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AI4ME
Artificial Inteligence For Museo Egizio

Executive Summary

This project investigates the possible future developments of Artificial Intelligence in the museology sector. The project was initiated and conceived by the Museo Egizio (ME) of Turin, seeking a big step towards digital innovation through the development of a centralized database system managed by Artificial Intelligence (AI). More specifically, the AI4ME project is part of the development of this system, called SiME (Sistema Museo Egizio), contributing to the implementation of AI in the area of personalized visit experiences. In order to understand the importance of this initiative, it is necessary to consider how the involvement of technology in museums has not yet had fully satisfactory results. The solutions are often too expensive for public institutions or they lead to dispersive results that do not enhance the user's visit. The **aim** of the project is therefore **two-fold**: on the one side, the improvement of the museum experience through user-centered visits and, on the other, a feasible solution to support the implementation of AI.

The proposed solution consists of the design of a web application that serves as a digital mediator between the museum collection and the visitors, helping them to explore the exhibition of the room of Deir-el-Medina through a **customised visit**. The app has three visit options, based on the amount of time the visitor can dedicate to the visit of the room. However, the possible visit paths are many more, as the exhibited objects have been assigned to seven themes and the app suggests the next step of the visit according to the visitor's interests, this way enabling them to construct their own visit.
The second fundamental role of the app is registering the user's visit choices through the scanning of QR codes, allowing ME to **collect the data of visit patterns** easily, while safeguarding the visitor's privacy. The gathered information will be indispensable in the first phases of AI implementation, because it will be used to train the AI algorithm until it becomes autonomous in providing visit suggestions.
This is the most achieveable solution, able to give significant contribution in the short time.

This project, starting from the case of ME, acts as a precursor to a more widespread process that aims at involving different cultural institutions towards a more inclusive, communicative, and enhanced museum experience through the launch of a very feasible solution that will help progressing towards a more complex technology, such as Artificial Intelligence.

The project developed in these months has allowed us to reach the point of delivering full documentation for the development of the web app. Additionally, an initial prototype has been developed. By the spring 2022, **the prototype web app will be incorporated into the overarching project SiME**, as an experimental basis to gather the data that will be necessary to train the AI algorithm.

Keywords

Web Application, Artificial Intelligence, New Museology, Personalized Experience, Data gathering

User Interface of the Application

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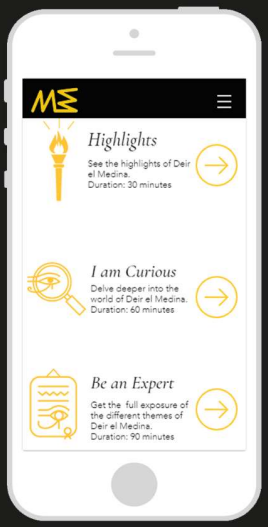

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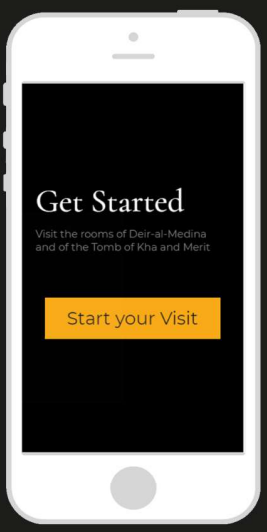

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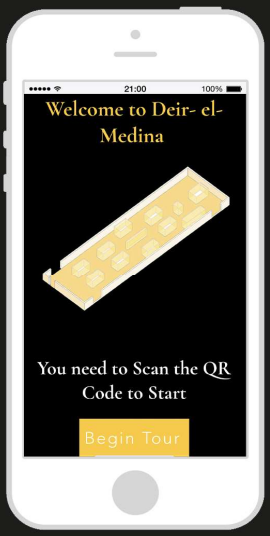

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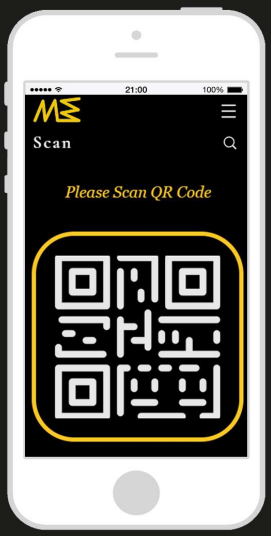

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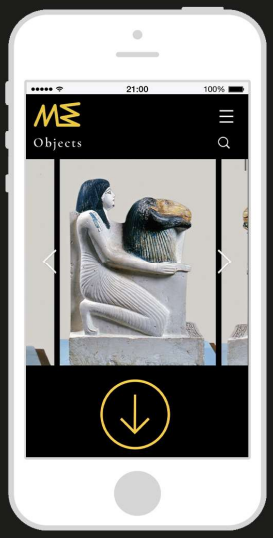

