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Virtual Reality Systems For Cultural Heritage, Museums and Art Galleries

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TECNOLOGIAS
E ARQUITETURA

Department of Information Science and Technology

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Dedico este projeto de dissertação aos meus professores, amigos e acima de tudo à minha família
que me tem acompanhado nesta longa jornada académica.

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Acknowledgement

This dissertation work is dedicated to my father João Monteiro, who always dream of giving me all the possibilities to get the academic fundaments that I reached today and achieve a respectful and integrated life in society. My mother Antónia Oliveira, transmitted me the principles: of resilience and motivation to achieve my objectives in life. To my adorable sister Sónia who gave me the tools, motivation and intellectual help on this journey.

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Resumo

Os objetivos deste estudo relacionam-se através revisão da historiografia até ao cenário atual da Realidade Virtual (RV) em Museus e Galerias de Arte. Relacionando estas novas tecnologias com a forma como devem ser entendidas quanto à sua interatividade, e ambivalência de formas para criar ensinar e produzir uma continuidade na herança cultural da arte em ambientes virtuais.

Este a projeto de dissertação será acompanhado desde o início até o surgimento dessas novas tecnologias de ambientes virtuais para o Museus e património cultural. Descrevo em detalhes as estratégias, tecnologias, historiografia e conceitos de Realidade Virtual , em Museus e Galerias de Arte. Este estudo tem como objetivo rever o máximo notícias publicadas consideradas para uso neste estudo com recurso a metodologias inovadoras de investigação. foi realizado a partir de um método de Machine Learning e News Fetching para busca de notícias e dispor de um grande numero dos conteúdos disponíveis e assuntos publicados em jornais e agências de notícias.

O tratamento dos dados é realizado sob um Algoritmo de Processo de Linguagem Natural, uma Técnica de Aprendizagem Automática para medir e avaliar a partir de um algoritmo de modelagem de tópicos.

Técnicas de aprendizagem automática possibilitam a análise e o estudo de uma grande diversidade de fontes em simultâneos. Este estudo permite concluir através dos métodos de investigação mencionados que o âmbito da realidade virtual em museus e galerias de artes estão em constante desenvolvimento na aplicação das tecnologias e no futuro desenvolvimento da realidade virtual.

Palavras-Chave: Arte Digital, Realidade Virtual, Ambientes Imersivos, Mineração de Texto, Realidade Virtual para análise Textual, Modelação por Tópicos

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Abstract

The aims of this study are related through the primordials to the actual landscape of Virtual Reality (VR) in Museums and Art Galleries. These new technologies must be understood as their interactiveness, supported technologies, and ambivalence of forms to create virtual environments.

This study aims to review as much of the published News as considered for use in this innovative investigation methodology. This Study will be conducted from a News fetching method to dispose of most of the available contents and available published subjects in newspapers and news agencies. The data treatment is performed under a Natural Language Process Algorithm, a Machine Learning Technique to measure and evaluate from a topic modelling algorithm. It will also be considered a new resource for textual data analysis in a virtual reality system to visualize the results of topic modelling.

From this dissertation work was possible to conclude some important aspects of tVirtual Reality using those described investigation methodologies. In the genre of virtual reality from museums and art galleries, develop and, design the implementation of new technologies and promising the future development of virtual reality. Those applications are wide and comprise great and diverse areas, and support educational projects, as also entertain and create new experiments proposing the fruitions and new storytelling of artists and their artworks.

Machine learning techniques it is actually a fundamental tool of research and with that analysis and AI technology enables not only to study a big amount of data and explore unlimited resources of study.

Keywords: Digital Arts, Immersive Reality Environments, Virtual Environments, VR for Textual Analysis, Topic Modelling

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Acronyms

AR - Augmented reality **LDA** - Latent Dirichlet Allocation

MXR - Mixed Virtual Reality **MMO** - Massively Multiplayer Online Server

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CHAPTER 1

Introduction

1.1 -The State of Art - Contextualisation and Problem definition

This chapter will present a brief contextual analysis of Art meant and historical values in museology that guarantees the preservation of cultural values and art legacy that nowadays benefit from a great diversity of technological forms of Virtual Reality Systems.

The central theme of this dissertation work, are how Museums and Virtual Reality are related to their mission to divulge artworks with new technologies on V.R. systems. It is about understanding the state of Art and those intrinsic innovations and technologies, which are fascinating possibilities for those who visit museums and those thematics in a virtual environment. The museums, spaces of learning, have the mission to preserve collections of Art represented by paintings, sculptures, photography, ready-made, performance works, video art, and new media and acknowledge these days the visit to a virtual environment proposing an immersive experience based on the Museum environment and also outdoors giving the possibility of the visitor to go through the Art without getting out of their based places. Knowledge, evasion, and enjoyment promise that everyone can access into this immersive sociological experience. A locally based museum in a distant city with a collection of artworks that could only be accessed by local visitors and tourists within the implementation of 3D scanning of architectural environments could be modelled and disposed of on a web-based application. (Kargas, A.; Karitsioti, N.; Loumos, G, 2019) Visitors can navigate and proportionate an almost real-life experience in the virtual Museum or even reconstruct virtual and navigational historical places. This new adaptation of technology created "one of the most important challenges of their modern history" (Kargas, A.; Karitsioti, N.; Loumos, G, 2019). Creating new forms of interactiveness and content display for visitors enhances a vital need to adapt, construct, and invite to a new engagement. It became one of the most essential implements for the Cultural Industries and museums; in this digital age, this adaption was imperative. Open up their collections of art with new storytelling and exhibit of their artworks. This dissertation work will disclose and define the present historiography and this new technology as a new medium, defining its genres of interaction immersion and applicability on its different genres and supports. It will be also comprise the related works, the technologies, Museology and Technological features of that emerging field of immersive and virtual realities. This investigation follows a textual analysis of news and new agencies to perform an innovative source of research that implements Machine Learning Algorithms. Aims to get in detail what is being related between news papers and media, performing a statistical form of study as Topic Modelling and Natural Processing Language (NLP) an Artificial intelligence. It enables synthesising, measurement and identify the principal constructs related about Virtual Reality, Augmented Reality a MXR Reality. It begins with the art meant and Museology mission to divulge and acknowledge cultural and artistic artworks and as a scientific contribution I propose a virtual reality system to visualise under Topic Modelling Result as a statistical form of Virtual Vizualition for Textual Analysis.

1.2 - Museums From Its Origins

From the beginning of the classical ages, artists' cultural values and historical works were not accessible to the public. In such a way, the highest classes of society preserved value as the monarchy and aristocratic families or the church that could finance the Artists as Patrons supporting their lives and artworks. The artists live their lives depending on the orders of paintings, portraits, sculptures, Jewellery, and some interventions in architectural spaces, such as fresco paintings and Iconography, to enhance the importance and visibility of the state of government or monarchical families. They had the mission to represent, using their techniques and talent, a moment in the history of their lives and create artefacts that could sublimate the importance of historical moments to their clients as a legacy preserved all the ages.

Museums as public places to contemplate works of Art have almost six centuries of existence. However, they appeared in the classical age in Greece with the foundation of [MoSeiom] from Aristotle. As a place for a public mission to preserve and present cultural values, it only remounts to the beginning of the 15th Century with the opening of Britain's Ashmolean Museum. The Museum has a paradigm on contemporary culture, about questions of identity and diversity from their Anthropologic perspective. A lot is being studied about Art History and Visual Culture. The Practical Tradition and Artistic Technique of museums date back to the end of the '50s beginning of the '60s when they belong to the mission of achieving a form that Museums as a social system could be broader than other cultural industries such as Media, Advertisement, Cultural Spectacles, and Tourism. On a mission to promote Design Consumption, Patrimonial Values, and Politics. (Ferdani, D., 2013) Museums have had to make a difference in their discursive lecture to distinguish from their historical representation and adapt to the exigences to new thematic and broad missions with the competitive global and great massive exhibitions (Macdonald, Sharon, 2006). One of these contemporary works is assigned to curators and theorists of Art that implement new global and digital communication strategies to a broader public.

1.3 - Virtual Reality as a future field of visualization systems, a new medium for museums and art Galleries

Although it is challenging to categorize works in any medium, it is sometimes helpful to classify works for study to define this medium genre. This dissertation focuses on virtual reality applications. It is helpful to classify applications with other available supports to allow the reader to understand common elements and learn from other applications similar to what they experience in other virtual and immersive experiments. As in education, museums, gaming, and even Science and medicine, how they are in some way diverse from each other and identify their similarities. In V.R., we typically associate the genre with the class of supported technology and also with that mode of interaction and immersive level. Which could be Multimodal, Hybrid, Collaborative or Tangible. *However, it could also be categorized as its interactions and immersive possibilities (Craig et al., 2009)* Such as semi immersive, immersive, high immersive and full immersive. Virtual Reality comprises 4 primary elements: virtual world, immersion, sensory feedback, and interactivity. *These forms of Virtual Reality for museums and art galleries are somehow developed application interfaces* immersive or fully immersive, that allow the participant to experience some model of a location through an undirected interactive narrative. (Craig et al., 2009) A typical genre that uses this form is the architectural or site walkthrough, often based on a real-world location supplied from a device-based medium a Virtual Space or a virtual Display such as Head-mounted Displays or Mobile phones or Simulators. The Participants are allowed to move throughout the modelled virtual world. Virtual Museums models recreate their Virtual environments to achieve immersive experiences inside and outside the Museum space with Virtual Reality and Augmented Reality systems with diverse forms of interaction proposes with entertaining games and evolving sensory feedback. Recent studies about technology

acceptance models enable concluding these virtual forms of virtual system mediums created a highly engaged and are accepted as new methods of education and a remarkable source of knowledge. (Moro, C. 2017) From these new supports and devices Human and Computer Interaction (HCI) is developing new interactivity and creative forms of usability with computers, Mobile Apps and Virtual reality systems. It produces multimodal experiences inside museums, recreating new narratives and performing an adaptation of their discursive lectures to the public.

This implementation of Virtual reality systems in museums traces back to the beginning of the internet with the first experiments with hypermuseums, cataloguing and disseminating virtual collections on the internet with The National Museum of Science and Technology, online since 1996, launched in 1999 and online with the 3D virtual cooperative environment. (Ferdani, Daniele, 2013:77) As technology and devices evolved multiple interactive applications became a useful tool for cultural sectors, and Museums made some adaptations to accept that challenge and embrace that technological field. The first AR that was implemented for cultural heritage was first implemented to supply the need for virtual guidance within museum space with visual markers and audio descriptions. as it was first created in the project Archeoguide (Ferdani, Daniele, 2013:77). That did use of mobile phones and wi-fi connection. Having the benefit of using these devices functions, as a camera, gyroscope, and display to reconstruct old roman structures, guide and add additional levels of information to reality, creating delightful and amazing possibilities for museology and the public to fruition and create a full experience of art, history and knowledge. This technology performs unique and engaging apps for museums, and this category of technologies is evolving and has been adapted to new fields as innovative simulators with augmented reality systems or the CAVE and other Collaborative Immersive Virtual Environments performing some great diversity of projects of art and cultural heritage worldwide. The Metaverse example of future sociological integration in the global scenario of networking and social media enables the Virtual presence of Museums World Wide, performing Some Interactive spaces, for divulging and make a presence on-line. Tangible user interfaces (TUI) have become an increasingly common way of building interactivity into digital experiences. AR, Head-mounted displays and touch tables provide a physical interface for screen-based to two-dimensional experiences and full immersive 360° video mapping “get-into-art experiments “ are getting more closure to the holographic and hyper-virtual dream of digital contemporary artists, offering them a diverse multiplicity of virtual mediums to explore the boards of human senses. ARSTechnica. (2013) The most fully immersive experiments that can already be produced are with 360° immersive projections and it's being performed in some museums whose walls and floors of those emblematic places are fully projected with advanced video mapping techniques as a recreation of the most beautiful artworks. Where visitors feel immersed in an amazing collaborative and multichannel experience.

1.4- Research Questions

This study aims to understand the concepts, foundations, supported technologies, and their evolutionary development. What are the most significant and interesting subjects regarding this field of Virtual Reality, Immersion, Sensory feedback and digital supports?

My research's main concerns and propose to answer are:

- 1- How have new technologies and informatics developments evolved to support Cultural Heritage functions and offer significant value in the distribution, publication, and management of Masterpieces of Art?
- 2- How do media and communication construct/build importance or relevance about virtual reality and cultural heritage, and how does this subject reveal the value of new technologies to the cultural scene of museums and galleries, and what is being related between News and newspapers?

There are also other questions I address regarding Machine Learning algorithms and News fetching Techniques:

- What are the most advanced Technologies in Museum Virtual Reality experiences?
- What are the Technologies that enable Virtual environments for museums?
- Why do museums dispose of Multimedia Technologies for Their Visitors?
- How do media and communication construct the image and reference museums and cultural heritage?
- What are the main constructs of communication about V.R. and museums in actuality?
- How is it possible to reconstruct and give realness to Art Works and Immersive Experiences to explore the sensory system of visitors and the main public?

1.5- Objectives

The aim of this study effectively represents a contribution made to a dissertation work that takes to the present days what is the state of Art of cultural heritage. How virtual technologies implementations greatly benefit the engagement and fruition of Virtuality inside the Museum and outdoors. It is a way that visitors and the public worldwide could get an immersive experience and a new form of proximity with art and cultural values.

This dissertation work will be described in detail the strategies, technologies, history, and concepts followed by a revision of related information published on news agencies. It was Researched from the beginning to the rise of these new technologies of virtual environments for cultural heritage. It is proposed to use a model of textual analysis using machine learning algorithms called LDA latent Dirichlet Allocation, an Artificial Intelligence interpreter with Python, a cross-platform programming language, to create a statistical presentation of what is performed. This study will be conducted through News fetching algorithms to get a big picture of what is being related through these new technologies using a massive crawling technique called text mining and news fetching. That allows accessing, reading, and interpreting the content of newspapers related to Virtual Realities, CyberMuseum, and Virtual Reality subjects on Cultural heritage. It will describe the technologies available, the history, and how they are considered by Museum strategic departments giving a form to that historiography of the present subjects on their evolution and principal conceptions, ideas, and techniques. All this work is to provide a complete understanding and reinforce the knowledge of Cultural Values and Cultural Heritage using Virtual Reality Techniques.

This study will provide insight into some of the technologies that support Virtual Reality in museums and art galleries and their specifications, application, methodologies, Technique and evolution over time. This dissertation also aims to connect the historiography of that evolution with the technologies that support cultural heritage and how they influence aspects such as publishing, dissemination, tracking, and preservation of masterpieces of Art. More than a historical overview of the issue, the main supports, devices, and technologies used on this new and innovative Media platform will be discussed. The research will concern the primary constructs of information by searching media databases of newspapers and news agencies to identify the main improvements, what is being constructed about the image of Virtual Reality in the present, and how media and communication related to that phenomenon. Understanding the semiotic worth of these constructs, I suggest a model of multiple analysis with this dissertation work, above to determine the fundamental constructs of this theme and how the principal subjects are related across all of the extensive acquired data. How frequently are they used? And Also it is proposed a scientific contribution to Data analysis visualization to be performed under a V.R. environment modelled originally for this academic purpose, which is essentially a Textual Analysis Visualisation under a virtual system (V.R). Created from a coordinate system of particles, topics from News are displayed, running on virtual environment under a V.R system. To perform navigation and see in 3D the quantitative data displayed as Topic Modelling. The goal of this technological project as a scientific contribution is to take advantage of the 3D coordinate system essentially and rendering styles and physic animation, with

the highest level of accuracy in visual elements, to display onto a virtual game style. A topic modelling presentation from the results collected from Topic Modelling algorithms obtained from newspapers and news agencies about the subjects will be interactively displayed in this virtual environment. This V.R. implement performs an innovative and unique visualization style for topic modelling results in a 3D environment.

Principal Objectives:

- 1 - The dissertation work is proposed to define the state o art of cultural heritage, Museum and their correlation to Virtual Reality Systems
- 2 - Define How does VR are great Implement for Museums
- 3 - Describe in Detail:
 - The Concepts
 - The Strategies
 - The Technologies
 - The Historiography
- All the related news published about that subject will be an investigation field to support the image that the media construct about these related subjects.
- 4- Review as most as possible, published information in newspapers and News Agencies
- 5-Enable Innovative Scientific Research making use of News Fetching
- 6-Perform a Topic Modelling from Collected Data
- 7-Create a VR, visual presentation of these topics under a VR system

1.6 - Investigation Methods

Following a textual analysis, these subjects will be understood from informative objects and respective relations between author/ Reader, Message / Support Language / Code, and Intrinsic information constructs and decode their semiotic worth. That analysis should occur as massive research on a scientific design research model to reveal more profound and more revealing aspects related thought the V.R. and Cultural Heritage subjects and related information collected through search engines such as Scopus, Google Scholars, Academia, ResearchGate, Libgen, and most popular agency news as Reuters, NYtimes, The Verge, BBCNEWS, Público and JN. The Investigation was be prepared from research with News Fetching and Text Mining Techniques. Through the most frequent and accessible databases of newspapers and information agencies.

From this method, the analysis was applied to a Textual analysis on an analytic contextual model of constructs and their respective information value, a topic model analysis using machine learning algorithms. The Latent Dirichlet Allocation (LDA), and a statistical presentation of qualitative data, using a model of multiple correspondences called PyLDavis. The Keywords were analyzed through a Machine Learning Algorithm to organise the words under a topic model-based system, coded in Python and running on a collaborative virtual machine. From this method, the analysis will apply a measure of multiple dimensions to an analytic contextual model of constructs and their respective semiotic value, under a multiple correspondence analysis statistical presentation. They could be visualized above a V.R. System for Textual Analysis specially developed for this dissertation proposal. As a unique and original contribution to museology and virtual Reality for Cultural Heritage systems.

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CHAPTER 2

Literature Review

2.1- Elicitations and conceptions of terms related to Museology and VR Cultural Heritage

2.1.1 - Concept of Museum

Museums only appeared from the goodwill and philanthropic vision of Patrons of Art, Monarchy, and Clerical, to preserve the artworks, and recover artefacts they thought could be open to persons from all social conditions. They could present their people with Opus Magnum pieces of Art and architectural interventions to places with mostly in Rome, where Art and history cohabit on humanity has saved historical wealth. However, when it was initially established, the [Mouseion] was only a place to learn and study for some limited classes of society.

The principal proposal and mission were to receive the essential minds of that classical era, attempting to compete on sovereignty and knowledge with The Geek Empire. The Founder of his lectures created the first Museum in the World, Aristotle's in The Greek Lyceum. The Museum was local to promote their study and research of subjects of knowledge and Science, Engineering, and Astronomy. (Macdonald, 2006)

The Mouseion of Alexandria was constructed in III B.C. by Ptolomeo and received the Illuminated mind of some personalities of Science. It was a place to study important subjects and knowledge. Was Established in The Alexandria Library, there was "something imperialist in the [Mouseion's] treatment of the books themselves – organising them, cataloguing them, and editing them" (Erskine 1995: 45). Although this heritage is no longer with us caused by a fire that destroyed Alexandria Library forever, it is believed that the history relates it as one of the wonders of humanity. According to history, it was afterwards rebuilt, but its Classical Ages heritage was lost forever.

The Capitoline Museums in Rome (1471) and The Ashmolean Museum in London (1678) started their public missions to provide knowledge, Art, and Science to the general public early in the Fifteen and Seventeen centuries. With important artefacts and archaeological evidence, botanical collections were revealed and formed the first public Museums with the projects of conservatory and preservation of human and cultural heritage.

The Museum is a place to promote ideas, Science, Culture, and Artwork and perform some thematic experiences. There are numerous and diverse types of museums. There are five types of museums: Ethnographic, which focuses on anthropological values, and cultural aspects. The Classical Museums present the heritage of the classical ages through representations of Art, portraits, jewellery, and sculpture. Archaeological, is those which focus on historical and relevant public places for humanity. Modern art museums and galleries also house the most recent and post-modern artworks from the most prominent contemporary artists. The sea Museum, astronomy, physics, electricity, and botany are all represented in science museums.

2.1.2 - Concept of Virtual

The humanities became interested in publishing their scientific works using new terms to define and perform a scientific definition to give meaning to this new manner of use to interact with visualization data systems. Somehow it could be relevant to publish their scientific research using interactivity and web-based structures as innovations because of the accessibility to other areas of knowledge with the emergence of the internet and visualization of information systems it was broadly accepted.

Possibly the concept was not well defined at the time in the '90s when some experiences using interactivity and visualization of data brought the first relation through humanities and virtual Reality,

defined as "interactive and virtual interaction ."In its first experiment with virtual Reality, Krueger related the term "artificial Reality" (Kruegger, 1970).

