



School Of Applied Arts And Sustainable Design

Postgraduate Dissertation

# URBAN NARRATIVES

*Integrating City Exploration  
And Personal Experience*

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Patras, Greece, January 2025

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*Integrating City Exploration  
And Personal Experience*

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## **Abstract**

The project focuses on enhancing urban engagement by integrating technology into city exploration, encouraging citizens to move beyond habitual, linear routes. Rooted in the idea that cities are dynamic organisms shaped by human experiences, it seeks to uncover the hidden narratives, stories, and rhythms of urban spaces. By allowing users to map their emotions onto physical locations via an interactive platform, it creates a shared emotional representation of the city, blending the tangible and intangible.

The system visualizes emotions as a dynamic particle system, analyzing and transforming them into an evolving urban "landscape" that coexists with the physical one. This approach creates emotional engagement, strengthens individuals' connection to their city, and provides valuable insights into the spatial and emotional dynamics of urban life. By exploring intersections between personal stories and the city's patterns, it bridges subjective experiences with collective narratives.

Keywords: Emotional Mapping, Urban Exploration, Data Visualization, Digital Media, Augmented Reality (AR), Algorithmic Design, Cognitive Mapping

### **Urban Narratives**

*Integrating City Exploration and Personal Experience*

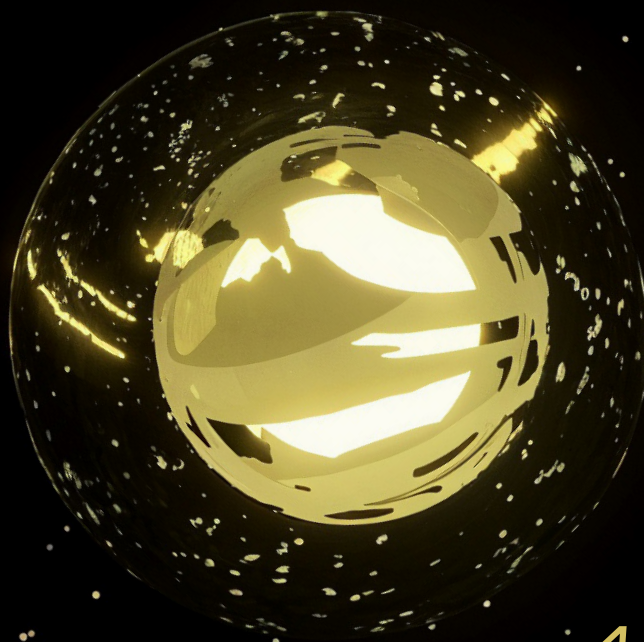
By Dimitra Vasileiou



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1

Analysis

## 1. ANALYSIS

### 1.1. Conceptual Foundations

In contemporary urban environments, personal experiences reveal that the routes individuals take in their daily lives tend to be predefined and highly specific, whether by car, bike, or on foot.

Space Syntax analysis (Hillier & Hanson, 1984)<sup>1</sup> supports this observation, highlighting how people prefer routes that maximize visibility and connectivity, favoring simpler and more accessible paths. These choices are aligned with everyday needs, as they facilitate quicker and more predictable navigation. In Space Syntax, visibility and connectivity are essential concepts that describe how people navigate through urban spaces. Visibility refers to how much of the surrounding area can be seen from a specific point, influencing how open or closed a space feels. Connectivity measures how well a point is connected to the surrounding spatial network. These factors shape the predictable walking patterns and highlight that individuals tend to follow familiar routes directly to their destinations, rarely deviating to discover less familiar or less connected areas.

Kevin Lynch<sup>2</sup>, in *The Image of the City* (1960), notes that disorientation in urban environments often leads to stress and anxiety. Some may find exploration exciting, but intense disorientation is generally unpleasant. Lynch emphasizes the importance of clear structures in urban spaces. Unexpected surprises and new experiences should happen within a framework that helps people stay oriented. Urban environments should be recognizable, offering people opportunities to explore without compromising their sense of direction.

However, the evolution of digital tools has minimized these negative experiences. With the widespread use of digital maps and navigation apps, people can plan their routes precisely, significantly reducing the chance of getting lost. As a result, urban trips can become preplanned and any disruptions or errors are seen as failures of the system. When it comes to leisure walks on people's free time, though, this emphasis on efficiency may limit the potential for exploration. As people tend to favor familiarity, well connected paths, or predefined routes, they may overlook less explored or less accessible areas, diminishing opportunities for discovery and engagement with the environment.

When safety concerns are minimal and disorientation isn't a major factor, the predictability of travel patterns can make urban experiences feel dull during leisure time. These habitual patterns limit engagement with the city's diversity, leaving some aspects of the urban environment overlooked. While efficient navigation is crucial for reaching destinations, it's important to reconsider one's relationship with the city's geography. By encouraging more spontaneous exploration, people can discover new paths and

experiences that deepen their understanding of the surroundings. This shift in perspective transforms the city from a mere background of other routines into foreground, an engaging space with endless opportunities for discovery and connection.

## **1 2. Urban Walks and Planning -The Brief History**

The relationship between individuals and the urban environment has been a persistent theme throughout history. Whether through spontaneous wandering, structured urban mapping, or digitally enhanced exploration, city traversal highlights how individuals perceive and connect with their city.

