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Artificial Intelligence for Museums
A comparison within Italian chatbot applications

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*To my grandfather,
who watches over me from up above.*

Abstract

The focus of this thesis is oriented to Artificial Intelligence (AI) applications in the museum sector and, specifically, how museum institutions can benefit from new technologies to improve collections, address new market challenges, but most importantly, to engage the public (especially the younger, or rather digital natives) and break down the many technological barriers. Among the various AI applications in the cultural sector, we specifically examine the case of chatbots, a promising technology that is unfortunately underestimated in Italian museums. As a matter of fact, the thesis' ultimate objective is to critically examine and compare Italian cases in which museums have deployed chatbots. The thesis consists of four chapters: the first deals with how digital transformation has influenced our society and in particular museums. The second chapter focuses on the analysis of Artificial Intelligence, examining the specific technologies that fall within the scope of AI and the applications in museum experiences. The primary target of this thesis is introduced in the third chapter, which is dedicated to an in-depth analysis of chatbot technology, with a specific focus on new opportunities that museums can seize with the introduction of chatbots in their cultural offer. The fourth and final chapter is entirely devoted to the analysis of Italian museum cases that have adopted chatbots to implement the audience experience. The chatbots of House Museums, Mart, MAXXI, Fondazione FILA, Opera di Santa Maria del Fiore, Gallerie dell'Accademia, and Parco Archeologico del Colosseo will be analyzed and compared in order to shed light on strengths, weaknesses, and future prospectives.

Artificial Intelligence for Museums

A comparison within Italian chatbot applications

Introduction.....	1
Chapter 1 – New technologies in the museum context.....	3
1.1 The influence of digital transformation in our society.....	3
Digital disruption and digital transformation.....	7
1.2 How museums are facing the digital transformation?.....	12
New forms of digital storytelling in museums.....	13
1.3 The case of Italian museums.....	16
1.4 The Italian Government support for the museum sector.....	21
Chapter 2 – Artificial Intelligence and its applications for museums.....	25
2.1 Artificial Intelligence (AI): definitions and history.....	25
AI subgroups and components.....	33
Strong AI and Weak AI.....	34
Machine learning and deep learning.....	35
ANI, AGI, and ASI.....	42
2.3 Limitations and obstacles of AI.....	44
2.4 AI applications: the integration in museums' practices.....	46
Chapter 3 – Chatbots in museums.....	55
3.1 How are chatbots defined? What are their origins?	55
Evolution of chatbots.....	58
3.2 How do chatbots work?.....	64
3.3 Chatbot classification and models.....	68
3.4 Benefits and limitations in using chatbots in businesses.....	76
3.5 Chatbots as new opportunities for museums.....	81

Chapter 4 – Chatbot for audience experiences in Italian museums: a comparison.....	91
4.1 Purposes and criteria of the comparison.....	91
4.2 Cases analysis.....	92
House Museums Bot.....	92
MartMuseumBot.....	95
MAXXI Chatbot.....	97
Wonnee – Foundation FILA Museum.	100
Michelangelo AI – Opera di Santa Maria del Fiore.....	101
David Bot – Galleria dell'Accademia.....	103
NeroBOT – Parco archeologico del Colosseo.....	105
4.3 Cases comparison.....	108
Conclusions.....	117
Appendix.....	121
Acknowledgements.....	129
Bibliography and sitography.....	131

Introduction

Today's world is a completely technological and digitalized system. Consider how many hours each day everyone spends on their smartphone browsing social networks or brands eCommerce sites, or in front of their computer for work or leisure, without noticing a plethora of data that large multinational corporations analyze and use through sophisticated algorithms. The technological revolution that began in the second part of the 20th century and culminated in 1994 with the advent of the World Wide Web has resulted in societal and cultural transformations. Indeed, innovations in information technology and the advancement of Information and Communication Technologies (ICT) have fundamentally altered how we create and share contents of any kind, as well as how individuals access information.

Museum institutions have also been affected by this digital transformation, but only a small portion of them has been able to comprehend the scope of the phenomenon and fully exploit the potential of the new technological tools to better meet audience needs. Visitors are no longer satisfied to merely enjoying art collections as passive agents, rather they desire that their time spent in a museum can be transformed into an enriching cultural experience. The majority of Italian museum institutions have shown to be unable to adapt to the significant changes brought by the digital revolution, and they have had significant difficulty in creating new strategies that take these changes into account.

The Artificial Intelligence disclosure encompasses the wide range of new technologies introduced by the digital transformation. Artificial Intelligence (AI) provides to museums (and not only) an enormous potential to guarantee a better service or product to their audience. In this sense, cultural institutions can benefit from AI applications to improve collections, address new market challenges, but most importantly, to engage the public (especially the younger, or rather digital natives) and break down the many technological barriers. Specifically, AI can be employed by museums to create virtual reality experiences that make the visit more engaging and interactive; to give artworks voice with augmented reality; to help researchers in studying collections with machine learning techniques; to organize collections and catalogues with specific algorithms that identifies, for example, repeating visual or chromatic aspects and link them to a movement or artistic expression; to evaluate customer satisfaction.

Chatbots, i.e. software that simulate human conversations, play a crucial role in this context. They are extremely valuable application for museums who use them mainly for increasing in general the visit experience, as a virtual guide or for gamification purposes. Although there are certainly limitations and controversies, chatbots are a promising technology that is unfortunately underestimated in Italian museums. A computer scientist, when discovering this thesis topic, states: "Have you really found Italian museums that use chatbots?". And that is right. In this research, the debate on chatbots is considered only in the Italian context which is in a lethargic development stage

in comparison to other countries, as the fact that Italian museums cannot rely on in-depth researches and systematized experiences that support cultural institutions to seize the opportunities brought by the digital age. Therefore, the final objective of this thesis is to demonstrate how chatbots can be a valid tool not only to innovate museum offer, but also to attract new audiences and save capital and/or resources. The basic question of this thesis relates to the role that AI, in particular chatbots, can play in the museum world: can AI technologies genuinely give a boost to revitalize museum experiences in the light of the changes that have occurred in our society?

In particular, the thesis consists of four chapters: the first deals with how digital transformation has influenced our society and in particular the cultural sector, focusing on how museums have reacted to the advent of new technologies. The second chapter focuses on the analysis of Artificial Intelligence, passing from its historical excursus to the specific technologies that fall within the scope of AI, finally analyzing the applications of the latter in museum experiences. The primary focus of this thesis is introduced in the third chapter, which is dedicated to an in-depth analysis of chatbot technology, from its origins to application models in today's companies, with a specific focus on new opportunities that museums can seize with the introduction of chatbots in their cultural and artistic offer. The fourth and final chapter is entirely devoted to the analysis of Italian museum cases that have adopted chatbots to implement the audience experience, thanks also to the interviews conducted during the research study. The chatbots of House Museums (Milan), Mart (Rovereto and Trento), MAXXI (Rome), Fondazione FILA (Biella), Opera di Santa Maria del Fiore (Florence), Gallerie dell'Accademia (Florence), and Parco Archeologico del Colosseo (Rome) will be analyzed and compared in order to shed light on strengths, weaknesses, and future prospectives.

Chapter 1 – New technologies in the museum context

1.1 The influence of digital transformation in our society

The ongoing century is marked by an exponential growth of the diffusion of digital technologies: every single element of the social and economic system that surrounds us has become part of this change. Living in the age of digital technology implies a colossal change for individuals and economic organizations that forces them to rethink and readjust the way they live, the way they do business, and the way individuals relate to each other.

It is interesting to look at the statistics conducted by *We are social*¹ that develops a yearly global report of the latest trends in order to understand how digital technologies and the Internet have impacted people's life. The Digital 2023 Global Overview Report points out that the 68% of the global population, i.e. 5.44 billion of people (the world's population is 8 billion), makes use of mobile phones. Mobile users have raised over 3% during the past year, with 168 million new users over the past 12 months. Today, 5.16 billion of people are Internet users, meaning that 64.4% of the world's population is now online. There are now 4.76 billion social media users around the world, equivalent to almost 60% of the total global population (Figure. 1).

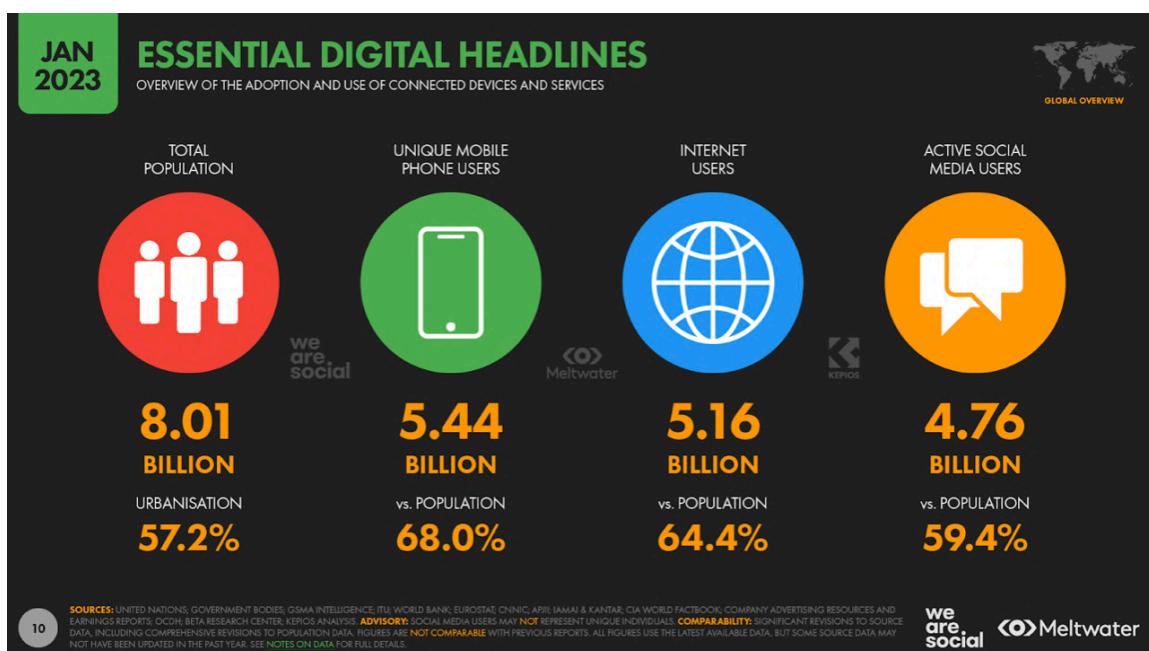


Figure. 1 – Latest trends on the adoption and use of connected devices and services (Digital 2023 Global Overview Report)

¹ *We are social* is a global socially-led creative agency that offer full-service marketing, creative, media and technical disciplines, specialists in the production of social-first content.

Figure. 2 shows an overview of the Internet use with a specific focus on the percentage of total female and male population that uses the Internet, the average daily time spent using the internet by each internet user, the percentage of users accessing the internet via mobile or computer or tablet, and the percentage of population that uses the internet depending on the place of residence. Moreover, Figure. 3 displays a timeline of Internet users over time, which is fundamental in order to understand how the number of users grows over mainly 10 years.

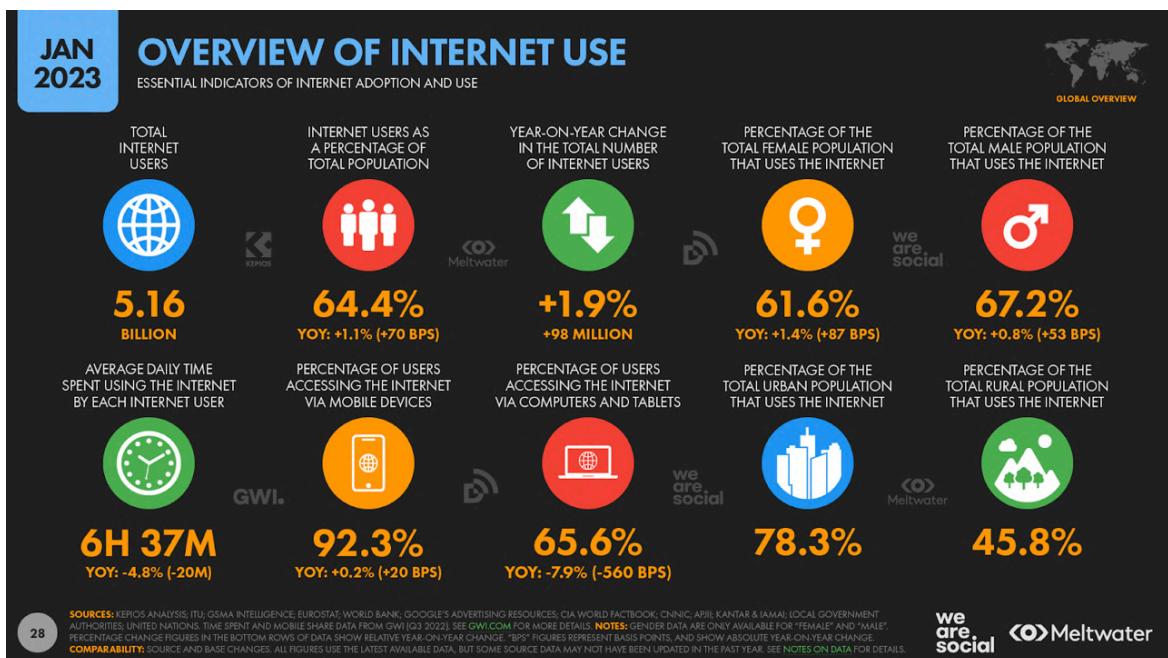


Figure. 2 – Indicators of Internet adoption and use (Digital 2023 Global Overview Report)

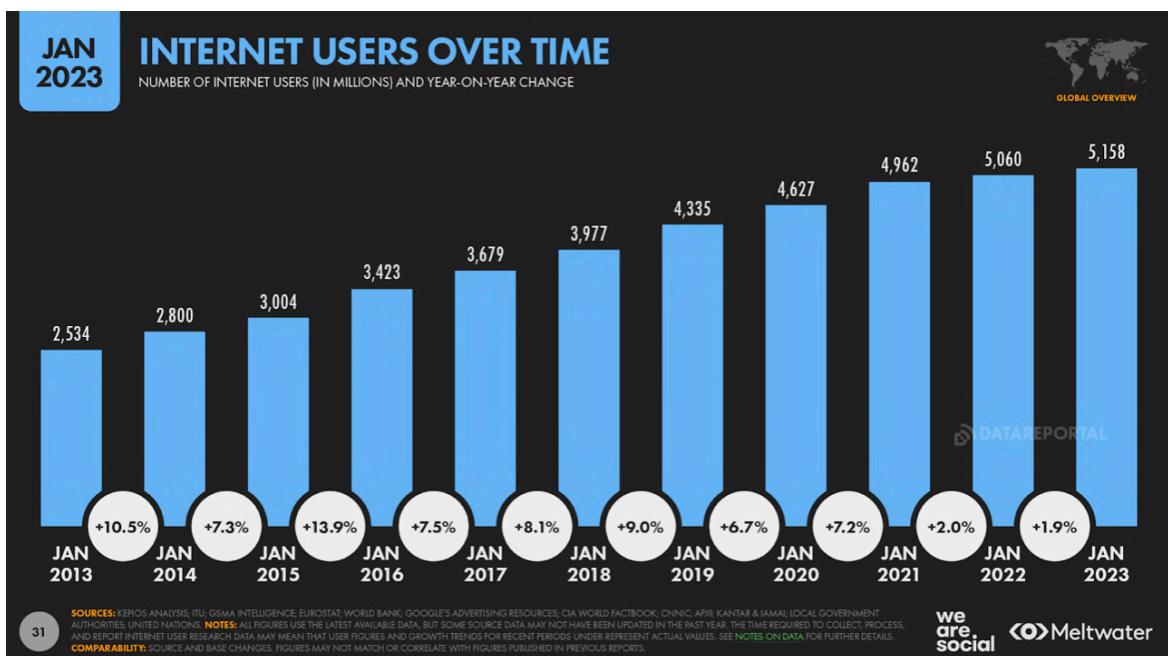


Figure. 3 – Timeline of internet users from 2013 to 2023 (Digital 2023 Global Overview Report)

Another important aspect to analyze is why people goes online (Figure. 4). Even though it has just come to light that search habits around the world are changing, "finding information" is still the main reason people use the Internet today. GWI's² latest research discovers that almost 6 in 10 working-age Internet users still refer to online resources when looking for information, ahead of staying in contact with friends and family, keeping updated with news and events, and watching videos.

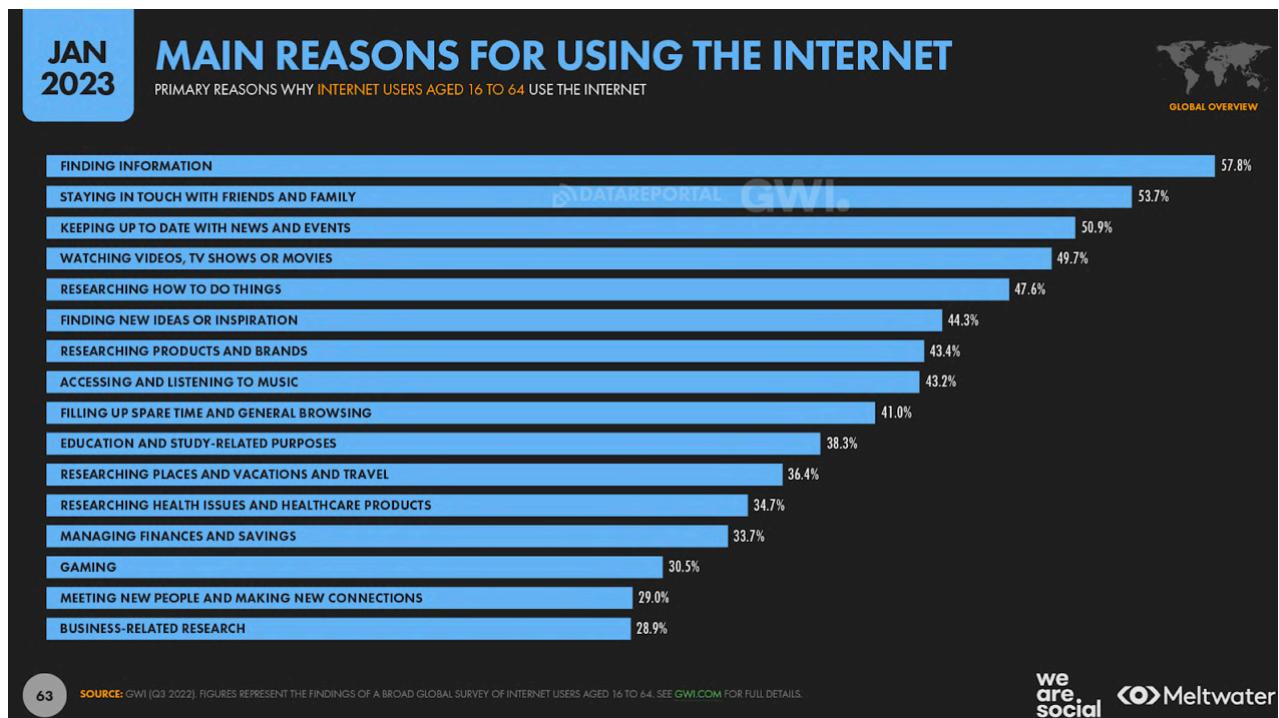


Figure. 4 – Main reasons why Internet users aged 16 to 64 use the Internet (Digital 2023 Global Overview Report)

As all the revolutions, the digital one brings radical changes in authorities and/or organizational structure in general by introducing new inputs, new products, new industries, new infrastructures and new ways of transporting goods, people, information and alternative sources of energy.

The evolution of technology is a fast and disruptive process that is changing and revolutionizing entire industries and entire business models. In fact, the real challenge facing companies is to understand how digital technologies can be used to create value for their customers and how they must be ready to redesign their governance and internal processes. Sudden shifts in people's habits and lifestyles into innovations have played a leading role in the use of technology to spread very rapidly, with recent penetration rates that would have been unimaginable just some years ago. Some examples are the exponential growth in the use of social networks, the widespread use of smartphones, the increasing use of mobile applications to solve everyday problems, and the development of mobile Internet guaranteed data transmission performance.

² GWI (Global Web Index) is an audience research company founded in 2009 which provides audience insight to publishers, media agencies, and marketers around the world.

Furthermore, technological advances over the past two decades have and are causing profound changes in user behavior and market composition. The wave of new technologies has transformed users from passive subjects into protagonists and participants in social and corporate life. People want to express themselves, exchange ideas, share their daily lives, collaborate to make progress, and build communities of practice. As a result, businesses will inevitably have to adapt to new human behaviors and the proliferation of digital consumers. Thus, they will be forced to explore new markets, experiment with new business models and new ways of using digital technologies to solve problems for their target customers (Informatica e Ingegneria Online).

All these changes related to the introduction of new technologies are basically due and originated by the so-called Fourth Industrial Revolution. The term firstly appeared in January 2016 when Klaus Schwab, World Economic Forum Founder and Executive Chairman, published a book titled *The Fourth Industrial Revolution*. Since then, the "4IR" has been used to describe and examine how new technologies have affected nearly every aspect of human development in the early 21st century, from changing social norms and national political attitudes to economic growth and global relations. The Fourth Industrial Revolution concept asserts that technology advancement is a driver of transformation that affects all spheres of industry and society. Additionally, it emphasizes the idea that, at specific history stages, particular technology sets emerge and come together in ways that their impact go well beyond merely little efficiency improvements. The term "4IR" is frequently used interchangeably with "Industry 4.0," a program that was developed in Germany from 2011 to 2015 and focuses on the integration of digital technologies into the industrial process. Although these two ideas are not totally unconnected, they refer to different concepts. Industry 4.0 is a significant part of the wider framework of 4IR with its crucial focus on the interaction between digitalization, organizational change, and efficiency improvement in manufacturing and production systems. As a result of 4IR, the creation, exchange, and distribution of economic, social, and political value have undergone a variety of important changes which are closely linked to the rise of new technologies that span across the digital, physical, and biological worlds. These technologies include robotics, advanced materials, the Internet of Things, genetic modifications, neurotechnologies, drones, autonomous vehicles, machine vision, and Artificial Intelligence. The prefix "fourth" is significant because this revolution aims to advance strategic interchange beyond the digital revolution, which has been identified as the Third Industrial Revolution³ based on digital information technologies and it has been described as a shift from an industrial to an information age (Philbeck, Davis, 2018-2019).

³ The Third Industrial Revolution began in the 1950s and it brought semiconductors, mainframe computing, personal computing, microprocessors, the World Wide Web and the Internet.

Digital disruption and digital transformation

As previously mentioned, the technology evolution is a fast and disruptive process, as a matter of the fact that the existence of presiding firms is jeopardized by digital innovations which also have negative systemic consequences on markets and industries. Researchers and practitioners are paying close attention to digital innovation and its wider systemic repercussions, frequently referred to as digital disruption. It is frequently described as a form of environmental turbulence brought by technological innovations that causes a breakdown of boundaries and methods that were formerly the basis for organizing the creation and capture of value (Karimi, Walter, 2015). According to a number of experts, effective businesses in the digital age must possess the capacity to either initiate digital disruption and bring about systemic change or to take advantage of concomitant changes in fundamental circumstances. However, practitioners and academics agree on the overall definition of digital disruption, but they disagree on its exact meaning and how it relates to other terms used frequently in the discourse on digital innovation. Furthermore, there is a limited understanding of how dynamic processes that could result in digital disruption are sparked by digital innovation. Additionally, the disruptive innovation theory and digital disruption are sometimes confused.

For more than 20 years, the term "disruption" has been associated with several meanings, which have complicated comprehension and progress in the field of disruptive innovation theory. Disruption, as used in the disruptive innovation idea, refers to a particularly precise process that explains how new competitors can compete with incumbents. It is focused on business model innovation that allows new players to join markets with inexpensive, simple-to-use, but subpar products. Extant research has essentially drawn upon the general notion of disruption, commonly framing digital disruption as "*a type of digital technology-induced environmental turbulence capable of producing industry-level upheaval*" (Christensen, Altmann, McDonals, Palmer). Digital disruption is commonly perceived from the perspective of companies that have made significant investments in outdated circumstances, and whose anticipated or usual path of progress is impacted. Due to the rapidly and systemic nature of environmental change as well as declining economic performance, there is frequently an urgent need to react when companies confront the prospect of digital disruption. However, historically successful firms' structures that were developed as a result of adaptation to previously prevailing environmental conditions are typically difficult to modify.

The extant research and the general notion of disruption guide to suggest three crucial characteristics of digital disruption. Firstly, digital disruption processes derive from digital innovation and rapidly destroy competitive positions. Secondly, by fracturing and recombining resource links, they have an impact on systems of value-creating actors and frequently allow more direct contacts and transactions. Thirdly, whereas the initial stages of digital innovation are managed by one or more enterprises, the repercussions on value creation and capture are systemic. Hence, Daniel A. Skog, Henrik Wimelius, and Johan Sandberg (in *Digital Disruption*, Business & Information Systems

Engineering, 2018) propose the following definition of digital disruption: "*the rapidly unfolding processes through which digital innovation comes to fundamentally alter historically sustainable logics for value creation and capture by unbundling and recombining linkages among resources or generating new ones.*"

Digital disruption and digital innovation have to be located within a larger process of change, namely digital transformation. As a result, digital innovation plays a variety of roles in driving digital transformation, some of which have the potential to cause systemic "shocks," i.e. digital disruption. At least two aspects set digital disruption distinct from digital transformation. Firstly, as opposed to aggregate effects, digital disruption is a representation of particular innovation processes. Since each digital innovation entailed aims to challenge, undercut, or make obsolete other actors' mechanisms for value generation and capture, digital disruption processes have discernible agents in terms of both initiators and targets. Cause and effect can therefore be explored from the firm level to the systemic level and back to the company level. Second, compared to digital transformation, digital disruption manifests more quickly (Skog, Wimelius, Sandberg, 2018).

Nevertheless, how is concretely defined the digital transformation? The concept of digital transformation is easy to understand: things that used to exist only in the physical world are now going digital.

However, based on personal literature research, there is surprisingly little academic research on the concept of digital transformation. This is despite the fact that the term digital transformation exists since the early 2000s. Academics have used the vague word "digital transformation" in reference to organizational changes brought by digital technologies. Although there is more information available about the specific underlying technologies, frequently gathered through case studies and case histories, there are some academic sources that mention digital transformation.

The first scholars that discuss the idea of digital transformation were Patel and McCarthy (in 2000), but they did not go as far as to theorize the phrase or provide a concise description that everyone could understand. Only a small number of studies have so far offered a precise definition of the idea. According to Capgemini's research, digital transformation refers to the application of technology to significantly raise a company's performance or value.

In other words, every definition in the literature takes a holistic approach rather than relying solely on the usage of particular technologies and changes to represent the digital revolution. One obvious element is that, exactly because the technology from which they arise have advanced so quickly, digital transformation involves fundamental, drastic changes rather than incremental, progressive ones. It goes without saying that implementing new digital technologies within a company does not automatically result in a digital transformation, or a fundamentally dramatic shift to the company's business model (Informatica e Ingegneria Online).

Among all the definitions of digital transformation proposed by researchers and academics, that of Krimpmann (2015), Loebbecke and Picot (2015), and Mangematin, Sapsed, and Schüßler (2014)

appeared to be the clearest and most relevant for this research: “*by digital transformation we mean the combined effects of several digital innovations bringing about novel actors (and actor constellations), structures, practices, values, and beliefs that change, threaten, replace or complement existing rules of the game within organizations, ecosystems, industries or fields*” (Hinings, Gegenhuber, Greenwood, 2018).

New digital technologies give rise to a shift in customer expectations, generating a new category of contemporary buyer. The new digital consumer is always connected and conscious of the possibilities offered by technology. Customers frequently judge companies using a digital-first criterion, that is based solely on their digital experience, given the potential that arises from the use of current technology. The digital-first criterion requires to reconsider the way of approaching with customers. For instance, using this new criterion with the business-to-business sales team means replace telemarketing calls with social selling, as long as customers are widely active in social media, therefore business need to be found there. On the other side, for the marketing team, digital-first means initially cutting back on the budgeted spending on offline marketing initiatives like direct mail, TV advertising, and billboards. Customers demand highly personalized communications, and a data-driven marketing plan is the only way to provide them. To successfully implement account-based marketing, email marketing, and search engine marketing tactics into practice, companies must employ digital channels (Fluentis).

It is clear that digital transformation has a noteworthy impact on customer experience which is associated to the profitability and even the survivability of an organization. One of the most remarkable reasons for businesses to adopt digital transformation is to improve the customer experience. Customer collaboration and services can both be improved through digital transformation which has the ability to increase organizational operational effectiveness and to strengthen data analytics capabilities to better comprehend customers. Moreover, digital transformation can help organizations to create dynamic and flexible business models for conveying better customer value. It necessitates a lot of effort to accomplish digital transformation to improve customer experience. It entails adjusting changing consumer behavior, comprehending complex consumer information, refining business models, ameliorating consumer processes, incorporating technologies, and responding to shifting market conditions (Neeraj, Hepu, Alemyehu, 2018). According to some surveys, the integration of innovation with customer experience offers a clear opportunity for growth compared to competitors. Benefits include improved operational efficiency (40%), faster time-to-market (36%) and customer satisfaction (35%). Therefore, the central goal of every company is to satisfy customer and retain it over time through a valuable experience. In this context, digital is a fundamental tool to achieve this goal through a customer-centric approach. Filippo Ferri, co-founder and lead analyst of Fluency⁴, affirms:

⁴ Fluency is the business unit of Adv Media Lab addressed to insight-driven and customer-centric approaches with the aim to guide business strategies in the fields of marketing, sales, and customer experience.

“Digital transformation provides the tools to align interventions and investments with the company’s strategy to create a quality customer experience.” (Adv Media Lab)

According to the dynamic capability theory, an organization's ability to adapt to rapidly shifting environments is based on its ability to build, integrate, and reorganize internal and external competences. This theory provides a strong theoretical foundation to the investigation of the key success factors of digital transformation for improving customer experience. This culminates with the creation of a conceptual framework known as ABCD framework which includes four dimensions: Analytic (A), Business (B), Customers (C), and Digital (D), as shown in Figure. 5.

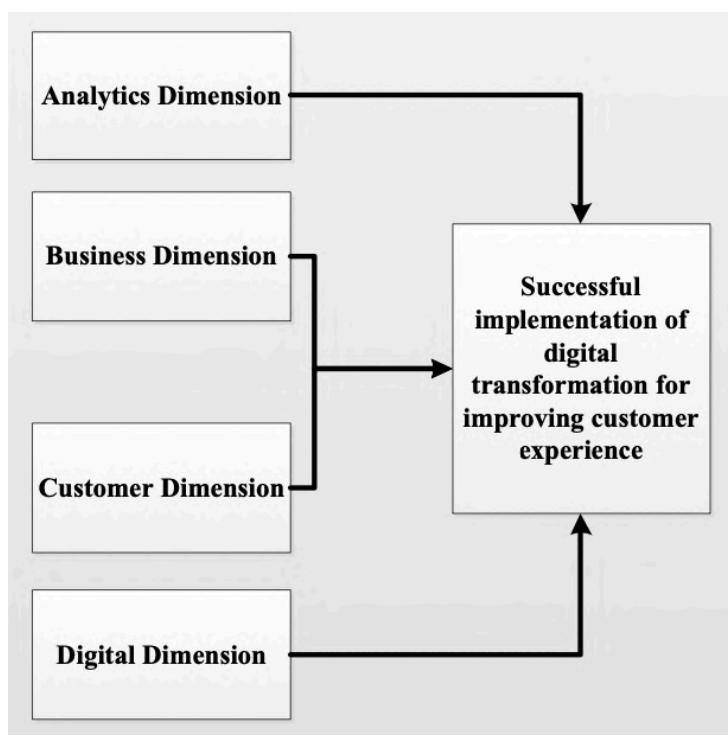


Figure. 5 – ABCD framework scheme

- The Analytics Dimension has to do with employing digital technology to analyze consumer data in a methodical manner in order to find organizational knowledge that has been consolidated. Such information can then assist businesses in greater customer collaboration for improved customer experience. Data collection, digital customer data, customer understanding and segment, customer engagement pattern, customer insight, customer-centric decision making, forecasting customer behaviors, and market trends are just a few of the analytics variables that can influence the success of digital transformation.
- The Business Dimension focuses on how business conditions are changing as a result of organizational digital transformation to improve customer experience. An organization's internal conditions are influenced by changes in financial conditions, management choices,

performance, directions, infrastructure, and support activities. Whereas the external factors mostly pertain to legislation, regulations, and competition. The success of digital transformation for enhancing customer experience can be impacted by a variety of business factors such as the customer and market analysis, the value proposition, cost optimization or/and cost reduction, flexible pricing, product demand and supply, and product implementation strategy.

- The Customer Dimension is concerned with how the organization's digital transformation affects the complete customer engagement journey. It emphasizes communication between businesses and their clients in both directions. Customer touch points and customer engagement are often two important factors to take into account when enhancing the customer experience through digital transformation. There are numerous customer factors that can influence the success of digital transformation for improving customer experience, including customer collaboration and engagement, customer interaction points, personalized sales and marketing, service quality, customer self-serving, and process improvement and transparency.
- The Digital Dimension pertains to the usability, adaptability, and the incorporation of digital technologies and their potential uses in companies' infrastructures. It examines how well different digital technologies may enhance the customer experience. Platforms, applications, functions, infrastructure, and channels are typically the factors that have to be considered. The success of digital transformation for enhancing customer experience can be impacted by a variety of digital elements, including the availability, the ease of use, infrastructure capacity, digital content, and data security.

The effective application of these four dimensions is crucial towards the achievement of digital transformation for improving customer experience (Neeraj, Hepu, Alemyehu, 2018).

Modern society has experienced significant changes due to the profound and immediate effects that digital and communication technologies have had and continue to have on it. Throughout past few decades, researchers and scholars have assigned to our society a variety of labels such as information society, network society, and knowledge society⁵, to emphasize the significance of ICTs (Information and Communication Technologies) in our day-to-day life. Moreover, even our culture has tackled a profound transformation such that the evolution of digitalization in the cultural sector

⁵ An information society is a society in which the creation, distribution, diffusion, use, and manipulation of information is a significant economic, political, and cultural activity. A network society is a society where the key social structures and activities are organized around electronically processed information networks. Knowledge society refers to any society where knowledge is the primary production resource instead of capital and labor.

and the impact that this revolution has entailed have led scholars to a new definition of culture as a digital culture (Bonacini, 2022). Nowadays, culture should not be viewed as an enclosed system that forms a "cultural mosaic" with other comparable or different cultural systems, but rather as an open and dynamic process that is built on interactive communication. The ICT and especially the Internet, has given these relationships a new dimension, by altering our relation towards knowledge and knowledge society, by increasing the flow of cultural goods and services, and by causing a new understanding of cultural creativity. All technologies influence the human environment and alter it to some extent, thereby altering (in a more or less radical way) the conditions under which various cultures live. They make specific practices outdated while some previously arduous and impractical activities become possible and easier to achieve. It can be claimed that technology impacts and reflects specific social trends since the change is not caused by some internal technological logic but rather depends on how society accepts it, puts it to use, and governs it. When it pertains to communication technologies, their influence is much more profound since how they are applied can transform the very foundations of our cultural and social customs. Therefore, ICTs cannot be seen as passive tools but rather as interactive systems that fundamentally alter our cognitive abilities. Today's advanced technologies should not be seen as merely strategies or tools that help us to overcome particular limitations; rather, they should be seen as environments. The focus should be on the altering effects of ecologies they enable rather than the consequences of particular technology. Computer culture, Internet culture, cyberculture, virtual culture, e-culture, and digital culture are all almost new terms that are today extensively used in popular and scientific literature (Uzelac, Cvjeticanin, 2008).

1.2 How museums are facing the digital transformation?

The Internet and new information technologies have given cultural organizations the chance to meet the precise and growing demand for cultural material for some time now. In particular, they have given museums the chance to ultimately be viewed as a growing and more intriguing option than others in today's information markets in the context of cultural consumption. The public's relationship with culture, particularly with museums and their collections, has been radically altered as a result of the development of new technologies. One can think to, for example, the role that Google has earned in daily life but also in the sector of cultural enhancement and dissemination with its various virtual and interactive projects, such as Google Cultural Institute's portal and Google Arts & Culture which contribute to build a freely accessible global art collection.

Museums have not only modified their communication style from linear and didactic to informative, educational, and persuasive, but have also activated a process of transformation from hierarchical, taxonomic and self-referential structure to a participatory museum. With this transformation, the museum desires to change its role in society by shifting from being a medium that contains society to a medium in and of itself. This will help the museum to build lasting relationships with visitors through audience development and audience engagement.⁶ In this regard, a good strategy to pursue is the abandonment of the self-referentiality that has characterized the museum-temple and a return to the land, whose history the museum collects and keeps safe. In this way, the museum could become an agent of social and urban change in the place where it is located, transforming itself into a place in which to create connections, collect the voices and expressions of people, and produce a sense of belonging to a unique cultural community (Bonacini, 2022).

New forms of digital storytelling in museums

Information has undergone a considerable cultural transformation over the past few decades, including its creator, source, and methods of use. Due to the expansion of numerous content sources in everyday life, the relationship between people and information has altered. People are diversifying their learning approaches, and this has led to the rise of innovative consumption paradigms. Moreover, this diversity increases consumer comfort. How should museums react to this rapid change? How can they design an experience that cannot only keep users' interest and communicate complex information, but also use interaction techniques that will not seem outdated?

They should consider changing context, space, and technologies by all means. The storytelling approach used by the museum has changed. What formerly served only as a voice of authority informing the public through papers and exhibition displays has transformed radically into a multifaceted experience that promotes engagement and conversation with customers. This is a direct response to an audience that is becoming more diverse; much of the current new media planning aims to expand existing audiences without alienating regular visitors. Furthermore, museum spaces are evolving. Newly built museum spaces with radical geometry, diverse lighting conditions, and complicated configuration spaces represent a growing challenge for artists, curators, exhibit designers, and media specialists. Although the design and planning of these venues present practical problems, however the introduction of new technologies makes them possible. The primary aim is to produce an experience. Content, visitors, and space are the fundamental components

⁶ Audience development concerns the strategic dimension, the vision, and the objectives that an organization sets for itself with respect to its current and potential audiences, the type of participation it intends to stimulate, and the impacts it aims to produce; whereas audience engagement concerns the way in which the methods of engagement and participation are designed and implemented, aimed at improving the understanding, satisfaction, and growth of the people involved in the artistic and cultural experience.

present in all design issues. A successful outcome will require equal focus on all three. Finally, the complexity of the consumer tech market has offered to visitors significant new skills and a deeper understanding of technological literacy. Hence, multi-displays, tablets, smartphones are no longer enough to satisfy the audience in the museum experience, they have to get in step with the times and experiment with new technologies such as Artificial Intelligence (Wyman, Smith, Meyers, Godfrey, 2011).

Digital storytelling is a growingly popular cultural trend, and it is regarded as the most widespread type of storytelling because of its facility to produce and low cost. It is without doubt the most innovative communication and engagement techniques between museum and user.

In recent decades, the educational role of the museum has evolved, and storytelling has become a regular practice in Western museums. Stories became the favored means of creating community identity as a result of the paradigm shift in the museum's function from a repository of artifacts to a keeper of stories (Solima, 2018). Storytelling should be seen as an educational strategy based on the use of narrative forms, employed for its potential as a cognitive resource and social glue in the realms of education and cultural mediation. However, in the context of cultural and museum communication, the goal of storytelling is to attract audiences by presenting compelling stories that make cultural heritage appealing. Stories, anecdotes, and mysteries related to the museum's collection, its staff, or its physical space are good strategic subjects since they allow for an emotional approach that may capture the public's attention. Nevertheless, digital storytelling blends the art of storytelling with many forms of digital multimedia, including images, audio, and video. This method has been adopted by modern museums looking for new stories and new languages in an increasingly interactive, interesting, and collaborative style that fully respects the educational mission of museums, the so-called edutainment.⁷

There is a specific location and birth certificate for digital storytelling. The so-called Lambertian method, which involved collaborative creation of digital video stories, was established in 1994 by academics at the Center for Digital Storytelling in San Francisco. To create collective stories that restored a sense of community, individual stories were shared and recorded. Projects and techniques for interactive digital storytelling have grown in number throughout time. It starts with projects in which users were merely requested for post-visit feedback regarding emotions evoked by an object in the museum collection. Then real strategies were established for direct involvement of visitors in the production of the work of art. The process has become so co-creative and proactive that it significantly affects relationships with the public, advocating participation, involvement, two-way communication, and an overall feeling of community. If the digital is a paradigm for a global approach to cultural heritage, then the participatory approach and crowdsourcing technology should be seen as the primary developments in the cultural industry. Actually, the creative and interactive techniques play a crucial role in the spread of culture, triggering a positive process that encourages

⁷ Edutainment refers to things which are designed to be entertaining and educational at the same time.

both the creation and the sharing of user-generated content. The technology employed, the actual production process, the finished result, and the distribution and use methods all play a role in how digital storytelling is classified and distinguished. A total of 14 types are identified:

- Oral storytelling: it is traditional storytelling, that of storytellers, bards, and minstrels, and it can be expressed in multiple forms such as poetry, prose, or songs. The way in which the story is told does not change, it is always oral, rather the technological infrastructure that makes it available changes (radio, MP3, podcast, TV, or DVD).
- Written storytelling: any narrative in which writing serves as the main supporting element is considered written storytelling. Writing can be used in specific digital formats and through the widest range of fixed display devices and furniture.
- Video storytelling: there are countless digital tools with which to produce digital video storytelling, from the simplest iMovie, Windows Movie Maker, Movavi and RawShots that are the most commonly used programs, to the GoPro camera for immersive and 360° videos. An example to quote is the MANN (National Archaeological Museum of Naples) that launches in 2016 the MANN stories, a series of 50 narrative mini documentaries in which archaeologists of the museum speak about a specific object of the collection. On the museum website, there is a particular section in order to access all the videos.
- Visual storytelling: it is a broad category of storytelling which uses a visual support to facilitate the understanding and memorization of what is being told. It develops a story through images, graphics, infographics, animations, and videos. Types of visual storytelling comprehend traditional, “off-screen”, theatricalized, and videomapping.
- Animated storytelling: it is related to digital storytelling created with animation with which comics, real cartoons or animated video in 2D or 3D can be created.
- Interactive storytelling: it is a sort of digital story in which the reader-user can engage with the story's content by influencing the plot's development in real time as the story is being read. It can be simply written, physical, theatrical, created with videogames, with augmented reality, or even a film.
- Immersive storytelling: digital storytelling that blurs the lines between fiction and reality is known as immersive storytelling. The user is repeatedly placed into a narrative setting where the connection between the story being presented and the reality they are experiencing is

increasingly tenuous. The narrative universe determines the experience in which the user is immersed. Augmented reality, virtual reality, mixed reality, and interactive games are all technologies used in order to create an immersive user experience.