The humanities have the need to define subjacent concepts of virtuality. As Deleuze refers in his dialogues about Virtuality, "In all of the cases, the distinction between the virtual and the actual is related to the separation of the most fundamental part of the time, when he goes forth it differences from two great ways, makes pass the present and conserves the past." (Deleuze et al. 1996). It reveals on, the separation between two moments of the object in the present time and how it could be preserved on the "cloud of memories" as it becomes virtual. Gilles Deleuze also distinguishes the value of virtuality images from themselves as less separable from the actual object and their implicit layers, even though virtual became the object itself. In another form, as Bergson refers, the memories are not actual image that takes form after the reflected object, but the virtual image coexists with the actual perception of the object. The memories are the image in virtual contemporary to the actual object as corresponds to its reflection in the mirror. (Deleuze, et al. 1996)

2.1.3 - Concept Of Virtual Reality

Virtual Reality has been conceived as a creative idea of Sensory places, Interactive interfaces, or Holographic displays and brings to the narratives a futuristic and pós-modern prediction of what could be observed and experienced in the Future, as almost all of us have seen in the Screenplay "*Matrix*" since its inception. It was the ability to produce an immersive experience in one place that had the same qualities as another place, whether virtual or fictional, syntactic or computer-generated, turning the person's local different. It is a computer game genre centred on a virtual world presentation or environmental space. Usually, 3D computer graphics visualized with head-mounted displays create a better sense of immersive virtuality by combining the real aspects of the environment with computer-generated 3D graphics, videos, and animations, merging Synthetic images or computer-generated graphics that could be accessed through a virtual space. (Mihelj, Matjaž, Novak, Domen, Beguš, Samo, 2019). This genre has inspired a wide range of concepts in literature, science fiction, and film. In his novel "Brave New World," Aldous Huxley also mentions a new notion of the screenplay in which the protagonist was the audience and could interact with the movie, the movie being its narrative and the spectator the main protagonist. The concept of V.R. could be traced to the mid of 1960 when Ivan Sutherland, in a manuscript, described V.R. as "a window through which a user perceives the virtual world as if it looked, felt, and sounded real" and in which the user could act realistically, and for that propose a few years later he created the first head-mounted display, for V.R. and A.R. consisted on two screens, one for each eye suspended from the ceiling. (Sutherland, 1965). The first real computational experience of virtual Reality happened in 1970 when it appeared for the main public as an application supported by computer graphics that supports interaction between user; It simulated a flight cabin to make possible testing with a stereoscopic vision supported by head-mounted displays to test a flight of an aircraft. (Pantelidis 1993). In 1970 the first time the term was assigned was from the innovative mind of Myron Kruegger who related the term Artificial Reality , (Myron Kruegger 1970), to an invention with computational features that could manipulate and react with objects in a virtual environment in his experiment. More about the late '70s, the technological world assisted in the development of a molecule display system based on a virtual environment. The project was called Group - III by William X, and it was possible to feel the forces between molecules using an interactive glove and motion-tracking cameras. The term "virtual reality", was first proposed by Laniner of American VPL Research Inc. In 1989, which described that computer simulation technology. (Jaron Lanier, 1980) It implemented another level of interactivity using a haptic system that could manipulate 3D objects in the virtual environment using a glove, or an Hand Held Device (HDD). However, the imagination went far as 1990, and we observed the major progress in virtual Reality with CAVE (Cave Automatic Virtual Environment). Essentially, it is a room with walls made of screen displays, a virtual and interactive environment controlled by motion trackers and cameras whose walls are background projections of the three dimensions of the virtual room. In some cases, even the floor is projected, and the sense of

movement is followed by the image projection with motion trackers . The visitor could see themselves inside the virtual room using special glasses called Head Mounted Displays (HMD) with a walkthrough interaction. Finally, in 1990, Paul Reilly associated for the first time the term "Virtual reality" with "Archaeology" (Raily 1990; Gillins 1997), referring to the three-dimensional reconstruction of objects and ancient buildings. From here, such a term was used to refer to several technologies of dynamic and interactive visualization systems (Ferdani, D, 2013). A.R. and V.R. and, recently, MxR have been considered the default immersive reality technologies in the domain of Virtual Reality for Cultural Heritage (Haydar et al., 2011; Papagiannakis et al., 2018). Having some subfields as tangible tables, 360° video mapping, simulators of augmented reality mobile app and interactive devices

2.1.4 - Concept Of Virtual Museum

A Virtual Museum can be thought of as a place to divulge a cultural heritage, which the collections can be tangible or intangible (Ferdani, D., 2013). Where collections are presented through multimedia support that links the information to the artworks from a Virtual environment supported by Web3.0 or from those of the main technologies available for virtuality are Augmented Reality, Virtual Reality, and Artificial Virtuality or Mixed Virtual Reality (MXR). The concept of a virtual museum could be defined and also known as a CyberMuseum, a HyperMuseum. It is a museum that incorporates computer-generated graphics to support collections and broadcasts from a physical museum. It dematerialises the contents of artworks and allows for virtual visits from worldwide. Would be used in conjunction with an augmented reality companion to a guided tour of a museum. It can effectively explore and manipulate 3D items. It dematerialises de contents of artworks and also could proportionate the view and manipulation of 3D objects and even add additional levels of information to exhibited artworks and artefacts, such as sound voices from the past as described audio guide. Moreover, it has features such as a virtual environment guide visit, Connection to other virtual museums, an online catalogue of images, interactive games, interactive experiences, entrance and reservation.

2.2 -What is Art Today?

The Museum, as a public-interest institution, must adapt to this new kind of contemporary mass image production. A space to explore visuals and Art is currently a challenging strategy for reinterpreting and displaying modern art subjects. As advertisement, cinema, television, magazines, and imagery became a multidisciplinary production that could be regarded as various levels of interest and technique. Some artists were compelled to make more rewarded works and expand their artworks to new markets that were formerly more valuable and demanded as digital markets, global cultural aggregators, global and massive exhibitions or even the new trend of Crypto Valuable Non-Fungible NFTs. As some artists refer to museums, they are separate institutions that house artworks in different locations, not necessarily requiring the consent of museums to show and exhibit their works. They are increasing the number of installations of their artworks in other institutions, including parks, small-town galleries, hotels, and even certain public spaces in general and even online. It is there where the link becomes stronger. The "online platforms" provide great interactiveness and new possibilities of massive and versatile exposure. As contemporary artists became a new generation of self-producers, this generation is more focused on the meaning sense of production, which reinvents and creates new concepts. The technique is nothing more than a support to a more relevant urging message in their dialogical sense. The public in this post-modernity age is somehow more informed than ever, and the artists are challenged to create conceptual work with a message that supplies new public interpretations and cultural values. However, the new generation

of contemporary artists is creating and educating new generations of the aesthetics public with some rewards efforts.

2.2.1 - The museology today and its modern approach to creating new experiences for public

How could museums compete with mass media, spectacle, and cultural industries? As advertisement, Music, Theatres, Movies, and Literature, Social Media, evolved as cultural industries. This makes us think about how they provide better entertainment evasion and cultural meaning to youngsters who even sometimes look for some sort of underground Art and culture. At the same time, they care about the way to preserve the interest in new artworks, new collections, and multimodal experiences, implementing alternative themes as innovative thematics for visitors as science and culture. They propose experiences to embrace the classical cultural heritage and at the same time, surprise their visitor with new values to the questions of technological innovations and scientific improvements. Museum on the contemporary scene dialogue amongst cultural events promoting Art and Science. Through advertisement and media to remain on a social presence and mediation to promote the work of artists, curators, and theories of Art. One project of the science museum that proposes V.R. experiments in Portugal is The Project Museums "Ciência Viva," which are places where Culture, Science, and Ethnography meet together in remote areas of Portugal even though there is a Center Ciência Viva in almost all the districts of Portugal. The experience allows multiple resources of knowledge and interactive environments. They use virtual reality and Augmented Reality devices to support interactive games and activities. "Museums and places of public interest that, as a cultural legacy, they had to redefine themselves in some way and create user experience projects that were accessible to their resources and technologies." They are retelling their narratives and digital presence in response to technology advancements and audience expectations of each location. Virtual tours are a major phenomenon that has attracted a large number of people of various ages and academic levels. They offer an immersive experience of the Portuguese Community's scientific, anthropological, and cultural history, to a deeper vision and comprehension of Science and the local industry environment, traditional wealth, and ethnography. But to achieve more global communication strategies, museums need to adapt to Massive and global aggregators of art, otherwise, they wouldn't be present on the multimedia and online scene, to promote and become visible to more visitors and continue on their mission to guarantee, art, culture, science and enjoyment on a sociological experiment.

2.2.2 - Case Studies of Virtual Museums

Rota do Românico - Virtual Environment - 360º Panoramic Virtual Tour

Another project discovered throughout this investigation, and it is the complete itinerary for architectural sites of historical significance, was found in www.RotadoRomanico.pt. From the beginning of Medieval history, Romanic was regarded as one of the first European architectural styles, distinguished by its rock edifications ornamented and constructed from columns, arcs, and gates. "Rota do românico" has been preserving and maintained their edifications and artworks. It has been remarked on and preserved their constructions along the times. Rota do Romanico on their virtual proposal carries us to Castelo Branco, Lousada, Celorico de Basto, interior places of Portugal where artificial virtuality presented to those visitors the most important and still preserved architectural places being characterized by romanic styles, such as Monasteries, Churches, and Gates and can appreciate their Medieval paintings and Iconography. At their V.R. system, we enter those constructions and are presented through a 360º visit where we can find more than architectural styles; we can find their collection of sacred Art, roof paintings, Sculptures, and Iconography. It is a completely immersive experience through religious Art and romanic style architecture that get together.

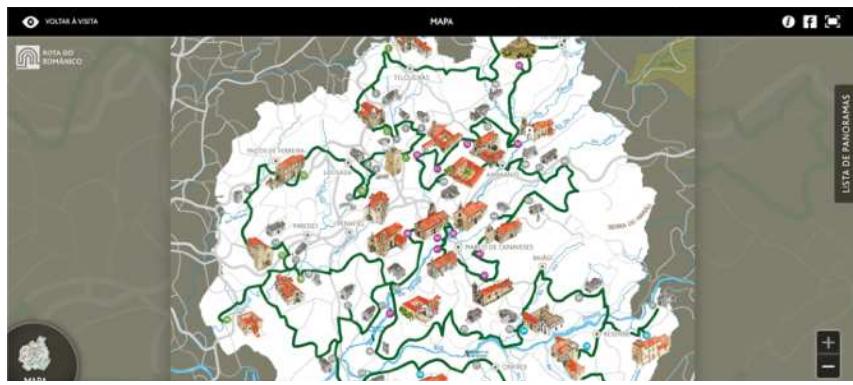


Fig.1.2 - Rota do Românico - Interactive Map of Cultural and Medieval Places



Vatican Museum

One of the most ancient museums that opens its doors to the public in the mid eighteenth century. It shows us in a wonderful way, their treasures that are housed in the Vatican Palace. It has around 70.000 artworks and fresco paintings on its ceilings and walls spread throughout fifty-four galleries. Sistine Chapel is one of the Vatican Museum's ex-libris, housing Michelangelo's opus magnum, "The Creation of Adam," as well as original Caravaggio's and Michelangelo paintings and statues. As a diverse collection of religious Art, Modern Art, renaissance art, and sculptures. It offers a fully immersive virtual environment with a 360° taken with high-resolution omnidirectional cameras. The navigational tour of the Vatican Palace and its most emblematic rooms in a very high-resolution viewpoint into the visitor's perspective, to improve the virtuous icons of Italian Art and Catholic wealth and history for everyone, with free Access worldwide.

High Resolution 360° Tour of Artificial Virtuality.

Fig. 2 - Galleries from Vatican Museum. Fig. 2.1 Galleries from Vatican Museum Raffaello's



Room

British Museum

The British Museum announced the opening of its virtual environment to promote Art and history with the update of the digital hyper museum. Their mission comes throughout the seventeen century. The technology approach deviates from traditional virtual tours. It is also an interactive project with a new layer of interactivity with users and a new and innovative proposed website. It is a website with interactivity between a chronological timeline and its linkage points. From 500 B.C to 2000 A.C., each point addresses an object of Art or anthropological proof of artworks. We could link to a page featuring images, videos, and audio descriptions of the evidence of that art piece, by selecting the connection point. It is a very intuitive user experience approach that is available with the mobile version and illustrates how culture and technology may combine on new perspectives and imaginative displays these days. an innovative and fun usability Hypermuseum



Fig. 3 - WebSite from British Museum

The Apple Museum -1992

Talking about projects of virtual museums should be incomplete without making reference to the project created by Apple in 1992. The very first virtual Museum was created on CD - Room. A navigational and interactive game-like interaction where the users could control and navigate through different sorts of virtual rooms. They would appreciate the history of Art and objects of design with also other rooms full 3d generated relating to themes such as Botanic, Astronomy, Physics, and Art in general.

Fig 4- cd room cover - “ The Virtual Museum” - Apple



VOMA Museum. - 2022

Its a very recent project of a Virtual Museum that acknowledges all different artistic movements, design objects and sculptures on a Bauhaus-style architecture created only from computer Generated Museum, performed with CGI and supported by the game engine Unreal5. Proposes a fully immersive and virtual experience in a Virtual Museum. It's the proof that computer graphics could embrace art to promote with some talent on a personal project the conception of a very interesting Museum where we can observe with detail the textures of painting, with their natural proportions and also their Materials, are well conceived and its possible to sight into the details of natural lighting that embraces the virtual environment such as mirrors and glass reflections. That was conceived with the mission to supply the sense of proportion, giving High resolution to artworks and supplying the lack of presence in this field from another aggregator of art that provide also virtual tours. Visitors can walk through the works, enlarge the paintings, watch the videos, access the technical information of each piece and read the informative texts of the exhibition. In addition, support spaces, as in a real museum, are made available to the spectator as a cafeteria that works as an online chat room and outdoor areas.



Fig5- Outdoors VOMA - Virtual Museum



Fig 6- Interiors VOMA - Virtual Museum



Fig 7- Artworks VOMA - Virtual Museum

2.3 - Technological Features of those Virtual museums

"Virtual museums of this genre can be a strong tool for comparative study and research into a specific subject, object, or location to accomplish the purpose of defining genres of interaction and disseminating cultural legacy and heritage to the public." Paulo Monteiro

Identifying the subject and the object performed in virtual reality systems is more than a research field to be identified, it offers significant information about technologies acceptance models, learning models, development of guidance and storytelling strategies, the technologies available from different regions, and how they are used for which proposes. Enabling a comparative study about interactiveness and digital supports. Most of those technologies described as multimedia supports or mediums evolved from those principles. As the access to publish, manage and broadcast these artworks The Museum Strategic Department adjusted and did some efforts to accept this challenge to become widespread geographically and more accessible and digital convergent. To present visitors worldwide with these new mediums and perform their own storytelling with these fascinating technological features as they are developing along time.

Virtual Reality was possible to develop in the '20 Century because of the less weight of computational processes and graphics units on computers and other devices. With enhancements in computer performance and new technologies of graphics engines and software, the technological implements used to build Virtual Reality became more accessible with lower production costs. Graphic engines and computing processors are generally available on any device, such as laptops, smartphones, and tablets, enabling digital convergence for any type of display. It allows the creation of digital content using several market alternatives, including open-source software that is compatible with almost every computer and developing features for a wide range of devices at an affordable cost.

The computational process solves the image processing in real-time using a byte matrix for every frame of an image in real-time rendering. The rendering that synthesises that image from groups of meshes known as primitives are low polygon mesh representation of an object or an architectural environment, and it runs under 3D software. The computer uses a Computer processor unit, a Graphic Processor Unit (GPU), to render the virtual images in the real-time process using rendering engines. Sometimes for frame rates with a high level of photo-realistic detail. To other rendering processes, the graphic board could render with a lower level of detail in 3d primitives on a real-time display, and less level of computational weight for the immediate result on interactivity and navigational proposes in a 3D interactive environment. Usually, these tasks are performed by a game engine such as *Unreal*, *Unity* and *Blender*, to produce games and app or WebGL Browsers files.

Cameras and other based-sensor as infrared, gyroscope, wi-fi connection and head-mounted displays are also widening their functionalities. They are incorporated on an almost mobile device and have capabilities of recognition and display virtual contents with high accuracy levels of precision, detail a realism which performs:

- 1- High level of interaction between user and device on the Recognition and interpretation of the virtual environment and Reality Inputs
- 2-Display contents from users' insights exploring almost Sensory abilities and functions as an extended reality of human senses enabling high sensory feedback.

Technologies are becoming more appealing to the wider public as they are becoming more interactive, user-friendly, and compelling. Having a more immersive experience is a rewarding

sociological experience which explores the generic skills of interaction. In the early days of digital convergence with the emergence of the internet, digitalised pictures were used to generate online databases and catalogs; HTML was the programming language used since web 1.0.

The abilities were limited to hyperlinks from the main page to hyperlinked pages also, including image galleries. Later with the development of a Javascript framework, WebGL API web-compatible files produced from Unreal and Unity and other game engines they created convergence to simulate 3D graphics in real-time for internet pages enabling and producing a virtual environment representation of the museum environment emphasising some artworks and adding a new level of interactivity to Virtual Museums Online.

Modelled Virtual Environments are programmed, and they include a virtual camera and navigation controls to be exported as web GUI (Graphical User Interface) as a game-style platform. It is available on all tablets to computers that have access to an internet browser. Enable Access to virtual spaces from a simple page walkthrough and enlarge artworks and display videos and animations. A WebGL file is produced from a game engine that turns the virtual experiment runs under the internet browser. Virtuality is accessible to every public, Museum, and other conservatory projects are also possible to perform under other options more simple to achieve, as the use of stereoscopy with 360° photography with a Metadata injection on High-Resolution Photography.

It is possible to recreate virtual tour environments with Photos using some available VR Development toolkits such as Apollophoto software, EXIF XMP, or 3DVista Player, Artool Kit VRBOX, and it is also possible to export a panoramic vision from omnidirectional cameras with images embedded with navigation controls to provide a tour on a simple web browser.

Google adopted the technology supported by the google street view plug-in to support V.R. in museums and art galleries worldwide. Using 360° (omnidirectional Cameras) and GPS information to reconstruct the interior of Museums and Art Galleries on a Project named Google Arts and Culture. This is a key to performing a virtual environment that provides a high resolution and a low computational weight for creating and publishing a virtual visit to a museum or archaeological site using internet webpages on 360°.

There are some diverse projects that enable the experienced of art from an immersive perspective. It could be an educative project or only for enjoyment propose. Some artworks are represented under an immersive environment proposing a visualisation experience online. These projects had great relevance since the development of projects as the “Metaverse” model, have had great acceptance and users worldwide disclosing a great interaction model and suggest a new field of research in the broadcast, dissemination and commerce of digital experiences and art trade. The VR paper is a relevant proportion on the projection and divulging of new artists. Online platforms as Screen Art - Metaverse NFT Online Gallery, artstation.com, behance.com promote worldwide individual projects from emerging artists and Vr Experiences creators. There are some examples o Virtual Museums online and VR Experiences promoting artists and VR for art and galleries presented in Table 1 and Table 2



Fig. 8 - Van Gogh Room - 360° Virtual environment

Table 1 - Examples of Virtual Museums Online

Museum Capitoli Virtual	https://tourvirtuale.museicapitolini.org/
Portuguese Romanic Tour	https://www.rotadoromanico.com/tour/index.html?idioma=pt#!p=1&v=0
British Museum of London	https:// britishmuseum.org
VOMA - Virtual Museum	https://www.voma.space/
Virtual Museum of Maritime Archaeology	http://www.abc.se/~pa/uwa/hot.htm
Virtual Museum of Natural History of London	http://nhm.ac.uk
The virtual museum of Japanese Arts:	http://web-japan.org/museum/

Table 2 - Examples of Virtual Reality Experiences Online

Virtual Museum Van Gogh	https://vangoghexpo.com/
Virtual Experiences From Stuart Campbell	http://www.sutueatsflies.com/art/alison-wonderland-virtual-concert

Global platform for Digital Artists - Giona Kpil	https://www.artstation.com/gionakpil
Mori Building Digital Art Museum	https://borderless.teamlab.art/pt/
Dreams of Dali - 360° Videos for VR	https://www.provideocoalition.com/dreams-of-dali-a-surrealist-vr-experience/
Artssy - AI art Generator and VR Generator	https://www.artssy.co/
Night café - AI art Generator	https://creator.nightcafe.studio/
Metaverse - Online Platform	https://demo.corporate-metaverse.com/
Screen Art - NFT art Gallery	https://world.viverse.com/

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CHAPTER 3

Requirements elicitation In Engineering for Virtual Reality

3.1 - Brief contextual Historiography of Present about Museums and History of Art

In this chapter, I will contextualise the mission of museums in writing the storytelling of the history of Art. Described as 3D multimedia tools for archiving, publishing, and managing cultural heritage material, one of the strengths is to enable their visibility in a great diversity of data types worldwide. Nowadays the massive use of mobile phones provided with cameras and wi-fi connections allows a more powerful experience during the visits. It is financial evidence of costs that before were supported by museums on the acquisition of radio set devices for audio guidance as PDA's or other support to provide better information for visitors. The visitor now could see and use on his own mobile phone with some level of interaction using their camera, display, and wi-fi connection for a visit inside and outside the Museum.

Not only enable museums to reach beyond their walls through virtual exhibitions with new interfaces, actual contents, and new approaches to experience Art. They offer new ways for visitors to access resources and participate in exhibitions. The virtual capability of museums with these devices reflects the needs and abilities of users, exploring the range of human senses, from an earring to touch and smell recognition even large screen projection, backgrounded projections above walls and floor into a cinematic full immersive (V.R) experience. Public museums these days provide a wide variety of displays and other mechanisms, even tactile devices, and weight sensations at the same time, they virtually enable hold fragile or restricted access items. In some full immersive experiments the visitor can interact with virtual projection on an installation with 360° video mapping to propose the most immersive experience for the visitor to feel surrounded from all kinds of inputs and stimuli at the same time feel all experiences as he was inside the artworks.

