionals from 15 museums and 6 universities in the United Kingdom and the United States. The Toolkit provides a basic overview of the obstacles and benefits of using AI.

The Network founders published an open and updating list of Artificial Intelligence (AI) initiatives in museums,³ mapping the activities where museums are applying AI technologies such as robots, chatbots, computer vision, natural language processing, and machine learning. As shown in the figure below the use of AI/CV technology is a growing and topical trend in museums and CH sites (Fig. 4) .

¹ “Museum Innovation Barometer” ed 2021 by Museum Booster <https://www.museumbooster.com/mib>

² AI: A Museum Planning Toolkit <https://themuseumsai.network/toolkit/>

³ List of Artificial Intelligence (AI) initiatives in museums - <https://web.archive.org/web/20231010044142/https://www.artsmetrics.com/en/list-of-artificial-intelligence-ai-initiatives-in-museums/>

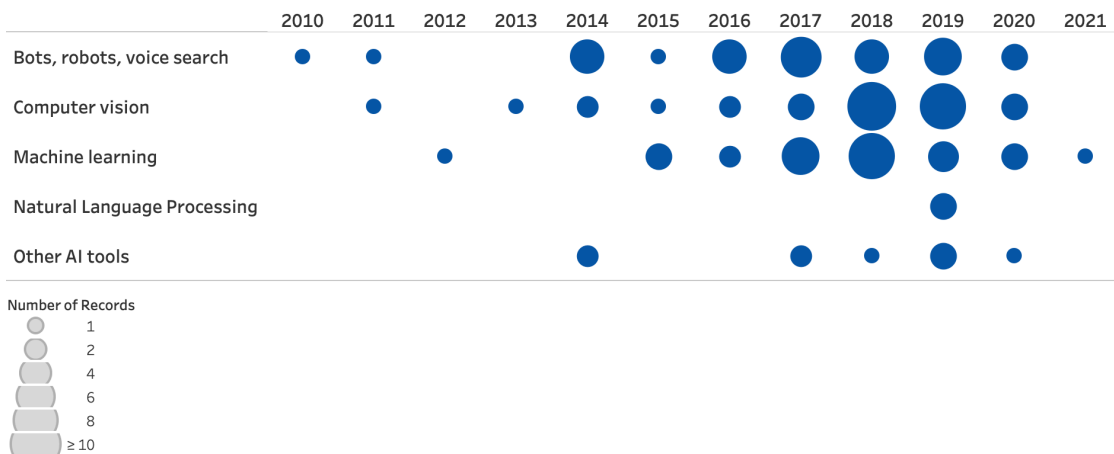


Fig. 4: Number of AI initiatives in museums (2010-2021)

Source: <https://www.artsmetrics.com/wp-content/uploads/2021/03/timeline-ai.png>

As the two founders note [Villaespesa & Murphy 2021, p.3] “Computer vision can help visitors to engage with collections in new ways, and help curators to develop new insights into objects that they may not have had the time or resources to research in an analogue manner. It is for these reasons that computer vision is fast becoming a potential instrument to enrich museum collections data in a diverse range of ways, which ultimately can have an important impact on the user experience.”⁴

This experience is useful to corroborate the RelnHerit strategy in developing and providing AI/CV tools in the Digital Hub, combined with guidelines practices for museum professionals and testing/designing the tools through interdisciplinary workshops and hackathons. “The experimentation model and structure vary per institution with the establishment of either internal or external collaborations. In some cases, this innovative work is generated solely by one or a few members of staff in the digital department. Hackathons, innovation labs and computer science competitions online are some of the formats that have been practiced by the museums in this study.” [Villaespesa & Murphy 2021, p.14]

Creating a network among cultural heritage professionals within and between museums, as well as experience sharing and knowledge exchange between cultural heritage professionals and technology experts. Reference to other Networks is also useful in promoting further collaboration of institutions involved in the platform with other EU projects.

“Some of the common themes and challenges in these case studies included the ethical implications of working with third-party algorithms and the lack of sufficient training data in the collection. A potential solution proposed during the project was the collaboration across museums in different aspects and stages of the application of AI tools. Firstly, potentially a group of large museums with the necessary resources could collaborate to develop an open-source algorithm with the documentation and guidelines to be reused by other museums. Secondly, related to the previous point, museums could work together to train an algorithm with multiple collections adding then more records to the training dataset” [Villaespesa & Murphy 2021, p.20]

⁴ Elena Villaespesa & Oonagh Murphy (2021) “This is not an apple! Benefits and challenges of applying computer vision to museum collections, Museum Management and Curatorship”, 36:4, 362-383, DOI: 10.1080/09647775.2021.1873827

One of the most relevant topics on CV/AI related to cultural heritage and museums concerns the training data and the creation of data-sets. This is an interesting and engaging theme of discussion for the future of the Project and the Digital Hub. Quoting the AI-Toolkit about "Why AI?". Thinking about AI, "*it is important to not only understand the technology you intend to use, but also what data it will require (as input) and what data it will generate as output*" [AI: A Museum Planning Toolkit, p.2].

According to the recent Recommendation CM/Rec(2022)15 of the Committee of Ministers to member States on the role of culture, cultural heritage and landscape in helping to address global challenges. "*Make the best of **digital technologies and in particular artificial intelligence***:

- *by considering the cultural dimension when addressing the impact of digital technology, in particular AI;*
- *by embracing an ethical framework regarding the use of digital technologies, and in particular AI, that protects human values and supports cultural diversity;*
- *by fostering collaboration and exchanges between professional and institutional actors (at local, national and European levels) to make better use of digital technologies, in particular AI, in the cultural and creative sectors through joint projects, training and awareness-raising activities, and to promote digital and AI-based services and content, notably in the audiovisual and cultural heritage sectors, also in support of plurilingualism.*⁵

3. Toolkit Strategy and Concept

3.1 National Survey Results

In the context of the WP3, the National Surveys Report (D3.1) contains conclusions and aggregate data resulting from the quantitative method of surveys on the current ICT tools (AI, computer vision, Internet-of-things, cloud-, fog-, edge- and mobile application development) employed in Cultural Heritage. It examines the current use of the technological tools and human resources available in the heritage sector. The deliverable reported on the availability of open-source frameworks and tools, as well as to commercial tools that have been proved to be commercially and technologically viable, with the aim to select tools that allow to create personalized visits, allow user interaction and learning-by-doing or by gamification. It is well evidenced how the concept of **digital innovation** has become pervasive in different sectors and that it requires a certain level of transformation in every organization that depends on the contingent challenges of adopting and using digital technologies. In this context of Industry 4.0, digital technologies have demonstrated unprecedented opportunities for sustainable cultural heritage management.

Innovative Digital Technologies are based on a "**user-centered**" and **interactive approach** to heritage management, using technologies to engage different audiences with various ages, many interests, and diverse visiting styles. Standard and innovative tools give the

⁵ Recommendation CM/Rec(2022)15 Adopted by the Committee of Ministers on 20 May 2022 at the 132nd Session of the Committee of Ministers
https://search.coe.int/cm/Pages/result_details.aspx?ObjectID=0900001680a67952

opportunity to extend museum and CH visits into sessions of experiential education by expanding the modes of visitor engagements.

An interesting finding from the national survey, useful for designing Toolkit Strategies, is that Museums and cultural heritage sites are particularly interested in **ICT tools for user interaction**. Despite the cost of development and maintenance for digital tools, it seems that a need of cultural professionals is to use open-source and re-usable interactive tools with which to increase their relevance in the digital age, consisting of a collaborative and participative dialogue with users. The lack of open-source solutions, which leads to maintenance problems and to the failure of reusing applications by different organizations. Developing these new apps following an open-source approach along with documentation on the digital hub of ReInHerit, allows small organizations with limited resources to re-implement them.

Professionals surveyed need to use **digital tools in the physical space** to perform digital components and they use more multisensory/immersive tools than AR/VR tools. Multisensory/immersive are the most used tools across all different age categories and mostly in Public museums, cultural heritage sites, and public authorities. Digital and mobile interactive tools are less used by Professionals surveyed, and they are more familiar with the use of Smart Environments and IOT tools than AI and CV ones. The usability of Smart Environments and IOT tools increases with age. AI and CV tools, although not very well known, are more relevant to more senior professionals.

ICT tools for interaction are used in the physical space to design interactive expositions creating multisensory and immersive experiences to engage the visitors with all senses in the exhibits, using tools for sound specialization and immersive audio, projections and video-mapping, video elements and visual information displays, 3D/4D elements, Holographic Imaginary Displays, Augmented - Virtual - Mixed reality, like Oculus Rift. ICT and Mobile interactive tools are used in many types of cultural institutions to create online, virtual and extended experiences, to increase user interaction of the visitors with the collections in different times and spaces. Above all web/mobile Apps, storytelling and social media and gaming tools. Smart Environments & IOT tools and sensors (Beacons, Smart objects, Li. Fi Technology).

An emerging research and development trend concerns **AI/CV tools**, more developed in large museums and known especially to CH professionals in Research Institutes, NGOs, or creative industries. Although Artificial Intelligence and its applications (such as CV) are experimental works and typically not widely deployed in museums and small- to medium-sized organizations, the applications developed in ReInHerit and distributed through the Digital Hub aim to reduce this technological gap. According to recommendations D3.1: *“it is strategic to design a ReinHerit digital toolkit based on open-source and re-usable innovative tools, helping museum and CH institutions, especially the small one, to increase their digital strategy. In the meantime, to provide them up-to-date guidelines, best practices, and selected training courses in the context of an interdisciplinary and collaborative Digital Platform that will enable them to achieve digital innovation” (p. 39)*

3.2 Audience & Target groups

Based on the WP2 guidelines and results, all types of organizations involved in the surveys are interested in the digital tools and digital games or technology-assisted experiences offered by the ReInHerit Digital Hub. It is clear that small and medium-sized organizations

need more external support and skills to implement and maintain the technology services and systems used. This indicates that **small and medium-sized museums** and CH sites are less likely to adopt these tools unless they receive support and guidance. The strategy that has been adopted for the toolkit is to develop tools for small and medium-sized organizations as well, offering technical guidance, open-source and reusable tools with best practices and training in the platform. According to the specific challenges of the GA and its Annexes (DoA, Part B, p. 5), *“in order to achieve their sustainable development, it is necessary for museums and heritage sites to implement co-creation processes, seek the participation of other social agents such as public institutions, the business sector and different community groups. Through the ReInHerit ecosystem cultural heritage organizations (small and medium size or those suffering from budget cuts), which are key players in the realization of cultural industries growth, will be provided with support (Cultural Hackathon, webinars, onsite training, Digital Hub, e-shop) to increase their capabilities and cooperation; and help them deal with the increasing precariousness of the professional heritage sector”*.