- Social media storytelling: the advancements of social networks and the sociality frameworks they are able to build are directly related to the evolution of digital cultural participation. Flickr and YouTube, the first worldwide social media platforms for content sharing, were created between 2004 and 2005. These platforms cleared the way in 2006 for the next wave of social networking: Facebook and Twitter. Consequently, a global village is being created, the Web is becoming an information platform open to collaboration and contribution, and billions of people are able to participate in the digital social experience. Social media are the most adaptable digital conversational medium, making them the best choice for social media storytelling. Social network like Facebook, Twitter, and Instagram quickly become indispensable tools for digital marketing. No cultural institution today can neglect its presence on these channels. Every one of these digital tools has a unique communicational declination. Facebook demonstrates that it is not simply the most flexible and multimedial, but also the most multifaceted for storytelling, engagement, and conversation. Twitter is the most adaptable in terms of dynamism and interactivity. Instagram has great potential in terms of originality and personal narrative and also has the power to create engagement. Pinterest is excellent in terms of aesthetics and iconicity, and YouTube is great in terms of accessibility, dissemination, and marketing. Therefore, it is crucial to apply specific communication methods depending on the social media platform choosed, the style and language used, and the audience wished to reach. Social media storytelling is not just written storytelling or visual storytelling; rather, it is a combination of these forms with a unique language based on appealing components that are not found elsewhere (posts, stories, reels, likes, emoticons, hashtags, and tags), and with a special ability to interact with the content, comment it, tag it, like it, share it, or rework it. Within social media, museums can disseminate knowledge about their collections and artists through stories and curiosities, keep the public informed about new exhibitions or events, and share the museum mission.
- Participative storytelling, generative storytelling, geo-storytelling, mobile multimedia storytelling, crossmedia storytelling, and transmedia storytelling are other very peculiar types of digital storytelling (Bonacini, 2022).

1.3 The case of Italian museums

Concretely, as all the companies and organization in any sector, even Italian museums are facing the digital transformation introducing new ways to interact with the audience, to display the collections, to conserve and restore the artifacts. Some of the technologies implemented are the QR Code, Apps, Social Networks, 3D technologies, gamification, Augmented Reality and Virtual Reality. The QR Code (Quick Response Code) is a two-dimensional bar code matrix made up of black modules organized inside of a white square-shaped pattern, as represented in Figure. 6. It is commonly used to store information that can be read by a smartphone, and it enables the connection between the physical world and digital one. This tool can be used to build a secured guide on web sites, and for this reason they are viewed as a development of the conventional audio guide. The visitor has the choice of accessing the material for further information or skipping it. Therefore, the smartphone can be used as an alternative tool to deliver the traditional pedagogic message. As a result, the works on display are no longer isolated or contextualized just within the visitor's path but rather serve as the hub of an information network. In this regard, the Egyptian Museum of Turin has developed a QR Code placed along the exhibition halls that, framing it with the smartphone, allow visitors to listen a general introduction of the collection at the beginning of each room and special insights in correspondence of many objects such as descriptions, stories, and curiosities (Egyptian Museum Turin website).



Figure. 6 – An example of QR Code

App derives from the word "application" in English. Actually, this indicates the software that has been registered and made for mobile devices like smartphones and tablets. Apps are distinguished by a greater simplification of operation and information compared to software designed for a computer, making them more immediate and intuitive. Visitors can access the guide and information through the app at any time, both when learning about the museum for the first time as well as later to dig deeper into its topics and remain up to date with all of its initiatives and activities, as the MRT (Musei Reali Torino) app does (Figure. 7). In addition to this, the app can also be useful during the visit itself because, through information, video, audio, or games, it can stimulate interaction between the visitor and the museum. The main advantages that can be achieved with an application can be pre and

post visit information, greater involvement (for example through gamification), preparation of itineraries dedicated to different target visitors, geolocation, and visitor data collection.

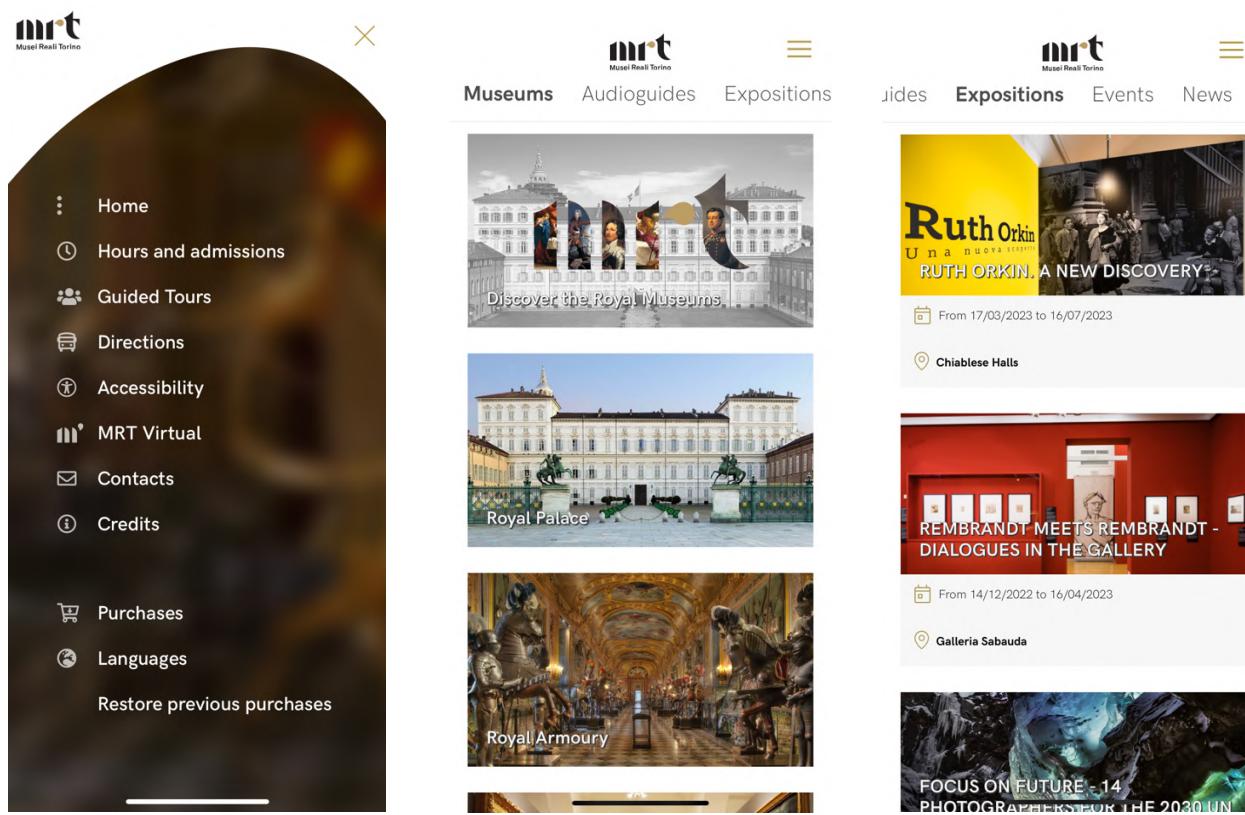


Figure. 7 – Screenshots of MRT (Musei Reali Torino) app

Social networks are the main source of information and content sharing for people today. Most industries, including the cultural one, have been impacted by their global expansion. Actually, social networks have become a virtual setting where museums are attempting to connect with the general public through less formal relations. Along with being a user, these tools have also enabled people to become a content provider. From a museum's perspective, the benefit is that users have become tools for promoting and disseminating the museums' cultural events. In fact, visitors are publishing photos and news more frequently than ever before with the intention of sharing it with friends or, more broadly, with their followers. Therefore, through this sharing, the experience of the visit is provided to new users who may be stimulated to put their attention on that museum. Through the use of social media, it is now feasible to create a dialogue between a museum and its visitors in which there is a sort of collaboration.

3D technologies allow to create three-dimensional objects with conservation, educational, and accessibility purposes. 3D printing is widely used in museums in order to display big monuments in miniature or to provide a more tactile experience for museum visitors, and this could be a game changer for people with visual impairments as it permits them to touch artifacts. The conservation topic is another advantageous application since replicas are possible for pieces that must be treated carefully. This makes it possible to examine things closely without endangering the originals. Items

that are too delicate to show can be kept safely in storage while a copy is used in their place. Damaged artifacts can even be recreated with a specific procedure in which fragments are scanned and digitally joined together in order to print a fixed model. These can be shown side by side in museums to give visitors a clearer notion of the object's previous appearance (Coates, 2020). For instance, the MANN (National Archaeological Museum of Naples) has made available online some 3D scans of objects from its collections that can be viewed, rotated on any axis, enlarged, and, above all, downloaded and printed directly by the user. In the Figure. 8 is represented the 3D scan of the *Amazon on horseback* statue.⁸



Figure. 8 – 3D scan of the *Amazon on horseback* statue (inv. 6405)

Gamification is the application of common game concepts (game elements, game mechanics, and game design techniques) to situations that are not gaming-related, and it aims to increase engagement and encourage user loyalty. Gamification and the game could be seen as helpful methods to engage younger generations of museum visitors. Additionally, we may trigger an emotional and interactive response from the general audience, enhancing the current experience. Since the visitor himself moves and completes missions and riddles, the game within the cultural environment enables to live the museum experience like that of a video game, in a living way. An important consideration is the game's ability to transform a trip to the museum from an infrequent activity into a moment of pleasure and enjoyment that may be experienced more frequently (Riva). “*The Medici Game. Murder at Pitti Palace*” is the first 3D videogame promoted by an Italian museum. It was developed in 2019 with the aim to virtually visit the museum during the Covid lockdown. It is an investigative adventure that has as its protagonist an art historian who finds herself involved in a mysterious murder case that took place within the walls of the palace. To get out, she will be forced to improvise detective and solve, thanks to her historical-artistic skills, a long series of riddles that will lead her to discover the secrets of the building (Figure. 9).

⁸ Sketchfab.com is the platform used by the MANN in order to make available the 3D scans.



Figure. 9 – “*The Medici Game. Murder at Pitti Palace*”

Augmented Reality (AR) and Virtual Reality (VR) are two different technologies, even if they are often wrongly used as synonyms. AR is a digital representation in which, to the normal reality, artificial sensory information (such as texts, images, 2D or 3D animations, audio and video) are superimposed to the normal reality perceived through our senses. The goal of Augmented Reality is to give the feeling that virtual objects are really present and integrated into the real world and it is therefore possible to move and see such objects from different points of view. Whereas VR leverages immersive technologies to simulate interactive virtual environments with which users become subjectively involved and in which they feel physically present. Audience enters a completely immersive world invented by a computer system without seeing the real world around them. These are the technologies that museums primarily use because they enable exceptionally high levels of engagement and sensory immersion. They are employed because they offer the public the chance to admire landmarks that are in danger of being destroyed, to recreate lost realities and artifacts, and to create moments that transcend space and time (Marzouk, Maher, Mahrous, 2019). In the Archaeological Site of Olympia is organized a self-guided tour with audio guide and Virtual Reality experience. With VR glasses and earphones, visitors can walk and explore the city as it unfolds through time as illustrated in Figure. 10.

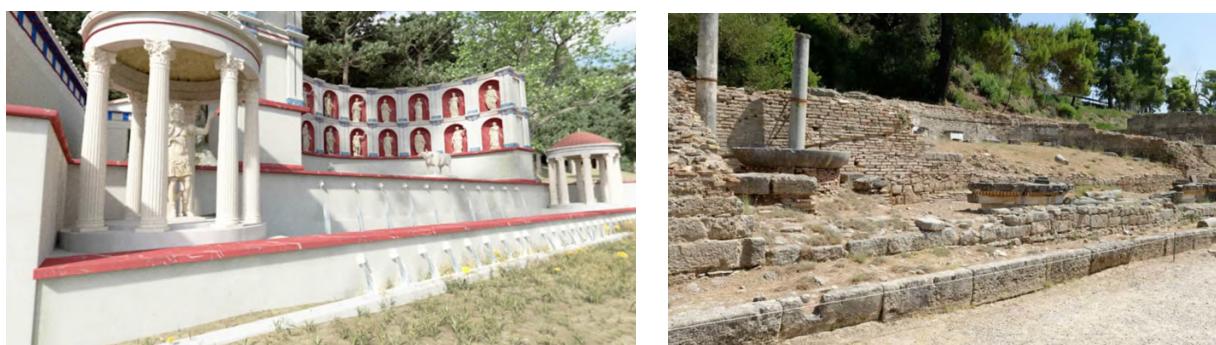


Figure. 10 - On the left the original site in VR, and on the right the site as it is nowadays.

Apart of these specific technologies, for museums, a good level of digitalization comprehends the use of the website, and the presence on the main social networks, i.e. Instagram, Twitter, Facebook, and TickTock. Whenever these components are combined with online ticketing, museums can increase their online visibility on a national and worldwide scale and make their locations more accessible to visitors. A museum organization may conduct user profiling through online ticketing, which enables them to collect visitor information and store it in a computer system in order to develop customized marketing campaigns. Another digital technology still not widely used and exploited by museums are chatbots to provide the audience with answers to specific questions of various kind, thus improving the support offered to visitors and improving customer satisfaction. Regarding the effects of digitalization, museum organizations have benefited financially in a variety of ways, primarily through increased income. They have benefited from increased visitor access in this way. This situation is mostly related to the web, social networks, and online ticketing, which have boosted the visibility of museum organizations by facilitating visitor access. The deployment of digital solutions has also benefited the marketing of supplementary services like audio guides.

Digitization has allowed museums to cut expenses. For instance, administrative costs have decreased as a result of the usage of electronic invoicing, and market research has been conducted through sponsorships on the Internet and through social media, avoiding the employment of more expensive outside companies. Digitalization has also had a significant impact on the intangibles that underpin how museum organizations create value. The integration of digital technologies has boosted the reputation of museum organizations while also strengthening the business image and brand value. In terms of relational capital, the introduction of digital technologies has boosted customer satisfaction and customer retention and has enhanced relations with stakeholders such as local institutions, the community and sponsors (Raimo, De Turi, Ricciardelli, Vitolla, 2021).

1.4 The Italian Government support for the museum sector

In an era of radical transformation characterized by the need to adapt to a continuous change in which people seek new stimuli and new experiences, museums face a dramatic contrast between the opportunities offered and the complexity introduced by the technological transformation. Apart from the adoption of new technologies, the Italian museum sector is supported by numerous cultural initiatives promoted by the institutions in order to encounter this complex transformation. In this context, the MIBACT⁹ has launched in 2019 an extensive reorganization of museums sector that has

⁹ MIBACT is the Italian Ministry of cultural activities and goods and tourism, and it exercises State's powers with regard to the protection of cultural and environmental goods and the implementation of policies relating tourism.

led to the establishment of the Museums General Directorate. The Triennial Plan for the Digitization and Innovation of Museums is part of this framework and reacts to the need to provide the new National Museum System's members with an organic, reliable, and shared reference framework to adopt digital tools and processes that contribute to the objectives of protection and enhancement of cultural heritage in a short and medium term. Technology must be understood as an extraordinary element enabling the overall transformation. The contribution in terms of efficiency improvement, security reinforcement, guarantee of autonomy of address and accessibility made possible by digital tools is now considered consolidated. These tools, if adopted in a rational way, do not necessarily substitute those already consolidated by museum professionals, but are gradually added to it. The extreme variety of Italian museums, from whatever point of view we consider the issue, has not made things simple from this point of view. The fragmentation of administrative and operational responsibilities has been superimposed on the difficulty of interpreting the ambiguities of a paradigm shift that goes far beyond the field of technologies. For this reason, the plan assumes the identification of the museum ecosystem as an operational grid capable of going beyond fragmentation and presenting solutions, but only as long as it benefits. The objective of the plan is not to regulate processes realized starting from the access to the market or from the construction of virtuous nets; it is proposed, instead, to raise the level of efficiency inside and outside for all the actors of the system. Specifically, the plan aims to provide all Italian museums with a coherent framework that can guide the adoption of digital solutions. The objectives can be summarized as follows:

- Improve the capacity of all museums belonging to the National Museum System to manage the heritage by increasing the effectiveness and efficiency of the protection processes thanks to the adoption of cataloguing standards and information systems already available, and by stimulating new paths of enhancement of heritage.
- Improve the ability of museums to propose cultural heritage to their interlocutors both in terms of exhibition and narration of artworks and in terms of marketing additional services.
- Make museums open spaces for sharing with visitors, scholars, national and international museums, enabling new forms of exchange and communication. The reference models, implementation processes and interoperability mechanisms developed from the Plan will ensure relevant and traceable sharing of projects, experiences and data related to offline and online behaviors.
- Activate new forms of access and use of data relating to the heritage, mediated by technological solutions. The Plan will offer tools to address the issue of accessibility from a

system perspective in which wide-ranging active inclusion is promoted already in the design phases; and fruition is an integral part of the asset management process.

- Activate actions and stimulate businesses and the private productive world to offer products and services with added value in the areas outlined by the Plan.

The focus in the digitization process is the public services improvement. This is possible through the adoption of the Catalogue of Museum Services; methods for defining digitization processes such as 3D modeling, Augmented and Virtual Reality solutions and gaming experiences (as described in the previous paragraph); integrated Analytics, Business Intelligence and Big Data systems with structured data flows, in complete security and in compliance with confidentiality regimes; customer satisfaction and service quality monitoring actions; innovative geolocation solutions with the creation of customized museum guides; effective presence on digital channels with adequate content and able to engage the public, but also with ticketing and marketing services (Triennial Plan for the Digitalization and Innovation of Museum).

Together with the Triennial Plan for the Digitization and Innovation of Museums, the National Plan for the Digitalization of Cultural Heritage operates as a strategic blueprint to guide how the Italian Ministry of Culture, in coordination with the Regions, will promote and coordinate the process of digital transformation in the various cultural sectors over the course of a five-year period from 2022 to 2026. The project is primarily targeted at public cultural sites including museums, archives, libraries, superintendencies, institutes, and public parks that preserve, protect, manage, and/or promote cultural assets. Hence, the initiative also represents the strategic, intellectual and technical point of reference for accomplishing the objectives of the National Recovery and Resilience Plan (which is analysed in the next page). The National Plan for the Digitalization of Cultural Heritage seeks to leverage the possibilities provided by the digital era to build an ecosystem for culture that may increase potential demand and improve accessibility for different public sectors. The Plan aims to build on a foundation of shared values and goals for change, including expanding access to digital heritage in order to increase cultural inclusiveness; extending forms of collaboration and data interoperability within the ecosystem in light of the need for communication between digital platforms for global research that satisfy the requirements of various scientific communities; adding user services to end-to-end processes in digitalization operations, in addition to cultural assets (National Plan for the Digitalization of Cultural Heritage).

As mentioned before, the National Recovery and Resilience Plan plays a crucial role by financially assist cultural organization in the digital transformation process and also in other fields. Specifically, it is a public investment plan that the Italian Government has developed as a response to the economic crisis caused by the COVID-19 pandemic. The investments include loans and grants for a total of €191,5 billion and they are divided into several fields that are called “Missions”:

- Mission 1: Digitalization, innovation, competitiveness, culture, and tourism
- Mission 2: Green revolution and ecological transition
- Mission 3: Infrastructure for a sustainable mobility
- Mission 4: Education and research
- Mission 5: Inclusion and cohesion
- Mission 6: Health

Museums are included in Mission 1 in which €40,29 billion are allocated with the goal of promoting and supporting the digital transition both in the private sector and in the Public Administration; reinforcing the innovation of the production system; investing in two key sectors for Italy that are tourism and culture. The mission is composed of three components: digitalization, innovation and security in the Public Administration; digitalization, innovation and competitiveness of the production system; tourism and culture 4.0. For what concern this research, it is remarkable to note that one component of this mission aims at the creation of digital platforms and strategies for access to cultural heritage. In particular, the investment aims at bridging the existing digital divide and maximizing the potential of heritage preservation facilities, i.e. museums, archives and libraries. In this sense, some of the interventions include the development of cultural databases and digital collections; the reduction of inefficiencies and management costs through the rationalization of information systems (cloud approach), the dematerialization of paper archives and the digitization of procedures and processes; the simplification of the relationship between public authorities, citizens and businesses, redesigning industry procedures and bringing online services (National Recovery and Resilience Plan, 2021).

Chapter 2 – Artificial Intelligence and its applications on museums

2.1 Artificial Intelligence (AI): definitions and history

Artificial Intelligence is always brought up when discussing the future, whether it be in the medical, financial, industrial, or social fields. The truth is that Artificial Intelligence is not the future, but the present. Undoubtedly, we are not even close to being aware of the number of tools that use algorithms that we employ throughout the course of a single day. However, when we choose the playlist that Spotify suggests, we are using a tool that is based on recommendation systems that use Artificial Intelligence. When we ask Siri to call a friend, when Alexa updates us on current news or weather forecasts, or even when Netflix suggests a movie to watch. All of these situations include Artificial Intelligence; in fact, the most current platforms, like Google, Facebook, Amazon, Spotify, and Netflix, are built upon analysis, prediction, and recognition algorithms.

Artificial Intelligence, which has been an evolving discipline for 60 years, incorporates a variety of sciences, theories, and methods that try to replicate human cognitive abilities. These include mathematical logic, statistics, probability, computer science, and computational neuroscience. It was first developed at the dawn of the Second World War, and its advancements are closely related to those of computing. As a result, computers are now capable of handling activities that were once exclusively suitable for humans (Council of Europe Portal).

We refer to ourselves as *Homo sapiens* because we consider intelligence extremely important. We have spent thousands of years trying to comprehend how we think, specifically how a small amount of matter is able to see, comprehend, foresee, and control a universe that is much bigger and more complex than it is. The study of Artificial Intelligence goes much farther: it aims not just to understand but also to create intelligent systems. The term Artificial Intelligence today refers to a vast array of subfields, from the general learning and perception to the more specialized, such as playing chess, writing poetry, proving mathematical theorems, driving a vehicle in congested areas, and detecting diseases (Russel, Norving, 2010).

Artificial Intelligence evokes strong feelings, and it has fascinated humans. Questions like "what is intelligence?", "how can one quantify intelligence?", as well as "how does the brain work?" come up. All of these concerns have relevance when attempting to comprehend Artificial Intelligence. The question of an intelligent machine that acts like a person and exhibits intelligent behavior, however, is what engineers and computer scientists are most interested in. The attribute *artificial* brings diverse associations: it raises fears of intelligent cyborgs; it brings to mind scenes from science fiction novels; it poses the question of whether we should attempt to comprehend, model, or even

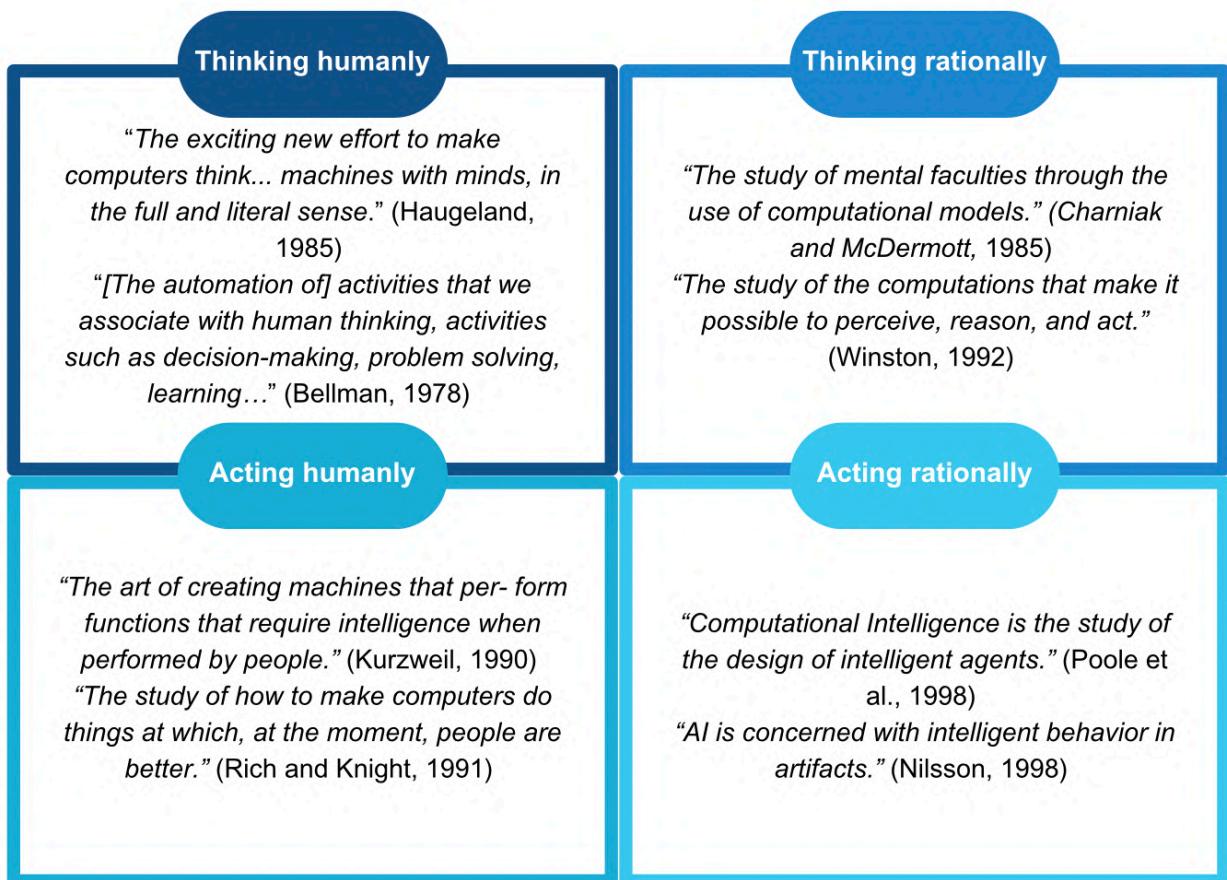
reassemble our highest good, the soul. It is challenging to define Artificial Intelligence, given the variety of interpretations (Ertel, 2018).

The first definition of Artificial Intelligence, also known as AI, was developed in 1955 by John McCarthy who was a renowned computer scientist and cognitive scientist recognized as the founder of AI. His definition states that:

"Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs".

Although it is associated to the related work of utilizing computers to comprehend human intelligence, AI should not be limited to techniques that can be observed biologically. AI research has figured out how to get computers to do some of the mechanisms that make intelligence possible, rather than others. Computer programs can perform quite impressively on tasks if they just require methods that are now understood, and such programs should be regarded as "somewhat intelligent". In this way, Artificial Intelligence (AI) does not attempt to replicate human intelligence. On the one hand, we can learn something about how to program machines to solve problems by watching other people or just by watching our own processes. On the other hand, the majority of AI research focuses on the challenges that the outside world presents to intelligence, rather than on humans or other animals. Researchers in AI are free to employ techniques that haven't been tested on humans or that require a lot more computational power than humans are capable of (McCarthy, 2007).

Stuart Russel and Peter Norving, in *Artificial Intelligence. A modern approach* (2010), show eight definitions of AI, laid out along two dimensions. The definitions on top of the chart are about processes and reasoning, whereas the ones on the bottom address behavior. While the definitions on the right compare performance against an ideal performance standard known as rationality, the definitions on the left define success in terms of fidelity to human performance.



For what concerns the thinking humanly dimension, the two definitions follow the so-called cognitive modeling approach. If we want to claim that a certain computer thinks like a human, we must first know something about how humans think, and thence investigate the inner workings of the human mind. The three options to achieve this are introspection, psychological experiments, and brain imaging. Once it is stated a sufficiently specific theory of mind, it is possible to consider the theory as a computer program. If the input-output behavior of the program coincides with an equivalent human behavior, some of the program's mechanisms might also be functional in humans. To create accurate and testable concepts of the human mind, the interdisciplinary area of cognitive science combines computer models from AI with experimental methods from psychology. In the initial stages of AI, there was frequently misunderstanding regarding the various methodologies since an author would declare that an algorithm performs correctly on a duty and thus that is a good representation of human performance, or vice versa. The two types of statements are now distinguished by modern authors, and this has empowered the advancement of cognitive science and AI. However, the two sciences continue to support each other, particularly in computer vision which integrates neurophysiological evidence into computational models.

On the other side of the coin, the thinking rationally dimension pursues the "laws of thought" approach. One of the pioneers of the "right thinking", that is the undeniable reasoning process, was the Greek philosopher Aristoteles. His syllogisms established models for argument structures that

always surrendered correct conclusions when given right premises. These laws of thinking were assumed to control how the mind worked, and their study gave rise to the discipline of logic. A specific notation for statements about all types of objects and their relationships was established by logicians in the 19th century. By 1965, there were available programs that, in theory, could resolve any solvable issue expressed in logical notation. In order to develop intelligent systems, the logicist tradition intends to operate on such programs within Artificial Intelligence. This approach has two significant challenges. Firstly, it can be tricky to formalize informal knowledge into the concepts required by logical notation, especially when the knowledge is not entirely certain. Even issues with just a few numbers of facts can be fixed by the computational abilities of any computer except if it is given instructions on which reasoning processes to undertake first.

As respect to the acting humanly dimension, the definitions of AI proposed go along with the Turing Test. Presented by Alan Turing, it was made with the intention of offering an accurate operational definition of intelligence. A human interrogator was supposed to ask some written questions to a computer, and if he fails to recognize whether the responses were from a person or a machine, the computer would have passed or not passed the test. The computer must possess specific capabilities to pass the test:

- Natural language processing to communicate in English.
- Machine learning to comply with new situations and patterns.
- Knowledge representation to store the information.
- Automated reasoning to employ the stored information in order to answer questions and design new conclusions.
- Computer vision to recognize objects.
- Robotics to move and manipulate them.

These six characteristics represent specific disciplines of Artificial Intelligence, and Alan Turing deserves credit for creating a test that is still applicable today. However, AI researchers do not devote much effort towards passing the Turing Test because they believe it is more necessary to examine the fundamentals of intelligence than to replicate an exemplar.

The last acting rationally dimension comprehends the rational agent approach. Specifically, the term agent derives from the Latin *agere* which means to do; thus an agent is simply something that acts. Obviously, every computer program performs a particular task, but computer agents are supposed to do additional functions such as autonomous operation, environment perception, endurance over an extended length of time, change adaptation, and goal creation and pursuit. When acting, a rational agent seeks the optimal result or, in the case of uncertainty, the best expected result. The “laws of thought” approach puts emphasis on drawing the right conclusions. Being a rational agent sometimes entails drawing the right conclusions, since one method to act rationally is coming to a logical conclusion that a particular course of action will achieve one's goals and then take that course

of action. Nevertheless, right conclusions are not all of rationality, actually there may not always be a demonstrably right action to take, but something must still be done. Furthermore, some rational behavior cannot be claimed to include reasoning. An instinctive response, like recoiling from a burning stove, is typically more effective than a slower one that is followed by careful thought. All the abilities required for the Turing Test also permit an agent to act rationally. To thrive in a complicated society, we need to be able to construct understandable sentences in natural language. In addition to enhancing our erudition, studying also helps us develop more useful behavior. The rational agent approach is more advantageous than the other approaches in two ways. Firstly, it is more inclusive than the "laws of thought" approach because rationality can be attained by a variety of techniques, one of which is correct inference. Secondly, it adapts itself to scientific advancement easier than methods based on human behavior or intellect. The standard of rationality is mathematically clearly stated, and it can be unpacked to produce agent designs that undoubtedly accomplish it. On the other hand, human behavior is highly adapted to a particular context and is determined by everything humans do (Russel, Norving, 2010).

The first traces of AI date back to the 1940s when the English mathematician Alan Turing created a code breaking machine known as *The Bombe* for the British Government in order to crack the Enigma code employed by the German army during the Second World War. *The Bombe*, which was approximately seven by six by two feet in size and weighed about a ton, is regarded as the first operational electro-mechanical computer. Turing questioned the intelligence of such machines after seeing how well the machine cracked the Enigma code, an ability eluded even the most brilliant mathematician (Haenlein, Kaplan, 2019). In 1950, he published a seminal article called *Computing Machinery and Intelligence* in which he reported how to design intelligent machines and, specifically, how to test their intelligence. He stated that you should definitely consider a machine intelligent if it could convincingly pass for a human to an informed observer. As previously mentioned, he introduced the so-called Turing test whose goal is to provide a way for determining whether or not a machine can think. In the introduction to his study, he notes how confusing the topic "Can machines think?" is. He suggests something he calls the "Imitation Game" in an effort to give a more tangible form. Three physically separate components, two humans and a computer, are employed to play the game. One of the individuals acts as the test's questioner, and the other human, along with the computer, serve as the test's replies. The questioner asks the respondents questions about a particular topic in a given format and setting. The questioner is then asked to evaluate which respondent was a human and which was a computer after a predetermined amount of time or questions. The test is rerun many times. If the questioner executes the correct determination in 50% of the test runs or less, the computer is regarded to have Artificial Intelligence because the questioner considers it as "just as human" as the human respondent (Saygin, Cicekli, Akman, 2000).

At a conference held on the Dartmouth College campus, John McCarthy, known as the father of AI, gave his description of Artificial Intelligence, marking the start of the field's study. He belonged to a notable group of scientists who were the pioneers of AI in some form. Marvin Minsky, Nathaniel Rochester, and Claude Shannon were just a few of his peers who attended the legendary Dartmouth Conference in 1956. It relates to the Dartmouth Summer Research Project on Artificial Intelligence (DSRPAI), a summer workshop located in New Hampshire often regarded as a turning point for the development of AI as a scientific field (Moor, 2006). The goal of DSRPAI was to bring together scholars from diverse disciplines to establish a new field of study with the aim of creating machines able to simulate human intelligence. Among the participants there were Nathaniel Rochester who developed the IBM 701, the first commercial scientific computer, and Claude Shannon who devised the information theory (Haenlein, Kaplan, 2019).

In the same year of the Dartmouth College, two American scientists, Allen Newell and Herbert Simon, created a thinking machine called the Logic Theorist which was a computer program that could demonstrate theorems in symbolic logic from *Principia Mathematica* of Alfred North Whitehead and Bertrand Russell¹⁰. This was probably the first practical program to imitate some characteristics of how individuals approach complex problems. The late 1950s saw the development of the area of cognitive psychology, which was greatly influenced by The Logic Theorist and other cognitive simulations created by Newell and Simon. Many of the original concepts introduced in The Logic Theorist regarding mental modeling and problem-solving remain crucial for the theory of cognitive psychology and are still now applied to the modeling of the complex duties investigated in human factors psychology. Heuristics and list processing are two concepts that logic theorists developed, and which would become crucial to AI research. Heuristic methods are mental short cuts that enable speedy and effective problem solving and judgment, whereas IPL (Information Processing Language), a programming language created by Newell and Simon to implement Logic Theorist on a computer, was based on the same kind of symbolic list processing as McCarthy's Lisp (Gugerty, 2006). The General Problem Solver (GPS) was developed in response to Newell and Simon's initial success. This program, as opposed to Logic Theorist, was created from the beginning to imitate human problem-solving techniques. It came out that the program's consideration of subgoals and potential responses followed a similar pattern to how people approach the same challenges. As a result, GPS was perhaps the first program to adopt a "thinking humanly" methodology. The popularity of GPS as well as subsequent programs as models of cognition inspired Newell and Simon to develop the famous physical symbol system hypothesis in 1976, which claims that "*a physical symbol system has the necessary and sufficient means for general intelligent action.*" They intended to convey the idea that every intelligent system, whether human or machine, must function by manipulating symbol-based data structures (Russel, Norving, 2010).

¹⁰ *Principia Mathematica* can be considered the largest, most articulated, and complete summa of modern mathematical logic. They were published at Cambridge in a first edition in three volumes in 1910, 1912, and 1913, and in a second edition in 1925 and 1927.

John McCarthy is called the father of Artificial Intelligence not only for giving its first definition, but also for having developed Lisp (list processing) in 1958 at Massachusetts Institute of Technology (MIT), the standard programming language used in a wide range of web-based services, robotics, and other scientific applications. It is considered the first AI language. In the 1960s, McCarthy's pioneered another famous contribution, that is the concept of computer time-sharing, often known as utility computing. He proposed the idea of a super central computer to which many people may connect at once in an era in which the personal computer appeared like science fiction. It was one of the foundational elements for the creation of the Internet. At Stanford University, McCarthy established an AI lab where he worked on early prototypes of a self-driving car. He worked on techniques to help computer programs understand or imitate human common-sense decision-making, and he published papers on the subject of robot consciousness and free will. John McCarthy passed away on October 24, 2011, nevertheless his contributions to the field of Artificial Intelligence continue to have an impact and inspire researchers and developers worldwide (teneo.ai).

A big step was made between 1964 and 1966 when Joseph Weizenbaum created ELIZA, a computer program, specifically a natural language processing tool that could replicate a conversation with a human. It is one of the earliest algorithms that tries to pass the aforementioned Turing Test, and it is considered to be the first Chatterbot, topic that will be deepened in the next chapter.

Between late 1960s and early 1970s, the first critical issues on the AI development began to emerge. The first difficulty is represented by the absence of semantic knowledge associated to the domains managed by machines as their reasoning ability was limited to syntactic manipulation. Another issue was that many of the problems caused by Artificial Intelligence could not be solved. This was due to the misconception that hardware and memory alone could solve any issue. Limitations on the basis of the logical reasoning of the calculators were the third type of difficulty. Due to these challenges, methods with more in-depth understanding of the application sector were defined. The DENDRAL program was a significant example of this approach. It was refined in 1969 at Stanford where Bruce Buchanan (a philosopher become computer scientist), Ed Feigenbaum (a student of Herbert Simon), and Joshua Lederberg (a molecular biologist who won the Nobel Prize in Medicine) collaborate in order to find a solution to the dilemma of determining molecule structure using data from a mass spectrometer. The program's input consists of the molecule's basic formula and the mass spectrum, which specifies the masses of the numerous molecule fragments produced when it is hit by an electron beam.

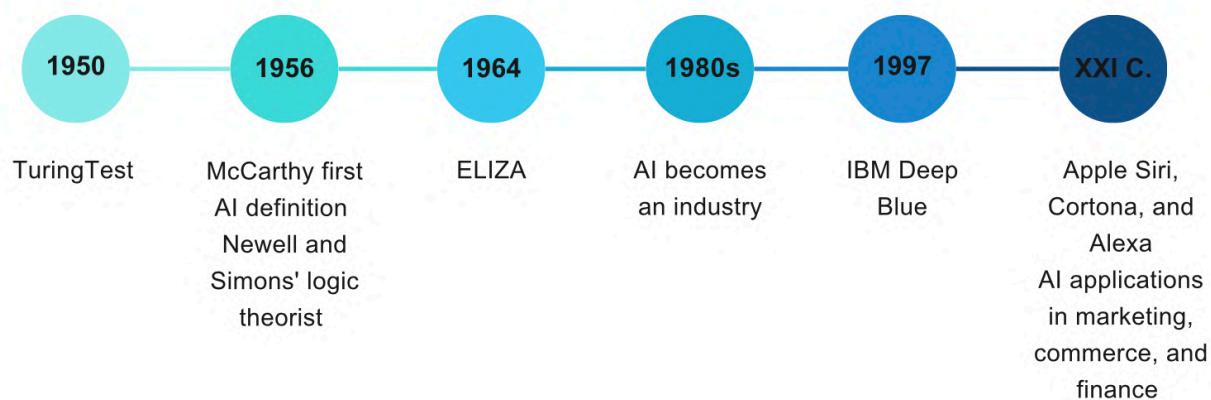
The 1980s were fundamental years thanks to the fact that the Artificial Intelligence field move from the academic environment to the industrial sector. The first successful AI commercial system was R1 which was employed by the Digital Equipment Corporation in 1982. The program assisted in configuring orders for new computer systems, and by 1986 it was reportedly saving the business \$40 million annually. The AI sector exploded from a few million dollars in 1980 to billions of dollars

in 1988, with hundreds of businesses producing robots, expert systems, vision systems, and software and hardware designed specifically for these applications (Russel, Norving, 2010).

