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Sueños de Extremadura: A Digitally Enhanced Immersive Experience

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Abstract

This thesis explores how artificial intelligence, and immersive technologies can be used to preserve and activate cultural heritage using textual archives. The project centers on *Bibliografía Extremeña* by Manuel Pecellín Lancharro, a literary catalog documenting the intellectual production of the Extremadura region from 1990s to 2023 and reimagines it as a digitally enhanced immersive experience. The research addresses a central question: how can a text-based archive be transformed into an interactive environment that fosters cultural reflection/exploration and user participation? Using a research-creation approach, the project combines theoretical analysis with practical implementation. It draws from literature on immersive experiences, presence, narrative design, and generative AI, culminating in the design of a proposal for an interactive installation titled *Sueños de Extremadura*. A key contribution of the project is the development of Cplex-AI, an agentic AI system responsible for structuring, enriching, and interpreting the data. In the proposed installation, four conceptual installations are designed, signaling the different degrees of continuation and separation that the used technologies afford in relation with the original, textual source of the project. Each of them, titled respectively *Realidad*, *Ensueño*, *Fantasía* and *Infancia*, were created to emphasize different aspects of Extremadura's cultural identity, including literature, landscape, and memory. The result is a fully text-driven immersive experience that demonstrates how archives can be brought to life through technology. This thesis offers a replicable model for cultural institutions seeking to engage contemporary audiences with historical content.

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1. Introduction

The digital era has given rise to an abundance of archives and collections that preserve the rich cultural and national narratives of the world. Artificial intelligence (AI) and immersive technologies (IT) provide unprecedented opportunities to explore these archives in unique and engaging ways. By merging cultural artifacts and heritage into captivating immersive experiences, these technologies allow us to experience data in transformative and meaningful forms. These approaches help to preserve culture in unique ways and revive old knowledge, experiences, and traditions, making them accessible to a wide range of audiences. Moreover, they contribute significantly to education and knowledge sharing, fostering connections and understanding across diverse communities and stakeholders.

The purpose of this research is to investigate how AI and immersive technologies can be used to preserve, explore, and promote cultural heritage using textual archives. Textual records, including manuscripts, letters, documents and archives, have long served as a primary means by which societies record their values, beliefs, and historical events. Over centuries, this practice has produced a vast and diverse body of archival material. This thesis recognizes these textual archives as historical artifacts and vital carriers of collective memory, essential for preserving and sharing the stories, knowledge, and traditions of the past.

This thesis will use *Bibliografía extremeña*, a comprehensive literary catalog curated by Manuel Pecellín Lancharro from 1990s to 2023, as an example of a textual archive that is translated into other media thanks to the application of several technologies. This archive documents the literary output of Extremadura, offering valuable insights into the intellectual and cultural interests of the region during the covered period. Serving as more than just a repository, *Bibliografía extremeña*

stands as a living record of the cultural narratives and historical contexts that have shaped Extremadura's identity over the last 30 years, a period in which the economic and political realities of Extremadura changed deeply due to events such as Spain's transition to democracy in 1978, the reorganization of the state into a system of autonomous regions that required Extremadura's intellectuals to define the region as a distinct entity, and Spain's integration into the European Union in 1986. Although the collection begins in the 1990s, more than a decade after these transformations started, Pecellín's effort can be understood as a response to the ongoing need to account for Extremadura as a newly recognized cultural and political community and to contribute to the development of its cultural identity within this new reality. The digitalized version of the catalog can bee found here https://bibextre.com.

Various technologies, such as virtual reality (VR), augmented reality (AR), mixed reality (MR), artificial intelligence (AI), and others, have the potential to transform textual collections like *Bibliografía extremeña* into interactive and immersive experiences. By bringing to life the social and historical contexts behind the works, these immersive technologies provide innovative ways for audiences, younger and technologically driven, to engage with and deeply appreciate Extremadura's literary and cultural heritage.

This investigation will focus on addressing the following questions:

- What are the essential components required to develop immersive experiences based on textual archives?
- What methodologies and technologies are available for transforming textual archives and their contexts into captivating, interactive environments?

- How can a text-based archive like *Bibliografía extremeña* be transformed into an interactive environment that fosters cultural reflection/exploration and user participation?

This project aims to bridge cultural preservation and digital innovation, ensuring that textual archives remain dynamic and accessible in the digital age. By leveraging advanced technologies, it seeks to transform textual collections into engaging, interactive experiences that resonate with modern audiences. As a case study, this project highlights *Bibliografía extremeña*, a rich textual archive that embodies part the literary heritage of Extremadura, showcasing its relevance and adaptability in the digital era.

This thesis will employ a research creation approach[1], integrating theoretical inquiry with practical implementation. By combining academic research with creative methodologies, the project aims to explore innovative ways to transform the *Bibliografía extremeña* collection into an immersive experience. This approach will facilitate the examination of the cultural and historical contexts surrounding the literary works while allowing for experimentation with immersive technologies. Ultimately, the research creation framework will enable the development of a dynamic platform that enhances audience engagement and fosters a richer understanding of Extremadura's literary heritage.

The author of this document acknowledges the use of AI as a tool to support its writing. While the research, analysis, and ideas presented are entirely the author's own, AI was employed to

[1] An approach to research that combines creative and academic research practices and supports the development of knowledge and innovation through artistic expression, scholarly investigation, and experimentation. The creation process is situated within the research activity and produces critically informed work in a variety of media (art forms). Research-creation cannot be limited to the interpretation or analysis of a creator's work, conventional works of technological development, or work that focuses on the creation of curricula (Chapman, 2012).

assist with grammar and language refinement. Visit appendix Example of AI-Assisted Writing for an example of AI assisted writing.

2. Literature Review and Theoretical Framework

This section reviews key literature on the potential of immersive experiences, with a particular focus on their role in cultural preservation and interactive learning environments. It also examines several case studies centered on cultural heritage, including notable works by artist Refik Anadol, highlighting both the strengths and limitations of such approaches in the context of heritage preservation. In addition, the section provides an overview of foundational concepts in artificial intelligence, leading up to the emergence of one of today's most transformative technologies (agentic AI) and explores how it can be harnessed to design digitally enhanced immersive experiences.

2.1. Immersive Experiences

Since Ivan Sutherland developed the first head-mounted display in 1968, numerous efforts have been made to enhance human perception through technology (Kumawat et al., 2020). Advances in immersive technologies have since given rise to a new form of storytelling and idea exchange, now widely known as immersive experiences (IE). For this work, it is crucial to have a clear definition of what constitutes an IE. Understanding this concept is essential for analyzing how various immersive technologies impact user engagement and interaction.

Han et al. (2023) defines immersive experiences as "the acceptance of one's engagement in the present moment, facilitated by multiple sensory inputs. This creates a seamless and continuous physical, mental, and/or emotional interaction with the current experience, which can leave a lasting mental and emotional impact on the user after the experience has ended". Han also argues that "immersive experiences are dependent on user engagement on a physical, mental, and

emotional level. It is plausible that the concept needs to be defined from a user perspective, rather than from a designer's perspective and intention. In this light, openness of users to engage in the immersive experience is considered a pre-requirement." In this definition, Han aims to highlight the multifaceted nature of immersive experiences, emphasizing that they are not merely about technological sophistication but also about the user's active engagement.

An immersive experience can also be understood as the extent to which a virtual environment fully engages the user's perceptual system, creating reactive psychological feedback that the user perceives and experiences during interaction. This feedback loop fosters a sense of involvement, absorption, and deep engagement with the stimuli provided by the virtual environment (Zhang, 2020). Zhang (2020) further supports the notion that immersive experiences represent the next evolution of storytelling. Zhang also posits that advances in digital storytelling and immersive technologies underscore the importance of the immersion factor as an indispensable aspect of user interaction with virtual environments.

Ruscella & Obeid (2021) asserted that a truly immersive experience not only stimulates various senses but also engages the user in such a profound manner that it diminishes or disconnects their awareness of the real world. They further elaborated on this by defining a successful immersive experience as "one that transcends a highly immersive one and encompasses the benefits of immersion, presence, and other qualities." This suggests that an effective immersive experience goes beyond mere sensory engagement to create a deep sense of presence, where the user feels as though they are within the virtual environment.

The concepts of immersion and presence are critical to understanding and evaluating immersive experiences. Immersion refers to the extent to which a user is absorbed by the virtual

environment, while presence is the feeling of being in that environment despite knowing it is artificial. These concepts are interrelated but distinct, and they play a crucial role in the effectiveness of immersive experiences. In the next section, a deeper exploration of these topics will be provided, examining the various dimensions and factors that contribute to successful immersive experiences.

Those definitions of immersive experiences examine the concept from different perspectives. The first perspective is the user side. The user of immersive experience must be fully conscious and open to experiencing all the sensory inputs. To achieve a state of immersion, the user needs to be willing to engage with the environment thoroughly. The second perspective is from the system side. A common definition of immersive experience is a virtual environment that engulfs the user's perception through a collection of stimuli directed at their perceptual system (vision, audition, tactile, temperature, smells). From this viewpoint, the system is entirely responsible for the level of immersion and the resulting experience of the user. The latter perspective, which will be utilized in this work, is a combination or balance version of the previous two, where both the user and the system share the responsibility for the success of the immersive experience.

An important aspect implicit in these definitions is the reliance on technology to achieve immersion. However, as we will explore in the next section, immersion can occur even without sensory stimuli, technology-mediated interaction, or virtual environments. This suggests that the concept of immersive experience is broader than commonly assumed in the reviewed literature. In this thesis, we will engage with those same foundational concepts, but within a more specific framework: digitally enhanced immersive experiences.

Given this, our definition of a digitally enhanced immersive experience is:

A technology mediated experience that captures the user's perceptual system so thoroughly that they lose awareness of their physical time and place, becoming fully absorbed in the virtual environment. In such experiences, the user's sensory inputs are so effectively stimulated and synchronized that the boundary between the real and virtual worlds becomes indistinguishable. This level of engagement creates a sense of presence where the virtual world feels as real as the physical one. The effectiveness of an immersive experience relies heavily on the seamless integration of sensory modalities, including visual, auditory, and sometimes haptic feedback. When these elements are harmoniously combined, they can induce a state of flow, where users are completely focused on and immersed in the experience.

2.2. Immersion and presence in a digital experience

The term “immersion” has been the focus of many researchers for some years. Definitions of immersion vary, with some centered around the system that offers the experience and its ability to absorb the user's attention, others around the stimulation of the user’s sensory system through different channels, and some treating it as a psychological state of the user. All these definitions share the common theme of the relationship between immersion and the user. Murray (2017) said that “immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all our attention, our whole perceptual apparatus”. Murray suggested that immersion is not solely the result of intense sensory stimulation. Instead, she argued that an engaging narrative can create immersive experiences even with minimal sensory input, as demonstrated by the captivating power of books

or some meditation practices. This perspective highlights that immersion can be achieved through mental and emotional engagement, not just through overwhelming sensory experiences. Therefore, the richness of the narrative and the ability to draw the user into the story can be just as effective in creating immersive experience as the most advanced technological systems.

In the context of technology digitally enhanced immersive experiences, immersion has frequently been associated with the video games industry (Haggis-Burridge, 2020; Popoli & Derda, 2021). Murray, (2017) also refers to immersion as the pleasurable experience of being transported to an elaborately simulated place, where the sensation of being surrounded by an entirely different reality takes over all our attention and engages our entire perceptual system. These ideas align well, as the primary aim of a video game is to transport the user into a simulated reality; one filled with interactions, narratives, and stimuli that encourage disconnection from the physical world and focus the user's attention on specific tasks designed to achieve a particular goal, such as learning, entertainment, meditation, or artistic expression. But what about digitally enhanced immersive experiences that don't follow the structure of a video game or incorporate gamification elements? How can we define immersion in a digital experience that does not aim to transport the user into a virtual environment, but instead manifests itself within the physical world?

To address these questions, we must first clarify the distinction between an *environment* and a *virtual environment*. In this context, an *environment* refers to the space in which an experience unfolds. This space can be physical, digital, or a combination of both. When the environment is entirely digital and detached from the physical world (as much as it can be), we refer to it as a *virtual environment*. Immersive digital experiences can occur in either type of environment (fully virtual or blended with the physical world). When an immersive experience involves technology

that alters the physical world (such as in Augmented or Mixed Reality) it becomes necessary to distinguish between the *actual* physical world and its *technologically modified* version.

Authors like Ruscella & Obeid (2021) said from immersion that it "is the objective degree of projecting stimuli onto the sensory receptors of a user" and supports the idea that an immersive experience should consistently stimulate the perceptual system of the user surrounding it with high quality audio-visual signals; the environment should be interactable and consistent with the story or plot. West et al. (2013) also expressed that immersion is not limited to vision alone. To achieve true immersion, the experience should be designed to engage the full body, incorporating locomotion capabilities and gestures. This holistic approach ensures that users can interact with the environment in a natural and intuitive manner, enhancing the sense of presence and making the experience more immersive and engaging.

Agrawal et al. (2019) defined immersion as a phenomenon characterized by a deep mental state in which the user may experience dissociation from the awareness of the physical world, with or without sensory stimulation. This state of immersion can occur when an individual's cognitive processes become so intensely focused on a particular experience or activity that they lose track of their physical surroundings. This definition contradicts the previous two from Ruscella & Obeid and West. It assumes that the responsibility of getting immersed is only for the user and is independent of if the user's perceptual system was stimulated or not. A good example of this could be daydreaming. When someone daydreams, they become so engrossed in their thoughts and imagination that they temporarily disconnect from the external environment. During this time, their mind creates vivid scenarios and narratives that feel real, despite the absence of any sensory input from the actual world around them. This expanded definition underscores that

immersion is not solely dependent on advanced technologies or sensory stimulation. It is fundamentally about cognitive engagement and mental absorption that draw the user's attention away from their immediate physical environment and into a different realm of experience, whether real or imagined.

It is important to distinguish between the terms immersion and presence, as they are often used interchangeably in different studies like (Zhang et al., 2017). Both terms are related to immersive experiences and the users, but they have distinct meanings. Immersion typically refers to the objective quality of the virtual environment and how it engages the user's senses, while presence refers to the subjective experience of being in that environment. Agrawal et al. (2019) utilizes a good example to mark the differences between immersion and presence: “one can be immersed when listening to electronic music but may not feel present due to a lack of spatial cues in the content, limited spatial fidelity of the reproduction system”. In this context, immersion refers to deep mental engagement and absorption in the music, where the listener is fully focused and emotionally involved. However, presence, which involves the feeling of being physically situated within the environment of the experience, is lacking. This is why definitions of immersion from authors like Agrawal et al. (2019) and Ruscella & Obeid (2021) agree that presence refers to the sense of being in an environment beyond the immediate physical surroundings. It involves the feeling of residing in a simulated environment with the illusion of being transported to a different place or time than where the user actually is.

2.3. Components and design principles of an immersive experience

Designing an immersive experience is a complex endeavor, particularly with the ongoing advancements in immersive technologies which expand the possibilities for interaction within these environments. Additionally, incorporating a storytelling component into these experiences can also be quite challenging. This element requires careful integration of narrative techniques with interactive technology to create a cohesive and engaging user experience. To achieve immersion and presence in immersive experiences, there are several key components that need to be carefully balanced. According to various studies (Hameed et al., 2019; Han et al., 2023; Ruscella & Obeid, 2021), successfully integrating these components is crucial for delivering a high-quality immersive experience and ensuring good Quality of Experience (QoE). These components often include interactive design, narrative integration, sensory engagement, and several others. Each plays a vital role in how users perceive and interact with the virtual environment, impacting their overall satisfaction and engagement levels. In this section, we will conduct a thorough exploration of these components, drawing on insights from the previously mentioned studies.

- Technology-mediated interactions: Technology-mediated interactions significantly enhance immersive experiences by leveraging various hardware, software, techniques, and technologies to transform them into interactive environments. The level of user interaction can vary significantly within these experiences. When users lack the capability to interact with the environment, they remain mere observers, resulting in a more passive experience. An example of this can be seeing a movie or listening to an

audio book, both passive actions. The next level of interactivity in immersive experiences involves giving users the ability to respond to questions or adjust parameters in real-time. For example, users might interact with a character within an immersive environment or modify elements of the landscape or scenario. Typically, these types of interactions are straightforward and designed to enhance user engagement without significantly altering the overarching narrative or outcome of the experience. If the user is provided with a body inside of the immersive experience he reaches the next level, embodiment. Challenging users to solve tasks within an immersive experience can transform it into a problem-solving environment. Similar to many video games, assigning objectives within the immersive environment can significantly deepen user immersion (Tanskanen, 2018). Moreover, allowing users to cooperate and communicate with others within the experience elevates its realism. When users interact not just with algorithms and virtual agents but also collaborate with other human beings, the experience becomes more engaging and authentic. This level of human interaction has been shown to enhance the overall user experience in virtual environments, fostering a sense of community and shared purpose that enriches the immersive quality (Daggubati, n.d.).

- Storytelling: is a critical component that has been proven to enhance the feeling of immersion within immersive experiences. According to Tanskanen (2018), storytelling is an integral element of every immersive experience. Tanskanen further categorizes storytelling within IEs into two distinct types, each serving unique functions and contributing differently to the depth and engagement of the experience. The first type of storytelling identified by Tanskanen is a scripted story or plot-based story. This approach

involves a prearranged narrative where elements such as place, time, events, characters, and scenes are meticulously planned and tailored to convey a specific message or idea. In the most basic IEs, only a few of these elements are predetermined, and the narrative is constructed around them. A more advanced level of this type incorporates user interactivity, where participants have the ability to make decisions that can alter aspects of the plot. This interaction increases the depth of engagement by allowing users some control over the narrative's direction. The most dynamic form of a scripted story is a fully interactive narrative, where users not only make choices but also have the capacity to create their own storylines. In this scenario, user decisions have a significant impact, shaping the events and ultimately influencing the outcome of the immersive experience. The second category identified by Tanskanen is emergent storytelling, also known as player-driven storytelling. This form of storytelling is closely tied to how users interact with the immersive experience (IE), resulting in each user having a unique and personalized emergent story. Unlike scripted storytelling, which is optional and can be pre-designed, emergent storytelling is an inherent feature of all immersive experiences. It arises naturally as users explore and interact within the environment, making choices and taking actions that lead to personalized narratives.

- Embodiment: refers to a state wherein a user within an IE perceives themselves as an integral part of that environment. It involves the user recognizing themselves and their actions as seamlessly connected to the virtual world around them. A user may feel detached from an IE if they lack physical representation within the environment, such as a body or avatar, effectively transforming them into mere observers. This detachment is

commonly observed in traditional media such as movies and books where the user does not actively participate in the environment. The introduction of first-person interactions, avatars, and movement capabilities within an IE represents a more advanced level of embodiment. In this scenario, users can control a virtual body, which helps bridge the gap between mere observation and active participation, enhancing the immersive quality of the experience. The highest level of embodiment is achieved with immersive technologies, such as VR, AR, and MX. These technologies enable users to interact within IE using their physical bodies. This direct physical engagement allows for a seamless integration of real-world actions into the virtual environment, making immersion much more profound and engaging.

All the previously mentioned elements are closely related, and while each component can enhance an immersive experience (IE), they are essentially optional. Striving to achieve the maximum level in all these components does not necessarily guarantee a successful or enjoyable experience. As Hassenzahl (2013) suggests, it is not the technology, design, or interface itself that defines success, but the experience created through them. A meaningful experience emerges from the integration of perception, action, and emotion, fulfilling psychological needs such as relatedness, stimulation, or autonomy.

Therefore, there is a critical need for balance and intentionality among all these elements. Properly integrating storytelling, embodiment, and user interaction without overwhelming any single aspect is key to creating a cohesive and compelling immersive experience. The goal is to harmonize these components to support the overarching purpose and ensure the experience remains engaging, emotionally resonant, and accessible.