### **1.2.1. Enlightenment Era (17th-18th Century)**

During the Enlightenment, cities began to be treated according to rationality. Architects emphasized order, reason and the importance of public spaces for common use. This era brought development of urban planning principles that prioritized accessibility and functionality. The Enlightenment also brought attention to the importance of public amenities, such as parks and green spaces. Enlightenment urban planning laid the groundwork for many principles still valued in modern city design. (Kostof, 1991)<sup>3</sup>

### **1.2.2. Romanticism and the Origins of Urban Strolling (Late 18th - Mid 19th Century)**

In the 19th century, the Romantics rebelled against the mechanistic world-view of the Enlightenment, advocating for a more holistic approach to nature and society. Central to this movement was the concept of *flânerie*, or urban strolling, which celebrated the act of leisurely wandering through city streets as a means of connecting with the soul of the city and its inhabitants. This practice was not just about physical movement but also about engaging with the city's character. (Shaya, 2004)<sup>4</sup>

### **1.2.3. Modernism (Late 19th - Mid 20th Century)**

The rise of Modernism in the early 20th century brought a big shift in urban design, further emphasizing functionality and efficiency as key principles. This movement was heavily influenced by the rapid industrialization and technological advancements of the time, which reshaped cities into centers of production and innovation. Modernist architects tried to address the challenges of urban growth, such as overcrowding, poor sanitation and complicated city layouts, by promoting systematic planning and standardized design. (Frampton, 1980)<sup>5</sup>

Architects like Le Corbusier played a crucial role in this era, envisioning cities as "machines for living." His ideas emphasized the use of geometric forms, zoning principles and high density housing to create efficient urban environments. In his concept of

the Ville Radieuse (Radiant City), Le Corbusier proposed a city structured around functional zones: areas for living, working and recreation, all interconnected by wide streets designed for automobile traffic. This approach sought to eliminate the disorder of cities, promoting a vision of urban life where every element served a specific purpose. (Le Corbusier, 1929)<sup>6</sup>

#### 1.2.4. The Garden City Movement (Late 19th - Early 20th Century)

The Garden City Movement, initiated by Ebenezer Howard in the late 19th and early 20th centuries, tried to address the challenges posed by the industrialization, such as overcrowding, pollution and poor living conditions. Howard's vision proposed a balance between urban and rural life through the creation of self-contained communities surrounded by green zones. These "garden cities" emphasized human-scale design and access to nature.

Howard's approach to urban planning shared some similarities with the principles of Modernism, particularly in its focus on functionality, systematic planning and efficiency. Both movements aimed to reshape urban environments in order to meet human needs and improve quality of life. However, while Modernist architects like Le Corbusier emphasized high density and machine-like urban structures, Howard prioritized a more organic and community-centered approach. His garden cities were intentionally small. They had zones for housing, work and recreation, all within walking distance. (Howard, 1902)<sup>7</sup>

#### 1.2.5. Mid to Late 20th Century

Postmodern urbanism emerged as a critique on Modernism's approach to city design. Advocating for a more human scale approach, Jane Jacobs, in her work *The Death and Life of Great American Cities* (1961)<sup>8</sup>, emphasized vibrant streetscapes, mixed use neighborhoods, and the importance of community engagement. Jacobs argued that cities thrive when they are designed to support improvisation and unplanned interactions, with walkable streets that foster connections between people and their surroundings.

Throughout the 20th century, urban walking emerged as not only a leisure activity but also a cultural critique. Concepts such as the psychogeographical *dérive* were introduced, pioneered by the Situationist International in the mid-20th century. *Dérive* aimed to disrupt the monotony of everyday life by encouraging individuals to wander aimlessly through urban environments, guided only by their impulses. Unlike structured navigation, *dérive* rejected the rationalized, functional use of urban space, favoring aimless wandering as a means to uncover the hidden layers of a city's emotional and psychological influence on its inhabitants. Psychogeography criticized the capitalist construction of cities,

which emphasized efficiency, productivity and consumerism at the expense of a more authentic human experience. By wandering without purpose, individuals could escape the routine patterns imposed by capitalism, rediscover forgotten spaces and foster a deeper connection to the urban environment. (Debord, 1958)<sup>9</sup>

Kevin Lynch's work, particularly his influential book "The Image of the City (1960)", is crucial in understanding urban design and the perception of cityscapes. Lynch introduced the idea that individuals create mental maps based on five key elements: paths, edges, districts, nodes and landmarks. These elements help people navigate and make sense of their urban environment, by emphasizing the importance of cities being visually memorable and coherent. He argued that a well structured city enhances the experience of its inhabitants, allowing them to develop a deeper connection with their surroundings.

Space Syntax, developed by Bill Hillier and his colleagues in the late 20th century, is based on similar principles, as it analyzes the spatial configuration of urban environments. This analytical framework studies how the layout of streets and public spaces affects social interactions and movement patterns within a city. It emphasizes the relationship between spatial configuration and human behavior, highlighting how connectivity and visibility influence movement and accessibility.