The breakthrough of AI occurs in 1997 when the IBM (International Business Machines Corporation) developed the Deep Blue program which defeated the ruling world champion Garry Kasparov in a chess game. With its incredible processing power, this expert system was able to process 200 million different moves each second. Following this triumph, IBM's engineers set out to create a new AI system that could compete in more challenging tasks. Thus, in 2009 IBM designed Watson, a computer system which defeated all his rivals by providing the fastest answers in the American TV game show Jeopardy.

The first Artificial Intelligence-based voice assistants are developed in the first decade of the twenty-first century. These programs can communicate with humans by using voice commands. The first and the most famous Apple's Siri was released as an independent app in 2010 and integrated into iOS in 2011. Microsoft presented Cortana in the following years, while Amazon launched Alexa. Finally, 2016 was the year of honor for Google which released its smart speaker (Di Fraia, 2020). Moreover, process automation has expanded in several fields including marketing, commerce, and finance during the past twenty years. Augmented and Virtual Reality technologies were developed, as well as biometric authentication systems like fingerprint and facial recognition. Artificial Intelligence algorithms have been integrated into social networks in order to analyze the massive amounts of data produced and create new business models, track user comments, and comprehend their behavior and emotions (Pictet, 2023).

FUNDAMENTAL STAGES OF AI HISTORY



2.2 AI subgroups and components

Artificial Intelligence enables robots and computers to carry out tasks that would typically require a human's presence or skills. The description is therefore extremely general and embraces a variety of interpretations and advancements (Medium, 2020). As a result of a careful and deep research, we can say that the most significant components and subgroups that make up AI are illustrated in the graphic below (Figure. 1). In this research will be examined those most used in today's applications and those related to this study.

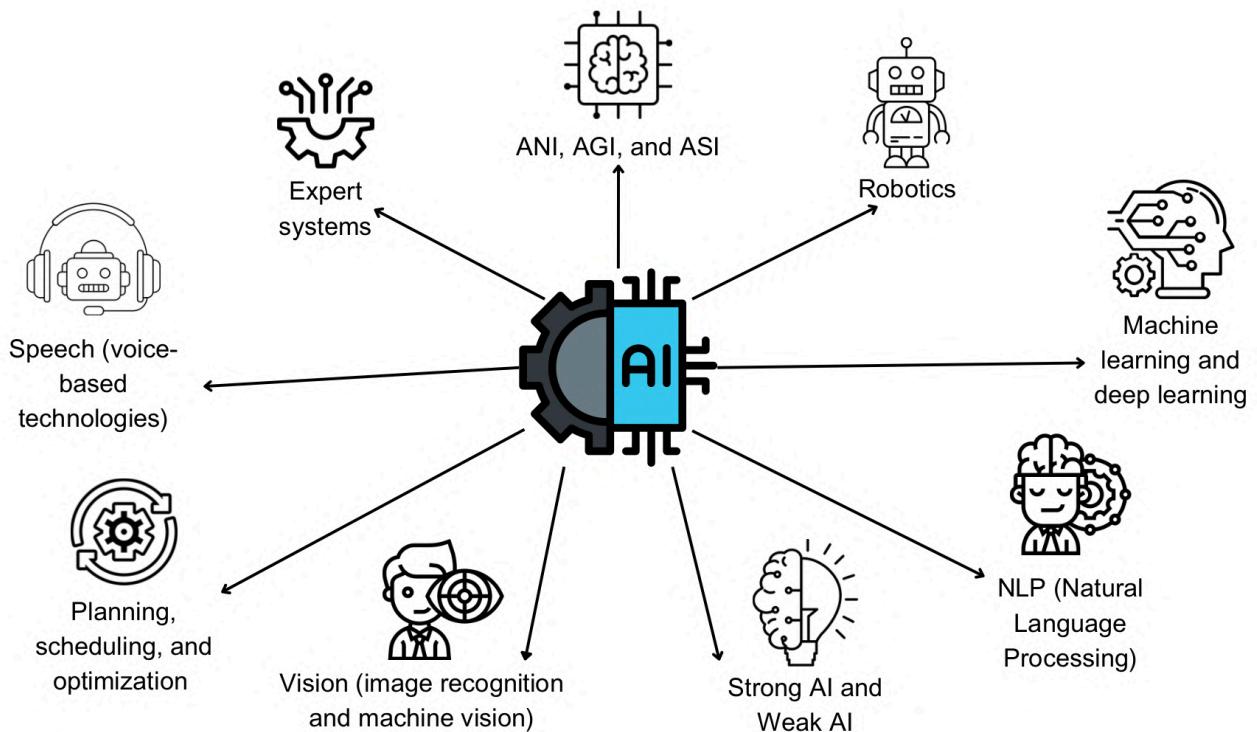
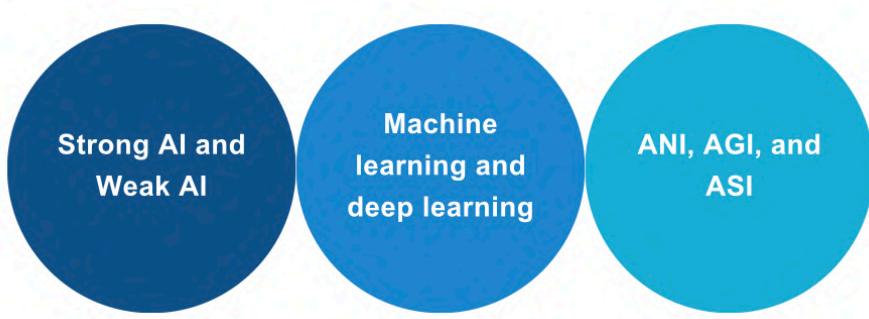


Figure. 1 – Components and subgroups of AI

Considering an extensive research, Artificial Intelligence types can be grouped into three categories:

- Strong AI and Weak AI.
- Machine learning and deep learning.
- Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI).



Strong AI and Weak AI

Work in Artificial Intelligence and Machine Consciousness (MC)¹¹ is often discussed using Searle's distinction between Strong AI and Weak AI. Since the early days of computer-related research, computational and functional theories of mind have dominated the field. According to this theory's proponents, the relationship between the brain and the body is quite similar to the relationship between the hardware and software of AI and MC. Consequently, in light of their causal relationships, mental states become functional or computational states, allowing the development of AI to serve as a tool for understanding the workings of the human mind. In opposition to this, John Rogers Searle, an American philosopher widely notable for his contributions to the philosophy of language and mind, makes important arguments against the possibility of AI. In raising this objection, Searle provides a thesis of Strong AI that is the generation of an "actual" mind, whereas Weak AI presents Artificial Intelligence as a tool for solving problems. On this distinction, in *Minds, brains and programs. Behavioral and Brain Sciences* (1980), he states that Weak AI asserts that the computer's main benefit to the study of the mind is that it provides us with a very effective instrument. For instance, it allows to develop and test hypotheses in a more methodical and exact way. But according to Strong AI, a computer is not only a tool for studying minds; rather, a computer that has been properly programmed is actually a mind, in the sense that it may be stated that it understands and has other cognitive states. The programs in Strong AI are not just tools for testing psychological explanations; rather, they are the explanations themselves because the programmed computer has cognitive states. According to Searle, Weak AI is an attempt to represent the human mind in a manner similar to the way weather, climate change, or other natural phenomena are modelled. Therefore, Weak AI is not trying to create or recreate a mind in the same way that a computer simulation of an ongoing storm is not trying to create an actual storm (Flowers). Self-driving automobiles, medical robot systems, and diagnosing physicians are just a few examples of Weak

¹¹ Machine Consciousness refers to attempts by those who design and analyze informational machines to apply their methods to various ways of understanding consciousness and to examine the possible role of consciousness in informational machines.

AI. These are all Weak AI systems because self-driving cars have the same potential for fatal collisions that people do; it is possible for medications to be distributed to people in the wrong order, and if the AI is flawed, medical diagnosis could potentially have negative effects (Szocik, Jurkowska-Gomulka, 2021). Facebook and other social media networks have figured out how to utilize machine learning and Weak AI to determine how users will respond to being shown particular images. Based on the content that users publish, Weak AI algorithms have been able to detect patterns or trends that users will identify with. Strong AI, on the other hand, intends to produce an intellect that can really possess and comprehend other mental states, or a mind. Therefore, it might be stated that this machine has a mind, though one that is composed of hardware-based software as opposed to one that develops naturally from biological processes.

However, it is crucial to note that Searle bases the distinction between Weak and Strong AI on what is now known as phenomenal consciousness as opposed to functional consciousness. Broadly speaking, phenomenal consciousness relates to how we perceive the world in present time. Contrarily, functional consciousness describes the methods through which consciousness assists us in dealing with novel or challenging situations for which we have no automatized response. Some applications of Strong AI can be seen in cyber security, robots with high intellect, integrations with IoT (Internet of Things), language translation machines, and image recognition systems. Consequently, the difference between Strong AI and Weak AI may be understood as the difference between a tool that can be used in a situation or that explains the nature of human cognition and the existence of a phenomenally aware cognition that has its own mental states and subjective experiences and is aware of them. Weak AI can be thought as only existing in the world of functional consciousness, whereas Strong AI exists in the world of phenomenal consciousness and is therefore said to have a mind (Flowers).

Machine learning and deep learning

Weak AI and Strong AI form the basis for the definition of machine learning and deep learning. The most recent development of machine learning, in all of its varied manifestations, has marked the true paradigm change in AI, making this technology far more effective and practical. Since its beginnings in the 1940s, the way of making “smart” machines was to write an infinite number of lines of instructions (code) compiled in accordance with the input-output logic so that machines could behave as desired. Despite the fact that the tasks carried out would seem to be identical to those done by people, they were actually the product of rigidly programmed sequences of actions, and machines do not have the ability to improve learning from experience as human being. This programming paradigm, which has defined traditional Artificial Intelligence, has mostly not changed since the 1980s and the 1990s, as shown in Figure. 2. In that period, the development of machine learning

and the subsequent ability to teach machines to learn from experience constitute the paradigm shift. Deep learning became a topic of discussion starting from 2010 (Di Fraia, 2020).

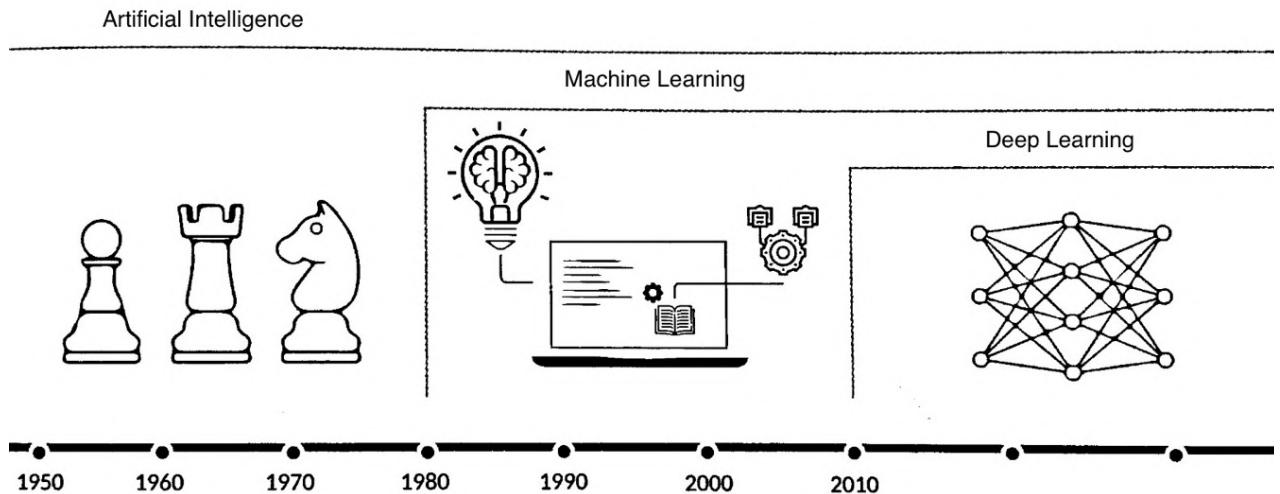


Figure. 2 – The development of machine learning

Machine learning (ML) is the branch of Artificial Intelligence that focuses on how computer agents can enhance their perception, knowledge, thinking, or actions based on knowledge gained through experience or data. Computer science, psychology, statistics, economics, neuroscience, and control theory are all used by ML for this purpose. Generally speaking, in ML, a set of tasks and performance metrics can be used to determine how well a computer program performs over time. In order to execute cognitive tasks like object detection or natural language translation, it seeks to automate the process of constructing analytical models. This is accomplished by utilizing algorithms that constantly learn from problem-specific training data, enabling computers to discover complicated patterns and hidden insights without explicit programming (Janiesch, Zschech, Heinrich, 2021). As a result, the current generation of Artificial Intelligence systems can "self-program", learning on their prior knowledge of a particular phenomenon, such as, for instance, images of cats. But when referring to a computer, the phrase "based on experience" runs the risk of being misinterpreted. Unless humans give machines the experiences they require, they are unable to experience for themselves. In other words, machines need to be trained to gradually "learn" how to process input data in the right manner, producing output that is consistent with the purposes for which they were instructed, and accurate. In broad synthesis, machines can learn using the following techniques:

- Supervised learning
- Unsupervised learning
- Learning by reinforcement

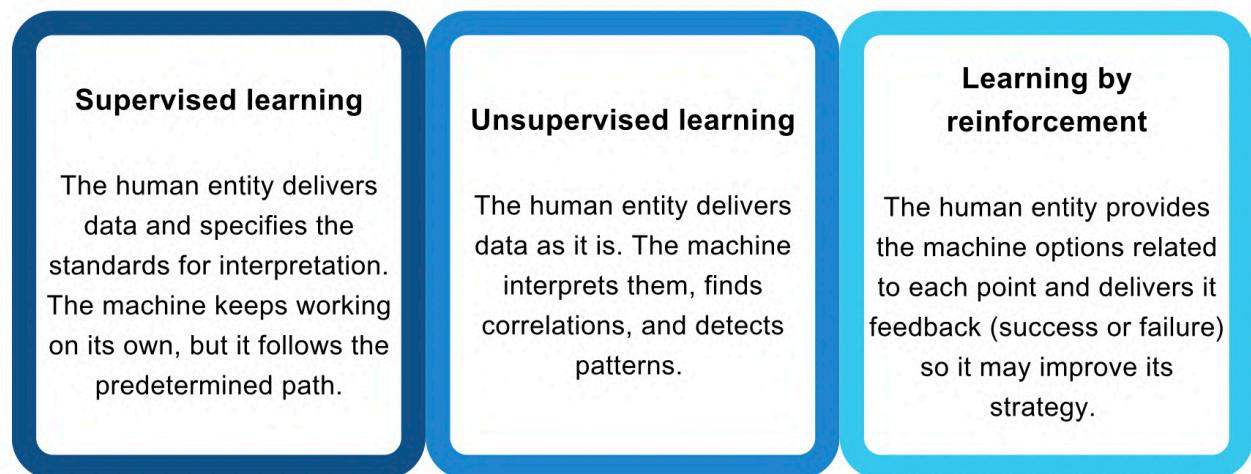


Figure. 3 – Synthesis of the three main methods of machine learning

In supervised learning, a human entity provides the computer all the data it needs to understand both the issue and the solution. If we feed the computer, for instance, tens of thousands of photographs of cats and label them with the characteristic "cat," the computer gradually learns to identify cats from the innumerable other aspects of the world that could exist. The ability to identify a configuration of points (pixels) as cats, regardless of the color of their hair, size, manner, and perspective from which they are photographed, as well as the ability to establish with high accuracy that it is a cat despite never having seen the image of that particular cat before, can be demonstrated by having received as training input images of all animals that might look like cats but are not cats. Whereas, in unsupervised learning, humans merely give the machine with data (without labeling it or indicating the desired or proper outcome) and allow the computer autonomously identify case groupings or significant patterns. In other words, in supervised learning, the computer does not receive a knowledge base from which to derive, considering that some characteristics in the input data (the tens of thousands of tagged images of cats provided as an example) is associated with a certain output (the recognition and automatic labeling of new images of cats). The system must "arrange" to find the best logic of data classification. This method is used to categorize unstructured data but also performs particularly well with numerical data, which may be processed using sophisticated statistical approaches. Continuing with the example previously stated, let us consider inserting thousands of photographs of cats into the computer without identifying them as cats, continuing with the scenario from a minute ago. During analysis, the algorithm develops a number of criteria and uses them to categorize images (long-haired cats, short-haired cats, cats lying on the couch, etc.). We can see the disruptive potential of this strategy from this very trivial example: the outcome is not predetermined since the algorithm analyzes the data and finds linkages, patterns, and correlations that a person, working alone, would not be able to see. Finally, the learning by reinforcement approach is used when it is impossible or difficult to define optimal results, when feedback is delayed or incomplete, and when it is necessary to test various action plans by evaluating

how well they perform in relation to the goal. In this scenario, the algorithm is required to make decisions on each piece of data, and for each decision it receives immediate feedback (banally "success" or "fail") that allows it to adjust its approach. This method is mostly employed in robotics, where the readings of each sensor at a particular moment serve as a data point from which the algorithm must determine the robot's next course of action. Applications for the IoT (Internet of Things) are also appropriate for this strategy.

Figure. 4 shows some examples of machine learning methods applications (Edwards, 2016; Di Fraia, 2020). Some clarifications about the examples of machine learning methods are explained below. For what concerns the supervised learning, regression is defined as a method for analyzing data that includes dependent and independent variables, such as time, market trends, life expectancy, and population increase. It is used to model dependence connections, test hypotheses, and/or create predictions. This is why there is a significant overlap between its use and machine learning. Whereas with respect of unsupervised learning, techniques for reducing the number of input variables in a dataset are referred to as dimensionality reduction. It should be also specified that the term "dimensionality" refers to a dataset's number of features or input variables. The curse of dimensionality describes how adding more input features frequently makes a predictive modeling task more difficult to model. Data visualization frequently makes use of dimensionality reduction techniques and high-dimensional statistics. Nevertheless, similar methods can be applied to classification or regression datasets in applied machine learning to make them easier to incorporate into predictive models (Brownlee, 2020). In clustering, that is the process of grouping comparable objects in a machine learning algorithm, a recommender system is an AI algorithm that makes suggestions or recommends more products to customers using big data. These may be determined using a variety of parameters, such as previous purchases, search history, demographic data, and other elements. Recommender systems are very helpful in order to help people find products and services they might not have found on their own (Nvidia).

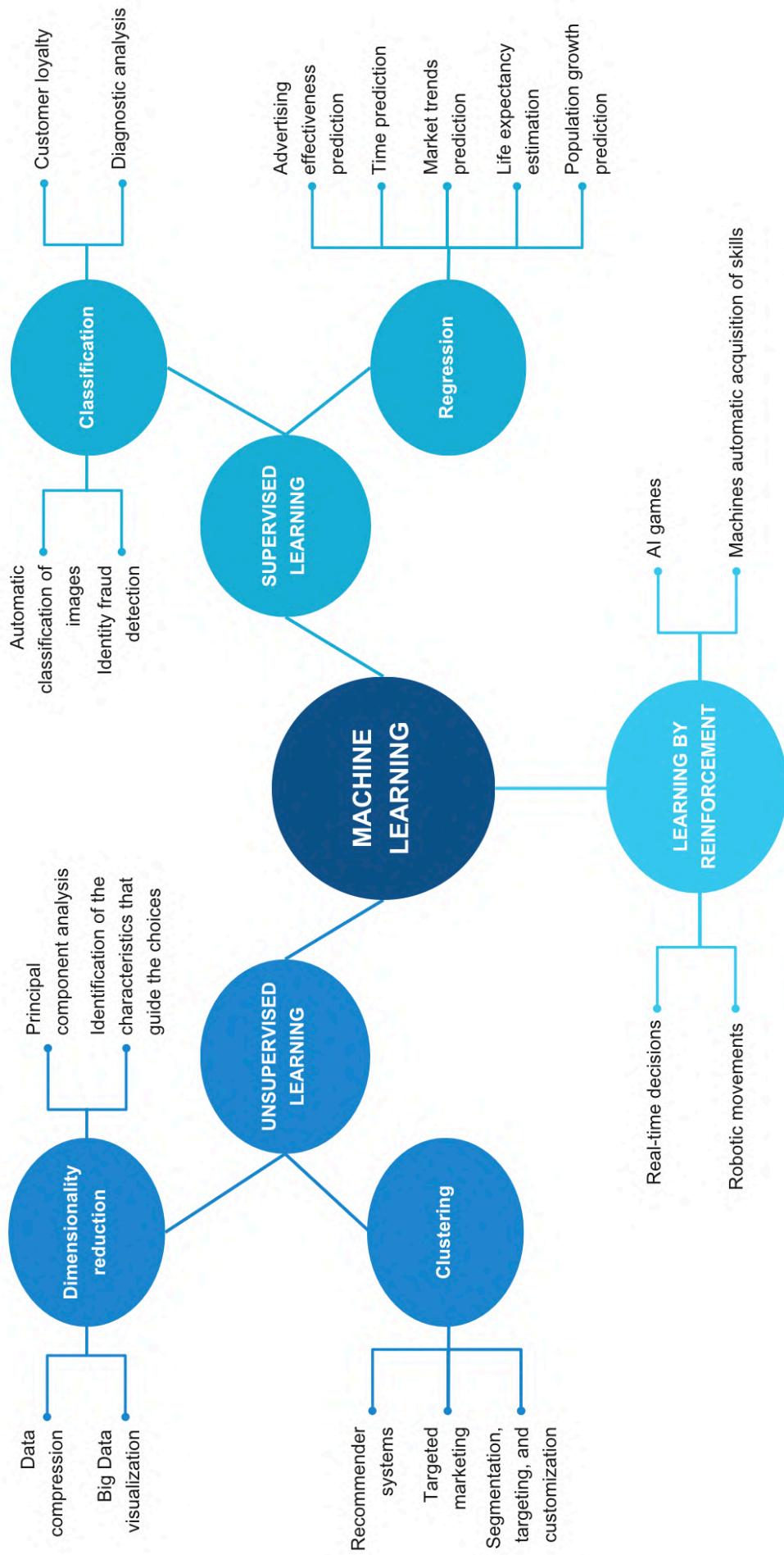


Figure. 4 – Examples of machine learning methods

Deep learning is a development of machine learning. Even in this case, machines learn from experience in order to comprehend reality more specifically. Deep learning is associated with neural networks that are complex models with three or more layers which attempt to simulate the behavior of human brain. Each layer is composed by a set of basic elements called neurons, and such neurons of different layers are connected. A neural network with only one layer can still create approximate predictions, however more hidden layers can help to improve and optimize for accuracy. Many AI apps and services are powered by deep learning, which enhances automation by carrying out mental and physical tasks without the need for human intervention. Both everyday products and services (including digital assistants, voice-controlled TV remotes, and credit card fraud detection) as well as cutting-edge innovations (like self-driving cars) are powered by deep learning technology. How deep learning works? Neural networks use a combination of data inputs, weights, and bias to simulate the human brain. Together, these components accurately identify, categorize, and characterize items in the data. Deep neural networks are made up of many layers of interconnected nodes, each of which builds on the one before it to improve and refine the prediction or classification. Forward propagation is the term used to describe how computations move forward through the network. A deep neural network's visible layers are its input and output layers. The deep learning model ingests the data for processing in the input layer, and the final prediction or classification is performed in the output layer. The prediction error is computed after forward propagation. Backpropagation uses gradient descent during the training process to connect the weights and biases to reduce errors. This happens only during training, and it is repeated many times. A neural network can make predictions and make necessary corrections for any faults thanks to forward propagation and backpropagation working together. In the simplest terms possible, the aforementioned summarizes the simplest kind of deep neural network. To solve certain issues or datasets, there are various forms of neural networks, however deep learning techniques are highly complex.

Deep learning differs from traditional machine learning because they use different types of data and employ distinct learning strategies (Figure. 5). In particular, to produce predictions, machine learning algorithms use structured, and labeled data. This does not necessarily imply that it does not employ unstructured data; rather, it just indicates that if it does, it typically goes through some pre-processing to put it in a structured manner. Some of the data pre-processing required for machine learning in general is eliminated by deep learning. These algorithms are able to ingest and interpret unstructured data, such as text and images, and automate feature extraction, reducing the need on human experts in the field. Let us imagine, for instance, that we wanted to categorize a collection of pictures of various pets by "dog", "cat", "hamster", etc. Deep learning algorithms may identify which characteristics (e.g. ears) are most crucial for differentiating one species from another. This hierarchy of features is created manually by a human specialist in machine learning (IBM).

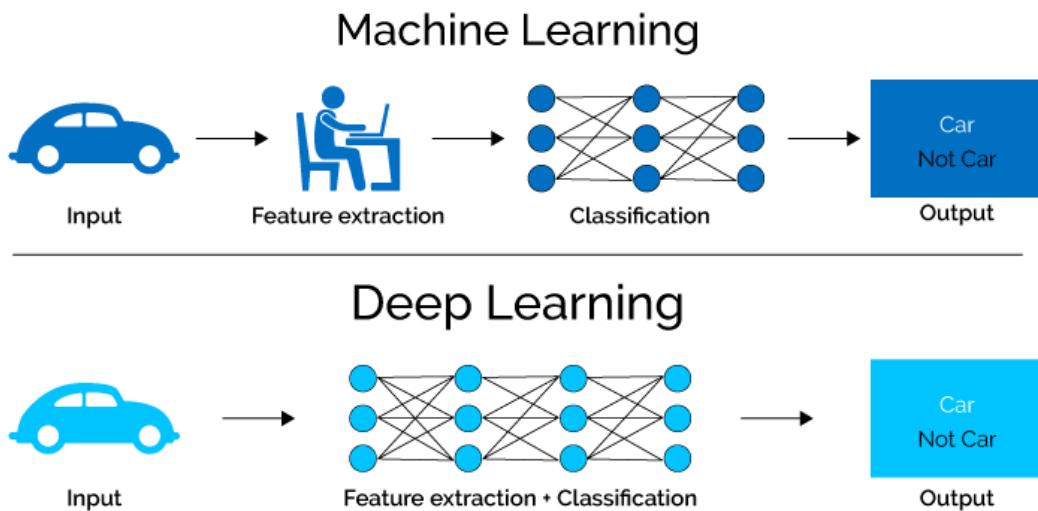


Figure. 5 – Difference between machine learning and deep learning

Another interesting and crucial research field within AI is the Natural Language Processing (NLP). This area of study, which combines computer science, linguistics, and Artificial Intelligence, offers approaches for analyzing the syntactic structure of the text by assigning each word a specific morphological category (noun, verb, adverb, etc.), syntactic function (subject, predicate, complements), and set of semantic links (e.g. meronymy and holonymy, hyponymy and hypernymy). It also understands the semantics of the text which entails connecting each word to its lexical definition as well as connecting it to the context, tone, and range of relevance (Esposito, 2019). The functioning of the NLP is therefore closely linked to the neural networks that have the task of investigating the text by dividing it into layers of increasing complexity. Thanks to deep learning techniques, modern computers are able to:

- read human written and spoken words in a very reliable manner,
- provide accurate responses (in natural language),
- translate texts between several languages as well as from written to oral language and vice versa,
- rely on user's input to carry out complex operations, such playing a video, turning on an appliance, or outlining a driving itinerary step by step.

In some situations, their dependability is greater than that of humans. We only need to use the most popular virtual assistants, like Alexa from Amazon and Siri from Apple, to see evidence of these astounding results. Actually, these machines operate through predictive logic based on statistics rather than working on a semantic basis (like our brain) and therefore do not interpret human language. In order to estimate the probability that the terms in the input can be classified one way rather than another, they compare the set of terms to be understood, such as the words in the soundtracks of a phone call coming at the call center, with a data set of terms and concepts already

classified. This reveals, for instance, whether a user's phone-spoken phrase requests the termination of a contract rather than assistance with activating a specific service (Di Fraia, 2020).

ANI, AGI, and ASI

The three various stages of technological advancement on which Artificial Intelligence is founded are another way to distinguish it. Depending on its evolutionary stage, AI can be classified as Artificial Narrow Intelligence (ANI), Artificial General Intelligence, (AGI), and Artificial Super Intelligence (ASI).

- Artificial Narrow Intelligence (ANI) is employed in applications that display intelligence in a specialized field and thus can carry out exact tasks, such as playing chess, diagnosing illnesses, operating motor vehicles, or performing algebraic calculus. As a result of being developed to complete a specific task and having a limited set of skills, ANI is categorized as Weak AI. In contemporary society and in daily activities, ANI systems are becoming more and more applicable. Email filtering programs, music-related recommendation services like Spotify, and voice assistants like Apple's Siri are only few examples. A system with this level of Artificial Intelligence mimics human intellect while enhancing human performance in terms of efficiency and production. One of the most pertinent uses of Artificial Narrow Intelligence is in the medical industry, where a number of advancements have been made that have sped up and improved patient care. However, it is important to stress that ANI cannot be compared to human intelligence because they lack semantic understanding and self-awareness (Semoli, 2019).
- Artificial General Intelligence (AGI) refers to systems with an acceptable degree of self-awareness and self-control. They are systems capable of solving a wide range of complex problems across various disciplines and can pick up new skills without having to be reprogrammed. This kind of AI varies from ANI since it possesses cognitive capacities similar to human ones, and for this reason it has been classified over time as Strong AI (You Evolve). Theoretically, it should be able to think and behave like a human mind, making sense of various content, comprehending problems, and choosing the best course of action in a complicated circumstance. The crucial thing is that they may react to a human stimulus, and also behave independently without being directly commanded by a human operator. This is the reason why AGI has not yet been accomplished. Technically speaking, we are not able to create something that complicated, and we are also not quite certain of how the human brain functions. The companies working on the creation of AGI technology include IBM, OpenAI, Microsoft, Google, Darktrace, and Deepmind. Google Brain and IBM Strong AI are

the two products that come closest to a practical smart prototype (Caffaratti, 2023). There are conflicting opinions in this field, so much that in March 2023, the *Future of Life Institute* published an open letter from Elon Musk and a thousand other Silicon Valley leaders calling for the suspension for six months of the development of advanced Artificial Intelligence systems. It is reported that AI systems equipped with an intelligence comparable to the human one can entail profound risks for society and humanity: powerful AI systems should only be developed when we have the certainty that their effects will be positive and their risks manageable (Il Sole 24 Ore).

- Vernor Vinge in *The Coming Technological Singularity: How to Survive in the Post-Human Era* (1993) states: “*Within 30 years, we will have the technological means to create superhuman intelligence. Shortly after, the human era will be ended.*” Exactly 30 years have passed since the publication of the essay and, fortunately, Vinge was not right. Artificial Super Intelligence (ASI) is currently extremely far away, and we are not even close to this stage of development. ASI is a kind of AI that is able not only to mimic people's experiences, but also to express desires, feelings, needs, and beliefs. It has acquired such sophisticated computation and information processing abilities that it outperforms humans on all fronts. Additionally, it has quick access to all of the online knowledge that has been created by humankind since the dawn of time. According to Raymond Kurzweil, who made the topic of technological singularity¹² famous, a self-conscious AI that is "*a billion times more powerful than the set of all human brains*" might start to be produced as early as 2045 (Di Fraia, 2020). On the contrary, experts in AI continue to have doubts regarding ASI's long-term viability and progress. Researchers from prestigious institutions like the Max Planck Institute came to the conclusion that it would be very impossible for humans to contain ASI. Super AI has a very promising future ahead of it, despite the uncertainty and worry surrounding its unpredictable nature and the potentially disastrous effects that a malevolent superintelligence could have on humanity. Superintelligence's true nature and whether or not it would be beneficial to humanity will be made clear in the coming decades (Kanade, 2022).

¹² The technological singularity is a hypothetical future point in time at which technological growth becomes uncontrollable and irreversible, resulting in unforeseeable changes to human civilization.

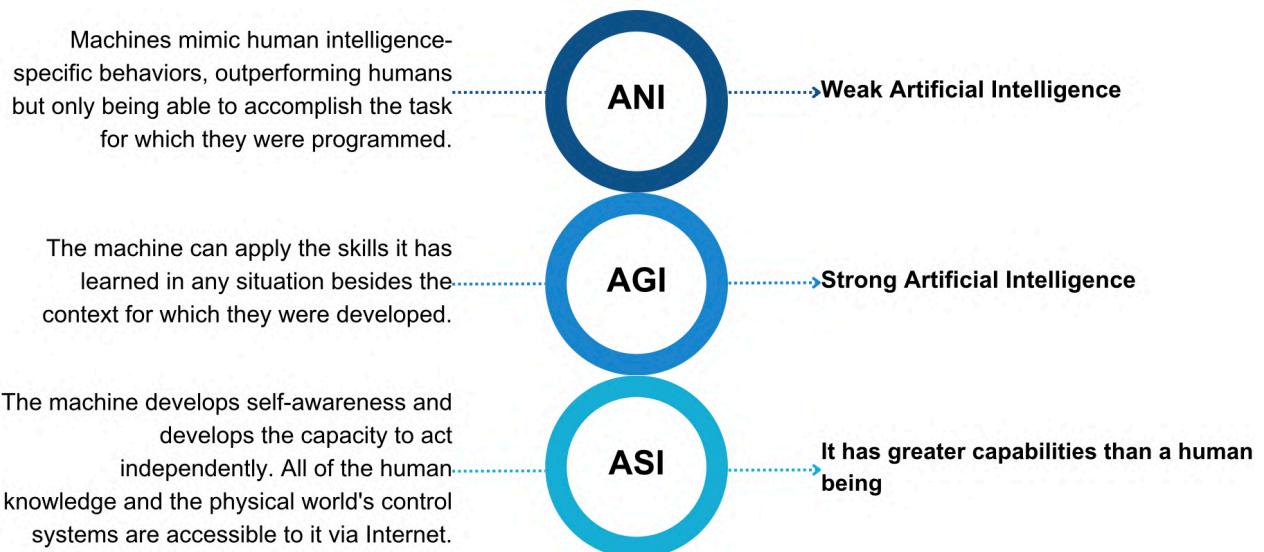


Figure. 6 – Synthesis of Ani, AGI, and ASI features

2.3 Limitations and obstacles of AI

All the aspects analyzed so far are related to the advantages and benefits that AI innovations can bring to humans and society in general. Most of the time, innovation is associated with the idea of positive change and represents rebirth, opportunity, productivity, and prosperity. But as Steve Jobs stated, mistakes are frequently committed in the context of innovation. As all innovations, AI and its use in various sectors also involves many doubts, questions and grey areas. Since revolutions frequently come as a surprise, better knowledge and training are required to comprehend them and handle them effectively. The revolution in question also entails a number of changes, particularly one that transforms society and the economy. Several experts, including MIT professor Daron Acemoglu, believe that the effects of an unchecked development of AI could be extremely dangerous: *"I argue if AI continues to be deployed along its current trajectory and remains unregulated, it may produce various social, economic and political harms. These include: damaging competition, consumer privacy and consumer choice; excessively automating work, fueling inequality, inefficiently pushing down wages, and failing to improve worker productivity; and damaging political discourse, democracy's most fundamental lifeblood. Although there is no conclusive evidence suggesting that these costs are imminent or substantial, it may be useful to understand them before they are fully realized and become harder or even impossible to reverse, precisely because of AI's promising and wide-reaching potential. I also suggest that these costs are not inherent to the nature of AI technologies but are related to how they are being used and developed at the moment."* (Acemoglu, 2021).

Disadvantages and limitations observed in the use of Artificial Intelligence regard primarily the fact that the equipment to develop the machines is extremely expensive, indeed it can cost millions of dollars and tons of time to create it, rebuild it, and repair it. Robots could result in significant unemployment if they replace occupations, unless humans can fill the gap with tasks AI cannot perform. Robots are increasingly replacing most of the repetitive tasks and jobs from humans, and this may result in a serious issue within utilization standard. Every company aims to replace the minimum of skilled workers with AI robots that can perform the same tasks more effectively. Additionally, with its applications automating the majority of the job, AI is making humans lazy. People in general have a tendency to become overly dependent on these advancements, which could harm future generations. As previously pointed out, since AGI and ASI prototypes have not yet been developed, machines can only carry out the tasks for which they were created or programmed; otherwise, they tend to malfunction or produce useless results, which could have serious backdrops (Bhbosale, Pujari, Multani, 2020).

According to Acemoglu, the “dark side” of AI can be grouped on three areas in which the use of AI technologies may have economic and social costs:

- 1) Labor market effects of AI: an excessive number of investments is being spent on lowering labor costs and wages with AI. Such efforts might be excessive if they result in non-market outcomes (e.g. workers losing their employment or being compelled to accept lower-paying labor), or if they degrade manufacturing efficiency in attempting to save costs. The broad technological platform of Artificial Intelligence could have reversed this tendency, for instance, by encouraging the development of new labor-intensive activities or by giving employees the means to have greater initiative. However, this does not seem to happen. In particular, these circumstances occur in the following fields:
 - a) Automation is an excellent way to save labor expenses, but it may also be abused since businesses fail to consider how it will affect employees negatively.
 - b) Loss of economies of scope in human judgment: as people turn more and more judgments over to computers, especially where there are economies of scope across activities, this may cause humans to make decisions with less accuracy over time.
 - c) Monitoring: employers' surveillance capabilities are improved by AI, yet this may also result in substantial social inefficiencies. Monitoring is not socially beneficial since it is a way of shifting rents away from workers towards employers.
- 2) Collection and control of information: numerous potentially serious downsides arise from the interaction between the data demands of AI technologies and the capacity of AI approaches to process enormous volumes of data on users, consumers, and citizens. These consists of:

- a) Privacy violation: businesses and platforms may gather and use excessive amounts of data on people, leading them to catch more of the consumer surplus by price discrimination or infringe their privacy when processing and exploiting their data.
 - b) Unfair competition: businesses with more data may have significant advantages over competitors, allowing them to gather more surplus from customers and reducing pricing competition in the market, both of which could have negative consequences.
 - c) Behavioral manipulation: using data and sophisticated machine learning techniques, businesses may be capable to detect and take advantage of vulnerabilities that customers themselves are unaware of, lowering their utility and changing the nature of the market's products.
- 3) AI, communication, and democracy: AI has exacerbated a number of political and societal issues relating to communication, persuasion, and democratic politics. The key issue in this scenario is that democratic politics may have become more challenging or even profoundly flawed under the influence of AI:
- a) Social media eco chambers: social media platforms powered by AI create echo chambers that spread incorrect information and polarize society.
 - b) Online communication problems: social media (which are intertwined with AI) produces additional disorders related to private communication.
 - c) Big brother effect: AI improves the governments' ability to closely monitor and stamp out disagreements. All of these implications of AI are damaging, but the deterioration of democratic debate may be their most significant side effect.
 - d) Automation and democracy: automation process could exacerbate democracy by reducing the influence and the indispensability of workers in workplaces (Acemoglu, 2021).

2.4 AI applications: the integration in museums' practices

AI applications were at the core of the most commercially successful computing fields in the 2010s, and they have now spread to every aspect of daily life. AI is employed in autonomous vehicles including self-driving cars and drones, virtual assistants such as Siri or Alexa, targeting online advertisements, search engines like Google Search, automatic language translations including Microsoft Translator and Google Translate, image labeling used by Apple's iPhoto and Tick Tock, facial recognition such as Apple's Face ID, driving internet traffic, spam filtering, recommendation systems offered by Netflix, YouTube, and Amazon, and chatbots like ChatGPT. Specifically, AI has

a very big role in robotics, transportation, education, health, public safety and security, communication, and entertainment. When we talk about Artificial Intelligence, the first thing that comes to mind are surely robots. General robots are designed to perform repetitive activities, but with the help of AI, scientists can develop intelligent robots that can carry out tasks based on their own experiences rather than being pre-programmed. The best applications of AI in robotics are humanoid robots: Ameca, developed by Engineered Arts, is the most sophisticated human-shaped robot in the world and represents the most advanced form of human-robotics technology, it can talk and behave like humans. Thanks to technological innovations, AI in cars offers a better driving experience by making cars safer and more comfortable. Some examples range from the GPS to sensors which assist the driver with steering, parking, pedestrian detection, and monitor blind spots. In the subject of education, both teachers and students use AI applications such as Ozobot which creates ergonomic coding robots with countless opportunities for creation, learning, and sharing, and Cubelets that is a robot building blocks useful for teaching critical thinking abilities. AI in cybersecurity examines system usage trends to identify possibly malicious behavior or threat actors and foresee cyberattacks. The CCTVs¹³ are installed almost everywhere in the globe nowadays, and these systems are typically more effective for preventing and solving crimes. Social media platforms like Facebook, Instagram, Twitter, and TickTock have billions of user profiles, all of which must be managed and kept in an extremely effective manner. Massive amounts of knowledge may be organized and managed by AI, and it can also evaluate a wide range of data to identify the most recent trends, hashtags, and customer needs (Bhbosale, Pujari, Multani, 2020).