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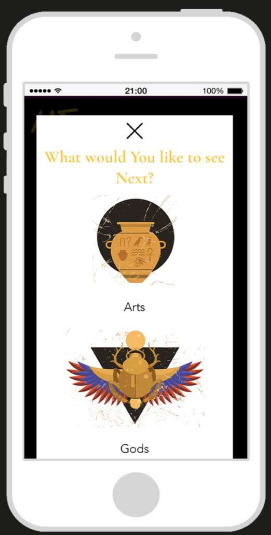

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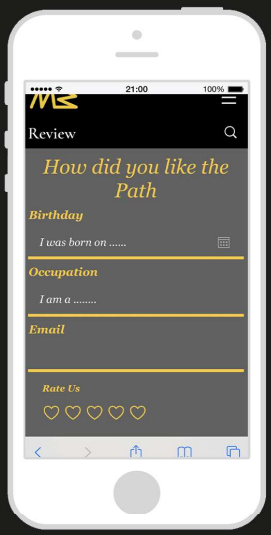

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Project description written by the Principal Academic Tutor

The objects held in museums may be defined as fragments of memories, that remain silent unless they are interrogated and allowed to share the stories that they contain. The way in which they are displayed and the information contained in their labels have been, until now, the main channel of communication with the publics of the museum.

The aim of AI4ME was to re-think the experience of a museum visit on the basis of the possibilities offered by the digital era in which we are now immersed and imagine a way in which the materiality of the objects might be enhanced and integrated by the immateriality of a wealth of additional information that may be conveyed in a digital way.

The ASP team was asked to think in practice, not in theory, and to focus on the executive project of an app that will guide the visitors through the room dedicated to the ancient site of Deir al-Medina in Museo Egizio, Torino. They were thus asked to face the practicalities of conveying theoretical thinking into a practical process, bearing in mind the direction in which we are heading: the accumulation of data to be then processed by AI algorithms, that will open the way to countless future applications inside and outside museums.

The result will be incorporated into the current project of digital transformation that Museo Egizio is undergoing.

Team description by skill

The AI4ME team is composed of 4 students from Architectural background and 1 Geoinformatics Engineering student. Even though, at first the Architectural background seemed distant from Artificial Intelligence, during the development of the project this specific team composition turned out to be a strength, as each person comes from a different discipline major.

Nouran has a Sustainable Architecture background and she has done a lot of research regarding Communication and Digital Inclusiveness of Digital Museums. Moreover, she comes from Egypt! Her background helped a lot on how to select useful information and on how to make communication in museums more inclusive.

Diletta studies Architecture Interiors and this background gave her a great capacity to understand the human relation with built space, as well as how technology could helpin improving the experience of the user.

Harris, who focuses on Building Architecture, has some experiences in data management of the building through BIM technologies, which is exactly what the museum needed for AI development.

Anna is enrolled in Architecture Construction City, which gave her a great comprehension in digital tools that are able to connect museums with their urban dimension: GIS is one of the tools to achieve it.

Lastly, the Engineer of our team, **Rodrigo**! He has a lot of experience and knowledge regading programming. Furthermore he had done a lot of research on tracking systems, which has been fundamental for the development of the solution in view of AI implementation.

Goal

The purpose of this project is to design a tool for personalized visit experiences in the **room of Deir-El-Medina** in Museo Egizio, that is able at the same time to collect the great amount of information needed to implement Artificial Intelligence.
The proposed solution consists of an interactive web based branching app that can use the case of the Egyptian museum as a starting point and then act as a precursor to a more widespread process.

Digital technology has changed the world and how we live in it: our aim is to propose how to best take advantage of this change for maximum impact. Digital platforms can enable users to connect and collaborate, to become participants instead of only viewers. The responsibility is to create a digital culture that guarantees the production of a thoughtful and fruitful digital experience.

Introducing a digital element such as a web-app allows a more complex storytelling not just in relation to what the space offers, but especially to how the exhibition space is lived. The story telling will depend on the user's choices, and our challenge will be creating a journey as interactive and interesting as possible while maintaining the value and the significance of the collection inside the museum, creating a more immersive experience (Giannini & Bowen, 2018).

Another aim of the project we are going to describe is following the emerging principle of "**new museology**", where the museum represents an educational and cultural institution, and where the visitor is a participant that strengthens the ties between the museum and society (Karayilanoğlu & Arabacioğlu, 2016), seeking to support, enrich and listen to the future user of the “new” museum.