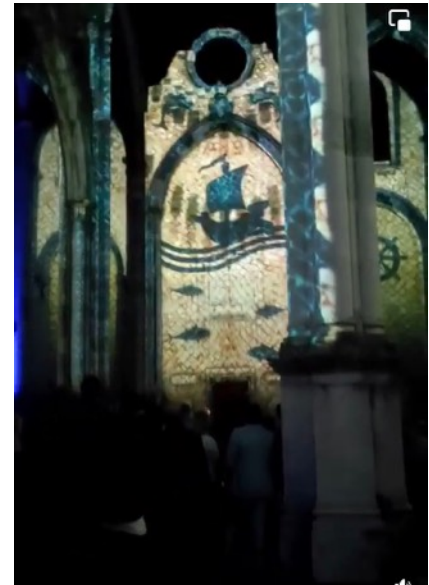


Fig 9 - 9.1 - 9.2 - 360° VR - Video Mapping

Curators and museums

From the beginning of post-modernity, much has been written, studied, and related about the Museum Mission and the new discursive and anthropological values of Art curators. One of the major relevant works done by the Museum is by Curators. They have the mission to discover, track, and deal with artwork creating new exhibitions, thematic visits, and describing those concepts to the public. They are engaging with new massive and global phenomenal of big exhibitions and even global markets of Art, creating new discursive storytelling and new interactions between Museums and the New Public.

3.2 - Context about the implementation of Virtual Museums

Previously, it was considered a new offer to tourists and visitors. The goal of complement a new degree of involvement and fruition within the museums.

Although they were first used for documented and published content and to provide audio descriptions of museums, they are used to show historical representations of the original data, artworks, or even ancient buildings with additional levels of information. Later, with new mobile handset features such as the gyroscope, camera, speedometer, and graphic processor unit, the images appear on the display or screen as 3D meshes. They were somehow more than producing a virtual representation on the mobile phones, with descriptive sounds and additional information.

The smartphone apps provided a certain level of immersive reality by giving stationary posters defined with an interactive level on Q.R. code Markers and web links. Sometimes using the Technical description, wall or canvas presented. They provided a simulation of augmented Reality called (A.R.) superimposing more additional layers to reality. Producing some interactive level with info and animations. With the advent of web-based technology, museum communication viewed virtual reality implementations favorably, although the actual presence above the Masterpieces loses its atmosphere and is regarded as a significant missing component. Only with head-mounted displays such as Oculus Rift or other virtual lenses can the weights of proximity and scale in front of the presence of a real Opus Magnum be achieved, unless some areas of the environment are 360° video mapped or scanned with 3D polygons and provide a nearly full immersive experience through a museum's virtual environment. "Web deployment of 3d applications is a much less mature field: Virtual Museums are currently using a variety of technologies for addressing the challenges that different content types and target audience pose to interactive web deployed applications." (Ferdani, Daniele, 2013) as Web 3.0 developed from Ai incorporated functions to manage and display to perform creation of user experience personalised content and AI art generators.

3.3 - Ambivalence and Spectre of forms of Virtual Reality

Some technologies, such as augmented Reality (A.R.) and Virtual Reality (V.R.), are available to produce immersive experiences using virtual Reality. Mobile phones, tablets, and personal computers are examples of device-based types of equipment. Display navigational 3D maps or build overlaid information for the real world. In the primordials, most cases of virtual Reality were computer game virtual environments and navigable worlds. There are other types of virtuality that are used as 360° video mapping into galleries and museums into a very immersive and full experience or spectacle where the visitor gets into the art and get immersed with a great diversity of stimuli.



Fig 10 - 10.1 -360° VR Projection - Video Mapping

3.4 - Development of Technological Features and Devices

There are some different kinds of virtuality. It could be only an augmented reality enabled using a simple tablet or smartphone to 360° video projection from a holographic display, or an interactive table. The difference became from the support that enables that immersive Reality. Different supports enable a Virtual Museum. From an HTML page with Web G.L. interactivity, HTC VIVE, Oculus Rift, A game engine, or Software to link hotspots of 360° panoramic photography or 360° video mapping. The most used in the rise of virtual museums were the HTML with CSS web pages, as long as the technology develop, game engines and web G.L. coupled to Head-mounted Displays came to the Reality of the dream of total immersive environments, of course, that technologies in not every case are affordable as in case o hybrid collaboration modes of interaction, or the implement of 360° full Video Mapping inside art galleries and Museums . Know with equirectangular photography that is being massive, has less effective costs and provides a great tour along with these beautiful and sometimes not geographically accessible Museums disposing artwork online. Hence a collaboration with Google, there are already enabling numerous art and cultural projects - such as Google Art and Culture, which gives to the virtual galleries some level of interactivity using the Google plug-in and stereoscopic cameras used on the base technology of Google Street View.

3.5 - In-site immersive realities

Immersive realities are some examples of technological means to achieve an immersive experience and could be defined as A.R. (Augmented Reality), V.R. (virtual Reality), and MxR (mixed virtual Reality) and are some of the examples that furthermore will be described and exemplified.

3.5.1 AR - Augmented Reality

The technology, Augmented Reality (AR), aims to create the illusion that virtual images are seamlessly blended with the real world. [Azuma \(1997\)](#)

The images generated are usually 3D reconstructions of Reality, or additional information elements that are overlaid through a display from the device, to the original environment and add a virtual level of information [Azuma \(1997\)](#). Usually, this kind of virtuality is available on mobile phones or tablets that use the camera to capture and the screen and into display the 3D information added and seen as adicitional blended images into the real environment. It relates to a real relationship between users and Reality. It depends on being in the place with the augmented reality application to

get the immersive effect of the digitally generated elements from the real source. Additionally,



Fig 11 - Augmented Reality

it could present audio descriptions, and with inertial sensors and cameras, it can navigate an environment and reconstruct structures, artworks and archaeological pieces of evidence with new layers of information blended to real environments. The first A.R. created for cultural heritage was called ArcheoGuide (Ferdani, Daniele, 2013:77), and it was a mobile phone app that allowed users to visit some archaeological sites and reconstruct the appearance of those original places using computer graphics and augmented Reality to give the original configuration an aspect of those buildings when they were built. Indeed, AR allows supporting learning, for example, increasing on content understanding and memory preservation, as well as on learning motivation. However, if V.R. benefits from definite fields of application and research areas, A.R. is still emerging in scientific scenarios. (Loomis et al., 1999; Heeter, 2000; Biocca et al., 2001).

Software that Supports Augmented Reality Experiences and Interactiveness.

ADOBE AERO is one of the available chosen software to test when using Augmented reality Systems. Through my experience of trial, I identify three great aspects that make this software and mobile application one of the most interesting and well-conceived for this proposal. One of the most important subject is its convergence between almost platforms and devices that support and its compatibility with the average 3D files systems, such as FBX, DAE, and GLS; with this application, Adobe aero also provides functions that could animate a virtual canvas with file formats as gifs, JPG and PNG imposing different layers and animations. From static to motion effects, the application triggers animations as the user gets closer to the virtual object, and it's possible to program different layers of triggering effects to produce a virtual interaction between the user and the augmented reality. What is a great improvement for art designers and digital artists that could sublimate their artworks in galleries. Using this interactiveness, permitting even the public to record the animations on canvas and store to appreciate, divulge, and even acquire a digital form of art digital certificated as NFT.

Sounds are also possible, and the animations will get another environment, especially when those experiences could be shared as links and published online through the art and Digital arts, Behance platform. www.behance.org

Art VIVE As a Virtual Canvas Software enables animate layers of creation both inside and outside the canvas with less to spend of time triggering effects and is very useful for animations, gifs

and video. It essentially supports online works with a 2D environment, allowing the user to import their original files and compose the canvas animation effects. Exporting to (A.R.) mobile apps for visitors on galleries and publishing their artworks with a purpose to divulge, share, promote and sell online their artworks.

3.5.2 - Virtual Reality - VR

How is it possible to reconstruct and give realness to Art Works and Immersive Experiences to explore the Sensory system of visitors and the main public? - Case Study 1

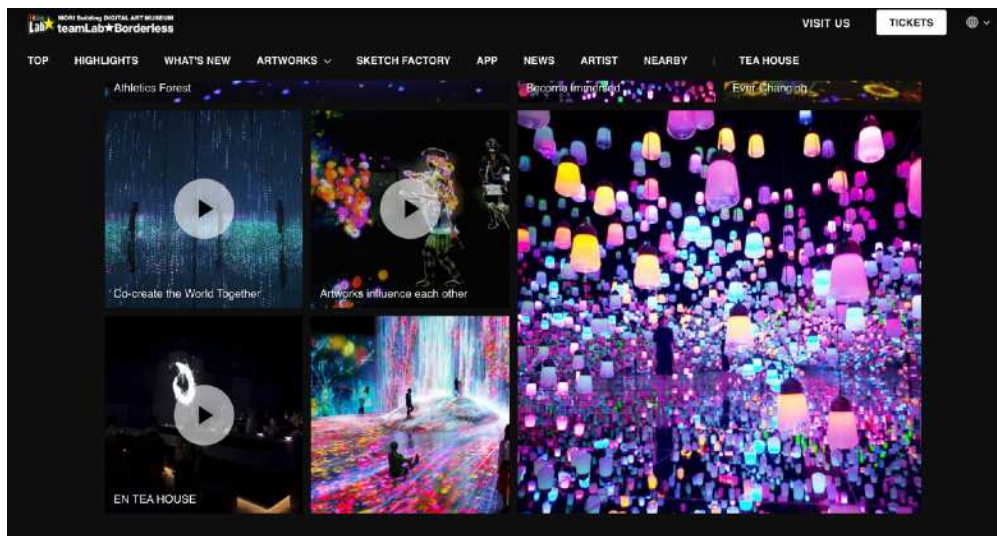


Fig 12 - Team Boarder Less - Digital Arts Museum - Web page

Combination of Synthetic images or computer-generated graphics that could be accessed through a virtual space, CAVE (Cave Artificial Virtual Environment), where the images are projected on a 360° vision or displayed on a tridimensional space using a Video projector and Head-mounted displays. CAVE is often referred to as a segment of the reality-virtuality continuum that transports users into a computer-generated virtual world, where users are expected to experience a high level of presence in the environment (Carmigniani et al., 2011; Steuer, 1992). Cave also has the potential to simulate imaginative and existing physical environments along with their processes and environmental parameters to engage and affect all of our senses, including touch and smell. (Billinghurst et al., 2015; Bekele et al., 2018; Kim et al., 2018) The visitor could navigate inside a virtual environment, as can be experienced when visiting The Mori Building Digital Art Museum (Shi Tianyi, 2020). Essentially is a space with background projections above walls and floor, recreating a fully immersive virtual environment within an art presentation.

This new digital technology is also the most important feature of the aesthetic experience of the Borderless Digital Art Museum, which makes the artworks immersive and superimposed.

According to the viewer's participation, the flowers in the image will experience growth through computer technology and computer systems such as laser projection and infrared photography. Connected to capture people's movements and produce various fantasy Special F.X. to achieve the result of interactive projection. (Shi Tianyi, 2020)

Teamlab Borderless Digital Art Museum has an innovative mode combining "environmental experience" and "multichannel interaction. It Has a unique aesthetic experience that is different from other immersive art exhibitions and is known as one must-see exhibition in the world". (Shi Tianyi, 2020)

3.5.3 - Mixed Virtual Reality

How is it possible to reconstruct and give realness to Art Works and Immersive Experiences to explore the Sensory system of visitors and the main public?

Usually generated 3d computer graphics visualized with head-mounted displays provide a better sensation of immersive virtuality combining the real aspects of the environment with computer-generated 3D Graphics, Videos, or Animations. The range of this virtualisation on this kind of technology makes, in most cases, Reality represented as more real than life and could even manipulate and move 3D assets with hand air movements. Used to be displayed with 3D virtual Goggles (HMD) and reconstruct and create the sensation of motion and deep interaction with the Virtual environment. Sometimes works with sensors that receive the visitor inputs and allow synchronous movement when walking through the navigational areas. One of such example of this technology developed for MXR is Called "MUSA" is a System of Content Management for cultural heritage related to exhibit prepared elements by the curators "Musa offers the possibility to manage a large variety of different data and to organize them in many different ways(Rubino et al., 2013) , The system supports the following content types: text, composed by an HTML documents and a CSS sheet defining its presentation semantic designing pages with user experience and visualisation of information, with images, graphics, video and audio and more high-quality 360° panoramic images, enhanced with embedded hotspots that, when selected, allow the linking of different types of digital media; Also provides 3D models, "showing virtual reconstructions of objects, rooms or even buildings; and as also an app to Augmented Reality files, registered with the camera view according to the positional data extracted from the markers.(Rubino et al., 2013) . It is possible with this technology to blend interactions between visitors and virtual artefacts with hand movements such as touch, move, and other interactivity. First, the



Fig. 14 - MXR System in Interactive

technological requirements of blending real and virtual elements to the extent that the blend appears as real as the real environment is extremely challenging. Second, MxR has been understood as a variation of A.R. or a fusion of A.R. and V.R. rather than a self-standing form of immersive Reality (Piumsomboon et al., 2019).

3.5.4 - VR - Video Mapping - 360° VR Projections

One of the most expressive and immersive experiences, that enables a high level of immersion in visitors is video mapping - 360° VR Projections. Its a Multichannel experience with high-resolution multiple video projections that provides a fully immersive experience inside all the existing surfaces of a building. Some of these multimedia spectacles are being worldwide spread with thematic visits for multiple visitors in a collaborative interaction mode. It presents to visitors the most relevant artistic icons on their historical moments about artists and their lives on a superimposed and synchronous video presentation. The visitor feels all different kinds of stimuli and has a fully immersive experience that supplies all the human senses. It is a magnificent way to face a virtual opus magnum of art displayed and felt inside an artwork. This genre is defined as multichannel and fully immersive environment, sometimes combined with a collaborative mode, not being much related to literature because video mapping 360°, is a very innovative implementation with a lack of academic documentation, that supplies to be identified as a new genre of interactiveness.



Fig 14 - 14.1 -360° VR Projection - Video Mapping

3.6 - Out-site immersive technologies

3.6.1 - Artificial Virtuality

It was proposed as an innovation in the advent of virtual reality systems, evolved as creating gamified virtual worlds, and is usually a device-based application as a game genre or a virtual navigational space. As it was exposed previously we can difference Artificial Virtuality from using the same technologies with less immersive effect.. It results from human interaction with a virtual interface, with some interactive features as a game genre interact. Not transposing the boundaries of proportion or total lack of external inputs. In this genre the user interacts with a GUI in the sense to explore a representation of a virtual world. After the evolution of web-compatible EXIF metadata files and Other Photography Metadata injection format files it is possible to reproduce those virtual worlds having from source real inputs from digital photography representing virtual 360° spaces inside web browsers, from high resolution HDRI images, as navigational worlds with linkage points. Usually GUI (Graphical User Interface) and a mouse, gamepad or command interact with the user to integrate instructions with the devices. A computer game genre centred on a virtual world presentation or environmental space defined as Artificial Virtuality.

Case Study 1 - Computation Museum

The Virtual Museum of computation is entirely created above a virtual world web server MMORPG and a game engine Open Simulator that incorporates different rooms and halls explaining the history of informatics. As features technologically advanced, as avatars that have the abilities to perform a conversation and direct the visitor through the museum, working as a guide and asserting to questions related to exhibition models. It incorporates on its NPCs a chatbot that answers to Visitors questions and can establish a fluent conversation through PandoraBots. This chatbot development supports intelligent agents to understand and



Fig 15- Avatar and Chatbot from Computation Museum

answer questions. It also enables a guide to the visitor as a conversational Bot and an NPC Character which works as guide in the virtual environment. The game engine used was the Open Simulator, which enables the creation of a massively multiplayer virtual space and incorporates the avatars with multiple intelligent agents. (Bos & others, 2015)

Case Study 2- Virtual Rome

Can Virtual Reality enhance the realistic vision of Art and archaeology with virtual features to represent them with the most effective detail about loose or old constructions and artefacts? Virtual Rome is a project directed by the VHLab, Institute of Technologies Applied to Cultural Heritage of the National Research Council (ITABC CNR), in collaboration with

Fig 16- VR Virtual Rome

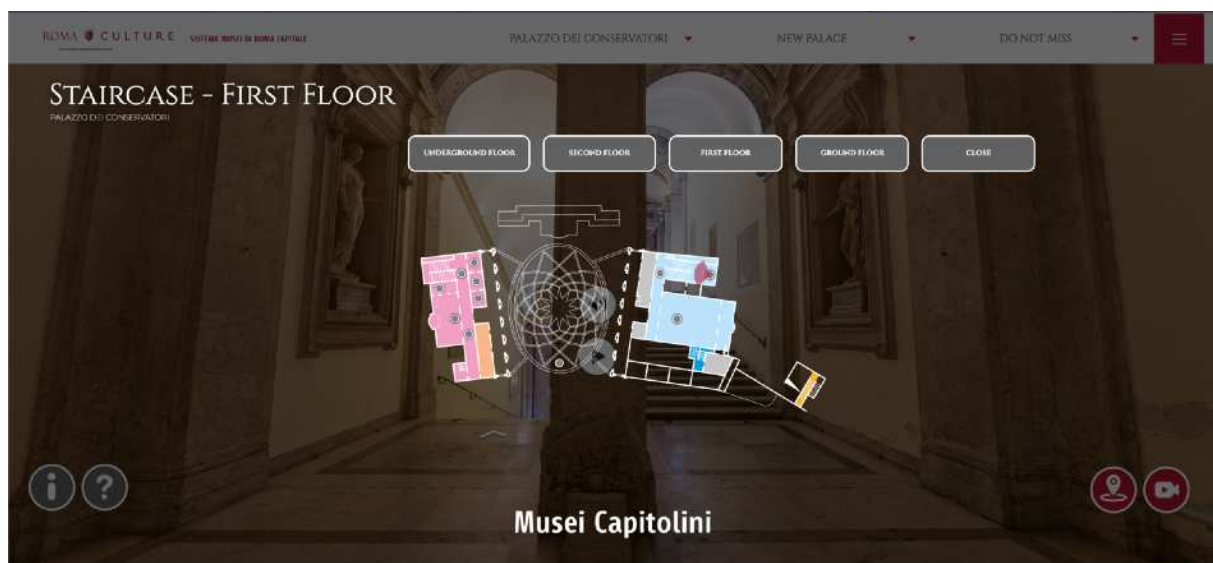


- GIS Openscene Graph supercomputing centre CINECA, Seat Pagine Gialle, (Pescarin, S., Palombini, 2009) and other local partners (the Chamber of Commerce of Rome and the Superintendency of Rome). The idea, born in 2006, has established the goal of creating a Virtual Reality application based on a Geographic Information System (GIS), which is interactive and navigable online.

The 3D rendering application is based on a web browser plug-in, able to display and navigate real 3D environments inside the browser, and it was built (on top of the 3D graphic library OpenScene-Graph) and released in 2004. A new plug-in, OSG4Web, was developed for a more interactive 3D experience. (Pescarin, S., Palombini, 2009) Available online links the landscapes with the natural environment and the buildings and constructions of ancient Rome. It is possible to navigate the terrains and discover the interior of monuments and reconstructions of Roman Villages.

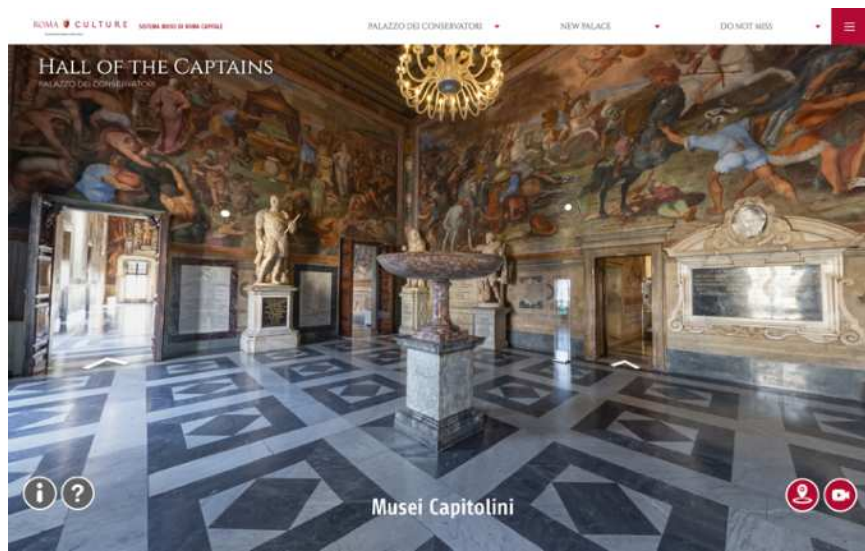
Case study 3

3.6.2 - Artificial Virtuality - Technique beyond 360 ° Panoramic Photography for Virtual Tour



Every photo we take on any camera is likely filled with Metadata. This data often contains location, camera model, lens type,

and general information about how the image was taken. It is this data that makes it possible to recreate virtual environments. How is this information stored in Metadata, EXIF, or XMP that could create 360° virtual environments?