3.3 Reach young people, locals, and tourists

ReInHerit WP2 guidelines and results indicate that a primary need is using digital tools to **diversify the cultural offerings**, engaging people in more enriching and meaningful experiences that cover the needs of all audiences. The **younger audience** especially uses digital tools, social networking services and text messaging as their main means of communication and learning. Young museum visitors are more likely to use digital tools in a museum environment and therefore would be more positively inclined towards the digital engagement activities and the solutions offered by the ReInHerit Digital Hub. They use digital tools to interact with the museum’s collections, creating and sharing new stories, during, after and before the visit. Social media sharing and new technologies can also play an important role in attracting younger audiences, promoting social inclusion, creating more narratives via participative storytelling. Cultural Heritage institutions need to expand their target audience and attract younger visitors, making museums and CH sites as more appealing and emotional places. It is important to develop solutions for audience development and engagement of different types of audiences, with a focus on **local communities** and through different digital tools and instruments capable of involving and motivating diverse audiences in experiencing.

According to the focus groups conducted with professionals and experts it is important to develop the tools so that museum experts and developers can dialogue with visitors. Hackatons and design-thinking workshops need to be organized, inviting communities into the creation process and understanding their needs, defining the problem, devising solutions, and testing prototypes. The Toolkit Strategy goal is to provide not just a tool, but a development process, inviting communities into the creation process. Tools are to be designed, developed, tested together through interdisciplinary Design Thinking workshops. In addition, visitors and professionals can interact with the digital platform, sharing a set of useful practices for museum professionals and in connection with national and international networks, in order to explore new trends on people-centered museums and sustainability with an interdisciplinary perspective.

According to the specific challenges of the GA and its Annexes (DoA, Part B, p. 8) *“there is a new generation of individuals, who do not find the complexity of the digital era and constant updates in the field of technology problematic; they are generally referred to as ‘Digital Natives (DNs), characterized by new demands (ICTs are their main information tools). Digital visitors are mainly composed of people who are between 20 years old and 35 years old that*

identify tourism as one of their main needs. These individuals through their travels they seek personalized adventures that make them feel integrated as residents and experience personal development. However, they want to participate in activities related to social trends, incl. sharing their personal data, which combines value and personal relevance."

3.4 ReInHerit Toolkit development processes

In order to keep under control the development process of the toolkit, evaluating the innovation, technology and sustainability of the apps, the ReInHerit consortium has created a Technical Committee that convenes regularly every month to examine the design and development of the apps. In addition to the Tech Committee have been selected also an Innovation Manager, Tech Manager and Sustainability Manager to evaluate each of such respective aspects. In particular the committee has defined an evaluation process for the apps to be developed, based on the results of surveys and focus groups, to check that the applications cover the following main areas:

- Innovation part
- Differentiation in the market
- Need to develop such an application
- Target Audiences
- Level of interaction
- Risks and challenges

3.5 Digital technologies for interaction and participation

As indicated in the GA and its annexes, the scope of WP3 toolkit *"is to develop mobile and web based applications based on participatory learning and enjoyment activities that give attention to user experience"* (DoA, Part B p. 4). Not all ICT technologies are capable of changing the traditional approaches of museums where visitors are passive and look at the artifacts without interaction. Tools like websites and social networks, with the associated analytics and management tools, or paperless ticketing systems are basically built upon standard technologies. More advanced technologies, like **AI and its applications (e.g. Computer Vision), chatbots, gamification**, etc. are much less common.

The most used technologies in small museums are websites and social media channels; this may be motivated by the fear of the risks and investments in terms of time, and human and financial resources. One of the greatest needs for museums is to be able to provide audiences with tools and activities for interaction, collaboration and inclusion: *"anyone who physically, digitally or tangentially interacts or engages with cultural heritage organizations can be defined as museum/heritage site audience. (DoA, Part B p. 8)* ReInHerit National Survey results indicate that Cultural Institutions are interested in digital tools for visitor interaction in the physical space to design interactive expositions and create multisensory and immersive experiences to engage the visitors with all senses in the exhibits.

Mobile Interactive Tools are also requested by many types of cultural institutions to create online, virtual and extended experiences, to increase user interaction of the visitors with the collections in different times and spaces. Innovative and emerging ICT tools are needed to create stronger emotional bonds between museums and CHS and visitors, enhancing the visitor experience triggering emotions, before, during and after the visit. Especially

multisensory tools and Immersive solutions based on Artificial Intelligence and Computer Vision (smart apps, mobile and wearable devices, sensor networks, multimedia augmented realities) help to design an emotional museum that uses new technologies to create, play, learn and desire to learn more. AI and VR combined are useful to know interests of visitors and personalize narratives and interaction according to their preferences. The results indicate that visitors prefer to use their smartphones or tablets in museums or heritage sites. In general users, especially the younger visitors, prefer *quick and smart interaction* with digital tools, using QR-Codes and do not download mobile apps and generally they want to be engaged and motivated in their use by first understanding the benefits, features and value added.

The toolkit idea therefore is to develop **web apps** (not necessarily downloadable, this depends on the performance reachable using web toolkits), as younger users do not download museum apps partly because they do not want to waste memory on their smartphones and devices. To be relevant, the toolkit strategy designs smart solutions to enhance and encourage curiosity, combining playful with local interest and inspiring memorable experiences. To be effective, the toolkit strategy aims to enhance and extend user experiences by analyzing and seeking to understand what aspects are desirable, the benefits in use, and the emotional and triggering effects of user engagement.

Considering the "Contextual Mode" of learning proposed by Falk and Dierking [Falk, Dierking 2012], the more multisensory, interactive and participatory the museum experience is, the more it will have a lasting impact on the visitor and thus enhance his or her learning on the subject. (Fig.5)

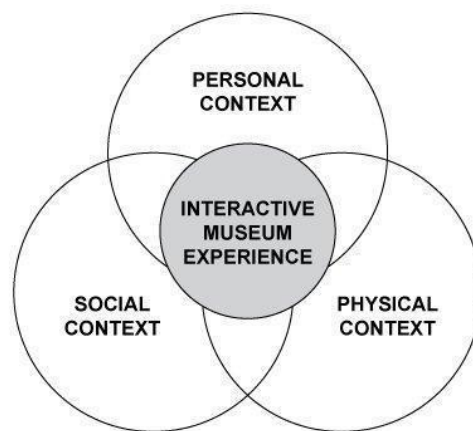


Fig.5: Contextual Model, Falk and Dierking, *The Museum Experience Revisited*, p. 26.

Visitors are guided by their own motivations, emotions, interests, and prior knowledge. This background has a huge influence on the experience the visitor gets from the stay, also on the memory they will have of it, and on recommendations to other users and friends. Emotions play a motivating role at every stage of the museum experience, from the decision to visit the museum to post-visit enjoyment, and visitors' **emotional engagement** is a prerequisite for effective and authentic learning. Digital tools can enhance the museum experience by triggering a multisensory experience or enhancing social interaction during the visitor's journey, improving the **personal, physical, and social aspects of the museum experience**.

Digital technologies enable personal connection, personalize the visit according to the user's needs, enhance playful and social interaction, and share personal experiences.

Therefore, digital tools will be developed to enhance the museum experience by triggering a multisensory experience or enhancing social interaction during the visitor's journey, improving the personal, physical, and social aspects of the museum experience. Digital and mobile applications based on CV/AI will be used to interact with the performance environment in a **playful approach**, based on **gamification** and **learning-by-doing** techniques. So that the audience has the opportunity to select objects to interact with, taking advantage of the “wow” effect to encourage deeper study of the artwork's content during and after visits. Visitors will be able to connect selected objects to their visit experiences, creating narrative and user-generated content to share on social media.

To ease the evolution and adaptation of the toolkit apps and components in new applications developed by the users of the Digital Hub, a series of technical webinars addressing AI, CV and modern ICT tools in general, will be prepared and made accessible from the Digital Hub. (Fig.6)



Fig.6: AI-CV Webinars Summary

3.6 AI/CV interactive tools

A goal of the toolkit strategy is to develop smart applications based on the BYOD (Bring Your Own Device) model that can be used by visitors with their smartphones for hybrid and extended interaction in physical and digital space. One aspect is to provide new ways to document and interpret the museum's collection and make it more searchable and browsable online. The various collections and many digitized objects, generally have very little supporting information, which means that although a digital image exists, the lack of metadata or keywords prevents the user from discovering these objects through search. A further issue involves the development of CV/AI algorithms trained to create new data for huge numbers of documents. This allows diversification of the information in databases, finding alternative ways to describe collections, providing access and creating new paths to navigate through the collections (Fig. 7). Neural networks are used to associate text describing the desired content of the image with the pixels in the image. In addition, instance recognition algorithms are used to create visual relationships between objects and artworks in the collections. Finally, game-based applications for playful interaction and sharing of media created by applications on social networks.

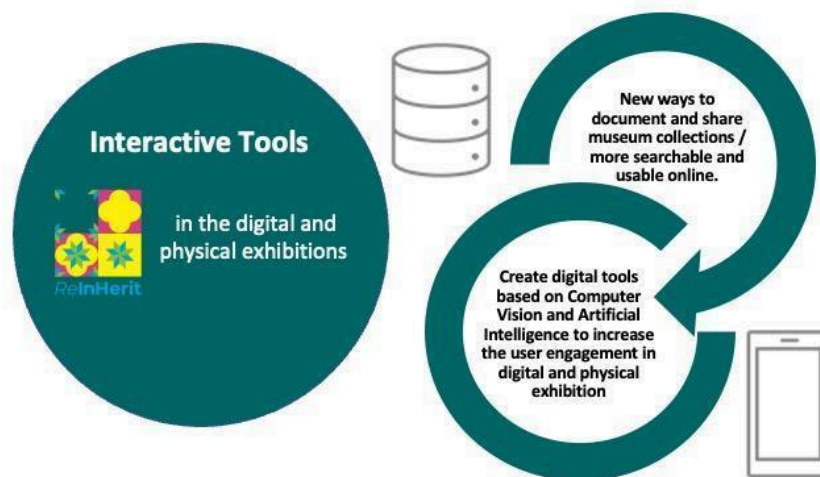
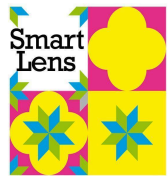


Fig 7: Toolkit Strategy: Smart Apps and AI/CV Tools for phy-gital interaction

Smart apps based on CV/AI technology that will be developed and open-source reusable and within the Digital Hub are the following:

3.6.1 Smart Lens



The idea is to have an app that can be used as a lens to observe the details of an artwork, getting the related information. Computer vision is used to recognize which “hotspots” of the artwork are associated with some specific information. The user is invited to explore the artwork, looking at the details. This type of interaction differentiates the application from other guides that typically provide information regarding the whole artwork, observing it from a distance. This application is designed for the visitors of a museum. It has been identified as useful within the context of the exhibitions of WP6. (Fig.8)

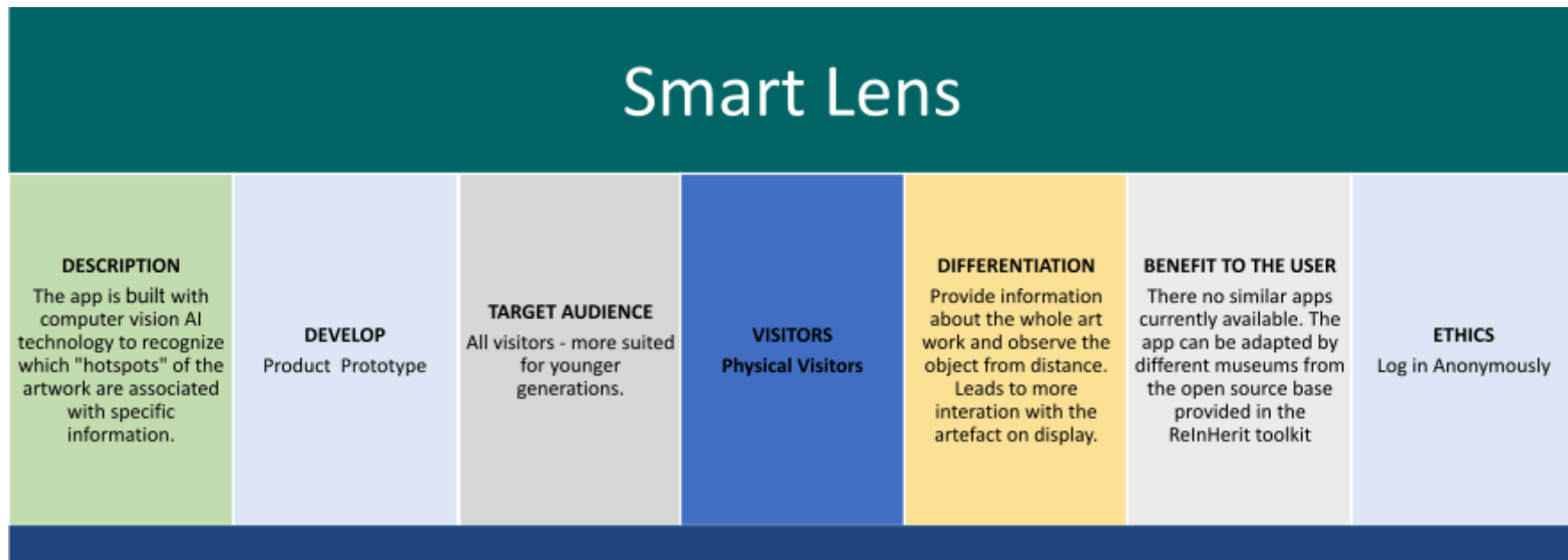


Fig.8: Smart Lens

3.6.2 Smart Tourism App



This application is designed for visitors of a cultural site, e.g. for cultural tourism. It uses computer vision and GPS to recognize landmarks and monuments. Landmarks can be annotated by the provider of the backend system, i.e. the people in charge of managing the tourist attractions can provide descriptions of the landmarks/monuments considering also accessible information, or can be harvested automatically from open sources to reduce the cost of the startup. The computer vision part is relatively novel in that it merges global features and local features to recognize the monument/landmark (this is needed to deal with large artifacts that may be framed only partially). Anonymous logging of the visit can be used for: getting analytics on the visits of a site/city; providing recommendations to the users in a collaborative filtering approach, akin to Amazon recommendations (Fig. 9).

The AI and CV components will be exploited in the Smart Tourism App planned in WP7.

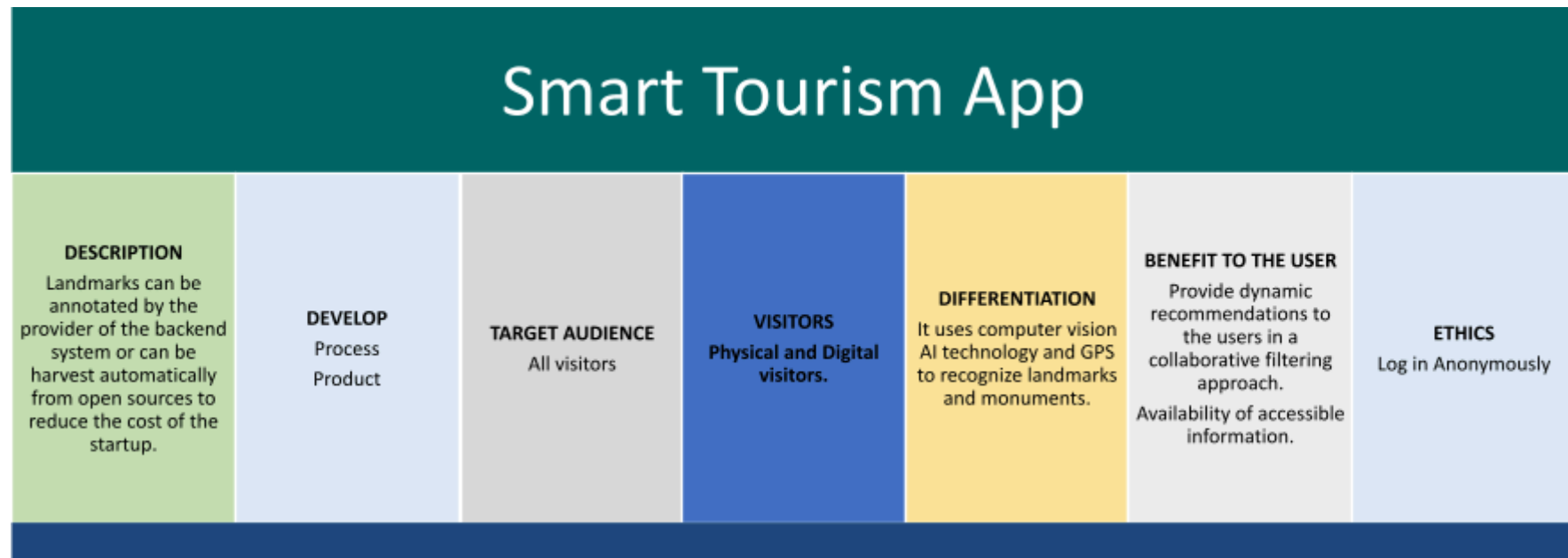


Fig.9: Smart Guide for Tourism Summary

3.6.3 Multimedia Chatbot



This chatbot is a server-based system that can be used to implement the functionality in web interfaces. The idea is to get descriptions and information on artworks using natural language and interacting in a chat, as it has become common in other domains than CH. The novelty is that the proposed chatbot can distinguish different types of questions: those related to the content of the image and those on the context of the image; typically visual question answering systems are focused only on the visual aspect. (Fig. 10)

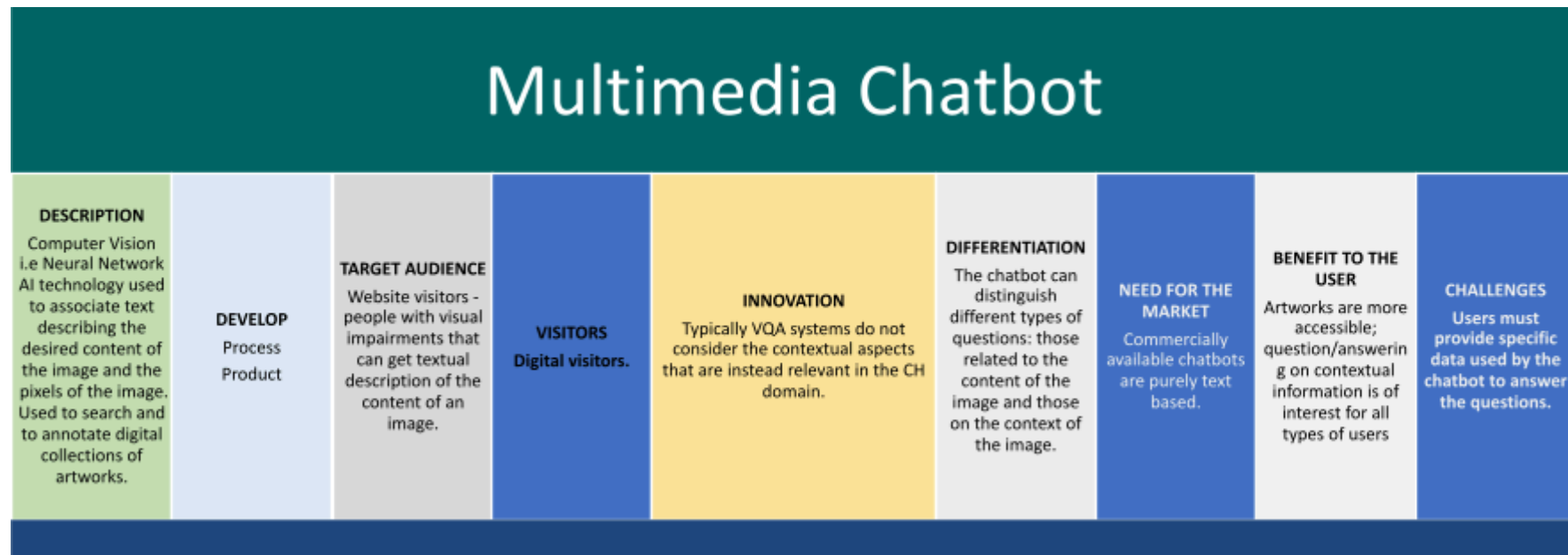


Fig.10: Multimedia Chatbot Summary

3.7 Digital technologies for management

These applications regard the management of artefacts and collections, to annotate and/or retrieve elements in collections using natural language or to restore digital artefacts that have been damaged by ageing supports.