### 1.2.6. Technological Transformations in Urban Walking (Late 20th - 21st Century)

Nowadays, urban exploration has undergone significant transformations with the integration of advanced technologies, blurring the boundaries between physical and virtual spaces. Contemporary urban walkers can navigate city streets using innovative tools that merge their physical experiences with digital enhancements. These technologies allow for the creation of interconnected narratives, enabling individuals to engage with urban environments dynamically.

Augmented reality (AR) enhanced walking tours, such as TimeLooper<sup>10</sup> and Streetmuseum<sup>11</sup> demonstrate how historical reconstructions can be projected onto present day landscapes. By simply pointing smartphones at specific locations, users can visualize past events or structures, merging history with contemporary urban life. This blending of digital and physical layers creates a deeper connection to the city, transforming landscapes into archives of collective memory. Other examples such as Geocaching<sup>12</sup>, a globally practiced GPS enabled treasure hunting activity, reinterprets spaces through gamified exploration. In a similar manner, applications such as Pokémon GO<sup>13</sup> and other guided AR/VR experiences have reintroduced game elements into urban space, encouraging individuals to interact with their surroundings in new ways.

The potential of these technological advancements extends beyond leisure and entertainment. AR, VR, and other digital tools are



increasingly used by artists, curators and other specialists to create immersive experiences that draw inspiration from how people interact with a space. These tools enable users to visualize data, reconstruct historical events, or even imagine future ones, offering new ways to engage with the complexities of modern cities. By merging physical and digital realms, these tools can deepen emotional connections to urban spaces and create participatory experiences that can strengthen one's identity.

### **1 3. Connections Between Walking and Urban Design Over Time**

Throughout history, walking has been deeply associated with the evolution of urban design and exploration. From the Enlightenment's rational layouts to the Romantic celebration of *flânerie*, urban walking has consistently reflected cultural values and societal priorities. Modernism's focus on efficiency redefined walking to mechanized movement, while Postmodernism revived its importance as a means of strengthening the sense of community. Psychogeography further expanded walking's role as a critical resistance practice, offering an alternative way to engage with urban spaces.

In contemporary contexts, technological advancements have added new layers to the experience, blending physical and virtual realities to create dynamic urban interactions. Despite these changes, the essence of walking as a means of exploration remains unchanged. Walking continues to be a vital link between individuals and their environments, offering opportunities to engage with the complexities of urban life. In this evolving landscape, the integration of technology into urban exploration presents great potential to transform the way cities are experienced and perceived.

On the other hand, while GPS tools and digital navigation maps are very useful, they can influence how citizens and wanderers engage with urban environments. As they prioritize efficiency in movement, these tools often discourage deviation from predefined paths, associating the act of getting lost with failure of the algorithm, rather than seeing it as an opportunity for discovery. This reliance on digital navigation can reshape the way individuals perceive their cities, reducing them to functional spaces. Additionally, it creates a passive interaction with the urban landscape. The thrill of stumbling upon something unexpected gets often eliminated, as the app presents destinations and attractions directly, leaving little room for discovery by chance. This may lead to a declined interest in wandering urban environments during one's free time, as the sense of curiosity, essential to meaningful exploration, gets overshadowed by goal-oriented navigation. As a result, the interaction with one's city may become monotonous.

Additionally, as GPS systems and mobile apps have developed, a decline in individuals' ability to navigate independently has been observed, particularly affecting abilities like spatial reasoning and map reading. This overuse may also influence brain structures, such as the hippocampus, which are crucial for navigation. (Huston &



Hamburger, 2023)<sup>14</sup>

So, the challenge is finding balance between the convenience of technology and the joy of curiosity and discovery, particularly during leisure time. While digital tools make navigation easier and more efficient, they can take away the excitement of exploring a city at one's own pace. By blending the use of technology with opportunities for independent exploration, cities can remain spaces full of surprises and creativity.

#### **1 4. Contemporary Strolling**

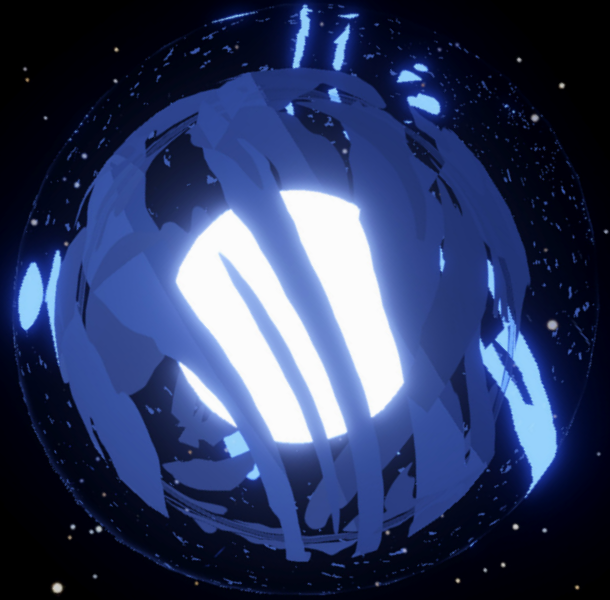
Historically, the act of *flânerie* or urban strolling was associated with privilege, as it required both the time and the economical and social freedom in order to engage in such wanderings. Gradually, urban exploration has evolved through various stages, followed by psychogeography to contemporary strolling. Urban wandering offers individuals a chance to reconnect with the city in more genuine and unstructured ways, breaking free from the repetitive routines of daily life, which are often tied to specific places and their perceived boundaries.