Because this Metadata is data that helps to describe the Content or characteristics from a file. For image and video files, embedded

Fig 8-WebGL controls and navigational map from 360° high-resolution photography.

information about the file. For example, the camera model used to take the photo. There are many different formats and standards of metadata in the world of Photography. Two of the most commonly used formats by camera manufacturers are EXIF (Exchangeable Image File): of image metadata. All images captured with a digital camera typically contain some amount of EXIF data.

Extensible Metadata Platform: a more recent format, developed by Adobe. EXIF exists to support 360° panoramic photos.

How could they be embedded with hot spot links to perform a virtual tour?

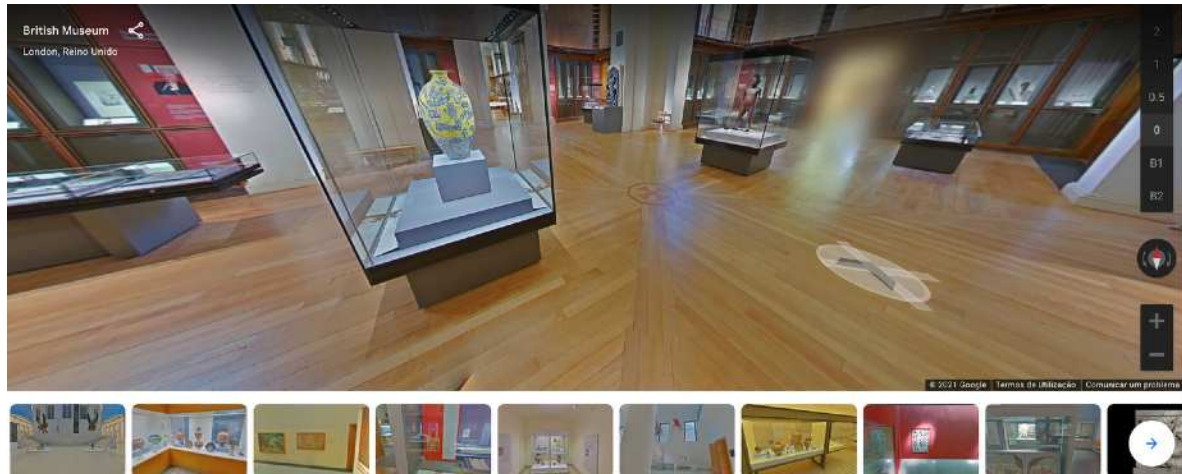


Fig . 27 - Equirectangular Photo from interior gallery

it allows the injection of metadata to perform embedded links and hotspots to proportionate to the browser the ability to create navigational areas through the 360° image. As digital Photography progressed, cameras added new features and functions, provided 360° images, and developed specialized equipment for this purpose, such as omnidirectional cameras. EXIF came along to fill in the not covered needs in data fields. In the world of 360 photography, most cameras and 360-generation tools include XMP Photo Spherical metadata others need to be converted to equirectangular Metadata in saved photos. Similarly, almost all software

Fig 28 - Plug-In Based Software to Map and Display 360° Panoramic photos for Virtual Environments - Google Arts and Culture

that can load a 360° photo and understands XMP Photo Sphere and equirectangular Metadata. Using a single standard, XMP (an ISO standard), it is much easier for developers to build software and Virtual reality SDK for web browsers.



For example, ApolloOne EXIF, PanoVision 3D, skybox, and Vista3D are the most popular development kit's for creating V.R. environments using 360° Photos.

Into the Metadata often depends on the camera features or proposed uses (e.g., if uploading to Google Street View, it will contain GPS information, whilst photos taken indoors will not have this information due to a lack of GPS signal. Whilst the photo has a GPS receiver, along with an accelerometer, gyroscope, and compass, metadata that allow to see in every direction using a 360° VR player on mobile or browser.

For example, XMP-GPano is used for photographs, while XMP-GSpherical is used for video. The information they provide is quite similar to that found in individual images - There are numerous proposed metadata models with standards like EXIF and XMP that are highly useful. As a result, practically all cameras are compatible to almost 360° web development Kit.

3.7- Software panoramic Vision, Game Engines, and HTML compatible Development Kits for VR and AR and Plug-ins

Some examples of distributed software to develop V.R. environments for Museums and Galleries are Pano2VR, RoundMe, Virtual Tour, SuiteMaterPoint, STQRY, Pano Weaver 9, VPIX360°, EON X Osgj, 360 video mapping - Resolume, OpenSceneGraph to WebGL BTF, EXIF, for photorealistic interactive and for rendering.

Game Engines as UNITY, the most diffuse game engine available in the market, open source, free license for academic proposes, enables programming some different types of compilation modes, even compatible with web browser WebGL, also OpensceneGraph, and Open Simulator and Angular.JS - Framework also developed in Javascript, an interactive canvas to web browsers, enables all different kinds of animations and interactivity. Responsive and available to create Mobile apps. There are some examples of projects using all these different kinds of development packages and available plug-ins and development Kits:

Table 4 - Development Kits and Plug-in base technology:

Metadata	Exif fixer Spatial Media Metadata Injector
----------	---

• Flash based:	• Papervision 3D X3D in-browser player
	• BS-Contact from Bitmanagement • OpenVRML
- Unity 3D	• XVR (IExplore only from VRmedia) • 3DCoform Unity3D demo • WEBGL
• VEX Development	
• WebGL:	• X3D under WebGL
	• X3DOM
	• SpiderGL a graphics library for 3d web applications
• Goggle Arts and Culture	• VR Google • Augmented Reality Google • 360° Metadata
• WebGL Development KITS and applications	• Adobe Aero • TVORI • Masterpiece Studio Pro • Gravity Sketch • Oculus Medium • Vuforia engine
360° video mapping	• Resolume

Table2.1 - Virtual Reality and Augmented Reality plug-in-based development Kits. Used for MX Reality systems with high rendering resolution and Tracking and Navigational available.

3.8 - Levels Of Immersion into Virtual Reality Systems

The experiments with V.R. became a complementary experience to improve the engagement and do with new technologies and devices, new cultural inputs, and immersive and Sensory stimulus to those who visit the museums. It could be differentiated by its Sensory environment and interactiveness.

Non-immersive systems. They are desktop systems in which users are just viewers. Interaction is reduced to actions performed by keyboards, mouse or trackballs, or other 3D interaction devices. These systems' advantages are the low costs and the high graphics performance. Also Known as Device Based Systems. (Bernsen, 1995)

Semi-immersive systems. Semi-immersive systems realize high-performance graphics coupled with large screen monitors, large screen, or multiple projection systems. (Bernsen, 1995) The sense of presence is greater than in non-immersive systems. Understood as Multimodal Environments

Immersive systems. Immersive systems are based on technology, making a user feel present in the synthetic environment by a "step inside" of the user through perceptive, cognitive, and functional immersion and interaction (HMD, head-mounted displays, multiple projections). The relevant characteristic, in this case, is the exclusion of external stimuli from the physical world. (Bernsen, 1995)

Full Immersive Systems:

These immersive systems are High-resolution 360° VR video Projections, converting the total area of a building or gallery space, fully projected above walls and floor, where the user feels totally immersed inside the environmental experience, where the perception and cognitive stimuli are fulfilled with all different kinds of inputs where visitor could, see, ear, taste and interact with the virtual projection. Being sometimes a participant or in another way spectator.

Qualitative performance in VR systems

Main Features	Non-immersive VR (desktop)	Semi-immersive VR (projection)	Immersive (head- coupled)	Full immersive(360° video mapping)
Resolution	High	High	Low - Medium	High
Scale (perception)	Low	Medium - High	High	Total
Sense of situational awareness (navigation skills)	Low	Medium	High	High
Field of regard	Low	Medium	High	High
Lag	Low	Low	Medium - High	Low
Sense of immersion	None - Low	Medium - High	Medium - High	High

Table 3 - Levels of Immersion - adapted from R.S. Kalawsky [13]

3.9 - Interaction Modes - Sensory FeedBack

Sensor Based

With sensors, such as motion trackers, eye gaze trackers, and speech recognizers, the interaction becomes synchronous within the virtual environment. These aspects are merged and used as inputs to command, orient, and navigate the virtual world.

Device Based

Usually, a GUI (Graphical User Interface) and a mouse, joystick, or gamepad command interact with the user to integrate instructions with the devices and the GUI of the Navigation World. Is a computer game genre centred on a virtual world presentation or environmental space Some amount of navigation and interactive representations such as extra descriptions, sound, and animations.

Tangible

Devices acting as haptic devices allow users to control and manipulate virtual things. It is feasible to catch, manipulate, or control even rare fragile or inaccessible objects to the public using a glove, this kind of haptic element (HDD) or use of interactive Tables (TUI). In most situations, of this genre is only available on-site during a museum visit because these range of equipment are typically expensive and are disposed of from the museum to the visitor to have a more sophisticated experience inside the museum with virtual reality.



Fig 16. Tangible Table(TUI)

Collaborative

Usually is a combination of sensor-based and Haptic devices and collaboration among users. They could interact and collaborate on a multiple-presence space in the virtual environment. This technology allows multiple users to interact with the same virtual environment simultaneously when the virtual reality system uses motion trackers and creates different forms of interaction to the personal user's perspectives, even sometimes with sensors such as motion trackers, calibrated cameras or eye gaze trackers.



Fig 17 and 17.1 - Project from Kimiko Ryokai; Yong (Leon) Li, Berkley, VR SandScape: Collaborative SARS VR System

Multimodal Virtual Environments

This is an example of how sensors receive the external inputs of users, such as eye gaze trackers, motion trackers, or haptic sensors. It provides and mimetic how users can interact through the virtual environment. This genre is closely related to Sensory responses. It allows the user to interact in real-time with the virtual elements as with MXR technology Telepresence and Avatars. (Kargas, A.; Karitsioti, N.; Loumos, G, 2014: 213)

Hybrid Interaction

It is one type of combination of collaborative and multimodal interaction. As it describes is the possibility to interact physically with the virtual environment using sensors and at the same time interact with other users in the same virtual environment. In all these Genres, the virtual environment can be displayed on various platforms, ranging from stereoscopic and holographic systems to web applications and interactive 3D Environments. Some examples exist as intelligent agents who can perform conversations and answer questions. (Kargas, A.; Karitsioti, N.; Loumos, G, 2019)

Multichannel

It is multiple channel interactive and collaborative mode provided within a fully immersive experience of multiple video projections displaying simultaneously a wide range of video mapping on surfaces, creating a multi Sensory experience to visitors. It could be also an experience that uses a range of sensors and haptic devices, gloves, moving chairs, exoskeletons MUI, or other mechanical devices combined to enhance the visitor's experience, sometimes users interact and make part of the video projection with the usage of cameras and motion trackers. It is a new interaction area, where the public assists to this great innovation into virtual environments with these new modes of interaction. Very closer to create sensory responses into visitor with a great proportion of immersion and multiple channel displays.

Fig.18 - 360° VR video Projection

How can we give Interaction to Art Works and Immersive Experiences to the main public? - Case Study 1

3.10 - Shared Interaction - Virtual environment navigation

Navigation Within Virtual Environments

The navigation within virtual elements depends only on determining the visitor's coordinates and giving them a path to follow in the navigation area. It is possible to propose a guided visit through the navigational place using a game engine or virtual environment inside the museum using infra-red cameras, motion trackers, GPS, wi-fi connection, markers and head-mounted displays. Using Technologies of Augmented Reality [Azuma \(1997\)](#), it is also possible to motion track using the inertial sensors of mobile phones and the camera device calibrating them with marks usually shaped as matrix or Q.R. codes.

It is defined as the ability to describe movement within the virtual space; when a visitor moves from one location to another, the coordinates derived through ways to track the visitor's movement and the type of navigation implicit in the virtual model are required. It could be represented in two ways: path planning and travel mode. The navigation in path planning avoids impediments such as collision detection and orients the visitor through a guided plan between subregions and paths defined in virtual space. In the travel mode, It could be represented also as various types of rendering. In this case, the render is presented progressively as the navigation gets closer to items, the procedural method uses the least amount of processing resources and shows only the closest objects. The immersive technologies discussed below are examples of possible displays for virtual environments that make use of tracking, interactivity, audio-visual content, and spatial movement technologies:(Billinghurst et al., 2015; Bekele et al., 2018; Kim et al., 2018)

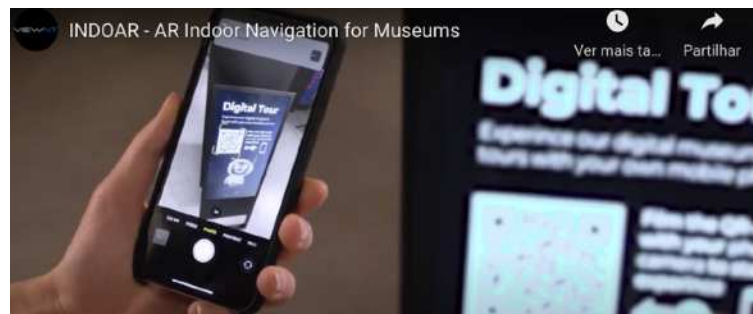


Fig. 19 - INDOOR - Companion on (AR) to navigate and follow inside the museum

In virtual environments, the tracking methods are usually applied to perform:

View control: Motion tracking devices control the camera's framing position and orientation. It is needed to create the user's perspective along the pathway. When they are used to create an image framing into the virtual world to a virtual environment that users perceive using a head-mounted display or projection displays. In some cases needs the usage of Markers or calibrated cameras

Navigational tracking: The sensors such as inertial sensors, cameras, and wi-fi connections dispose of features that recognize the coordinates through the virtual world. Object Selection and handheld manipulation: Using magnetometer from Mobile phones devices to manipulate and interact with virtual objects.

Avatar animation: Create a physics simulation of motion through procedural animations that allow the telepresence of avatar motion in the virtual world. (Kargas et al., 2020)

The available Sensory feedback methods could be: Non-Visual, Inertial Magnetic, ultrasonic, Visual form cameras and Device Based interfaces, With Markers, Procedural Animations with robotic Exoskeletal MUI, Mechanical and gloves Haptic Devices, HDD.

Interaction With other Users

When using a virtual environment system, it is possible to share the interaction between users connected at the same time where they can share or compete for this kind of experience. Another level of interaction is called collaborative, hybrid, or mixed interaction. (Mihelj et al., n.d.). It is only considered when it needs the collaboration of other participants to elaborate, construct, or interact with the virtual system. This kind of usage is not very common above a virtual reality for cultural heritage but represents a possibility to explore.

CHAPTER 4

Technological Elicitations of Virtual Environments

4 - Virtual Reality Graphics Modelling Software

3D modelling represents three-dimensional objects and environments using three-dimensional polygons and perspective views.

The digital objects are modelled using a wide variety of distributed software. The most professional and complete products are known as proprietary software or development Kits. It requires a license for use, such as Autodesk, Maya, Cinema4D VRStudio, Hence, open-source software is as good as proprietary software with the same functions as Adobe AERO, Viewfuria, and Unity, Blender 3D. With some expertise and other forms of creativity, it is conceivable to create a dimensional aspect of a 3D object in any of these types of software.

Knowing sculpting techniques and geometry skills are needed to achieve excellent results. The vertexes are worked on edge loops, extrusions, cuts, and scales until the primitive achieves the desired shape. This range of software products provides to virtual scene, various viewpoints, and perspectives, and in all cases, requires a render engine, which synthesises the virtual image after the render process is complete. The computational process of virtual reality graphics models is usually created using 3D modelling techniques and appropriate software and graphic engines. It is called the traditional 3D modelling technique. However, already available technologies simplify this arduous and sometimes exigent task called 3D Scan. Structure from motion (SFM) pictures with cameras or other sensors such as laser beams or infrared structured light may enable that task with less time expense and resources.

4.1- VR and 3D modelling

Usually, this technique depends on kits of development known as modelling proprietary software or specialized products such as V.R. development KITS such as Adobe Aero, TVORI, Masterpiece Studio Pro, Gravity Sketch, Oculus Medium, Vuforia engine. Nowadays are already available solutions of open source 3D modelling and animation software such as Blender 3D, like the proprietary software that works with Geometric primitives, 3D meshes, vertex points, Textures, animation and game logic engines. A certain level of technique and art is supposed to produce realistic models.

To produce 3D virtual models with geometry, the artist must proficiently understand the software and its limitations. However, great software and an amount of technology could create fantastic and unseen VFX, as we have already seen in movies, sci-fi, and games in general. To get amazing results will need to be familiar with sculpting techniques, building structures, Texturizing UV maps, Physics, and other related topics, as well as how to assign realism to models and lighting concepts to create a more realistic atmosphere. The synthesized image or virtual worlds could be rendered through a Virtual Camera or exported as environmental 3D objects to game engines to supply the code needed for interactivity, real-time navigation, and gameplay. The artist then exports the models to different plug-ins allowing for real-time animation rendering and interactivity between different types of supports and devices. The most usual Game engines are Unreal, Unity, and Blender Game Engine, which nowadays are also a great resources to create V.R. and MXR immersive environments



Fig 21 - Blender Game Engine - Virtual Environment Of a Museum

4.2 - Real-Time Construction of 3D models

The main purpose of these technologies is to create in a real-time procedure a 3D and complex model of the vertex shape of an object or environment from a task that, in most cases, is complex and difficult. It is necessary to know sculpting and project architectural spaces. These new technologies are already making it possible to perform that process easily with different ranges of accuracy and resolution.

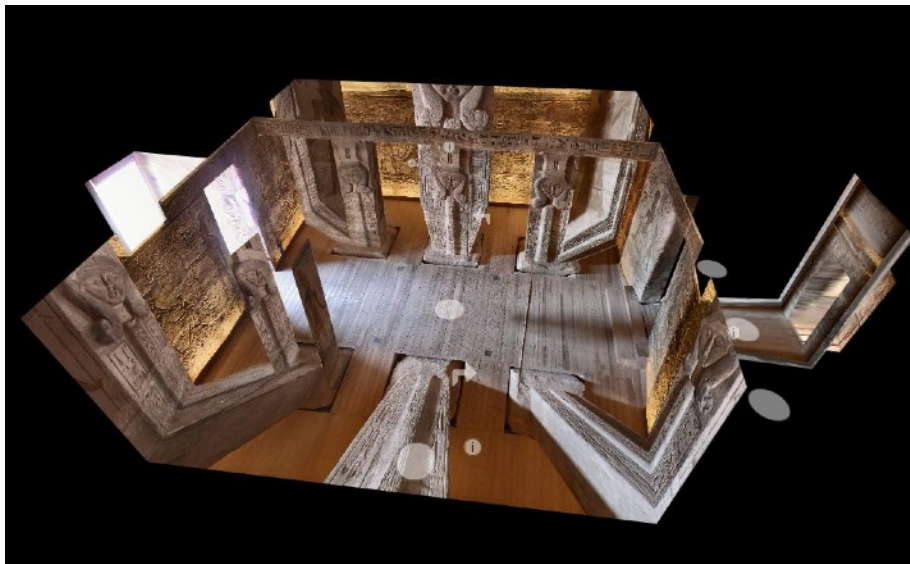


Fig 23 - 3D Modelled Interior of a Museum gallery

4.3 - 3D Scanning

Creating a 3d virtual environment is supposed to recreate a tridimensional model of the environment using a mesh of polygons. This task was created by modellers and artists using 3D software. However, this task is simplified with LIDAR, Laser Beams, Infrared Scanners, and Photogrammetry. These technologies have different costs and depend on the wider range and focal length and precision detail of those types of equipment and the consequent results of recreated models. Some less expensive 3D scanners have a noisy effect, and the models must be re-arranged. The most precise Laser Scanners have long focal lengths and provide better reproduction of models and environments. The 3D Scan came to provide an easier way to produce tridimensional objects in less spent of time. Even though these technologies are becoming popular and some smartphones have already disposed of LIDAR Systems to scan a range of models turning 3D modelling accessible to the public, with free and accessible Apps, nevertheless it is still an expensive device technology with different ranges of precision.

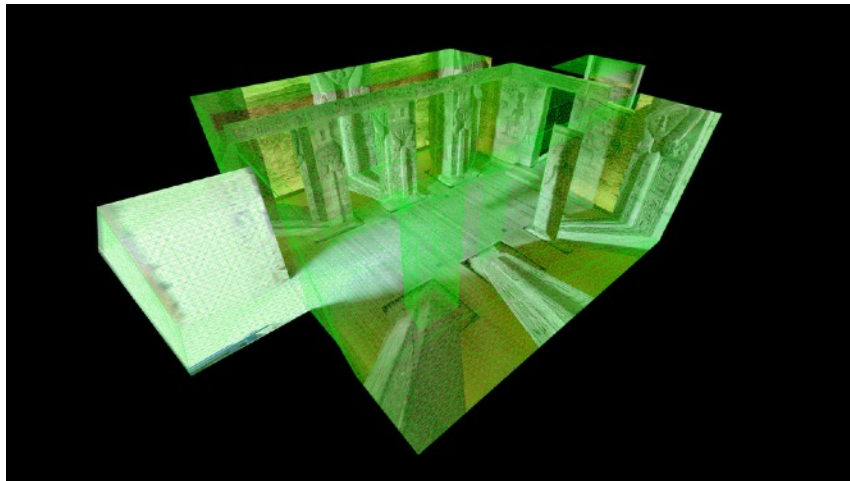


Fig 24 - LIDAR (Laser. Range Detection)Laser Beam for 3D Scanning

4.4 - Technologies for 3D Scan

Photogrammetry and LIDAR were developed by the industry because of their high accuracy of measurement, which can be achieved with multiple ranges of Photos and laser beams. As Photogrammetry evolved and was used in movies, became a widespread technology known as Motion Structure taken with Omnidirectional cameras. Although it has other levels of utility, some authors refer to Motion Structure and LIDAR (Light Detection and Ranging) as great measurements to improve the time consumption of modelling real environments. The technique of Photogrammetry 3D is also a technique developed from stereo imaging and cloud noise technique described as the combination of two images captured at the same time from different angles, measuring the average between the distance of colour depth amongst the histograms of both images. The histogram is the reference graphic that measures the level of colour on a bitmap image and combines the cloud point noise converting them into a 3D virtual environment after a computational process.