By combining the previous components, the ideas of Hassenzahl (2013) and the 5 best practices recommended by the MoMoLab studio (*MoMoLab's 5 Best Practices in Interactive Experience Design*, 2023) we can extract a few design principles in the context of a digitally enhanced immersive experiences based on literary catalogs like "*Bibliografía Extremeña*":

- Storytelling and Narrative Design: A strong narrative thread is essential when translating literary works into spatial experiences. Exhibits should be framed around compelling stories or themes that connect the pieces of a literary collection.
- Spatial, Interactive, and Multi-sensory Engagement: An immersive exhibit can employ visual, auditory, and tactile elements to make literature tangible. Key design principles include presenting literary content in interactive and multi-sensory formats so that visitors of all ages and backgrounds can connect with it. A generative artificial intelligence system could be helpful in this transformation.
- Authenticity and Contextualization: To honor literary heritage, immersive designs must balance creativity with authenticity. Preserving the original voice and context of literary works is paramount even as they are adapted for new mediums.
- User Participation and Co-Creation: Interactive literary installations are most memorable when they invite visitors to actively participate. Rather than a one-way presentation, co-creative elements let the public become part of the storytelling process.
- Inclusivity and Accessibility: Ensuring accessibility is both an ethical responsibility and a design requirement.
- Sustainability and Maintainability: Because the goal is to preserve literary heritage, the longevity of both the exhibit content and the interactive systems must be considered. Robust, maintainable design is a key principle for any interactive museum installation.

2.4. Opportunities for Immersive Experiences in Cultural Heritage Preservation

Nilson & Thorell (2018) defined cultural heritage as the “contemporary society’s use of the past” and based his research on the idea that the cultural heritage shapes regions identities and is a reflection of the past. Khakzad (2015) also refers to cultural heritages as “that part of the past which we select in the present for contemporary purposes, be they economic, cultural, political, or social”. Cultural heritage includes traditions or living expressions inherited from our ancestors and passed on to our descendants (Heritage & U. I. C, 2019). Cultural heritage encompasses both the tangible and intangible elements of a culture that hold significance for a society or community. Initially focused on physical artifacts and monuments, the concept has expanded to include traditions, practices, knowledge, and expressions that form a culture's identity (Vecco, 2010). Tangible cultural heritage involves physical objects such as buildings, art, and historical artifacts that reflect a society's history and values. Intangible cultural heritage, meanwhile, covers non-material aspects like customs, languages, performing arts, and traditional knowledge, all of which are passed down through generations and contribute to the unique cultural identity of a community (Heritage & U. I. C, 2019; Pistola et al., 2021).

The opportunities that emerging technologies like VR, AR or MR present for interacting with both tangible and intangible cultural heritage are vast and transformative. Unlike conventional approaches, these technologies facilitate multisensory engagement, incorporating haptic devices, spatial audio, and mixed reality to merge tactile responses with digital content. For example, VR gloves allow users to "feel" the texture of ancient artifacts, while spatial audio in AR can recreate the soundscape of a historical setting, enhancing immersion (Kailas & Tiwari, 2021). They also

enable real-time exploration, making it possible to recreate ancient sites that no longer exist or conduct interactive archaeological explorations. Users can walk through a digital reconstruction of a lost civilization, observe how structures evolved over time, or even simulate excavations, uncovering artifacts layer by layer (Wang et al., 2024). Moreover, these technologies support personalized experiences, such as adaptive storytelling, where narratives change dynamically based on user interactions, making each experience unique. This could include AI-driven historical simulations that modify dialogue and events based on user choices or immersive experiences that adjust to the user's mood through biometric feedback, creating a more responsive and engaging cultural encounter.

A notable example of immersive technologies applied to cultural heritage preservation is the work of Refik Anadol and his studio, Refik Anadol Studio (RAS). Anadol's projects exemplify the transformative potential of AI-driven art and immersive environments in reinterpreting and safeguarding cultural memory. By harnessing vast datasets and cutting-edge machine learning models, Anadol’s work transcends static representations of cultural artifacts, transforming them into dynamic, evolving installations that engage audiences on sensory and emotional levels (Anadol & Kivrak, 2023).

Anadol’s Machine Hallucinations series is a prime example of how immersive technologies can visualize “collective memory” and urban history. In Machine Hallucination: NYC, Anadol processed over 100 million images of New York City, using generative adversarial networks (GANs) to create fluid, abstract representations of the city’s architectural and cultural evolution (Anadol & Kivrak, 2023). This immersive audiovisual installation reflects the city’s “collective memory”, offering visitors a sense of emotional connection to the space while also preserving its identity through digital art. Originating from the work of Halbwachs (2020), collective memory

has been conceptualized as both a body of knowledge that informs cultural identity and a process of continual negotiation and reinterpretation of the past. Unlike history, which aims for objective documentation, collective memory is shaped by identity formation and often resists revision even in the face of new evidence. It is maintained and transmitted through cultural tools such as narratives, rituals, monuments, and digital media, making it a dynamic, evolving representation of shared past experiences that influence both individual and collective identities. In contemporary contexts, immersive technologies and artificial intelligence offer new ways to document and visualize collective memory, as seen in projects like Anadol's, which use machine learning to analyze vast datasets of historical and cultural imagery.

Similarly, Anadol's *Unsupervised*, based on data from the Museum of Modern Art (MoMA) in New York, exemplifies an innovative approach to cultural preservation by harnessing AI to reinterpret and revitalize historical archives. Using machine learning models trained on thousands of artworks from MoMA's collection, Anadol generates dynamic visualizations that evolve in real-time, transforming cultural artifacts into fluid, immersive experiences. This method preserves artistic heritage and at the same time recontextualizes it, allowing audiences to engage with the past through continuously shifting digital lens.

Anadol applies machine learning techniques, particularly generative adversarial networks (GANs), to train models on the Museum of Modern Art's (MoMA) collection, engaging with the concept of machine hallucinations as a form of computational creativity. By processing this extensive archive, the AI generates new visual compositions that reinterpret historical artworks through a variety of stylistic filters. These outputs retain recognizable patterns and aesthetic features from the original pieces, yet present them as fluid, continuously evolving animations. In

doing so, Anadol transforms the passive nature of the archive into a dynamic, living system, offering a novel mode of cultural preservation and reinterpretation through artificial intelligence.

In the context of literary and historical preservation, this research draws inspiration from Anadol's approach to transforming large datasets into immersive experiences. Just as Anadol's work with MoMA's collection reimagines art through machine intelligence, this project aims to visualize a part of the literary heritage of Extremadura by leveraging AI and immersive technologies. The archive "*Bibliografía extremeña*", which documents the region's literary output from 1990s to 2023, serves as the foundation for this initiative. By processing the bibliographic data through machine learning models, this project seeks to create an evolving visualization of Extremadura's literary landscape, offering users an immersive journey through the cultural development of the region.

2.5. Limitations of immersive Experiences in Cultural Heritage Preservation

While immersive technologies offer exciting opportunities for reimagining the preservation and presentation of cultural heritage, they also introduce several critical limitations that must be considered. These limitations transcend the technical, conceptual, ethical, and social aspects and they shape how these tools can be responsibly and effectively integrated into heritage work.

One of the most immediate challenges is technological access. High-quality immersive experiences often rely on expensive equipment such as VR headsets, spatial audio systems, motion sensors, or haptic feedback devices. This creates a barrier for many museums, cultural institutions, or community organizations that lack the funding or infrastructure to adopt such

tools. Moreover, the pace at which these technologies evolve presents a problem for sustainability: what is innovative today may become obsolete in just a few years, making long-term maintenance and preservation difficult. In contrast to traditional artifacts, immersive experiences tend to age quickly, both in terms of hardware and software compatibility.

Another concern relates to the authenticity and interpretive nature of immersive reconstructions. While these experiences can feel realistic, they are often stylized or curated versions of the past, shaped by the perspectives and biases of their creators. This can lead to oversimplification, distortion, or even romanticization of historical realities. The immersive nature of these technologies can paradoxically give users a false sense of historical accuracy, what feels "real" may not necessarily be true. In this sense, immersive reconstructions must be approached critically, as interpretive narratives rather than definitive representations of the past.

There is also an ethical dimension to consider. Transforming heritage into a digital experience risk turning complex histories and identities into entertainment products. Particularly when dealing with sensitive or traumatic pasts, such as colonization, displacement, or conflict, immersive formats may unintentionally trivialize or commodify cultural memory. These concerns are amplified when the communities whose heritage is being digitized have little or no control over how it is represented or who profits from it. The use of AI-generated content further complicates this issue, as training data can reinforce dominant cultural narratives while excluding marginalized or non-Western knowledge systems.

Finally, from a cognitive and emotional perspective, immersive technologies can be overwhelming. The multisensory design that makes these experiences compelling can also lead to overstimulation, especially when layered with sound, visuals, interaction, and narrative

choices. In some cases, this complexity can dilute the educational message or historical narrative, replacing deep engagement with spectacle. While adaptivity and personalization are often praised features, they can fragment storytelling to the point where users come away with a shallow or disjointed understanding of the heritage being presented.

Let's use Refik Anadol's *Unsupervised* installation at the Museum of Modern Art (MoMA) as an example for the previous arguments. The installation is deeply reliant on advanced technologies, from high-performance GPUs to large-scale projection environments, limiting its accessibility and reproducibility beyond elite institutions. Additionally, although the AI generates novel compositions from existing data, it does so through a process that abstracts and aestheticizes historical works, potentially detaching them from their original social, political, or cultural contexts. The immersive spectacle may captivate audiences, but it also risks reducing complex artistic narratives to fluid patterns of motion and color. Moreover, the creative agency is largely shifted to the algorithm and the artist's curatorial choices, raising questions about authorship, representation, and interpretation. Who decides what aspects of the archive are emphasized? Which work is foregrounded or omitted? In these ways, *Unsupervised* exemplifies both the transformative and problematic nature of immersive AI-driven heritage projects, offering innovation, but also demanding critical reflection.

Should we consider this kind of project as a representation of the entire collection it draws from, or as a completely new artwork that exists independently of the original context and the social dilemmas surrounding the pieces it reinterprets? Is this truly an act of cultural heritage preservation, or is it a transformation that moves away from preservation altogether? From my perspective, this represents a new form of art. It is inspired by the past but rooted in the methods and aesthetics of the digital age. Rather than preserving history in a fixed form, it reimagines it

through tools like artificial intelligence. Just like the technologies it relies on, this approach will eventually become outdated. In the future, someone might take today's immersive experience and reinterpret it again, creating something entirely new from what we now consider innovative.

Considering these limitations, it is essential to approach immersive experiences not as replacements for traditional heritage practices, but as complementary tools. Their power lies not just in their ability to simulate or visualize the past, but in how they invite critical reflection on what it means to preserve and engage with cultural memory in the digital age.

2.6. Generative Artificial Intelligence

According to Russell et al (2020) Artificial intelligence (AI) is a vast field of study that seeks to replicate or simulate the human capacity to reason, make decisions, solve problems, and perform complex cognitive tasks. Anantrasirichai & Bull (2022) said that AI techniques enabled machines to perform tasks that typically require some degree of human-like intelligence, making some process easier, more accurate, faster, and cheaper. There are several types (or classes) of artificial intelligence, though nowadays one of the most used are a family of algorithms called machine learning: “Machine learning (ML) is the science (and art) of programming computers so they can learn from data” (Géron, 2019), this algorithms employs computational methods to ‘learn’ information directly from large amounts of example data without relying on a predetermined equation or model (Anantrasirichai & Bull, 2022). But the class of AI that is really the engine of generative AI is the neural networks, especially the deep neural networks, a subset inside machine learning models inspired by the networks of biological neurons found in our brains (Géron, 2019), the word deep means that there are several layers of artificial neurons inside of the model known as hidden layers. All these perspectives agree that the ultimate goal of

artificial intelligence is to mimic human intelligence. Initially, AI relied on statistical and mathematical approaches, but more recent developments have focused on replicating the structure of the human brain. These artificial "brains" are small in comparison to real human brains and, in reality, are not very similar in their composition. Rather, they emulate the structure and interconnected model of our brain neurons, making them incredibly powerful and capable of creating things never seen before.

Now let’s explore the generative part of the title of this section. Generative AI refers to a subset of artificial intelligence that focuses on creating new content. Unlike traditional AI, which primarily analyzes and interprets existing data, generative AI produces outputs by learning from vast amounts of training data. Generative AI leverage on deep learning techniques to learn underlaying patterns and structures inside the training data, this enables them to generate coherent and relevant new content (Cavalhero et al., 2024).

Generative Artificial Intelligence (GAI) has demonstrated significant potential to transform a wide array of fields in recent years. Notably, advancements in machine learning and deep learning have yielded promising results across various sectors, ranging from science to industry (Guo et al., 2022). This transformative power is evident in the automation of repetitive tasks, which enhances efficiency and reduces human error. Moreover, generative AI supports human creativity and innovation by facilitating the development of novel products and inspiring new ideas. This dual capability of generative AI to automate and augment human effort underscores its pivotal role in driving progress and fostering innovation across multiple domains.

Even though GAI is capable of synthesizing a substantial amount of content in short periods of time, its capabilities are closely tied to the quality and quantity of data used during training, as

well as the architecture of the entire system. Chatterjee (2022) argued about this that “the limits to AI are availability of data and of computational power”. Generative AI learns from training data in a manner that enables it to create new content incorporating distinct elements from this original input without replicating it exactly. However, Chatterjee (2022) highlights a significant risk associated with this method: the potential to perpetuate or reproduce existing race and gender stereotypes. This underscores the importance of addressing biases in training data to ensure that GAI technologies are developed and deployed in a responsible and equitable manner. Another limiting factor of GAI highlighted by Chatterjee is the substantial computational power required. Sastry et al (2024) note that "the relationship between AI performance and model size, data, and training compute has tended to follow a power law." This means that as the complexity of the model increases, the computational resources required grow exponentially. Furthermore, Sastry emphasizes that this computing power is not only necessary for training but also for deploying and operating the system, making the overall process very expensive.

Generative artificial intelligence remains an emerging and evolving area of research, marked by ongoing experimentation and rapid advancements. At the same time, new uses and applications are continuously emerging, expanding its potential across various fields. The integration of generative AI with immersive technologies has the potential to change how immersive experiences are created and consumed. The real-time capabilities of many AI models offer a significant opportunity for integration within the immersive experience building pipeline.

Another significant application of generative AI is in the creation and innovation process. Some authors argue that creativity is inherently a human trait (Anantrasirichai & Bull, 2022), and generative models, due to their reliance on previous data and user input, are not truly "creating" new ideas but rather generating content based on existing information. Despite this, artists are

increasingly using generative AI to explore new ideas and concepts. By leveraging these tools, they can significantly increase their output of creative artifacts (by up to 50%) and receive more favorable feedback (Zhou & Lee, 2024). This approach allows artists to experiment more freely and push the boundaries of their creative practices, ultimately enhancing the overall quality and diversity of their work. Furthermore, Zhou & Lee also argue that the content produced by AI can indeed be considered creative in certain contexts. This perspective challenges traditional notions of creativity and suggests that generative AI can contribute uniquely inventive and valuable outputs that enrich the fields in which they are employed.

The launch of ChatGPT by OpenAI in 2022 brought generative AI into the global spotlight, but this was just the beginning of a broader wave of innovation. Since then, a significant number of new models have been developed to address specific creative tasks. Examples include Microsoft's Copilot, Meta's Llama models, and Anthropic's Claude. These models are categorized as Large Language Models (LLMs) and are primarily designed to generate text. However, the scope of generative models extends beyond text generation. There are models specifically crafted for creating audio, such as Stable Audio Open, and others focused on generating images, including OpenAI's Dalle, Midjourney, and Stable Diffusion.

Some companies, like Meta, offer their models under a free license and even develop lighter versions of these models. This approach allows individuals without access to supercomputers to run the models locally and still achieve high-quality results. For instance, Stability AI provides a free solution for audio generation through Stable Audio Diffusion and a highly regarded model for image generation, Stable Diffusion, now in its third version. These developments underscore the growing accessibility and diversity of generative AI technologies, enabling a wider range of users to harness these powerful tools for various creative and practical applications.

On the other hand, there is also a vibrant community supporting these technologies. Products such as Automatic1111 and ComfyUI are developed and maintained by the open-source community. These tools further enhance the accessibility and usability of these models, enabling a massive number of creators to leverage them more effectively. Both Automatic1111 and ComfyUI serve as graphical interfaces that simplify the creation of workflows for generative AI models. For instance, ComfyUI offers a node-based interface that allows for high customization of the workflow and greater control over the final outputs. Such projects democratize the use of advanced generative models by providing user-friendly platforms that cater to both novice users and experienced creators. This community-driven approach not only fosters innovation but also ensures that these powerful tools are more widely available, encouraging a broader spectrum of creative and practical applications.

So far, we have discussed generative AI as if it were a monolithic entity, but in reality, it encompasses a variety of different models, each with distinct capabilities and applications:

- Variational Autoencoders (VAEs): These models function as generative tools that encode input data into a condensed latent space. VAEs feature two main components: an encoder that converts data into this latent format, and a decoder that reconstructs the original data from its encoded state. They are particularly effective in generating images and synthesizing data (Doersch, 2021).
- Generative Adversarial Networks (GANs): GANs feature a dual-network architecture involving a generator and a discriminator that engage in a minimax game. The generator creates synthetic data, while the discriminator evaluates whether the data is real or produced by the generator. During training the generator has no access to the real images, the only way to learn is through the discriminator. This setup allows GANs to produce

highly realistic images, videos, and various other forms of data in a short time (Creswell et al., 2018).

- Transformers: These models utilize attention mechanisms to excel at identifying long-range dependencies within sequential data. Widely used in various generative applications such as natural language processing, language translation, and image generation, transformers employ self-attention techniques to analyze and generate detailed outputs from input sequences (Lin et al., 2022).
- Diffusion Models: These models specialize in learning to reverse the process of adding noise to data, a technique rooted in principles from non-equilibrium thermodynamics. They operate by simulating a predefined Markov chain of diffusion steps, gradually learning to reconstruct the original dataset by reversing the noise addition at each iteration. This approach allows them to generate highly detailed and accurate imitations of the original data (Gumaan, 2024). Generally speaking, diffusion models tend to produce superior results, albeit over a longer period of time. To address this efficiency issue, recent advances have been made in optimizing the architecture and pipelines of the generative process. These optimizations allow for fewer steps in the data generation phase, effectively speeding up the overall process while maintaining high-quality outputs (Kodaira et al., 2023).

In this section, we have explored the concept of generative AI, its capabilities, some significant advancements made in recent years, and its current state of development. In the next section, we will delve into how generative AI can be utilized to create immersive experiences, examining the potential applications and the transformative impact it can have on this field.

2.7. Generative Artificial Intelligences in the immersive experiences

The transformative capabilities of generative artificial intelligence have also arrived at immersive experiences. According to Cavalhero et al (2024)“artificial intelligence, in the context of the metaverse[2], serves as a catalytic force for the creation and management of complex virtual environments”. The real-time generative capability of AI “allows for the personalization of user experiences, optimization of social interactions, and generation of adaptive content”. In the contexts of immersive experiences generative AI can also be used to enhance the overall experience by automating intelligent decision-making and creating customized user experiences (Lv, 2023). New generative AI technologies simplify the creation of high-fidelity simulations, allowing developers to construct complex scenarios simply through language descriptions, bypassing traditional, labor-intensive methods like detailed 3D modeling (McCormack & Grierson, 2024). Guo et al. (2022) explains that AI can be helpful in the creation of more realistic virtual worlds and provide a more intelligent interaction inside of it. It is clear that the advancement of generative AI will transform the metaverse and immersive experiences, impacting not only the designers but also the end users.

In the design process of immersive experiences, content creation is a primary task. This process can be challenging and labor-intensive, particularly when attempting to represent abstract

[2] The metaverse is a 3D virtual space where elements of reality and fiction coexist, as described by (Cavalhero et al., 2024). It can be viewed as an ecosystem of immersive experiences, forming a unified virtual space through the integration of various virtual experiences (Chamola et al., 2024).

concepts or exploring new ideas where the desired outcome is uncertain. Additionally, it is beneficial to work with early prototypes of the system during this exploratory phase. Content creation is a crucial component of designing immersive experiences, but it's not the only element essential for achieving true immersion. Storytelling plays a pivotal role as well; it shapes how users perceive and engage with the environment, making the experience compelling and memorable. Additionally, user interaction is critical, it determines the level of engagement and how intuitively users can navigate and interact within the virtual space. Of course, the social aspect of the experience also cannot be overlooked. This involves how users communicate with each other within the virtual environment and how these interactions enhance the sense of presence and community. Generative artificial intelligence greatly facilitates those aspects of design. Next, we will explore several scenarios in which generative AI can be used to create interactive immersive experiences.