3.7.1 Smart Retrieval



This application is designed to be desktop based (using a web interface) to be used as additional search tool in museum websites or to manage, in general, multimedia collections. It provides content-based image retrieval facilities, i.e. search images based on their content. The novelty is in the computer vision part, i.e. the neural network used to associate text describing the desired content of the image and the pixels of the image. MICC has developed a novel approach to perform conditioned image retrieval, i.e. searching an image using an example and additional text, expressed in natural language, that describes a modification w.r.t. the content of the sample image. Using other neural networks (so in this case the novelty is limited) it is possible to add also uni-modal search paradigms: text-to-image retrieval and image-to-image retrieval. The system can be used also to perform tagging, using a zero-shot learning approach, i.e. an approach where it is not necessary to train explicitly the network to recognize a specific content. This is extremely beneficial for small museums that may not have the large resources needed to collect training data required to train explicitly a neural network to recognize a visual concept. (Fig. 11)

Smart Retrieval

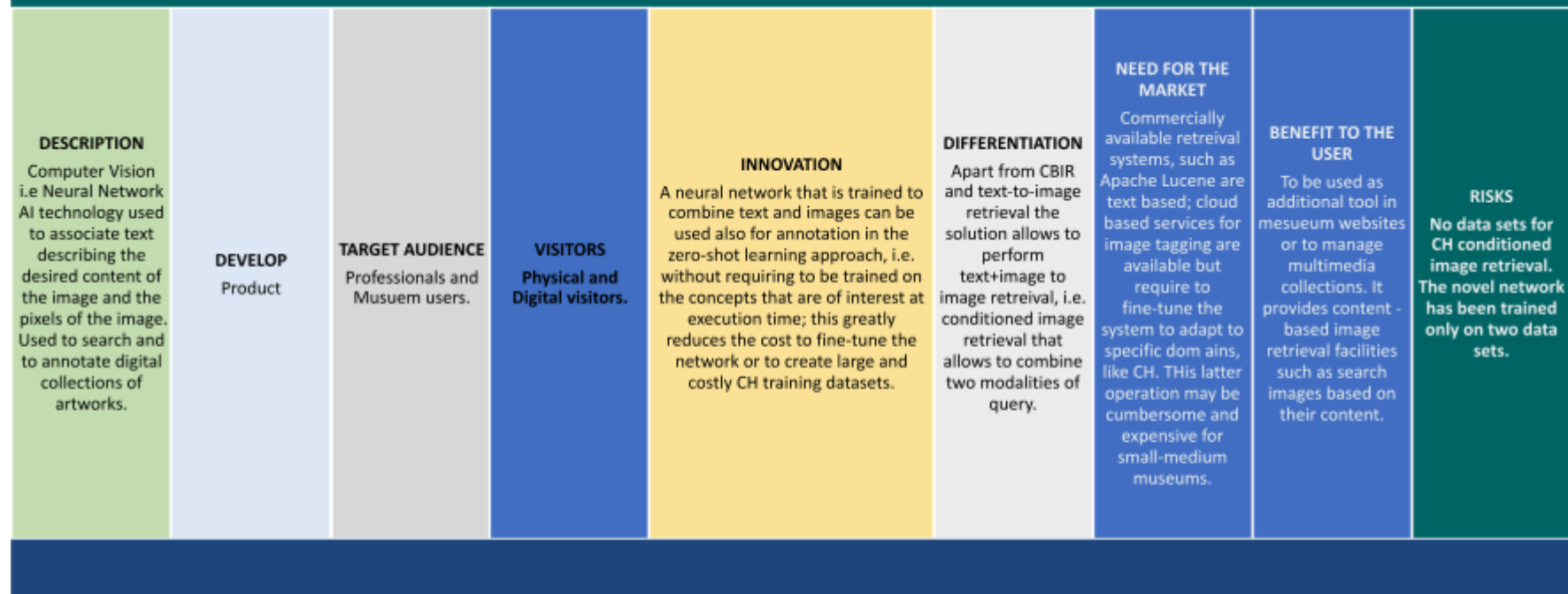


Fig.11: Smart Retrieval Summary

3.7.1 Smart Video Restoration



Analog videos of historical archives often contain severe visual degradation due to the deterioration of their tape supports that require costly and slow manual interventions to recover the original content. We are working on a novel neural network that uses a multi-frame approach and is able to deal also with severe tape mistracking, which results in completely scrambled frames. The network can be used to reduce also other types of tape defects that are less severe than tape mistracking. We think that it may also work on films to reduce scratches and mold. The novelty is in the neural network that reduces these artifacts. (Fig. 12)

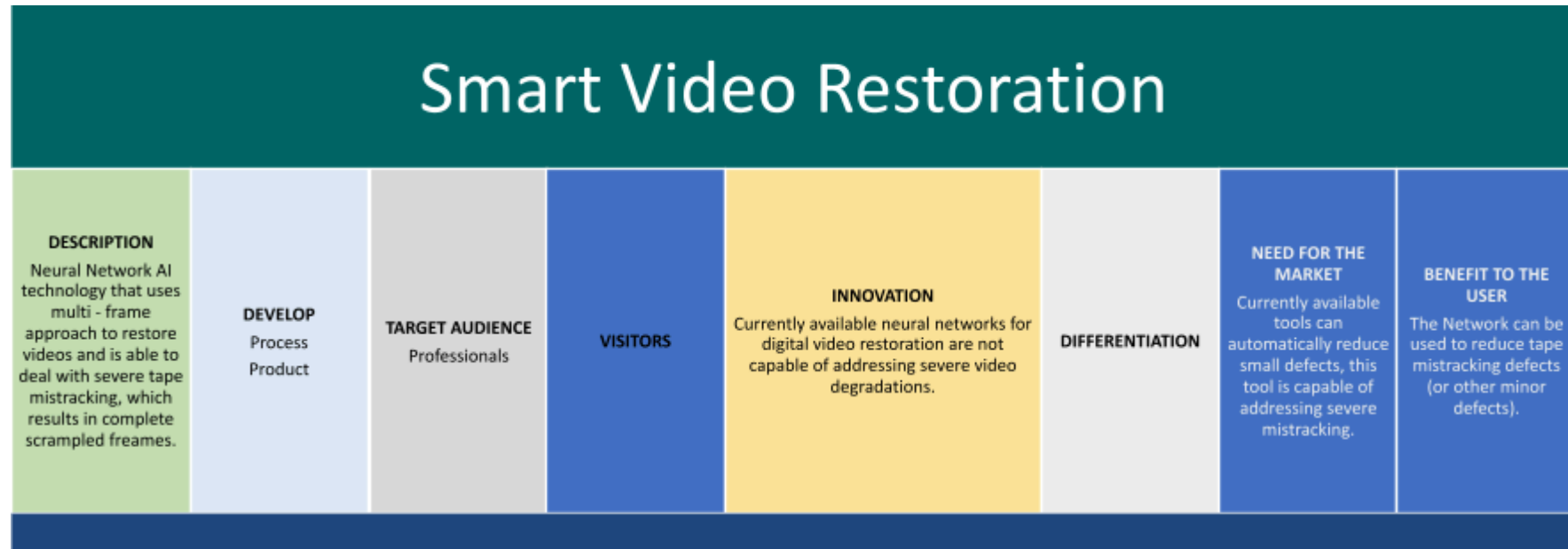


Fig.12: Smart Video Restoration Tourism Summary

3.8 Gaming and Gamification Tools

Gamification is the process of exploiting strategies and game dynamics into scenarios that are not a game [Robson-2015]. It has already been proved to be useful to enhance skills and competences in a variety of domains such as marketing, industry training and entertainment. Certainly also cultural heritage can benefit from a gamification approach which represents an opportunity to engage visitors to museums content through the design of more entertaining, social and challenging digital learning scenarios [Karahana-2021, Khan-2020, Bonacini-2022, Paliokas-2020], to help museums to move from the traditional "look and do not touch" toward a "play and interact" approach. In fact, it has been observed that the availability of tools like gamified e-guides to visitors contributes to the sustainability of museums [Bieszk-Stolorz-2021].

3.8.1 Story-based Video Game



A *game* is a structured form of play, usually undertaken for entertainment or fun, and sometimes used as an educational tool. Key components of games are goals, rules, challenge, and interaction. Games generally involve mental or physical stimulation, and often both. Many games help develop practical skills, serve as a form of exercise, or otherwise perform an educational, simulational, or psychological role. A *video game* is an electronic game that involves interaction with a user

interface to generate visual feedback on a two- or three-dimensional video display device such as a touchscreen, virtual reality headset or monitor/TV set.

A main goal in the development of the strategy for the RelnHerit project is to *engage people with museums using interactive stories*; stories can be predefined or emergent and can come from several sources: the artifacts and collection of museums, the people (experts/non-experts) working and managing museums, the city/country that the museum lives in, visitors, even from the processes used to run a museum. Video games are a way of attracting younger audiences, however, there are thousands of games out there; it is not easy to differentiate from the rest and it is quite difficult to innovate in the game-playing aspect. *A disruptive way of approaching innovation is in the game creation process itself*; novel AI methods (such as text to image) will be used to generate game assets (imagine alternate reality interpretations of artifacts such Greko-Chinese pottery with modern art) as described by people (experts and the public). These assets will be used in the context of a museum management game; players will be able to design, build and manage their own museums using assets created by other players. This co-creation process can then be used as part of the advertisement of the game; think for example a physical mini-exhibition of the AI generated art linked to the release of the game, where visitors can physically visit museums and see these creations or people posting their creations as used in the game in social media.

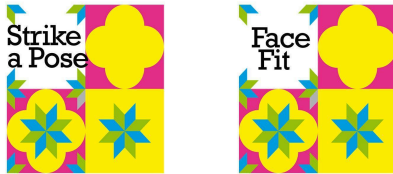
The "story-based" element of the RelnHerit video game then comes down to the following: a) the short stories that people give to create the assets b) the expert provided stories and c) the emergent stories that are being created by users when linking digital artifacts to build exhibitions in the management game. A fundamental contribution of the RelnHerit project will be the *Game Design Document (GDD)* that will document the whole process used to create the video game; from the workshops, co-creation processes, inspirations, game mechanics, art, audio, engine choices, etc. This will also include lessons learned; these will serve as useful information and guidelines for small museums and development teams.