Understanding the problem

The digital tranformation process Museo Egizio is undergoing, reflects a need of many other 21st century museums aiming at being part of the new museology paradigm. And today, innovative digital technologies represent a great chance of achieving that.

For this to happen, it is necessary to realize that today's audience needs a different kind of involvement within museums, something that many Italian institutions have not yet provided. But what is the **contemporary visitor** looking for? The user seeks a personalized experience, characterized by participation and interaction as fundamental values, and digital contents and technologies represent significant tools to realize it and to support the museum’s communication. In fact, some of the most discussed objectives within the museum sector are now those of audience development and "**user-centered**" museum strategies, underlining the importance of the public in the processes of fruition and cultural value creation.

Moreover, working with a real stakeholder, so concretely involved in the project, has meant proposing a **feasible solution**, respecting the needs of our stakeholder, that, as a real customer, had specific requests, budget, and time schedules.
The challenge consisted in finding a solution that could be affordable for everyone, in the name of a search for greater inclusiveness in the use of new technologies, and that would put the visitor at the center. The idea was to improve the visitor’s experience, that can seem dispersive to non experts visitors, and provide a user-centered experience in order to create a personalized narrative.
Interactive, participatory and enhancing are the key words for the contemporary visitor. And, especially, they turned out to be the secret to be followed in order to propose a solution that was appealing enough to visitors to give rise to the data collection process necessary to start a future Artificial Intelligence system.

Generating a solution

Starting from an in depth study of Museo Egizio's exhibition in the room of "Deir-el-Medina" and from numerous discussions with the administrators of the Egyptian museum, we have designed a digital tool able to support visitors' experience, amplify the physical visit, prepare a base for AI and integrate with the SiME. SiME, which is an acronym for "Sistema Museo Egizio", is part of a digital innovation process ME is undergoing and it consists of a core database and a series of satellite apps (figure 1). The great amount of information collected by the apps and contained by the database will be managed by an artificial intelligence algorithm.

The proposed solution, which will be incorporated into SiME, is that of a **web based branching app** that will help visitors in creating their own personalized visit and that at the same time will help ME to start studying and gathering data about visit patterns.
We have worked towards the development of a web-based software capable of managing and cross-referencing the galaxy of different data related specifically to the room dedicated to the exhibition of the artifa the site of Deir-al Medina. The final aim is creating a cross-media digital environment in which intangible content enhances and supports the understanding of material culture.
On the visitors' front, the project consists of a personal guide tool aimed at improving the visit by engaging the user and creating an interactive and more personalised experience based on the different interests, following a selected thematic thread, with the possibility of making further choices at crucial points. In order to include the largest possible audience, it was decided to design a smartphone web application, taking into consideration two main aspects: the diffusion of personal portable devices and the resistance to installing apps due to the problems of lack of storage space.

The objects exhibited in the room of Deir-El-Medina have been assigned to seven thematic paths, which will be used by the app to suggest the next step of the visit, but it will be the visitor to construct their own visit, by deciding which objects to see and scanning them through QR codes. QRCodes allow to protect the user's privacy (by not accessing their GPS) and gives the application a possibility to know precisely when a user is located in a specific point in the room. This data is registered by the app and collected because it will be indispensable in the first phases of AI implementation, as it will be used to train the AI algorithm until it becomes autonomous in providing visit suggestions.