4.5 - Laser Scan

There are various types of laser scanners; this technology is highly accurate, works with a variety of conditions, and is laser beam technology for varying distances. Some of them work from short to long distances, depending on the equipment requirements. This equipment emits a source of light, a laser beam, and reacts to the object's surface. The light is measured by how long it takes to return the laser mirror, and its measure applies a physics calculation that determines all the coordinates of the object surface's vertex points in that range. This new technology is used to determine the distance and coordinate points of a volume, surface, object, or environment. Usually, these 3d model representations do not have the same visual characteristics as the image of the objects because the laser does not determine colour and texture. (Miller et al., 2015)

4.6 - infrared Kinect

It is a sensor-based device found on Kinect equipment that emits a ray of light and operates with infrared. It intersects surfaces, detects movements, and simplifies the tasks of modelling a high polygon Mesh in 3D. These devices are primarily used indoors, have a limited range, and movement can cause a noisy effect depending on how the sensor interprets the geometry of the 3D object as well as the environment. It requires acceptable lighting conditions and is primarily used indoors because of its limited range of focal length. However, a recent study by Lindlbauer and Wilson (2018) attempted to perform a live 3D reconstruction of the physical environment where a V.R. user was physically situated. The authors used eight Kinect cameras for room-scale coverage to stream scenes from the real world and were even possible to clone motion tracking of users in the room as telepresence avatars

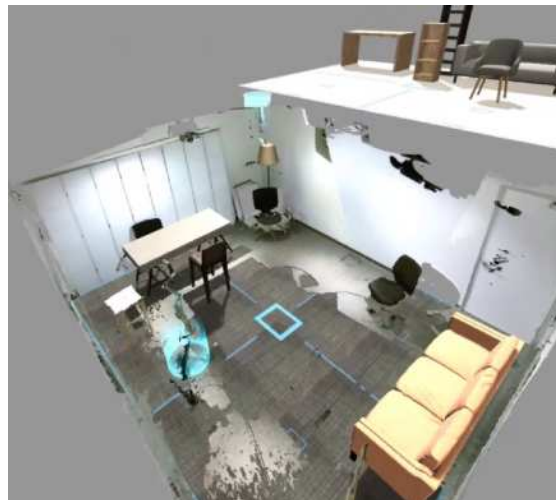


Fig 25 - Kinect model

4.7- Stereo Vision and Photogrammetry 3D - SfM

Cameras, as digital component, interpret the rays of light received on that surface and converts the real image to a digital and binary code on an RGB matrix that frames the original image and converts it into a digital output. There where the light is converted to an image is called CCD. The CCD is the digital analogy to film on analogue cameras. The CCD, calibrated and synchronised to produce a stereo-vision effect, interprets two images simultaneously. One for the left eye other for the right eye, and mixing those two images or a more range of photos combined could proportionate a stereo vision effect, known amongst photography professionals and digital producers as **SfM Structure from Motion**. The combinations of both images are interpreted through a point cloud noise image recognition, the is a computer vision process, (Mongelli et al., 2017), an algorithm of proximity/ distance and calculation. is a well-known technique for reconstructing 3D structures from continuous two-dimensional (2D) stereo images and point cloud and mesh models are performed as 3D spatial data generated from SfM. First, a point cloud is created from photographs; then, a mesh model is made up of meshes whose vertices are the refinement points of this point cloud. Because of this, a photograph-based point cloud has a higher resolution with a more range input images (Mongelli et al., 2017), It also measured the distance of the objects in the field of view and, when combined, created a 3d polygon mesh representing a 3D model for virtuality. The economic value and measurement accuracy of SfM point clouds have already been thoroughly verified by comparative studies with LiDAR point clouds, such as buildings and environments however, these are usually area-oriented rather than object-oriented. Measures the surface points in the objects on the field of view and when combined create a 3d polygon mesh, that represents on a 3D model used to virtuality.



Fig 26 e 27 - Photogrammetry 3D from a Castle, resource from camera capture with stereo 3D Capture device

4.8 - Virtual Reality Graphics Displays Input and OutPut Devices



Fig 28 -Hand Held Device and HMD



Fig - 29 First stereoscopy Display

The arrival of stereoscopic devices began in 1839 when Ken Dunkley invented the first stereoscopic lens to see 3D Photography from analogue sources using the parallax effect. The idea became digital when in 1962 appeared, the first non-commercial use for head-mounted displays available on one single lens to display aircraft information for pilots. The commercial use of head-mounted displays occurs with Forte VFX 1 (Bekele and Erik Champion, 2019). Later HoloLens - Oculus Rift - HTC Vive - Quest, and other Competitors dispose to the main public of a great diversity of devices with stereo headphones, Bluetooth, and even wireless connections.

Tablets Smart Phones and interactive tangible tables are also disposed to perform V.R. The CAVE environments are a different type that provides an interactive experience using virtual elements such as 360° Video projections, Infrared sensors, and other tracking devices. These devices are shown, and you can see the images below. For instance, one of the recent HMDs, "Microsoft HoloLens," which is built mainly for an A.R./MxR experience, can also be used for V.R. scenarios with the ability to touch and move with air hand movements those change, move and enlarge virtual assets. Such potentials are changing the trend of the enabling technologies behind immersive reality to establish a versatile platform. ((Bekele & Champion, 2019)



Fig 30 -MXR - Immersive Reality

On the Table Below are represented some commercial offers off Displays and input devices

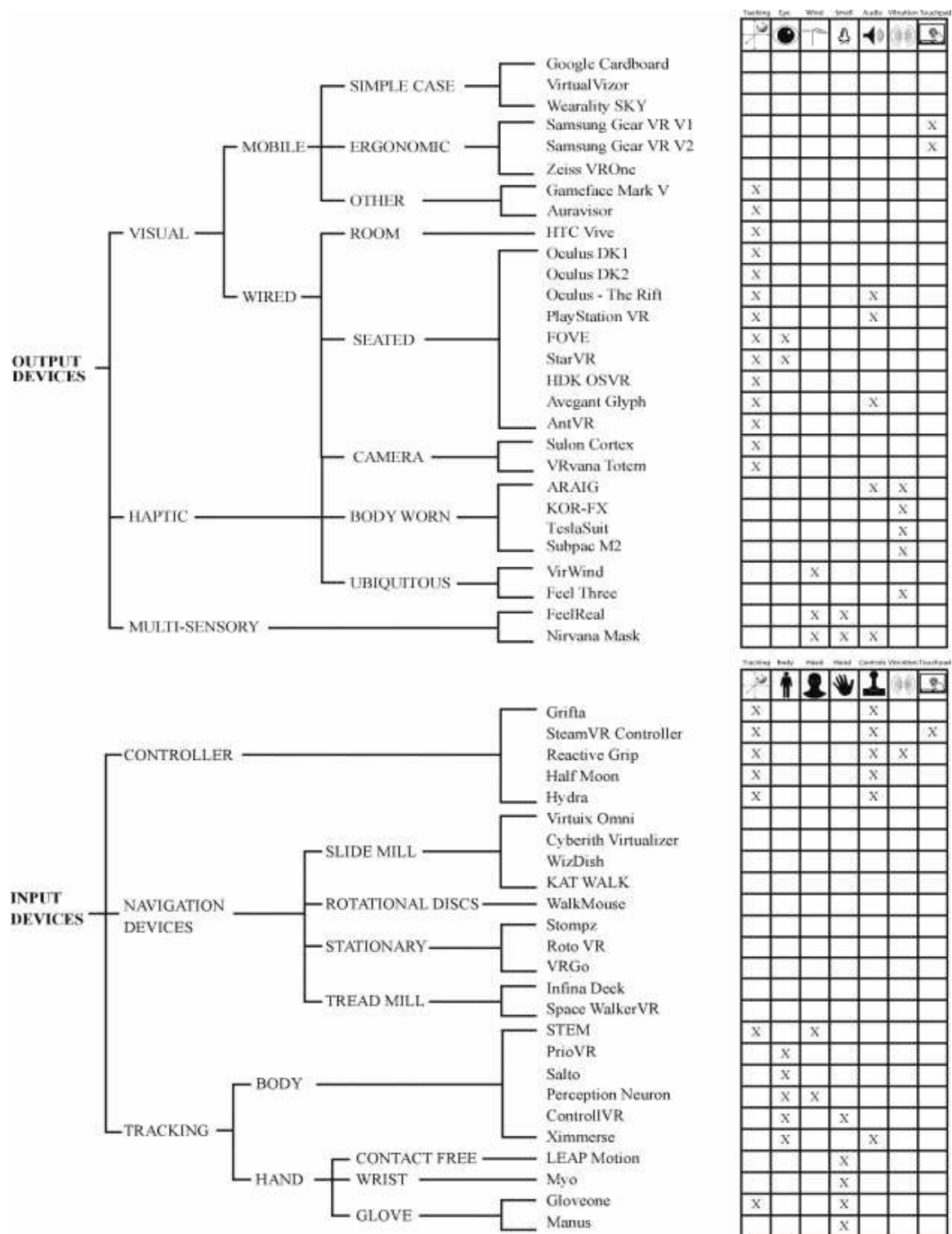


Fig-31 Devices List - Inputs and Output Devices for VR (Anthes et al., 2016)

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CHAPTER 5

Methods

5.1 - Proposed Investigation Model

It is proposed a scientific research model to reveal deeper and more interesting aspects to disclosure related subjects thought the V.R. and Cultural Heritage. The related information were collected through research engines such as Scopus, Google Scholars, Academia, ResearchGate, Libgen, and most popular agency news as Reuters, NYtimes, The Verge, BBCNEWS, Publico and J.N.

The Investigation was prepared from the Design research model (Peefers,2008) following the most relevant steps of the Investigation until Text Mining and News Fetching Techniques. The main objective is to perform Machine Learning Techniques. The strategies, technologies, historiography, and concepts about V.R. and Art Galleries and Museums are already documented, so further the study will be conducted to a revision of related information published on new agencies provided from deep research using News fetching and Natural Language Process (NLP) algorithms.

The usage of a model of textual analysis using machine learning algorithms, and an Artificial Intelligence interpreter in Python are proposed with NLP (Natural Language Processing) A.I. That is effectively an Artificial Intelligence algorithm, based on linguistics that interprets natural language inputs from documents and all different types and resources, and through a probabilistic measure that allows interpreting the meaning, the intent and infer the principal meaning from constructs of that topics.

To create a statistical frequency of words, related on news and agencies publications or a set huge amount set of documents, the algorithm used was LDA, Latent Dirichlet Allocation, to perform these Functions of interpreting textual data sets using the programming language Python. This A.I. identifies the main constructs presented from topics and the main words and themes published about that information. A massive crawling technique that allows News fetching algorithms and get in detail a big picture of what is being related through these new Technologies was used to access, read, and import newspapers' content related to Virtual Realities, CyberMuseum, and Immersive Experiments.

It proposes a Design Science Research methodology described in six layers, the fundamentals of the investigation model, defining the most relevant steps of the investigation methodology. Even though there are some proposes of design research models as (Peffer:2008) describes in its model in this case a new proposal was conceived focused on the major steps to defining an independent investigation method.

- 1- First, identify and motivate the problem, as formulated on the research questions, and how it could be possible to achieve the most relevant data about the subjects to be measured in quantitative and qualitative units.

- 2- Define Objectives and propose an answer or Define a path through the investigation research based on research questions.

- 3-Implement on the Design stage, to test implement and make the use of a Machine Learning Model. In this phase was Fetched Informative Data as a News fetching method to perform, and also define and disclose the thematics evolved.

4- Demonstrate results obtained from investigation research to satisfy the meaning of textual data exported as Dictionaries and Repositories and interpret their semiotic worth.

5- Finally, Statistical data processing which uses Machine Learning to represent the collected data articles graphically through Topic Modelling Techniques.

Additionally, apply Depurative Data Processing to select, performs, and minerize constructs with major relevance with respective qualification and ratio to perform a Visual Presentation.

6-As a scientific contribution, It will be developed a Virtual environment to Perform topic modelling visualization under a device-based system, semi-immersive using the game engine Blender and equirectangular visualization that performs to visualize the results of the topic modelling presentation under a VR system and head-mounted display

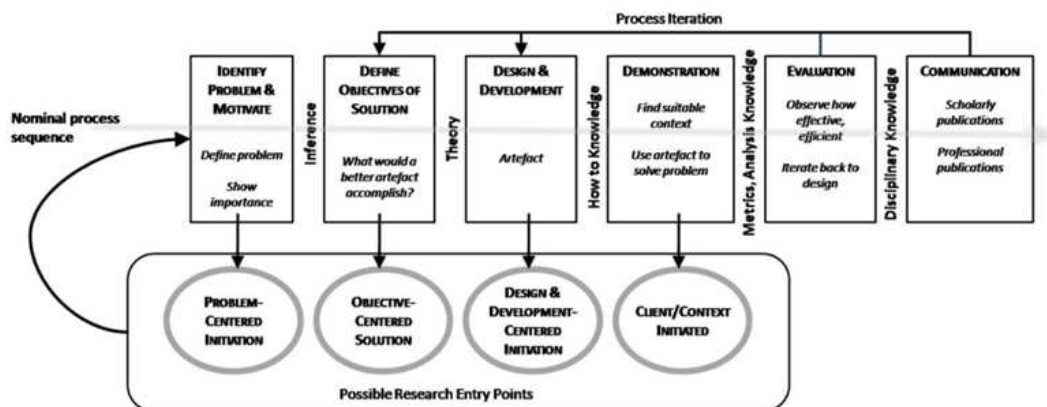


Figure 32- Design Science Research Methodology (Adapted from Peffers et al.2008)

5.2 - News Fetching and Topic Modelling Structures and Scripts

The objective is to apply Python, an algorithm to fetch News under newspapers publishings and news agencies, in Portuguese and English, using that programming language to fetch, extract, and parse all these massive informative pieces collected and submitted to a Natural Language Processing System.

The usage of a model of textual analysis using machine learning algorithms, and an Artificial Intelligence interpreter in Python NLP (Natural Language Processing) is proposed.

That is an Artificial Intelligence based on linguistics that interprets natural language inputs from documents and all different types of different resources. Web crawling and text mining are used for deep research on News and publications with a News fetching and Python Algorithm to perform the source of the data set. Latent Dirichlet Allocation provides deep research through the corpus of a text using keywords and word count systems, creating a Topic Modelling Framework. Using that functions the selected words and crawling phrases for certain expressions and keywords would reveal the intrinsic meaning of the available content. Summarising and returning the most important constructs and where they are placed on a document. it extracts and evaluates the most relevant information on Topic modelling representation.

5.3 -Textual Analysis of Publications and News

The Machine Learning Tool Supervised LDA Model works well with text classification. The concept is to label every document with its most representative constructs and then use that labelling to train the model to recognise the most relevant topics of this data.

- Machine Learning and Topic modelling Script LDA Model

How the LDA is so useful and its different approaches from other topic modelling algorithms? Creating a task to sort by categories or classify a significant number of data from websites, forums, social networks, and, in this case, information from newspapers and news agencies may be a complex task if we have a large amount of data to deal with it. To make this work easier and make it possible to infer the theme of that resources, it should be used LDA (Latent Dirichlet Allocation) is a useful Machine Learning A.I. to topic modelling, and also combined with pyLdaVis may present a statistical form of distribution of those topics.

This research also enabled a stop word algorithm that is simply a data exploration of the topic model that can filter out irrelevant topics and disinteresting or misleading content in NLP (Natural Language Processing) applications.

5.4 - Machine Learning and Topic modelling Script

What is the LDA topic modelling Machine Learning Algorithm?

Latent Dirichlet Allocation

LDA was first developed by researchers David Blei, Andrew Ng, and Michael Jordan in 2003. LDA topic modelling discovers topics that are hidden (latent) in a set of text documents. LDA or Latent Dirichlet Allocation is an unsupervised topic modelling algorithm that performs an identification of the most relevant topics of a written document without the need for labelling data, Training model and now it enables the function to create Labelled variables to measure the terms related to a subject on a massive amount of documents through a non-zero probabilistic function. (Blei et al., 2003) It works and reveals the meaning and infers the theme of that documentation, measured by that article. That could and all sorts of documentation unsupervised with labelling those terms. Evolving from a reverse engineering algorithm, Dirichlet is a keynominal probabilistic function discontinuous in all its variables that assumes a sort of several topics defined at the beginning of the algorithm and tries to find correspondence between them with the most frequent use of those topics. (Blei et al., 2003) Determines if they are being symmetrical or asymmetrical among their correspondence and returns the most frequent topics from the range of all documents. Hence the terms identified can be clustered and labelled to identify future trends and the most constructs of their information. (Blei et al., 2003)

The algorithm has the following steps:

- 1- Assume that exists several topics a (K) in all the range of documents
- 2- Distribute the topics (k) from all the documents (m) identifying correspondence symmetrical or asymmetrical assigning from each topic.
- 3- Remove wrong words from the topic word assignment as words that are not Verbs Nouns for instance remove also acronyms and adverbs.
- 4 - it probabilistically performs a measure of term frequency (ϕ)of how the terms are assigned and their frequency in the overall distribution

- 5 - Performs its calculation for each (w) on all documents iteratively
- 6- Finally, it is possible to perform the word term frequency and the Dirichlet probabilistic key nominal frequency for each topic.

The Model

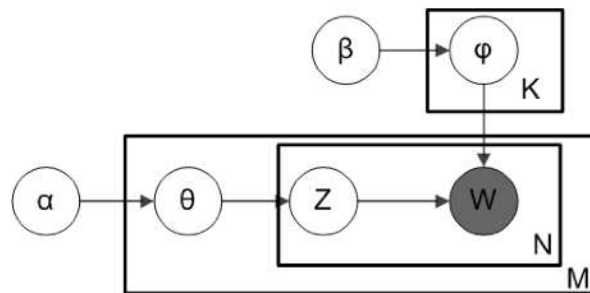


Fig 33 - A Diagram of the Topic Modelling is known as a plate diagram of an LDA model where: adapted form ((Blei et al , 2003)

α is the per-document topic distribution,
 β is the per-topic word distribution,
 θ is the topic distribution for document m ,
 ϕ is the word distribution for topic k ,
 z is the topic for the n -th word in document m , and
 w is the specific word

EXPLAIN PYLDAVIS

If we have a large number of data to visualize, to make this work easier, Python Model Management supports topic modelling exploration through the use of a Machine Learning tool called pyLDAvis. It is primarily a data exploration topic modelling project that works with NLP (Natural Language Processing) projects. The Machine Learning Tool pyLDAvis works well with text classification and the purpose is to label every document with its most representative constructs that labelling to train the model to recognise the most relevant topics of this information, is called unsupervised learning of text classification. Therefore comes the topic modelling task and without training, data is possible to cluster the specific constructs as words labelled with a predefined list and present from a vizual distribution. The topic models provide a frequency rate for each word. For example, in this example, for each word that characterises the theme: Experiment "0.29" Museum "0.59" Virtual "0,45" Augmented "0.34" Mobile "0.25" We can conclude from the first construct identification that the text is about a Museum. The second might be about a virtual experience. The third construct is Augmented reality; the fifth is mobile technologies. It allow to conclude from the first 5 constucts of topic one that subject is about a mobile or Augmented reality in a virtual experiment for Museums. More than just providing us with some important information about what it is being related to text, PyLDAvis allows us to see the labelled terms and most relevant constructs of that information using two complementary forms of visualization on a chart bar that represents the main constructs of

related information and a bubble chart that performs a multiple correspondence analysis of qualitative data.

The first topic is about an art collection of Photography, and the second is about an interactive experiment of virtual reality using Mixed Virtual Reality. Each bubble represents a topic. The larger the bubble, the higher frequency of the number of constructs in the corpus about that topic. Blue bars represent the global frequency of each constructs in the text corpus. If the topic is selected, the blue bars of the most frequently used words will be displayed in red bars give the estimated number of times a given term was generated by a given topic being present statistically on that topic. As can be seen from the image below, The word with the longest red bar is the word that is used as the most frequent term on the News.CSV file belonging to that topic.