Content creation is the most recognizable way of using generative AI. So far, we have talked about generating audio, images, and videos, and certainly generative AI can democratize content creation for immersive experiences (Cavalhero et al., 2024). Advance machine learning techniques like the previous described GANs, VAEs and diffusion models offers excellent opportunities for creating and enrich visual content inside a virtual environment (Chamola et al., 2024). Advancements in AI have extended even further, with models now being utilized for video creation and 3D modeling. With this capability, a wide range of applications such as visual effects, automated video production, landscape creation, 3D objects modeling, and avatar creation can be achieved and produced using AI technology. Also, AI audio production can improve the level of adaptability and realism inside an immersive experience. Generative AI can be used to generate realistic sounds of natural scenarios and arouse certain emotions in the user

by adapting in real-time to their interactions. This opens up tremendous opportunities for users, particularly those without technical expertise, to create their own custom environments, avatars, and experiences. By democratizing these complex processes, AI enables more individuals to participate in content creation, fostering creativity and innovation across various digital platforms.

The storytelling component is crucial in shaping immersive experiences, as it establishes the context for time and place, which is essential for creating a compelling narrative (Ruscella & Obeid, 2021). In this realm, AI-driven storytelling methods can significantly enhance the realism and immersion of narratives. The use of AI, particularly in character development, can transform interactions within these experiences. Chatbot capabilities, for instance, can be integrated into characters, allowing them to interact with audiences in a more natural and responsive manner. Furthermore, generative AI can be instrumental in developing the overall plot, describing scenarios, and crafting characters. This technology enables the generation of detailed and cohesive story elements that can adapt dynamically to user interactions.

Generative AI has demonstrated its effectiveness in enhancing user interactions and social dynamics within various experiences. A prime example of this is its real-time translation capabilities. Deep neural networks and Natural Language Processing (NLP) techniques have significantly advanced the field of language translation (Jawahar et al., 2021). With these technologies, communication within immersive experiences can be greatly enhanced, allowing users from different linguistic backgrounds to interact seamlessly. This application of AI not only facilitates smoother communication but also enriches the user experience by bridging language barriers, making it a powerful tool for global interaction. The real-time translation capabilities of generative AI extend even further with the integration of speech-to-text and

speech recognition features found in transformer-based models. Several studies have recognized these capabilities and have applied the transformer architecture to these tasks (Bahar et al., 2019; Bansal et al., 2017; Di Gangi et al., 2019). This enhancement allows for a more dynamic and interactive communication experience, where spoken language can be seamlessly converted into different languages in real time, fostering clearer and more effective communication across diverse user groups. In the same context, generative AI can be employed to implement accessibility features within immersive experiences. By using generative models, automatic captions, audio descriptions, and adaptive interfaces can be created, enhancing inclusivity for people with disabilities (Cavalhero et al., 2024). Sign language translation has also seen significant improvements through the use of transformer-based architecture. Generally speaking, sign language can be more challenging to learn than a new spoken language (Yin, n.d.). By employing generative AI, communication with deaf individuals can be greatly enhanced. These AI systems can accurately interpret sign language in real-time and convert it into spoken or written language, and vice versa, thus facilitating smoother interactions and breaking down communication barriers for the deaf community. Those AI-driven features make immersive environments more accessible by providing real-time assistance and adaptations that cater to a variety of sensory and mobility needs, thereby ensuring that everyone can fully engage with the content regardless of their physical limitations.

2.8. Agentic AI and immersive experiences

Generative AI and more specifically LLMs are good for some tasks that don’t require much cognition like text summarization, translation or explaining a concept. State of the art LLM models are trained in bast datasets and as a consequence have a huge knowledge base. But we

have to remember that LLM are basically Machine Learning algorithms, they are machines trained to predict the next work in a sequence, in a good number of scenarios we will have an accurate result, but sometimes the model can give us wrong information, this is known as hallucinations.

There are lots of researchers trying to reduce these hallucinations from different fronts. The recent LLM DeepSeek-R1 (DeepSeek-AI et al., 2025) presents a novel approach to training and creating a model that self-reflects in a similar way to humans before giving a final answer. Even though this approach has proven significant ability in solving complex problems and tasks its approach can be a little expensive computationally speaking. DeepSeek-R1 uses a thinking window where the model reflects about the task given and then produces a final answer. Sometimes the thinking window can be very long and as a consequence the same happens with the number of tokens generated (syllables, words or group of words). The number of tokens generated is directly connected to the number of resources wasted so this increase in tokens generated means wasting more money and energy.

There are some other techniques used for reducing hallucinations like Retrieval augmented generation (RAG) (Mohammad, 2024) or Chunked Augmented Generation (CAG) (Surulimuthu & Rao, 2024) that incorporate external sources or knowledge during generation. These approaches enabled better creativity and accuracy due to access to more diverse, current and contextual knowledge. These approaches are useful due to two main reasons, hallucinations and the limited size context windows that the different models have. This context windows is the amount on tokens we can send to the model as an input for text generation. In many cases the knowledge base is bigger than the context window and RAG and CAG help with selecting only the relevant content from the knowledge base and pass it to the model. RAG and CAG help with

generating more accurate responses based on factual data, but when it comes to tasks with a higher level of difficulty or that involve several steps, we need something different.

Agentic AI refers to AI systems capable of pursuing complex, evolving goals with minimal or no human supervision. Unlike traditional or generative AI, Agentic AI systems are autonomous, adaptive, and goal-oriented, blending decision-making, environmental awareness, and self-directed action (Acharya et al., 2025). Agentic AI has made it possible to delegate repetitive tasks that require some cognition, and the rules are not well defined or are constantly changing to these AI agents.

At the very basic level, Agentic AI are LLMs with enhanced capabilities. An AI Agent can interact with tools, retrieve relevant knowledge, and reason through multiple steps to accomplish complex tasks. For example, when a user query is submitted, the agent first interprets the intent and determines what kind of external support it needs. If the query involves factual information or current events, the agent might use a retrieval tool like RAG (Retrieval-Augmented Generation) to search for up-to-date content. In addition to RAG, the agent can access "tools" for tasks like calculations, web scraping, translating, or calling external services.

The field of Agentic AI is rapidly evolving, with new approaches and standards emerging every day. One of the most recent is the Model Context Protocol (MCP), an open standard that allows developers to create secure, two-way connections between AI agents and external data sources (*Introducing the Model Context Protocol*, n.d.). Its architecture is simple: service providers set up MCP servers that expose data, while AI applications act as MCP clients that connect to and interact with these servers. In the past, tool integration had to be handled manually by agent developers. With MCP, that responsibility shifts to the service providers, making the process

more efficient. The complexity is hidden behind the MCP protocol, allowing agents to access tools and data in a unified and seamless way.

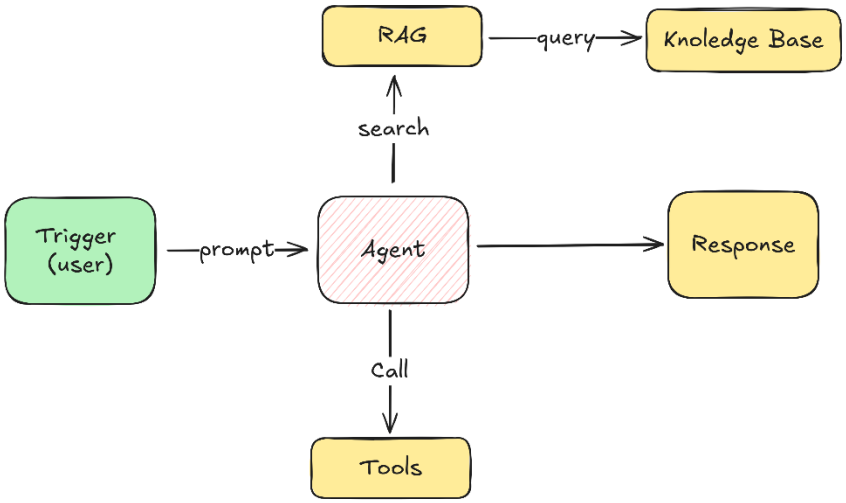

Figure 1: Agentic AI representation

The integration of tools, RAG, and MCP into the LLM ecosystem is only the beginning. A new advancement, known as Multi-Agent Collaboration (MAC), introduces the concept of specialization among agents (Chawla et al., 2024). This approach involves multiple agents working together, with each one focused on a specific task. These agents coordinate and communicate with one another to solve complex problems more effectively through collaboration.

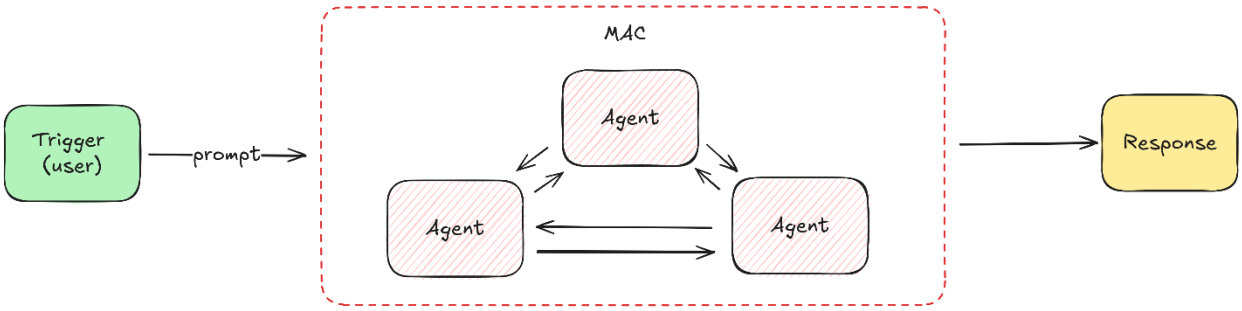

Figure 2: Multi-Agent Collaboration

In summary, the shift from basic LLMs to Agentic AI represents a move toward more capable, connected, and autonomous systems. With the integration of tools like RAG, MCP, and multi-agent collaboration, these models are better prepared to handle complex tasks and interact with real-world data. Agentic AI-powered immersive experiences may well become the new standard.

2.9. Overview of existing Immersive Installations

Immersive experiences are not a recent practice. Humanity has explored the concepts of immersion and presence since its earliest days through storytelling, religious rituals, and various forms of prehistoric art. In contrast, the use of modern tools, particularly digital technology, to enhance human perception and create immersive environments is a much more recent development. As mentioned earlier, the first notable attempt was Ivan Sutherland's creation of a head-mounted display in 1968. Since then, significant advancements have been made in various fields related to digital technologies, many of which have been applied to immersive experiences. Today, numerous projects are developed and showcased around the world by artists, creators, and studios from diverse backgrounds, each using digitally enhanced immersive technologies to preserve cultural heritage in unique and innovative ways.

In this section, we examine four emblematic contemporary installations: Refik Anadol Studio's AI-driven works, teamLab's Borderless, Dubai's Museum of the Future, and the Las Vegas Sphere. Through the lens of our conceptual framework (Immersive Experiences, Immersion and presence in a digital experience and Components and design principles of an immersive experience), each example is described succinctly and later evaluated with respect to key components of immersive experiences: sensory engagement, storytelling, embodiment, interactivity, and AI use, as well as access, authenticity, and ethical considerations.

Let's begin with Refik Anadol Studio and its two projects previously introduced in Opportunities for Immersive Experiences in Cultural Heritage Preservation: *Machine Hallucinations* & *Unsupervised*. To briefly recap, both projects use generative adversarial networks (GANs) trained on large collections of archival images. In *Machine Hallucinations: NYC*, the dataset consisted of millions of images of New York City, while in *Unsupervised*, the network was trained on the Museum of Modern Art's art collection. Using these trained networks, the studio developed abstract, continuously evolving visualizations. In Machine Hallucinations, these visuals were projected onto large architectural surfaces, while in Unsupervised, they were presented within a darkened gallery environment. The outcome offered more than just visually impressive animations. These works provided new ways of interpreting archival data, generating both transformed versions of existing material and entirely original forms inspired by the same datasets.

When we examine Refik Anadol Studio's work through the lens of our conceptual framework, certain limitations become apparent if we are to consider these installations as fully realized, digitally enhanced immersive experiences. While *Machine Hallucinations* and *Unsupervised* succeed in delivering powerful sensory immersion; they fall short in fostering true embodiment.

Audience members remain passive spectators rather than active participants; there is no meaningful body-centric interaction beyond their physical presence in the space. The storytelling is abstract and driven by data, lacking a structured or coherent narrative arc. Viewers may interpret patterns and transitions in personal ways, but the experience does not offer guided storytelling or opportunities for interactive agency. Their role is limited to observing the evolution of the algorithm's output without any ability to influence or respond to it. Access and sustainability present additional concerns. As we saw in Limitations of immersive Experiences in Cultural Heritage Preservation, these installations require high-performance computing hardware, complex projection systems, and large physical spaces, restricting them to elite institutions with the financial and technical means to support such infrastructure. Furthermore, the rapid pace of technological change introduces challenges in preserving these works for future audiences, both technically and conceptually.

teamLab is a Japanese collective made up of artists, designers, engineers, and programmers who create large-scale, interactive digital art installations. Their work blends art, technology, and nature to build immersive environments that visitors can walk through and engage with directly. These installations often fill entire rooms or buildings and are designed to feel magical, dreamlike, and alive, even though they are entirely digital. Some of their projects blur the line between the physical and digital worlds, allowing people to change the digital environment through physical actions. Architecture is also a key element in teamLab's creations, shaping how people move through and experience the artwork.

Two notable installations by teamLab are Borderless World and Future Park. Borderless World is a digital art museum where artworks move freely across walls, floors, and rooms, creating a seamless, ever-changing environment that responds to visitors' presence. Future Park is an

interactive, hands-on space designed especially for children, where drawings and actions come to life digitally, encouraging creativity, collaboration, and play through technology. For more information about teamLab's works, it is recommended to visit their official website (https://www.teamlab.art/).

teamLab's approach highlights a fundamentally different philosophy of immersion compared to artists like Refik Anadol. Rather than relying on complex AI systems to process and reinterpret vast datasets, teamLab focuses on immediate, embodied interaction and sensory richness. Their installations invite visitors to become active participants, shaping the environment through movement, touch, and play. This creates a sense of agency and presence that is more physical than conceptual. However, the lack of narrative structure and the emphasis on spectacle can sometimes result in experiences that feel more like entertainment than cultural or educational engagement. Furthermore, while the immersive environments are visually and experientially compelling, their reliance on high-end production and global branding raises questions about the balance between artistic depth and commercial appeal.

The Museum of the Future, located in Dubai and opened to the public in 2022, offers a striking journey into the year 2071. Its core concept: focusing not on the past, like most museums, but on envisioning the future, is more than just a novel idea. It reflects a bold and visionary shift in how museums can engage with audiences and rethink the role of cultural heritage in a rapidly changing world. Instead of simply preserving artifacts or telling historical narratives, the Museum of the Future challenges visitors to consider what lies ahead for humanity. Through speculative exhibitions on space exploration, climate change, artificial intelligence, biotechnology, and social development, it invites people to participate in shaping the future, rather than just learning about the past. This approach redefines the function of a museum: from

a space of memory to a platform for possibility. Importantly, this future-oriented vision does not disregard cultural heritage but reframes it. It asks how traditions, knowledge systems, and values from the past can inform and inspire future societies. In doing so, it opens a new dimension of heritage preservation, one that is dynamic, forward-looking, and deeply intertwined with innovation.

Evaluating the Museum of the Future as a digitally enhanced immersive experience might not be entirely fair, but it offers useful insights. The museum does a great job of creating structured, immersive stories through themed sections. Its use of light, sound, scent, and movement is carefully planned to support each storyline. However, this high level of control can limit the visitor's ability to explore freely or shape their own experience. Instead of inviting people to co-create meaning, the museum often places them in the role of passive observers. Interestingly, this approach feels closer to traditional museum experiences than to something truly new or experimental, despite the museum's aim to be different. While there are interactive features like AR stations and VR pods, these are mostly short, individual experiences. They are not fully woven into the larger space or narrative, which reduces the sense of active participation. The impressive large-scale sets mainly act as visual backdrops, guiding visitors along a fixed path rather than encouraging open exploration.

Accessibility also presents challenges. Although the museum attracts a global audience and has strong international appeal, its ticket prices and central, high-end location may make it less accessible to local communities, especially those with lower incomes. Ethically, the museum's goal to reimagine future heritage raises some important questions. By showing imagined futures, it risks projecting today's beliefs and power structures onto tomorrow. This can limit the diversity of perspectives presented. Corporate sponsorships and partnerships add another layer of

concern, as they may influence which stories are told and how. This raises the question of whether the futures shown are truly open and inclusive or subtly shaped by commercial and political interests (Merlin, 2023).

Finally, The Sphere, which opened in 2023 in Las Vegas, United States, stands as a monumental showcase of cutting-edge technology, designed as a next-generation venue for exhibitions and concerts. It features an ultra-high-resolution 16K × 16K wraparound screen, a 167,000-channel beamforming audio system, immersive 4D effects such as wind, haptics, and scent, along with fully programmable dome projections. When examined through the same lens as the Museum of the Future (while also recognizing that The Sphere is more than just an immersive installation) a critical perspective can lead to compelling insights. Although primarily created for entertainment, its advanced technological environment invites questions about the evolving role of immersive media, the boundaries between spectacle and substance, and how such spaces might also engage with cultural storytelling, audience agency, and even future-oriented narratives.

The Sphere offers a groundbreaking level of sensory immersion, delivering visually and acoustically rich experiences that have been described as “virtual reality without headsets”(*The Las Vegas Sphere | Everything You Need to Know | Visit Las Vegas*, 2024) . Its massive scale enhances this effect, creating an overwhelming sense of presence through lifelike environmental cues such as wind, scent, and synchronized motion. However, its approach to storytelling remains largely fixed and author-driven, centered around pre-scripted concerts and cinematic presentations. While future developments may introduce AI-driven content capable of generating dynamic narratives, current experiences offer little real-time interactivity or user agency. Spectators remain seated and passive, with no opportunity to physically explore or influence the

digital environment. Although the Sphere's technological infrastructure can support advanced AI applications, much of its content is still pre-rendered, leaving the potential of generative or adaptive storytelling largely untapped. Accessibility also raises important questions; with its $2.3 billion investment and high-ticket costs, the Sphere functions as a luxury spectacle, available mainly to those who can afford it. This exclusivity contributes to its elite status but limits its cultural reach. Ethically, the emphasis on spectacle over substance carries the risk of promoting what might be called "spectacular authenticity": the illusion that high-resolution simulation equates to truth. Furthermore, the environmental impact and consumerist underpinnings of such a large-scale installation warrant deeper critical reflection, especially in a time of global resource sensitivity.

The analysis of two immersive experience creators (Refik Anadol Studio and teamLab) and two immersive spaces (the Museum of the Future and The Sphere) reveals key limitations in the current landscape of digitally enhanced immersive experiences. Refik Anadol’s work showcases advanced AI integration but often lacks a clear narrative, relying heavily on user interpretation and risking hidden biases in data selection. In contrast, teamLab emphasizes user participation and sensory interaction, though it leans on rule-based systems rather than AI and walks a fine line between entertainment and educational depth. The Museum of the Future offers strong, structured storytelling but struggles with generating emergent narratives and deeper user agency. Meanwhile, The Sphere excels in sensory engagement and embodiment but provides little to no interactivity, keeping audiences in a passive role. A common thread across all examples is their reliance on high-end technology and significant financial investment, which raises questions about accessibility, sustainability, and the democratization of immersive cultural experiences. Now, don’t misunderstand the previous words; each of these projects represents a remarkable

achievement. Refik Anadol Studio, teamLab, the Museum of the Future, and The Sphere all showcase the extraordinary potential of modern technology to expand the ways we tell, remember, and imagine human stories. Their use of digital tools to evoke emotion, stimulate the senses, and engage audiences marks an exciting evolution in how culture and heritage are experienced. It should be noted that for this research, none of these installations were visited in person; all information was gathered from online sources including the official web pages of the projects or studios.

2.10. Copyright, Textual Archives & Collaboration with Rightsholders

Transforming *Bibliografía Extremeña* into a digitally enhanced immersive experience utilizing different technologies like artificial intelligence inevitably implicates the moral and economic rights of the authors whose works make up the catalogue (*EU AI Act*, 2023). In most jurisdictions, including Spain (where the works originated), Canada (where this research is housed) and the European Union (whose law governs much online dissemination), copyright grants creators exclusive control over reproduction, adaptation, public communication and, in civil-law countries, the integrity of their works. Respecting these rights is therefore both a legal duty and an ethical cornerstone of any heritage-technology project.