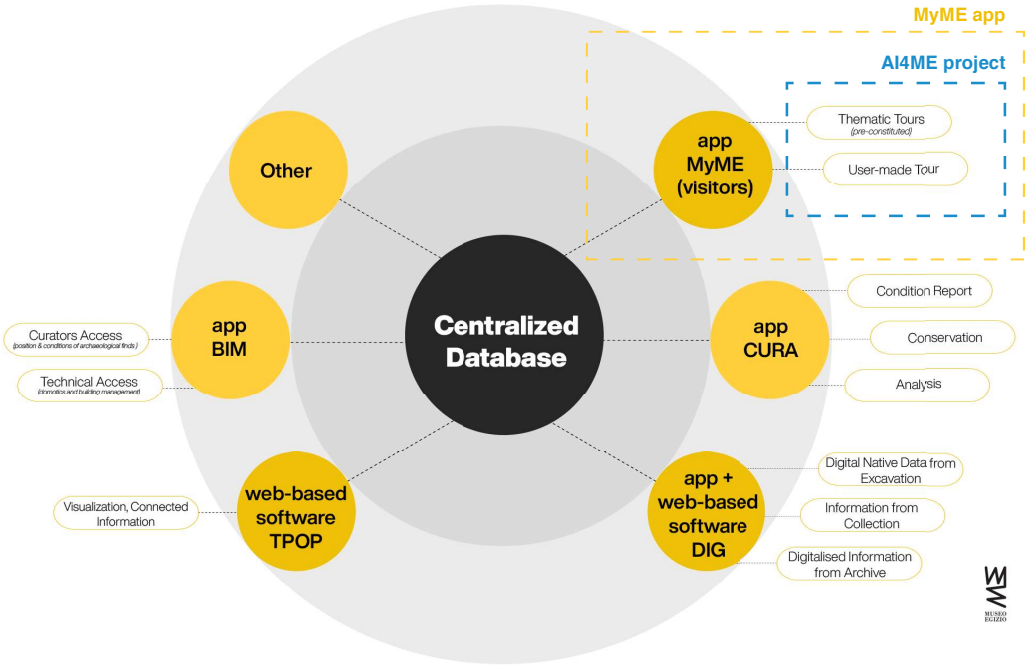

Fig. 1. The role of the AI4ME project in the framwork of Museo Egizio innovation process with SiME.

Regarding the personalization of paths, the app allows the visitors to start the visit from a chosen thematic path among several options and, when there are "**bridges",** to switch to another path. These bridges actually represent connections among objects and, when encountering one, the app will ask the visitor a question and, depending on the answer, suggest which object to see. As you can see from this map of the room of Deir-el-Medina (figure 2), there are a lot of these bridges and themes, which will allow to create a multitude of different narratives and paths.

The AI4ME application is highly adaptable and replicable, because it is a system that can be implemented in different conditions while following specific demands. This is possible thanks to:

1. The AI schemecan be applied in other museums due to the selection of correct informatics tools such as **Javascript** and the use of state-of-the-art **relational database systems**.

2. This development of Artificial Intelligence exploits tools such as **BIM** and **GIS**, which have a great capability for data interoperability for museum collections.

3. **Systematic development phase**, thanks to which even partial phases could be re-scaled and adapted to the needs of a specific museum.

Innovation is an intrinsic part of our project and it can be subdivided into two parts, innovation specific for Museo Egizio and innovation for Artificial Intelligence in museums. **Innovation for Museo Egizio** contributes to a general digitalisation currently being developed as a system, where visitors not only will interact with objects in the traditional way, but they will use their smartphones to be guided in a personalised tour.
On the other hand, the **novelty regarding Artificial Intelligence** concerns the data collection through the designed application. This app will register the movement of the users as well as their choices, and after collecting data for approximately 1 year, it will contribute to the AI algorithm construction.

One of the key points for this work is the **project implementation** that will be completed by **spring of 2022**, when the SiME system is launched. This work will not only remain as a prototype or as an idea, but it will be fully integrated in the Museo Egizio IT system, being part of the SiME system and contributing as a key player for the museum digitalisation.

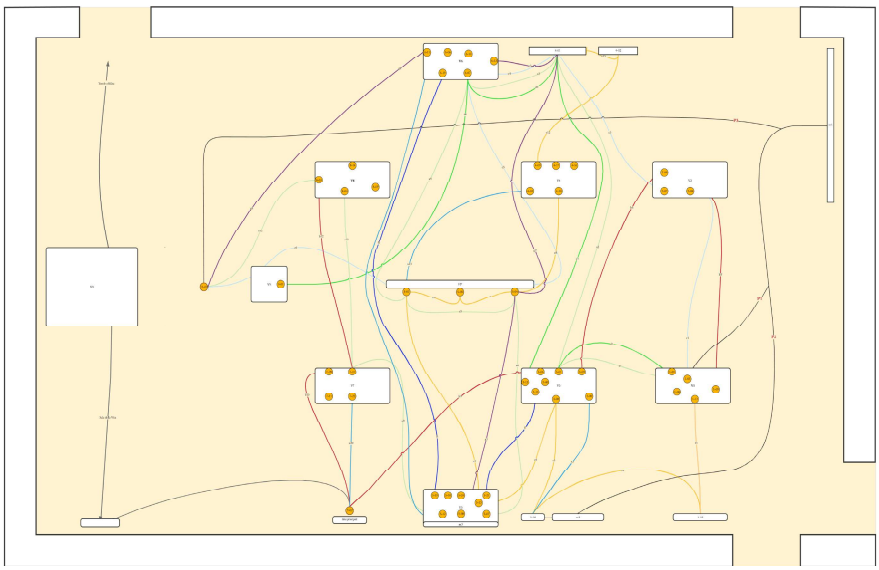

Fig. 2. Plan map of the room of Deir-El-Medina showing the 7 thematic paths and the bridges among objects, designed by the curator of the exhibition Enrico Ferraris. Drawing produced by Enrico Ferraris.