In the current era of globalized cities, *flânerie* has gained significance. As cities become increasingly interconnected and influenced by cultural exchange, urban walks can evolve into reflective and critical practices that engage with the complexities of these transformations. Far removed from the leisurely pursuits of the 19th-century Parisian *flâneur*, modern *flânerie* can offer wanderers the exploration of myriads of layers of globalized cities, navigating not only their physical spaces but also their symbolic and cultural aspects. (Kramer & Short, 2011)<sup>15</sup>

#### **1 5. Psychosocial and Cultural Aspects of Walking**

Walking, as a practice, has great psychosocial and cultural significance, extending beyond mere physical movement. Research indicates that walking has notable benefits for mental well-being, including reducing stress, enhancing mood, and sparking creativity<sup>16</sup>. The act of walking provides meditation that allows individuals to process emotions and thoughts, making it both restorative and introspective.

Culturally, walking has been connected with symbolic and social practices. Religious pilgrimages, for example, transform walking into a spiritual journey, creating a sense of purpose and connection to the divine. Similarly, political marches defined walking as an act of collective resistance and solidarity, turning public spaces into places for social change and resistance. These diverse practices highlight how walking serves as a bridge between personal reflection and collective action.



2

Urban Exploration

## 2. **URBAN EXPLORATION**

### 2.1. **The Exploration Aspect**

Walking and mobility are central aspects of wandering, offering the physical way to traverse urban spaces and engage with the environment. However, exploring and wandering is not only about physical movement, but it is also driven by the deeper urge for discovery. This desire to discover, encounter the unexpected or engage with the surprise of the unknown, transforms the act of walking into an act of personal growth. The act of exploration satisfies a fundamental human need to uncover new perspectives and meanings in the spaces we inhabit.

#### 2.1.1. **Collective Exploration**

Exploration is fundamentally driven by human curiosity and the desire to expand our knowledge. Tourist exploration, for example, is often driven by the need of experiencing new cultures, places and diverse ways of living. In parallel, space exploration represents humanity's pursuit of knowledge and adventure beyond our planet's boundaries. These experiences not only enrich individual lives but also contribute to the collective understanding of human existence and our place within the universe. Exploration is at the heart of human progress, driving advancements in science, culture, and societal development. Therefore, from the ancient sea voyages to the modern space missions, exploration has continually pushed humanity beyond its boundaries. Each journey into the unknown has uncovered new knowledge, employed innovation and challenged existing norms, shaping our understanding of the world and our very place in it.

#### 2.1.2. **Inner Exploration**

Known psychologist Carl Jung placed great importance on the idea of exploration, both within ourselves and in the world around us. A key part of his concept of individuation, meaning the process of becoming a whole, involves inner exploration. He saw this as a journey into the unconscious, where hidden fears, desires and common archetypes live. In *Memories, Dreams, Reflections*<sup>17</sup>, he wrote, "*Your vision will become clear only when you can look into your own heart. Who looks outside, dreams; who looks inside, awakes,*" capturing the importance of exploring the inner self, in order to find clarity and purpose. Jung also believed that exploration is a natural human drive. He described the Seeker or Explorer human archetype, which represents our curiosity and need to venture into the unknown. This could mean physical travel, emotional growth and intellectual discovery. He believed that stepping beyond what is familiar, both within ourselves and in the world, can lead to new insights and a deeper comprehension of one's life.

Exploration is a big part of the human experience and is often seen in myths and stories as a hero's journey or a quest for meaning. (Campbell, 1949)<sup>18</sup> The hero's journey monomyth, a universal narrative structure that is used in a lot of stories, describes a hero who embarks on an adventure, faces challenges and finally undergoes emotional transformation. This archetypal journey mirrors the human drive to venture beyond the familiar, discover deeper truths about oneself and the world, or even seek purpose.

"Not all those who wander are lost"  
— J.R.R. Tolkien, *The Fellowship of the Ring*<sup>19</sup>

The dual nature of exploration, as both a personal and a collective experience, highlights its significant meaning in shaping societal and personal narratives and aspirations.

### 2.1.3. The analogy with digital games

When understanding the concept of exploration, an interesting analogy can be drawn with the digital and often imaginary worlds of open world digital games. These games are designed to encourage exploration, inviting players to wander, discover and interact with their environments. Through these digital worlds, we can gain insight into what drives us to explore and what elements make exploration enjoyable, particularly when safety concerns are low.

In digital settings, safety concerns are minimal. Players may experience stress or excitement, but these feelings do not translate into tangible risks. This allows for a unique form of exploration, where players can freely navigate without the same anxieties they might face in the real world.