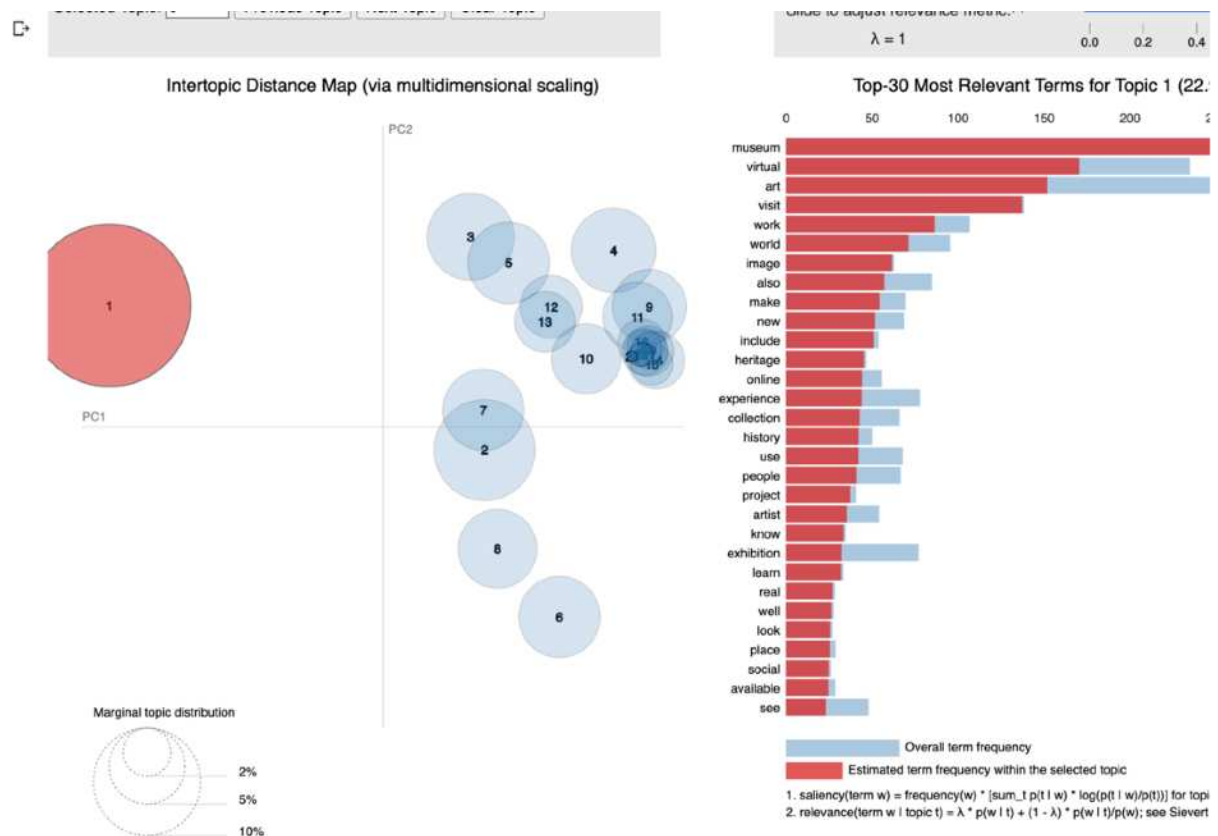


Fig 35 - PyL Davis - First Topic - 30th principal constructs

PyLDAvis visualization

- The further the bubbles are away from each other, the more different they are
- For example, it is difficult to tell the difference between topics 4,5 until 10
- They seem to be both about Art and Museology but it is much easier to tell the difference between topics 1 and 3 because they are distant
- We can tell that topic 1 is about a museum virtual reality experience.
- A good topic model will have big and non-overlapping bubbles scattered throughout the chart.

Visit the Machine Learning PyLDavis Version with Topic Modelling Multiple analysis distributed Graphics go to Link to this research Machine learning NLP and Topic Modelling Algorithm to interact with the data visualisation system:

<https://colab.research.google.com/drive/1Cipj-JOUIUzKkPIKutd0JwVdo9GFjbEo?usp=sharing>

5.5 - Results and Multiple Correspondence Analysis

To create a statistical frequency of words in related news and publications from agencies or a large set of documents, the PyLDavis algorithm was used to determine the frequency of terms and the proximity between topics and main constructs published about this information from a Statistical visualization .

More than just providing us with some important information about what it being related to text, PyLDavis allows us to see the labeled terms and most relevant constructs of that information using two complementary forms of visualization on a chart bar that represents the main constructs of related information and a bubble bar that performs a multiple correspondence analysis of qualitative data.

It is very informative and displays the most relevant words on a chart bar, and it also provides the multiple correspondence analysis methods between constructs and the representativeness between information and relevant topics presented on the Blue Chart Bar. The model recognizes the frequency of the word and how many times appears on the document.

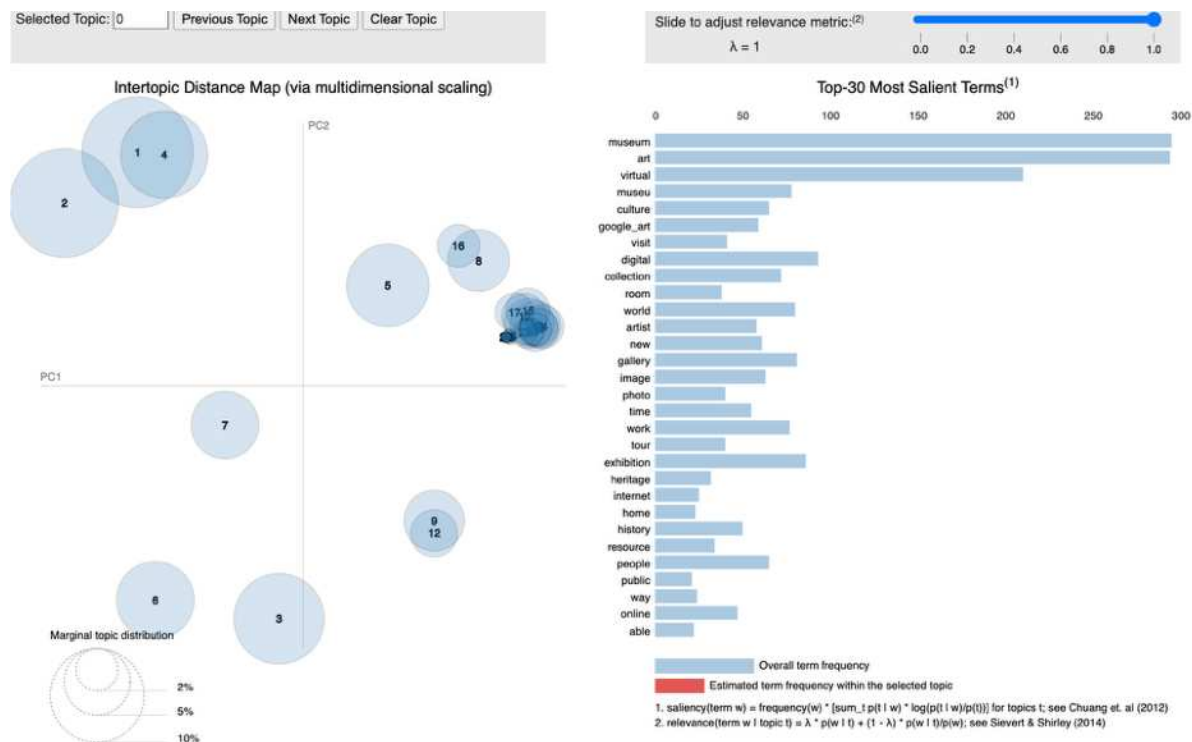
More than describing and understanding the subject, was relevant to understand how do media and communication construct/build importance or relevance about VR and cultural heritage, and how does this subject reveal the value of new technologies to the cultural scene of museums and galleries, essentially what is being related between news and newspapers?

How does Media and communications are relating to that virtual environment strategies in Museum and Art Galleries?

The subjects that are being recently related, are proposals of new experiments in the museum using the abilities of new devices and technologies, sometimes direction to digital arts or in some form rescuing the interest to classical artists.

The Digital Artists from the contemporary scene are using methods of immersive ambients, photorealistic recreations, rebuilding environments artefact and old sculptures implementing AI to create art,

The image that is being constructed from media and communication using this method of research above newspapers and news agencies are being related to these VR technologies that are available to everybody, even from their homes and would be a promise of learning and knowledge. They main informative constructs identified are described as innovation, inventive, creative, educational, and providing new virtual features to their collections, digital Artis, and performing new forms of access to their Legacy and Cultural Values.



Augmented Reality It's a new way to follow virtual visits in the museums, guiding visitors, enabling audio and video descriptions, useful with a camera display and wi-fi connection, to enable a great diversity of multimedia outputs. As technology becomes more widespread and powerful, practically all locations of cultural interest are investing in their communication platform and compelling narratives for visitors from all over the world. Some parts were created from aggregators of multimedia and online resources, such as Google Arts and Culture.

Model description, Semiotic Value and Construct identification

To create a statistical frequency of words in related news and publications from agencies or a large set of documents, the *Py/Davis* algorithm was used to determine the frequency of terms and the proximity between topics and main constructs published about this information from a Statistical visualization. The principal Topics are distributed into nineteen principal Topics, each one defining the resource of investigation in thirty essential constructs for each topic, the most experiences related are defined accordingly to the research method, using Keywords. that reveals that the resources did the important features of filtering what was collected from news and the model was assertive to the machine learning algorithm selection of those subjects.

They are supported from a chart bar representing the instantiations of the 30 most relevant constructs for each topic. These graphs automatically update from each topic, and it is possible to ensure that, the news fetching method is related to the studied subjects. Even there was a limitation of this study that validates in some cases some words that are not related to that subjects. This could happen when the news fetching algorithm parses some meta information from the HTML source, referring topics as "HTML", "Jpg" "countries", and so on. However, this issue should be avoided to take in advance what comes from the result of POS and stop word parse to speech to infer the main subject and most relevant topic filtering from Verbs, Nouns and Adjectives.

It is possible to understand from the graphs 3 aspects.

1- The Topic model performs a calculation of the most representative terms from all the data sets imported to the machine learning algorithms.

2- It separates from distance and areas the different topics representing a major relevance on News related with Terms and Principal components as Frequency and their constructs

3- The POS part of Speech and Stop words allows for the removal of misleading information such as pronouns, and adverbs, and Html meta information.

Model Description

The data set consists of a collection of 135 articles collected online using a news fetching technique in python. Its source is newspapers and news agencies that published in the last year articles related to visits to museums and virtual reality. Are articles that were imported into dictionaries to then were organized to CSV FILE and exported by author, title, content and source.

The model identified 335 consctruts divided into 19 topics by the 2 main components of each axis, which can be characterized as frequency and proximity. being the PC1 axis characterized by the most frequent topics about subjects as Museums, Art, and Virtual featuring PC1 essentially to relate as Art and Museums and the PC Axis 2 defining proximity between topics related to Technology, Education and forms of virtual reality. That axis being essentially characterized by a more technological field.

The main inferences of this study are on each subject:

Topic Modelling 1 - "Museum" overall frequency - 8

We can conclude that the machine learning algorithm selected from major Topic, the word "Museum" as the most present in use frequency above the News CSV File from the average articles. This word is commonly related to "Collection" "Educational" "new" digital" and "Virtual", "Digital" , "Online" and "Gallery" which gives us the perspective that the majority of this News fetching is well performed on the selected keywords and gives the relevance and consistency to Museumlogy and Virtual Reality experiences being related in New Data set. This Cloud of Words allows us to infer that from the begin of the research many News from a range from all above articles published from newspapers and news agencies are about virtual experiences in Museums and compelling to readers to visit Museums and appreciate that Innovative interventions.

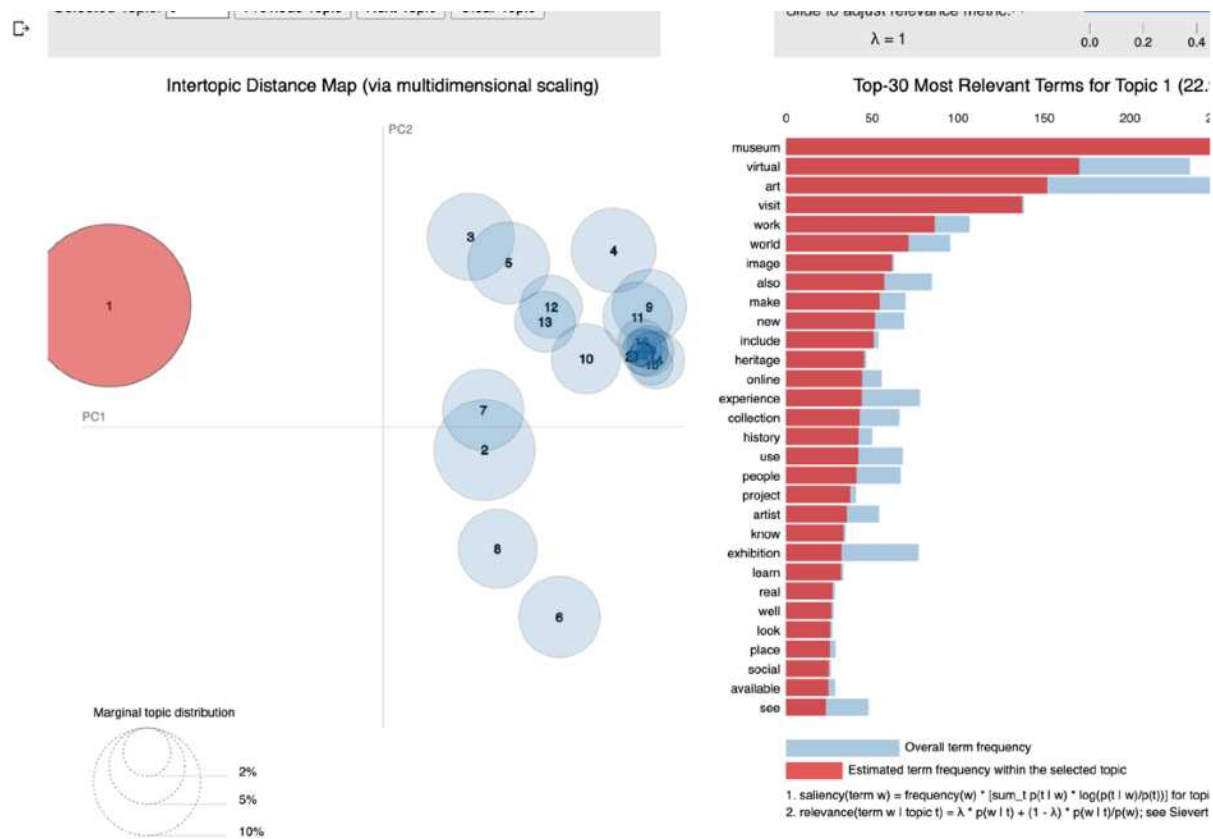
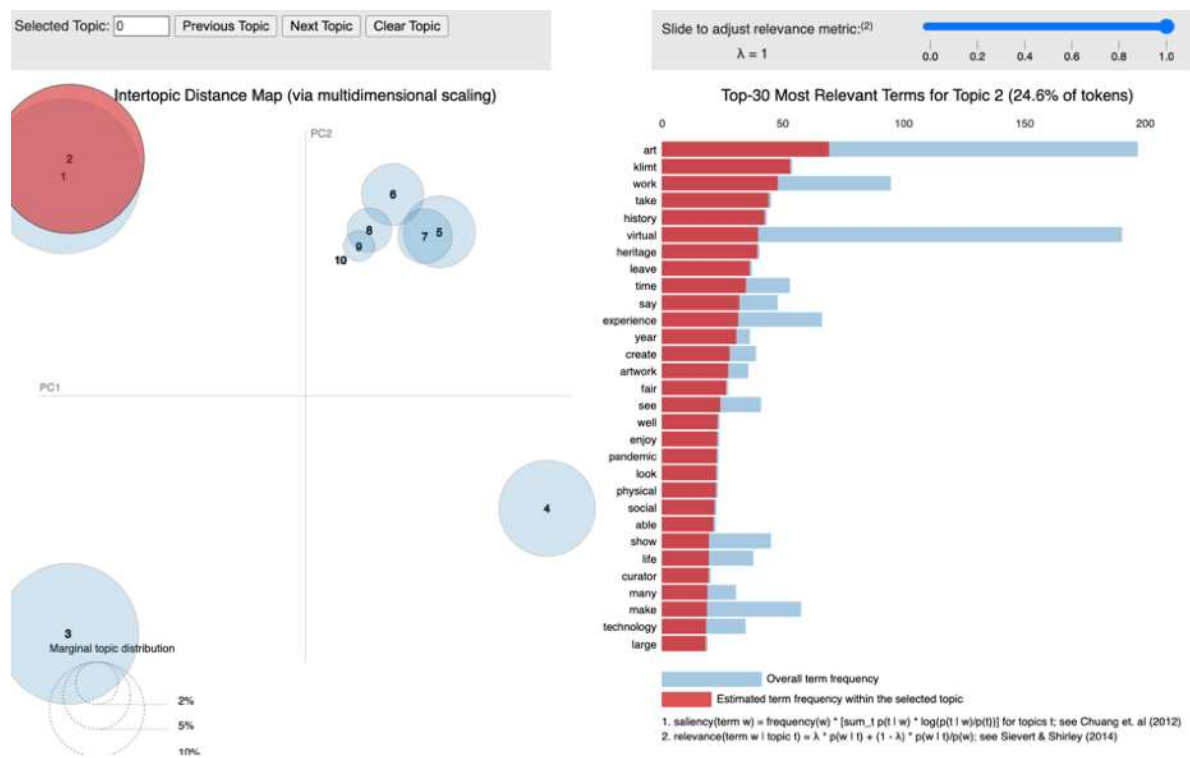


Fig. 33 - PylDavis first Topic - 30th principal constructs

Topic modelling 2 - "Art" overall frequency - 6

Art Term is usually related to "Paintings" "Gallery" "Museum" even when the related subject is virtual reality and we can understand that some news is about a new virtual platform. Describing Virtual



Paintings, promoting some exhibitions in virtual reality or the development of Machine Learning Applications as the example of Image Processing algorithms to perform artwork or that evolved to complete lost works of some painters recovering the original colours of those paintings and the using of neural networks AI to perform art creation.

The results of terms frequency are represented in a bubble form in which the distance between parameters and Principal Components topics is established from axis Pc1 and Pc2.

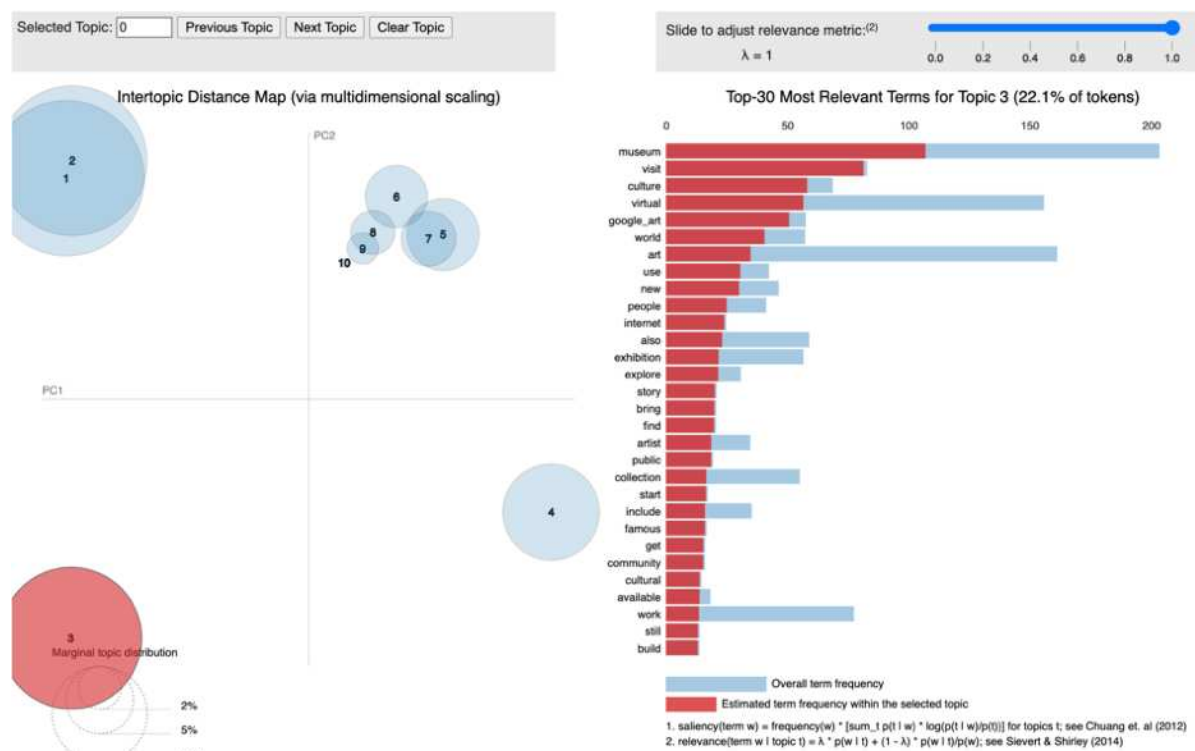


Fig. 34 - PyIDavis third Topic - 30th principal constructs

Topic Modelling 3 - "World" and "Digital" Overall frequency - 4

The dispersion of the Topic "world" and Digital is related to the global e massive virtual experiences available globally from virtual platforms and online resources. Much of this News is related to platforms of global dissemination of art and culture, such as Google Arts or Global Virtual Experiences Global and Virtual Markets, for people to enjoy and experience art from their homes.