Story-Based Video Game

<p>DESCRIPTION Develop a Museum Management Video Game inspired by the Museum processes. Game assets will be generated using a co-development process between creators, experts, the public and text-to-image AI technologies.</p>	<p>DEVELOP Process Product</p>	<p>TARGET AUDIENCE Young Audiences</p>	<p>VISITORS Mostly Digital Visitors</p>	<p>INNOVATION Comes from the co-creation process that includes human (Experts, public) input to AI systems to generate alternate reality art pieces and concepts for the video game. The purpose is to interact with young audience and professionals in the process and document the feedback / involvement / reaction in order to develop a game.</p>	<p>DIFFERENTIATION Co-creation game asset generation by AI is novel in a museum setting. Even in the industry, this is something that companies/creators just started exploring</p>	<p>NEED FOR THE MARKET</p>	<p>BENEFIT TO THE USER A fun game experience. Engagement in the creation process.</p>	<p>RISKS The game might not succeed, but this is a risk with most creative products. However, the process will be documented and be shared on the Digital Hub.</p>
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Fig.13 Story-Based Video Game Summary

3.8.2 Strike-a-Pose & Face-Fit



These two applications are designed to employ gamification based on body pose and face expression recognition using computer vision. Gamification is the process of exploiting strategies and game dynamics into scenarios that are not a game. It has already been proved to be useful to enhance skills and competences in a variety of domains such as

marketing, industry training and entertainment. Cultural heritage can also benefit from a gamification approach which represents an opportunity to engage visitors to museums content through the design of more entertaining, social and challenging digital learning scenarios, to help museums to move from the traditional “look and do not touch” toward a “play and interact” approach. The user is requested to replicate the pose or the facial expression of a painting, once the challenge is completed he gets information about it and new media that can be shared on social network to help increasing the engagement of the museum, e.g. as a video of the person that replicates a series of poses of different artworks or as versions of the painting where the face of the visitor has been substituted to that of the painting. The apps can be used on a mobile phone or as an installation within the museum, e.g. placed before entering the room with the artworks. The novelty is in the interaction design and in the sharing of the media created by the apps on the social networks. (Fig. 14)

Strike a Pose & Face - Fit

<p>DESCRIPTION</p> <p>Gamified interaction with artworks. The novelty is in the interaction design and in the sharing of the media created by the apps on the social media networks.</p>	<p>DEVELOP</p> <p>Process Product</p>	<p>TARGET AUDIENCE</p> <p>Museum Visitors mostly young generation.</p>	<p>VISITORS</p> <p>Physical Visitors</p>	<p>INNOVATION</p> <p>Two past applications that involved users asking them to replicate pose and expressions was used as an installation in a large museum (Cleveland Museum of Art). These apps are designed to work both on mobile devices and as installations, using a gamification approach that produces new media content that can be shared on social networks to increase museum engagement. Being open source they allow also small museums to provide a gamified experience otherwise too expensive to implement.</p>	<p>DIFFERENTIATION</p> <p>Opportunity to engage visitors to museums content through the design of more entertaining, social and challenging digital learning scenarios, to help museums to move from traditional "look and do not touch" toward a "play and interact" approach.</p>	<p>NEED FOR THE MARKET</p>	<p>BENEFIT TO THE USER</p> <p>Engaging experience for younger audiences; obtain personalized media that can be shared on social media.</p>	<p>RISKS</p> <p>These types of applications make sense for collections that include appropriate artworks that can be mimicked.</p>
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Fig.14: Strike-a-Pose & Face-Fit Summary

3.9 Toolkit development strategy and ethical aspects

Considering the results of WP2 briefly reported in a previous section, visitors preferences and museums' needs, the Toolkit strategy aims at introducing innovative and **interactive tools** able to increase visitor engagement and based on a user-centered approach. Mobile device applications are to be developed as first-class targets that make it easier to follow the **BYOD (Bring-Your-Own-Device)** approach. **AI/CV-based tools** are a way to interact with the performance environment with a playful approaches, based on gamification. In order to adopt a sustainable management perspective, the strategic focus of the toolkit is the development of **open-source code**, so as to facilitate maintenance issues and reuse of applications by different organizations. In order to promote a "future-oriented" Digital Strategy focused on modular and reusable digital architecture, the codes of these applications are associated with additional documentation and webinars; all these materials are accessible in the Digital Hub. The next figure shows these main 4 development pillars.

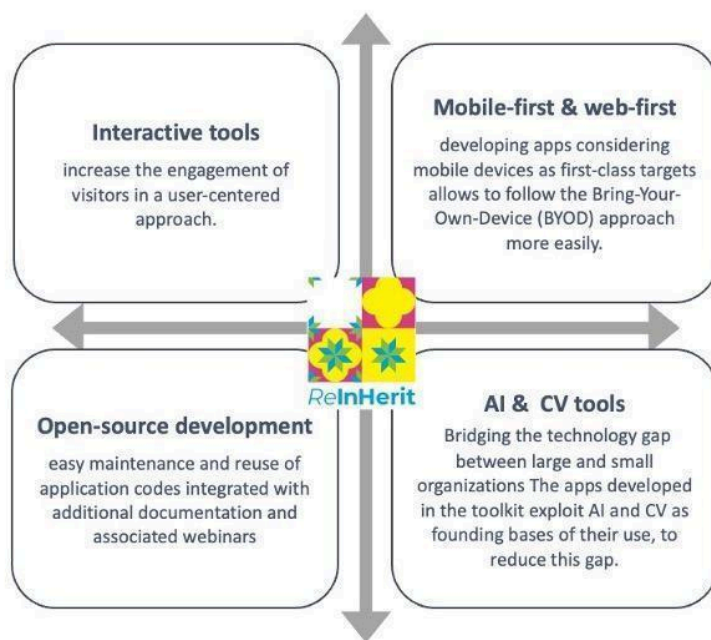


Fig. 15 – ReinHerit Toolkit Strategy

Regarding ethical and data management aspects, the applications developed within ReInHerit do not store personal information of the users, the generated media are not stored and are provided only to the user. The neural networks used in applications like Strike-a-Pose and Face-fit have been shown to work fairly with users sampled in diverse world regions (Face-fit) and with users with different attributes (i.e. gender, age, skin color - Strike-a-pose), as shown in the Model cards⁶ of the respective models.

The Toolkit apps are based on the **ReInHerit Ethics Card** (Fig. 16) developed by a Consortium partner. These cards analyze different aspects of the applications, such as **Training Data**, **User Data**, **Data Security** and **Copyright aspect**.

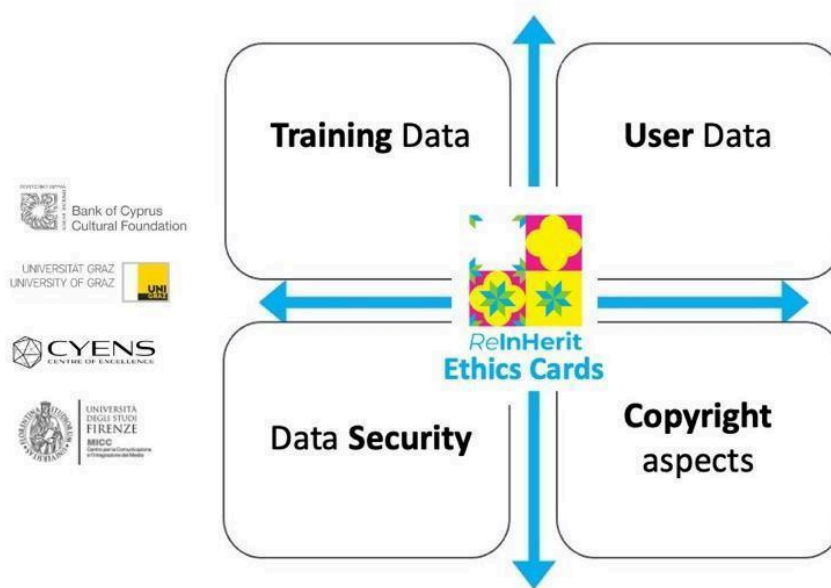


Fig. 16- ReInHerit Ethics Cards

⁶ Model cards are a form of documentation that provides a standardised way of presenting information about Machine Learning models. They were first introduced by Google in 2018, and have since become increasingly popular across the industry as they provide a concise, holistic picture of a Machine Learning model including information such as what is the Data used for training & evaluation, what are the limitations and the ethical considerations.

4. Expected Results

As indicated in the Introduction, the initial brainstorming of the *phase (I)* was useful to identify skills and basic technologies of the WP3 partners involved in the process of development of apps in the fields of AI, IoT, gamifications tools, immersive performances and Digital technologies for CH management.

During the *phase (II)* workshops were held to present research and work previously carried out by partners in national and international contexts with focus on new technologies for museums and cultural heritage. A vivid collaboration has been established, among several partners, especially during the onsite workshop and study visit in Graz (May 2022). MICC-UNIFI participated in the WP3-WP4-WP6 Workshop co-organized with University of Graz and GrazMuseum. MICC team met the GrazMuseum staff to visit the 360Graz exhibitions, followed by an inspiring brainstorming discussion on synergies between Digital Toolkit (WP3) and the traveling and digital exhibitions (WP6), where the partners discussed innovative tools for playful engagement and users' interactions with collections, exploiting CV/AI technology. A thematic Workshop on "*Artificial Intelligence and Computer Vision for Cultural Heritage*" was held at the Institute Centre for Information Modelling - Austrian Centre for Digital Humanities | University of Graz. The UNIFI-MICC team introduced to students and digital humanities professionals the latest research activities regarding Computer Vision and Multimedia technologies for Cultural Heritage and presented some prototypes for museums and cultural heritage sites developed by MICC/UNIFI.

The Reinherit partners defined the Toolkit implementation in the Digital Hub (WP4). The focus was on the requirements of WP3 in relation to the Hub: infrastructure works, categorization of the content and the ways within the hub (taxonomies and metadata). With a clearer shared vision of how the Toolkit (components and apps) and the Webinars will be presented on the Hub, working on tags and other metadata for the toolkit and the webinars, to complete the implementation in the platform.

The final phase (III) of the Toolkit Strategy concerned the identification of innovative tools, focused on playful engagement and user interactions with the artworks and collections, including planning activities to test them in a real-world context and with a participatory community. The strategy produced will be useful in carrying out the upcoming tasks of WP3 in relation to the other WPs. Specifically, to test and apply some tools in the context of traveling exhibitions (WP6) and to produce the necessary materials to be included among the Digital Hub's resources.

As introduced, the basic idea is not only to produce end tools, but also to identify a dynamic and interdisciplinary process of co-creation, to share open-source and reusable digital solutions for CH museums and sites, and to provide related training aimed at CH professionals. D3.2 is a critical and preliminary result, and to be considered as a working framework for future reports. It will be in line with upcoming deliverables on Toolkit Phases, Mobile Applications Demonstrator, Story-Based Game and The Training design of courses and syllabi for the main technologies and practices identified and addressing in particular AI, IoT, mobile development.