Copyright exists to strike a balance between protecting the rights of creators and enabling public access to knowledge, culture, and innovation (*Copyright Licensing in the Digital Environment*, n.d.). It safeguards both economic rights such as the ability to authorize reproduction, distribution, and derivative works and moral rights, which include the right to be credited and to object to uses that distort or harm the integrity of the work. These protections are especially

relevant when adapting literary content into new formats, such as immersive environments/experiences or AI-enhanced visualizations, where transformation and public display are central. However, copyright also imposes limitations on works still under protection generally cannot be reproduced, modified, or publicly communicated without permission, unless covered by an exception or limitation under national or supranational law. For this reason, projects involving digitization, machine learning, or reinterpretation of archival texts must carefully navigate this legal framework to ensure that no unauthorized uses occur.

In line with these principles, this project adopts a strictly rights-respecting approach. No copyrighted content will be scraped, reproduced, or used without prior authorisation from the creators or, where necessary, the acquisition of an appropriate licence. While the work is conducted entirely within an academic context these legal safeguards are viewed as complementary, not substitutes for ethical engagement. Crucially, from the very beginning, the creator of the *Bibliografía Extremeña*, Manuel Pecellín Lancharro, was informed of the project and his explicit permission and collaboration were secured. His enthusiastic support not only provides legal and moral clarity but also strengthens the scholarly integrity and cultural authenticity of the immersive experience.

3. Data and Methodology

This chapter outlines the methodologies and processes implemented to collect, analyze, and present data for this research. The journey begins with data collection, encompassing the digitization of texts from the *Bibliografía extremeña* and the compilation of visual and contextual materials related to Extremadura. Following this, data analysis methods are discussed, focusing on the organization, categorization, and preparation of the collected data for integration into immersive experiences.

3.1. Data collection

Thanks to the foundational work carried out over many years by Manuel Pecellín Lancharro, we now have access to a substantial bibliographic catalog that serves as the basis for this project. His meticulous documentation and classification of Extremadura's literary production provide both a valuable archive and a structured framework that this thesis builds on to explore new possibilities in digital and immersive cultural heritage.

Building on this foundation, the data collection process is the foundational step in this research, focused on gathering and digitizing the diverse materials necessary to bring the *Bibliografía extremeña* collection to life in an immersive digital context. This section details the methods used to compile and prepare both textual and visual data, ensuring their readiness for analysis and integration into the project's components.

The digitization of the *Bibliografía extremeña* collection began with the physical books, many of which existed solely in print. These were carefully scanned to produce high-resolution digital images. Optical Character Recognition (OCR) technology was then applied to extract the text

from the scanned images, converting it into machine-readable format. This process was meticulous, as historical fonts, page layouts, and occasional text damage required manual corrections to ensure accuracy.

However, transforming the scanned books into a structured and meaningful digital archive requires going beyond simple digitization. The collected data was structured into a format that identified critical attributes for each book, such as the title, author(s), city, publisher, year of publication, category, and, in many cases, a column specifying the catalog or edition in which Pecellín included the entry. Additionally, the dataset included reviews written by Pecellín, providing valuable commentary and insights into the significance of each work.

Creating this structured archive was an intensive process that involved a combination of automated and manual techniques. Regular expressions were employed to automatically detect key attributes within the extracted text. These methods, combined with manual validation, resulted in a semi-automated system that significantly reduced the workload while maintaining a high level of accuracy.

Once the data was structured, a comprehensive cleaning process was undertaken to address the noise and inconsistencies introduced during OCR. The extracted text often contained errors, such as extraneous characters, misinterpreted letters, or formatting issues. To address this, the project leveraged Cplex-AI (more in the next chapter), using the capabilities of an AI Agent to assist in data cleaning. The Agent was instructed to act as a spell checker and grammar corrector, with specific guidelines to avoid altering the content of bibliographic references. Its sole task was to correct typographical errors and improve the readability of the data without compromising the integrity of the original entries.

For books already in digital format, the process differed significantly from that of physical books. In these cases, there was no need for scanning or OCR. Instead, the main focus was on transforming the text from an unstructured format into a structured one. By directly working with digital texts, the process was streamlined, allowing for efficient structuring of the data without the additional challenges posed by noise or inaccuracies introduced during OCR.

Here is the graphical representation of the methodology for digitalizing textual archives. The process differentiates between physical and digital books:

- Physical Books: Undergo scanning, OCR, attribute detection (semi-automated), and Agentic AI assisted data cleaning before being converted into a structured dataset.
- Digital Books: Skip scanning and OCR, requiring only the structuring of attributes directly from their unstructured format to be integrated into the final dataset.

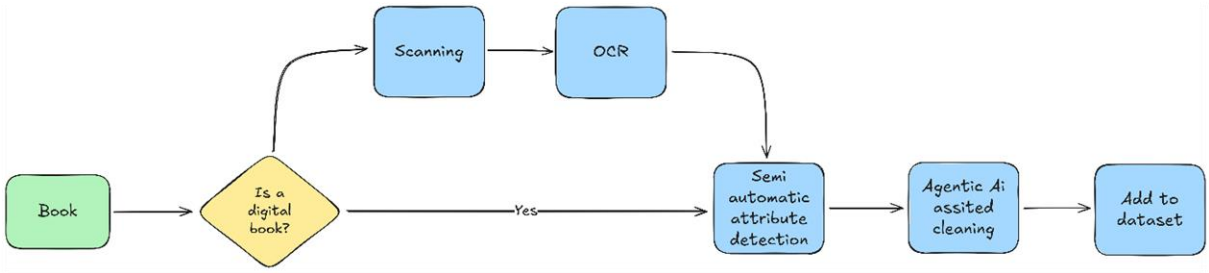

Figure 3: Graphical representation of the methodology for digitalizing textual archives.

The entire process was implemented using Python and integrated tools like the Google Cloud AI for OCR and Cplex-AI for Agentic AI assisted data cleaning. Python's libraries, such as pandas and re, were essential for structuring and automating attribute detection, ensuring efficiency and accuracy in transforming both physical and digital books into a structured dataset.

This methodology (combining digitization, OCR, structured data organization, semi-automated attribute detection, and Agentic-AI assisted cleaning) provides a robust framework for digitalizing textual archives. It ensures the preservation of the original material's integrity while enhancing accuracy, and quality of the data. By leveraging advanced technologies like OCR and AI, this approach enables the transformation of physical collections into structured digital datasets that are adaptable for various applications. Moreover, it addresses common challenges in textual digitization, such as noise, errors, and inconsistencies, making it a scalable and versatile model for unlocking the potential of textual archives in the digital age.

3.2. Data exploration

This section explores the content of *Bibliografía Extremeña* through digital methods, following its prior digitization. As we have said previously the collected data was structured into a specific format that includes attributes for each book, such as the title, review, author(s), city, publisher, year of publication, category, and, in many cases, a column specifying the catalog or edition in which Pecellín included the entry. From this point forward, we will refer to the entire catalog and its structured attributes as the dataset, and to each individual attribute as a column, in order to align with the common terminology used in data analysis.

The dataset contains a total of 8,785 books and 8 columns (title, description, year, catalog, city, editorial, category, author). The majority entries have all its attributes complete, with only 10.9% of the entries containing missing values due to the absence of this information in the original collection. The *author* column could contain a single author's name, or a list of names separated by comma. The columns *title*, *description*, *city*, *editorial*, *catalog*, and *category* are string-type columns. The *catalog* column represents a range of two years (start year – end year), indicating

the period during which the books included in that catalog were collected. This range corresponds to the original collection, where each catalog group books are published within a specific time span. The year column is of numeric type and represents the publication year of each book.

The books in the dataset were written by over 5000 authors. However, the exact number is uncertain, as several entries contain values such as 'AA.VV.' or 'otros', which indicate that the book was authored by multiple people beyond those explicitly listed in the entry.

The dataset mainly contains books published between 1900 and 2023, although there are a few apparent outliers, such as the entry titled “El Obrero Federal,” a newspaper originally from 1889 and “La voz de Extremadura,” another periodical dated 1908. These cases are included not because the original documents were published within the dataset’s time range, but because they have been the subject of recent rediscoveries, studies, or facsimile editions published in the last few decades. In this sense, the inclusion of such entries reflects the contemporary editorial and scholarly interest in recovering and recontextualizing historical materials, rather than strictly adhering to their original publication dates. Additionally, the years with the highest number of published books are 2008, 2014, and 2009, in that order.

The following graph is a representation of the distribution of books by years:

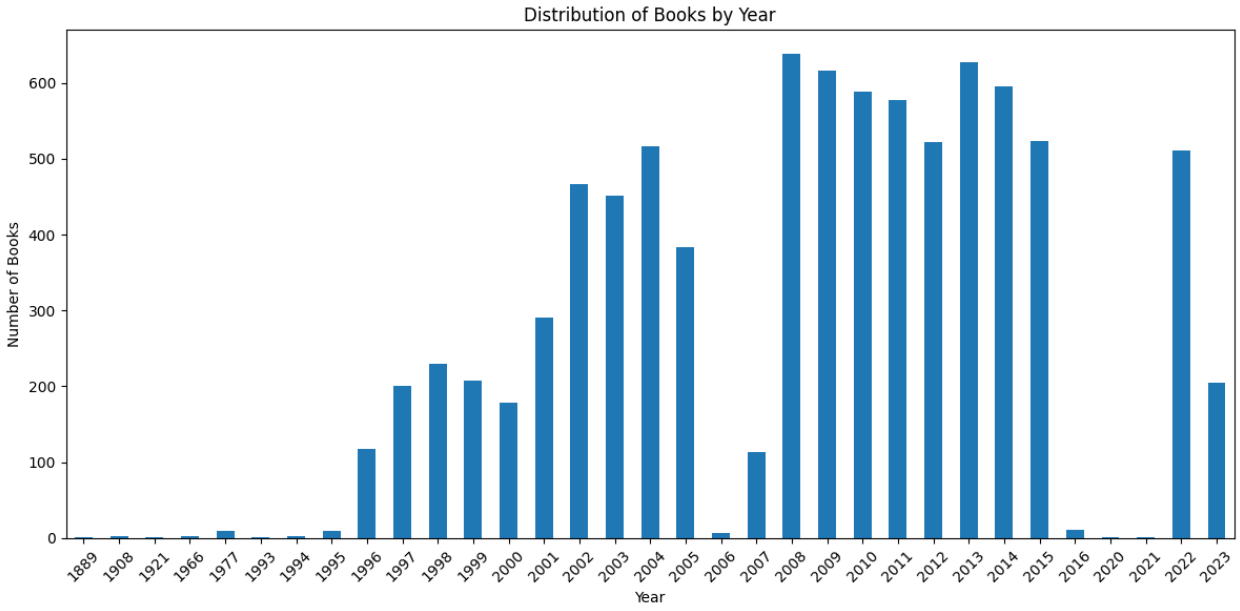

Figure 3: Distribution of books by years

The categories contained in the dataset are 20, including one special category "*sin categoría" (no category*) assigned to 730 books of the dataset, representing the 8.31% of the books. The most common category by difference is "*literatura*" (literature) representing 2076 books (23.63%) followed by "*antropología*" (anthropology) representing 824 books (9.38%) and "*ensayo*" (essay) with 798 books (9.08%). This data shows a strong emphasis on literary production within the catalog, reflecting the cultural and creative interests of the region. The prominence of anthropology and essays also indicates a significant presence of scholarly and critical works, suggesting a balance between artistic expression and academic research in Extremadura's publications. The following graph shows the distribution of books by category including the percentage that each category represents from the total:

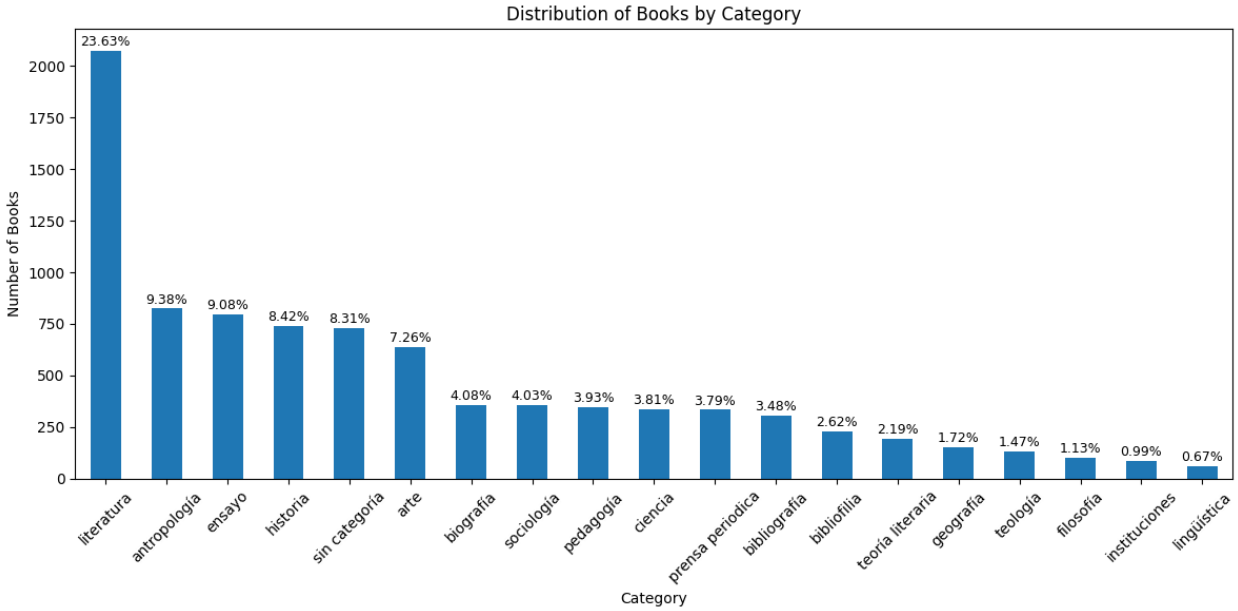

Figure 4: Distribution of books by category

The cities column contains over 480 distinct entries. However, some of these entries refer to the same locations but are listed differently. For example, “Sevilla, Cáceres” appears as a single entry, while “Sevilla” and “Cáceres” also exist as separate entries, indicating inconsistencies in how city names are recorded. It was decided to retain the original formatting in order to maintain consistency with the structure of the source dataset. As the capital, Badajoz is the most prolific, accounting for 26.7% of all publications, followed by Cáceres and Mérida with 14.56% and 14.22%, respectively. The following graph shows the top 10 cities with the majority of books:

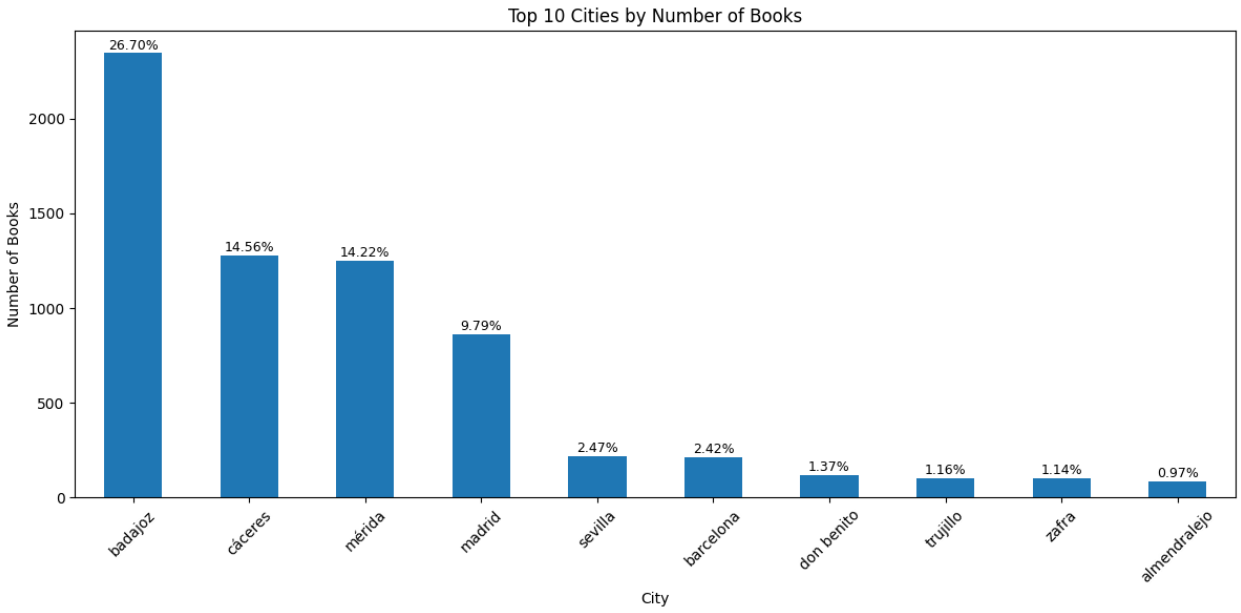

Figure 5: Top 10 Cities by number of books

The dataset contains over 2,400 unique editorials, with "*Diputación"*, "*Autoedición"*, "*Ayuntamiento"* and "*Universidad de Extremadura"* leading the list in terms of number of publications. This suggests that institutional and self-publishing play a significant role in the regional publishing landscape, highlighting the importance of public bodies and local initiatives in the dissemination of bibliographic content in Extremadura. The top 10 Editorial by number of publications and the percentage they represent are shown in the following graph:

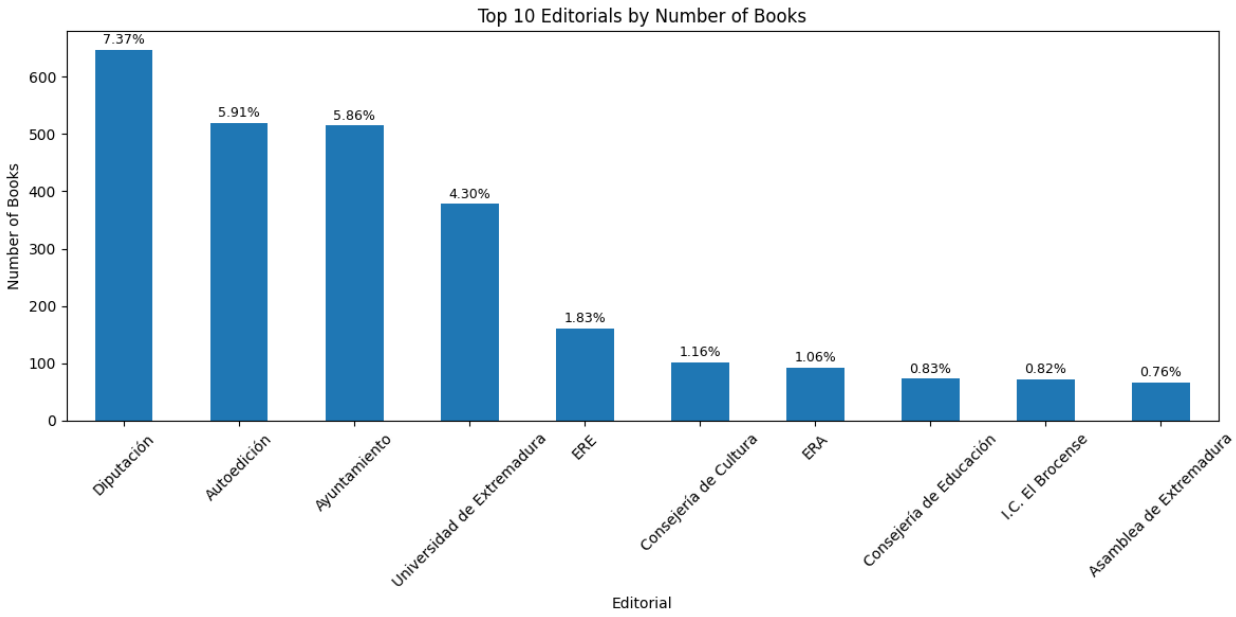

Figure 6: Top 10 editorials by number of books

As a final step in this data exploration, a word count was created based solely on the book titles and the results are "beautiful". The resulting word cloud reveals the most frequently recurring terms but also offers a visual summary of the thematic richness within the collection. Prominent words such as *Extremadura*, *Historia*, *Poesía*, *Memoria*, and *Ciudad* highlight the central focus on regional identity, historical narratives, and literary expression. Names of key cities like Badajoz, Cáceres, and Mérida further emphasize the local scope of the works.