In well-designed games, players respond instinctively to visual cues that guide their movements, signaling where they should go or where they might encounter danger. This creates a dynamic where players make choices based on the in-game consequences that could follow. The exploration factor is not always a given, as in a lot of contemporary games the focus is not on the quality of the exploration, but on the creation of large amounts of game content. The gameplay often revolves around progressing from one point to another in order to unlock abilities or acquire specific artifacts. As a result, the exploration aspects tend to become uninteresting and repetitive when the objectives are clearly highlighted on the map. Individuals may find themselves focused on reaching specific goals, paying little attention to the digital world that surrounds them, much like how GPS navigation can eliminate the experience of urban wandering by prioritizing efficiency.

On the other hand, in some games the exploration urge starts to emerge when the players start to believe that they encounter

something interesting or unusual. The key here lies to the possibility rather than the certainty in a form of a map pin. This possibility of the unknown causes curiosity. A game designer might have designed something, maybe a special artifact, or a new character interaction. The design factor plays a big part, because it has an intention, it gives the player great satisfaction to have been able to discover something that might be significant. These encounters are in the most part not based on the spectacle, as in modern games great graphics and visualization are being considered as a given. They are random game elements or characters that offer hints and insights into the game's lore and spark curiosity and emotional engagement.

So, as in virtual games, in real life too, what makes the journey of exploration so intriguing is the potential promise of a rewarding discovery. This offers a sense of unpredictability and allows room for individual curiosity and interpretation.

#### **2.1.4. Artistic and Creative Exploration**

For artists, writers and creators, exploration is both a source of inspiration and a method of discovery. Urban spaces, with their mix of history, culture, and daily life, provide an endless palette for creative expression. Walking through cities often lead to spontaneous encounters with people, places and stories, sparking ideas that may not arise in static environments. These experiences offer a way to engage with the world in its raw and real form, transforming everyday observations into compelling narratives that can inspire art.

### **2.2. Exploring Urban Environment: A Dual Perspective**

The act of exploration operates on two levels: personal and collective. Both of them contribute to shaping our understanding of the world. On a personal level, exploration allows individuals to venture beyond their routines, whether by wandering through places, engaging with new ideas, or seeking emotional growth. On a collective level, exploration fuels shared experiences and advancements. Together, these perspectives highlight how exploration, whether physical, intellectual, or emotional, bridges the gap between personal and societal growth, offering both individuals and communities a way to engage with the complexities of existence.

Additionally, these personal discoveries create new meanings to the city itself, enriching its collective narrative with different perspectives and stories. These personal discoveries help define the social fabric, as inhabitants of a city are connected in one way or another. In line with the theory of the commons, urban spaces and resources are shared by everyone in the community. Theory of the

commons refers to the shared use of resources that are accessible to all members of a community. In an urban context, it applies to public spaces like streets, parks, or squares which are collectively used by society. Unlike private property, these "commons" are intended to serve the collective good, fostering inclusivity and collaboration among citizens. The theory emphasizes the importance of the non discriminating access and the shared responsibility of preserving those resources for future generations. It also suggests that the ways people use and interact with them shape the social fabric of the city, reinforcing connections and a sense of belonging. (Ostrom, 1990)<sup>20</sup>

A common example of the theory of the commons is the scenario of a community managing a lake with fish. In this context, the lake is considered a shared resource or a "common" and the community collectively relies on its fish. If every individual were to fish as much as they wanted without considering the long term health of the lake, it could quickly become alienated. However, when the community works collectively to establish rules, such as fishing limits, seasons, or other sustainable methods, it ensures that the lake remains a viable resource for everyone, not just for the present but also for future generations.

This analogy applied to the urban context, suggests that the inhabitants of a city should collectively manage shared resources or "commons" of their city of residence. It is very important to recognize the complexities of a city and the value of shared spaces, by understanding the diverse perspectives, needs and challenges faced by the whole community. This journey begins with awareness, progresses to understanding and ultimately leads to action. Through exploration and discovery, individuals can gain insight into how various actions, or the lack thereof, can affect society. Just as with the example of the lake, this process requires continuous attention, understanding and engagement, all of which are results of the initial willingness to explore and uncover these complex dynamics.

### **2 3. What makes us explore**

Exploration is driven by a complex mix of curiosity, the need for personal growth and the desire to contribute to the shared knowledge. People are motivated to explore by the tangible outcomes of their actions but also by the intangible rewards of discovery. Exploration goes beyond the physical act of traversing new spaces, rather it involves emotional engagement that can lead to growth. The act of wandering through a place evokes emotions ranging from excitement and wonder to introspection and even fear. Psychologically, it satisfies a fundamental need for stimulation, contributing to well-being and creativity.

"What makes the desert beautiful is that somewhere it hides a well."

-Saint-Exupéry, Little Prince<sup>21</sup>

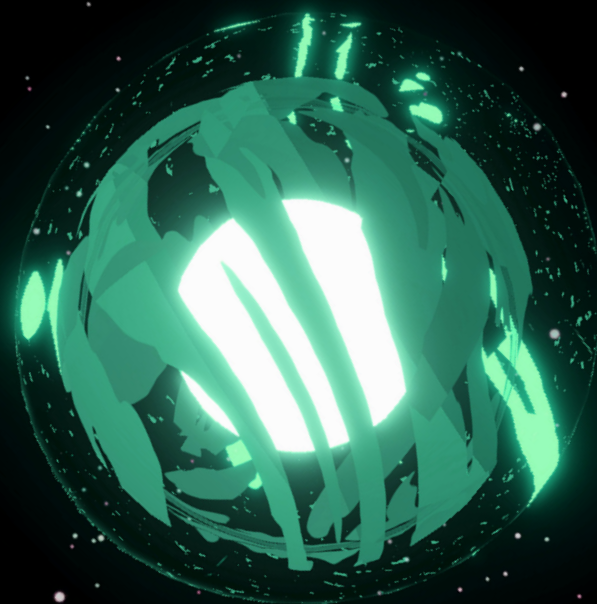
## **2 4. Quantitative data and subjective experience**