4.1 Dissemination, exploitation and communication

The ReInHerit Toolkit will be promoted through the ReInHerit communication and exploitation tools. The Digital hub as well as the apps included in the Toolkit will be promoted through the consortium actions, events, press releases, interviews and they will be offered for free.

The Digital Hub provides the core platform for addressing the key challenges of the sector: audience reach, 4.0 Industrial Revolution, professional fragmentation, environmental concerns and digital/physical tourism. The Hub will constitute a valid digital medium to promote substantial sector collaboration and communication, to promote digital collections sharing and to support the creation of the digital heritage ecosystem. The Toolkit will create opportunities for audience engagement, cultivate active citizenship, enable project ideas sharing and encourage EU cohesion.

Through the Toolkit a considerable effort will be made to involve audiences in the dissemination and acquisition of knowledge through interactive and immersive means establishing a dynamic dialogue with relevant key stakeholders. The applications will firstly be used by the consortium members and then be offered to professionals and other museums and heritage sites or travel associations throughout Europe. The Toolkit will be also disseminated through disseminations such as scientific publications. For further information see D7.2 Dissemination and Exploitation Plan 1 st version and D7.5 Dissemination and Exploitation Plan 2nd version.

5 Recommendations and Generative AI Regulation

The AI/CV applications, specifically the web apps Strike-a-Pose, Face Fit, and the multimedia chatbot, represent cutting-edge technologies in the fields of artificial intelligence and computer vision. These applications leverage advanced algorithms and generative artificial intelligence (GenAI) tools to offer interactive and engaging experiences to museum visitors.

The model and strategy identified and proposed by the ReInHerit Project aim to address emerging needs within the context of small and medium-sized cultural institutions. This is primarily achieved by advocating for sustainable open-source solutions, aligning with guidelines, and adopting a collaborative and co-creative approach that bridges and facilitates dialogue among various disciplinary sectors.

Considering the latest recommendations of experts working in museum and cultural contexts on the topic of digital learning, we focused on the motivations highlighted by experts recognising the role of immersive experiences, digital learning and playful user engagement. Some latest studies show how digital learning and playful user engagement are used to inspire curiosity and encourage further learning. User engagement plays a key role in creating memorable experiences [NEMO 2023]⁷, by incorporating a playful approach, museums invite visitors to actively participate and explore the collections. AI/CV-based digital tools can also be used to enhance the user experience and promote a more engaging and effective learning environment.

⁷ [NEMO 2023] [Digital Learning and Education in Museums - Innovative Approaches and Insights](#)"" Report 2023, NEMO - The Network of European Organizations.

Redefining the future of cultural heritage and museums requires a fundamental reconsideration of the concept of learning. Learning should no longer be perceived only as the act of acquiring knowledge and providing information about museum collections. Although expert knowledge about these collections is valuable, visitors should not be considered as passive recipients of this information. Instead, the primary focus should shift from the collections themselves to the users and learners, together with their methods of interaction and motivation.⁸ Learning is an active process of personal transformation and active engagement with experience.⁹ Instead of being passive recipients of information, people learn by making sense of their experiences and motivating them to interact with the collections and their stories. For museums, this means that they should focus on the experiences of visitors, rather than on the exhibition itself. Museum content can be an instrument of the learning experience but is never the center of it. This perspective offers museums enormous opportunities to design learning experiences, including digital ones. This learner-centered approach requires a new mindset and revisiting the very logic of museum and exhibition design. Learning should be seen as an integral part of the visitor experience - unconventional, emotional, playful and transformative at the same time¹⁰. *“Learning might take place unintentionally, as seen, for example, in the process of playful interaction with museum objects, in the format of a chatbot”* [NEMO 2023]¹¹.

With reference to the above mentioned report of NEMO, museums to be relevant need to consider the potential of AI. GenAI technologies, AI chats such as ChatGPT, can open up interesting possibilities for museum mediation and meaningful storytelling for diverse audiences. However, there are several important considerations that should be addressed and discussed. [NEMO 2023]¹²

GenAI technologies are still rapidly evolving and likely to have a profound impact on education and research and which are yet to be fully understood. Therefore, its long-term implications for education and research even in non-educational and non-formal contexts such as museums require immediate attention and further in-depth review. In particular, the use of Artificial Intelligence and Computer Vision in the cultural and museum domain raises a set of fundamental issues that are still under discussion and hold significant importance for the future of society, with substantial implications in educational and professional settings [UNESCO 2023].¹³

⁸ Concerning the Museum Collection in relation to Public Involvement and Public Benefit see the Museums Association - Code of Ethics for Museums (UK) *“... museums and those who work in and with them should: - actively engage and work in partnership with existing audience and reach out to new and diverse audiences - treat everyone equally, with honesty and respect - provide and generate accurate information for and with the public - support freedom of speech and debate - use collections for public benefit for learning, inspiration and enjoyment”* - Principle 1 (pag 9)

<https://www.museumsassociation.org/campaigns/ethics/code-of-ethics/#>

⁹ Concerning this approach of learning with reference to D. Kolb's theories and “UK Campaign for Learning” see M. Sani Introduction in *“Emotions and Learning in Museums”*, [Mazzanti, Sani 2021] NEMO p. 4

¹⁰ For more details about innovative Learning Experiences see “Design2Learn Project”

<https://web.archive.org/web/20230329184626/https://www.design2learn.info/>

¹¹ [NEMO 2023] p. 6

¹² [NEMO 2023] p. 95

¹³ [UNESCO 2023] UNESCO has developed and released the first-ever global Guidance for Generative AI in Education and Research to support countries amidst the rapid emergence of GenAI technologies - 2023 *“Guidance for generative AI in education and research”* <https://unesdoc.unesco.org/ark:/48223/pf0000386693>

Important steps and recommendations for regulating GenAI on the basis of a human-centered approach include concerns related to the Ethics of AI Chatbots, user privacy policy compliance, training data, and the scientific accuracy of chatbot outputs.

The aim of our ReInHerit project is to draw attention to the following critical issues in the museum and technology context and to create opportunities for open discussion within a network in the context of the Digital Hub. This is done through the development of solutions and applications to be discussed, tested, redesigned and shared with experts in the field, through webinars, forums, co-creative hackathons and participation in national and international conferences and workshops. With reference to the ReInHerit Toolkit, it is important to address the following aspects during application development, which are described in the two development phases of the Toolkit. (see the sections “Co-creation and Ethical use of AI tools” in Deliverables D3.3 and D3.8).

- **Training data:** AI applications involve extensive **training on large data** sets. It is crucial to ensure that the final training is **ethically sourced** and **respect the privacy of users**. This issue has been addressed by the computer vision community in recent years. The datasets commonly designed for standard evaluations are designed to account for both issues.
- **Transparency:** Chatbot must be **transparent about how the data is used** and ensure that the data is stored securely and, where appropriate, anonymised.
- **Scientific accuracy:** Chatbot responses must be **tested** and **validated** by museums. This is especially important for applications that provide historical or scientific information to museum visitors through solutions that avoid AI “hallucinations”.

Furthermore, a clear disclaimer should be provided to users, highlighting that the chatbot's responses are based on AI algorithms and may not be infallible. Users should be encouraged to approach any information received from the chatbot critically and cross-reference it with other reliable sources for verification.

In conclusion, the AI/CV apps Strike-a-Pose, Face-fit, and the VIOLA multimedia chatbot represent state-of-the-art technology that enhances the museum experience for visitors. However, it is vital to ensure that these applications are built on ethical principles, respecting user privacy, and handling personal data responsibly. Additionally, maintaining the scientific accuracy of the chatbot outputs is essential to provide visitors with reliable information. By adopting a comprehensive approach to these aspects, museums can offer an enriching and responsible technological experience to their visitors.¹⁴

¹⁴ The ACM Code of Ethics and Professional is designed to inspire and guide the ethical conduct of all IT professionals and includes principles and guidelines, which provide explanations to help the actions of information technology professionals - Association for Computer Machinery - Code of Ethics and Professional Conduct (International) <https://www.acm.org/code-of-ethics>

6. Ethics annex

In this section are reported the **Ethics Cards** for the applications developed for the ReInHerit Toolkits. These cards analyze different aspects of the applications such as **Training Data, User Data, Data Security** and **Copyright aspects**.

ReInHerit Face-fit application



Authors: Marco Bertini

TRAINING DATA SETS

We did not train any Machine Learning model; therefore we did not generate/use any existing datasets for this purpose. We used a pre-trained model for face landmark detection: MediaPipe Face Mesh. The Model Card is available online: <https://drive.google.com/file/d/1QvwWNfFoweGVjsXF3DXzcrCnz-mx-Lha/preview>

- *Did you create the dataset or are you using an existing one?*

The pre-trained ML model was trained on a dataset collected by the authors of the model. The dataset is described in “Real-time Facial Surface Geometry from Monocular Video on Mobile GPUs”, CVPR Workshop on Computer Vision for Augmented and Virtual Reality, Long Beach, CA, USA, 2019

- *What is the source of the data for the existing dataset?*

The authors report that the images were globally sourced. No further details were provided in the paper describing the model.

- *What is the source of the data for the dataset you created?*

No training dataset was created for the application.

- *What is the content of the data for the existing dataset?*

The dataset used to create the pretrained model is a set of faces. Details are provided in the Model Card of the dataset cited above.

- *What is the content of the data for the dataset you created?*

No dataset was collected.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No dataset was collected.

- *Which content of the data has been used? Have any identifying features been collected?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

The authors of the model evaluated its capabilities to handle different ethnicities, genders, etc. Results are reported in the model card.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

The authors of the model evaluated its capabilities to handle different ethnicities, genders, etc. Results are reported in the model card.

USER DATA

- *Do we collect personal user data?*

The appearance of the user is captured by camera. The images created in Facefit are sent by email to the user alone, they are deleted from the server immediately after the mail has been sent. The log of the sent emails is purged to avoid collecting any personal data.

- *Do you inform the user when/if their personal data is collected?*

Users are informed that access to camera is needed to have the app work properly.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

Obtaining the appearance of the user is necessary for the purpose of the application. However, the appearance is not stored.

- *What type of user data are collected?*

Only the appearance of the user is obtained by the camera during the game. No personal data is stored.

- *What is the purpose for collecting this type of user data?*

The facial appearance is used to create the images sent to the users. No personal data is stored or maintained by the app.

- *Where is this set of user data stored?*

No personal data is stored. Images are sent to the users by email and are not stored in the app or server.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected. Emotional or triggering effects are elicited from the user during the game but are not analyzed nor stored.

- *Does the hardware used collect any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in a Dockerised environment that separates it from the server.