The word count also reflects a deep connection of the Bibliografía's content with nature and rural life. Terms such as *naturaleza*, *tierra*, *piedra*, *pueblo*, *comarca*, and *raíces* point to a strong awareness of place, landscape, and ancestral ties. These words suggest that the region's natural environment and rural identity are not just settings but central themes in many of the works. Culture is another prominent topic, with frequent mentions of *cultura*, *arte*, *fiestas*, *feria*, *teatro*, *poeta*, and *poesía*. These terms reveal a vibrant cultural ecosystem in which literature,

performance, and communal celebration play key roles in shaping and preserving Extremadura's heritage.

Figure 7:Word cloud of book titles

The number of books in the collection is not enormous and, in fact, represents only a small fraction of all creative works inspired by Extremadura. However, the connection to the land, culture, and traditions is so strong that it resonates deeply throughout the dataset. This profound attachment is evident in both the themes and language used across the titles. Additionally, the data shows that the preferred genres for transmitting cultural heritage among the people of Extremadura are history and poetry; genres that allow for both documentation and emotional expression. Natural and rural landscapes also play a significant role in Extremadura's literature, serving not just as settings, but as symbolic spaces that reflect identity, memory, and belonging. The proposed immersive experience will take these compelling findings into account, with the

hope of representing Extremadura as faithfully and meaningfully as *Bibliografía Extremeña* itself.

3.3. Cplex-AI

Cplex-AI plays a central role in the solution proposed in this thesis to transform *Bibliografía Extremeña* into a digitally enhanced immersive experience. We can understand Cplex-AI as a system; if we apply the definition of a system to this context: "a set of things working together as parts of a mechanism or an interconnecting network," or "a group or set of related or associated things perceived or thought of as a unity or complex whole" (*System | Oxford English Dictionary*, 2025), Cplex-AI functionalities align with both of these definitions.

Cplex-AI is composed of multiple components, each with specific responsibilities and functions, but all working toward the same goal: turning a text-based archive or catalog into an immersive digital experience. As previously discussed, the concept of immersion is broad, and Cplex-AI can only operate on the textual archive in its digital form. The user, however, remains the essential element for the immersive experience to take shape and acquire meaning.

As discussed in the data collection chapter, the first task of Cplex-AI was to clean the book data and correct imperfections introduced during the OCR phase of the digitization process. It also assisted in identifying various attributes within each book entry. For instance, some entries in the original archive lacked specific fields such as "city." However, by analyzing the reviews written by Pecellín, it was often possible to extract this missing information.

Although the process itself may not seem particularly complex, the amount of manual effort required to accurately parse, clean, and structure the archive data would be considerable. Cplex-

AI significantly reduces this workload while also minimizing the potential for human error, which can arise from fatigue, oversight, or inconsistency.

We also acknowledge that AI agents are not exempt from generating errors, particularly through hallucinations. This is why incorporating multiple agents and verification tools has become a crucial aspect of the workflow. For example, we included tools designed to check and standardize author names, cities, and publishers. Since the same entity often appeared under different variations, this normalization step was essential for maintaining data consistency and integrity throughout the archive. In a parallel level there was another agent checking if the result of the previous step was accurate, this agent worked as a quality control before real human quality control.

At this point Cplex-AI could be only a script running and editing a simple database or a csv but as the amount and the complexity of the tasks arose the system evolved into a more robust and capable one. The next tasks for Cplex-AI where more focused in conducting the proposed immersive experience and user centered activities.

Beyond data cleaning and normalization, Cplex-AI's responsibilities expanded to include a set of more advanced and multimodal tasks aimed at enabling the immersive experience proposed in this thesis. Among these tasks was the creation, maintenance, and querying of a vectorized database to support retrieval-augmented generation (RAG) and semantic search across the digitized *Bibliografía Extremeña* archive. This allowed users to explore the archive through meaning-based queries rather than relying solely on exact keyword matches.

Cplex-AI was also responsible for generating a knowledge base and producing various forms of media content derived from the original book entries. A vectorized database was developed to

serve as the foundation for Retrieval-Augmented Generation (RAG) operations, while a separate vectorized database containing all book entry titles was created to enable the user to perform semantic search using a traditional text field to introduce a query that later will be transformed to embeddings and compared to the entries in the vectorize database (a similar process to RAG but in this case used for humans). This dual structure can be viewed as a metaphor: both the user and the machine engage with the same data through similar methods yet operate on different interpretive levels.

Beyond data structuring or knowledge representation and retrieval, Cplex-AI played a key role in interpreting and transforming book entries into diverse formats such as images, animations, summaries, and other creative outputs that make the original content more accessible and engaging. It also began reimagining entries in visual forms, including dynamic animations that brought the archive to life through narrative and motion. This marked the beginning of its multimodal capabilities, which will be examined in greater detail in the following chapter.

The role of Cplex-AI was fundamental to this thesis and to the entire project. As a system, Cplex-AI is constantly evolving, incorporating new processes, functionalities, and features. Its application is not limited to this specific case. In fact, Cplex-AI can work with different data sources and serve a variety of purposes depending on the context. Of course, it is not a magical solution. Some adjustments are needed when processing new formats or archives. Still, it remains a flexible and adaptable system that, while not perfect, can be shaped to fit the requirements of almost any dataset.

The development of Cplex-AI within this thesis follows a research creation methodology, where theoretical inquiry and practical experimentation are interwoven. Rather than treating Cplex-AI

solely as a technical tool, the process of building and refining it became a site of creative exploration. Several prototypes were developed, and each iteration, whether focused on data cleaning, multimodal generation, or immersive design, was informed by both conceptual frameworks and hands-on practice. This dual orientation allowed the project not only to solve technical challenges but also to question how AI systems might reshape cultural archives, user engagement, and the very notion of immersion.

3.4. Touchdesigner

The use of TouchDesigner in this thesis also follows a research creation methodology, where technical experimentation and creative inquiry unfold together. TouchDesigner was not approached as a simple rendering engine but as a dynamic environment for prototyping, testing, and refining techniques that shaped the visual and interactive language of the project.

TouchDesigner is a visual development environment designed for creating real-time interactive multimedia content. Originally developed by Derivative (*Derivative*, n.d.), it is widely used in fields such as live performance, digital art, immersive installations, and interactive design. The software operates on a node-based architecture, where visual, audio, and data processes are represented as interconnected operators. This structure allows artists and designers to prototype complex systems quickly, integrating multiple inputs and outputs while maintaining a high degree of flexibility.

Among the key techniques developed were particle simulations, optical flow analysis, real-time filtering, and custom pipelines for multimodal content integration. Particle systems were explored as a way to create organic, evolving visuals that metaphorically connect user input with

archival knowledge. Optical flow analysis provided a subtle mechanism to translate physical presence and movement into visual transformations, adding layers of responsiveness and embodiment. Real-time filtering and stylization techniques were implemented to reinterpret AI-generated outputs, transforming them into distinct aesthetic forms such as watercolor textures or block-like abstractions.

Through iterative prototyping, these techniques were adapted, layered, and recombined in order to create the visuals and incorporate subtle interactions for the installations developed (see next chapter). As mentioned, optical flow was used for one of the interactions. Optical flow is a computer vision technique that calculates the motion of objects, surfaces, or edges between consecutive frames of a video sequence. By analyzing the displacement of pixels, it generates a vector field that represents the direction and speed of movement within the image (Szeliski, 2022).

TouchDesigner offers several ways to achieve motion-based interaction, such as background subtraction through the Difference TOP, blob tracking combined with thresholding, or more advanced approaches using depth cameras like the Kinect and external libraries such as OpenCV or Mediapipe. For this project, optical flow was selected for its ability to provide a straightforward and accessible form of movement detection. It represents a lighter computational load for the system and contributes to the overall economy of the project, avoiding the need for specialized or costly sensors while still enabling responsive and engaging interactions.

When applied in TouchDesigner, the use of optical flow is straightforward. The software includes a built-in component that provides real-time motion analysis with adjustable parameters, making it possible to customize sensitivity and resolution according to the specific needs of the

project or exhibition space. This flexibility allows optical flow to be adapted to different scales and contexts without requiring additional hardware.

The capability of optical flow to detect movement is particularly powerful because it eliminates the need for specialized sensors, which can be costly or restrictive. Instead, standard video input devices such as webcams can be used to capture interaction data, lowering the technical and financial barriers while maintaining high creative potential. In this project, this accessibility was crucial for embedding responsive elements into the immersive experience while keeping the system adaptable and sustainable.

3.5. Design framework

The transformation of any cultural heritage artifact into an immersive experience must be supported by a design approach on par with that of an art installation exhibition. Building on this premise, and drawing from various studies, three primary actors involved in the exhibition of a digitally enhanced immersive experience focused on cultural heritage preservation have been identified.

The first and most crucial element is Cultural Heritage, which constitutes the core substance of the experience. Cultural heritage must be approached with respect for authenticity, ensuring that reinterpretations remain faithful to the historical and cultural fabric of the source material. As Naparat (n.d.) warns, design decisions, especially those driven by high-tech sensory methods, risk mediating or distorting the intended cultural messages, undermining the authority and integrity traditionally associated with heritage exhibitions. In the transformation process, the essence of the original artifact must remain intact; the shift is not a true transformation but rather

a careful translation into a new platform or medium. While every act of translation inevitably introduces some degree of alteration, it is essential to manage these changes consciously and accept them as part of the process. Rather than resisting the shift, designers should seek opportunities within the new medium to enhance and extend the artifact's meaning, ensuring that the core cultural essence is preserved while embracing the expressive possibilities of the new platform.

The visitor or user of the immersive experience emerges as the second critical actor. As Ahmad (n.d.) emphasizes, fostering user autonomy and promoting informal learning are essential. Allowing visitors to navigate their own pathways through non-linear explorations encourages deeper, more meaningful, and self-directed engagement with the content. Autonomy not only enhances involvement but also respects the multiple interpretations that inevitably surface when cultural heritage is translated into an experiential format. At the same time, following Naparat (n.d.) discussion of the "entrance narrative," it becomes crucial to consider the diverse backgrounds, knowledge levels, biases, and expectations that visitors bring to the installation. Designing a thoughtful entrance narrative can help calibrate the visitor's initial encounter with the experience, guiding them toward the intended interpretive journey while maintaining openness to individual meaning-making.

The third critical actor in the design of an immersive experience focused on cultural heritage is technology. A major risk associated with technology-mediated installations is the potential overuse of technological elements at the expense of distorting or overshadowing the intended cultural message embedded in the heritage artifact. Technology must function as an active mediator of meaning, shaping how users perceive, interact with, and emotionally connect to the cultural archive. As Ahmad (n.d.) emphasizes, technology should be deployed thoughtfully, with

the aim of deepening inquiry, fostering reflection, and enriching the interpretive experience, rather than merely serving as a source of entertainment or distraction. Following Yoshida (2023) perspective, technology should also act as a vehicle for cultivating new modes of attention, privileging slower, more contemplative engagements that counter the fragmentary tendencies of hyper-digital environments. Ultimately, technology must support deeper exploration while also ensure accessibility and relevance for a diverse range of visitors, respecting the varied backgrounds and experiences they bring to the immersive encounter.

The teams behind this type of exhibition must be composed of individuals from diverse disciplines. A multidisciplinary team reinforces the originality of the exhibition by diversifying the points of view and ideas included in the final product and at the same time enhances the user experience and strengthens the communication of the cultural message. Coming from a computer science background and being deeply enthusiastic about the potential of AI tools, sensors, algorithms, and emerging technologies, I am excited about the possibilities these innovations offer for the final immersive experience. However, it is important to recognize that this project is not fundamentally about technology. It is about honoring the small yet significant fragment of cultural heritage that *Bibliografía Extremeña* represents within the broader landscape of Extremadura's traditions, and about finding the most meaningful, clear, and engaging way to transmit that cultural message to the user.

The design of the solution proposed in this thesis is grounded in a set of experience-centered principles drawn from a synthesis of scholarly frameworks (Ahmad, n.d.; Hassenzahl, 2013; Naparat, n.d.; Yoshida, 2023), industry best practices (MoMoLab, 2023), and insights from immersive media studies (Hameed et al., 2019; Han et al., 2022; Ruscella & Obeid, 2021; West et al., 2013; Zhang, 2020; Zhang et al., 2017), all of this studies has been covered in the literature

review chapter. These principles were not simply adopted, the idea is to apply them to ensure the transformation of *Bibliografía Extremeña* into a multi-sensory, emotionally resonant, and adaptive immersive environment while putting special attention to preserve the cultural meaning of the original artifact. Below, each principle is explained with its rationale and the expected experiential outcomes.

1. Why-What-How Framework
    - **Design Principle:** Begin with Why (user needs and psychological fulfillment), then define the What (functionality), and lastly shape the How (interaction design).
    - **Rationale:** This principle ensures that all technical and interactive decisions serve a deeper human purpose. The experience is not technology-driven, but human-centered.
    - **Expected Result:** A system that does more than display data, it elicits personal connection, emotional engagement, and narrative meaning through interaction.

2. Narrative and Storytelling Integration
    - **Design Principle:** Narrative is treated as the backbone of interaction. All installations are structured around stories, both scripted and emergent.
    - **Rationale:** Literary archives like *Bibliografía Extremeña* are inherently narrative. Embedding storytelling allows visitors to explore the content, context and meaning.
    - **Expected Result:** Visitors experience the archive as a living entity, responsive, affective, and capable of generating personal stories, thus transforming literary heritage into a multisensory journey.

3. Multi-sensory Engagement and Embodiment

- **Design Principle:** Design for a balance of visual, auditory, and embodied interaction, avoiding sensory overload.
- **Rationale:** Sensory diversity improves accessibility and supports varied cognitive and emotional entry points. Embodiment increases presence and emotional depth in immersive experiences.
- **Expected Result:** A richer, more inclusive experience that invites deeper attention and engagement, enabling users to feel "inside" the archive rather than outside observers.

4. User Co-Creation and Participation
    - **Design Principle:** The system should allow for user input, decision-making, and co-creation in real time.
    - **Rationale:** Giving agency to the user transforms passive interaction into active participation, enhancing memorability and personal relevance.
    - **Expected Result:** Each user's journey becomes **unique**. The archive becomes a collaborative partner rather than a passive element of the installations, enabling emergent narratives and creative reimagining.

5. User guidance and autonomy
    - **Design Principle:** Provide clear initial guidance to users while preserving their freedom to explore and interpret the experience independently.
    - **Rationale:** A balance between guidance and autonomy prevents disorientation while fostering personal engagement. Initial cues and scaffolding help users enter the

experience meaningfully, but excessive control would limit their agency and potential for discovery.

- **Expected Result:** Visitors feel supported but not constrained. They can navigate the immersive environment with confidence, shaping their own journeys and creating personal connections to the cultural content.

6. Contextual Authenticity
    - **Design Principle:** Ensure that reinterpretations preserve the original cultural and historical context of the archive.
    - **Rationale:** Immersive reinterpretation and AI risks distortion. Anchoring outputs in authentic data from *Bibliografía Extremeña* maintains respect for the source.
    - **Expected Result:** Interpretative freedom does not undermine heritage integrity. Visitors gain both emotional and intellectual insights into Extremadura's literary landscape.

7. Sustainability and Maintainability
    - **Design Principle**: The system should be scalable, adaptable, and durable over time.
    - **Rationale**: Immersive systems often degrade quickly due to technological obsolescence or lack of modularity. This project is conceived as a growing ecosystem.
    - **Expected Result**: The installations can evolve with new data, technologies, and user feedback. Longevity ensures ongoing cultural relevance and educational value.

8. Inclusion and Accessibility

- **Design Principle**: Design for diverse cognitive, emotional, and physical user needs.
- **Rationale**: Cultural archives belong to everyone. Designing inclusively ensures broader access and reduces the gap between technology and heritage.
- **Expected Result**: More visitors (regardless of age, background, or ability) will be able to connect with the archive through the different interactions.

Most of these elements are drawn from the subchapter "Components and Design Principles of an Immersive Experience." They define the characteristics that an immersive experience must embody to foster deeper connections with the audience and to enable an effective transformation of the *Bibliografía Extremeña* archive. The other principles come from a compilation of some exhibitions design good practices. Together, these principles informed every aspect of *Sueños de Extremadura* (the proposed IE of this thesis) development, from data architecture to interface aesthetics. Rather than building a system that merely represents culture, this project aspires to design a system that performs culture: live, adaptive, and always in dialogue with its users. In the next chapter we will talk about *Sueños de Extremadura,* it's main installations, components, ways of interactions and how it accomplishes the design principles of this framework.

4. The project

Sueños de Extremadura is a digitally enhanced immersive experience that aims to showcase the rich cultural heritage of Extremadura, exploring how its past and present can come together to transform a valuable resource into a work of art. Before diving into the details of the immersive experience itself, it's important to provide some context about Extremadura. The following

sections will briefly summarize the region's history and cultural background, with a particular emphasis on its literary tradition. Finally, the work of Manuel Pecellín Lancharro will be discussed, highlighting *Bibliografía Extremeña* and its significance in preserving part of Extremadura's literary legacy and its relevance to this thesis.

4.1. Historical Background

Extremadura's history is full of fascinating chapters that have shaped its unique identity. From ancient times to the present, each era has left its own mark, helping to create the rich cultural landscape we see today.

Long before the Romans arrived, the region was home to indigenous tribes such as the Lusitanians. These early people left behind stone carvings and artifacts that reveal their deep connection to the land. When the Romans conquered the area in the 2nd century BC, Extremadura became part of the Roman province of Lusitania. They founded cities like Emerita Augusta, known today as Mérida, in 25 BC, which quickly became an important administrative and cultural center. Even today, visitors can admire remarkable Roman ruins such as the theater and amphitheater in Mérida, which are among the best-preserved in Europe (Altman, c1989).

After the fall of the Roman Empire, the Visigoths took control and introduced early Christian influences. The arrival of the Moors in the 8th century brought significant cultural and architectural changes, including new agricultural methods and the construction of impressive fortresses. By the 12th century, during the Christian Reconquista, Extremadura returned to Christian rule. This period saw the rise of important medieval landmarks like the Alcazaba of

Badajoz. The blending of Visigothic, Moorish, and Christian traditions during this time played a major role in shaping the region's cultural and architectural character.

During the Renaissance, Extremadura was deeply influenced by Spain's Golden Age, a time when art and literature flourished. Famous explorers such as Hernán Cortés and Francisco Pizarro, both from Extremadura, launched expeditions to the Americas. Their achievements brought wealth and new ideas to the region. The Baroque period added even more richness, with striking architecture like the Monastery of Guadalupe, an important religious and cultural landmark. Located in the province of Cáceres, the monastery became a major center of pilgrimage and spiritual life, renowned for its artistic heritage and its role in promoting scientific and medical knowledge. It also held significant transatlantic importance: the devotion to the Virgin of Guadalupe in Extremadura directly influenced the cult of the Virgin in Mexico, becoming a spiritual bridge between Spain and the New World.

4.2. Extremadura's literature

Over the centuries, Extremadura has given rise to a wealth of literary works that reflect its history, society, and the spirit of its people. Through literature, we get a window into the values, struggles, joys, and everyday experiences of the communities that call this region home.

Extremadura's literary heritage is rich and diverse. Many of its authors have drawn inspiration from local folklore, traditions, and the striking landscapes that stretch from the mountains of the north to the plains of the south. For example, local legends about the heroic Lusitanian leader Viriato have inspired countless poems and stories, celebrating themes of resistance and resilience that are still deeply rooted in the regional imagination.

Extremaduran literature offers many powerful examples of the deep connection between writing, nature, rural life, and local communities. Contemporary work continues this tradition while adding new layers of reflection and critique. Diego Doncel's *Amantes en el tiempo de la infamia* explores themes of memory, displacement, and identity, touching on how both personal and collective histories shape people's relationship with place. Álvaro Valverde's *Desde fuera* offers a meditative look at landscape and solitude, inviting readers to reflect on the passage of time and the quiet beauty of rural surroundings. Meanwhile, Juan Ramón Santos's *El tesoro de la isla* brings a playful yet thoughtful perspective on life in small communities, highlighting local customs, humor, and the delicate balance between tradition and change.