Urban wandering or exploration is shaped by both objective and subjective factors. On one hand, measurable data such as Space Syntax analysis, Kevin Lynch's concept of imaginability, weather and seasonal changes provide insights into how people collectively engage with and navigate urban spaces. These data driven approaches highlight the functional aspects of the city, revealing its infrastructure, land use and organizational patterns, which regulate movement and flow. Urban life, however, is also defined by the overlapping rhythms of human activity, social practices and infrastructure. Daily routines, public transport schedules and seasonal cycles create the rhythmic patterns of urban space, shaping how people interact with their environment at different times of the day or year (Lefebvre, 2004)<sup>22</sup>.

Henri Lefebvre's Rhythmanalysis further explores these patterns of urban life, highlighting how urban rhythms are created from the interplay between cyclical elements, such as day and night and human made schedules like work hours or public transportation schedules. These rhythms are influencing how individuals interact with a city. For example, the flow of commuters during peak hours or the liveliness of public squares on weekends show the rhythmic dynamics that influence both urban flow and collective behaviors.

On the other hand, the subjective experience introduces an individual layer that is less predictable. Each person's perspective is shaped by their unique emotions, memories, beliefs and aspirations, influencing how they navigate and interact with a place. This individuality shapes how one responds to the city's rhythms, either harmonizing with or diverging from them. So, while objective data can provide insights into the physical structure of a city and its collective patterns, it falls short of capturing the personal motivations and perceptions. Personal experiences create a different relationship with the city that is highly dynamic and cannot be fully quantified.





3

• Emotional Landscapes



### **3. EMOTIONAL LANDSCAPES**

#### **3.1. Emotional, Psychological and Philosophical Dimensions**

From psychology to urban planning, and from subjective to quantitative data, cities can be studied through various aspects and diverse fields. A city can be analyzed by its layout, environmental features or the rhythmic cycles of activity. When attempting to incorporate the different narratives that exist within a city, several parameters interplay, shaping the lived experiences of its inhabitants.

The final outcome of this interplay between spatial, environmental, social and psychological factors is often the emotions that emerge within the inhabitants. These emotions are shaped by a complex web of influences that cannot be fully captured through spatial or quantitative analysis alone. Emotions encapsulate both personal and shared experiences of urban life, serving as the product of this complexity and as one of the most accessible ways to understand a city's influence on its people.

##### **3.1.1. Theory of emergence**

This concept is highlighted by the concept of emergence, which explains how diverse factors interact to create a final outcome that cannot be fully understood by examining each element in isolation. Emergence acknowledges that complex systems arise from the interplay of many components and elements, often in unpredictable ways that are not directly tied to a single cause. (Holland, 1998)<sup>23</sup>.

For instance, in a city, traffic patterns, social interactions and commercial activity are shaped by numerous factors, including urban design, environmental conditions and cultural practices. While each factor can be studied independently, the city's overall functioning emerges from their interaction, producing outcomes that cannot be entirely reduced to any single reason.

Similarly, individual narratives and perspectives arise from a blend of influences, such as cultural background, social interactions, memories, personal experiences and psychological states. Although factors like the presence of green spaces or weather conditions can be analyzed, the diverse experience of a city is an emergent phenomenon shaped by the dynamic interaction of these elements.

Emergence serves as a key concept and a foundation of this essay, which centers on the visualization of different perspectives and narratives within a city. Emotions, as an outcome although shaped by various factors, can provide a common language and an intuitive way to understand the complexities of urban life. By observing this outcome, we can begin to connect diverse factors, group them and study their underlying causes.

"Cities, like dreams, are made of desires and fears, even if the thread of their discourse is secret, their rules are absurd, their perspectives deceitful and everything conceals something else."

-Italo Calvino, *Invisible Cities*<sup>24</sup>

### 3.1.2. Phenomenology

Phenomenology, a philosophical approach, suggests that meaning does not exist separately of human experience but is created by the combination between our senses and the world around us. Phenomenology proposes that meaning is not something that is simply uncovered through logical analysis, but it is something actively created through our consciousness.

In contrast, the Cartesian method<sup>25</sup> suggests that the world has an inherent meaning. It was influenced by René Descartes, who believed that emotions and sensory experiences are distractions from the real meaning of the world, that has a fixed external reality. Phenomenology challenges this perspective. It emphasizes that our experiences, including our emotions and perceptions, are not just imperfect interpretations, but they can shape the final meaning. For example, in a live performance or a theatrical play, emotions, personal experiences and the cultural background of the audience will influence how they perceive the meaning of the performance. These subjective experiences contribute to the overall perceived meaning, rather than just being wrong interpretations. The meaning is not fixed or static; it is created through the interaction between the performance and the audience's consciousness.