- *Did you assess potential forms of attacks and vulnerabilities?*

We separated the application from the server environment; an attacker that gets into the Heroku server cannot access the application; no personal data is stored. Temporary files are created in randomized directories that are deleted after use, to avoid accessing the state of the application.

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

N/A

- *What is the timeframe for the security coverage and updates?*

Dockerised applications like this one are separated from the running environment. The application has been written using Django framework for the backend web functions. The latest version of Django is used to ensure that no vulnerabilities are present in the framework.

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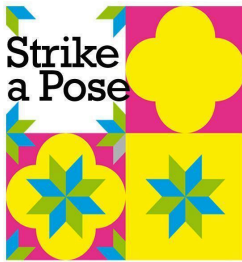
- *What is the copyright for the training data?*

No training data is collected. The images in the demo (not training data) were provided by WP6 partner or have Creative Commons license.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

A curator wrote the description of the artworks associated with the content provided to the users. These are not part of the training data.

ReInHerit Strike-a-pose application



Authors: Marco Bertini

TRAINING DATA SETS

We did not train any Machine Learning model; therefore we did not generate/use any existing datasets for this purpose. We used a pre-trained model for body pose detection: MediaPipe Movenet. The Model Card is available online: <https://storage.googleapis.com/movenet/MoveNet.SinglePose%20Model%20Card.pdf>

- *Did you create the dataset or are you using an existing one?*

The pre-trained ML model was trained on a dataset collected by the authors of the model. The dataset is described in

<https://blog.tensorflow.org/2021/05/next-generation-pose-detection-with-movenet-and-tensorflowjs.html>

- *What is the source of the data for the existing dataset?*

The authors report that the model was trained on the standard COCO dataset (<https://cocodataset.org>) and on an internal dataset used within Google, called Active.

- *What is the source of the data for the dataset you created?*

No training dataset was created for the application.

- *What is the content of the data for the existing dataset?*

The dataset used to create the pretrained model is a set of images showing different body poses. Details are provided in the Model Card of the dataset cited above.

- *What is the content of the data for the dataset you created?*

No dataset was collected.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No dataset was collected.

- *Which content of the data has been used? Have any identifying features been collected?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

The authors of the model evaluated its capabilities to handle different ethnicities, genders, etc. Results are reported in the model card.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

The authors of the model evaluated its capabilities to handle different ethnicities, genders, etc. Results are reported in the model card.

USER DATA

- *Do we collect personal user data?*

The appearance of the user is captured by camera. The videos created in Strike-a-pose are sent by email to the user alone, they are deleted from the server immediately after the mail has been sent. The log of the sent emails is purged to avoid collecting any personal data.

- *Do you inform the user when/if their personal data is collected?*

Users are informed that access to camera is needed to have the app work properly.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

Obtaining the appearance of the user is necessary for the purpose of the application. However, the appearance is not stored.

- *What type of user data are collected?*

Only the appearance of the user is obtained by the camera during the game. No personal data is stored.

- *What is the purpose for collecting this type of user data?*

The body appearance and movements are used to create the video sent to the users. No personal data is stored or maintained by the app.

- *Where is this set of user data stored?*

Videos are sent to the users by email and are not stored in the app or server.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected. Emotional or triggering effects are elicited from the user during the game but are not analyzed nor stored.

- *Does the hardware used collect any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in a Dockerised environment that separates it from the server.

- *Did you assess potential forms of attacks and vulnerabilities?*

We separated the application from the server environment; an attacker that gets into the Heroku server cannot access the application; no personal data is stored. Temporary files are created in randomized directories that are deleted after use, to avoid accessing the state of the application.

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

N/A

- *What is the timeframe for the security coverage and updates?*

Dockerised applications like this one are separated from the running environment. The application has been written using Django framework for the backend web functions. The latest version of Django is used to ensure that no vulnerabilities are present in the framework.

COPYRIGHT

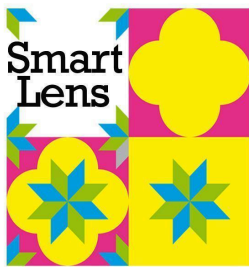
- *What is the copyright for the training data?*

No training data is collected. The images in the demo (not training data) were provided by WP6 partner or have Creative Commons license.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

A curator wrote the description of the artworks associated with the content provided to the users. These are not part of the training data.

ReInHerit Smart Lens application



Authors: Marco Bertini

TRAINING DATA SETS

We used a pre-trained model for object detection: SSD Mobilenet provided by Google. The model was fine-tuned for the objects of the WP6 exhibitions.

- *Did you create the dataset or are you using an existing one?*

The pre-trained ML model was trained on the standard computer vision dataset COCO. The dataset is described <https://cocodataset.org/#detection-2020>

- *What is the source of the data for the existing dataset?*

The dataset was collected by Microsoft from various open sources.

- *What is the source of the data for the dataset you created?*

The images used for fine tuning were provided by WP6 partners. Each partner contributed the images of the objects in their possession.

- *What is the content of the data for the existing dataset?*

The WP6 partners provided images of their objects and indicated which parts of the artworks were to be considered of interest.

- *What is the content of the data for the dataset you created?*

A selection of artworks chosen by WP6 partners for the exhibitions of WP6.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

The data used for the fine tuning is relevant for the project and was created by partners of the project.

- *Which content of the data has been used? Have any identifying features been collected?*

Relevant highlights of artworks were selected by WP6 partners.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

Accuracy of detection was measured during fine-tuning.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

Accuracy of detection was measured during fine-tuning.

USER DATA

- *Do we collect personal user data?*

No personal data is collected by the app.

- *Do you inform the user when/if their personal data is collected?*

No personal data is collected by the app.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

No personal data is collected by the app.

- *What type of user data are collected?*

No personal data is collected by the app.

- *What is the purpose for collecting this type of user data?*

No personal data is collected by the app.

- *Where is this set of user data stored?*

No personal data is collected by the app.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected.

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in the device of the user.

- *Did you assess potential forms of attacks and vulnerabilities?*

The only possible attack is to change the web application served by Heroku, that requires to obtain the credentials of the user that access Heroku. A two factor authentication is used to secure the account

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

N/A

- *What is the timeframe for the security coverage and updates?*

The application is developed using JQuery framework. The latest version of JQuery is used to ensure that no vulnerabilities are present in the web application.

COPYRIGHT

- *What is the copyright for the training data?*

The images used for fine tuning were provided by WP6 partner expressly for this purpose.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

WP6 partners provided all the information needed by the application. This information is not part of the training data.

ReInHerit multimedia chatbot application



Authors: Marco Bertini, Paolo Mazzanti

TRAINING DATA SETS

In the final version of the chatbot we did not train any Machine Learning model; therefore, we did not generate/use any existing datasets for this purpose. We used a pre-trained model for Natural language Understanding and chat functionalities (Chat GPT).

- *Did you create the dataset or are you using an existing one?*

No dataset was created. The model has been trained by OpenAI.

- *What is the source of the data for the existing dataset?*

OpenAI has not disclosed details on the dataset used to create their model.

- *What is the source of the data for the dataset you created?*

No training dataset was created for the application.

- *What is the content of the data for the existing dataset?*

The chatbot uses (not for training) data provided by WP6 partners of the project.

- *What is the content of the data for the dataset you created?*

No training dataset was collected.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No dataset was collected.

- *Which content of the data has been used? Have any identifying features been collected?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

No dataset was collected.

USER DATA

- *Do we collect personal user data?*

No personal data is collected.

- *Do you inform the user when/if their personal data is collected?*

Users are informed that unanswered questions are collected as part of a collaborative approach to improve the descriptive content of artworks.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

Not applicable.

- *What type of user data are collected?*

The text of unanswered questions is collected anonymously.

- *What is the purpose for collecting this type of user data?*

To let curators add descriptive texts to answer the collected unanswered questions.

- *Where is this set of user data stored?*

In a temporary database.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

Not applicable.

- *How long will the data be stored?*

Not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected.

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in a Dockerised environment that separates it from the server.

- *Did you assess potential forms of attacks and vulnerabilities?*

We separated the application from the server environment; an attacker that gets into the Heroku server cannot access the application; no personal data is stored.

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

Not applicable

- *What is the timeframe for the security coverage and updates?*

Dockerised applications like this one are separated from the running environment. The application has been written using Django framework for the backend web functions. The latest version of Django is used to ensure that no vulnerabilities are present in the framework.

COPYRIGHT

- *What is the copyright for the training data?*

No training data is collected. The images in the demo (not training data) were provided by WP6 partner or have Creative Commons license.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

WP6 partners providing the content wrote the description of the artworks associated with the content provided to the users and the metadata. The application supports a selection of ICOM standards fields; metadata used in the digital exhibition is used in the application.

ReInHerit Smart Tourism application



Authors: Marco Bertini

TRAINING DATA SETS

We did not train any Machine Learning model; therefore we did not generate/use any existing datasets for this purpose. We used a pre-trained model for image retrieval: MobileNet v2. The Model Card is available online: https://huggingface.co/Matthijs/mobilenet_v2_1.4_224

- *Did you create the dataset or are you using an existing one?*

No training data was used for the app. The dataset used to train the MobileNetV2 model by the authors is described in the Model card and is the standard computer vision dataset ImageNet-1k.

- *What is the source of the data for the existing dataset?*

Imagenet has been created within the ImageNet initiative from open source data..

- *What is the source of the data for the dataset you created?*

No training dataset was created for the application.

- *What is the content of the data for the existing dataset?*

No training dataset was created for the application.

- *What is the content of the data for the dataset you created?*

No dataset was collected.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No dataset was collected.

- *Which content of the data has been used? Have any identifying features been collected?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

Not applicable.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

Not applicable.

USER DATA

- *Do we collect personal user data?*

No personal data is collected.

- *Do you inform the user when/if their personal data is collected?*

No personal data is collected.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

No personal data is collected.

- *What type of user data are collected?*

No personal data is collected.

- *What is the purpose for collecting this type of user data?*

No personal data is collected.

- *Where is this set of user data stored?*

No personal data is collected.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected.

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. The application runs on the device of the user.

- *Did you assess potential forms of attacks and vulnerabilities?*

The application runs on the device of the user; an attacker should take control of the device.

- *What safety measures have been taken in case of cyber-attacks?*

Not applicable.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

Not applicable

- *What is the timeframe for the security coverage and updates?*

The latest versions of supporting libraries are used to reduce issues related to their use.

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- *What is the copyright for the training data?*

No training data is collected. The images in the guide have Creative Commons license.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

The creators of the guide are expected to provide accurate and up-to-date information.