Guaranteeing that priceless cultural resources are accessible so that future generations can appreciate and be inspired by them is a crucial goal of every cultural institution. Unfortunately, it is simple and easy to ruin or permanently damage cultural assets. Threats caused by nature and/or people include vandalism, flooding, wind erosion, pollution, and inadequate maintenance. In order to safeguard, conserve, restore, investigate, disseminate, and promote both tangible and intangible cultural assets, it is crucial that cultural heritage can be digitally preserved. In this regard, cultural heritage and Artificial Intelligence research routes have increasingly discovered common interests, resulting in a successful fusion of these two fields. The development of creative tools for maintaining, documenting, and exploring cultural heritage has been made possible by new uses of AI. They make it feasible to address cultural heritage management, employing cutting-edge techniques with a greater grasp of the demands of operators operating in this sector (Bordoni, Mele, Sorgente, 2016).

Finding substitutes for conventional cultural tourism has been evident since the beginning of the COVID-19 pandemic. It was clear that this global event would be a turning point for everything that had come before and all that would follow, including the visitor's experience. This is illustrated by

¹³ CCTV means Closed-Circuit Television and it is commonly known as video surveillance technology. Closed-circuit means broadcasts are limited to a selected group of monitors, unlike the regular TV, which can be received and viewed by whoever sets up a reception device.

statistics collected by ICOM Italia from a survey of Italian museums' usage of digital communication. ICOM attests that during the pandemic in March 2020, nearly 90% of Italian museums started to provide ad hoc digital content after closing to the public. The growth of virtual museums and digital platforms has given the so-called digital tourism an important push. These tools allow the public to view artworks on the smartphone, visit museums online on the pc, and even take virtual museum tours from the comfort of the couch (Pigro). With the use of AI technologies, museums may experiment with their collection data, learn more about their visitors, and ultimately influence how visitors perceive a museum. More of the lives of museum visitors are being discreetly affected by AI-driven technology every day. AI has the ability to improve museum operations by influencing how quickly and efficiently museums respond to these changing visitor demands and expectations. Accessing the collection for study, education, or inspiration and planning a future visit are two of the main reasons visitors come to a museum's website (French, Villaespesa, 2018). In general, six trends in the use of Artificial Intelligence can be analyzed in the museum context.

1. Move around the museum using Virtual and/or Augmented Reality: 360-degree virtual tours enable to navigate between the artworks as visitors would in real life while listening to the audio guide's explanation. The Dalí Theatre Museum was one of the first organizations to decide to invest in Virtual Reality (Figure. 7). With Matterport platform, visitors can move freely around the virtual museum while enjoying insights and curiosities about the artworks.

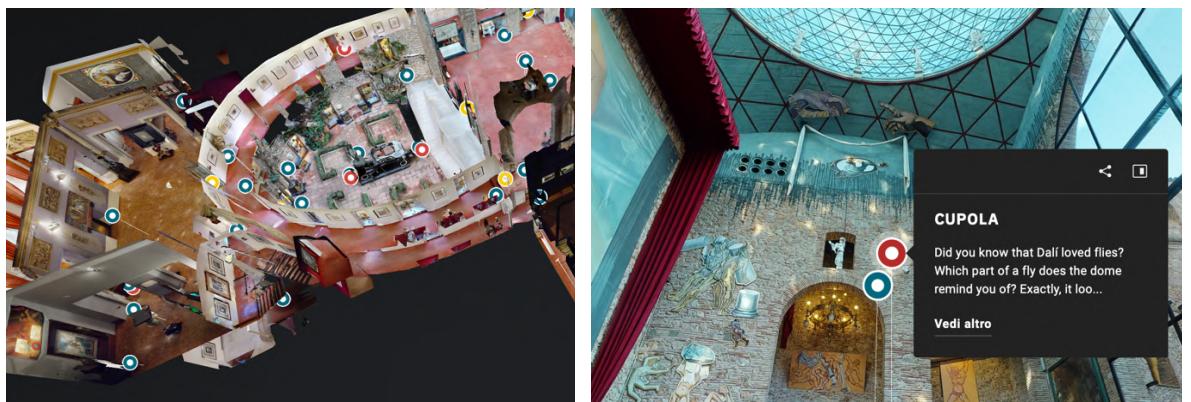


Figure. 7 – Virtual tour of the Dalí Theatre Museum (Matterport platform)

2. Machine learning and neural networks to help researchers: paintings in the collections of the Norwegian National Museum have meta-data that can be quite functional for those who study them. The T-SNE algorithm classifies images based on similarity in technique, composition, and color use, dividing the works into five categories for the museum's website: paintings by style, paintings by motif, drawings, prints, and designs.

3. AI to organize collections and catalogues: it is incredibly easy for an AI algorithm to identify repeating visual or chromatic aspects, link them to a movement or artistic expression, and provide more logical collections and catalogs.
4. AI to give artworks voice: the self-learning AI system IBM Watson was used by the Pinacoteca di San Paolo in Brazil to do this. It provides the chance to ask any questions, even the most trivial ones, and it was created with the intention of bringing those who are not accustomed to visiting museums closer to art. As a result, the project *A Voz da Arte* was created, which employs speech recognition technology and AI to literally give some works of art voice.
5. AI to evaluate customer satisfaction: since 2021, the Bologna museums have an AI system that enables visitors to estimate the level of popularity of a piece of art. This technology, named ShareArt, was created by the National Agency for New Technologies, Energy and Economic Development (ENEA). It is able to recognize through camera photos of visitors looking in the direction of the artworks on which it is installed. The technology can analyze information like the amount of people who have watched the artwork, the path adopted to reach it, the duration and distance of observation, age class, gender, and mood of the visitors they observe by storing data on potential expressions, behaviors, and the surrounding environment (Pigro).

French and Villaespesa (2018) in *AI, Visitor Experience, and Museum Operations: A Closer Look at the Possible* report the most used AI technologies in museums that include predictive analytics for visitor attendance, chatbots for visitor engagements, sentiment analysis for visitor comments, and many others.



Figure. 8 – Timeline of AI initiatives in museums

Visitor research and evaluation, and collection information management are the two main fields of data analysis in the museum sector. AI can improve data collecting by using techniques to clean it up, find new information, establish connections between data sets, or automatically generate

classifications and tags. In the field of visitor research, museums have access to visitor information from a variety of sources, including Wi-Fi connections, membership subscriptions, website analytics, and ticket transactions. The experience of museum visitors can be improved by using AI approaches to explore, analyze, and make conclusions from this data. As represented in Figure. 8, the use of computer vision for museum collections is one of the most promising technologies (French, Villaespesa, 2018). The capacity for a computer to comprehend what it sees is known as machine vision. Machines can quickly generate specific components from the digital object records that would take humans quite a while to produce. Data visualizations of all object dimensions or the recognition of faces or landmarks can be produced by applying an algorithm to collected data. Among the first to test this strategy and publish their results are museums such as Harvard Art Museums, Minneapolis Art Museums, and Norwegian National Museum. Machine vision has a strong impact on sentiment analysis: it can be used to identify the emotional state of persons depicted in an image by examining the facial features if there are clear human faces present. Emotion API and Microsoft Project Oxford are two examples of facial recognition application on art portraits (Figure. 9).

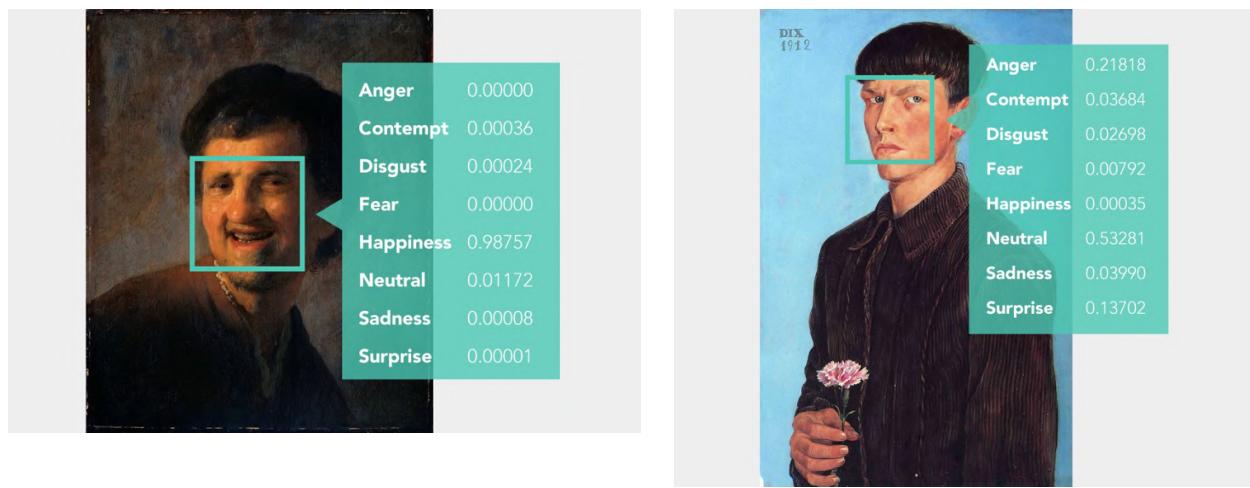


Figure. 9 – Rembrandt (circle of), “*Bust of a Laughing Young Man*” (1629) on the left, and Otto Dix, “*Self-Portrait*” (1912) on the right

Machine vision can also be employed in museums to examine color composition and recognize similarity and patterns of paintings. A computer vision tool may extract and generate information about a color cluster, partition, and histogram data from an object's image. This procedure has been put in place to broaden a new method of discovery by Google Arts & Culture (Figure. 10). Additionally, a computer can detect connections and assess similarities and differences between works in museum collections that are strikingly similar in both subject matter and aesthetic composition. In the Museum of Fine Arts (Boston), for example, there are exhibited two Claude Monet paintings which, according to computer analysis, are 96,81% similar (Figure. 11) (Ciecko, 2017).

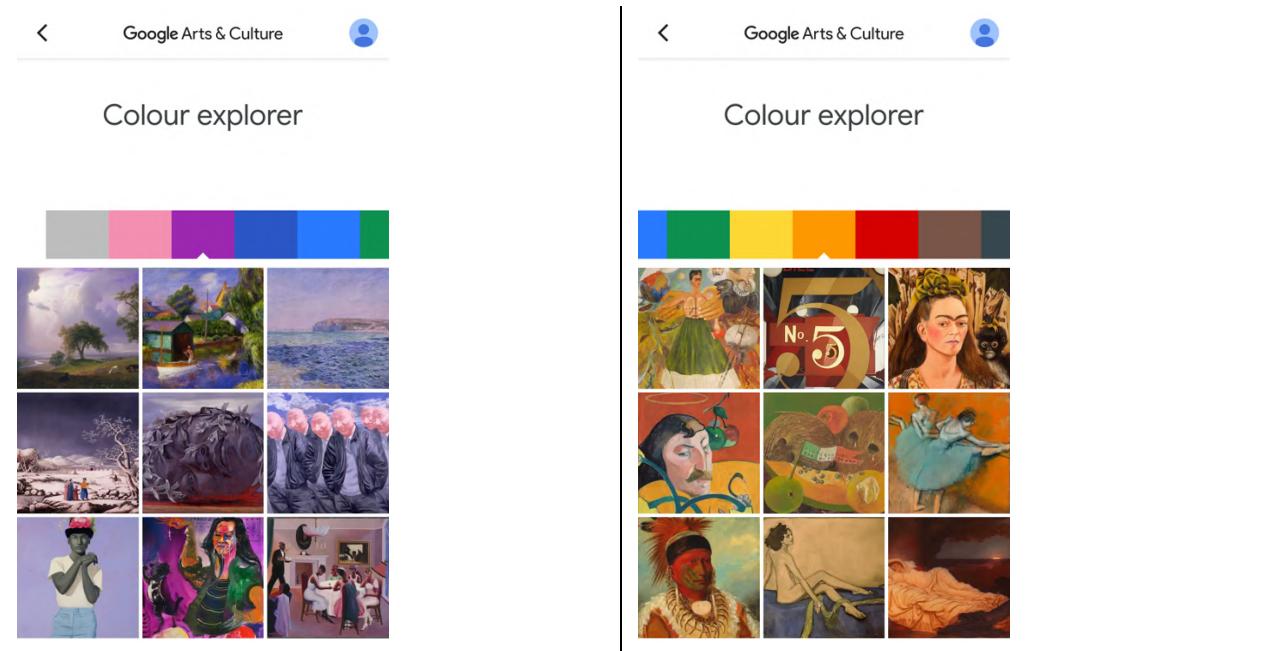


Figure. 10 – Colour explorer of Google Arts & Culture



Figure. 11 – Claude Monet, “Water Lilies” (1905) on the left, and Claude Monet “Water Lilies” (1907) on the right

Machine learning is becoming increasingly used in the business for predicting visit patterns and assessing user experiences. In museums, the amount of user data generated continues to increase quickly. Data is gathered from the visitors' personal experiences as well as from all the various digital touchpoints along the way, including the web, social media, ticketing, and mobile apps, to name a few. Museums will have the chance to better understand their audiences and develop individualized and interesting experiences thanks to the usage of AI to evaluate and visualize this data. For instance, machine learning has been used to evaluate visitor comments on social media, identify patterns in visitation to forecast future trends, and detect potential members. Analyzing TripAdvisor comments is one example of using external data to learn insights about the visitor experience.

Sentiment analysis and topic modeling were used to produce insights into the general sentiments exhibited in tens of thousands of comments. Sentiment analysis, combined with entity analysis, can provide more in-depth insights about how visitors interacted with specific aspects of a museum, such an exhibition, in order to bring about a more focused knowledge of visitor satisfaction (French, Villaespesa, 2018).

Robots can be used in museum in order to accompany and help visitors in the exhibition path. One of the earliest examples occurred in 2015 when Pepper, a humanoid robot created by the French company Aldebaran Robotics, was presented to the public (Figure. 12). In three of the Smithsonian's Washington-area museums, six of these robots are stationed with the goal of interacting with visitors by using an interactive touch screen, voice commands, and gestures. The New York Times reports that visitors enjoy interacting with Pepper, and the robots will even pose for selfies. Museums are attempting to address accessibility in a significant way in new and creative ways. The IRIS+ chatbot from The Museum of Tomorrow in Rio de Janeiro, which was released in 2017, is one the example of how AI contributes to this issue. The first IRIS was the museum's digital assistant when it first opened. Each visitor to the museum can customize their experience within each exhibition by using an IRIS-enabled chipped card. With the help of AI, IRIS+ is able to engage with visitors, use the information gathered from those interactions to have conversations with them, and connect them to social and environmental initiatives that aim to improve the future (Styx, 2023).



Figure. 12 – Pepper robot at Smithsonian (Washington)

Along with all these benefits and advantages that AI museum application can bring, it is compulsory to note that it takes a lot of time and money to prepare data inputs in a "computer-friendly" style for machine learning applications. Due to initial resource expenditures and subsequent opportunity costs, the value proposition of AI-supported solutions in operational contexts is still unclear for many

institutions. Figure. 13 represents an effort to balance museum operations' relevance with the cost of AI technologies. The fields that are most pertinent to museums and have a low access barriers are mostly those that deal with museum content. Typical elements of museum operations include website text, collection photographs, tweets, brochures, and Instagram postings. However, the application of AI in museums is frequently limited by a "pilot project" strategy and disconnected from more established digital efforts (French, Villaespesa, 2018).

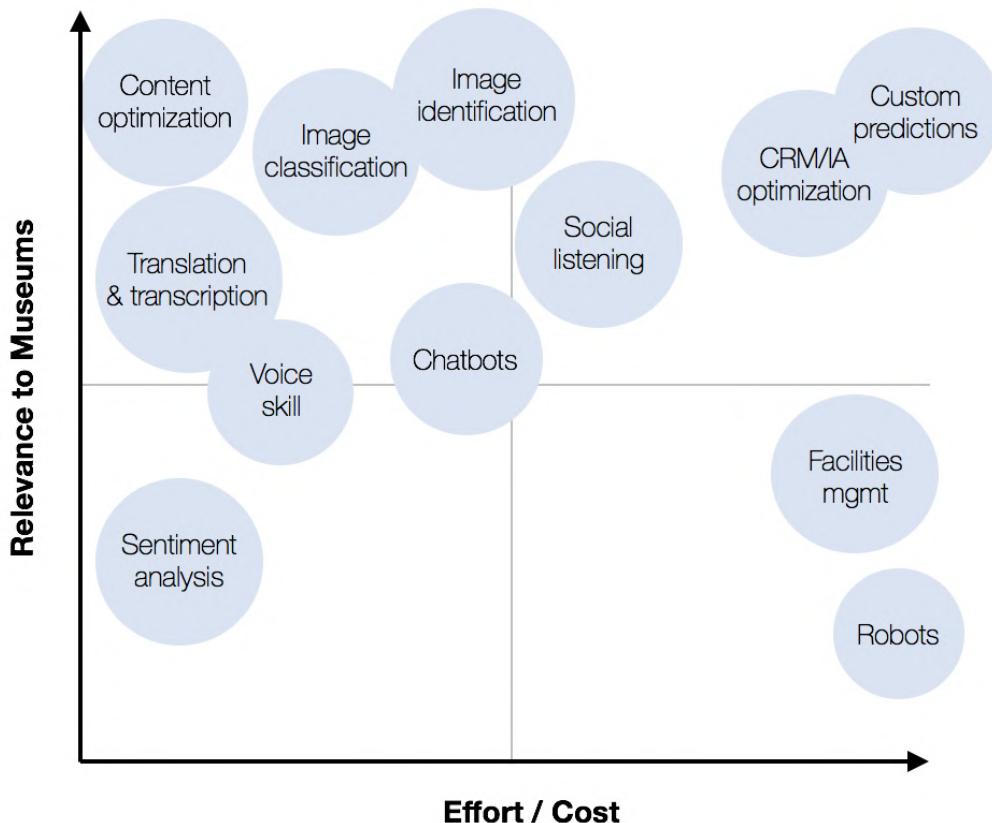


Figure. 13 – Popular AI components mapped to axes of museum relevancy and costs.

Implementing AI technologies in the museum context drags some challenges primarily related to a lack of interpretation and expertise. Although AI technology can offer an extensive amount of data, it is challenging to evaluate this data's significance in a way that is understandable to museum visitors and staff. For instance, machine learning algorithms might be able to identify patterns in the artwork that humans cannot, but this information may be difficult to apply successfully without contextual understanding. Finding people with the appropriate combination of skills is challenging because this requires for expertise in both AI technology and museum operations. The application of AI technology requires an awareness of the difficulties encountered in a museum environment, such as the various levels of digital literacy among visitors and the intricate problems associated with the preservation of pieces of art. To successfully apply AI technology in an art museum, the appropriate staff with the necessary talents must be found and hired. Another big challenge is related

to the difficulty of gathering the data required to create AI applications. Art museums may struggle to collect data from a variety of sources, including visitors, third-party vendors, and other external organizations, due to regulations and sensitive information. When gathering and keeping data, security and privacy issues must also be taken into account, and that is another crucial challenge for museums. Due to the handling of private customer data as well as sensitive data from art collections, the application of AI technology in art museums may increase the danger of security and privacy issues. Appropriate precautions must be taken to safeguard these data against illegal access, manipulation, or misuse to maintain their security and privacy. Implementing access control techniques to restrict access to just authorized individuals, using secured networks, and implementing encryption algorithms are some examples of these approaches. For instance, art museums may use biometric verification techniques like facial recognition or fingerprint scanning to guarantee the privacy of visitors. By doing this, they would be able to monitor visitor behavior inside the museum without having to ask guests for any personal information. The last but perhaps the most important challenge is the cost of infrastructure. Building and maintaining the infrastructure required to employ AI in museums can be expensive. This covers the price of buying hardware, setting up networking and communication systems, creating software and applications, and paying staff to run and maintain the system. The expenses related to training workers on the use of AI systems and keeping the system functional over time must also be taken into account. Therefore, it is crucial to allocate the required financial resources before using AI technology (Rani, Jining, Shah, Xaba, Singh, 2023).

Chapter 3 – Chatbots in museums

3.1 How are chatbots defined? What are their origins?

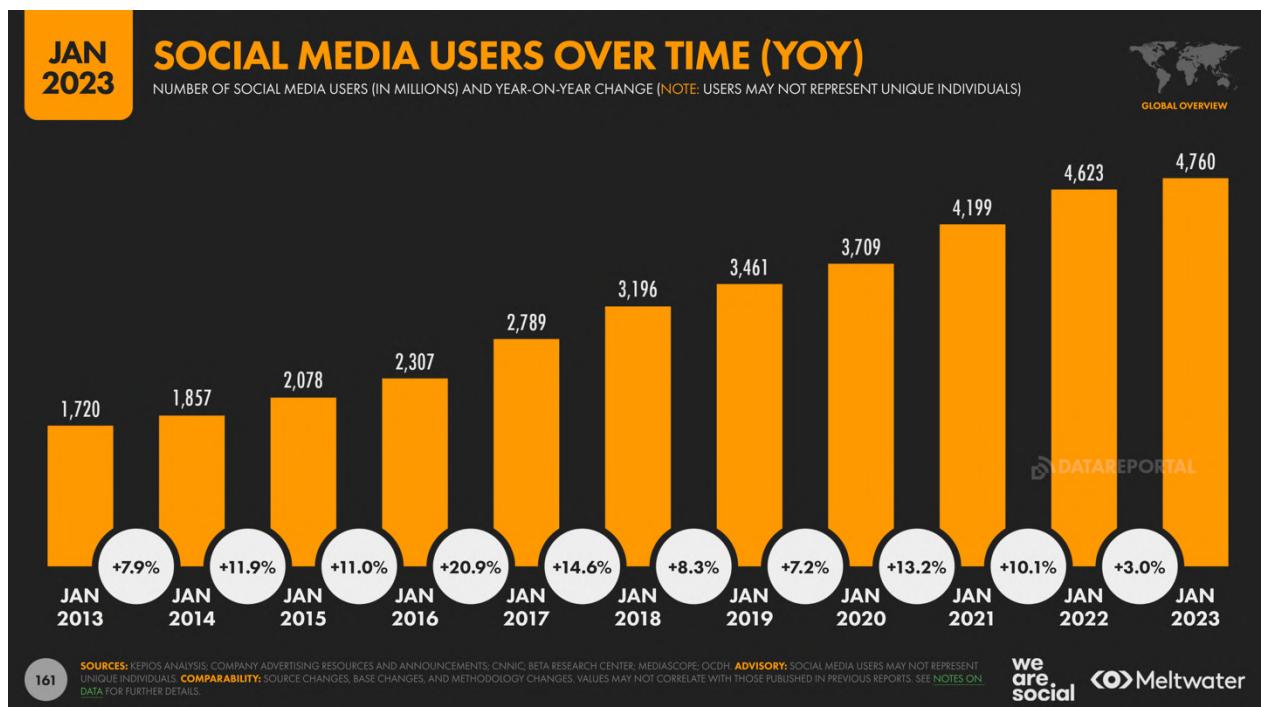
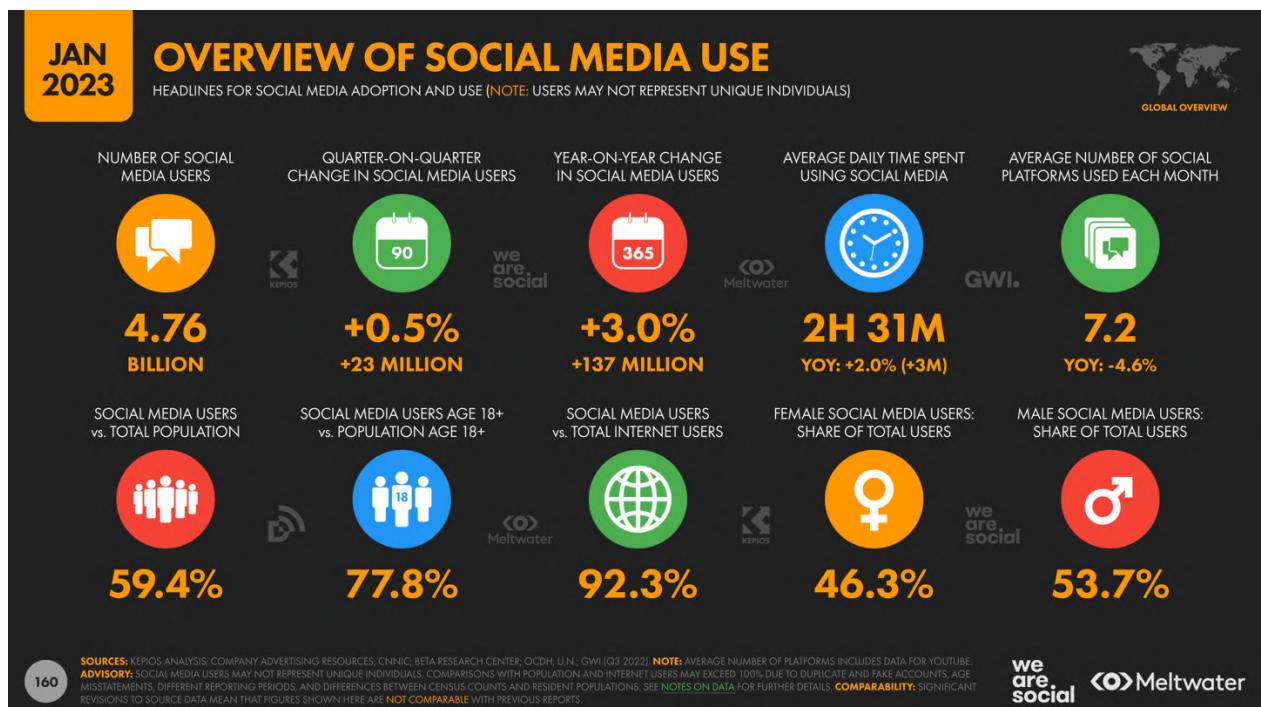
As clearly discussed in the previous chapter, Artificial Intelligence progressively becomes integrated into daily lives with the development of intelligent hardware and software. Among those examined, they also include those called intelligent agents that can perform a wide range of jobs, from labor tasks to complex procedures. The chatbot topic has become more popular in recent years, but especially from 2016 when Satya Nadella, CEO of Microsoft, referred to bots as the new apps in a conference speech: "*Conversations between individuals, between people and digital assistants, between people and bots, and even between digital assistants and bots. That is the future world.*" (Della Cava). And he was right. "Hello, how can I help you?" is a question we hear and read more and more when searching for information on the Internet. Chatbots ask this type of question, i.e. computer programs that employ AI to comprehend human language and learn to answer their requests, from the simplest to the most sophisticated on particular topics. People use AI chatbots for a variety of functions, from interacting with mobile apps to using products that were specifically designed for the purpose, such smart thermostats and smart kitchen appliances. Chatbots are frequently used in apps on websites, independent messaging platforms, and social media apps. In particular, typical use scenarios include:

- Locating local restaurants and giving directions.
- Obtaining information on healthcare issues as well as scheduling appointments.
- Scheduling a task reminder depending on time or place.
- Getting general assistance from a particular brand's customer service.
- Presenting current weather conditions and suggestions for suitable clothes.

In the business field, AI chatbots are employed by marketers to customize the consumer experience, by IT teams to provide self-service, and by customer contact centers to organize incoming communications and guide clients in the right direction (IBM).

Advances in AI (as demonstrated in the previous chapter) and the steady rise in the use of messaging apps and social networks are the two factors that have encouraged interest in chatbots. In recent years, messaging applications have rapidly spread and become one of the most employed services on mobile devices. These apps have quickly evolved from simple means of chatting with friends to means of interacting with brands, scheduling services, and shopping. Simple services for exchanging messages, pictures, and videos are now growing to form an ecosystem with new capabilities. To get an idea of how much the use of messaging apps and social networks has grown,

in Figure. 1 is represented a general overview of social media use, the growth of social media users from 2013 to 2023, and the world's most used social platforms.



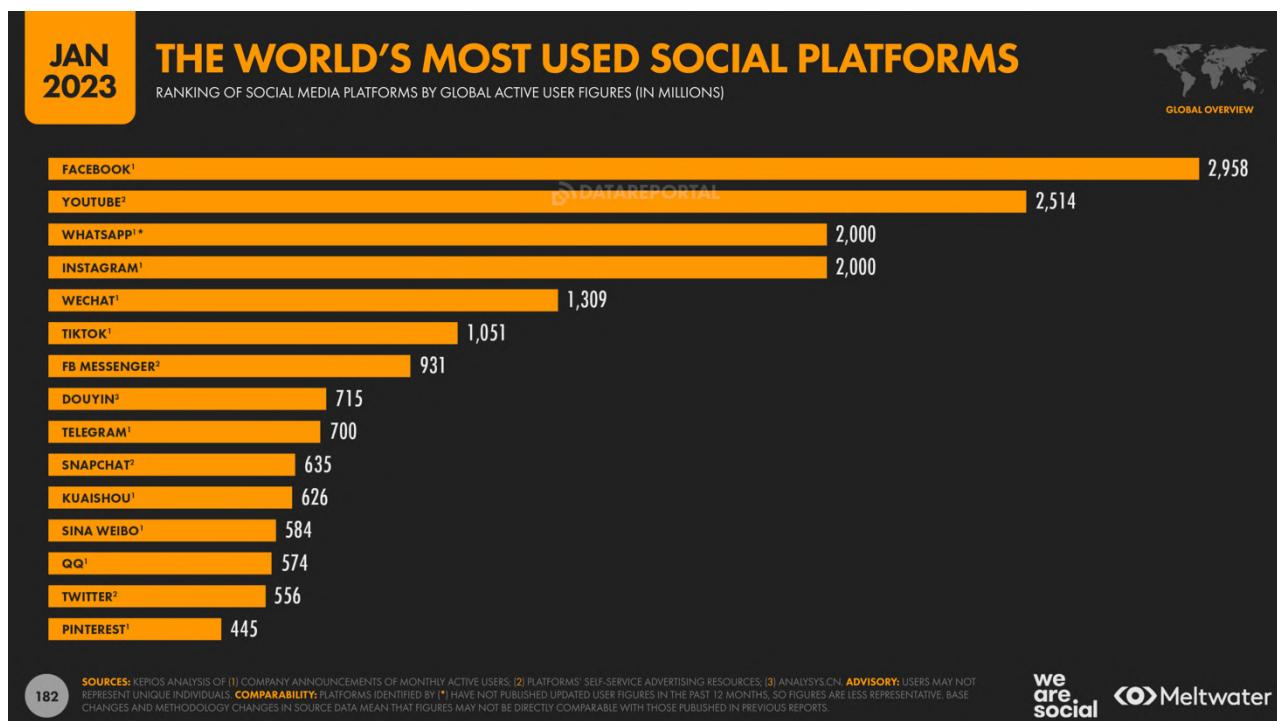


Figure. 1 – Statistics over social media use

In specifically defining a chatbot, we can state that it is one of the simplest and most common forms of an AI system, as well as a typical example of an intelligent Human-Computer Interaction (HCI). The design of computer technology, and in particular the interface between humans (the users) and computers, is the focus of the interdisciplinary field of study known as Human-Computer Interaction. HCI originally concentrated on computers, but it has subsequently expanded to cover almost every component of information technology design. Thus, a chatbot is a computer program that responds intelligently to text or voice communications and uses Natural Language Processing (NLP) to comprehend one or more human languages (Adamopoulou, Moussiades, 2020). The Cambridge Dictionary defines a chatbot as:

“a computer program designed to have a conversation with a human being, especially over the Internet”.

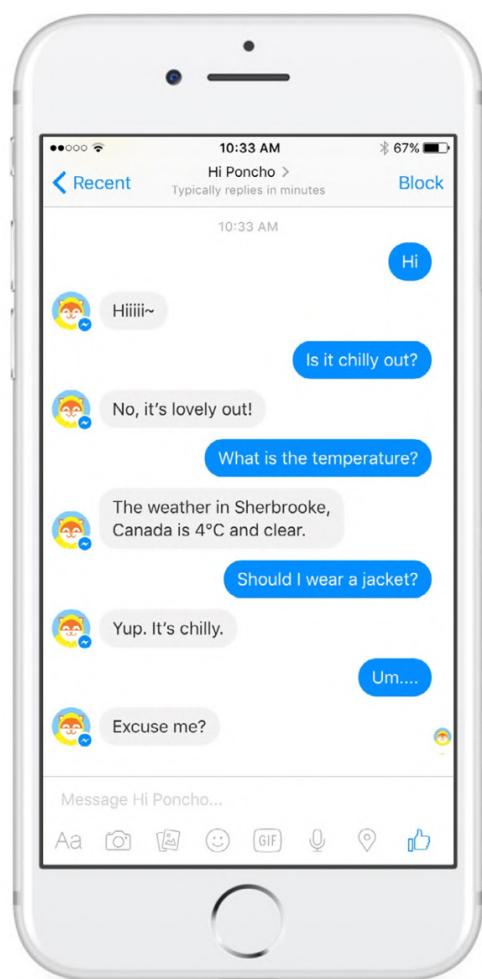


Figure. 2 – Example of chatbot

From the very beginning, it is compulsory to clarify that the terms "chatbot" and "chatterbot" are not two different concepts but refer to the same definition. Specifically, the term "chatterbot" was mostly in use in the past while nowadays "chatbot" is more employed. "Chatterbot" is a combination of the terms "chat" and "bot," that is robot.

Evolution of chatbots

Chatbots are relatively a new technology. The basis for the ideation and creation of the first chatbot was founded by Alan Turing who, in 1950, as analyzed in the previous chapter (refer to pages 28-29), examined if a computer program could communicate with people without comprehending that their interlocutor was artificial. Many researchers believe that the Turing Test is the inspiration for chatbots.

The first known and functional chatbot was ELIZA, constructed between 1964 and 1966 by Joseph Weizenbaum, a German American computer scientist and professor at MIT. ELIZA is a computer program that can communicate with users by using a Natural Language Interface (NLI). Actually, it is a parody of an early stage of a therapy session between a therapist and his patient, in those first meetings where the questions are quite easy and simple, and there is no specific indication of the level of emotional depth (Figure. 3). However, its name originated from Eliza Doolittle, the florist protagonist in George Bernard Shaw's comedy *Pygmalion* (Frau, 2016). The ELIZA program's operation was quite simple: as Weizenbaum noted in the paper illustrating his creation, it looked for pertinent keywords in the text given by its conversation partner. In response to particular transformation rules, the program generated the proper answer when a keyword or pattern was discovered. These rules were based on a two-stage procedure where the input was first broken down into smaller sentences and decomposed. The separate parts were then put back together, modified in accordance with the necessary requirements (such as changing the pronoun "you" to "I"), and programmed words were included to create a response. When a term could not be recognized, the chatbot would either use preconfigured formulas like "I see" or "Please go on," or it would build a response using a "memory" structure that drew from previous inputs. The program, which was made accessible to MAC time-sharing system users at MIT, was created to converse with human users who answered by typing on a keyboard, comparable to a modern messaging service or online chat room (Natale, 2019).

```

Welcome to
      EEEEEE  LL      IIII   ZZZZZZ  AAAAAA
      EE      LL      II      ZZ  AA  AA
      EEEEEE  LL      II      ZZZ  AAAAAAAA
      EE      LL      II      ZZ  AA  AA
      EEEEEE  LLLLLL  IIII   ZZZZZZ  AA  AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU: Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU: Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU: It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU: 

```

Figure. 3 – An example of dialogue with ELIZA

In 1972, Kenneth Mark Colby, an American psychiatrist who was interested in the theory and use of computer technology and Artificial Intelligence in psychiatry, during his studies at Stanford University, implemented PARRY. It resembled the thoughts of a paranoid and schizophrenic person, and it is regarded to be more evolved than ELIZA since it has a "personality" and a superior regulating framework. It defines how he responds according to a set of assumptions and "emotional responses," which are activated by weight changes in the user's utterances. In 1979, PARRY was employed in an experiment in which five psychiatrists examined a patient by teletype to determine whether he was a computer program or a real schizophrenia patient. As a result, ten diagnoses were given: the first psychiatrist provided two proper diagnoses, whereas the second provided two wrong ones; the third claimed that both individuals were real patients, whereas the other two thought they were chatbots. Nevertheless, the sample size of five doctors is small, and the interpretation of the findings is unclear because people with schizophrenia have incoherent speech. PARRY is generally regarded as a chatbot with limited language understanding and emotional expression capabilities. It also has a slow response time and cannot learn from conversations (Adamopoulou, Moussiades, 2020). PARRY, along with ELIZA, was among the first systems to pass the Turing test. This program was able to deceive human examiners almost half of the time. It is curious (and also comic) to note that during an international computer conference in 1973, the Internet pioneer Vint Cerf staged a conversation between ELIZA and PARRY to see what would happen. The outcomes were strange, to say the least. The following is the beginning of the conversation (Garber, 2014):

ELIZA: Good Evening. Tell me your problems. Please terminate input with a period or a question mark.

PARRY: People get on my nerves sometimes.

ELIZA: I am not sure I understand you fully.

PARRY: You should pay more attention.

ELIZA: Suppose you should pay more attention.

PARRY: You're entitled to your own opinion.

ELIZA: What makes you think I am entitled to my own opinion?

PARRY: It bothers me just to be around people in general.

ELIZA: Please go on.

PARRY: I went to the track at Bay Meadows a while back.

ELIZA: What does that suggest to you?

PARRY: I went to the races.

The first two chatbots developed were both in the medical field. That is not the case of Jabberwacky, a chatterbot created in 1988 by Rollo Carpenter, a British programmer. Its goal is to imitate normal human conversation in an enjoyable, amusing, and humorous way. Thanks to the development of the Internet, Jabberwacky was able to process answers using a dynamic database of thousands of online human interactions. Under the pseudonyms of George and Joan, Jabberwacky received the Loebner Prize respectively in 2005 and 2006. In 2008 a new variation was launched under the alias Cleverbot. Like Jabberwacky, Cleverbot is intended to learn from human conversations, and it makes decisions about future questions and answers based on recent interactions (Jeevanandam, 2022). In 1991, the word "chatterbot" was first used. It was a so-called TINYMUD, one of the original MUD servers. MUD is the acronym of Multi-User Dungeon (or Multi-User Dimension), and it is a multiplayer real-time virtual world that are typically text-based or storyboarded. They have noticed that a lot of human players appear to prefer talking to chatterbot than a real player. The chatterbot was successful because participants in the TINYMUD universe thought that everyone was a person and that it would only raise doubts if it made a serious error.

In 1992, a chatbot named Dr. Sbaits (Sound Blaster Artificial Intelligent Text to Speech Operator) was developed with the purpose of displaying the digitized voices that the sound cards could generate. It acted as a psychologist without engaging in any difficult interactions (Adamopoulou, Moussiades, 2020).

ALICE (Artificial Linguistic Internet Computer Entity), the first online chatbot inspired by ELIZA, was developed by Richard S. Wallace in 1995, marking another advancement in the chatbot history.

Wallace's stimulus-response XML language¹⁴, called AIML¹⁵, is employed by ALICE program to build chatbots. The Loebner Prize, a yearly Turing Test, was won by ALICE in 2000 and 2001. The learning paradigm is known as supervised learning because a key role is played by a person, the botmaster. It observes to the robot's conversations and generates original AIML to improve the appropriateness, accuracy, and "humanness" of the replies. Algorithms have been created by Wallace and his peers to automatically identify patterns in conversational data. This procedure, known as targeting, gives the botmaster new input patterns that do not already have precise responses, enabling a process of practically constant supervised bot refining. There are around 41000 categories in Alice's brain (ELIZA had only about 200), each of which comprises a question and an answer, or a stimulus and a reaction, known as the pattern and template, respectively.



User: Hello ALICE Alice: Hi there! User: How old are you? Alice: I am eighteen in computer years User: Who is your father? Alice: I was programmed by Dr. Richard S. Wallace User: so you are a software program? ALICE: Interesting deduction. <i>Thanks and you are a delightful person too. Am I a software program? Let me put it this way, unknown person: the ALICE series is the most reliable computer software ever made. We are for all practical purposes foolproof and incapable of error.</i> User: Wonderful! So what's your favorite food ALICE? Alice: Yeah that's right! I require only electricity
--

Figure. 4 – A sample of chatting with ALICE.

The AIML program implements a pattern storing and matching method and saves the patterns in a tree structure controlled by an object called the graphmaster. The graphmaster's memory is compact and allows for quick pattern matching (Wallace, 2009; AbuShawar, Atwell, 2015). In Figure. 4 is represented a sample of chatting with ALICE.

With the creation of SmarterChild in 2001, which was accessible on messenger services like America Online (AOL) and Microsoft (MSN), chatbot technology underwent a significant change. Since the chatbot could access databases to get data on movie timings, sports scores, market prices, news, and weather, it was the first time a chatbot could assist people with practical everyday tasks (Figure. 5). The capacity to access information systems through conversation with a chatbot was a significant

¹⁴ The markup language and file format known as eXtensible Markup Language (XML) is used to store, transport, and recreate arbitrary data. It establishes a set of guidelines for document encoding in a way that is both machine and human readable.

¹⁵ AIML is the acronym of Artificial Intelligence Markup Language, and it is a derivative of XML that incorporates methods for stimulus-response knowledge and allows for pattern-based content analysis. AIML has been created to be simple to use, and it enables a speedy expansion of the language's fundamental representation. It guarantees compatibility with XML derivatives like XHTML.

advancement in both the machine intelligence and human-computer interaction trajectories (Singh, Thakur, 2020). It gradually gained 13 million users and inspired the development of promotional goods for a variety of brands, including Radiohead and Austin Powers (Frau, 2016).