While phenomenology centers on personal experience, it is not just about complete subjectivity. It acknowledges that individual experiences are deeply intertwined with the external world and shaped by shared cultural, social and historical contexts. Different perceptions and interpretations are not created in isolation, but they are influenced by the world and relationships that are formed within it. In essence, meaning is neither purely objective nor purely subjective, rather it is created by the way an individual and the world interact. They mutually co-create meaning.

### 3.1.3. Spatial Phenomenology

Geographer Henri Lefebvre proposed the idea of a relative space, emphasizing how space is lived and experienced by people in their everyday lives. He introduced the concept of three types of spaces:

- Representations of space (mental or abstract spaces such as maps and plans)
- Spatial practices (how space is physically used)

- Representational spaces (symbolic or lived spaces, shaped by imagination and vision)

Lefebvre argued that while representations of space often dominate, true freedom and individuality are found in spatial practices and representational spaces, where people actively reshape their environment.

Several philosophers contributed to the phenomenological understanding of space by giving attention to the emotional, existential, and bodily experiences of space.

Bachelard (1958)<sup>26</sup> explored how domestic spaces create emotional reactions, shaping people's experiences of them. Bachelard believed that spaces, particularly intimate spaces like homes, hold personal significance as they are linked to memories, emotions and dreams. These spaces serve as anchors for emotional experiences. In the context of cities, historic buildings, monuments and other landmarks can carry deeper meanings to individuals, beyond their functional use, serving as anchors for collective memory and identity. Additionally, people can be connected to certain public spaces, such as cafés, parks, or a market square. These spaces can evoke several emotions, much like personal objects at home.

Merleau-Ponty (1962)<sup>27</sup> focused on the embodied nature of our relationship with space. His philosophy emphasizes the "lived body" and its relationship with the world. For Merleau-Ponty, the body is not passive, as it moves through space. It is actively involved in constructing our understanding of that space. Perceptions of space are not results of external factors, instead they are shaped by our bodily experiences. This view suggests that space and body are mutually constructing meaning, as the way we experience space is linked to how we inhabit and move through it with our bodies. For instance, the way a child perceives and interacts with a playground is different from how an adult experiences the same space. The child's smaller physique or playful intentions create a unique spatial reaction that is very distinct from the adult's detached perspective.

Heidegger (1971)<sup>28</sup> develops the concept of space through his notion of being in the world. Heidegger emphasized how people "learn to dwell" in space, which involves not just existing within a space but understanding it through engagement with its environment. For Heidegger, the act of dwelling in space is a fundamental part of human existence. A space is not a container of activities, but it can shape our understanding of ourselves and the world around us.

### **3.1.4. Emotions as final outcome - Knowledge**

Understanding emotions can be a source of knowledge and understanding of the usage of a space. It does not replace logical or objective truths but acknowledges the importance of

individual perspectives. Emotion reading can help build a different understanding of a space, whether private or public. This approach can help redefine our understanding in a more inclusive and collaborative way.

Emotions, in this context, are considered as the final outcome and the simplest method to interpret the complexities of an urban space. Also, they can reveal different narratives that exist within the urban context. Urban narratives are not only dependent on spatial characteristics, but they emerge as a result of many complex factors. Therefore, emotions are considered as the final result and in a way, as quantitative data that emerge from various factors.

## **3 2. The concept of the project**

Based on the above analysis, the main focus of this interactive app is urban exploration. This project aims to create a tool that can influence and redefine the relationship between citizens and their city during their leisure time. The focus is not on creating a navigation tool, but on encouraging city wandering as an activity.

Additionally, the chosen data that gets incorporated as input into the app are the emotional states of the people who use it, as they provide a common language. They are considered as the final outcome of various factors that interplay within the urban context. When grouping emotions into teams, various "common truths" of public spaces can be revealed.

The final factors that are considered crucial for the app are analyzed below.

### **3.2.1. Emotions as input**

As highlighted earlier, the app aims to operate within a city, allowing users to move around freely and input their emotional states or responses to specific places as they pass through. These shared inputs will be interactable by others. This method aims to foster a collective understanding of how different locations are experienced by different people. By introducing personal narratives into a shared platform, people can connect and form a deeper emotional and social understanding. Overlooked emotions, demographics, or certain shared experiences that exist in places can create a deeper sense of connection within a community.

The understanding of not being alone in moments of happiness or sadness or potential shared experiences among citizens can provide emotional comfort and help individuals feel more connected and understood.

As highlighted earlier, emotions can offer valuable insights into how individuals perceive certain places, serving as a foundation for a

more inclusive and bottom-up approach to understanding and shaping these spaces.

A central aspect and one of the main themes of this project is individual agency and perspective that can form diverse narratives. The app incorporates a decision-driven approach, meaning that agents have control on whether they share their emotions, as well as choosing anonymity or not. Participation in sharing emotional states will not be a requirement.

### **3.2.2. Mobility**

Mobility plays a crucial role in shaping how we experience places, as our bodily movement can define our understanding of a place. Walking, cycling, commuting or driving offer different perspectives, affecting how we interact with our surroundings.