The terms "Google", "people", "Work", and "News" are often common because of their frequency of use and in this case, subvert the coherence model. They are not insignificant. It reveals that Google has some preservation projects and promotes virtual environments in Museums and Galleries. They are accessible to the public and visitors all around the world, and the image of Virtual Reality is constructed as relevant, innovative, a new way to preserve and present collections of art, and being engaged in virtual experiences to cultural values as new experiences.

3- The News corpus is verified, translated and interpreted to distinguish from the original language source to the translated version of the article.

- On an Estimated term frequency on each topic, we can identify related constructs that allow us to identify the main subject of the topic, with terms related to the collected source.
- The Overall Term Frequency we can identify that mostly of presence to the construct of Museum, New, Experiences, Recreation, Augmented, Reality, Virtual, Reality, Technology, Public, Internet, digital, arts, and Heritage

From the 30th main Topic We could infer that using the chart bar the most common and used construct that allows classifying the news are:

TOPIC1 The Most frequent topics were Virtual, Museum, art, Gallery, Room, digital Museum,

Exhibition, Experience, and Open Resource. Allows Infer from that the topic, that is the most relevant construct for the topic modelling representation, because it presents the most frequent and relevant topics amongst all constructs list, being present in almost other news and subjects published, creating massive proximity between the same topics and allows to conclude there is on the most of news published related to the Virtual Museum Exhibitions. considered as New Experience and Innovative proposal. This two topics characterised as Museumology and Virtual Art describe the Principal Axis 2

TOPIC2 - The main constructs were "Online exhibition, See, Online, and Virtual, Experience as open Resources to the main public with open access to gallery rooms in museums or free access for online visitors. It also refers to the possibility of free access to digital content online from museums using this new technology

TOPIC3 - Virtual, Augmented Reality, VR, People, Immersive, Public art artwork Represents and more about Virtual Museum, however in a more distant position from other topics probably they have different subjects that make the third topic more distant than others. Topic 1 e 2 Most relevant topics are close to the main principal components

Topic 30s most relevant topics are in the distance from the principal components of topics 2 e 3 and is represented by different topic principal components.

Discussion

The LDA model combined with the Topic Viewing tool PyLDavis is stable, consistent and a useful and easy learning tool in order to implement textual analysis of topics.

Allows to model every data sets. of written documents, whether texts, news articles or social media feeds, reproducing the results for data sets of all lengths. constitutes a useful tool for analyzing

textual data due to the possibility of converting text into variables, defining vectors that identify their frequency in the totality of all articles and allowing an analytical visualization through a histogram graph and a model of multiple distributions.

It is possible to conclude through empirical inferences that this large amount of topics is more frequent in topics 1 and 2 With the constructs Museum, Art , History Painting, Virtual Heritage, Artwork and Experience and closer in Topics 4 5 6 7, With the constructs Digital Metaverse, Technology, VR, Camera, Mobile, Augmented reality, Educational, Virtual, and Internet being able to categorise each axis as PC1 Art and Museums field PC2 Technology field.

In its opposite dimensions are subjects more outside the context of this study, as topics performed from words as educational tools proposed or other types of artistic interventions. It also allows conclusion through a hidden dimension ((Blei et al., 2003), the result of the inferences obtained by the analysis of the principals, a lot of information that could go unnoticed. Examples of some hidden inferences are from Topics related as AI Neural Networks for creating art, using Artificial Intelligence as Convolutional Neural Networks to Perform artworks and VR.

CHAPTER 6

Conclusions

6. Conclusions

The Virtual Reality for Cultural Heritage proposal is incredibly relevant, and it is driving artists and their works to become more visible. Museums are making the most significant changes to the virtual world, spending significant resources on technology to provide richer, more remarkable, and immersive experiences both inside and outside the museum.

Their new technologies, which range from old RFID to current wireless and GPS connections, are being evaluated to improve their holographic presentations and virtual tours on-site with new game engines and power wi-fi connectivity.

Moreover, as technology becomes more widespread and powerful, practically all locations of cultural interest are investing in better communication platforms and compelling narratives for visitors worldwide. This enables the realisation of a long-held ambition to global access to art and culture. Some parts are created from aggregators of multimedia and online resources, such as Google Arts and Culture. Without the works of curators, gallerists, and theories of art, these implementations would not be possible. This study attempts to review as much of the literature as possible using investigative methodologies and synthesise the historiography of current technology, the evolutionary works and their intentions to be democratically available to everyone in almost remarkable moments of art history, The News Fetching allow the perception about a massive collection of articles where its possible to conclude that it's possible to demonstrate that Bayesian estimation can be used to learn such News Fetching models from very large text corpora, using Topic Modeling LDA as a working example. The resulting Topic Model LDA from News model was shown to extract substantial hidden information from the set of news and articles, including new topics, related information, new supports and technology, future trends and other potential application. Museums as well as being a powerful presence to the internet public in this epidemic era when individuals are increasingly encircled in their homes with fewer opportunities for evasion. It reveal that Museums they are linked to communication and media, the source of this study's support, promote as offer a complementary experience to a museum visit. They are increasing the usefulness of a new technology that has been applied. They are described as innovative, inventive, creative, and providing new virtual features to their collections, digital Arts scene, and archaeology and performing new forms of access to their Legacy and Cultural Values.

Since the beginning of the web, with available online databases and web pages, Museums adopted their communication strategy to promote their collections and dispose of Master Pieces of art to link to a wider and most global market of art and networking.

The museum with these (V.R.) technological features could propose to visitors the most complete and interesting storytelling within the experience inside the museum. The experiments with Virtual Reality became a complementary experience to improve the engagement and do with new technologies and devices new cultural outputs and immersive and Sensory stimulus to those who visit the museums. Later with the insurgence of panoramic vision and embed metadata photography it is possible to recreate the space of a virtual museum online and gave a navigational and immersive visit by linking photos and panoramic vision to browser navigational systems

Augmented Reality [Azuma \(1997\)](#) became a new offer to guided tours inside and outside the museum being able to reconstruct lost artefacts, architectural places, or archaeological evidence, its possible to give and perform reconstruction and add new layers of information to the reality as it is seen. It is a new way to follow virtual visits in site the museums, guiding visitors, Enabling audio and video descriptions, useful with camera display and wi-fi connection, to enable a great diversity of

multimedia outputs. It reduces overall the costs of disseminating and implementing of these immersive experiences.

How do media and communication construct/build importance or relevance about virtual reality and cultural heritage, and how does this subject reveal the value of new technologies to the cultural scene of museums and galleries, and what is being related between News and newspapers?

The image that is being constructed from media and communication using this method of research above newspapers and news agencies using news fetching and topic modelling, are being related to these V.R. technologies that are available to everybody, even from their homes, and would be a promise of learning and knowledge. The museums are very interested also in divulging their virtual tours and opening their doors through the internet to visitors, divulging their thematics or becoming associated web global and massive platforms such as Google Arts and Culture, or MET 360° with video panoramic vision or throughout a Virtual Immersive Multimodal Museums Platform.

Virtual Technologies dispose of a diverse offer from support and display Innovative and Technological advanced into an immersive experience. Are getting more closure from human senses, insightfull, and with a new range of stimulus inputs. The Digital artists from the contemporary scene are using methods of immersive ambients, photorealistic recreations, and rebuilding environments and artefacts, from old sculptures to guiding inside and outside the museum, and augmenting the experiences with V.R. googles where we can get into the art on amazing possibilities as facing an opus Magnus of art wherever is it from the globe. Machine learning techniques are being implemented to create NPC as guide companions through the museum visit, as conversational intelligent agents. The Metaverse example of future sociological integration on the global scenario of networking and social media enables the Virtual presence of Museums World Wide, performing Some Interactive spaces, for divulge and make a presence on-line being interesting support to broadcast and trade art as NFT or other digital certificated copies. have had a great acceptance and users worldwide disclosing a great interaction model and suggest a new field of research in the broadcast, dissemination and commerce of digital experiences and art trade.

Museums are relating and reinventing old narratives, creating beautiful experiences above the art proposed these days is a major task for museums that adapt to perform a global presence within internet landscapes and knowledge technologies. The media and communication agencies offer a proposal to evasion and learning experiences inviting access, visit and experiment with these interactive experiments.

6.1 - Limitations

This study has its limitations because the news agencies and newspapers only provide information from the date of published News since month before, the collected data information is published and submitted to the database. The report begins in August and September till the end of December, the date when it has applied the study for evaluation, causing some difficult to determine exactly this subjacent meaning of that subjects from the beginning of this new technologies all along the time.

This study should be improved if it collected News and information from the web and the most significant search engines, supported by a library of documents and News Repositories extended in time. However, it was effectively the limitation of this study. It was supposed not to research web pages and content online with web scrapping techniques but in News published from news agencies and online databases of newspapers and media sources.

6.2 - Future Research

This research compelled me to propose a technological approach to V.R. system as an innovative and unique Virtual Reality System for this project. Employing a topic modelling data analysis produced from the Machine Learning Algorithm. It should be a technical contribution to developing textual analysis visualization systems for museums and cultural sectors as a unique work. This technological project aims to take advantage of the 3D axial coordinate system and rendering styles and physic animation, with the highest level of accuracy in visual elements, and display it in a virtual game style the topic modelling results. The results collected from Topic Modelling algorithms obtained from newspapers and news agencies about the subject will be interactively displayed in this virtual environment. A particle system will be constructed using the 3D coordinate system for each dimension of the topic modelled set. These particles have their style and are different between topics. Those particles became part of a more complex system of visualization that performs an immersive experience in visualizing text with the most relevant topics. They present frequency of use and relevance above other dimensions in all other topic modelling sets, such as intensity, frequency, and proximity between multiple correspondence dimensions.

Fig 38 e 39 - VR System for textual analysis of topic modelling

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Annex A

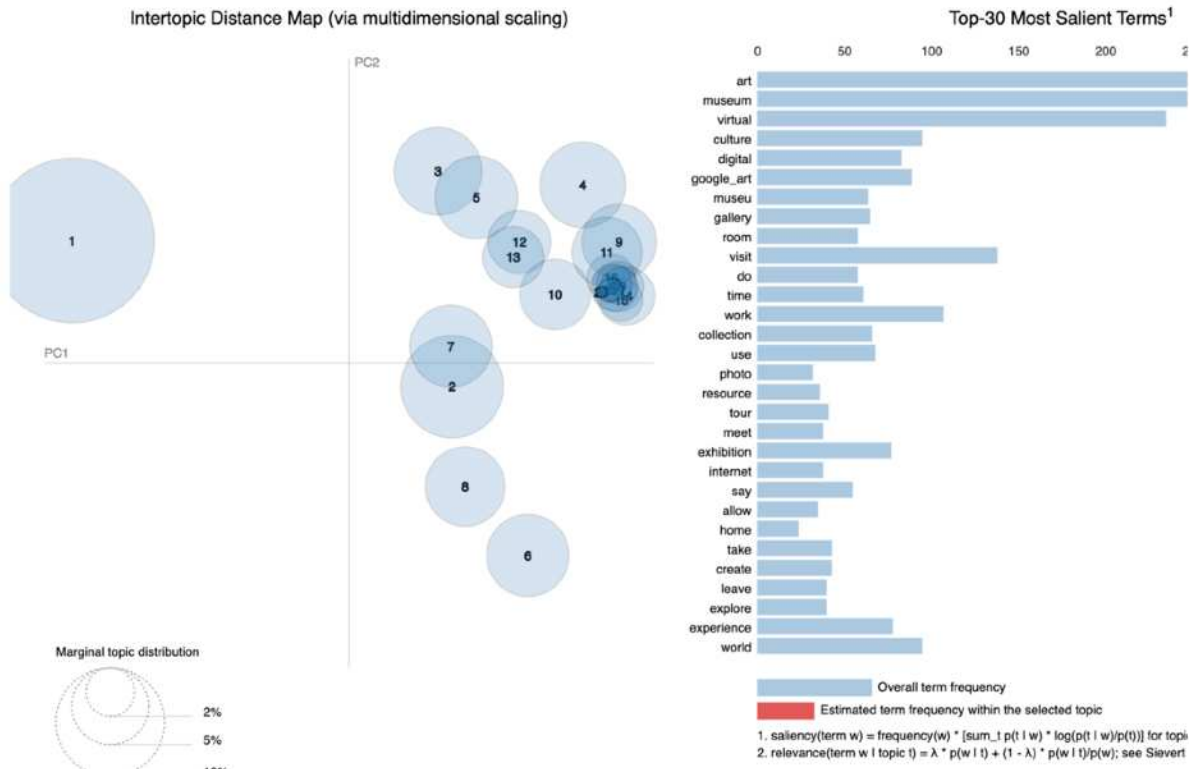


fig. 1- 30th principal topics and multiple correspondence analysis. 135 ar

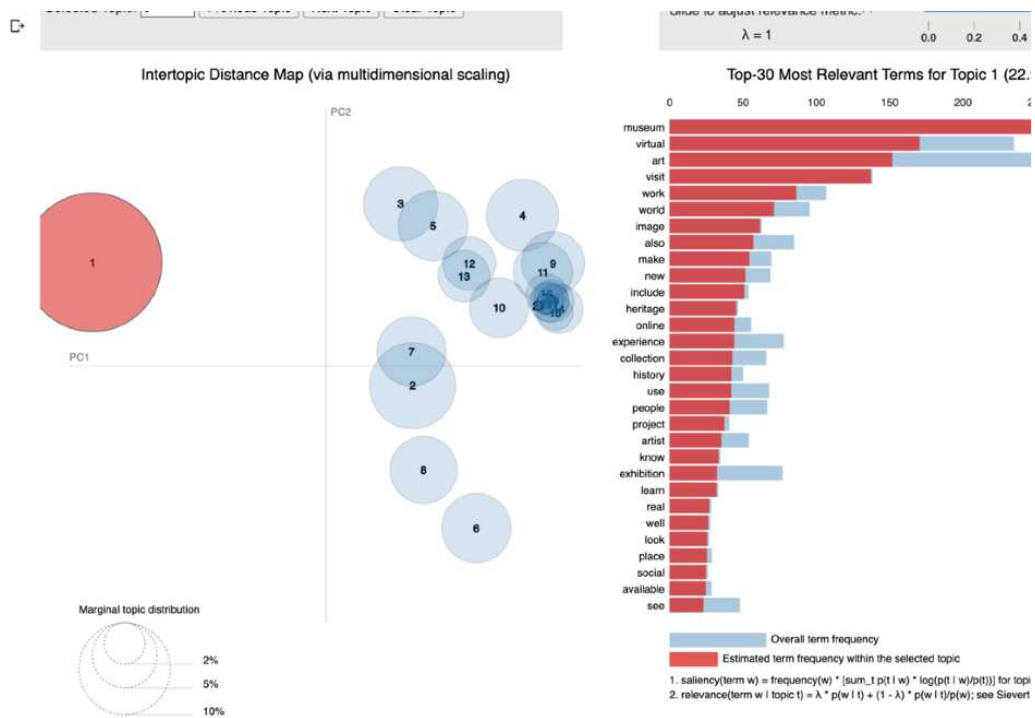


fig.