Together, these works show how Extremadura's literature preserves the spirit of rural life within its literary tradition. These are just a few examples of the many remarkable works that have emerged from the region. What's even more valuable is that these three books and their authors are well documented in *Bibliografía Extremeña*, ensuring their place in the region's cultural memory thanks to the work of Manuel Pecellín Lancharro. And these are only a small sample, *Bibliografía Extremeña* includes many more works that reflect the rich and diverse literary landscape of Extremadura.

4.3. Manuel Pecellín Lancharro and *Bibliografía extremeña*

Manuel Pecellín Lancharro has left an indelible mark on the intellectual landscape of Extremadura. A prolific writer, bibliographer, and academic, he was born on September 14, 1944, in Monesterio, Badajoz. His extensive career has seen him not only as a professor and researcher but also as a key figure in numerous cultural institutions, both within and beyond his region. Pecellín Lancharro has had a significant impact on the cultural development of

Extremadura. From 2005 to 2013, he directed the Boletín of the Royal Academy of Extremadura, where he currently serves as Secretary and oversees the institution's website. He also co-founded and served as Vice President of the Union of Bibliophiles of Extremadura (UBEx), where he created and edited the monthly bulletin Oeste Gallardo. Moreover, he was the founding director of the Publications Service of the Provincial *Diputación* of Badajoz, a role he held for eight years. His leadership at the Center for Extremaduran Studies and its academic journal for a decade was particularly notable, as he published numerous papers and curated a consistent section of bibliographic reviews.

Pecellín Lancharro's intellectual journey began at the San Atón Seminary in Badajoz, where he completed his secondary education. He later pursued theological studies at the Pontifical University of Salamanca, writing a dissertation on the thought of Pierre Teilhard de Chardin. His academic interests expanded when he earned a Licentiate in Philosophy from the Complutense University of Madrid, where he later completed his doctoral thesis on Krausism in Extremadura, a significant contribution to the study of philosophical currents in 19th-century Spain. Throughout his career he has balanced his passion for teaching with his scholarly endeavors. Since 1976, he has been a secondary school professor, having earned his Catedrático position through rigorous examinations. He held leadership roles as the director of two prominent institutes: "Pedro de Valdivia" in Villanueva de la Serena and "Reino Aftasí" in Badajoz. His teaching also extended to the University College of Santa Ana in Almendralejo, where he lectured on Cultural Anthropology. Additionally, he offered doctoral courses at the University of Extremadura's Institute of Education Sciences (ICE) and collaborated with the Aesthetics Research Team at the University of Seville.

Pecellín Lancharro's influence is particularly pronounced in his contributions to the cultural and intellectual life of Extremadura. He co-founded the Association of Extremaduran Writers, eventually serving as its president. As a contributor to the *Gran Enciclopedia de Extremadura*, he authored 170 articles in the "Science and Thought" section, showcasing his breadth of knowledge across a wide array of subjects. Furthermore, his advisory roles for the Ministry of Culture of the Junta de Extremadura and the Assembly of Extremadura reflect his dedication to regional development. He was also a vocal and active member of the Royal Economic Society of Friends of the Country in Badajoz and the Matilde Landa Association. Pecellín has published widely in academic journals such as *Alor Novísimo*, *Ars et Sapientia*, *Alcántara*, *Anaquel*, *Turia*, *Capela*, and *Guadalupe*. He regularly contributed to the netwspapers *HOY* and *ABC*. His involvement in *El Urogallo* is particularly noteworthy, where he coordinated Extremadura-related sections and authored numerous articles for their monographs. He also has been invited to lecture at prestigious institutions, including the Universities of Extremadura, Salamanca, Barcelona, Trento (Italy), Covilhã (Portugal), and Bochum (Germany). These international engagements underscore his reputation as a scholar of global reach, particularly in the fields of philosophy and cultural history.

Through his extensive body of work, both in scholarly publications and cultural institutions, Manuel Pecellín Lancharro has cemented his place as a pillar of Extremaduran intellectual and academic life. His unwavering dedication to regional scholarship, coupled with his leadership in fostering cultural initiatives, has significantly shaped the preservation and promotion of Extremadura's heritage. As a prolific writer, educator, and cultural advocate, Pecellín Lancharro's influence extends beyond academia, resonating in the public sphere and leaving a lasting impact on the intellectual fabric of the region. His contributions have not only enriched

the cultural identity of Extremadura but have also positioned it within broader academic and philosophical conversations, ensuring its place in the national and international scholarly landscape.

Bibliografía extremeña is a collection of works compiled by Manuel Pecellín Lancharro, in which he meticulously gathers, categorizes, and analyzes every publication either about Extremadura or authored by a writer born in the region. Spanning from the 1990s to 2023, this collection serves as a comprehensive catalog of the region's literary output. Each entry is organized by category and includes details such as the author's name, the city and publisher of publication, and the year of release. Additionally, Pecellín provides thoughtful reviews for each work, adding critical insight to the entries.

The collection holds significant importance for several reasons. Over more than 30 years, Manuel Pecellín Lancharro has meticulously documented all written works related to Extremadura, whether focused on the region or produced by its authors, ensuring that the cultural production of Extremadura is preserved for future generations. This compilation serves as a valuable resource for analyzing literary and editorial trends across different periods, allowing researchers to study changes in themes, styles, and literary approaches over time. Additionally, it plays a crucial role in conserving the region's bibliographic heritage by safeguarding works that might have otherwise been forgotten. By highlighting local authors, the collection helps revalue their contributions and enhances their visibility within the broader national and international literary landscape. Furthermore, it acts as an essential pedagogical tool for educators, students, and cultural promoters, facilitating the development of educational programs and exhibitions centered on the identity and culture of Extremadura. Overall, Pecellín's work significantly contributes to the understanding and appreciation of Extremadura's literary and cultural heritage.

4.4. "*Sueños de Extremadura*"

The main goal of transforming *Bibliografía Extremeña* into an immersive experience is to make it accessible to a broader audience, including those unfamiliar with Extremadura and its literary heritage. At the same time, the project serves as both a preservation effort and a tribute to the remarkable work of Manuel Pecellín Lancharro and his contributions to academia and literature.

This initiative also aims to demonstrate how a text-based, collection, archive, or catalog can be reimagined as an immersive experience. Furthermore, it stands as an example of how cutting-edge advances in artificial intelligence, immersive technologies, and software engineering can be harnessed to safeguard and celebrate cultural heritage.

It is important to mention that this project is not an imagination exercise, the final result of this thesis will be an immersive experience that could be exposited in any art gallery, museum or public space. Also, all the installations described in this section will be developed by the publication of this thesis.

4.4.1. The system

At this point it is a good idea to remember the concept of system expressed in the Cplex-AI chapter: "a set of things working together as parts of a mechanism or an interconnecting network" (*System | Oxford English Dictionary*, 2025). As a system this immersive experience is composed of several parts, all of the work in solving a specific problem or performing a particular task. Next each component will be described along with its role and function within the project.

Input channels: The input channels serve as the system's primary means of collecting data from the physical medium, enabling the integration of real-world elements into immersive experience in real-time. This component includes sensors, cameras, microphones, and other data-gathering technologies that capture text, images, sounds, and environmental interactions.

Output channels: The output channels are mainly designed for human senses, since this immersive experience focuses on direct interaction with the audience. These output channels are the touchpoints with the users, and each will provide sensory stimulation to the audience. They may include visual elements like projections and/or displays, as well as auditory features such as spatial sound and adaptive audio feedback.

AI Engine: The AI will be responsible for orchestrating the entire installation, continuously processing inputs and generating corresponding outputs in real time. Acting as the core engine of the experience, it will analyze incoming data, interpret user interactions, and dynamically adapt the installation's responses. This Engine is composed of different parts:

1. **Image Generation Model:** This component consists of an AI model for image generation, specifically trained with images of Extremadura to create visuals that reflect the region’s cultural and historical essence. Recognizing the high computational demands and extensive datasets required for AI model training, the approach leverages a pre-trained base model, such as Stable Diffusion 1.5 (another state-of-the-art model also can

be used). To fine-tune the AI for the specific aesthetic and contextual needs of the installation, a lightweight adaptation method, such as LoRA[3], has to be used.

2. **AI Agent ("Cplex-AI"):** The AI agent will function as the artificial mind of the immersive experience, embodying its living, responsive, and adaptive nature. This agent will have full access to the *Bibliografía Extremeña* dataset and will be equipped with a comprehensive understanding of how to interpret input data and generate meaningful outputs. Leveraging modern AI frameworks like LangChain[4] the agent will be enhanced with advanced capabilities, including Retrieval-Augmented Generation (RAG) and tool calling. These technologies will enable it to dynamically fetch relevant information, process complex queries, and interact autonomously, making the immersive experience more intelligent, independent, and contextual aware.

Archive Data: The *Bibliografía Extremeña* dataset will serve as the foundational knowledge base for the immersive experience, acting as the fuel that powers the AI engine and shown as one of the main installations. The data will be stored in a digital format and made available in multiple representations, with some designed for direct user interaction and others optimized for system processing.

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[3] A LoRA (Low-Rank Adaptation) model is a type of model adaptation technique used in Stable Diffusion and other generative AI models. In the context of image generation, it works by modifying the output of a base Stable Diffusion checkpoint to more closely resemble a pretrained style or subject. Unlike full fine-tuning, LoRA models are significantly smaller and do not function independently; instead, they add additional information and weights to guide the generated image towards a specific look or concept (Ćulafić et al., 2024).

[4] LangChain is a framework for building LLM powered applications and systems like AI Agents (*Introduction | LangChain*, n.d.).

To bring all these components together, several open-source tools or frameworks were developed and integrated to function as a cohesive system. The entire *Bibliografía Extremeña* collection is now digitalized and available as a website powered by Laravel and Vue. For the creation of the Agents LangChain has been used and a vectorized database powered by the postgress pgvector extension has made it possible to perform task like RAG. The system orchestrator is Touchdesigner (TD), a node-based programming environment specialized in real-time performances and digital art exhibitions. Touchdesigner was in charge of receiving all the input from different sources, calling the components when needed and showing the output as an animation. Additionally, in order to use some sensors like the Muse EEG headband an application was developed to work as bridge/driver/connector between the device and Touchdesigner. Other open-source tools like ComfyUI for in demand image generation, Stream diffusion for real-time image generation, and media pipe joined with the TD component allowed us to collect real-time user data like movements, gestures and poses.

4.4.2. The user

As discussed in sections such as “Immersion and presence in a digital experience” and “Design framework”, the user's role is pivotal in any immersive experience. Immersion and presence are not solely products of advanced technology or intricate design; rather, they are significantly influenced by the user's engagement and willingness to be immersed. Regardless of the system's complexity or the variety of tools and interactions it offers, the user's active participation is essential to achieve a genuine sense of immersion.

The designing of the proposed IE was made with the user in mind and considering the aspects presented in the section “Design framework”. Firstly, the system must be accessible to the widest

audience possible. This means allowing people of different ages and with different levels of knowledge about Extremadura and its literary output. Said this, the target audience is simply the general public and hopefully we can say that the output is also good enough for a more artistically demanding audience.

Two additional key elements guide the user experience within the proposed immersive environment, both recognized for their ability to enhance user immersion. As highlighted in the literature review chapter, user collaboration within an immersive environment has been shown to deepen the sense of immersion. With this in mind, the proposed immersive experience incorporates several activities designed to foster user collaboration. For example, one task that initially could be perceived as disconnected or unrelated to the others involves a user searching the digitalized catalog. This simple search can alter the visual style, location, or topic of the visual output. It will be curious to see how long it takes for the user to relate those two things. At the same time, other users interact with the same visual output using full-body movements, which are captured and integrated into the system and also affects the visual outputs.

The previous example effectively introduces the second point: user-machine co-creation. In the proposed immersive experience (IE), a key aspect is that each user will have a unique experience. This uniqueness is made possible by the stochastic characteristics of AI. With numerous varying factors, the system can produce entirely different results, making this one of the strongest aspects of the IE. Furthermore, when each user obtains different outcomes that are co-created (meaning the user is actively involved in the creation process) a sense of satisfaction could emerges, leading to a deeper emotional connection with the experience.

When working with *Bibliografía Extremeña* or any other cultural archive as a source, it is inevitable that multiple narratives and sub-narratives emerge during the experience. These can surface organically through interaction or be structured into the design of the system. In line with the two modes of storytelling described in the theoretical framework (scripted stories and emergent storytelling). These stories can be used to articulate each installation within the immersive environment, with all installations contributing to the telling of a shared overarching narrative. However, each one does so through a different format and mode of interaction offering varied ways of engaging with the same content.

Scripted stories can be perceived or constructed from the content within each book entry. These entries often contain more than bibliographic data; they include historical context, author backgrounds, thematic keywords, and publication details that, when curated thoughtfully, form coherent narrative arcs. Also, a form of scripted storyline can be created by selecting a specific subset of entries focused on a particular topic such as regional folklore, religious texts, or political writings or simply by presenting entries in chronological order. In contrast, emergent storytelling arises from the users' interactions with the system. Through their movement, choices, queries, and collaborations with others, visitors generate personal, unscripted narratives that are shaped in real time.

Finally, according to our design framework, the user should be guided within the immersive experience while maintaining a suitable level of autonomy and freedom. This balance must be carefully considered and designed. User exploration and informal learning are among the desired characteristics of the final immersive experience.

4.4.3. The installations

According to Hornecker & Stifter (2006) the term *installations* refers to interactive exhibits, either digital or physical, that are integrated into the exhibition environment. These installations move beyond the role of static displays by functioning as interfaces that promote user interaction, thereby supporting educational, entertaining, and creative experiences.

The proposed immersive experience embraces this concept by creating physical spaces where users can engage with both digital and physical materials. These installations will enable interaction with the original content through various modalities, each highlighting a different aspect of *Bibliografía Extremeña* and the region of Extremadura. The following sections provide a detailed description of each proposed installation:

- ***Realidad*:** This installation represents the most traditional approach to digital preservation: a publicly accessible online database containing the full corpus of *Bibliografía Extremeña* (https://bibextre.com). Users interact with the collection via multiple search modalities, including keyword queries, filters by author, year, city, and publisher. During performance time this installation transforms into a more minimalistic and modern one (getting inspiration from platforms like Netflix) where the users insert queries in a search field and a semantic search brings new book entries. The minimalist design seeks to encourage the exploration of the archive, users will introduce different queries to see what else is inside the catalog, in semantic search adding, changing or removing a word or even a letter can change the output. Also, results are limited during rendering to just a couple of options and the user doesn't have any idea of how many more books there are or what else can be found. This installation also has an automatic mode where books are just extracted from the catalog and rendered on

the screen. Moreover, the users will have the option to give a thumbs up to the rendered book based on what he can read and perceive from the overall exhibition. For an example of how this installation looks see appendix "*Realidad*". This interface ensures long-term access to the data while serving as the foundational layer upon which the other installations build more speculative and experiential interpretations.

- ***Ensueño*:** This installation explores the emotional dimension of archival engagement through a brain-computer interface. By measuring the visitor's brainwave activity, CPlex-AI interprets their emotional state and describe a relevant book from the *Bibliografía Extremeña* catalog in a poetry style. The book could come from the automatic mode or by an interaction initiated in *Realidad.* When a user rates a book this book entry gets propagated to *Ensueño* and is used as the base for content generation. The system then presents both the original book title and an AI-generated reinterpretation of the book's content in the format of a poem shaped by the detected emotional state. The output includes both written text and an AI-narrated version, synthesized in the voice of the author of (Manuel Pecellín), creating a deeply personalized and affective experience. The visuals for this installation are generated inside of Touchdesigner in the shape of a particle system mimicking a neuron, representing the connection with the user wearing the EEG sensor and the archive as a knowledge base. Also, speaking capabilities are given to this installation representing the empowering or giving voice to an archive that may be condemned to be stacked in a corner. *Ensueño* is a more abstract way of exploring *Bibliografia Extremeña* this time the query process happens in a more subtle way, almost unnoticed, based on the EGG brainwaves and Cplex-AI. Users using this installation will also be able to rate what it perceives using hand gestures, this time

thanks to technologies like mediapipe from google. See appendix "*Ensueño*" to have an idea of how it looks.

- ***Fantasía:*** is an immersive installation inviting visitors to co-create speculative visual representations of Extremadura. Powered by Cplex-AI, it generates fantastical imagery rooted in regional cultural references, drawing on real-time data and interactions from "*Realidad*". When a user rates an entry in either installation, Cplex-AI transforms the rated content into a series of images using its image generation component. These images are displayed on a large screen through an animation where each image` is interpolated and rendered in a watercolor style. The diffuse quality of the watercolor effect, combined with the fluid animation, evokes a dreamlike atmosphere, symbolizing the evolving and interpretive nature of collective imagination.

  In *Fantasía*, visitors assume the role of contemplative observers. This installation emphasizes reflection on how specific regions, landscapes, or visuals can inspire creative processes. Simultaneously, it explores the reverse engineering of this creative journey through AI. A key element of the installation is its use of optical flow—a computer vision technique that detects movement through a webcam. *Fantasía* is designed to encourage stillness and contemplation: when there is too much movement in the space, the visuals become increasingly blurry and diffuse, making objects and shapes harder to distinguish. This subtle effect adds an interactive layer to the experience, reinforcing the importance of quiet observation. By leveraging Cplex-AI, the system transforms textual content from rated entries into visual representations, effectively translating literary elements into imagery. This process underscores the bidirectional relationship between text and image, illustrating how narratives can inform visual art and vice versa.

- ***Infancia*:** This installation offers a playful and interactive experience, designed to engage visitors (especially younger audiences) through dynamic visual storytelling rooted in the portion of cultural heritage of Extremadura found in *Bibliografía Extremeña*. Like the other installations, *Infancia* draws from user interactions in *Realidad*. Whenever a user rates an entry into those experiences, *Infancia* responds in real time by generating corresponding visuals.

  These visuals are produced through an image-to-image generation pipeline powered by Streamdiffusion. The Streamdiffusion model will also be "influenced" by the same Lora model used in *Fantasía*. The resulting imagery is then stylized into a LEGO-like aesthetic using a custom visual filter implemented in TouchDesigner. This creates a whimsical, blocky reinterpretation of the source material, infusing the archive with a sense of nostalgia and play.

  Infancia invites visitors to explore and manipulate this world through an interactive game interface. The use of real-time image generation and webcam-based inputs allows elements from the real world to be integrated directly into the experience, blending the physical and digital in a light-hearted, creative environment.

These four installations constitute the foundational expressions of the project, offering distinct modalities of interaction with *Bibliografía Extremeña*. However, they are not conceived as fixed or static entities. Rather, they represent the initial phase of a larger, evolving system designed to remain open to continuous development.

4.4.4. The spatial layouts

As part of the project's resolution, a proposal is presented for a temporary exhibition installation designed to adapt to any architectural space, regardless of its shape, size, or function. To address this spatial uncertainty, a hierarchical circular concentric structure has been designed, allowing it to be implemented in diverse contexts without compromising its exhibition logic or narrative.

The layout is based on a continuous and linear circulation system, beginning with a single entrance that marks the start of the experience and ending with an aligned exit, creating a closed, coherent, and progressive journey. The design of the installation follows both functional and symbolic criteria, incorporating elements such as lighting, vertical vegetation, and interactive technologies to create immersive experiences based on literary content connected to the Extremadura region.

The installation is organized into three concentric circles: a symbolic central core, a first ring for introduction, and a second ring for immersive experience. This layout establishes a clear, hierarchical, and enveloping spatial sequence. The circular form is not arbitrary, studies have shown that curved pathways enhance orientation, movement flow, and content integration in museum and gallery installations (Vartanian et al., 2013).

All construction elements will be mobile and non-permanent, allowing for installation and dismantling without altering the host space. This ephemeral nature relies on the use of modular furniture and lightweight materials that define the space without creating rigid barriers (Tzortzi, 2015).

The proposed exhibition setup will be divided into several parts:

Entrance: The entry point is marked by an ambient floor projection simulating the vegetation of the Extremadura region, serving as a symbolic transition into the proposed narrative universe. On either side of the entrance, graphic panels display images of the Extremadura's landscape, helping visitors contextualize the exhibition both geographically and aesthetically.