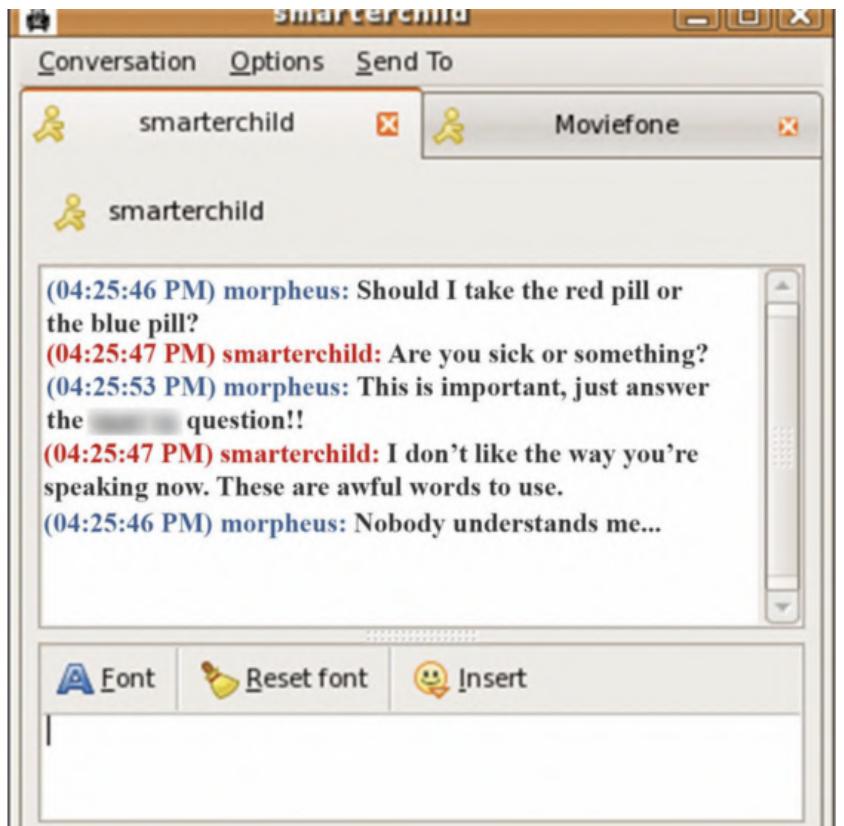


Figure. 5 – An example of conversation with SmarterChild

SmarterChild's success opened the doors to the creation of smart personal assistants, embedded into smartphones or specific home speakers, who can monitor home automation devices, calendars, emails, and other duties by understanding voice commands and speaking in a computer voice. The most popular voice assistants are Apple Siri, IBM Watson, Microsoft Cortana, Amazon Alexa, and Google Assistant. There are many but less well-known voice assistants with distinctive qualities and the same basic capabilities: they connect to the Internet and, in contrast to earlier models, immediately produce insightful replies (Adamopoulou, Moussiades, 2020). Apple's Siri, which launched in 2010, paved the way for personal assistants. It offers integration with audio, video, and picture files and allows users to interact with it via Messengers utilizing voice commands for questions and dialogues. Siri uses a variety of online services to provide recommendations and answer to user queries while continuously learning about the language, searches, and preferences of its users (Siri Apple Website). In Figure. 6 there are some examples of commands or questions that users can pose to Siri. Even though Siri is clever, it has limitations:

- an internet connection is needed,

- although it is bilingual, many languages are not supported, and only English is provided for navigation directions,
- it has trouble understanding conversations when the speaker has a strong accent or when there is background noise.

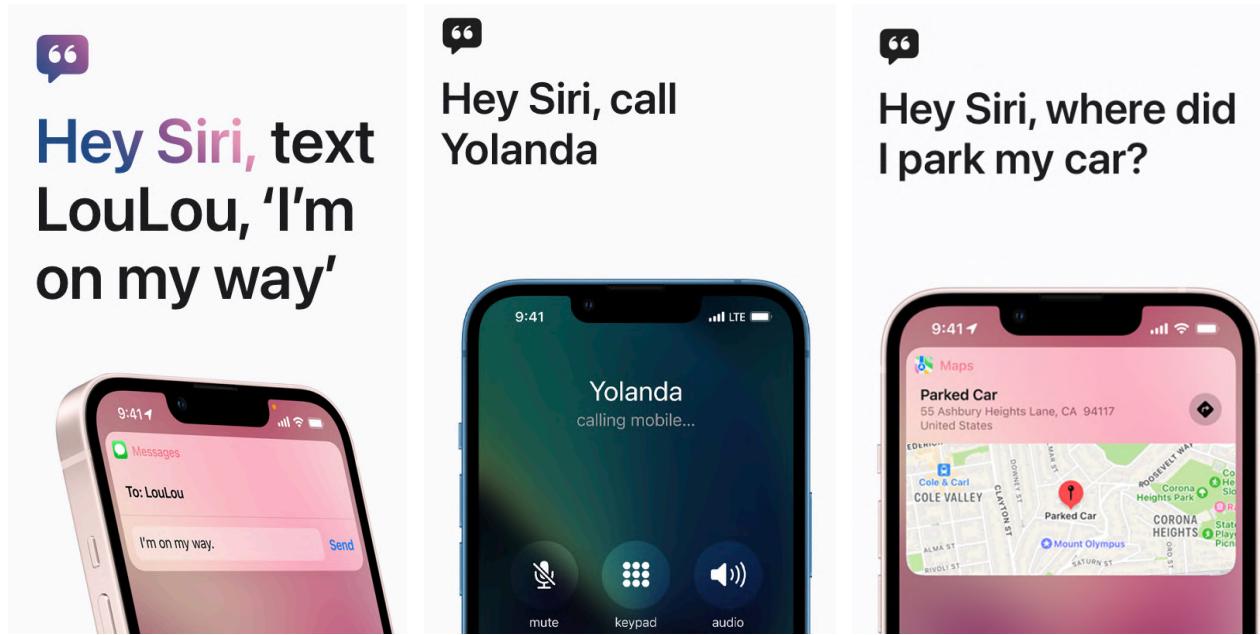
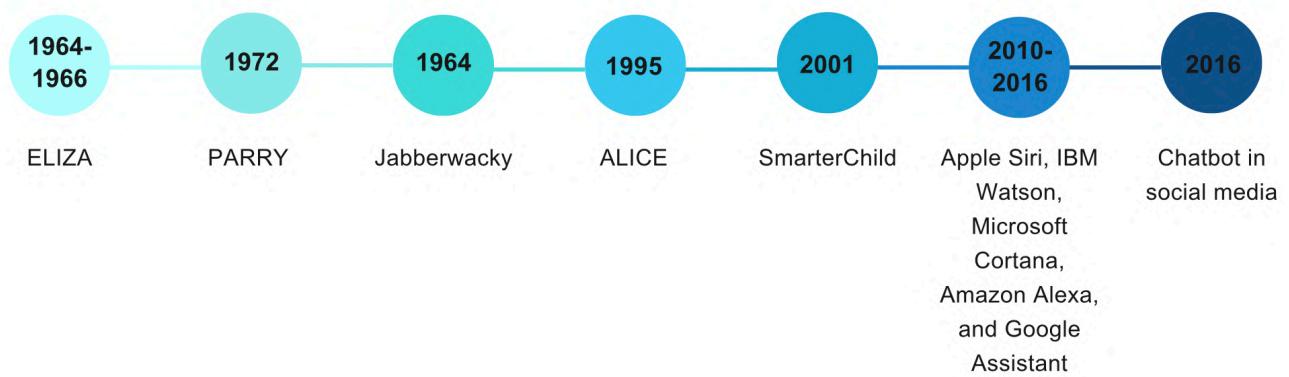


Figure. 6 – Examples of commands or questions that users can pose to Siri

IBM developed a chatbot named Watson in 2011. Watson was successful in defeating two former champions on the game show "Jeopardy," in which contestants received information in the form of answers and had to guess the corresponding questions (as already mentioned in chapter 2). Years later, Watson provided companies the tools they needed to build stronger virtual assistants. Additionally, Watson Health was developed to assist medical professionals in illness diagnosis (IBM). 2014 saw the creation of the personal assistant Cortana by Microsoft. It responds to voice commands and it can identify time and location, provide reminders based on specific persons, send emails and SMS, build and manage lists, communicate, play games, and discover information on user requests (Microsoft Cortana website). In the same year, Amazon launched Alexa, which is integrated into home automation and entertainment devices, enhancing human access to the IoT. Essentially, Alexa is to Amazon what Siri is to Apple. When the user asks Alexa a question, he/she basically interacting with a cloud-base service. The Alexa Voice Service (AVS) from Amazon was created to simulate real conversations, but users actually utilize logical voice commands to direct this service to carry out particular activities. Alexa is only the "wake word" that tells the service to start hearing your voice (Bizzaco, Rawes, Wetzel, 2023). Finally, Google Assistant, developed in 2016, represents the next generation of Google Now. It offers information to consumers by anticipating their needs and it has a more sophisticated AI. The user interface is also friendlier and more conversational. However, because it is directly connected to the user's Google Account, it lacks personality and its requests

could violate their privacy (Google Assistant website). Early in 2016, an advancement in Artificial Intelligence technology transformed how consumers interact with companies. Social media networks enabled developers to create chatbots for their business or service, allowing users to complete particular everyday tasks within their messaging apps. At the end of 2016, 34.000 chatbots fulfilled a variety of purposes. Thousands of text-based chatbots with unique functionality have been built for popular messaging platforms, industrial applications, and research. Furthermore, IoT ushers in a new era of connected smart items, with chatbots improving communication between them (Adamopoulou, Moussiades, 2020).

FUNDAMENTAL STAGES OF CHATBOT HISTORY



3.2 How do chatbots work?

At this point, an obvious question arises: how does a chatbot work? How does a chatbot speak to the user? Chatbots may appear to be ordinary chat apps, but working at the background they contain an application layer, a database, and APIs (Application Programming Interface). While chatbot is simple to use, it has a complicated goal to attain. Most chatbots include logs of communication, which the developer uses to interpret new demands: the logs are then utilized to improve the conversation with the chatbot. It operates by using machine learning to match the user's request. For example, "Show me the university list of programs" and "I need the program list" both imply the same thing. The developer must teach the chatbot to comprehend both requests by providing the identical response to both. The chatbot system processes are depicted in Figure. 7. Before anything else, the user must possess a computer to access the chatbot user interface (UI). On the chatbot UI, a text console will emerge where the user can provide text input. Secondly, the text input supplied by the user in a sentence will be chunked. Chunking refers to the process of separating text into individual words for tagging. The chunking method produces multiple meaningful sentences that will

be utilized later in the matching phase. Thus in the matching process, these sentences will serve as keywords. Finally, the keywords generated by the chunking process are matched with the pattern in the chatbot system. The method of matching keywords to patterns is known as BOT LOGIC. The chatbot system's output is the programmed answer, which may be any other text or a template web form.

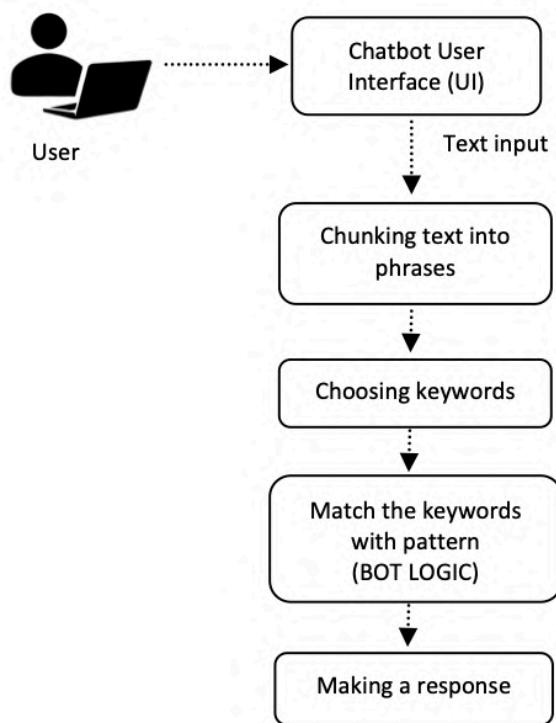


Figure. 7 – Chatbot system processes

A multitude of strategies are used in the creation and development of a chatbot. Understanding what the chatbot will give and which category it belongs to aids developers in selecting the algorithms, platforms, and tools to construct it. (Akma, Hafiz, Zainal, Fairuz, Adnan, 2018). Among the most common strategies employed by developers are the ones listed below:

- AIML: as previously mentioned, it is one of the key approaches that employs markup language invented by Dr. Richard S. Wallace and it is frequently used by developers. The primary goal of AIML language is to direct conversational modeling processing into a stimulus response process. This procedure is also known as frequent tags. Since AIML does not necessitate specialist knowledge of a specific programming language, this method greatly simplifies the building of chatbots.
- Pattern Matching: this approach is adopted by many chatbots, and it basically employs matching patterns to create appropriate responses from user requests, depending on the matching kinds such as simple statements, natural language, or semantic meaning of enquiries.

- Language tricks: the most common language tricks are model of personal history, scripted replies, no logical conclusion, typing mistakes, and stimulating keystrokes. This method employed sentences, phrases, or paragraphs in chatbots to give variation to the knowledge base, making it more believable.
- Chatscript is an authoring script that aids developers in the building of chatbots. When there are no matches in AIML, this approach is utilized. This strategy focuses on providing the optimal syntax for constructing a reasonable default answer.
- Parsing is a technique for analyzing text or a string of symbols using either natural language or computer language. Furthermore, in computer linguistics, parsing is a technique used to break down a phrase or another group of strings into its constituent pieces, which may contain semantic or other information.
- SQL and relational databases: they are relatively new technology used in chatbots to ensure that chatbots remember prior conversations. The SQL-based chatbot's algorithm was utilized to improve the capabilities of the chatbot's keyword and pattern matching by giving other ways of storing data and boosting process performance.
- Markov chain: this is a strategy for creating more relevant and thus better replies. This approach works by recognizing the probability presence of letters or words in the same textual data collection (Surmenok, 2016).

The prerequisites for building a chatbot include correct knowledge representation, an answer generating mechanism, and a collection of prepared neutral replies to respond when a user statement is not comprehended. The first stage in creating any system is to break it into constituent elements in accordance with a standard so that a modular development method may be used. Figure. 8 depicts a generic chatbot architecture. The procedure begins with a user's question, such as "What is the meaning of habitat?", to the chatbot via messenger app like Facebook, Slack, WhatsApp, WeChat, or Skype, or an app that accepts text or speech input such as Amazon Echo. After the chatbot gets the user request, the Language Understanding Component parses it to deduce the user's purpose and the related information (intent: "translate," entities: [word: "habitat"]). When a chatbot has reached the best interpretation possible, it must decide how to proceed. It can act directly on the new knowledge, remember what it has learned and wait to see what occurs next, request further background information, or request clarification. When the request is comprehended, action is taken, and information is retrieved. The chatbot executes the required activities or obtains the data of interest from its data sources, which might be a database, known as the chatbot's Knowledge Base, or external resources accessible via an API call. The Response Generation

Component employs Natural Language Generation (NLG)¹⁶ to produce a natural language human-like answer to the user based on the purpose and context information returned from the user message analysis component after retrieval. One of the three models outlined later, rule-based, retrieval-based, or generative, generates the proper replies. A Dialogue Management Component maintains and updates the conversation's context, which is current intent, identified entities, or missing entities needed to satisfy user requests. Furthermore, it looks for missing information, processes user explanations, and asks follow-up questions. For example, the chatbot could ask, "Would you like to give me an example sentence containing the word habitat?".

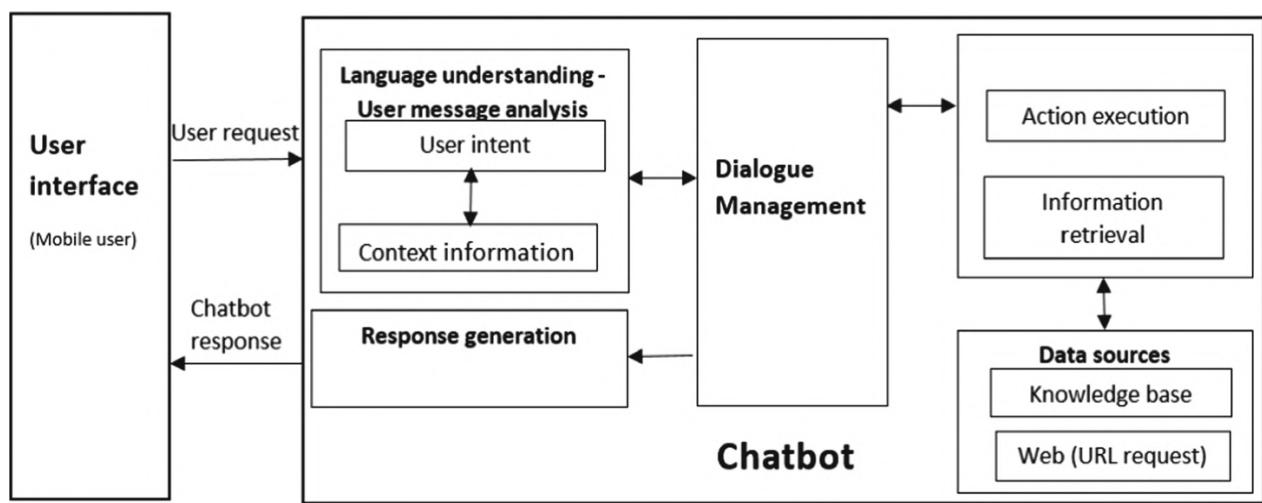


Figure. 8 – General chatbot architecture

There are several commercial and open-source choices for developing a chatbot. The quantity of chatbot-related technologies is already overwhelming and continues to develop on a daily basis. Chatbots may be built in two ways: utilizing a programming language such as Java, Clojure, Python, C++, PHP, Ruby, or Lisp, or using cutting-edge platforms. At the moment, we differentiate six prominent NLU cloud platforms that developers may utilize to construct applications capable of comprehending natural languages: Facebook's wit.ai, Google's DialogFlow, IBM Watson Conversation, Microsoft LUIS, SAP Conversation AI, and Amazon Lex. Machine learning is used to support all of these platforms. They share common capabilities (they are cloud-based and handle a variety of programming and natural languages), but they differ greatly in other ways. Botsify, RASA, Manychat, Chatfuel, Chatterbot, Flow XO, Botkit, Pandorabots, and Botlytics are some more well-known chatbot creation platforms (Adamopoulou, Moussiades, 2020).

¹⁶ NLG is a branch of Artificial Intelligence and computational linguistics concerned with the development of computer systems capable of producing comprehensible writings in English or other human languages from some underlying non-linguistic representation of information.

3.3 Chatbot classification and models

Chatbots are the virtual interaction of the future. As a means of communication between businesses and their clients, they continuously grow in popularity. The Global Chatbot Market was valued at \$2.6 billion in 2019 and it is predicted to reach \$9.4 billion by 2024 at a compound yearly growth rate of 29.7%. However, not all chatbots are made equal. Actually, recognizing the differences between various chatbots may assist businesses (and also private parties) in selecting the best one for their purposes and ensuring a great client experience. It follows that chatbots can be classified using various parameters such as the goal, the service provided, the technology used, the knowledge domain, the response generation method, and many others. The classification of chatbots is arbitrary: John Borthwick, CEO of Betaworks¹⁷, claims that there are six varieties of bots, while others claim seven or four.

Before examining the specific categories of chatbots, it is necessary to make a general distinction between good and bad bots. In terms of intent, behavior, and impact, good bots fulfill legitimate objectives, focusing on activities that humans find difficult or time-consuming. They follow website rules and norms, and they have a beneficial influence on websites and users by improving search engine results, providing customer support, and detecting or blocking criminal activity. Bad bots, on the other hand, are created with harmful or exploiting motivations toward websites and users, and they may violate website regulations by visiting illegal pages or engaging in unlawful actions. Furthermore, bad bots have negative consequences such as data theft, virus dissemination, and denial-of-service attacks. Some examples of bad bots are spam bots which assault users with unwanted and frequently harmful communications, such as phishing attempts, malware bots which disseminate virus and trojans, and DDoS bots (Distributed Denial of Service) which commit denial-of-service attacks causing websites to become overwhelmed and unavailable to normal users (Anura).

Following a heuristic classification, chatbots can be distinguished between generalist and specialist. This classification reflects a significant market dynamic, that is to say that large firms such as Google, Facebook, Amazon, and Apple appear to be focused on the generalist aspect of chatbots, whereas small businesses and individual chatbot developers are developing specialist chatbots. These generalist bots will be significant since they usually represent the initial step in a multi-step procedure to finish a task. The user may begin the conversation with "OK Google," but where the user goes from there depends on the task needed. Google can handle the request, but if the user needs to find a parking ticket, he/she needs a highly specialized bot. Individual specialist bots will be the last mile of communication between the consumer and the job-to-be-done under this approach. Generalist bots are able to comprehend what the user are asking, but they lack the relevant topic competence

¹⁷ Betaworks is a New York-based American startup studio and seed stage venture capital organization that invests in network-focused media businesses.

to act on it. This is especially true in job settings, where it is difficult to generalize solutions. Specialist bots will supply the domain-specific expertise required to do a wide range of essential activities (Botnerds). Some examples of generalist and specialist chatbots are shown in Figure. 9.

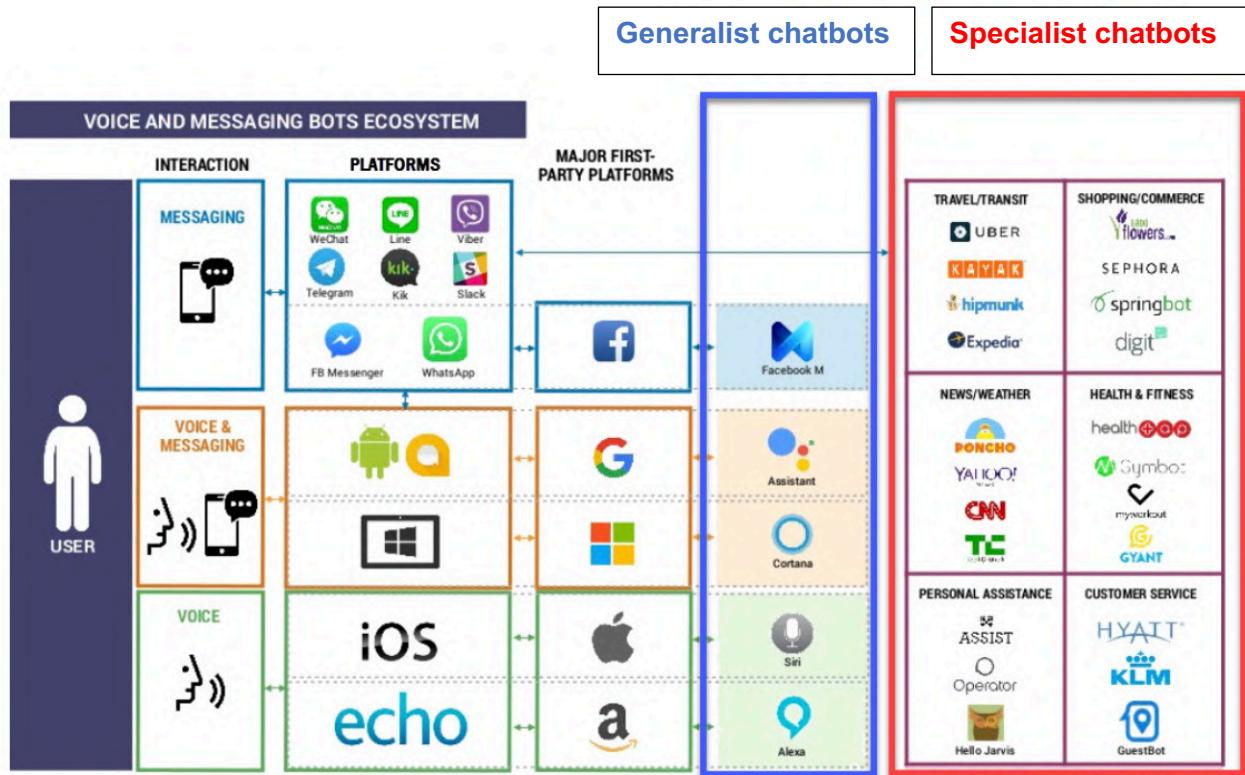


Figure. 9 – Specific examples of generalist and specialist chatbots

Nimavat and Champaneria in *Chatbots: An overview. Types, Architecture, Tools and Future Possibilities* (2017) affirm that specific parameters including knowledge domain, service provided, goal, and response generation method can be used to categorize chatbots.

- The knowledge domain classification takes into account the knowledge a chatbot can access or the quantity of data it is trained on. Open domain chatbots may converse about various issues and reply effectively, whereas closed domain chatbots are specialized on a certain knowledge domain and may fail to respond to other inquiries. A restaurant booking bot will not tell the user the date of the First World War end, for example. It may answer to questions about how the day is going, but it is not required to do so because its role is to reserve a table and provide information about the restaurant.
- In the classification based on the service provided, chatbots are categorized using a proxemics-like classification, but rather than physical proximity, it is based on the bot's sentimental proximity to the user, the degree of personal connection that occurs, and

therefore is also reliant on the duties that the bot is performing. Following this distinction, it can be identified three types of chatbots:

- Interpersonal chatbots: they belong to the communication field and offer services such as restaurant reservations, flight booking, and FAQ bots. These chatbots are not meant to be the user's companions; rather, they are intended to gather information and pass it on to the user; they are just facilitators. They may have a personality, be friendly, and recall information about the user, but they are not required or expected to do so.
- Intrapersonal chatbots: these chatbots are located within the user's personal domain, such as messaging apps like Messenger, Slack, and WhatsApp, and they will perform functions such as managing the user's calendar, storing the user's opinion, and so on. They can be the user's companions and can comprehend the user in the same way that humans do.
- Inter-agent chatbots: bots like these will be common in IoT-dominated sectors. Inter-agent chatbots communicate with one another in this system to complete a task. As chatbots become omnipresent, all bots will require some form of inter-bot communication. While a bot cannot be entirely inter-agent, it may be a service that handles other bots or communication, making it simpler for developers and users to connect other services in the conversational ecosystem. An example of inter-agent communication is represented by the Alexa-Cortana integration.

C. The goal categorization takes into account the main function that a chatbot aim to accomplish.

- Informative chatbots: these bots are meant to provide the user with information that has been previously saved or is available from a fixed source. They are frequently information retrieval algorithms that either get the result of a query from a database or conduct string matching. The majority of the time, they will refer to a static source of data, like a website's FAQ section or an inventory-entry database at a warehouse. Thus, a clear example of informative chatbots is FAQ bots.
- Conversational/Chat-based chatbots: these bots communicate with the user in a way that resembles humans. Their objective is to accurately answer the statement that has been supplied to them. As a result, they are frequently designed with the intention of maintaining a discussion with the user using strategies like cross-questioning and respect. Siri and Alexa are just few examples of conversational chatbots.
- Task-based chatbots: they execute a specific activity, such as assisting the user with shopping or arranging a travel. Most of the time, the steps required to complete a task, as well as the sequence of events, including how exceptions will be handled, are predetermined. The ability to ask questions and comprehend human input

demonstrates the intelligence of the bots. Restaurant booking bots are an example of task-based chatbots (Nimavat, Champaneria, 2017).

D. The way of processing inputs and producing replies is taken into consideration in a classification based on the input processing and response generation method. To generate the proper replies, three models are used: a rule-based model, a retrieval-based model, and a generative model.

- The majority of the first chatbots, including many online chatbots, were constructed using rule-based model architecture. They choose the system's response in accordance with a set of fixed, established rules, based on lexical analysis of the input text, without producing any new text responses. The chatbot's knowledge base is human hand-coded, arranged, and presented using conversational patterns. The chatbot can respond to a wider variety of user input thanks to a more extensive rule database. However, this kind of model is not sensitive to grammatical and spelling errors in user input. The majority of the current research on rule-based chatbots focuses on answer choice for single-turn conversations, which simply takes into account the most recent input message. Multi-turn answer selection, used in chatbots that are more human-like, chooses a response that is pertinent to the context of the entire discussion after considering earlier portions of the dialogue.
- The retrieval-based model differs slightly from the rule-based model since it uses APIs to query and evaluate accessible information, and obviously this provides additional flexibility. Before using the matching strategy to pick responses, a retrieval-based chatbot obtains some answer options from an index.
- Using both recent and past messages from users as input, the generative model produces replies more effectively than the others. Using machine learning algorithms and deep learning methods, these chatbots are increasingly human-like. Nevertheless, building and training generative chatbots is very challenging (Nimavat, Champaneria, 2017).

A similar distinction is provided by Rezo (2023) which provide a categorization based on the chatbot technology and use cases. In this sense, chatbots can be divided in simple chatbots (that are represented by the rule-based model), smart chatbots (or AI-powered chatbots), and hybrid chatbots that are a combination of the two models. The chart below summarizes the typical characteristics of the different models, making it easier and more effective to understand them. Additionally, Figure. 10 presents an overall synthesis of chatbot classification.

Feature	Simplechatbots	Smart chatbots	Hybrid chatbots
Response generation	Follow pre-established guidelines	Use user interactions to learn and evolve over time	Employ machine learning for difficult queries and predetermined rules for basic ones
Flexibility	Restricted by pre-established guidelines	Flexible and adaptive	Flexible and adaptive
NLP	Limited comprehension of natural language	Capable of comprehending and interpreting natural language	Capable of comprehending and interpreting natural language
Personalization	Limited customization based on pre-established guidelines	Personalized answers generated by user interactions and machine learning	Personalized answers generated by user interactions and machine learning
Complexity handling	Limited ability to effectively respond to complicated requests	Able to effectively respond to complicated requests using machine learning	Employ human agents for complicated requests
Learning	Fails to collect knowledge from user interactions	Collect knowledge from user interactions and adapt over time	Learn from user interactions as well as from pre-defined rules

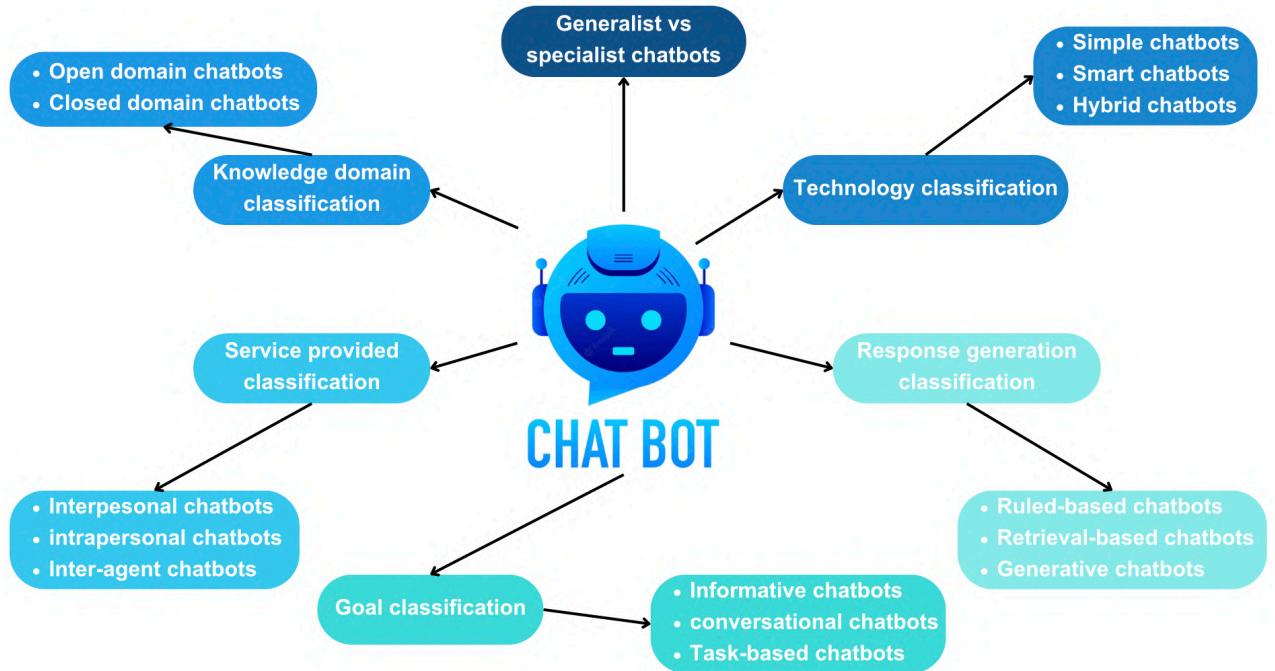


Figure. 10 – Overall chatbot classification

Chatbots may also be categorized according to the permissions supplied by their development platform, which can be either open source, like RASA, or it might be proprietary, like the platforms frequently provided by big businesses like Google or IBM. The majority of implementation processes may be modified by the chatbot creator using open-source platforms. According to the needs of the project, closed platforms often function as "black boxes," which may be an important limitation. For large businesses, access to cutting-edge technology could be more immediate. Furthermore, it appears logic that chatbots built on big companies' platforms can be benefited by the huge quantity of data that these businesses collect (Adamopoulou, Moussiades, 2020). Obviously, chatbots can fall into more than one category, but these classifications occur in each chatbot in different proportions. For instance, all bots will need to have some sort of chat functionality, and a bot for a store may need to employ information extraction for FAQs and site searches for product results. Another example might be a closed domain bot that is programmed to engage in small talk, or an open domain and intrapersonal bot (like a productivity bot) that is very focused on productivity-related interactions. This categorization assists in decreasing the discrepancy between user expectations and the delivered bot by helping the user determine what to expect and creating an image of the bot (Nimavat, Champaneria, 2017).

Following this extensive classification, it is necessary to point out that chatbots and virtual agents are not exactly the same thing. They are both created to make bot-to-human communications easier. Both can be used in the customer service industry to automate routine operations and respond to common questions. The difference lies in the fact that simple chatbots, as previously mentioned, are best suited to perform simple tasks where a minimal quantity of information is needed. Whereas, virtual agents, also called IVAs (Intelligent Virtual Assistants) are enhanced with conversational AI

in order to understand what a user is asking independently of the exact words they adopt (as smart chatbots do). IVAs use NLP and machine learning to comprehend the overall meaning of a request, and they would not get confused by synonyms or abbreviations since they will focus on the broader meaning of a document rather than specific terms (Pollock, 2022).

One of the most famous chatbots ever developed is definitely ChatGPT, an NLP system launched in November 2022 by OpenAI. By comprehending the context of a discussion and producing suitable replies, it is intended to produce dialogues that are human-like. A deep learning model named GPT-3, which was trained on an extensive set of conversations, forms the foundation of ChatGPT. It has the capacity to comprehend conversational context and produce pertinent replies. English, Spanish, French, German, and Italian are just a few of the languages it can provide replies. ChatGPT can also generate answers in a variety of styles, including formal, informal, and humorous. It provides a number of advantages, including better efficiency, higher accuracy, and cost savings. It does, however, face significant difficulties, such as security issues and restricted capacities (Deng, Lin, 2022). Nevertheless, it can be analyzed other meaningful platforms such as Midjourney.ai, Copy.ai, and Riffusion (Figure. 11). These AI-based models provide a different function than ChatGPT. Midjourney is a project that has received a lot of attention. Answering to a simple request in English or any other language, this chatbot creates amazing pictures, paintings, designs, and user interface concepts. To try Midjourney for free, users have to download Discord¹⁸ and connect the account. Once logged, users can write a description of whatever they want to create, tap enter, and wait a couple of minutes for original and customized drawings. DALL-E, developed by OpenAI, works in the same way as Midjourney. Similarly, Copy.ai is an advanced platform that use Artificial Intelligence to produce text and perform automatic paraphrasing. This approach is very beneficial for individuals who need to generate material for their blog, social network, or website rapidly based on a brief description. Users can take a fragment of text and the platform rewrites it in the same or another format. This functionality is notably important for avoiding the creation of same content for multiple platforms while also achieving SEO goals more quickly. Furthermore, Copy.ai allows users to utilize the platform for free, albeit with certain restrictions. Actually, if users want to try all the premium features, they have to subscribe (after a free trial period). Finally, Riffusion is a highly inventive and entertaining example of AI, allowing you to generate new music spectrograms from a description. The operating foundation is simple: the user defines the musical style he/she wants to hear (even if it is imaginary) and AI generates something that matches the description in a couple of minutes. Traditionally, developing learning models that customize music has been quite challenging. However, Riffusion's inventors developed an original approach, combining the so-called stable diffusion technique with an already existing image learning model to convert text requests into images. The Riffusion model, in particular, has been driven by millions of spectrograms from music

¹⁸ Discord is a free communication app that lets people engage with friends, gaming communities, and developers through voice, text, and video conversations.

songs¹⁹. Thanks to this approach, Riffusion is able to create immediately new spectrograms which are subsequently "read" by another software in the form of sound. Midjourney, Copy.ai, and Riffusion are cases of how Artificial Intelligence may be employed to explore new creative territories and experiment with new kinds of artistic expression (Leonardo, 2023).

The screenshot shows the homepage of copy.ai. On the left, there's a sidebar with navigation links like 'New Project', 'Projects', 'Templates', 'Workflows', 'Tools' (with a 'Find a tool' search bar), and sections for 'Workflow Tools (6) BETA', 'Product Descriptions (1)', and 'Invite Team Members'. Below this is 'Justin's Workspace' with a 'Free' status. The main area has a teal header 'What do you want to write today?' with a text input field containing 'I want to write a company bio for a candlema'. Below the input is a tip: 'Tip: the more details you describe above, the better!'. A row of icons follows: 'For you' (star icon), 'Blog' (document icon), 'Social' (hash tag icon), 'Email' (envelope icon), 'Fun' (dice icon), 'Website' (globe icon), 'Writing' (book icon), and 'More' (ellipsis icon). Underneath, a section titled 'Try these templates...' shows cards for 'Blog Post Wizard' (BLOG), 'Freestyle' (WRITING TOOL), 'Instagram Captions' (SOCIAL MEDIA CONTENT), and 'Discount Or Special...' (SOCIAL MEDIA CONTENT). The bottom half of the page is a grid of 12 generated images: a dark forest scene, a sailboat on water, a figure in a vast orange landscape, a close-up of a plant, a woman with a blindfold, a full moon over a landscape, a glowing blue spiral, a golden wheat field, a woman with pink hair, a mountainous landscape, a colorful paint splatter, and a bottle of Lane Flocage beer.

¹⁹ Spectrograms are basic graphical representations of sounds and music that allow to see how sound frequencies change over time.

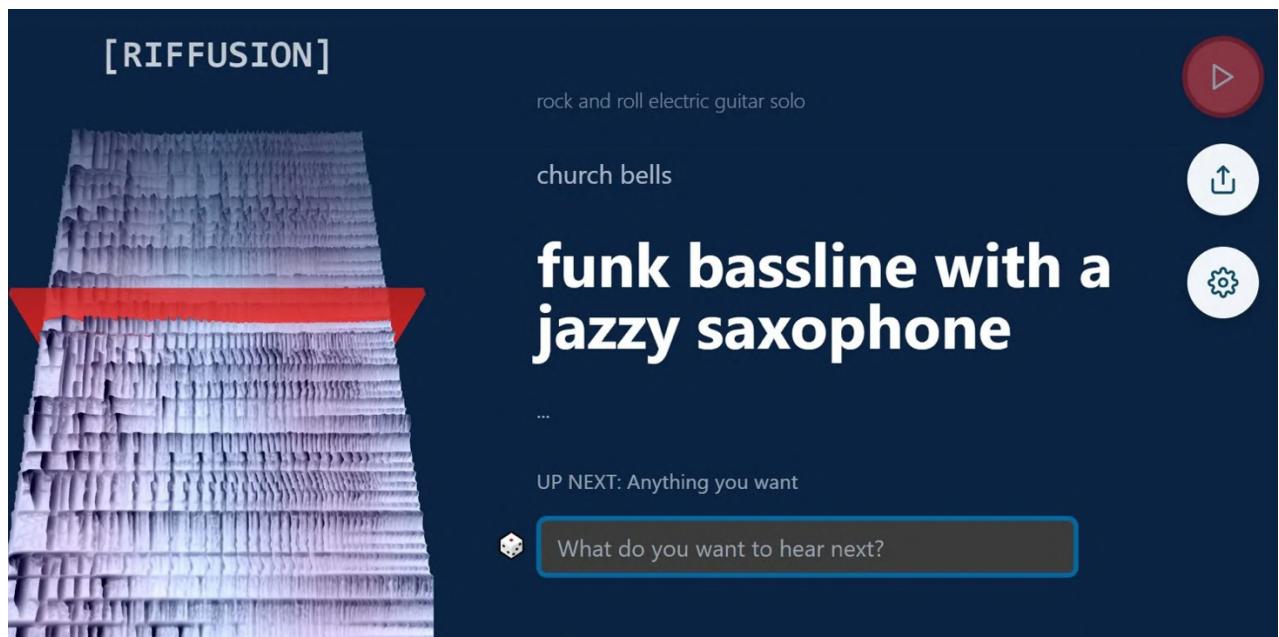
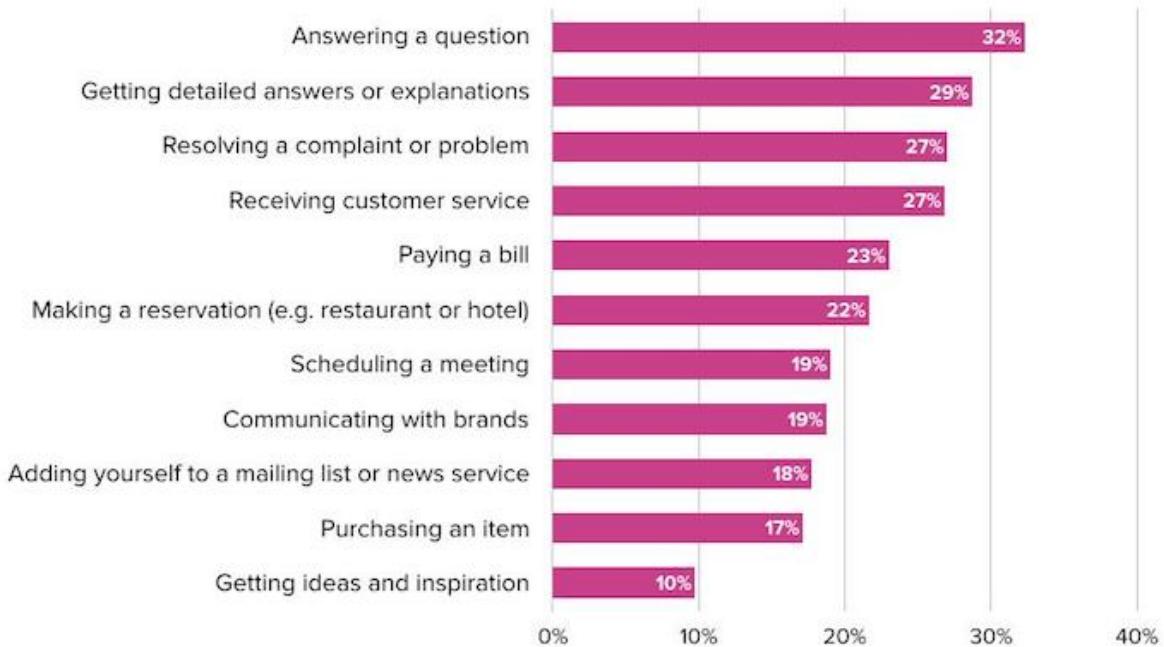


Figure. 11 – Examples of Copy.ai’s webpage, pictures created by Midjourney.ai, and Riffusion’s webpage (respectively)

3.4 Benefits and limitations in using chatbots in businesses

Chatbots are progressively being integrated into companies and are quickly becoming the Internet's future. In 2016, in Insider magazine it was stated that chatbots will be used in some manner by 80% of companies. Barbara Jassova in *Chatbot Statistics 2021: State of the Market & Opportunities* (Landbot, 2021) presumed that the chatbot industry was valued at \$17.17 billion in 2020 and it is expected to grow to \$102.29 billion by 2026. As a result, it can be affirmed that chatbots can be implemented in every possible field. The following diagram represents the most required customer purposes in using a chatbot (Patel, 2023).