Main bibliographic references

Bezerra, J. D. H., & de Souza, C. T. (2019). A model-based approach to generate reactive and customizable user interfaces for the web of things. Proceedings of the 25th Brazillian Symposium on Multimedia and the Web, 57–60.

Biagi, L. (2020). Indoor Positioning. Positioning and Location Based Services.

Brumm, B. (2019). What is a database? In Beginning oracle SQL for oracle database 18c (pp. 3–7). Springer.

Bu-Pasha, S. & others. (2018). Location data, personal data protection and privacy in mobile device usage: An EU law perspective.

Chung, L., Cesar, J., & Leite, S. P. (1999). Non-functional requirements in software engineering.

CISCO. (2020). Location Tracking Approaches. Wi-Fi Location-Based Services 4.1 Design Guide. https://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Mobility/WiFiLBS-DG/wifich2.html

Couto, R. de S., Secci, S., Campista, M. E. M., & Costa, L. H. M. K. (2014). Network design requirements for disaster resilience in IaaS clouds. IEEE Communications Magazine, 52(10), 52–58.

Deak, G., Curran, K., & Condell, J. (2012). A survey of active and passive indoor localisation systems. Computer Communications, 35(16), 1939–1954.

Fakhroutdinov, K. (2015). UML 2.5 diagrams overview. UML Diagrams-Overview, Reference, and Examples.

Garg, G. (2015, August 8). How museums can enhance visitor experience. Scanova Blog. https://scanova.io/blog/blog/2015/08/08/visitor-experience-museums-qr-codes/

Giannini, T., & Bowen, J. (2018). Of museums and digital culture: A landscape view. EVA.

Goossens, J., & Baruah, S. (2000). Multiprocessor algorithms for uniprocessor feasibility analysis. Proceedings Seventh International Conference on Real-Time Computing Systems and Applications, 315–322.

Jackson, M. (1995). The world and the machine. 1995 17th International Conference on Software Engineering, 283–283.

karayilanoğlu, G., & Arabacioğlu, C. (2016). The'new'museum comprehension:"Inclusive museum."

Ma, R., Yi, C., Zhang, L., & Yan, J. (2020). Design of and Research on underground pipeline system in campus based on 3DGIS. E3S Web of Conferences, 165, 03004.

Mather, C. (2021). How Covid-19 could influence the use of QR codes in museums and exhibitions. LindedIn. https://www.linkedin.com/pulse/how-covid-19-could-influence-use-qr-codes-museums-chris-mather

MGNSW. (2021). Using QR codes in museums and galleries. Museums & Galleries of NSW.

Mooney, J. D. (1997). Bringing portability to the software process. Dept. of Statistics and Comp. Sci., West Virginia Univ., Morgantown WV.

Peng, X., & Chen, B. (2021). The undervalued power of museum-guided tours: A case study of Xuhui Art Museum in China. Museum Management and Curatorship, 1–20.

Pérez, A., Risco, S., Naranjo, D. M., Caballer, M., & Moltó, G. (2019). On-premises serverless computing for event-driven data processing applications. 2019 IEEE 12th International Conference on Cloud Computing (CLOUD), 414–421.

QR Code Chimp. (2020). QR codes for museums and exhibitions. QR Code Chimp. https://www.qrcodechimp.com/qr-codes-for-museums-and-exhibitions/

Roy, P., Chowdhury, C., Kundu, M., Ghosh, D., & Bandyopadhyay, S. (2021). Novel weighted ensemble classifier for smartphone based indoor localization. Expert Systems with Applications, 164, 113758.

Schiller, J., & Voisard, A. (2004). Location-based services. Elsevier.

Serrano, N., Gallardo, G., & Hernantes, J. (2015). Infrastructure as a service and cloud technologies. IEEE Software, 32(2), 30–36.

Setiyadi, A., & Setiawan, E. (2018). Information system monitoring access log database on database server. IOP Conference Series: Materials Science and Engineering, 407, 012110.
TOFAN, F.-C., & GHIURCĂ, D.-Ş. (2017). INTERACTIVE MULTIMEDIA APPLICATIONS IN MUSEUM EXHIBITIONS.

Voigt, P., & Von dem Bussche, A. (2017). The eu general data protection regulation (gdpr). A Practical Guide, 1st Ed., Cham: Springer International Publishing, 10, 3152676.
West, S. (1993). Feasibility analyses, an explanation! Cost Engineering, 35(3), 35.