First Concentric Circle (Introduction and Interaction Zone): This ring surrounds the central core and represents the visitor's initial stage of familiarization with the theme. It is defined by non-structural vertical elements, such as suspended textiles or modular panels, that outline the perimeter without fully enclosing it. At the exact center of this circle stands a pedestal displaying the physical books (*Bibliografía Extremeña*) that serve as the foundation for the immersive experiences. The pedestal is lit from above, creating an iconic effect that highlights it as the heart of the narrative (a symbolic center of knowledge).

This zone includes:

- A panel featuring the biography and image of author Manuel Pecellín, establishing the link between his work, his context, and the installation.
- A table or digital totem equipped with tablets, providing access to digital versions of the books via a website created specifically for the project (*Realidad*). This site plays a key role in showcasing the literary material and integrating it into the exhibition experience.
- A pedestal holding the physical books on which the immersive experiences are based (*Bibliografía Extremeña*).

This first area is conceived as an educational and introductory space, enabling visitors to understand the purpose and content of the installation before fully immersing themselves in the next phase.

Second Concentric Circle (Immersive Experience Zone): This broader ring contains the core content of the installation: three thematic sectors containing *Ensueño, Fantasia e Infancia*. These are arranged in a sequential, circular manner, allowing for a progressive narrative experience that reflects a transition from the tangible to the introspective or symbolic. Each sector is gently separated by vertical vegetation simulating Extremadura´s landscapes, which provides thematic division without hard partitions.

Each sector is internally structured into three radial spatial bands:

- Inner circulation band (closest to the introductory ring): allows visitor movement between sectors.
- Staying band (middle zone): where the sensory experience takes place and visitors can pause and engage.
- Technology band (outermost zone): where the projections, sensors, and interactive devices are located.

Closing of the Journey: The exit is located at the opposite end of the entrance, completing the concentric circular route and concluding the exhibition experience as a narrative journey. The installation is designed to adapt to various spaces without altering its symbolic structure or functional logic.

Lighting and Wayfinding: The general lighting will be soft and warm to enhance immersion and prioritize the visibility of the projections. A continuous LED strip will be integrated into the floor, extending from the entrance to the exit and passing through each sector, functioning as a sensory guide throughout the journey (Bitgood, 2013).

The following figure represents the spatial layout for a possible exhibition of the proposed digital immersive experience:

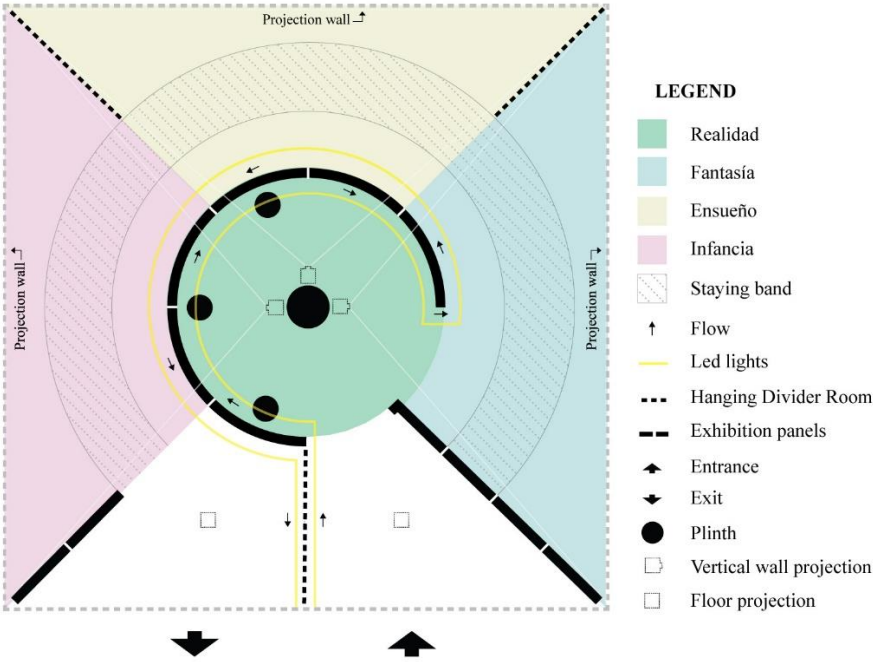

Figure 8: Spatial layout of Sueños de Extremadura

4.4.5. The hardware

The hardware requirements for the proposed immersive experience are directly tied to the four main installations and their functions, along with additional devices and services that support them:

- *Realidad*: This installation serves multiple purposes: as a support element for other installations, as a digital catalog accessible online, and as an interactive installation. Due to its multifunctional nature, we can identify two distinct sets of hardware requirements:

1. Support and Digital Catalog Functions:

   These require a server with at least 1 CPU, 1 GB of RAM, and 10 GB of disk space to host the digital catalog and provide support functionalities.

2. Exhibition Setup:

   When displayed physically as part of the exhibition, the installation will include three tables equipped to allow public interaction with the website. The only requirement for the tablets is the screen size, it is desirable that the tables have a screen size from 10 to 15 inches (large). In addition to the physical setup, QR codes will be provided so that visitors can access the digital catalog on their own devices.

- *Ensueño*: This installation requires a computer capable of running TouchDesigner or TouchPlayer (*System Requirements*, 2025). To ensure optimal performance, a more specific hardware setup is recommended: a computer with an Intel i5 or higher processor, an NVIDIA graphics card with at least 4GB of dedicated memory, and a minimum of 8GB of RAM.

  In addition to the computer, the exhibition setup will also require a large-format TV or projector with a minimum resolution of 4K to ensure a clear and immersive visual presentation. The screen should be at least 85 inches in size (or equivalent projection size) to adequately showcase the content and enhance audience engagement.

  Ensueño also incorporates an EEG sensor to read users' brain waves. While any commercially available EEG headset should be compatible, the installation has been tested with the Muse sensor, which is therefore the recommended device for optimal performance.

- *Fantasía*: This installation will require a similar setup to *Ensueño* for the Touchdesigner/TouchPlayer component and a similar component for the visuals (screen or projector). *Fantasía* will also need to run a ComfyUI server in the background for image generation, having this other requirement increases the amount of VRAM and RAM needed, we suggest a Nvidia RTX 4090 or one of the latest Nvidia RTX 5000 series starting from the RTX 5080 and at least 16GB of RAM for an excellent performance.

- *Infancia*: This installation will also need to fulfill the requirements of Touchdesigner/TouchPlayer and the screen size recommendation. Additionally, *Infancia* utilizes Streamdiffusion. Given that Streamdiffusion is a pipeline for image generation in real-time the frames per second (FPS) rate is very important and we need to guarantee at least 30fps. Having this constrain increases the requirements of this installation to a Nvidia RTX 4090, Nvidia RTX 5080 or superior and at least 16GB of RAM.

  Infancia will also require a webcam for collecting real-time images from the audience and transform them using Streamdiffusion and Cplex-AI using the catalog. The webcam should be plug-and-play via USB, have HDR support (for better results under different lighting setups) and should be compatible with a framerate and resolution of 30fps at 4K or 60fps at 1080p.

- Agents (Cplex-AI): The agents will be available through a web service. A 1CPU 1GB of RAM and 10 GB of disk space should be enough to power the web service. As we have mentioned this Agents are powered by large language models (LLM) we may use a third-party service like the Open-AI, Anthropic or Google and consider the cost of using their services or just opt for free alternatives like Ollama. However, using these free alternatives

comes with hardware considerations: we must take care of the infrastructure and running high-performance models locally (or in a server) requires substantial system resources. While smaller models can run on more modest setups, they may provide lower-quality responses. For example, most Ollama models with 7 to 13 billion parameters typically require 16 to 32 GB of RAM, at least 50 GB of disk space, and around 8 GB of VRAM. Larger models demand significantly more VRAM and memory.

- Additional hardware for the audio is also required; the proposed immersive experience will utilize ambient music and installations like *Ensueño* will produce audio outputs. We recommend the Bose S1 Pro+ portable speaker or similar, it is portable making it easier to place at any point of the installation without the need for cables and has a good battery life and sound quality.

4.4.6. The software

The proposed immersive experience is a compelling example of how diverse software tools (even those not originally intended for artistic use) can be creatively integrated into an art project.

- *Realidad* is a web application built with Laravel (with Inertia JS and Vue 3 for the public faced section and Filament for the admin panel). It also uses PostgreSQL with the pgvector extension (for RAG), redis and horizon for the queues.

  Realidad communicate with the other installations through the event system in Laravel (broadcasting) using Ably or by direct request/response interactions. The other installations

are built in Touchdesigner and can use the built-in web client for making web requests and a custom component for using the Ably SDK in Touchdesigner.

- *Realidad*, *Ensueño* and Fantasía are built in Touchdesigner (TD). Even though TD has a free license for enthusiasts or people that just want to learn how to use the software; for exhibitions it is recommended to have an educational or commercial license, specifically if high resolution images are a must.
- Free community tools and software like ComfyUI, Streamdiffusion, Mediapipe, LangChain, N8N and some others were also used in this project.
- After the publication of this thesis a free and open-source application built with the Tauri framework for collecting the Muse sensor data and send it through the OSC protocol will be released. This application was used in this project to facilitate the process of bringing brain data into Touchdesigner.

4.4.7. All together

The following graph presents all the components of the proposed digitally enhanced immersive experience. It outlines four main interactive installations: *Realidad*, *Ensueño*, *Infancia*, and *Fantasía* each aligned with a conceptual theme: digital catalog, literature and poetry, art, culture and creativity, and landscape and nature, respectively.

At the core of the system is Cplex-AI, which acts as the connective intelligence. It receives input from Realidad based on user ratings. This input then triggers the generation of new prompts or book targets, which are propagated to the other installations. These prompts guide the content experienced in *Ensueño*, *Infancia*, and *Fantasía*, ensuring the experience evolves dynamically based on user interaction and connecting all the installations.

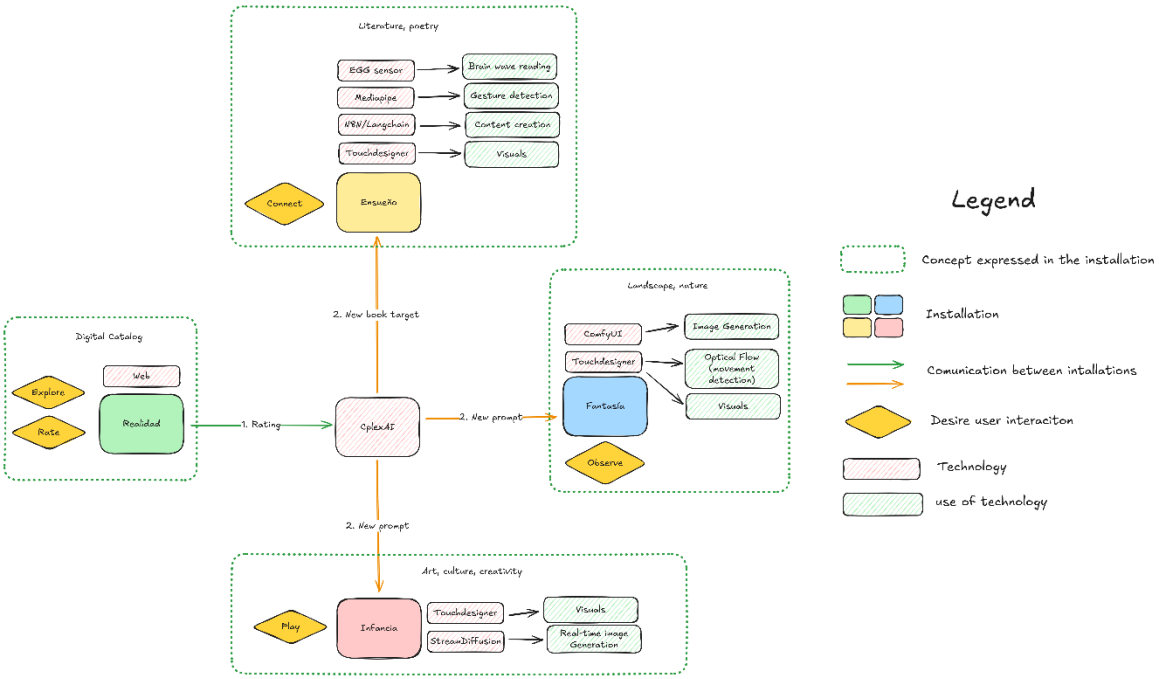

Figure 9: All pieces of Sueños de Extremadura

Each installation uses specific technologies:

- Ensueño leverages EEG sensors for brainwave interpretation, Mediapipe for gesture detection, LangChain/N8N for content generation, and TouchDesigner for real-time visuals.
- Fantasía uses ComfyUI and TouchDesigner to blend image generation and optical flow (movement detection), responding to visitor motion with visual transformations.
- Infancia employs Streamdiffusion and TouchDesigner for real-time image creation, focusing on playfulness and cultural expression.
- Realidad, the entry point, functions as a digital catalog interface, inviting visitors to explore and rate content, thereby influencing the rest of the experience.

The flow of interaction is guided by desired user actions: Explore, Rate, Connect, Observe, and Play which initiate deeper engagement with each conceptual area.

Altogether, this immersive experience seeks to create a responsive, co-creative space where regional identity, literature, memory, and nature are continuously interpreted and reimagined through artificial intelligence and artistic technology. Its goal is to foster a dynamic dialogue between the visitor and the cultural landscape of Extremadura, inviting participants to observe and actively engage, reinterpret, and emotionally connect with the region's heritage through interactive and generative tools.

5. Conclusions

This thesis explored the intersection of immersive technologies, artificial intelligence, and cultural heritage preservation through the design of a digitally enhanced immersive experience based on *Bibliografía Extremeña*. By integrating theory, data analysis, and creative design, the project demonstrates how a traditional textual archive can be reimagined as an engaging, interactive space that invites reflection, observation, participation, and co-creation.

The literature review established a strong foundation for understanding immersive experiences, their psychological and sensory dimensions, and their potential applications in cultural contexts. It also examined the roles of generative and agentic AI in enhancing narrative, interaction, and personalization within immersive environments. Through the case studies of artists like Refik Anadol and a critical assessment of technological tools, the research identified both the transformative potential and the ethical and technical limitations of immersive technologies.

The data exploration phase revealed rich patterns within *Bibliografía Extremeña*, highlighting the centrality of literature, poetry, and history in the region's cultural output. It also underscored themes like rural life, natural landscapes, and community identity. These insights informed the design principles and thematic direction of the immersive experience.

Cplex-AI, developed as a core component of this project, played a dual role: first, as a tool for structuring, cleaning, and enriching the bibliographic data; second, as an active system capable of adapting, generating, and curating content for user interaction. This agentic AI system demonstrates how AI can move beyond static data processing to become a creative and participatory force in cultural expression.

This project also stands as a clear example of a text-driven immersive experience; an experience built entirely upon the textual content of a literary catalog. It shows how meaning can be extracted directly from text and transformed into multi-sensory, emotional, and spatial interactions. This approach opens new avenues for archives and libraries to engage audiences through the power of language alone.

Ultimately, *Sueños de Extremadura* seeks to display archival content in an animated fashion transforming a literary catalog into a dynamic, sensory, and participatory environment. This project seeks to prove that immersive technologies, when used thoughtfully and ethically, can foster new ways of engaging with heritage, deepening users' emotional and intellectual connections to regional identity.

The work presented here is a prototype for broader applications of immersive, AI-driven experiences in the cultural sector. It invites further exploration into how archives, narratives, and technologies can collaborate to preserve and evolve collective memory in the digital age.

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7. Appendices

7.1. Example of AI-Assisted Writing

The following is an example of how AI was used in this thesis to refine some of the paragraphs. All ideas presented in this work are entirely the author's own. The initial version of the paragraph was written by the author, and AI was employed to enhance clarity and improve the language flow. The paragraph included here is part of the thesis and could change during the final review process. Below is the initial version of the paragraph:

> *Bibliografía extremeña* is a collection of books made by Manuel Pecellín Lancharro, where he put together, categorize and analyze books about Extremadura or wrote by people born there. It goes from 1990s to 2023, and is like a big catalog of the region books. Each book is in a category and says the name of author, the city, the publisher and year when it come out. Also, Pecellín write some reviews for the books and give his opinion, making the list more interesting.

Here is the same paragraph after being refined with the help of AI:

> *Bibliografía extremeña* is a collection of works compiled by Manuel Pecellín Lancharro, in which he meticulously gathers, categorizes, and analyzes every publication either about Extremadura or authored by a writer born in the region. Spanning from the 1990s to 2023, this collection serves as a comprehensive catalog of the region's literary output. Each entry is organized by category and includes details such as the author's name, the

city and publisher of publication, and the year of release. Additionally, Pecellín provides thoughtful reviews for each work, adding critical insight to the entries.

It can be observed that the main ideas were not changed. Both paragraphs share the same structure and convey the same core points, almost sentence by sentence:

1. *Bibliografía extremeña* is a collection compiled by Manuel Pecellín Lancharro.
2. The collection gathers, categorizes, and analyzes books about Extremadura or by authors born there.
3. The collection spans from the 1990s to 2023.
4. Each book is placed into a category and includes details such as the author's name, city, publisher, and year of publication.
5. Pecellín provides reviews and personal insights, adding value and interest to the collection.

7.2. Realidad

The following screenshot showcases the webpage (https://bibextre.com) developed for presenting "*Realidad*." This straightforward interface is built using Laravel and Vue.js, incorporating basic user interactions. Users can select a book from the list to display its details centrally, rate it using buttons located at the bottom, and utilize a 'Next Book' button accompanied by a countdown timer. Once the timer reaches zero, the system automatically transitions to the next book in the list, facilitating an automatic mode for seamless browsing. The

final version of this webpage may differ, as updates and changes are still in progress at the moment of writing this.

Figure 10: Screenshot of the online catalog presented as "Realidad"

7.3. Ensueño

Ensueño's workflow is divided into three main parts:

1. **Visual Representation Subnetwork:** A dynamic particle system shaped like a neuron, symbolizing the mental connection with the user through the Muse headband.
2. **Content Subnetwork:** Responsible for retrieving text content from n8n whenever an event is triggered on the webpage.
3. **Main Orchestration Network:** Coordinates the entire system: receiving input from the Muse headband, managing the subnetworks, and calling external services like ElevenLabs for real-time text-to-speech generation.