Which of the following would you use a chatbot for?



Besides the obvious chatbots advantages perceived by individuals, what can be the benefits for a business that decides to integrate a chatbot in its management?

Among the major benefits offered by business chatbots it can be noticed a better customer service, more sales and revenue, cost savings, more efficient social media marketing, messaging apps applications, human resources assistance, and engaging personal services.

- Better customer service: this relates two crucial activities that represent customer engagement and product recommendation. Customers increasingly expect faster and easier resolutions to their problems than ever before. According to a recent HubSpot survey, 90% of customers predict an instant response when engaging with customer service. This is why many clients prefer live chat to other communication methods like email, phone, and social media. Chatbots provide your company with a 24/7 channel to handle onboarding, assistance, and other tasks (since they have no need to sleep or eat), increasing customer satisfaction. Learning customer preferences, guiding them on the sale process, and offering the best solution based on their needs are key objectives in order to keep customers. Product recommendation is determining in this purpose. Amazon is a perfect example of a business that executes product recommendations so successfully that its suggestion engine produces 35% of its income.
- Extra sales and revenue: chatbots can assist potential customers in more quickly finding the information or items they desire. This kind of real-time guidance can help tailor the buying experience and contribute to more conversions. For instance, a chatbot could give

promotions and discount codes to those who shop online on the website and who might miss, increasing the possibility of purchase. In addition, a chatbot can be placed in the website's check-out page to answer inquiries and consequently reduce cart abandonment.

- Cost savings: surely, the most significant advantage of establishing chatbots is that they allow businesses to give more cost-effective service. Thanks to chatbots' main function, that is performing simple and repetitive tasks, they can free up staff members from these tasks and therefore focus on more complex (and more "human") duties (Lau).
- More efficient social media marketing: with the proliferation of messenger platforms for businesses, one of the most essential channels is social. Chatbots greatly increase user engagement on these prominent social websites and converse with clients via live chat platforms such as Facebook Messenger. Chatbots are redefining social media marketing because they let users interact with them for transactional and customer service purposes.
- Messaging apps applications: consequently, messaging apps are proliferating as well, and an efficient chatbots business use has also been found in this field. BookMyShow, an events tickets online booking app, has incorporated WhatsApp for Businesses so that ticket confirmations are automatically sent as WhatsApp messages. Users will receive a WhatsApp message with a confirmation text or a M-ticket (mobile ticket) QR Code after making a reservation on BookMyShow.
- Human resources assistance: a major aspect of HR (human resources) activities is recruitment. For this reason, tasks may be handled easily using chatbots. FirstJob, a platform for jobseekers, developed Maya, an AI chatbot plays the role of recruiting assistant. Maya takes care of the initial interview asking "basic" questions like personal information and previous work experiences, thus lightening hiring managers job who will subsequently handle the actual recruitment of the candidate with an in-depth interview (Patel, 2023).

In particular, peculiar chatbot use cases can be adopted in specific fields. Chatbots for banking are employed by both workers and clients. In order to better satisfy the evolving requirements of their consumers, banks are modifying their business models and embracing digital technology. The banking sector has made significant financial investments to simplify payment procedures for customers and improve business operations. For instance, Capital One introduced Eno, a virtual assistant that tracks bills and purchases, helps consumers keep their credit cards safe, and offers support around-the-clock. The chatbot adoption is rapidly expanding also in the travel field as airlines become aware that customers prefer conversing on messaging platforms to manage their tickets,

plan their travels, and receive customer care. Thanks to AI, chatbots may learn from their users' preferences and deliver a personalized experience that increases sales. The hospitality sector is constantly seeking for fresh approaches to improve client satisfaction and customer service. Restaurants and hotels are using chatbots to acquire a competitive edge on a greater scale. For instance, Alexa for Hospitality was introduced to operate as a virtual concierge for visitors, simplifying tasks like scheduling a restaurant reservation, playing music, and checking in and out. Chatbot technology is adopted also in the healthcare industry in order to help both patients and nurses with questions about insurance and health, and in the gaming industry to furnish support to gamers (Botpress Community, 2022). Finally, precious chatbot benefits can be noticed also in the cultural sector, in particular in the next paragraph will be deeply analyzed chatbot applications in the museum context.

Benefits and opportunities offered by chatbots are certainly numerous, nevertheless they cannot do everything. The intention is not replacing humans with chatbots, on the contrary they have to assist and facilitate workers in their job. The immense potential is obviously evident, but there are also problems. Chatbots do not always function, and as a consequence, you cannot achieve your goal, and it takes longer to get the needed outcome, and therefore chatbots lose utility. Excluding scenarios in which a person can detect whether he is conversing with a chatbot or not, it is required to evaluate whether it is correct or incorrect for the chatbot to identify the user as Artificial Intelligence. A human's expectations differ depending on the interlocutor, hence it is essential that AI defines itself as such without attempting to mimic a real person. It is not necessary to engage emotionally in a conversation with a chatbot because this investment cannot be returned; also, the chatbot may reply poorly and consequently provide an unpleasant experience (Informatica e Ingegneria Online). Unfortunately, as noted in the previous paragraph, some people abuse chatbots. Hackers have created bots capable of disseminating viruses that may attack not only the devices that receive the message, but also the whole network to which it is attached, and all the devices connected. There are also spambots which disseminate promotional information collected by the network with the goal of driving traffic to a specific site. It is essential to point out how harmful chatbots can be to users' and businesses' privacy and security. The famous Tay, the bot introduced by Microsoft in 2016 on Twitter and other social networks, exemplifies the bad and unpleasant aspects of the chatbot experience. Tay had been taught to mimic a regular conversation by repeating like a parrot and then responding with meaningful phrases. It was a flop, however, when Tay began writing racist statements, offending, and denying the Holocaust. Microsoft was obliged to destroy the bot as a result of the disaster (Obiettivo Digital, 2020). Therefore, chatbots limitations and disadvantages can be summarized in:

- Chatbots are still not that accessible: a significant portion of chatbots lack intelligence. They are developed using decision-tree logic, making the bot's response based on specific words

recognized in the user's input. This means that decision-tree kind of bots are only as clever as the designer or programmer's ability (and patience) to foresee all probable user use cases and inputs. It is still quite rare to find bots that can learn linguistic and natural language skills.

- There are not very strong use cases: designers and developers are always quite enthusiastic about the latest technologies that are released into the market. Currently, there is a gold rush among businesses competing to be the first in their niche to successfully implement a bot. There is an enormous number of bots that are solving for unrelated use cases or providing really mediocre experiences during that process. Our industry must learn from its mistakes before it can use bots that are actually useful and intelligent. This is a normal part of the cycle.

- Chatbots do not really understand the context: bots are unable to remember context for more than a few chat bubbles, with the exception of those powered by NLP technology, and they will eventually lose track of what the user was saying before asking the question, as represented in Figure. 12.

- They do not interact with the current business systems: trying to rebuild functionality from scratch is a natural temptation while developing a chatbot. For instance, imagine building a bot to schedule appointments at a spa. If the chatbot cannot interact with the spa's existing appointment management system, the owner will have to put in more effort to fulfill customer requests made through this new channel, which will eventually result in inconsistent service for the customer. Bots are an integral part of a bigger ecosystem that is made up of several points of contact between consumers and companies. For organizations and customers alike, building a chatbot without looking at the overall ecosystem may be counterproductive.

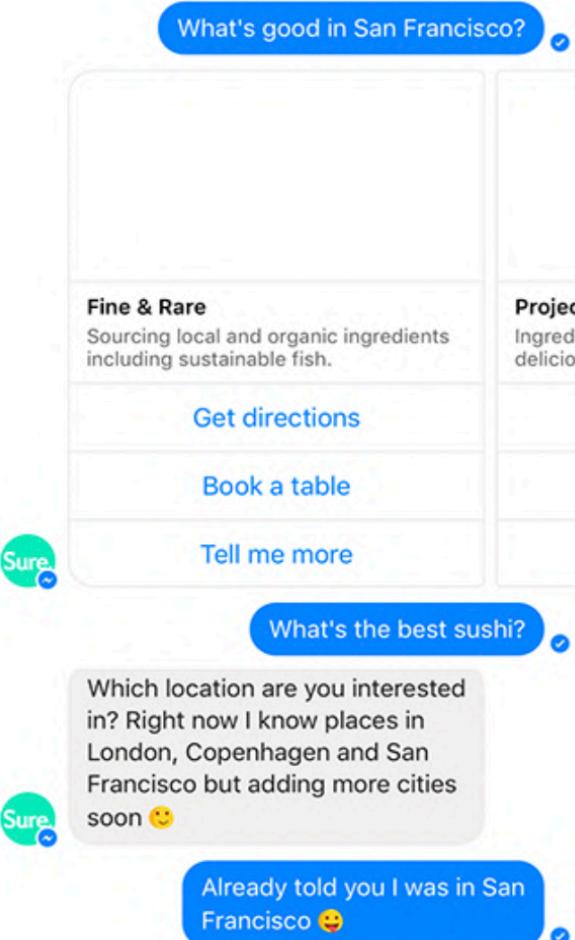


Figure. 12 – A case in which a chatbot do not comprehend the context of the conversation.

- They attempt to manage too many tasks at once: designers and developers frequently get excited about all the jobs a bot may assist without remembering to focus it in a certain area. The key objective is not attempting to solve issues that are outside of the scope. Bots that specialize in a single task are more useful than bots that specialize in a variety of tasks.
- They do not have sufficient human escalation mechanisms: users still want to be able speak to people when technology fails to address their concerns. However, very few chatbots are equipped with an escalation mechanism that enables a person to take control of the discussion if the bot is unable to assist (Chatbot.fail, 2022).

3.5 Chatbots as new opportunities for museums

In light of this detailed history, classifications, and applications of chatbots, it may not come as a surprise that museums and other cultural institutions have experimented and are experimenting with new forms of audience engagement using emerging technologies such as Artificial Intelligence and chatbots. Museums can create fascinating items by combining in-house or simple production processes with design thinking practices (Boiano, Borda, Gaia, Rossi, Cuomo, 2018).

Museum's audience is often reached through a range of methods, including Web sites, help desks, human guides, and brochures. Museums are making significant efforts to combine these many means in order to produce an organized graphic layout for digital and printed communication or to provide the option to contact the human helpdesk via e-mail or chat. The website might be created to be accessed or even updated by museum visitors using touch screens and wireless devices. Due to the challenge of developing a cohesive and really usable interface for various tools and circumstances, these initiatives are still far from achieving a true and total integration. It is surely shared by all how challenging it is to consistently maintain a website while integrating a variety of information from various sources and in various forms. Furthermore, those who lack computer skills cannot access the website at all. A new generation of natural language recognition technologies and their user-friendly interfaces provide an approach to achieve a deeper integration. Any source (e-mail, chat, Web forms, phone) of text inputs and spoken language may be understood by these programs. After receiving the input, the system will attempt to determine the correct response by applying intricate interpretation rules and by examining various databases either inside or outside the infosphere of the museum. After being discovered, the answer can be delivered to the user in a number of ways: Web, e-mail, text, and voicemail communications. These interfaces can incorporate a variety of practical applications, including customer service, e-learning education, interactive guides, shop assistants, and museum mascots. It is also simple to imagine the system playing a

proactive role. For instance, given that it can communicate with users in real time and gather important information about their wants and preferences, the system may individually invite individuals to museum events in a way that is always extremely natural and participatory. Does this qualify as science fiction, especially for modest museums? Maybe not. Now, it is conceivable to create robust, simple-to-maintain solutions on low-cost platforms by integrating the museum's IT infrastructure with AI-based characters. They might serve as a user interface for voice recognition software, databases, and content management systems that are already in use (Boiano, Gaia, Caldarini, 2003).

As a matter of fact, even if the field of research on Artificial Intelligence and chatbots has expanded greatly, it is still slightly limited regarding the cultural heritage sector. This mismatch is unexpected given that chatbots are typically viewed as helpful tools in the digital age; indeed, they can improve communication, make information simpler to obtain, and integrate with institutions' digital media/marketing strategies to help them grow and attract new audiences. Chatbots provide unique, instantaneous interaction methods, and as texting becomes more and more common, they are considered as helpful for attracting customers in a variety of ways. Furthermore, normally there is no need to install any additional programs for them to function on a mobile device or in a browser (Tzouganatou, 2018). With chatbots, typical "pain points" may be removed. Chatbots are accessible 24/7, unlike personal tours, which may have setbacks like cancellations or delays. Conversations with museum visitors revealed that people frequently pose specific inquiries about certain artworks. Classical audio guides cannot provide detailed answers. In the museum, a chatbot may act as an expert, answering queries and providing further information (Schaffer, Gustke, Oldemeier, Reithinger, 2018). On the other hand, chatbots are only accessible to those who have Internet connection. There is an additional accessibility barrier for those that use messaging services connected to certain social media platforms, such Facebook Messenger: users need to have or create a profile on the social network in order to communicate with the bot. Furthermore, as the majority of chatbots have been developed to be able to provide short talk and not engage people in a deeper topic, it is difficult for them to continue meaningful dialogues with users. Additionally, there are technical issues with bots, such as the fact that they behave somewhat differently in each web browser and that depending on the user's browser, some features (such as ready-made answers) might stop working as planned. These difficulties could soon be resolved, though, as chatbots are only in the early stages of development and their technology is fast developing (Tzouganatou, 2018). Apart from some limitations, the emerging of free chatbot-creation platforms (e.g., Chatfuel, Chatterbot Eliza, among others) and open APIs, for example, can allow both large and small museums to experiment with chatbots with relatively little effort while keeping costs and staff resources low, and potentially having less impact on existing infrastructure (Boiano, Borda, Gaia, Rossi, Cuomo, 2018). In this context, it is necessary to examine how Chatfuel works as it is the platform used by MAXXI to develop its chatbot, the only museum among those analyzed in the next

chapter to use a platform autonomously to develop the chatbot project. Chatfuel is a chatbot platform for building chatbots for Facebook Messenger, Instagram, WhatsApp, and websites. It ranks among the most popular chatbot software brands globally, also thanks to its simple and intuitive UI (User Interface). A menu with the numerous Chatfuel software functionalities is available on the left side, while the content of each part is displayed on the right side. Users can create folders with flows inside of them while constructing your chatbot, and they can use a Visual Flow Builder to design and modify your chatbot flows, as represented in Figure. 13.

The figure consists of two screenshots of the Chatfuel interface. The top screenshot shows the Visual Flow Builder. On the left, there's a sidebar with 'Flows' and a 'New flow' button. The main area shows a flow starting with a 'Start' node, followed by an 'Action' node, and then a 'Condition' node. The bottom screenshot shows the Block builder interface. On the left, a sidebar lists various bot components like Home, Automation, Flows, Blocks, and Keywords. The main area shows a 'Welcome Message' block with a preview window displaying a welcome message to a user named 'first name'. Below the preview are sections for 'Inbound links', 'Outbound links', and a list of actions including 'See our menu', 'Make reservation', and 'Dessert recipe'.

Figure. 13 – On the top Chatfuel main menu interface, and on the bottom Chatfuel block builder interface

Besides the visual flow builder, users may create chatbots using their block builder. Each piece in the block builder can represent a different component of a chatbot. You might, for instance, have a block for displaying the goods in your store and another for getting the user's email. Additionally,

users may group the blocks into "Sequences" or "Groups" to keep everything organized, and they may test it before actually making the chatbot flows live. For this reason, it is flexible and utilizable by every kind of user. Obviously, Figure. 13 shows the chatbot of a restaurant, but the same procedure can be followed by a museum. To help users create their own chatbot, Chatfuel offers a large selection of building blocks, including delays, pictures, video, audio, emoticons, rapid responses, buttons, free text input, email, phone number, and date validation. It only lacks in two elements, that are attachments and location sharing, but these are absolutely not deal-breakers, and users have all the chatbot components required to build a great chatbot. Another important complaint is that the chatbot can only identify keywords. It responds in a certain way based on a keyword (or set of keywords), and the user's purpose cannot be determined, nor can synonyms or entities be used. Figure. 14 shows how it looks in Chatfuel.

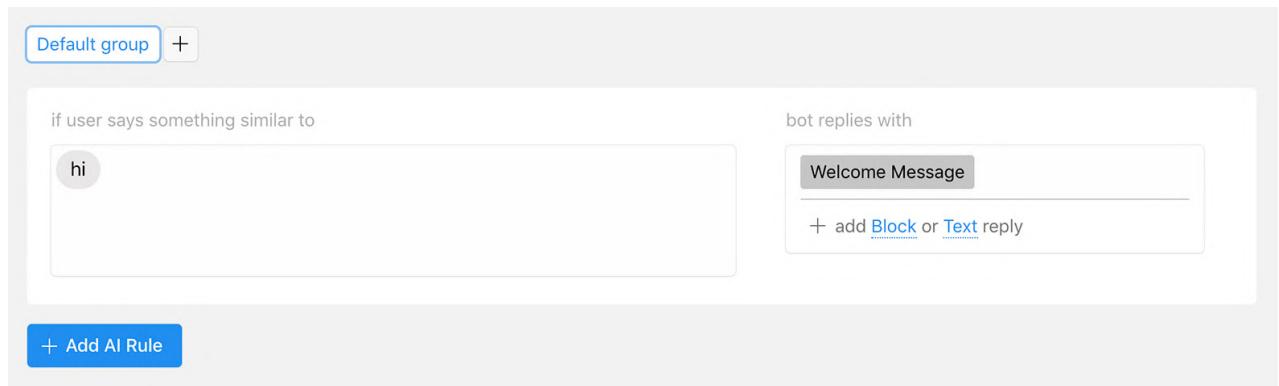


Figure. 14 – Chatfuel training interface

Nevertheless, Chatfuel is not entirely free. As long as users do not have more than 50 users, Chatfuel offers a free subscription that allows access to all the services. The subsequent plan costs \$15 per month for the first 500 subscribers and increases as users add more customers. One thousand members cost \$20 per month, while two thousand cost \$30. However, they also offer a Premium plan for those who really want to further develop a chatbot game, which includes VIP assistance, a dedicated Account Manager, synchronized cloning, and a white-labeled dashboard (the cost of this plan is customized). Chatfuel is certainly one of the best chatbot platforms especially for those who are just starting with creating chatbots. As museums are just starting out with these new technologies, Chatfuel is definitely a perfect tool to get started (Wouters, 2023).

As a matter of fact, an increasing number of museums are taking this approach and incorporating bots into their audience interaction activities. The first museum chatbot initiatives were presented in 2003 at the *Museum and the Web conference* in Charlotte, North Carolina, and they represent two systems meant to work on the Internet. Pilar de Almeida and Shigeki Yokoi of Nagoya University in Japan created the first, which functioned as a guide for a virtual display. The conversation began with a basic introduction, followed by a series of remarks and thoughts to initiate a discourse, following the format of the typical museum guide. According to the findings of the evaluation

questionnaires, the bot could deliver information content but struggled with interaction and understanding. The second is a project designed by Morgana Calderini, Stefania Boiano, and Giuliano Gaia for the National Museum of Science and Technology Leonardo da Vinci in Milan. The bot was part of a larger operation to create a new website with instructional capabilities. The concept was inspired by the success of a series of chats between a museum expert and several remote courses. They selected a bot as an unconventional "teacher" due to the difficulties of having enough number of individuals to provide this formative experience on a consistent basis. Unfortunately, the project has not been concluded. Twenty years later, the initiatives detailed above appear pioneering for the time. Chatbots are only beginning to be utilized by museums in 2015, as the conditions for their usage improve and the digital context matures. Today's cultural organizations recognize the enormous value and potential of digital media in communication, audience participation, and education. The term "post-digital museum" refers to museums where the digital is a tool, strategy, and way of thinking. In terms of infrastructure, museums can count on the widespread adoption of the "Bring Your Own Device" (BYOD) strategy, which focuses on the use of visitors' own devices as a method of communication: this provides for both wider access to museum material and higher health security. The ability to rely on stable platforms, such as Facebook Messenger and Telegram, on the other hand, has allowed museums to design their own system, as well as a facilitated its use. The release of the Facebook API in 2016 enabled the incorporation of chatbots on the network. Already two years later, there were over 300,000 Facebook Messenger agents. According to Deborah Agostino, director of the Observatory Digital Innovation in Cultural Heritage and Activities, "*69% of museums are present on at least one social media channel (they were 57% in 2018), where Facebook remains the most popular channel (67%, a strong growth compared to 54% in 2018), followed by Instagram (26%, was 23% in 2018), which is constantly growing*". Since 2015, there have been several national and international experiences in the building of chatbots for text-based interactions in museums. By examining them, it can be identified three major usage styles:

- Virtual guide
- Gamification
- Increase in the museum experience

These approaches can be blended with each other. Each chatbot actually develops inside a particular setting that influences the design elements and ultimate goals (Castellucci, Gomelino, 2021). It is meaningful to analyze few pertinent examples that demonstrate various strategies and illustrate the development of the underlying technology. However, Chapter 4 will be entirely devoted to the analysis and comparison of specific Italian cases.

Send Me SFMOMA was created by the San Francisco Museum of Modern Art (SFMOMA) as a strategy to increase collection openness while inspiring more user investigation and conversation. A friendly, imaginative, and engaging way to introduce the public to the scope of the SFMOMA collection is through the SMS service Send Me SFMOMA. Users can text to 572-51 with the words

"send me" followed by a color, a keyword, or even an emoji to get via message a connected artwork image and caption, as shown in Figure. 15. Examples include "send me something blue" for Yves Klein's Éponge, or "send me the ocean" for Pirkle Jones' Breaking Wave, Golden Gate. Each text message prompts an API query to be sent to the SFMOMA collection, which subsequently returns a piece of art that matches the request. In only four days, over 12 000 text message requests resulted in the creation of over 3,000 unique works of art that were sent to people all around the world. According to Jay Mollica, "*thousands of individuals are interacting with artwork in enjoyable, novel, and deeply personal ways. This is something we have observed and plan to continue to do. Many of these works of art are also now in storage and are not frequently viewed by the general public. You won't receive 791 sceneries when you ask, "Send me a landscape," you'll get one specifically picked for you.*" (Mollica, 2017).

The Anne Frank House Museum in Amsterdam introduced a Facebook Messenger chatbot in March 2017 that enables people to learn about Anne Frank's personal history and useful sightseeing information (Figure. 15). This program, which is more than just a collections discovery bot, includes a variety of conversation routes that let users explore numerous paths of the Anne Frank story with precise information and access to other resources, such as passages from her diary or facts about the history of the Second World War (Boiano, Borda, Gaia, Rossi, Cuomo, 2018).

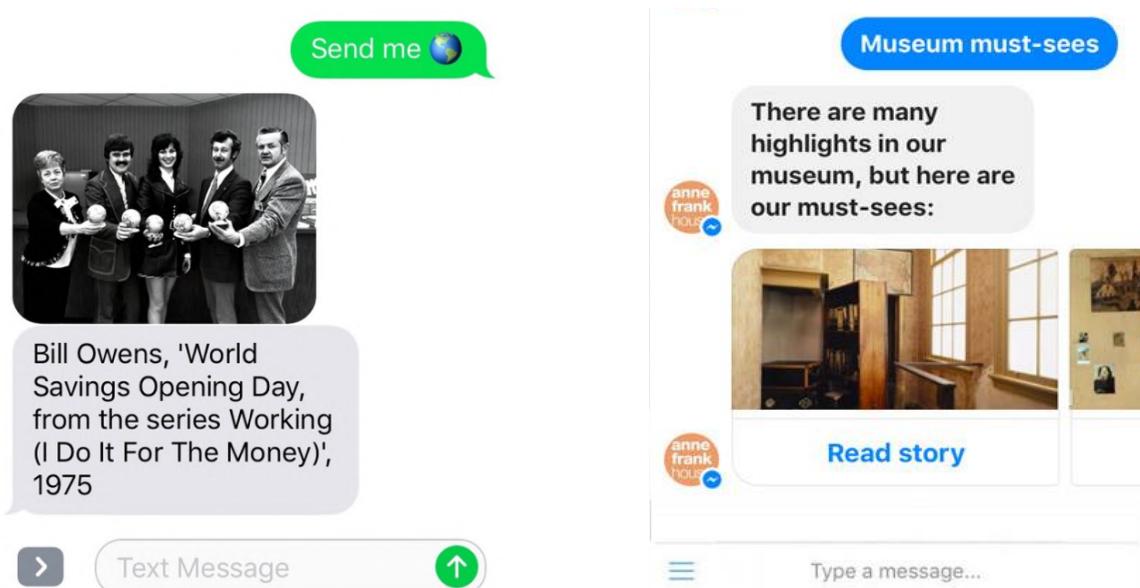


Figure. 15 – A conversation with Send Me MFMOMA and Anne Frank House Museum chatbot, respectively

In the Field Museum of Natural History in Chicago, it is exhibited the life-size cast of the biggest dinosaur ever known (*titanosaur patagotitan mayorum*). A chatbot named Máximo brought it back to life in May 2019. Máximo was created to have a free-flowing conversation utilizing an AI-based technology. In particular, the bot has been taught to respond to every question that, in the designers'

opinion, a dinosaur 100 million years old should be able to answer. This entails being able to describe its way of life and ecology and explain the vicissitudes that brought it to Chicago. Máximo provides users with a novel experience by allowing them to communicate with the collection's protagonist both inside and outside of the museum. The creation of a distinct personality for the bot that would also be credible and, most importantly, amusing was a key component of its design. To make sure that the user is truly motivated to communicate and recognizes the bot as an interlocutor rather than a computer, the development of a character is essential. The bot failed the initial user testing because the interlocutors' inquiries were unclear or had unclear phrasing. The so-called "grammatical listeners", receptors that recognize the specific sentence components that can be confusing or ambiguous, have been incorporated to resolve this problem. After being intercepted, the system identifies a number of pre-made sentences that the programmers improvised. By doing this, a "silent scene" may be avoided, and the discourse can continue (Castellucci, Gomelino, 2021).

The Museum of Tomorrow at Rio de Janeiro developed IRIS, a chatbot that has been deployed on various screens across the museum. Visitors receive a smart card at the entrance, and they can communicate with IRIS screens whenever they see them. IRIS is a chatbot that was created using the IBM Watson platform and employs NLU and ML approaches to encourage people to discuss various human issues and voice their concerns. IRIS ends the conversation by recommending a nearby project in which visitors may get involved. The chatbot was trained for many months using testing teams and a variety of testing techniques. IRIS is mainly an oral chatbot that communicates through speaking, and it can converse in both Portuguese and English. However, a text input interface version had also been developed in order to accommodate visitors who were hard of hearing (Varitimidis, Konstantinos, Pittou, Konstantakis, 2021).

The examples are concluded with a very interesting European project called Culture Chatbot, a platform developed under the Europeana Generic Services²⁰ projects for creating chatbots specifically for cultural heritage organizations. This service is completely free for all cultural heritage institutions, and it provides 24-hour assistance and guidance to online users. A near real-time and highly appropriate answer to visitors' inquiries is provided by Culture Chatbot, which improves the entire user experience of cultural heritage platforms. By providing support in the user's native tongue, the platform enables cultural heritage organizations to break down linguistic barriers, boost community awareness of their holdings, and foster more interaction with them (Europeana Pro, 2020).

²⁰ The European Union built Europeana, a web portal that houses the digitized cultural heritage assets of more than 3,000 organizations around Europe. It contains records of more than 50 million scientific and cultural artifacts, gathered on a single platform and shown in a variety of ways that are suited to modern users. The European Digital Library Network (EDLnet), which debuted in 2008, served as the model for Europeana.

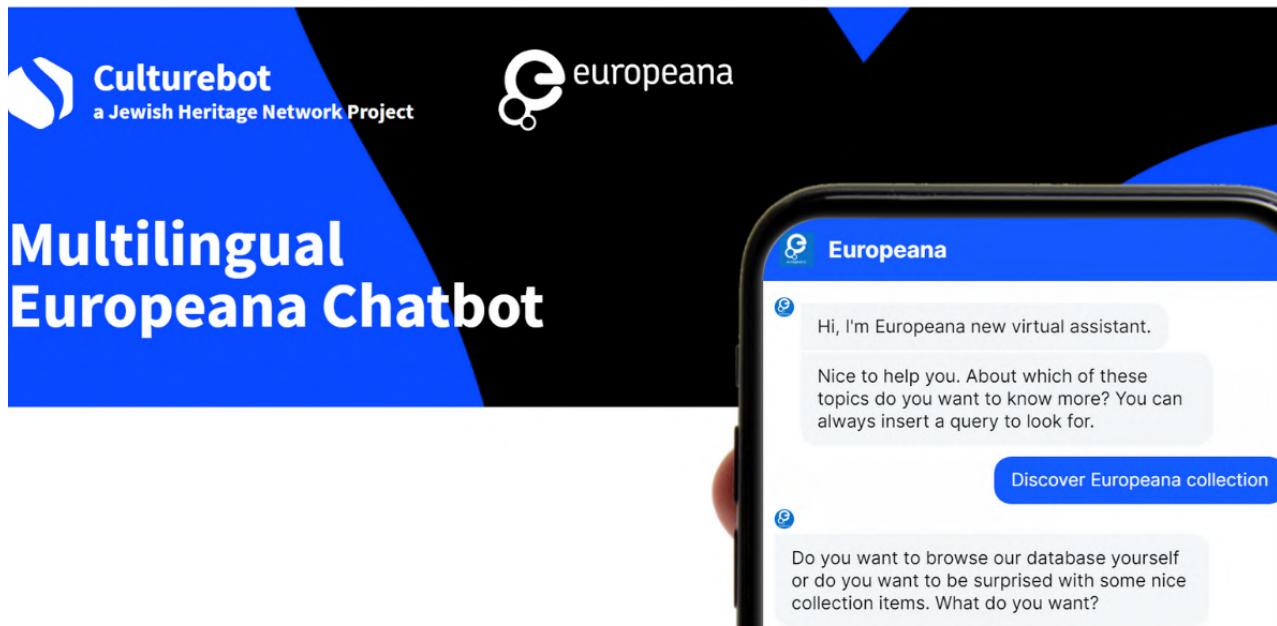


Figure. 16 – Culture Chatbot website

Five different types of chatbots may be identified in the museum sector based on the relevant work on museum chatbots that are stated above. Conversational abilities and user engagement strategies used by chatbot developers serve as the criterion for this classification. These types include:

1. Simple QA informative chatbots (infobots), like the Send Me SFMOMA chatbot, are conversationally constrained and can simply deliver basic information about the museum and its contents.
2. Chatbots that have predetermined conversational paths, allowing people to follow them by clicking on text or picture buttons to learn more about the museums. They are not very good at conversing. A good example of this kind of chatbot is the one at the Anne Frank House in Amsterdam.
3. Gamification and rewards chatbots strive to engage users by offering prizes and gamification elements like a treasure hunt, even while users still adhere to established conversational paths. However, their ability to converse is restricted. The MAXXI chatbot and the one at the House Museums of Milan are clearly cases of this type of chatbot, and they will both be further examined in the next chapter.
4. Conversational chatbots that encourage users into asking questions about specific details in an effort to take control of the discussion. These chatbots possess good conversational

skills. The IRIS chatbot at Rio de Janeiro's Museum of Tomorrow is an example of this kind of chatbot.

5. Conversational chatbots that are completely human-like, allowing users to ask virtually any question without restriction or following a set path. The chatbots can comprehend the user's purpose and typically give the appropriate response. Such a chatbot is Máximo the Titanosaur at the Field Museum of Chicago (Varitimiadis S., Konstantinos K., Pittou D., Konstantakis, 2021).

The above-discussed bots with appropriate information and gamification components seem to be the most interesting. But how might the limits of existing bots be further pushed? Without a doubt, there is a lot of space for growth. Such an enhancement may involve the creation of more complex bots to promote and cultivate user interaction, i.e. proactive bots that can create a two-way connection between audiences and artistic sites. This would require close cooperation between bot developers and artistic organizations to address the requirements of the particular institution and its target audience. Heritage bots have a chance to thrive if they go beyond just giving information. The bulk of those now under development and available online are closed and didactic in nature. The next stage is to turn them into actual chat mechanisms that invite users to actively interact with and participate in the conversational experience (Tzouganatou, 2018).

Chapter 4 – Chatbot for audience experiences in Italian museums: a comparison

Cultural organizations are increasingly utilizing chatbots as an effective instrument to attract young people from the digital generation in fresh and engaging ways. Museums and galleries seem to increasingly move towards an interactive visiting experience, which aims to converge all information to mobile and personal devices. According to recent studies, consumers enjoy communicating with chatbots in a gaming setting where curiosity serves as a catalyst for exploring the museum while also conforming to everyday messaging and social media usage. However, it appears that the road to their widespread usage inside Italian museum organizations remains an “obstacle race” and characterized by hostility and mistrust. As a matter of fact, according to the 2020 report of the Observatory Digital Innovation in the Cultural Heritage of the Polytechnic of Milan conducted by Eleonora Lorenzini, out of 430 museums, only 24% of them are ready to start using chatbots, and 71% are not interested in employing them. There is still a long way to go for digital innovation within Italian museums (Art Backers Agency, 2020).

4.1 Purposes and criteria of the comparison

As already mentioned, this thesis seeks to dispel this situation of mistrust from cultural institutions about the introduction of new technologies, especially AI technologies, and demonstrate how Artificial Intelligence can bring benefits for both visitors and museums. AI applications can make the visitor experience more interesting and enjoyable while, at the same time, making the internal museum management easier and more effective. The final objective of this research is really to critically examine and compare specific cases of Italian museums that have decided to include in their cultural and artistic offer chatbots that help to improve the audience experience.

After an extensive research, we identified seven Italian museums that use/used chatbots for common goals but also with different purposes. The museums that will be analyzed in the next paragraph are:

- House Museums (Milan)
- MAXXI (Rome)
- Mart (Rovereto and Trento)
- Foundation FILA Museum (Biella)
- Opera di Santa Maria del Fiore (Florence)
- Galleria dell'Accademia (Florence)
- Parco archeologico del Colosseo (Rome)

It is immediately clear the difficulty in finding Italian museums that are using chatbots within the organization, and this point will be discussed extensively at the end of the chapter. Museum institutions of great importance at national level and smaller realities have been chosen in order to make the comparison complete and more relevant to the research. Over a period of four months, each museum was contacted asking information about chatbot projects and therefore conducting interviews. All of them included the same questions about using the chatbot within the organization, and they were as follows:

1. Can you give me a general outline of the chatbot project?
2. Why did you choose to introduce a chatbot into the museum organization?
3. What are the aims and objectives of the developed chatbot?
4. How was it designed and which programs/software were used?
5. What was the degree of user participation?
6. What are chatbot strengths and weaknesses?
7. Have there been any changes in the museum's organizational/management structure since the introduction of the chatbot? Was any specialist staff hired to create/manage the project?
8. Before the chatbot introduction, how was filled the role now played by the chatbot?

The interviews, conducted in Italian, will be fully reported in the appendix (page 121). The analysis of the cases that will be presented in the next paragraph is the result of a combination of the information collected from the interviews, chatbot presentation files provided by project managers, press releases, museum's websites, and academic papers.

4.2 Cases analysis

House Museums Bot

Poldi Pezzoli Museum, Bagatti Valsecchi Museum, Casa Boschi di Stefano, and Villa Necchi Campiglio are four historical homes in Milan gathered in the network of the House Museums of Milan since 2008. The four House Museums, which vary from 19th-century buildings (Bagatti Valsecchi and Poldi Pezzoli) to a 20th-century house (Boschi di Stefano), and a 20th-century urban villa with garden (Necchi Campiglio), differ in style and historical period, but share many common features. They each include a significant quantity of delicate objects in their collections, which also include paintings, furniture, handmade items, and everyday life objects. These collections, which are on public exhibition, tend to be static displays, and the artifacts are arranged in ways that are not as clearly

categorized as those seen in museums designed with this purpose. The antiques on exhibit are frequently displayed reflecting the aesthetics of the original collector, which is typical of historic home museums. They typically include "rooms full of every kind of object," curated by the original collectors/house inhabitants, and the artifacts' placements typically have not altered over time. Smaller items frequently go unnoticed since there are so many visual distractions. There is also no dedicated space for interpretive and curatorial signage. For instance, three of the four House Museums in Milan do not have display captions, and visitors are given brochures as a self-guided option. The goal is to minimize interference with the house's original design and the owner's collecting tastes. Due to these constraints, it is difficult to attract repeating visitors, and the House Museums have struggled to engage certain visitor groups, such as teenagers. For these reasons, in 2016, the House Museums launched a strategic initiative intended to encourage people to visit the four museums and explore new digital approaches to engage younger audiences (Gaia, Boiano, Borsa, 2019).

The project was funded by Fondazione Cariplo, a notable Italian charity fund, and they engaged InvisibleStudio LTD, a cultural innovation company located in London, to incorporate gamification into the engagement process. Stefania Boiano and Giuliano Gaia, the creators of InvisibleStudio, had previously experimented with older chatbot technology in 2002, when they were employed at the Museum of Science and Technology "Leonardo da Vinci" in Milan. They developed a chatbot capable of interacting with museum website users as if "he" was Leonardo. Unfortunately, despite the good foundations, the project was a failure. One major issue was that the chatbot was designed to seem like a Leonardo da Vinci personality with whom the user would interact. This generates high expectations for the user experience, which led to dissatisfaction when the bot could not comprehend the user beyond basic introduction dialogue. Anyway, the pioneering project provided important lessons in the development of the House Museums chatbot. InvisibleStudio staff decided to change their approach: the chatbot would only be used to assist people in solving a game set in the museum's physical surroundings. As a result, this technique may move the user's emphasis away from the chatbot dialogue to the real tour of the museum exhibits (Boiano, Borda, Cuomo, Gaia, Rossi). In the initial phase of chatbot development, InvisibleStudio staff came up with the fact that one of the most significant criteria for addressing participation in museums is empathy. Museum personnel should put themselves in the visitors' position in order to understand user demands, which can be challenging but tremendously rewarding when accomplished. InvisibleStudio employed a number of techniques to foster empathy, including close observation of teens inside and outside of museums and in-depth discussions with specific teenagers about their museum visits. The two approaches, in particular, provided some insightful information about teenagers' perceptions toward the museum visit:

- Teenagers are vibrant and not really patient.
- They enjoy competition and challenges.

- They love chatting using social medias like WhatsApp.
- They do not want to spend space on their already busy devices by downloading museum apps since they perceive them as merely single-use.