2- 30th principal topics and multiple correspondence analysis

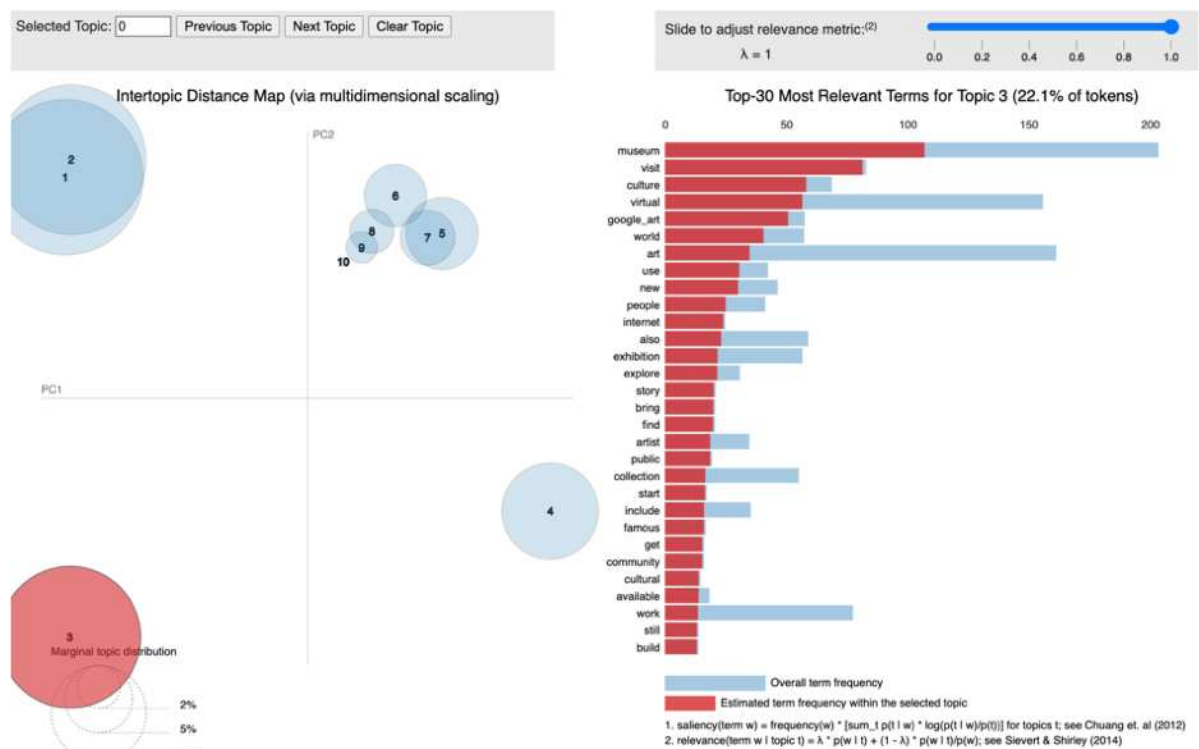


fig.3 Topic 1 and multiple correspondence analysis

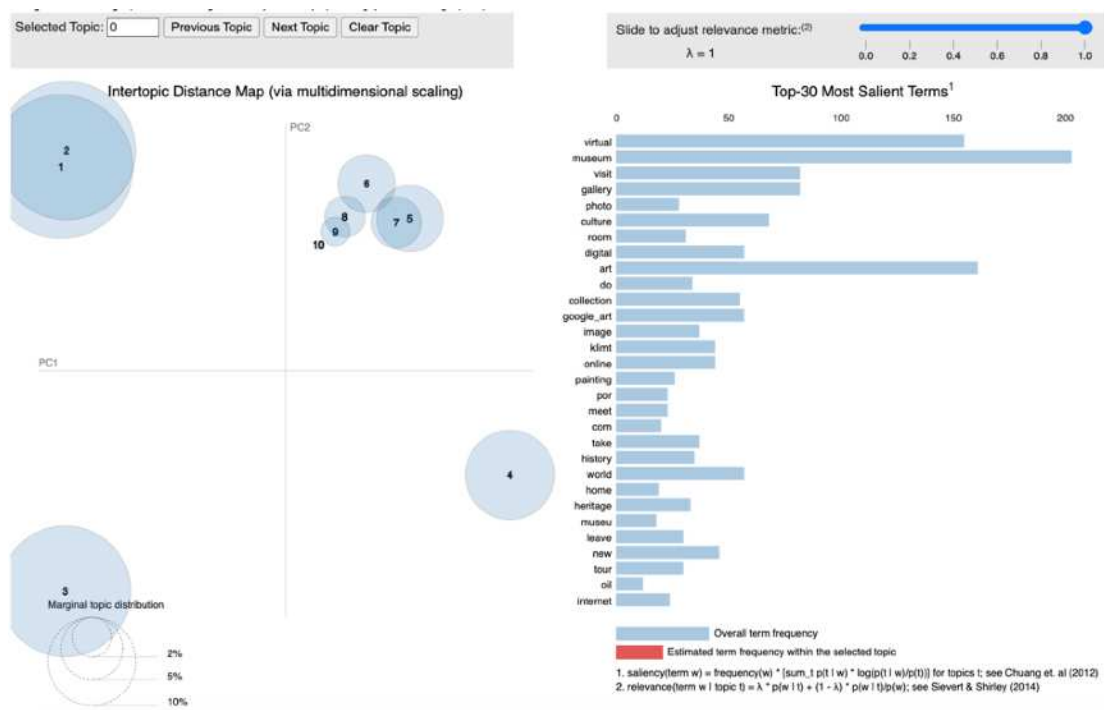


fig.4 Topic 1 and multiple correspondence analysis 135 articles

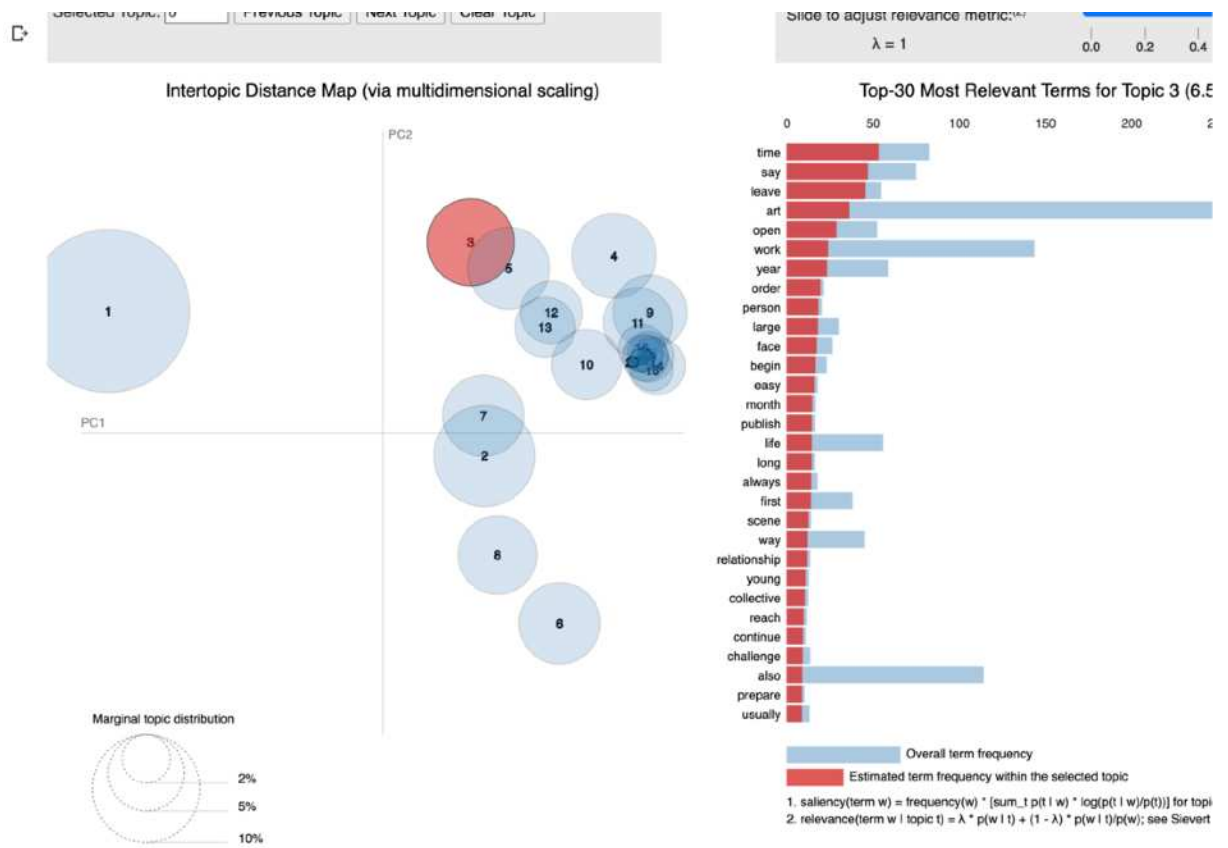


fig.5 Topic 3 and multiple correspondence analysis 135 articles



Annex B - Jupyter Based Environment - Python Machine Learning

```
[26] pip install --upgrade gensim

Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: gensim in /usr/local/lib/python3.7/dist-packages (4.2.0)
Requirement already satisfied: scipy<0.18.1 in /usr/local/lib/python3.7/dist-packages (from gensim) (1.7.3)
Requirement already satisfied: numpy>=1.17.0 in /usr/local/lib/python3.7/dist-packages (from gensim) (1.21.6)
Requirement already satisfied: smart-open>=1.8.1 in /usr/local/lib/python3.7/dist-packages (from gensim) (5.2.1)

[27] pip install pydavis==3.2.1

Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: pydavis==3.2.1 in /usr/local/lib/python3.7/dist-packages (3.2.1)
Requirement already satisfied: futures in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (3.2.0)
Requirement already satisfied: pandas<0.17.0 in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (0.16.0)
Requirement already satisfied: numexpr in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (2.8.3)
Requirement already satisfied: functools in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (3.2.1)
Requirement already satisfied: wheel==0.22.0 in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (0.22.0)
Requirement already satisfied: Jinja2>=2.7.2 in /usr/local/lib/python3.7/dist-packages (from pydavis==3.2.1) (2.11.3)
Requirement already satisfied: MarkupSafe in /usr/local/lib/python3.7/dist-packages (from Jinja2>=2.7.2->pydavis==3.2.1) (2.0.1)
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/python3.7/dist-packages (from pandas<0.17.0->pydavis==3.2.1) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (from pandas<0.17.0->pydavis==3.2.1) (2022.1)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.7/dist-packages (from python-dateutil>=2.7.3->pandas<0.17.0->pydavis==3.2.1) (1.16.0)
Requirement already satisfied: packaging in /usr/local/lib/python3.7/dist-packages (from numexpr->pydavis==3.2.1) (21.3)
Requirement already satisfied: pyparsing>=3.0.5,<=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging->numexpr->pydavis==3.2.1) (3.0.9)

[28] import re
import numpy as np
import pandas as pd
from pprint import pprint

# Gensim
import gensim
import gensim.corpora as corpora
from gensim.utils import simple_preprocess
from gensim.models import CoherenceModel

# spacy for Lemmatization
import spacy

# Visualization tools
import pydavis
import pydavis.gensim
import matplotlib.pyplot as plt
matplotlib.pyplot.imshow

# Enable logging for Gensim (This is optional)
import logging
logging.basicConfig(format='%(asctime)s: %(levelname)s: %(message)s', level=logging.ERROR)
```

Fig 11. Jupyter Python Notebook - Importing Repositories and Dictionaries

```
[29] import nltk; nltk.download('stopwords')

[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data] Package stopwords is already up-to-date!
True

[30] from nltk.corpus import stopwords
stopwords = stopwords.words('english')

[31] from google.colab import drive
drive.mount('/news/museums.txt/')

Drive already mounted at /news/museums.txt/; to attempt to forcibly remount, call drive.mount("/news/museums.txt/", force_remount=True).

[32] #Title: Install gspread, authenticate and load data from a Google Sheet
!pip install --upgrade -q gspread

from google.colab import auth
auth.authenticate_user()

import gspread
from oauth2client.client import GoogleCredentials

# Default data from
# https://web.me.uk/edu/avery/index/model.html#SECTION060220000000000000000000
data = 'News_Museums' # @param {type:'string'}
data_rows_to_preview = 35 # @param {type:'integer'}

data = open('/news/museums.txt', 'r')
data.columns = ['sentences']

def sent_to_words(sentences):
    for sentence in sentences:
        yield(gensim.utils.simple_preprocess(str(sentence), deacc=True))

data_words = list(sent_to_words(data))
print(data_words[:1])

Double-click (or enter) to edit

[33] # Build the bigram and trigram models
bigram = gensim.models.Phrases(data_words, min_count=5, threshold=100) # higher threshold fewer phrases.
trigram = gensim.models.Phrases(bigram[data_words], threshold=100)
```

Fig 13. Jupyter Python Notebook - Importing Data BASE

```
Com tentativa de Word Cloud TOPIC MODELLING FINAL
File Edit View Insert Runtime Tools Help

Code + Text

def sent_to_words(sentences):
    for sentence in sentences:
        yield(gensim.utils.simple_preprocess(str(sentence), deacc=True))

data_words = list(sent_to_words(data))
print(data_words[:1])

[['carmen', 'mola', 'was', 'popular', 'spanish', 'novelist', 'three', 'male', 'writers', 'made', 'her', 'up', 'description', 'antonio', 'mercero', 'agustin', 'martinez', 'and', 'jorge', 'diaz', 'not', 'only', 'created', 'series']]

Double-click (or enter) to edit

[ ] # Build the bigram and trigram models
bigram = gensim.models.Phrases(data_words, min_count=5, threshold=100) # higher threshold fewer phrases.
trigram = gensim.models.Phrases(bigram(data_words), threshold=100)

# Faster way to get a sentence clubbed as a trigram/bigram
bigram_mod = gensim.models.phrases.Phraser(bigram)
trigram_mod = gensim.models.phrases.Phraser(trigram)

# See trigram example
print(trigram_mod[bigram_mod[data_words[0]]])

[['carmen', 'mola', 'was', 'popular', 'spanish', 'novelist', 'three', 'male', 'writers', 'made', 'her', 'up', 'description', 'antonio', 'mercero', 'agustin', 'martinez', 'and', 'jorge', 'diaz', 'not', 'only', 'created', 'series']]

[ ]

[ ] # Define functions for stopwords, bigrams, trigrams and lemmatization
def remove_stopwords(texts):
    return [[word for word in simple_preprocess(str(doc)) if word not in stop_words] for doc in texts]

def lemmatization(texts, allowed_postags=['NOUN', 'ADJ', 'VERB', 'ADV']):
    """https://spacy.io/api/annotation"""
    texts_out = []
    for sent in texts:
        doc = nlp(" ".join(sent))
        texts_out.append([token.lemma_ for token in doc if token.pos_ in allowed_postags])
    return texts_out

def make_bigrams(texts):
    return [bigram_mod[doc] for doc in texts]

def make_trigrams(texts):
    return [trigram_mod[bigram_mod[doc]] for doc in texts]

# Remove Stop Words
data_words_nostops = remove_stopwords(data_words)

5s completed at 16:40
```

Fig.14 - Jupiter python Notebook - corpus lemmatisation

```
colab.research.google.com/drive/142X4_nnT5K4m6nfMirWLI_gFzAUeQY5d#scrollTo=l6paj-CBVY8I

Com tentativa de Word Cloud TOPIC MODELLING FINAL
File Edit View Insert Runtime Tools Help

+ Code + Text

[36] def sent_to_words(sentences):
    for sentence in sentences:
        yield(gensim.utils.simple_preprocess(str(sentence), deacc=True))

    data_words = list(sent_to_words(data))

    print(data_words[:1])

    [['carmen', 'mola', 'was', 'popular', 'spanish', 'novelist', 'three', 'male', 'writers', 'made', 'her', 'up', 'description', 'antonio', 'mercero', 'agustin', 'martinez', 'and', 'jorge', 'diaz', 'not', 'only']]

Double-click (or enter) to edit

[37] # Build the bigram and trigram models
bigram = gensim.models.Phrases(data_words, min_count=5, threshold=100) # higher threshold fewer phrases.
trigram = gensim.models.Phrases(bigram(data_words), threshold=100)

# Faster way to get a sentence clubbed as a trigram/bigram
bigram_mod = gensim.models.phrases.Phraser(bigram)
trigram_mod = gensim.models.phrases.Phraser(trigram)

# See trigram example
print(trigram_mod[bigram_mod[data_words[0]]])

[['carmen', 'mola', 'was', 'popular', 'spanish', 'novelist', 'three', 'male', 'writers', 'made', 'her', 'up', 'description', 'antonio', 'mercero', 'agustin', 'martinez', 'and', 'jorge', 'diaz', 'not', 'only']]

[ ]

[ ] # Define functions for stopwords, bigrams, trigrams and lemmatization
def remove_stopwords(texts):
    return [[word for word in simple_preprocess(str(doc)) if word not in stop_words] for doc in texts]

def lemmatization(texts, allowed_postags=['NOUN', 'ADJ', 'VERB', 'ADV']):
    """https://spacy.io/api/annotation"""
    texts_out = []
    for sent in texts:
        doc = nlp(" ".join(sent))
        texts_out.append([token.lemma_ for token in doc if token.pos_ in allowed_postags])
    return texts_out

def make_bigrams(texts):
    return [bigram_mod[doc] for doc in texts]

def make_trigrams(texts):
    return [trigram_mod[bigram_mod[doc]] for doc in texts]

# Remove Stop Words
data_words_nostops = remove_stopwords(data_words)
```

Fig.15 - Jupiter python Notebook - Stop Words

```

Com tentativa de Word Cloud TOPIC MODELLING FINAL
File Edit View Insert Runtime Tools Help

+ Code + Text
alpha="auto",
per_word_topics=True

# Print the Keyword in the 10 topics
pprint(lda_model.print_topics())
doc_lda = lda_model.transform(documents)
df_lda = assign_model(lda_model)

[0.030*material" + 0.015*kid" + 0.000*al" + 0.000*dish" + 0.000*apple" +
0.000*topic" + 0.000*coloring_book"),
[32,
0.056*market" + 0.038*immersive" + 0.030*artist" + 0.013*select" +
0.019*face" + 0.015*pitch" + 0.012*group" + 0.006*international" +
0.000*startup" + 0.000*training"),
[3,
0.072*look" + 0.070*social" + 0.056*create" + 0.039*team" +
0.038*love" + 0.033*impact" + 0.033*grande" + 0.027*gather" +
0.026*channel" + 0.019*industry"),
[30,
0.133*image" + 0.078*painting" + 0.058*todo" + 0.040*com" +
0.026*contemporary" + 0.025*circa" + 0.019*camera" + 0.019*passos" +
0.017*fact" + 0.017*curate"),
[15,
0.035*life" + 0.028*pandemic" + 0.027*call" + 0.023*discover" +
0.024*may" + 0.021*face" + 0.021*work" + 0.020*art" + 0.020*highlight" +
0.020*give"),
[29,
0.359*act" + 0.063*enjoy" + 0.047*arte" + 0.029*appear" +
0.026*experiment" + 0.018*file" + 0.015*weak" + 0.011*pocket_gallery" +
0.010*web" + 0.009*augmented_reality"),
[17,
0.072*resource" + 0.056*first" + 0.033*found" + 0.030*old" +
0.030*exist" + 0.026*become" + 0.026*age" + 0.026*design" + 0.021*use" +
0.021*invite"),
[4,
0.036*new" + 0.033*virtual" + 0.028*physical" + 0.027*artist" +
0.027*create" + 0.027*help" + 0.024*part" + 0.023*world" + 0.022*many" +
0.021*visitor"),
[27,
0.142*museum" + 0.079*virtual" + 0.042*museu_nacional" + 0.042*com" +
0.036*que" + 0.028*line" + 0.022*museum" + 0.022*page" + 0.021*door" +
0.020*conhecer"),
[8,
0.070*virtual" + 0.068*tour" + 0.063*photo" + 0.055*take" +
0.033*available" + 0.032*start" + 0.029*gallery" + 0.029*guide" +
0.026*score" + 0.025*walk"),
[10,
0.199*museum" + 0.072*virtual" + 0.056*room" + 0.056*collection" +
0.048*work" + 0.036*internet" + 0.034*home" + 0.030*video" +
0.025*exhibition" + 0.024*show"),
[12,
0.003*visit" + 0.019*art" + 0.011*culture" + 0.026*experience" +
0.026*gallery" + 0.025*museum" + 0.020*google_art" + 0.023*history" +
0.021*heritage" + 0.020*use"]]

```

Fig.16 - Jupiter python Notebook - Lda principal constructs List

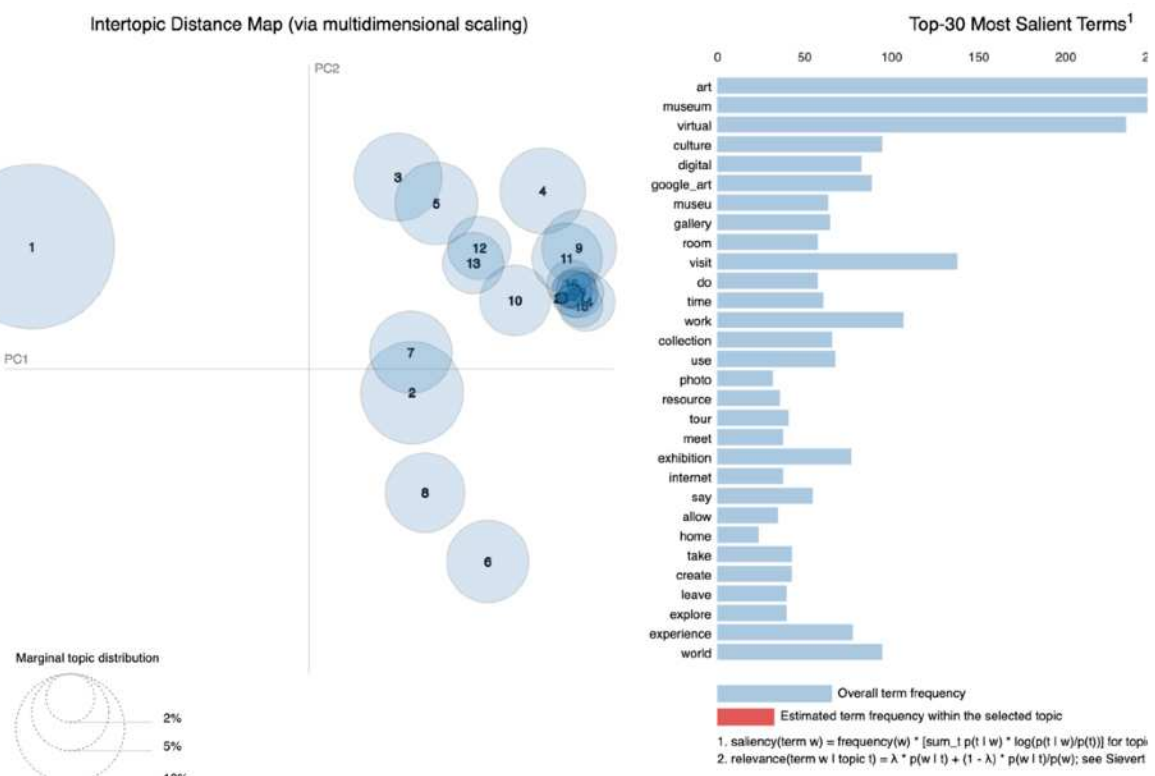


Fig.17 - Jupiter python Notebook - PyLDavis Statistical presentation

SKLearn - 30th Principal Topic

Fig 18. Jupiter Python Notebook 3D Vizualization.- PyLdavis
Statistical presentation

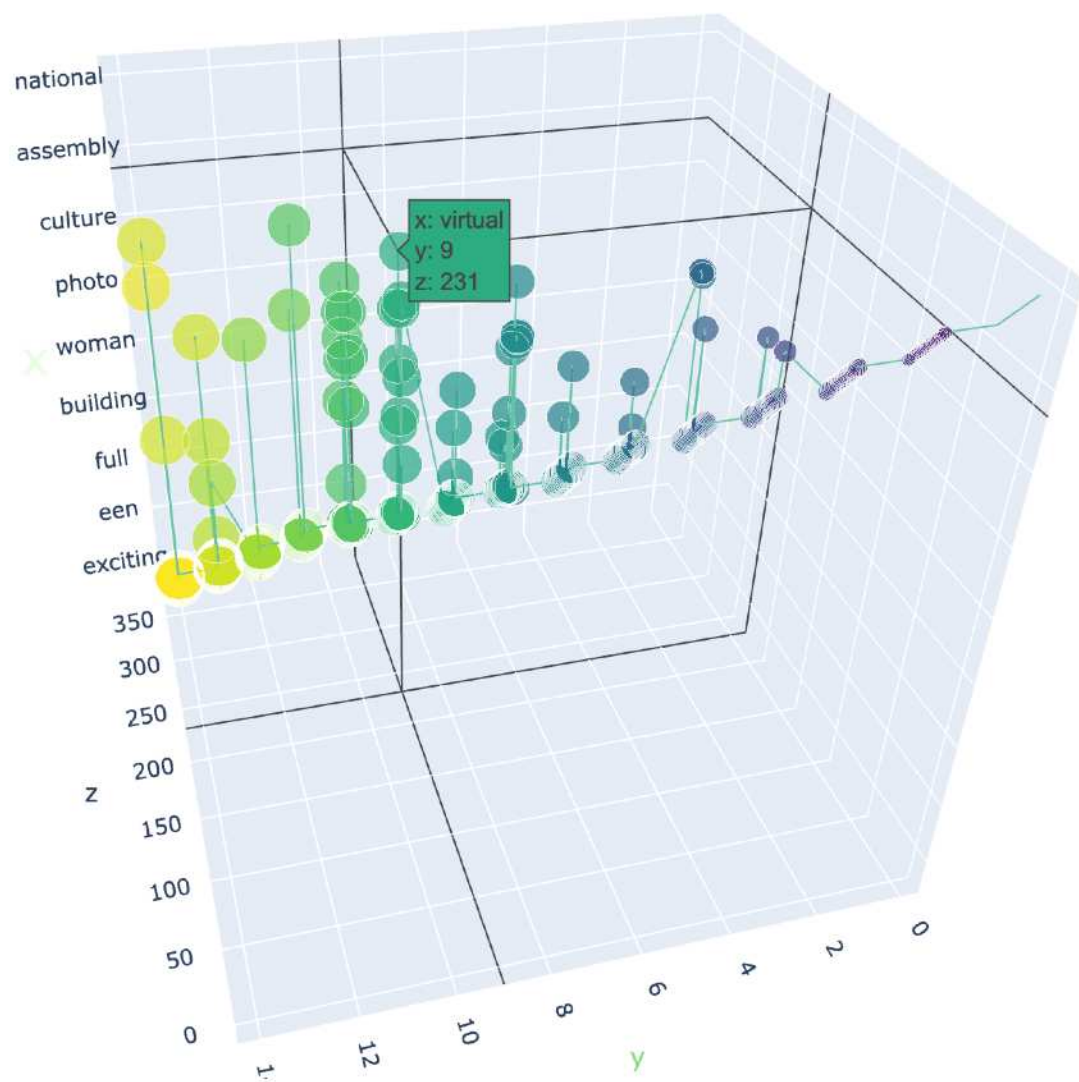


Fig 19. Jupiter Python Notebook - PyLDavis Statistical presentation of topics under 3D Visualization of Multiple correspondence analysis