ReInHerit Smart Retrieval application



Authors: Marco Bertini

TRAINING DATA SETS

The Model was fine-tuned. The base model is CLIP from OpenAI. The Model Card is available online: <https://github.com/openai/CLIP/blob/main/model-card.md>

- *Did you create the dataset or are you using an existing one?*

The pre-trained ML model was trained on a dataset collected by the authors of the model. Fine tuning was performed using standard datasets for combined image retrieval (FashionIQ, CIRR) and for cultural heritage fine tuning was performed using the NoisyArt dataset.

- *What is the source of the data for the existing dataset?*

The authors of the fine tuning datasets collected the images from open source collections.

- *What is the source of the data for the dataset you created?*

No training dataset was created for the application.

- *What is the content of the data for the existing dataset?*

FashionIQ shows dresses, CIRR contains images of any kind, NoisyArt contains a collection of artworks.

- *What is the content of the data for the dataset you created?*

No dataset was collected.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No dataset was collected.

- *Which content of the data has been used? Have any identifying features been collected?*

No dataset was collected.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

Not applicable.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

Not applicable.

USER DATA

- *Do we collect personal user data?*

No user data is collected.

- *Do you inform the user when/if their personal data is collected?*

No user data is collected.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

No user data is collected.

- *What type of user data are collected?*

No user data is collected.

- *What is the purpose for collecting this type of user data?*

No user data is collected.

- *Where is this set of user data stored?*

No user data is collected.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected.

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in a Dockerised environment that separates it from the server.

- *Did you assess potential forms of attacks and vulnerabilities?*

We separated the application from the server environment; an attacker that gets into the Heroku server cannot access the application; no personal data is stored. Temporary files are created in randomized directories that are deleted after use, to avoid accessing the state of the application.

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

Not applicable.

- *What is the timeframe for the security coverage and updates?*

Dockerised applications like this one are separated from the running environment. The application has been written using Django framework for the backend web functions. The latest version of Django is used to ensure that no vulnerabilities are present in the framework.

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- *What is the copyright for the training data?*

No training data is collected.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

Not applicable.



Authors: Marco Bertini

TRAINING DATA SETS

- *Did you create the dataset or are you using an existing one?*

We used the Harmonic 4K video dataset for training the model.

- *What is the source of the data for the existing dataset?*

The videos of the dataset have been collected and made available by Harmonic company.

- *What is the source of the data for the dataset you created?*

We used an existing dataset.

- *What is the content of the data for the existing dataset?*

The dataset comprises scenes of different types, natural scenes, man-made objects, scenes with persons, etc.

- *What is the content of the data for the dataset you created?*

No dataset was created.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

The variety of the contents is useful to train the model to be capable to deal with different types of contents to be restored. Harmonic created the dataset so the be as varied as possible.

- *Which content of the data has been used? Have any identifying features been collected?*

No identifying features were used.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

Not applicable.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

Not applicable.

USER DATA

- *Do we collect personal user data?*

No user data is collected.

- *Do you inform the user when/if their personal data is collected?*

No user data is collected.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

No user data is collected.

- *What type of user data are collected?*

No user data is collected.

- *What is the purpose for collecting this type of user data?*

No user data is collected.

- *Where is this set of user data stored?*

No user data is collected.

- *Do you use any Third Part services to store the data?*

No third part service is used.

- *If you use Third Party services, what are the safeguards you adopted?*

No third part service is used.

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No data is stored so this is not applicable.

- *How long will the data be stored?*

No data is stored so this is not applicable.

- *How are emotional and triggering effects processed? Are they stored and where?*

No such data is collected.

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

No data is collected by the hardware used.

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The application does not store personal information. It is stored on Heroku, so it can be attacked as any web service stored on Heroku. Attacks may perform denial of service of the application; we rely on Heroku for the protection w.r.t. this type of attacks. The application runs in a Dockerised environment that separates it from the server.

- *Did you assess potential forms of attacks and vulnerabilities?*

We separated the application from the server environment; an attacker that gets into the Heroku server cannot access the application; no personal data is stored. Temporary files are created in randomized directories that are deleted after use, to avoid accessing the state of the application.

- *What safety measures have been taken in case of cyber-attacks?*

No personal data is stored.

- *Could the user data be deleted if requested?*

No data is stored.

- *Will the user data be shared with third party or consortium partners?*

No data is stored or shared.

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

Not applicable.

- *What is the timeframe for the security coverage and updates?*

Dockerised applications like this one are separated from the running environment.

The application has been written using Django framework for the backend web functions. The latest version of Django is used to ensure that no vulnerabilities are present in the framework.

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- *What is the copyright for the training data?*

No training data is collected.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

Not applicable.

ReInHerit Video Game



Authors: Theodoros Kyriakou, Andreas Panayiotou, Panayiotis Charalambous

TRAINING DATA SETS

We did not train any Machine Learning model; therefore we did not generate/use any existing datasets for this purpose. We did however digitize in 3D some artifacts of the BOCCF museum to be used in the game.

- *Did you create the dataset or are you using an existing one?*

No machine learning/AI datasets were created during the development of the game.

- *What is the source of the data for the existing dataset?*

No training data/machine learning datasets are used in the game.

- *What is the source of the data for the dataset you created?*

No training data/machine learning datasets are used in the game.

- *What is the content of the data for the existing dataset?*

No training data/machine learning datasets are used in the game.

- *What is the content of the data for the dataset you created?*

No training data/machine learning datasets are used in the game.

- *Is the content of the data relevant/useful to the scope and aim of the project?*

No training data/machine learning datasets are used in the game.

- *Which content of the data has been used? Have any identifying features been collected?*

No training data/machine learning datasets are used in the game.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in training data input data?*

No training data was used in the game.

- *What measures have been taken to test, monitor and rectify negative discrimination (bias) in algorithm design?*

No algorithms were designed and operated in the game, related to training machine learning models.

USER DATA

- *Do we collect personal user data?*

No personal user data is collected in the game.

- *Do you inform the user when/if their personal data is collected?*

No, as no personal data is collected in the game.

- *Did you conduct an assessment of the necessity and proportionality of the data collected?*

No personal user data is collected in the game.

- *What type of user data are collected?*

No personal user data is collected in the game.

- *What is the purpose for collecting this type of user data?*

No personal user data is collected in the game.

- *Where is this set of user data stored?*

No personal user data is collected in the game.

- *Do you use any Third Part services to store the data?*

No, as no personal data is collected in the game.

- *If you use Third Party services, what are the safeguards you adopted?*

No Third-Party services used to store data

- *Do you inform the users of how their data are proceeded (collection, storage and deletion procedure)?*

No personal user data is collected in the game.

- *How long will the data be stored?*

No personal user data is collected in the game.

- *How are emotional and triggering effects processed? Are they stored and where?*

N/A

- *Does the hardware used collects any other sets of data and what data processing takes place? E.g. use of Xiaomi Redmi 10C mobile phone in D3.7*

N/A

DATA SECURITY

- *How exposed is the app to cyber-attacks?*

The game itself is hosted on a website. That means that the game is exposed to the same vulnerabilities as the website. Also, this means that a determined hacker can access the binaries of the game and therefore modify its state. This can only result in changes in the state of the game (i.e., current level, virtual money, points, etc.). This is harmless and no game is safe from this...

- *Did you assess potential forms of attacks and vulnerabilities?*

N/A

- *What safety measures have been taken in case of cyber-attacks?*

N/A

- *Could the user data be deleted if requested?*

No personal user data is stored in the game.

- *Will the user data be shared with third party or consortium partners?*

N/A

- *If yes, how will they be shared and how will you ensure the user privacy is preserved and protected?*

N/A

- *What is the timeframe for the security coverage and updates?*

N/A

COPYRIGHT

- *What is the copyright for the training data?*

No training data/machine learning datasets are used in the game.

- *What basic conventions have been used to align the description of the training data with scientific standards/conventions?*

N/A

7. Appendix

List of meetings and workshops associated with the production of this deliverable.

1. **WP3 ReInHerit Toolkit Presentation** (24th March 2021)
2. **Consortium Meeting** (08th November 2021)
3. **ReInHerit presentation at “MuseiEmotivi Training Course** 6th Edition of the interdisciplinary training course for museum professionals “EmotionalMuseums”, Florence IT - Galileo Museum (17th September 2021) MICC-UNIFI, BOCCF, UNIGRAZ, MATERAHUB
4. **Story based game development**, 1st brainstorming session (14th December, 2021) RISE-CYENS_ WP3_T3.5
5. **Digital Hub workshop**: 17th of February 2022 online meeting hosted by UniGraz
6. **Workshop AI+CV for Cultural Heritage** (21st February 2022) MICC-UNIFI_ WP3_T3.3
7. **Consortium Meeting** - 2nd year (28th March 2022)
8. **Workshop “Artificial Intelligence and Computer Vision for Cultural Heritage”** Graz - AU, in collaboration with UniGraz (WP4) and GrazMuseum (WP6) (23-24 May 2022) MICC-UNIFI WP3_ T3.3
9. **Game app workshop**: 15th of June 2022 CYENS visited the BoCCF team
10. **Smart tourism app meeting** : 20th of July 2022 a coordination meeting regarding the smart tourism app.
11. **Immersive performances meeting**: 5th of July 2022, exchange of ideas meeting hosted by CYENS
12. Regular meetings of the **tech committee** are taking place.
13. **ReInHerit Study Visit and Consortium Meeting** in Brussels, 8-12 May 2023 Brussels
14. **Testing ReInHerit apps | Research Fair** at the Arcada University of Applied Sciences, May 2023 - Finland
15. **ReInHerit mobility activities**, visit and meeting with BoCCF in Florence at MICC Media Integration and Communication Center of the University of Florence, 13 July 2023
16. **ReInHerit Hackathon | XR&AI Summer School** 2023 Matera IT 17-22 July 2023.
17. **Summer School DigitArch**. Digital Collection Curator for Archaeology, Reggio Emilia IT, 6 September 2023.
18. **ReInHerit Toolkit - Macerata Humanities Festival** 29-30 September 2023 Macerata IT
19. **“Museums+AI Workshop”**, Milan IT 9 October 2023

8. References

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- D2.2 “State of the Art Report - Literature Review”
- D2.3 Questionnaires Report
- D2.5 “CH Management Guidelines”.
- D3.1 “National Surveys Report”
- D4.1 “Requirements Analysis Report”
- D4.2 “Digital hub”
- D6.1 “Pilot Phase, Traveling Exhibition, Digital Exhibition, Strategy”
- D7.2 “Dissemination and Exploitation Plan 1st Version”
- D7.5 “Dissemination and Exploitation Plan 2nd Version”
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