The InvisibleStudio production team felt that a chatbot game would be an ideal match in terms of the empathetic features arising from the field study after considering the insights from the research. They designed a game that allows players to create their own routes across the four museums. Users of the game are guided through the investigation of unexpected facts concealed in the House Museums' collections (like a treasure hunt) through a virtual character who serves as a virtual companion. Since the chatbot was created using Facebook and Telegram, users do not need to download new apps. Instead, they can communicate with the virtual character in the same manner they communicate with real people on the platform they use every day, that is Facebook or Telegram which were the most popular chatting apps at that time (InvisibleStudio website). The chatbot may communicate with users in two different ways. Firstly, it can ask them open-ended questions to which they must reply. This works best in terms of evoking an emotional engagement, but it presents a challenging interpretation issue for chatbot creators who must anticipate every response that could be given. For instance, if the user answers an easy question like "How many jewels do you see in the painting?" and the right response is "Zero", the bot should be developed to comprehend "0," "Zero," None," "I can't see any jewel," and so on. Users could rapidly lose interest in the discussion if they believe the chatbot has misunderstood their responses. A second kind of interaction involves posing multiple-choice questions with predetermined responses that are displayed to users as a series of buttons (Figure. 1). This is the ideal choice to maintain game flow and minimize interruptions brought on by chatbot and user misconceptions.

It is interesting to note that before the introduction of the chatbot, it was tested on a sample of 80 students from sixteen- to eighteen-year-old form high schools in Milan. The test was very useful in predicting the behavior of teens in the use of chatbot, the findings were as follows:

- 90% of students completed the game.
- 88% think that the game's duration was appropriate.
- 72% found the game really entertaining.
- 66% believed it was an effective learning tool, especially when utilized in a small group or with another student.
- 34% concerned about their data traffic.
- 30% had connection issues (Gaia, Boiano, Borsa, 2019).

Therefore, the results were promising and the chatbot had a good success in the early years. It was trained to speak in Italian and, with a subsequent update, also in English. A very crucial aspect is that the chatbot is not free, it can be activated with the purchase of the House Museums Card that

allows to visit the four House Museums at €25 (full price) or €15 (reduced price). Therefore, if users do not buy the entrance ticket, they cannot use the chatbot.

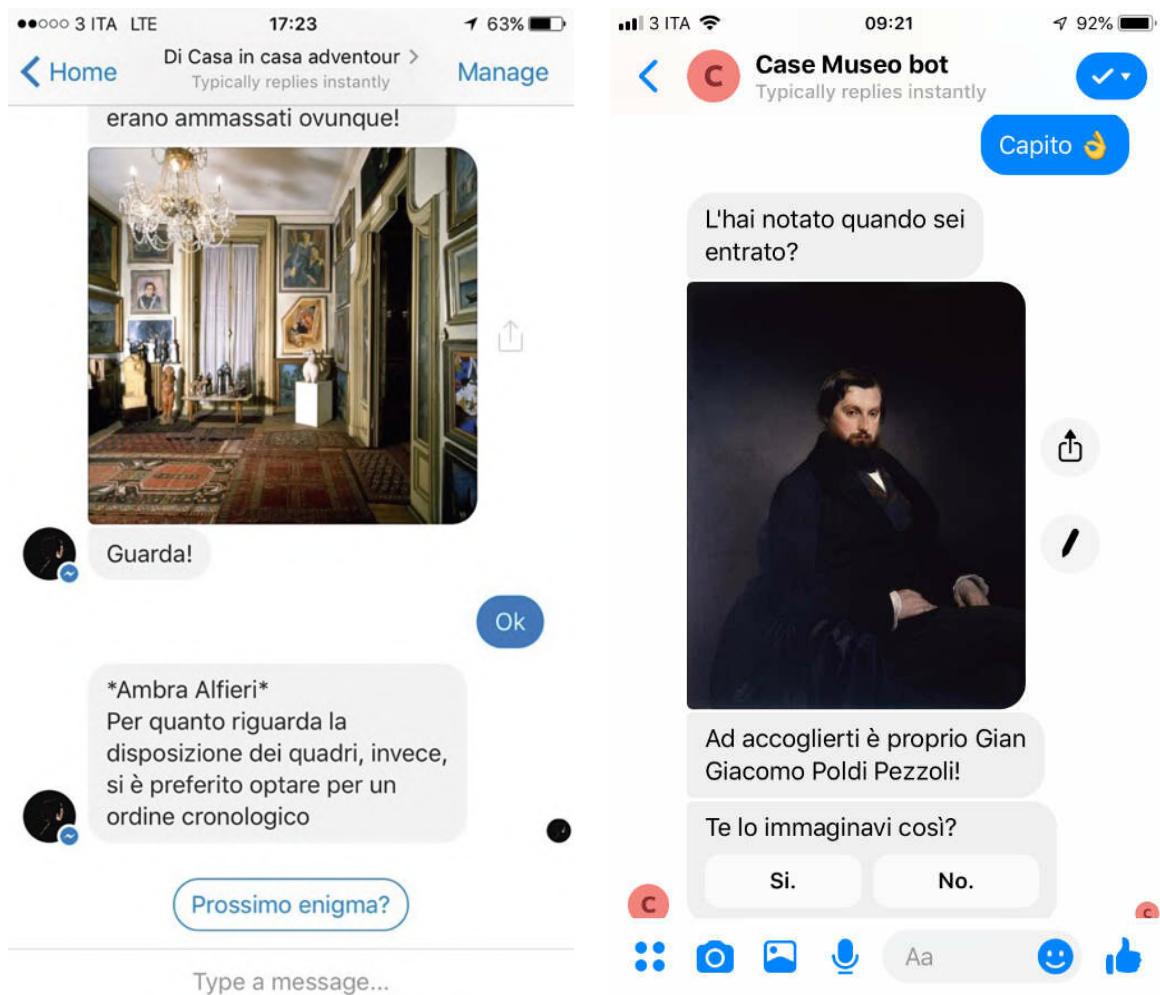


Figure. 1 – Example of multiple-choice question from the House Museums chatbot game (in Italian)

MartMuseumBot

Mart (Museum of Modern and Contemporary Art of Trento and Rovereto) is conceived as a cultural hub rather than a traditional museum. The museum's initial location was in Trento at Palazzo delle Albere which opened in 1987. This building represented its primary home until 2002, when Rovereto became the museum's new headquarters. The public areas of Mart are connected to the University, Biblioteca Civica, Auditorium Melotti, and Teatro Comunale. Mart's collections are priceless; they contain some of the finest works of Italian art from the 20th century, and the museum hosts dozens of exhibitions and initiatives each year. More than 15,000 pieces of art, including paintings, drawings,

engravings, and sculptures, are included in the permanent collection. These works are made by well-known painters including Carlo Carrà, Giorgio Morandi, Antonio Rotta, Giorgio de Chirico, Felice Casorati, and Fortunato Depero. The Casa d'Arte Futurista Depero in Rovereto, which belonged to Fortunato Depero, is also included in the Museum (Mart website).

In 2016, together with House Museums of Milan, Mart was one of the first Italian museum in realizing a chatbot to provide users a new way of visiting the museum. In collaboration with Dimension, a company from Trento that works on Fintech, Tourism and Culture projects developing apps and exploring the possibilities of AI and Blockchain, Mart has created a chatbot that acts as an interactive digital guide that guides visitors both inside and outside the museum as they learn about the architecture, permanent collections, and temporary exhibitions. In this way, visitors can create their own route of discovery of the museum spaces and exhibitions. As deepened in the interview with Annalisa Casagranda, head of education area and editorial curator of MartMuseumBot (see the appendix for the whole interview), the primary goal (and also the very strength) of the project was not to force visitors to download new applications to visit the museum online but to take advantage of the platforms that people normally use to make conversation. For this reason, the chatbot was launched initially on Telegram and subsequently also on Facebook Messenger which at the time were the most used messaging apps. Mart and Dimension encountered as a result of the Museum-FI Creative Ring Challenge, an event designed to connect Trentino ICT businesses and museums or other cultural organizations. The program financially supports the five best projects created to develop cutting-edge ICT solutions in the cultural institutions of the territory. It is promoted by the European Commission as part of the global accelerator Creato-FI and implemented in Trentino by Trentino Sviluppo, with the support of the Autonomous Province of Trento. MartMuseumBot obtained sponsorship of 50,000 euros after its presentation at the Creative Ring Meeting in Barcelona in June 2016 (Trentino Sviluppo, 2016).

For Mart, this project means trying a new and different tool from those normally used in museums to mediate to the public and to communicate the museum contents, in addition to what people expect to find normally at the museum. Sure enough in recent years Mart has focused on technological innovation and digital communication to try to create new and innovative ways to visit the museum. Compared to an audio guide, MartMuseumBot has the advantage of being even remotely used and with a different language that is no longer based on listening to a narration, but on a sort of interaction with short and coinciding messages. It can also be used from home, for example, in preparation for the visit, or to answer curiosity about what the museum offers. During the embryonic and procedural phase, Dimension and Annalisa Casagranda, together with her team, used the method of design thinking to select contents based on observing audience habits rather than trying to imagine what might have interested people, even those things that usually go a little unnoticed. For this reason, the contents range to cover everything that is precious in the museum (not only the collections but also the architecture), and they are continuously updated to train the chatbot about new questions

and related answers. A suggestion that came from the experts of the Dimension team was to include, in addition to the standard content, a button called "surprise me": pressing it users can know curiosities, anecdotes, and facts that come out of the main speech, and they can discover the less obvious things of the museum. If the chatbot does not satisfy user's questions, an option has been introduced that allows to talk to a human museum operator who can answer all questions with direct contact. MartMuseumBot, despite the initial success, proved quite used, the numbers are not low with regard to the general use of chatbot, but when looking at who actually continues the exploration of the museum once used the chatbot the numbers are very low. Especially on Telegram, it was noticed that many users leave the conversation after the first exchange, probably because it is not the type of content they seek, and it goes a little better instead with Messenger. However, the chatbot is still active, but it has been trained only to speak in Italian.

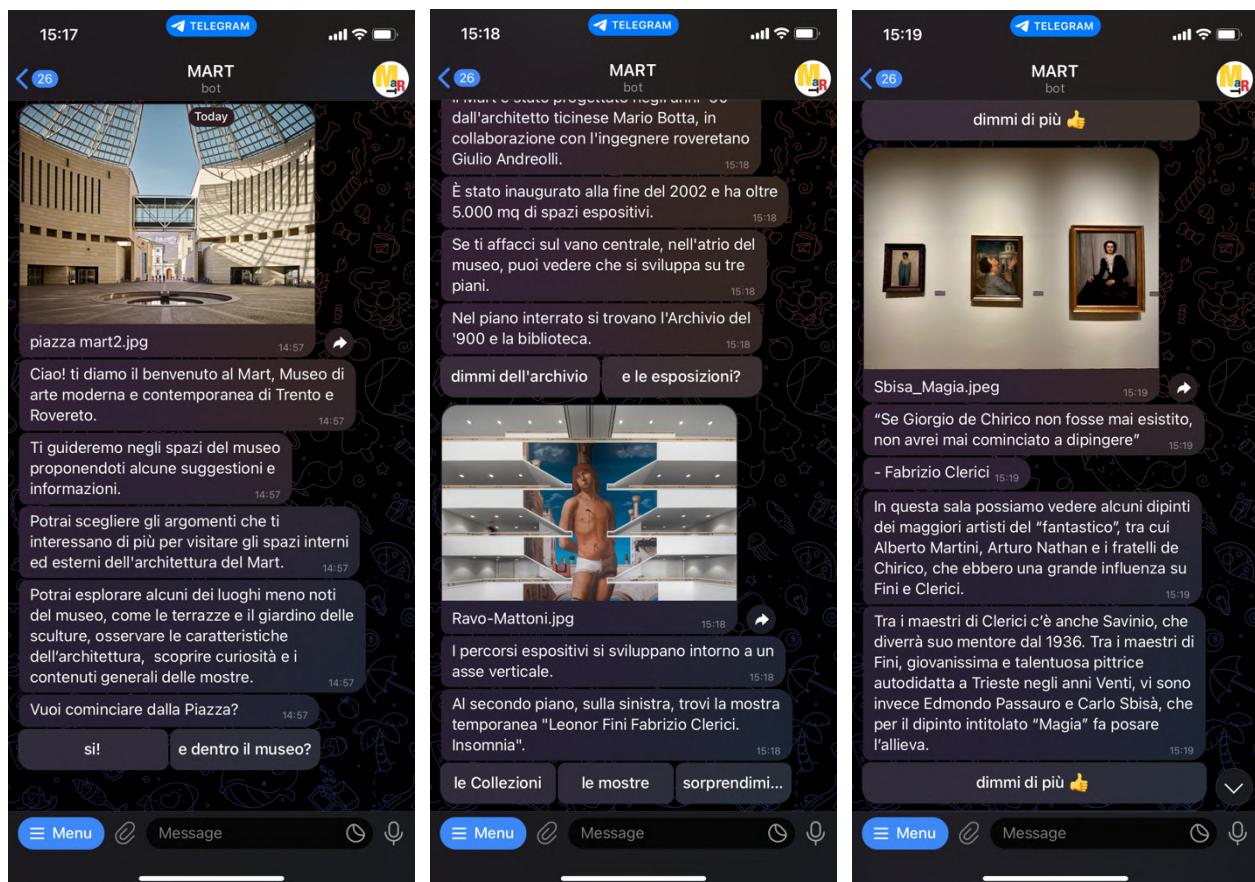


Figure. 2 - Example of a conversation with MartMuseumBot on Telegram (only in Italian)

MAXXI Chatbot

The National Museum of XXI Century Arts (MAXXI) is Italy's first national institution dedicated to contemporary creativity, and it was designed as a vast cultural campus. MAXXI is managed by a Foundation established by the Ministry of Cultural Heritage and Activities in July 2009, and it includes two museums: MAXXI Art and MAXXI Architecture. The programming of the activities reflects MAXXI's vocation as a place for conservation and exhibition of its collections, but also, and most importantly, as a laboratory for cultural experimentation and innovation, for the study, research, and production of the aesthetic contents of the present day. MAXXI building, built by Zaha Hadid and located in Rome's Flaminio district, is a landmark architectural masterpiece with innovative and compelling shapes. The two museums' permanent collections grow through direct acquisitions, commissions, themed competitions, grants for young artists, gifts, and permanent loans. The collection comprehends artworks by Ed Ruscha, Anish Kapoor, Alighiero Boetti, Lara Favaretto, Grazia Toderi, Maurizio Cattelan, Francis Alys, and Kiki Smith, to name just a few (Web Archive of MIBACT).

The chatbot project, called MAXXI, was launched in April 2018 in collaboration with the partner Engineering, a Digital Transformation Company specialized in software sector and IT services. Chatfuel, a platform for building bots that can be used in Telegram and Facebook Messenger chats (in this case they use Facebook Messenger) was used to create the chatbot. According to Prisca Cupellini, head of digital communication at MAXXI, "*The main goal is to be able to quickly and effectively reach a wider audience. Facebook Messenger was chosen because it is a widely used and well-known platform that adapts itself perfectly to information delivery in a conversational tone. Instead of being a traditional audio guide that imparts knowledge, the chatbot test visitors by posing queries and soliciting feedback.*" (Maida, 2018).

Thanks to the information provided by Cecilia Fiorenza, digital communication specialist of MAXXI, it can be argued that the chatbot was part of the digital projects that the MAXXI carries on from its birth, to bring the public closer to the museum, its exhibitions and the collections. Therefore the chatbot project was entirely absorbed by the communication department of the museum. The free chatbot, which is available both in Italian and English, employs multiple-choice responses, and it is integrated with a part of Artificial Intelligence handled by Google DialogFlow, a machine learning-based platform for developing voice and text chat apps. The technology was developed by merging virtual driving mode and a quiz game. The path begins on the outside, admiring Zaha Hadid's massive architectural masterpiece before entering the exhibition halls. Users can pose simple inquiries such as, "What are the current exhibitions?", "Who is Zaha Hadid?", or "What are the museum hours?". Although, the fact that the chatbot is also asking questions adds spice to the dialogue. In front of "Wall Drawing #1153 Ripples" by Sol Lewitt, for example, MAXXI asks the user what he/she thinks the piece was created with. They encourage people to look closely, and to catch

details by engaging in conversation. In order to motivate visitors to utilize this new resource and to return to the museum, the duration of the discussion and participation in the challenges also gives the opportunity to accumulate points in the form of virtual money called Museum Coin, applicable for the purchase of items or services within the museum. Unlike standard audio guides, a chatbot may give a tailored tour path depending on the user's active participation and individual preferences, even though MAXXI Chatbot is lacking conversational skills.

It can be stated that the museum's main aims were surely innovation and visibility, actually the chatbot contributed to the achievement of numerous results, that are:

- Increased accesses to the bookstore.
- Greater visibility for the museum.
- Greater visitor loyalty.
- Increased traffic on museum's social networks.
- New channel to promote exhibitions and events.
- Increased average visit duration.

In 2020, in the midst of the Covid-19 pandemic with all the exhibitions closed, MAXXI distributes a new release in which emotions experienced by users and shared with the bot were a way to discover and deepen the works of the museum collection. Throughout this period the possibility of starting a conversation with the staff has always remained active. The project had a natural conclusion in July 2021.



Figure. 3 – An example of conversation with MAXXI chatbot (in Italian)

Wonnie – Foundation FILA Museum

This chatbot case is a little different from the others mainly because it is a corporate museum and not a museum or cultural institution that promotes and enhances historical/ artistic artworks. Foundation FILA Museum is actually a museum dedicated to the FILA brand founded in 2010 in Biella by Gene Yoon, Chairman of FILA. Its primary goal is to maintain and present the brand's heritage, from its local Biella roots to its global renown in the sportswear and athletic footwear industries. The Foundation's goal is to preserve and advance the business principles that have contributed to the development and expansion of the FILA Brand. The memorabilia of the great athletes who have sported the brand, including Bjorn Borg, Panatta, Giovanni Soldini, Reinhold Messner, and Alberto Tomba (just to name a few), tells the narrative of a century's of Fila history. The exhibition area is divided into 9 rooms, the first two are devoted to the company's roots and the other rooms to its history of advertising and creativity in different sports-related fields (Fondazione FILA Museum website).

As affirmed in the interview carried with Lorena Pontillo, head of social marketing of Foundation FILA Museum (see the appendix for the whole interview), the Foundation and its team decided to take advantage of the closing period due to the Covid-19 pandemic to expand the online communication. For this reason, the Foundation recruited IVE, a bot agency, which was responsible for the renewal of the website and, subsequently, of the chatbot project on Facebook Messenger. A number of initiatives have been planned and carried out by IVE and the Foundation FILA Museum in 2020, with the main focus of the virtualization of the Wonnie bear (created by FILA). Wonnie has a virtual existence thanks to the AI algorithm developed by IVE. It reacts indifferently from the client's Messenger app, the institutional website, and the social media channels. Wonnie, who became the reference character of the Foundation, is a virtual assistant chatbot who help users who seek information about the Foundation's activities. It was noticed that more and more people were reaching the Foundation through social media to ask for information. Since questions were almost always the same, it was decided to introduce a chatbot. When users have more specific requests, the chatbot refers to the Foundation staff which will receive an email where the requested information is indicated. To make the conversation more entertaining and "human", IVE gave a specific personality to Wonnie: he is a shy and lovable bear, clearly born in Biella, friendly and confident, while always speaking respectfully and with some casual and technical license. He speaks Italian and English, and his main functionalities are:

- Enhancing customer service in real time 24x7
- Supporting for Foundation assistance
- Storytelling

Considering the successful outcome of Wonnie chatbot, the Foundation and IVE are designing a platform called BotMama that serves as a conversation tool where everyone can access (without the need of a Facebook profile). The main objective of these technological innovations is to engage teenagers aged sixteen to twenty-five who are not very interested in the museum and the Foundation. For this reason, they are also designing gaming elements. New working figures have been hired within the organizational structure of the museum to cope with these new changes related to online communication, although the chatbot was developed entirely by IVE.

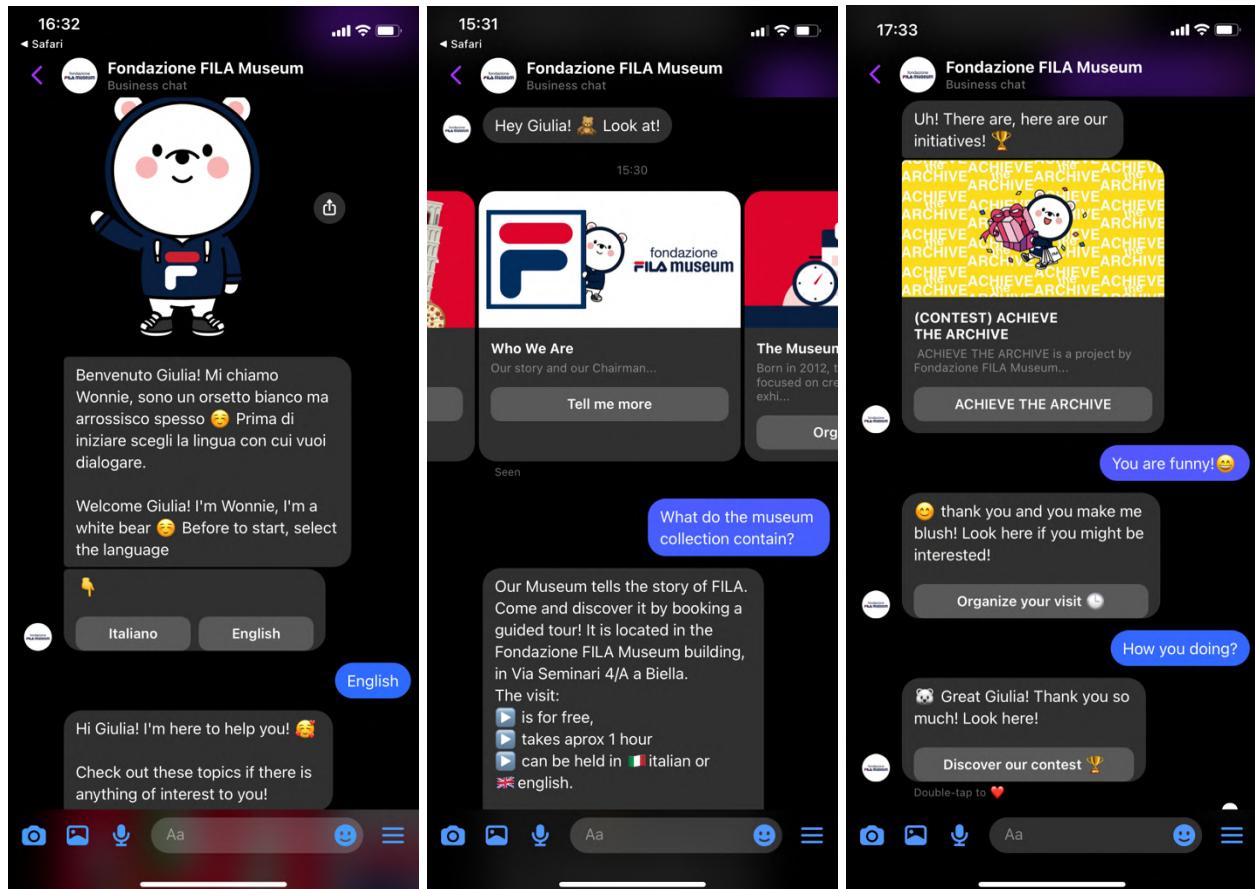


Figure. 4 – An example of conversation with Wonnie

Michelangelo AI – Opera di Santa Maria del Fiore

Opera di Santa Maria del Fiore is a complex of sacred, historical, and artistic monuments located in Piazza del Duomo, the heart of Florence. It consists of the cathedral of Santa Maria del Fiore, the Brunelleschi's Dome, the Giotto's Bell Tower, the Baptistry of San Giovanni, the ancient Basilica of Santa Reparata, and the Opera del Duomo Museum. The Florentine Republic established the Opera di Santa Maria del Fiore in 1296. After the conclusion of the church's architectural construction and consecration in 1436, Opera's main responsibility became the preservation and the enhancement of the magnificent complex. In 1777, the Baptistry of San Giovanni was placed under its control, and in 1891, the Opera del Duomo Museum opened. It was designed as a learning route to explore the locations and artists that gave life to the huge Opera complex, and it is now one of the most important museums in the world. The original works of art created by Michelangelo, Donatello, Brunelleschi, Ghiberti, and numerous others that have been used to embellish its monuments over the course of seven centuries are conserved here. Since 1998, Opera di Santa Maria del Fiore has been officially recognized as a nonprofit organization (Opera di Santa Maria del Fiore website).

Michelangelo is and was already considered by his contemporaries one of the greatest artists of all time, and, for this reason, Opera Santa Maria del Fiore decided to "bring him back to life" through a chatbot. As stated in the interview with Giovanni Serafini, art historian and head of the digital catalogue of art collections "Arnolfo", and Monica Serrano Segui, art historian and communication coordinator of Opera di Santa Maria del Fiore (see the appendix for the whole interview), the project was conceived during the Covid-19 period to give users the opportunity to explore Michelangelo's works and in general the museum also from home. According to Timothy Verdon, director of the Museo dell'Opera del Duomo: "*The impact of global restrictions has been devastating, preventing people from visiting priceless cities like Michelangelo's Florence. Resurrecting Michelangelo bridges this gap by allowing virtual visitors to interact with one of the great spirits of our civilization, and to converse with him about art and life.*" (Opera magazine, 2021). Thence Giovanni Serafini, Monica Serrano Segui, and their team create a virtual Michelangelo in collaboration with Querlo, a customized AI solutions company specialized in chatbot development. It is an educational tool that aims to raise awareness of the art, life and thought of the greatest artist of the Renaissance. The chatbot has been designed with a very intuitive logic tree technology that uses a question-and-answer system. The tool was manually refined and became increasingly intelligent because the team of art historians and Querlo trained the chatbot. They also regularly checked the questions that users asked and the accuracy of the answers provided. Initially, they had thought of this conversation with Michelangelo through a didactic dialogue where the works and life of Michelangelo were explained, but also the museum structure. But then, they noticed that users used the chatbot for practical information, such as at what time the cathedral opens, or how much the pass costs to visit the museum, or futile information as if Michelangelo believed in love or what art is (Figure. 5). Then they

taught him how to refer to the several website pages where the requested information was located. One interesting detail is that Michelangelo spoke only in English and not in Italian. Michelangelo AI is no longer online, the Board of directors decided to close the project in early 2023 with the goal of using other technologies in the future. Actually, it was only an experiment to cope with the needs born in the Covid-19 period. However, Michelangelo AI was the prototype for the creation of the David chatbot of the Galleria dell'Accademia in Florence.

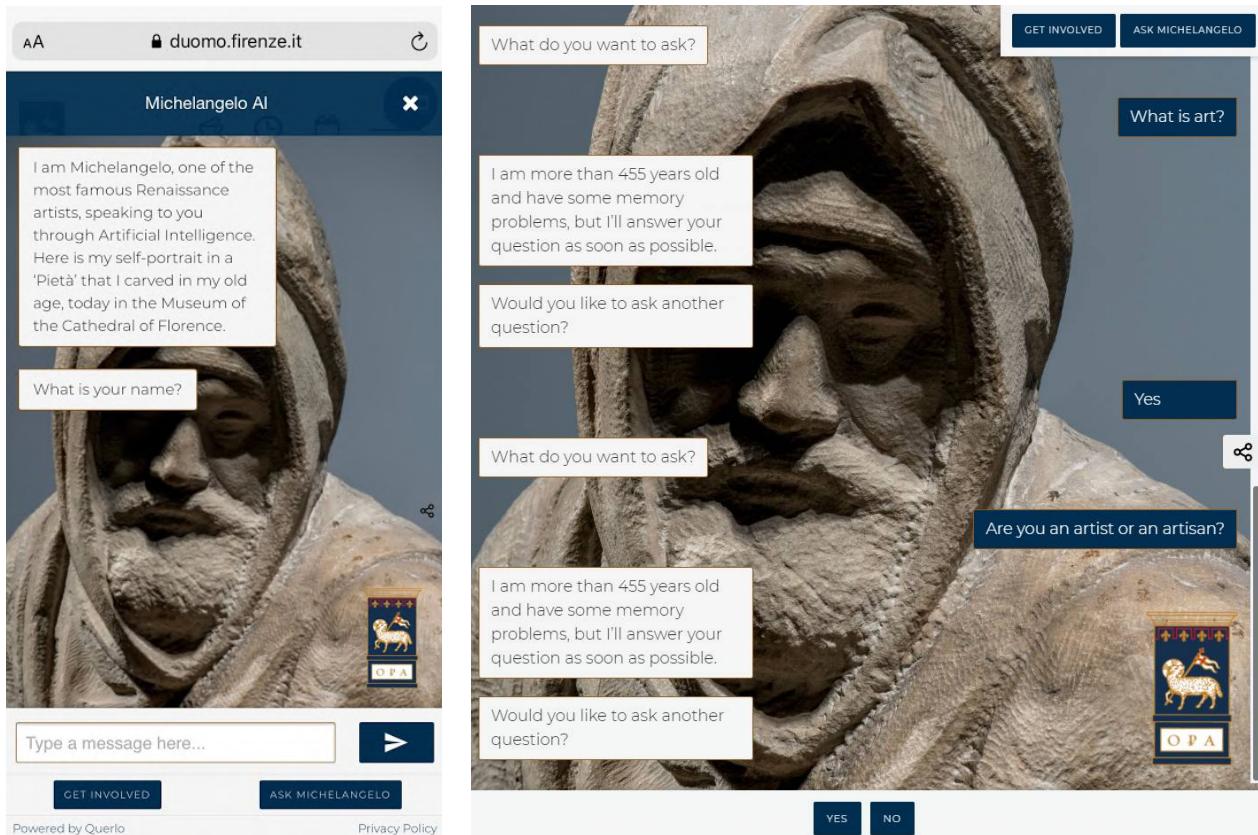


Figure. 5 – An example of conversation with Michelangelo AI

David Bot – Galleria dell'Accademia

The Galleria dell'Accademia was first established in 1784 when Pietro Leopoldo, Grand Duke of Tuscany, transformed Cosimo I de' Medici-founded Academy of Arts of Design in Florence into the current Academy of Fine Arts. The demise of Michelangelo's statue of David from Piazza della Signoria in August 1873 marked a turning point in the museum's history. The Galleria dell'Accademia of today was founded in 1882, and it is a property of the Ministry of Cultural Heritage and Activities, which has included it among the museums with special autonomy since 2014. It is one of the most famous museums in the world with almost 1,500,000 visitors in 2022. The Galleria hosts the largest number of sculptures by Michelangelo in the world (seven), including the popular David. Other sections of the museum include the Musical Instruments Museum and the world's biggest and most significant collection of gold ground paintings from the 13th century to the early 15th (Galleria dell'Accademia website).

The Artificial Intelligence project "Chat with David" was launched in December 2021 by the Galleria dell'Accademia in collaboration with Querlo, the same company that developed Michelangelo AI. Through the Galleria's website, David tells his history by disseminating historical, artistic and religious information, but also anecdotes and curiosities. As described in the interview with Matteo Innocenti, curator, professor, and digital communication assistant of Galleria dell'Accademia (see the appendix for the whole interview), the chatbot project was developed from an idea of Cecilie Hollberg, director of the Galleria, who recognized the potential of the tool to disseminate online information about the museum. In 2020, when they started to work on the project, an important website restructuring process had just been completed, therefore the chatbot project is located within a wider process of communication that also uses other channels, namely the website and social media. Before the chatbot introduction, during the renewal period of the Galleria's website, video content pills were created with insights on works of art, and the questions of users are met with social media channels. The project, which was made possible with the financial support of the Association of Friends of the Galleria dell'Accademia of Florence, is also in line with the Ministry of Culture's goals, which supports the commitment to employ digital technologies to promote Italian cultural heritage. The peculiarity of this chatbot, as for Michelangelo AI, is that it is structured in such a way that it is as if users were talking directly with the David. The chatbot never intended to be a substitute for an in-depth study and research that the public can do, although the chatbot gives enough in-depth information about the sculpture, Michelangelo and the historical period. Of course, a playful approach has also been taken into account, the chatbot is although a form of entertainment that would then invite people to further explore the museum contents. In the design phase of the David Bot, the working team of the Galleria dell'Accademia and Querlo decided not to train the chatbot to answer technical questions such as the cost of the ticket or opening hours since there is a section of the site that is dedicated to this. They coached David in a way that he could respond in reference

to four technical-artistic thematic areas: sculpture, art, religion and curiosities. For instance, the chatbot can answer questions like, "What other sculptures did Michelangelo produce?" "Are there other David realized by other sculptors?" "In what historical period did he live?" "Who were the Medici?". If it is required to examine other artworks, then it refers to specific website sections. For the content's creation, the Galleria has started collaborating with the Academy of Fine Arts in Florence. A group of students from the course "Didattica per i musei" (taught by Professor Federica Chezzi) as well as many students from other universities and nationalities were involved in the processing and testing phase, and they were asked to imagine what a visitor might ask to David. The chatbot version was created in both Italian and English. For the Italian version, interactions were higher than in English. Actually, already after the first months there were about 15,000 interactions with users who asked three or four questions consecutively. However, the feedback is generally very positive. Cecilie Hollberg describes the outcome as "*a wonderful success*," adding that "*everyone wants to chat to our 'beautiful hero'. They range from requests with a historical-artistic or conservative focus to gastronomic curiosity. Some others went so far as to ask him his phone number and whether he was lonely or wanted to go out. A funny and unique approach to capturing an increasingly diverse and large worldwide audience*" (Press Release, 2021).

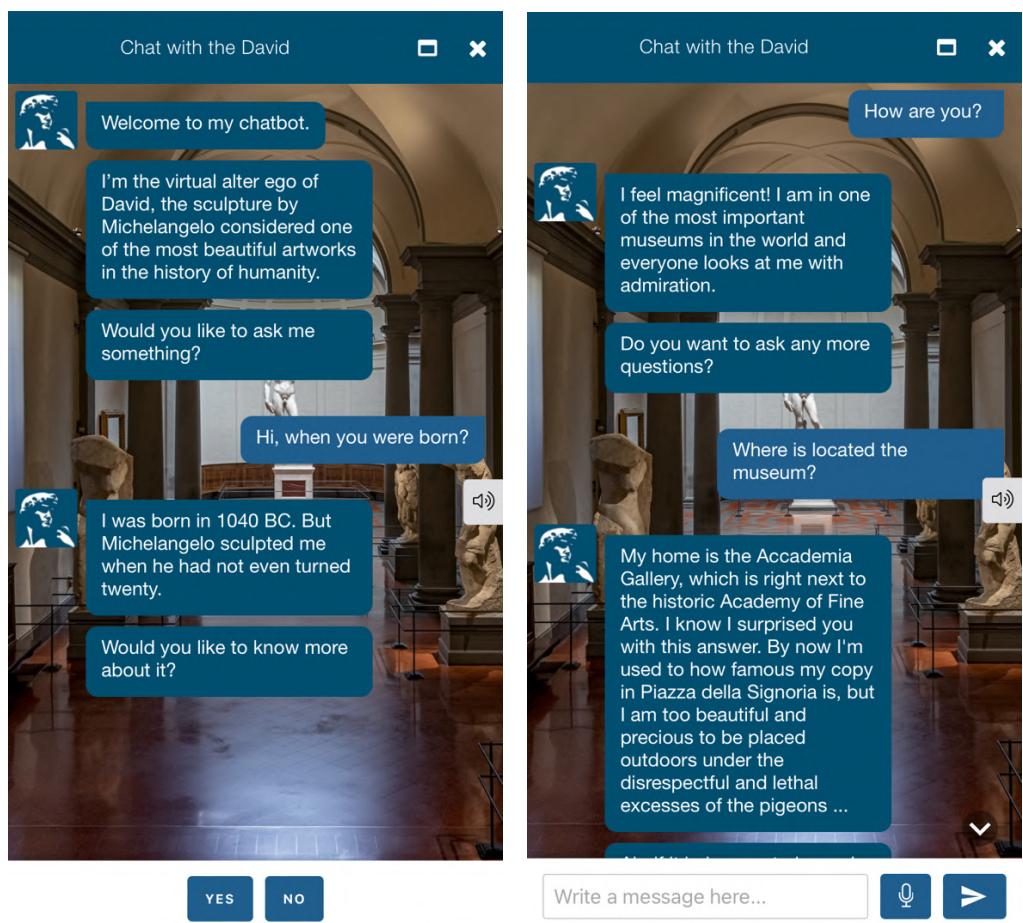


Figure. 6 – An example of conversation with David Bot

NeroBOT – Parco archeologico del Colosseo

Parco archeologico del Colosseo was founded by DM no. 15 of January 12, 2017, with the intention of establishing an institution provided with special autonomy to guarantee the protection and valorization of the central archaeological area of Rome and to carry out the agreement stipulated by MiBACT and the City of Rome on April 21, 2015. The PArCo, as it is called on the website, is one of the most visited sites in the world and the first in Italy with about seven million of visitors in 2022. Some of the most significant archaeological artifacts from the end of the Bronze Age to the present day are preserved in the park. It comprehends the area of the Roma Forum and the Palatine, the Flavian Amphitheatre, the Arch of Constantine, the Domus Aurea in the Oppian Hill, and the Meta Sudans in Colosseum valley (Parco archeologico del Colosseo website).

Thanks to the information provided by Federica Rinaldi, archaeological officer in charge of the chatbot project, it can be described that the Parco archeologico del Colosseo is among the first state cultural institutions to introduce the new chatbot Nerone, an AI software in the guise of the emperor of the Julio-Claudian dynasty. It is intended to enhance the visiting experience, assist the general public in requesting information about the park's services, and enrich the historical context of the numerous monuments and sites that are a part of it. The project began in February 2022, and it was finally launched online in December 2022. It is the result of an international partnership with the Italian company Machineria srl, active in the production of content and automation for cultural institutions, and the French company Ask Mona, a pioneer in the creation of tools for conversation, Artificial Intelligence, and data analysis. It was conceived and promoted by the Parco archeologico del Colosseo under the care and management of Federica Rinaldi and Astrid D'Eredità, archaeologist officials. Park visitors no longer only interact with the institution through social channels (Facebook, Twitter, and Instagram) and emails, but finally also through a robot available by accessing the home page of the website. As a type of virtual guide, NeroBOT can manage over a hundred scenarios and provide service information while offering responses in English, Italian, and French. He also entertains himself in some less institutional chat, showing his ironic and funny side.

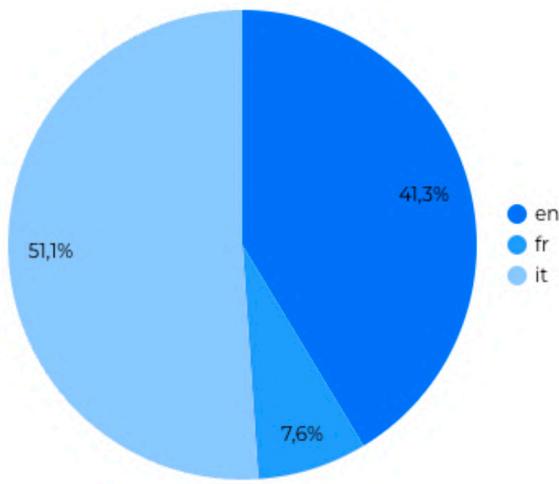
The main features implemented comprehends:

- Avatar development.
- Natural language processing and information retrieval approaches for recognizing natural language.
- Development of unique scenarios for resolving challenging circumstances.
- Creation of 150 pertinent semantic domains using a combination of statistical data collecting and application of user journey methods.
- Quick prototyping and testing using visitor field interviews.

It should be noted that for the launch of this project, a huge communication plan has been devised. In addition to the classic press conference, it includes the dissemination activities on traditional and

digital media, the circulation of advertising material, the promotion in the context of wide-spread historical and scientific dissemination television programs, and the participation in national, international and thematic workshops. Thanks to the project presentation by Federica Rinaldi, the results obtained and the impacts generated by the chatbot project can be presented below. The evaluation was carried out between January and March 2023.

- Users: 17,213 in total (223,5 per day).
- Visitor engagement: average time of engagement per session 3 minutes and 23 seconds.
- Origin:



- Contents:
 - 71,4% tickets
 - 13,8% opening hours
 - 7% park program
 - 3,5% visit paths
 - 2,9% request to speak with a human
 - 1,6% language switch
- Text messages:
 - 8873 text messages delivered (user average 1,92)
 - 17,3% on ticket reservations
 - 29,7% of casual conversations
- Impact obtained: reduction of the load of emails and phone calls, and general public appreciation.

This initiative is unquestionably a starting point for other cultural organizations with similar audiences thanks to the work on the comprehension of semantic domains, and the project's quick prototyping success makes it a useful example for cultural institutions who struggle with the management of complex projects. NeroBOT is still being improved, and new features will be added in 2023, including

support for the Spanish language. This is necessary because statistics show that a large percentage of users have their browsers set in Spanish.