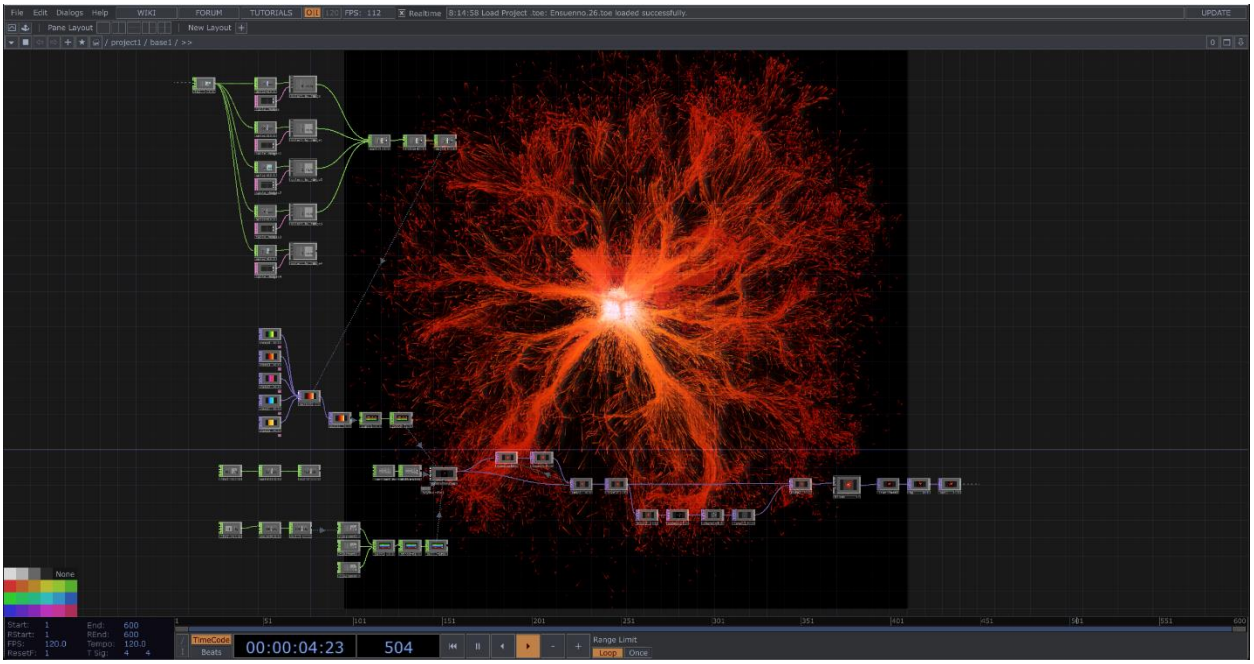

Figure 11: Enseuño´s visual representation subnetwork

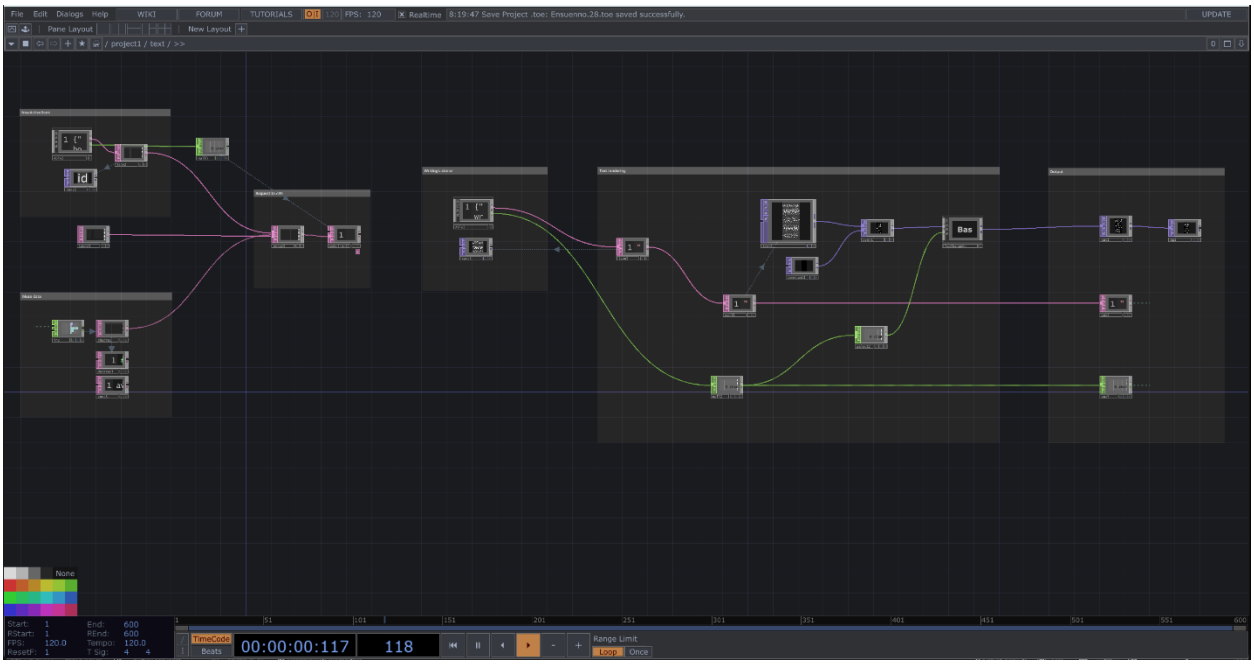

Figure 12: Content Subnetwork

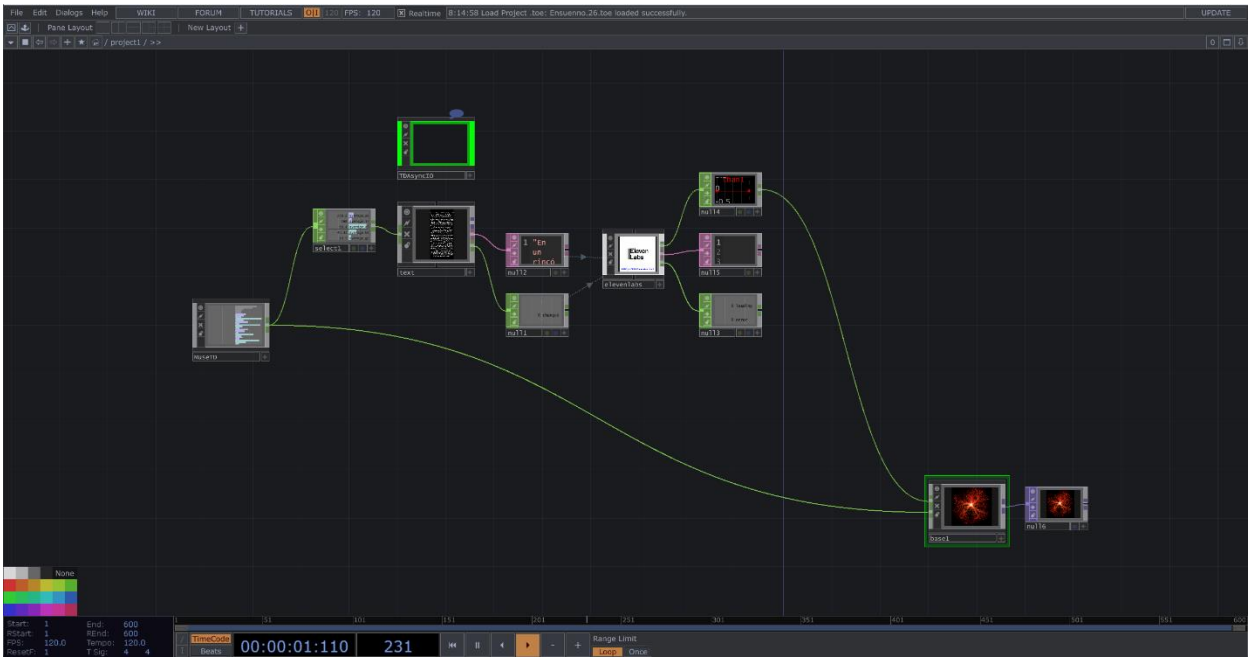

Figure 13: Main Orchestration Network

7.4. Fantasía

Fantasía's workflow is elegantly simple. A TouchDesigner component, integrated with Ably via its Python SDK, acts as an event listener; triggered whenever a book is selected and the n8n workflow ("PromptWriter") finishes generating a new prompt. TouchDesigner continuously sends prompts to ComfyUI for image generation. The resulting images are then transformed using filters that apply styles such as watercolor or dreamlike diffusion. When a new prompt arrives, TouchDesigner updates ComfyUI accordingly, and the process continues in a seamless, infinite loop.

An additional creative technique used in the installation is optical flow. By leveraging TouchDesigner's built-in optical flow component along with a webcam, the system detects the movement of the audience. The more movement detected, the more intense the visual filter becomes, resulting in an increasingly diffuse and ethereal final image.

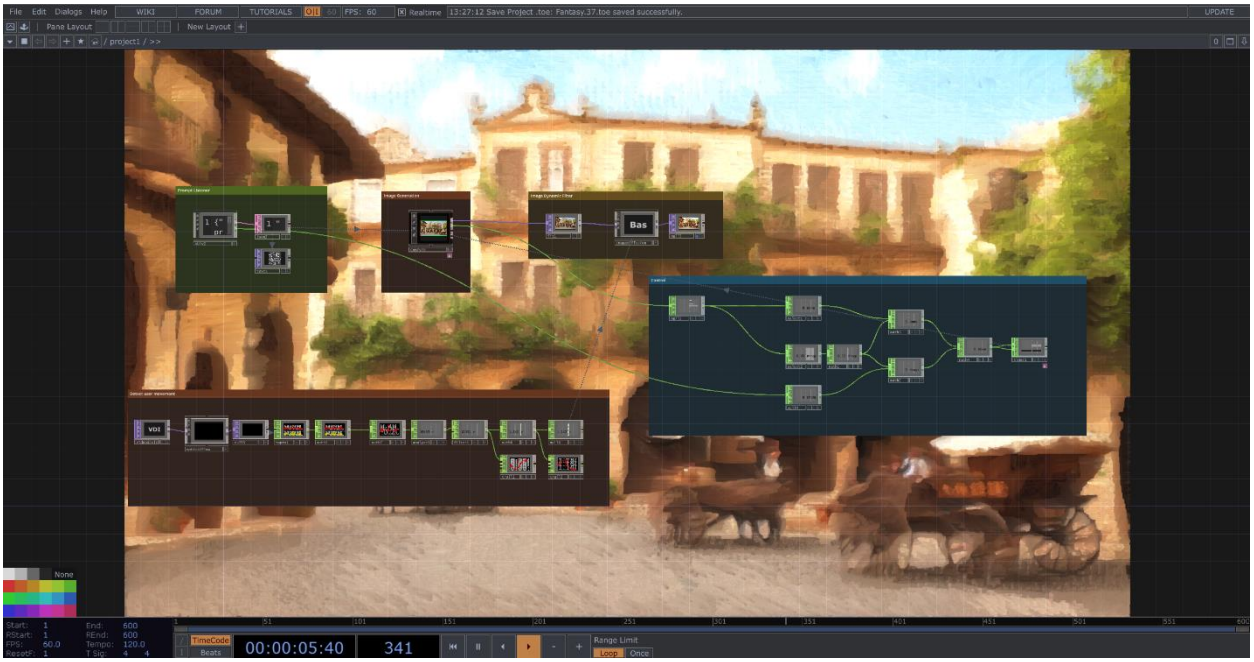

Figure 14: Fantasía´s Touchdesigner network

The following are additional examples of *Fantasía*'s output. Please note that these are taken from an animation, the original experience is dynamic, not composed of static images. The images are generated from the book "Extremadura. Cien años" by Blasco Fuerte, Julian (1996). And the result of the PromptWriter n8n workflow is: "A nostalgic view of Extremadura, Spain, featuring eight antique postcards showcasing the charming architectural styles of old towns, such as Cáceres and Puerta Palmas. The setting includes traditional mule carts traversing cobblestone streets, melon vendors selling fresh produce in the bustling Plaza Mayor, all captured in soft, warm lighting to evoke a sense of history and change over the past century. This scene embodies a vintage postcard aesthetic, with vivid pastel colors and intricate details reflecting the cultural richness of Extremadura".

Figure 15: Fantsía, example 1

Figure 16: Fantasía, example 2

7.5. Infancia

Infancia functions similarly to Fantasía, using a TouchDesigner network with components that listen for events from n8n to update the prompt. However, unlike Fantasía, Infancia employs StreamDiffusion for image generation. The visual output is transformed through a unique Lego-like aesthetic, created in TouchDesigner using image instancing and 3D objects.

Infancia is designed to be playful and interactive. Users can actively engage with the installation, triggering real-time changes. A live camera feed captures the scene, and thanks to StreamDiffusion's image-to-image capabilities, the system can generate responsive visuals on the fly, turning real-time input into dynamic, evolving imagery.

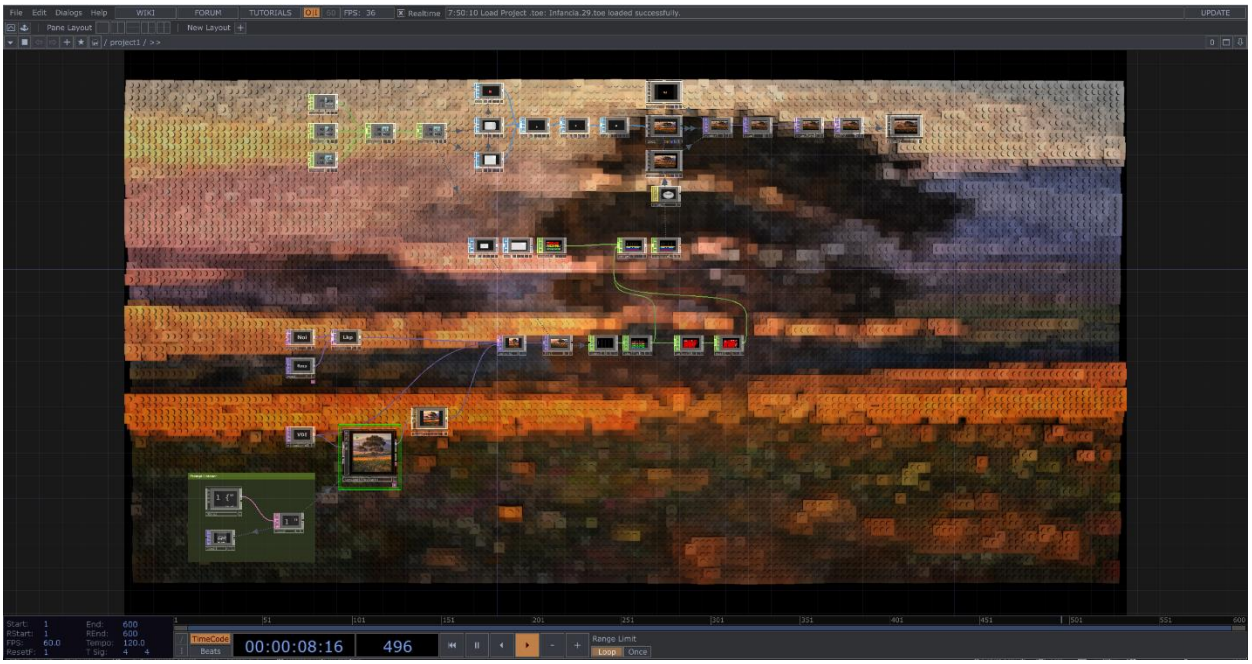

Figure 17: Infancia's Touchdesigner network.

The following are additional examples of Infancia's output using the prompt: "A picturesque view of an idyllic village in Extremadura, Spain, nestled among rolling hills, featuring rustic

stone houses with red-tiled roofs, surrounded by vibrant wildflowers and green fields under a clear blue sky. Sunlight bathes the scene in golden hues, creating a warm and inviting atmosphere. Traditional Spanish architecture is showcased with charming balconies adorned with colorful flowers, while distant mountains frame the background. The foreground includes a winding dirt path leading through the village, inviting exploration and discovery." Inspired by the book “El Quijote en Extremadura” by several authors.

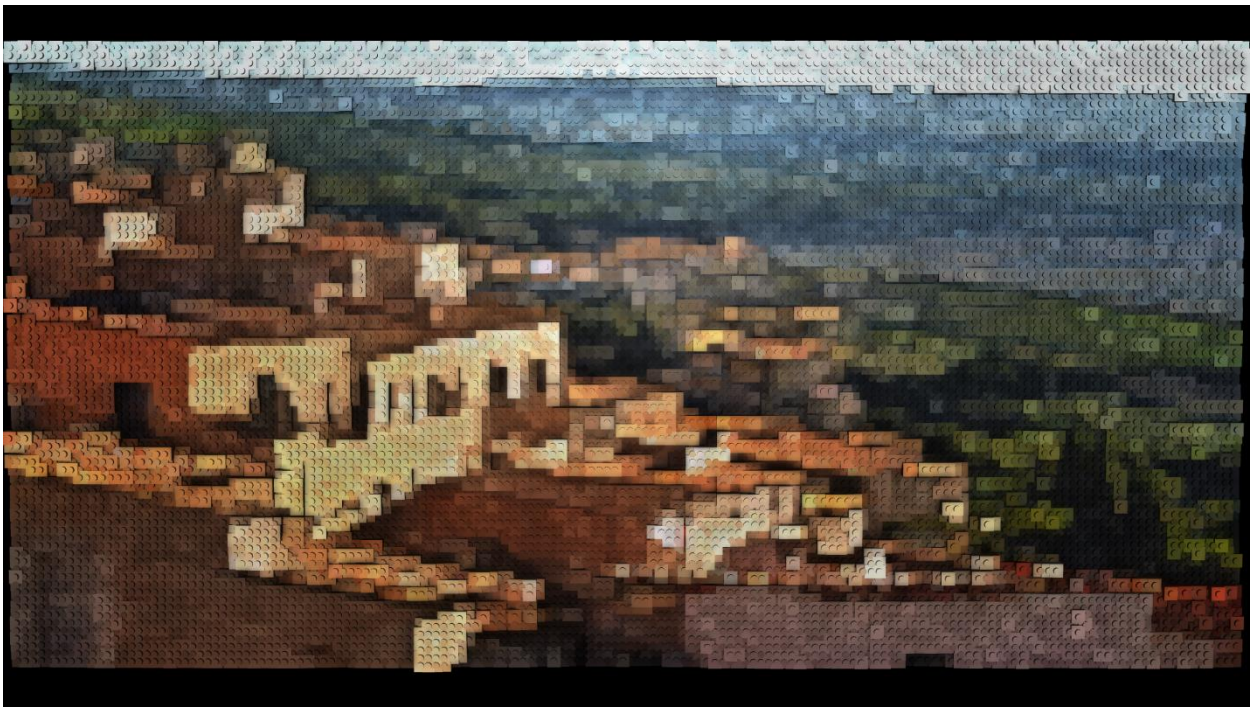

Figure 18: Infancia, example 1

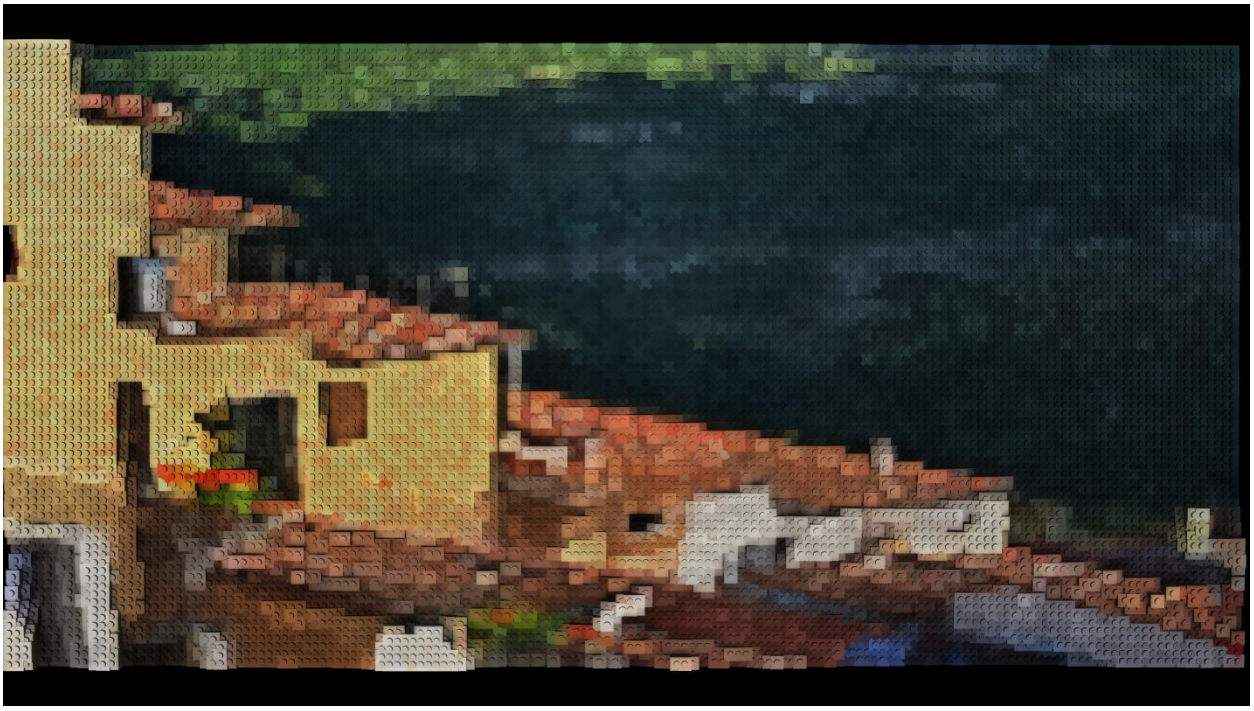

Figure 19: Infancia, example 2

8. Curriculum Vitae

Name: Luis Enrique Reyes Pérez

Education:

- Master of Arts, Western University, London, ON, Canada (2023-2025)
- Bachelor in Computer Sciences, Universidad de las Ciencias Informáticas, Havana, Cuba (2017-2022)

Mentoring Experience:

- Teaching Assistant: Programing my digital life DH 1011A, Creativity Studio DH 2127B, Creating with AI DH 3110B. (2023-2025)

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- Dean’s Entrance Scholarship (2023)
- Chair’s Entrance Scholarship (2023)