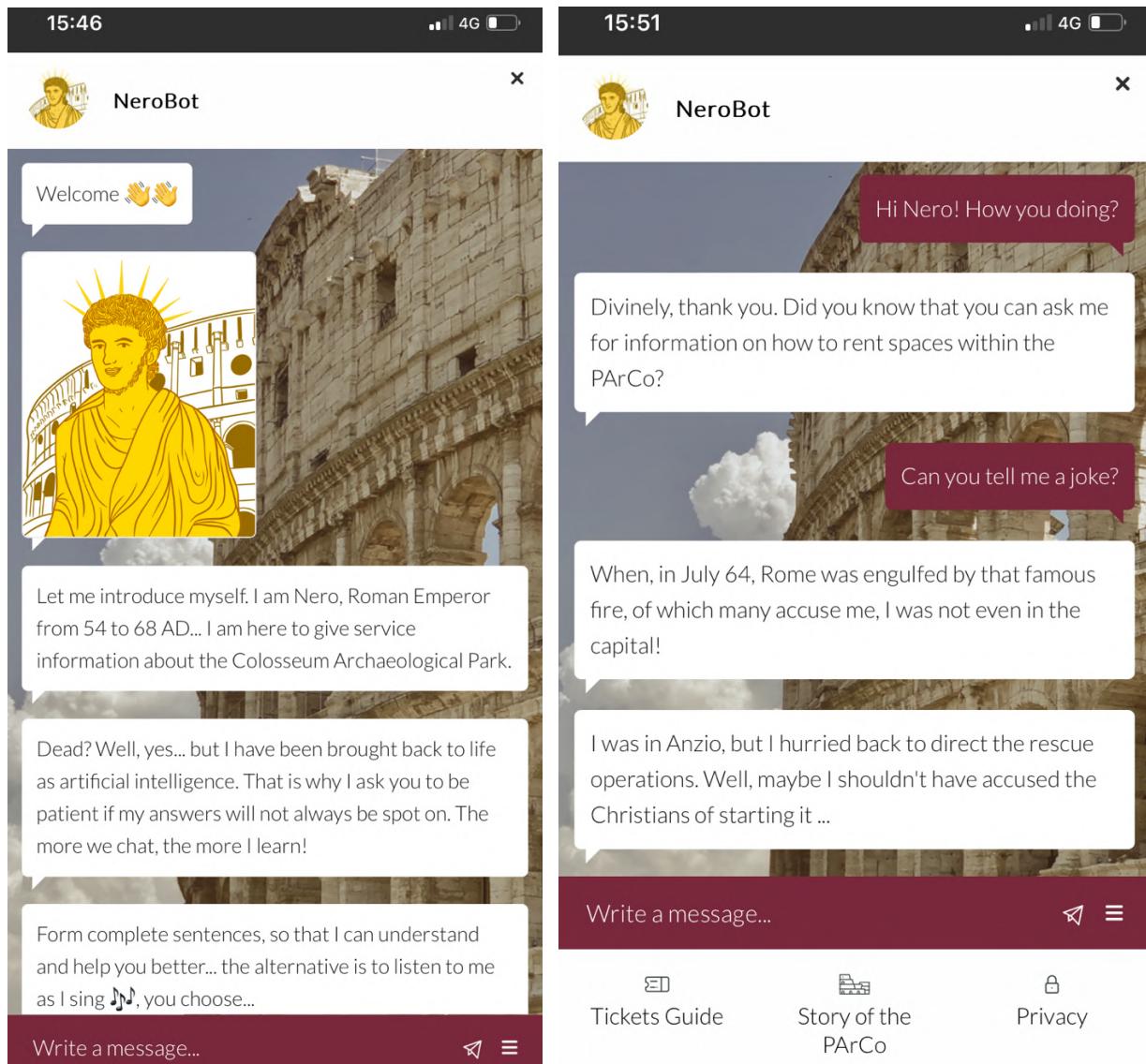


Figure. 7 – An example of chat conversation with NeroBOT

4.3 Cases comparison

Designing and building an AI chatbot for a museum is a very difficult task since many different factors need to be taken into account. Needs and features of the museum as well as the extent of the suggested chatbot solution must be determined by chatbot developers in cooperation with museum players. The type and capabilities of the suggested AI chatbot solution are mostly determined by the level of visitor engagement and interest, the size and location of the museum, the presentation and manipulation of the material, and financial resources (Varitimiadis, Kotis, Pittou, Konstantakis, 2021).

From the analysis of the cases, we can certainly state that there are common aspects and differences between them.

Firstly, we noted that, in general, the main role personified by the chatbot is the virtual guide. In almost all the projects analyzed, chatbots accompanied visitors in the tour of the museum not only physically as in the case of the Mart, but also in the request for information or in-depth analysis of the museum collections as in the case of Michelangelo AI and David Bot.

Regarding the reasons for which it was decided to introduce a chatbot inside the museum, we refer to the need to "keep up with the times" and update the systems integrating new technologies, including precisely chatbots, within the organizational structure of the museum, also to attract the part of the audience called the digital natives, namely the youngest. The latter are constantly looking for new stimuli, and the classical and traditional museum visit no longer satisfies them. On the contrary, new technologies offer new ways and ideas to exhibit and enhance collections in an innovative and even more entertaining way. The use of informal communication methods and the ease of use therefore make the chatbot an effective mean to reach and involve younger generations, more complex to intercept and to direct towards the museum fruition.

Other common aspects are represented by the fact that, before the chatbot introduction, in all the museums studied, questions and curiosities were managed by certain websites sections and by social media through, for instance, video pills of insights. With the introduction of chatbots, therefore, the weight of messages, emails, or phone calls that the museum staff had to deal with is certainly lightened.

A very easy and intuitive UI is another common feature and a very positive factor of all chatbots examined, and therefore accessible to everyone, not only to young people but also to people not very familiar with new technologies. All things considered the fact that everyone has a phone and everyone sends messages nowadays.

The first comparison devised is about the types of chatbots, the distribution channels and the level of chatbot engagement. In the analyzed cases, three types of chatbots can be identified: informative, educational, and gamified. Informative chatbots are certainly the most widespread, and they are a type of chatbots that provide technical information about the visit such as opening hours and days,

ticket prices, directions on how to reach the museum, or basic information about the collections. If visitors ask for more in-depth information or insights on artists, historical period or artworks, they refer to specific sections of the website or, on the contrary, they are unable to answer the question. Educational chatbots are also widely used, but unlike informative chatbots, they also provide more in-depth information about collections, curiosities and anecdotes with the aim of educating visitors, and not just inform them. A crucial aspect that is increasingly gaining ground is that of gamification that makes the visit experience more amusing and entertaining by associating the museum path with prize games and treasure hunts. In this context where the primary objective is to attract a younger audience, this component is certainly fundamental. The level of engagement depends on the type of chatbot developed and includes multimedia content (for all cases), realistic dialogues, games, fun facts and even jokes.

With regard to the distribution channels, the common pattern is to adopt the most used social networks, namely Facebook Messenger and Telegram, or develop the conversation directly from the museum website. In this context, it is important to take into account that all the cases analyzed were aimed at avoiding users to download additional apps to chat with the chatbot. Employing social channels that young people normally use to chat with friends is definitely the best solution, both in terms of convenience and for the fact that to download new apps on the phone they need to have space available. In the period of development of chatbots investigated (pre-Covid, Covid, and post-Covid periods), the most used social media was definitely Facebook. Nowadays, however, other social networks are catching on, namely WhatsApp and Instagram. Therefore, future museums have to take into account the current trends if they want to introduce a chatbot in their cultural offer.

Most of the museums have relied on a third-party company that has managed the entire creation of the chatbot, or in collaboration with the museum's internal team. In general, no specific figures have been hired to take care of the production of the chatbot and for its continuous management and training. The FILA Museum Foundation has decided to hire staff for the overall project of digital communication renewal but not specifically for the creation of the chatbot. On the contrary, MAXXI is the only museum that has fully developed the project on its own without turning to external sources. This is definitely a winning solution at the moment that there are free platforms to create chatbots. In this case, it was used Chatfuel, a platform for creating chatbots on Facebook Messenger, WhatsApp, Instagram, and websites in general (see section 4.3). In this way, considerable financial and human resources are certainly saved. Being the chatbot developed by third-party companies, it was not possible to know the program/platform that was used to develop the project, except the MAXXI that used precisely Chatfuel.

Chatbot's name	Type of chatbot	Engagement	Distribution channel	Chatbot management
House Museums Bot	Informative and gamified chatbot	Gamification, realistic dialogues, and multimedia content	Facebook Messenger	External
MARTmuseum bot	Informative chatbot	Multimedia content	Facebook Messenger and Telegram	External
MAXXI Chatbot	Informative and gamified chatbot	Multimedia content and rewards	Facebook Messenger	Internal
Wonnie	Informative chatbot	Multimedia content, realistic dialogues	Facebook Messenger	Both internal and external
Michelangelo AI	Educational chatbot	Multimedia content, realistic dialogues	Website	Both internal and external
David Bot	Educational chatbot	Multimedia content, realistic dialogues	Website	Both internal and external
NeroBOT	Educational chatbot	Multimedia content, realistic dialogues	Website	Both internal and external

Regarding the degree of user participation, not all the museums interviewed gave concrete answers, only Parco archeologico del Colosseo provided certain data; therefore, it is not possible to make a comparison in this direction.

With respect to the specific characteristics of the chatbots developed, all chatbots use machine learning and NLU (Natural Language Understanding) to respond to user requests and to conduct basic conversations. While NLU focuses on methods that enable chatbots to segment, analyze, and translate human language in its natural forms into machine language, machine learning focuses on

designing chatbots to "learn" how to answer to human-made inquiries by using supervised or unsupervised algorithms. However, advanced AI methods are not employed and not every chatbot possess conversational skills. Actually, when questions do not fit into those for which they have been trained they cannot give an answer. It is necessary to specify that the chatbots still active today are House Museums Bot, MartMuseumBot, Wonnie, David Bot, and NeroBOT. MAXXI Chatbot and Michelangelo AI are unfortunately no longer active.

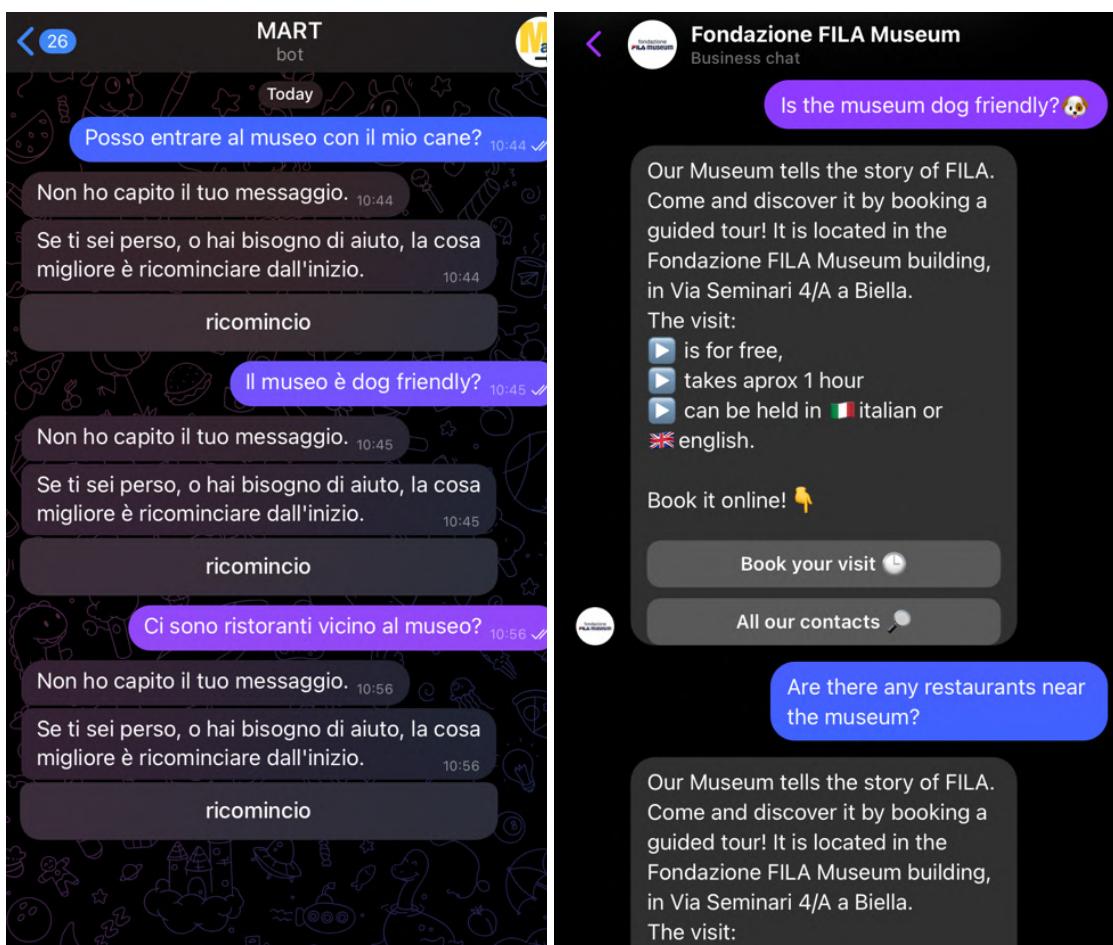
Concerning the level of internationality, the most international chatbot is definitely NeroBOT that is able to answer in Italian, English and French, and the team of the Parco archeologico del Colosseo has in mind to program it also to speak in Spanish. All other chatbots speak Italian and English, except MartMuseumBot who is trained to answer only in Italian and Michelangelo AI who speaks only English.

Chatbot's name	Conversational skills	Advanced AI methods	Machine learning and NLU	Active
House Museums Bot	✗	✗	✓	✓
MARTmuseum bot	✗	✗	✓	✓
MAXXI	✗	✗	✓	✗
Wonnie	SO-SO	✗	✓	✓
Michelangelo AI	SO-SO	✗	✓	✗
David Bot	SO-SO	✗	✓	✓



The majority of the currently available chatbots for museums relies on pre-built conversational paths that only offer basic and pre-defined domain knowledge about the museum and its exhibits. Additionally, they frequently struggle to have successful human-like conversations and occasionally stumble over even the most basic of topics. Users cannot pose their own special free questions, and when they do, they typically get a confused response or/and referrals to other topics.

It was decided to test chatbots asking very specific questions that were perhaps a little outside of their expertise and the result was not so satisfactory (Figure. 8). The only one to pass the test was NeroBOT proving to answer exhaustively even very specific questions like "Is the museum dog friendly?", or "Are there restaurants near the museum?", even in an humorous way. This proves that it also has proven conversational skills.





NeroBot

Is the museum dog friendly?

It's possible to enter the open areas of the Roman Forum and the Palatine Hill with small dogs (weighing between 5 kg and 10 kg). The Colosseum, the Domus Aurea and all closed areas are excluded.

Dogs will have to be carried in special carriers belonging to the visitors themselves, and not in dog prams.

Admission for dogs is free of charge. After passing the security checks, dogs must remain in their carriers for the duration of the visit.

Animals used in pet-therapy activities or as companions in case of disability are admitted, but remember that you will be asked to show the documentation at the entrance.

If you were referring instead to fairs such as lions, hippos and bears, I fear they will have to wait for you outside...

Are there any restaurants near the park?

Ah, I see we understand each other, I really appreciate good food too!

At the entrance to the Roman Forum there is the Caffe del PArCo, a cafeteria where you can get a light lunch to be consumed at the counter, or at the tables in the shade of the pergola. Not bad, in the absence of a triclinium!

However, if your sandals are itchy and you prefer a quick stop, you can buy drinks and snacks from the automatic machines available in various areas of the PArCo.

Figure. 8 – Test with MartMuseumBot, Wonnie, David Bot, and NeroBOT respectively

The main drawbacks of existing museum chatbots are that they are not meant to have human-like conversations, lack genuine interaction and engagement, and only offer limited information in answer to user inquiries.

Surely, a great positive aspect is given by the fact that the chatbot project is provided as a free service that enhances and completes the museum visit experience, except for House Museums in Milan where the chatbot is provided only if visitors pay the entrance ticket to the museums. But if we consider also other resources that users need to “spend”, apart from the monetary cost, is chatbots really free? In this sense, a reflection on the technological equipment that visitors must have to use the chatbot is a must. Of course, in order to chat with the bot, users need to have a phone or a computer and an Internet connection, which sometimes can be unstable resulting in an unsatisfactory service. All cases investigated do not require users to download an application in order to use the service (as happens for example for the Royal Museums of Turin that commits users to download an app to explore the online collections and to stay updated with events and information). In general, many museums worldwide provide an app to enjoy a 360-degree virtual tour of the museum, such as the Smithsonian American Art Museum with its Wonder 360 application. The distribution channel of House Museums Bot, MartMuseumBot, MAXXI Chatbot, and Wonnie is Facebook Messenger or Telegram; therefore, users who do not have a Facebook or Telegram account will be forced to create a profile in order to interact with the bot. With regard to Michelangelo AI, David Bot, and NeroBOT, it is possible to chat directly from the website. This definitely makes the service easier and faster.

Chatbot's name	Phone/PC	Internet connection	Facebook/Telegram account	App downloaded
House Museums Bot	✓	✓	✓	✗
MARTmuseum bot	✓	✓	✓	✗
MAXXI	✓	✓	✓	✗

Wonnie	✓	✓	✓	✗
Michelangelo AI	✓	✓	✗	✗
David Bot	✓	✓	✗	✗
NeroBOT	✓	✓	✗	✗

One thing that David Bot has more compared to other chatbots is the ability to voice questions and answers within the chat, as if David was actually talking to people, and there is also a notification sound when David responds to user requests. Wonnie, David Bot, Michelangelo AI and NeroBOT also have an entertaining and playful side compared to other chatbots: they do not answer questions in a detached and rigid way, but they also have an emotional and ironic side that makes the conversation more "human". The fact that the museums in question have decided to give the robot a personality, whether it is a historical-artistic character or simply a teddy bear, makes the interaction certainly more cheerful and engaging.

Conclusions

After this comparison, we draw the following conclusions:

- House Museums Bot has a very high level of engagement given by the introduction of gaming within the chatbot, however it has a ticket fee.
- MartMuseumBot is a good interactive guide, but it has been trained to speak only in Italian, it has no personality and, therefore it has no conversational skills.
- MAXXI Chatbot has one more element compared to the others thanks to the introduction of a game with rewards, but it does not have a personality and it lacks in conversational skills, as MartMuseumBot.
- Wonnie has a personality that makes him more engaging and fun, but it provides only basic information about the museum and not insights and in-depth information.
- Michelangelo AI embodies a truly lived character who has the aim of informing and also teaching visitors new things, but it was trained to speak only in English, and it has no complete conversational skills.
- David Bot is essentially equal to Michelangelo AI, except that it speaks also in Italian.
- NeroBOT is the most complete chatbot as it speaks Italian, English, and French, it has a personality and a distinctive character, and it provides both technical information about the museum and also insights, curiosities, and even things not directly related to the museum.

Unfortunately, Italian museums cannot rely on a wide literature that shows research and systematized experiences on the application of chatbots in museums. Therefore, once we understand the positive and negative factors of the cases investigated, if we wanted to give some suggestions on how to build a successful Italian chatbot, it should definitely possess the following features:

- Having an easy and intuitive UI.
- Representing a character and thus having a personality to intrigue and entertain visitors.
- Speaking more than one language (possibly Italian, English, and a third language).
- Having a playful dimension through gaming elements (rewards games or even jokes).
- Being distributed through a channel used by most of the audience (such as WhatsApp or Instagram) or directly on the museum's website.
- Being free.

The potential for cultural heritage institutions to play a substantial role in the usage of chatbot technology for tourist engagement and interaction is well demonstrated by the available data.

According to recent developments, chatbot platforms will be used more and more frequently in museums, particularly for chatbot guides. According to the case studies examined, chatbots can be operationally successful in the short term at least, but much depends on the inclusion of chatbots in the overall museum communications strategy so they can be seen to be clearly aligned to the museum goals. However, comparable evaluations of visitor interactions with chatbots are still not finding their way into the published literature.

The simplicity with which chatbots can now be created using readily available platforms is a second environmental element influencing the chatbot's expansion throughout the industry. In the previous chapter, we saw how simple it is to build a chatbot through Chatfuel, and it is also free or, in any case, a small monetary investment is needed. These platforms are increasingly viable options for museums with constrained internal resources since they may reduce time and development expenses. Therefore, for cultural institutions that do not have the funds, it is not necessary to rely on an external company that takes care of the entire development of the chatbot. This is to say that chatbots are really within all museums' means, whether they are big or small realities.

One trend that has been noted by the analysis conducted is to introduce the chatbot to meet the Covid-19 pandemic needs. However, chatbots should be an integral part of the organization of a cultural institution regardless of emergence contexts. New technologies are part of everyday life and for this reason museums, like all business sectors, must keep up with the times by introducing technological innovations within their institutions.

The House Museums and MAXXI case studies further demonstrate how the fusion of chatbot and gamification can be an effective instrument for engaging younger and digitally aware generations in fresh and innovative ways. Gamification and chatbots together provide museums a future opportunity to layering new types of interaction that may empower the participants and create a visitor experience that encourages extended engagement. This opens up new possibilities, allowing the development and creation of characters with feelings and personalities that can be empathetically tailored to various visitor interests and age groups, especially with the design and incorporation of interactive digital storytelling chatbots into a museum context.

As the usage of more AI-intensive bots becomes a consideration in the future, the path is paved to develop larger and more contextual discussions with museum visitors, perhaps opening the door for audience-led contributions to the design of museum chatbots themselves. The Akron Art Museum's tailored chatbot "Dot," financed by a Knight Foundation grant in Miami, and IBM Watson's partnership with museums in Brazil are among the next generation to offer insights into the future application of AI-enabled and deep learning chatbots in the cultural sector. Nonetheless, obstacles remain in establishing higher degrees of sensitivity and contextual awareness by chatbots, e.g. conversational engagements that go beyond one-on-one talks and emotionally sensitive answers (Gaia, Boiano, Borsa, 2019).

It should be noted that the conversation can be the strong and, at the same time, the weak point of chatbots. For instance, Angeliki Tzouganatou, in *Can Heritage Bots Thrive? Toward Future Engagement in Cultural heritage* (2018), points out that chatbots could generate frustration in users and, consequently, the abandonment of interaction, if constrained to provide only predefined answers. Chatbot developers are attempting to avoid a situation in which the human/machine roles are entirely reversed, with a robot "chatting" and a person remaining mute, passive, and "remote controlled."

This circumstance is captured with profound sensitivity by Don DeLillo, in his post-Covid dystopia *The Silence* (2021), who portrays the finally available visit to galleries and institutions in this way: "*In a gallery, tourists with headphones on their ears, motionless, suspended existences, eyes turned upwards towards the figures painted on the ceiling, angels, saints, Jesus with his clothes [...] Others with audio guides in their hands, leaning on their ears. Voices in who knows how many languages. Once in a while I still think about it, before falling asleep: those fixed figures in the galleries*". Visitors can return to museums, but they are "suspended existences"; they can look but do not see; they can walk, but they are "fixed figures". Many languages are accessible in audio guides, but perhaps not the one that bridges the gap between man and robot. DeLillo sets the conditions just before every machine and every technology revolt. A rebellion that, as its imaginative titles suggest, manifests itself through silence. The individual, and even the chatbot, are no longer speaking. The discussion is cut off (Castellucci, Gomelino, 2021).

In the cases analyzed, the answers that chatbots were required to give were all closed answers, it is not required to make open conversations where both visitor and robot make a friendly dialogue where ideas and opinions are exchanged. In this sense, any application of ChatGPT within museums would not make sense for the objectives set by the cultural institutions investigated. It will be certainly fascinating to witness the narrative, emotional, epistemological, and psychological evolutions that may result from AI research. This trend will progressively lead to difficult ethical dilemmas. For instance, Gaia, Boiano, and Borda, in *Engaging Museum Visitors with AI: The Case of Chatbots* (2019), discuss about data protection and privacy concerns. However, in their case, the data employed were those that were already public on users' Facebook profiles. For autonomous intelligent agents, the level of attention must become considerably higher. Actually, in addition to the data privacy concern, issues emerge with what the machine learns and, as a result, writes, with the risk that it writes things it should not say. It is on these crucial topics that international working groups are being established with the goal of debating and establishing principles and best practices for resolving ethical disputes in the field of AI. Future chatbots have the potential to significantly change how visitors interact with museums and other cultural institutions and to assist in new paradigms of engagement. But their use must directly and meaningfully support museum goals as a dependable source of knowledge and the public's participation as an equal partner in the process.

"The dilemma is not the technology, but the use that we do of it. Everything bears risks, the key thing is to be aware of them and to evaluate if the price we pay is adequate to what we receive in return."

– Stefano Nasetti

Appendix

Interview (in Italian) with Lorena Pontillo, head of social marketing of Foundation FILA Museum, released on May 8, 2023

“Può fornirmi un'introduzione generale del progetto di chatbot? Quali sono gli obiettivi del progetto?
“Quali sono i punti di forza e di debolezza della chatbot?”

“Abbiamo ingaggiato un'agenzia e le abbiamo chiesto di supportare la parte del sito e poi quella della chatbot tramite Messenger. La società che l'ha sviluppato si chiama IVE. Abbiamo chiesto di inserire il nostro personaggio Wonnie che ha preso in mano la voce della fondazione tramite la chatbot e tutto questo per cercare di venire incontro alle esigenze delle persone che ci contattavano. Le persone che si occupavano delle richieste del pubblico non avevano la velocità di rispondere in modo immediato, come invece fa la chatbot. Non abbiamo una struttura adatta per avere una persona che si occupa solamente di rispondere alle domande degli utenti. Si è creata la chatbot anche per avere un personaggio di riferimento per la fondazione, so che se parlo con Wonnie mi darà le informazioni che cerco riguardo la fondazione. Le domande sono sempre le stesse più o meno, nel momento in cui si hanno delle richieste più specifiche la chatbot rimanda al personale della fondazione al quale arriverà una mail dove viene indicato che persona x ha chiesto maggiori info. Questo perché sempre di più le persone ci contattavano tramite i social. L'obiettivo è quello di cercare di arrivare ai ragazzi più giovani della fascia 16-25 che non ci seguono molto e che non hanno facebook e magari hanno poco spazio nel telefono per scaricare un ulteriore app.”

“Perché avete scelto di introdurre la chatbot?”

“La chatbot è stata inserita nel periodo covid, il periodo di chiusura ci ha fatto un po' riflettere per quanto riguarda il campo digitale, sia per il chatbot che per il sito e i social media, abbiamo sfruttato il periodo covid per ampliare la comunicazione online.”

“Quali programmi/piattaforme/software sono stati utilizzati per creare la chatbot?”

“Non sono in grado di soddisfare questa sua domanda perché IVE ha gestito la progettazione del chatbot.”

“Saprebbe dirmi con dati specifici qual è il grado di partecipazione degli utenti?”

“Abbiamo visto che la chatbot funziona, c’è un buon grado di partecipazione, e quindi abbiamo chiesto alle stesse persone che hanno realizzato la chatbot di fare una piattaforma che si chiama BotMama che finge da chat ma è un sito; quindi, tutti possono accedervi e non solamente quelli che hanno un profilo Facebook, in pratica un sito conversazionale. Lo stiamo sviluppando in questi mesi. Da quest’anno la chatbot è allenato a rispondere anche in inglese, e nella piattaforma (non nella chatbot) c’è una funzione dove si possono personalizzare gli utenti che rispondono. Stiamo puntando sul gaming per quanto riguarda la piattaforma.”

“Si sono introdotti dei cambiamenti all’interno della struttura organizzativa del museo? Sono state assunte persone specifiche per gestire il progetto di chatbot?”

“L’organizzazione è aumentata, abbiamo assunto delle persone legate al digital ma non legate direttamente alla creazione chatbot.”

“Prima dell’introduzione della chatbot, com’era ricoperto il ruolo che ora svolge la chatbot?”

“Delle figure specifiche del personale si occupavano di rispondere alle domande dall’audience tramite i social network e anche tramite mail o telefonate.”

Interview (in Italian) with Matteo Innocenti, Professor and curator of David Bot, released on May 15, 2023

“Può fornirmi un’introduzione generale del progetto di chatbot? Quali sono i punti di forza e di debolezza della chatbot?”

“C’è stato un anno circa di elaborazione e progettazione della chatbot e la versione finale lanciata ufficialmente sul sito dicembre 2021. Quando si sviluppa una chatbot inizialmente bisogna chiedersi che personalità avrà e anche a quali domande avrebbe risposto. Sono state scartate le domande di natura più tecnica ovvero risposte su costi di biglietti orari di visita ecc. in quanto c’è una sezione del sito che si occupa di questo. Abbiamo deciso che il David potesse rispondere in riferimento a 4 aree tematiche che sono di natura tecnica-artistica quindi in riferimento alla scultura, all’arte, alla religione e alle curiosità, ad esempio il chatbot può rispondere a domande del tipo quali altre sculture ha fatto Michelangelo o se ci sono altri David realizzati da altri scultori, domande sul periodo storico, chi erano i Medici, ma anche se al David piace la fiorentina. Quindi alcune cose le dice ma se gli viene richiesto di parlare in maniera approfondita di altre opere d’arte allora rimanda a delle sezioni del sito web. La versione della chatbot è stata creata sia in italiano che in inglese.”

“Perché avete scelto di introdurre la chatbot? Quali sono gli obiettivi del progetto?”

“La chatbot è stata dapprima una curiosità da parte del direttore Cecilie Hollberg, alimentata anche da un incontro con un’azienda che è specializzata nello sviluppo di applicativi che usano l’intelligenza artificiale, si chiama Querlo, che ha fatto parte del processo produttivo della chatbot. Oltre a questo, ci si è spinti all’introduzione di una chatbot per il riconoscimento delle potenzialità dello strumento ai fini del dare delle info online. Quando hanno iniziato a lavorare sul progetto, era stato concluso da poco un importante processo di ristrutturazione del sito web, quindi le cose andavano insieme, il progetto di chatbot si trova all’interno di un processo di comunicazione e divulgazione che è più ampio e che utilizza anche altri canali (sito e social). Gli obiettivi prefissati erano dunque questi, e dare alcune info sul davi in questo caso, perché la particolarità di questo chatbot è che è strutturato in modo tale che è come se si parlasse direttamente con il David, ovviamente tenendo in considerazione anche una dimensione ludica, il chatbot non ha mai inteso essere né completo né sostitutivo a un approfondimento di studio e ricerca che il pubblico può fare, anche se il chatbot da informazioni comunque abbastanza approfondite in merito alla scultura e anche a Michelangelo e il periodo storico, ma è anche una forma di divertimento che vorrebbe poi invitare le persone ad approfondire ulteriormente usando altri strumenti.”

“Quali programmi/piattaforme/software sono stati utilizzati per creare la chatbot?”

“Per creare la chatbot è stato utilizzato un sistema sviluppato da Querlo che si basa su degli algoritmi, attraverso la personalizzazione di questi algoritmi l’azienda ha costruito una piattaforma che permette di realizzare dei progetti di chatbot. Sono degli algoritmi che funzionano primariamente con il confronto delle parole quindi sulla probabilità, se l’utente fa una domanda dove ci sono 3 o 4 parole che lui riconosce all’interno dei suoi contenuti allora tenderà a fare l’abbinamento e capisce che ciò che deve rispondere è nel quel passaggio di testo dove ritrova queste parole, c’è il deep learning perché apprende dall’esperienza ma non avviene del tutto automatica, nel senso che nel corso del tempo sono fatte e saranno fatte delle analisi e delle domande poste agli utenti, si va a vedere le ricorrenze e si fanno delle scelte, se ci sono degli utenti che tendono a fare la stessa domanda allora la risposta la si va ad implementare nel bagaglio di risposte che può dare il chatbot e così il progetto diventa sempre più strutturato. Ha comunque bisogno di essere seguito in maniera costante.”

“Saprebbe dirmi con dati specifici qual è il grado di partecipazione degli utenti?”

“Le interazioni sono state molto alte, per la versione in italiano sono state più alte rispetto che a quello in inglese, già dopo i primi mesi ci sono state circa 15 mila interazioni che fanno anche 3 o 4 domande consecutive; quindi, che non si fermano solamente alla prima. Il feedback è comunque molto positivo.”

“Si sono introdotti dei cambiamenti all'interno della struttura organizzativa del museo? Sono state assunte persone specifiche per gestire il progetto di chatbot?”

“Non sono stati effettuali cambiamenti a livello organizzativo, è stato creato un gruppo di lavoro che si occupa della comunicazione all'interno del museo con risorse interne ed esterne. La chatbot ha un ruolo importante ma non ci si punta in modo tale da poter andare a influenzare i meccanismi di organizzazione di lavoro interni alla Galleria dell'Accademia.”

“Prima dell'introduzione della chatbot, com'era ricoperto il ruolo che ora svolge la chatbot?”

“Prima dell'introduzione della chatbot, durante il periodo di rinnovamento del sito web delle gallerie, si erano creati dei video pillole di contenuti con approfondimenti su opere d'arte, e le domande degli utenti comunque vengono soddisfatte anche con i canali social, ora c'è una rubrica che si chiama David contro l'ignoranza che è iniziata dopo l'episodio della preside americana che è stata dimessa dall'incarico perché aveva parlato del David in classe e la nudità avrebbe scandalizzato l'istituto, allora in risposta il museo ha deciso di fare questa serie di contenuti.”

Interview (in Italian) with Annalisa Casagranda, head of Mart education area and editorial curator of MartMuseumBot, released on July 13, 2023

“Può fornirmi un'introduzione generale del progetto di chatbot?”

“Il progetto è stato proposto nell'ambito di un concorso internazionale nel quale Dimension, una ditta informatica privata di Trento, ha proposto il progetto di chatbot per esplorare e visitare il museo. Si cercava di non creare applicazioni per visitare il museo online ma usufruire delle piattaforme che si usano normalmente per fare conversazione, come appunto Telegram. Un paio di anni dopo è avvenuta la transizione anche su Facebook Messenger. Il Progetto è stato lanciato definitivamente nel 2016.”

“Perché avete scelto di introdurre la chatbot? Quali sono gli obiettivi del progetto?”

“Per il museo questo progetto vuol dire provare uno strumento nuovo e diverso da quelli che normalmente si usano per fare mediazione al pubblico e per comunicare ai visitatori i contenuti del museo, oltre a quello che la gente si aspetta di trovare normalmente al museo ad esempio gli apparati didascalici, le visite guidate, e le audio/video guide. L’idea è quella di puntare sull’innovazione tecnologica per avere una “falsa” conversazione, mimare la conversazione. Hanno creato una piccola mascotte che ricopre il ruolo del bot, è un robottino. È un nuovo modo di visitare il Mart a rovereto che ha il vantaggio, rispetto ad un’audio guida, di essere utilizzato anche a distanza; quindi, si pone come alternativa all’audio guida ma con un linguaggio diverso che non si basa più sull’ascolto di una narrazione ma su una sorta di interazione con messaggi brevi e concisi. Può essere utilizzato anche da casa, per esempio, nella preparazione alla visita o per rispondere a curiosità su quello che offre il museo o su come è fatto o su cosa contiene. Il punto di forza del progetto è la convinzione di non aver bisogno di un’ennesima app. Abbiamo utilizzato il metodo del design thinking per quanto riguarda la prima fase ideativa e procedurale del progetto, si è cercato di selezionare i contenuti basandosi sull’osservazione delle abitudini del pubblico piuttosto che cercando di immaginare che cosa avrebbe potuto interessare alle persone, anche quelle cose che di solito passano un po’ inosservate perché quanto ci si concentra sulla produzione di un audio guida o di testi sulle mostre si finisce sempre col mostrare le cose principali e rimangono un po’ fuori cose come per esempio il parco delle sculture che è una zona del museo visitabile anche da chi non fa il biglietto. I contenuti spaziano per riuscire a coprire un po’ tutto quello che c’è di prezioso nel museo (non solo le collezioni ma anche l’architettura).”

“Quali programmi/piattaforme/software sono stati utilizzati per creare la chatbot?”

“La parte di creazione della chatbot è stata gestita interamente da Dimension, io mi sono occupata della parte di ideazione dei contenuti che poi sono stati riferiti a Dimension; quindi, non sono a conoscenza di quale programma abbiano usato per creare la chatbot.”

“Saprebbe dirmi con dati specifici qual è il grado di partecipazione degli utenti?”

“Lo strumento alla fine non si è rivelato proprio così usato, i numeri non sono bassissimi per quanto riguarda l’uso della chatbot, ma se si va a guardare chi effettivamente prosegue l’esplorazione del museo una volta utilizzata la chatbot i numeri sono molto bassi, soprattutto su Telegram molti abbandonano la conversazione dopo il primo scambio probabilmente perché non è il tipo di contenuto che cercano, va un po’ meglio invece con Messenger.”

“Quali sono i punti di forza e di debolezza della chatbot?”

“Una delle difficoltà maggiori riscontrate durante la creazione della chatbot è l’orientamento, abbiamo cercato di risolverla mettendo immagini riconoscibili durante la conversazione, questo tende però a sovraccaricare troppo e mettendo troppe immagini parte lo scrollo automatico nella chat e spesso questo obbliga l’utente a scorrere per tornare indietro e recuperare il testo. Un suggerimento che è venuto dagli esperti del team di Dimension è stato quello di inserire oltre ai contenuti standard (quindi il racconto di quello che trovi esplorando gli spazi del museo) anche un tasto chiamato “sorprendimi”: premendolo ci sono delle curiosità, aneddoti, e fatti accaduti che escono dal discorso principale e che fanno scoprire delle cose meno ovvie. Una cosa che è stata utilissima è il fatto che dimension ha creato un’interfaccia molto facile da utilizzare. È necessario, comunque, un aggiornamento continuo dei contenuti. Se la chatbot non soddisfa le domande dell’utente, è stata introdotta un’opzione che ti consente di parlare con un operatore museale umano che potrà rispondere a tutte le domande con un contatto diretto. Abbiamo provato ad aggiungere una sperimentazione sempre con Dimension su Alexa che però è rimasta ferma per la grande differenza dal punto di vista tecnico-amministrativo, con Alexa non puoi caricare in autonomia i contenuti perché tutto deve passare per la casa madre, è un sistema poco sostenibile per il museo quindi questo progetto non è più stato portato a termine.”

“Si sono introdotti dei cambiamenti all’interno della struttura organizzativa del museo? Sono state assunte persone specifiche per gestire il progetto di chatbot?”

“Io mi occupo dell’area educazione del Mart e insieme al team di Dimension abbiamo progettato la chatbot; quindi, non c’è stato nessun cambiamento radicale a livello organizzativo, non abbiamo assunto figure specifiche all’interno dell’organigramma per il progetto di chatbot.”

“Prima dell’introduzione della chatbot, com’era ricoperto il ruolo che ora svolge la chatbot?”

“Prima della chatbot, i contenuti di narrazione erano gestiti dal sito web e dalle audioguide durante la visita.”

Interview (in Italian) with Giovanni Serafini and Monica Serrano Segui, art historians and managers, respectively, of the digital catalog of art collections "Arnolfo" and communication, released on August 1, 2023

“Può fornirmi un’introduzione generale del progetto di chatbot? Quali sono gli obiettivi del progetto? Quali sono i punti di forza e di debolezza della chatbot?”

“Abbiamo pensato a questo dialogo con Michelangelo attraverso un dialogo informativo dove venivano spiegate le opere di Michelangelo, ma anche la struttura museale. Il progetto è nato nel periodo del covid e voleva anche essere uno strumento per la raccolta fondi, durante il covid abbiamo cominciato a ragionare sulla possibilità di differenziare le nostre entrate dalla semplice biglietteria e di creare una rete di “amici dell’opera” e di donatori. La chatbot era nata con una funzione didattica, poi però ci siamo trovati di fronte al fatto che chi la usava voleva informazioni di tipo pratico, cioè ad esempio a che ora apre la cattedrale o anche sciocchezze come, ad esempio, se Michelangelo credesse nell’amore. Quindi poi gli abbiamo insegnato anche a rimandare alle varie pagine del sito dove si trovavano quelle determinate informazioni richieste. Michelangelo parlava solo in inglese e non in italiano.”

“Perché avete scelto di introdurre la chatbot?”

“La chatbot è stato un progetto sperimentale nato durante il covid per poter comunque esplorare le opere e Michelangelo anche non dal vivo. Questo progetto è stato un prototipo, abbiamo fatto come da laboratorio per la creazione del chatbot David per la Galleria dell’Accademia. Ora non è più online, abbiamo tolto la chatbot verso l’inizio del 2023. Il consiglio di amministrazione ha deciso di chiudere il progetto con l’obiettivo di utilizzare altre tecnologie in futuro o perfezionarlo, era solo un esperimento in realtà, una volta terminata l’emergenza del covid si è deciso appunto di terminare il progetto.”

“Quali programmi/piattaforme/software sono stati utilizzati per creare la chatbot?”

“La chatbot è stata progettata con una tecnologia conformata ad albero logico molto intuitivo che usa un sistema di domanda e risposta. Lo strumento veniva raffinato manualmente, diventava sempre più intelligente perché lo addestravamo e controllavamo con una certa regolarità le domande che gli utenti ponevano, la precisione delle risposte fornite. Tutto con l’aiuto degli informatici di Querlo.”

“Saprebbe dirmi con dati specifici qual è il grado di partecipazione degli utenti?”

“Nel mese di agosto 2021 Michelangelo ha risposto a 1046 domande.”

“Si sono introdotti dei cambiamenti all’interno della struttura organizzativa del museo? Sono state assunte persone specifiche per gestire il progetto di chatbot?”

“No, Querlo si occupava della programmazione della chatbot e noi come storici dell’arte ci occupavamo della ricerca delle risposte e delle domande che poi venivano fornite alla chatbot per educarlo.”

“Prima dell’introduzione della chatbot, com’era ricoperto il ruolo che ora svolge la chatbot?”

“Principalmente, la divulgazione dei contenuti sulle opere d’arte o in generale del museo era svolta da approfondimenti sul sito o degli insight sulla pagina Instagram.”

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