The chosen method of interaction for the app is walking. As mentioned, walking allows for a slower and more immersive exploration of a city, encouraging people to engage with their surroundings. Walking can create a stronger and personal connection with a certain place, as it is both a physical activity and a philosophical practice. It can reshape understanding and create critical thinking, by analyzing existing norms that can be questioned and redefined.

While walking is the chosen method for interaction, it is important to note that the app does not mean to exclude those who have mobility challenges. The concept of walking refers to a slow and meaningful traversal through a place that emphasizes personal engagement with the environment. Other forms of mobility can also offer insights how certain interactions happen in a place. Since our bodies and their challenges can shape the shared meaning of places, the variety of different bodies and different movement types can offer the most truthful results.

Combining walking and mobility with digital tools, the project aims to create a real time experience. With the focus being on blending physical and digital layers the integration of AR (Augmented Reality) can provide this result, as agents can observe various emotions linked to certain spaces as they move through them while using their phones. So, the motivation is not to transform an existing city into a digital one but to blur the borders between tangible and intangible. The result would be the creation of a new invisible layer that lies within the existing one and creates a world in between.

### **3.2.3. Exploration: Discovering the unfamiliar**

As highlighted before, the paths individuals take in their daily lives are linear and goal oriented. As a result, many spaces within

the urban environment remain hidden or overlooked. When trying to redefine relationships with a place and its inhabitants, the unfamiliar aspect takes a central role. Exploration has as a main theme the discovery of something unexpected. Encouraging people to venture outside of their habitual paths can reshape their final understanding of a place.

The idea of this project is not to direct users to specific areas, but to allow walks to evolve naturally. This approach shifts exploration from being location specific to being decision driven, enabling agents to feel in control. The project focuses on promoting a safe environment where users aren't forced to face the unfamiliar, but can explore freely based on their personal preferences and curiosity. As a result of the above, introducing visual cues within the app can spark curiosity and strengthen the desire to venture into unfamiliar places, without that being a requirement. These visual cues will represent the emotional inputs of others. This creates an opportunity for agents to explore spaces that have emotional significance for other people, but their decision remains entirely personal.

#### **3.2.4. Exploration: Rediscovering the familiar**

Although exploration is about discovering something new, rediscovering the familiar plays a big factor for the app. In the context of the constantly evolving cities, places that individuals think they know might evolve, or one's perception of them might change.

The app introduces a new layer of interaction that redefines the meaning of the familiar by incorporating other perspectives. Observing familiar streets with a different lens can shift their meaning or unveil unnoticed details and forgotten stories.

#### **3.2.5. Archive and Memory**

##### **Collective Memory**

Urban environments are deeply linked to the forming of individual and collective memory. Aldo Rossi in "The Architecture of the City" (1966)<sup>29</sup> discusses memory as an essential component of the urban context. Rossi introduces the concept of the urban artifact, referring to elements of the city, such as buildings, monuments, or public spaces that carry layers of historical and cultural meaning. These artifacts serve as archives of collective memory, shaping the identity of both the place and the individuals who inhabit it. Cities are "collective memories" and their physical form is the manifestation of those memories.

As a result of the above, the app focuses on the inclusion of diverse emotions, even those that might be overshadowed by dominant power dynamics within a city. It allows getting in touch with

different responses to events or keeping up with different stories and potentially overlooked artifacts. It also provides different interpretations of urban artifacts, revealing the various ways people interact with and assign meaning to them. Finally, it lays the groundwork for new stories and collective memories to be seen.

## **Personal Memory**

Individuals often seek to capture memories. This act of memory making is a core part of the human experience. One key element of the project aims to weave individual memories together with the shared narratives of a city. By doing so, this process can create a dynamic, evolving memory of a place; one that reflects both personal journeys and the communal identity of a city.

As a result, the project focuses on creating a digital archive where users can capture and share their personal emotions, contributing to an evolving collective memory. By organizing these emotional inputs into a shared framework, they can be analyzed through different disciplines, in order to uncover new patterns and insights as an output.

Additionally, it allows users to engage with the experiences of others. As the app evolves, past experiences will be captured and will allow both individuals and the community, creating a dynamic, to analyze the changing emotional landscape of a city.

## **3 3. Similar works**

Emotional Cartography: Technologies of the Self, by Christian Nold<sup>30</sup>, explores how emotional responses can be integrated into the understanding of urban environments. It presents practices such as Galvanic Skin Response, which is used to map emotions in real-time, creating "emotion maps" that reflect personal experiences tied to specific locations. Individuals use wearable devices to measure emotional responses in different spaces. Although it critiques the potential misuse of such technologies for human control, it emphasizes the importance of subjective interpretations and personal narratives in spatial mapping.

Drawing inspiration from the above, the app proposed in this project takes a different approach by emphasizing subjective emotional inputs rather than physiological measurements. This app encourages users to voluntarily share their emotions and personal experiences, fostering a decision driven form of exploration of urban spaces. The aim is not to create emotional maps, but a systematized collection of data, which then can be analyzed through different disciplines. By prioritizing agency, the project aspires to create an inclusive platform that empowers individuals to share and explore the emotional landscapes of their cities.





4

The app



## 4. FINAL PROJECT

### 4.1. The App

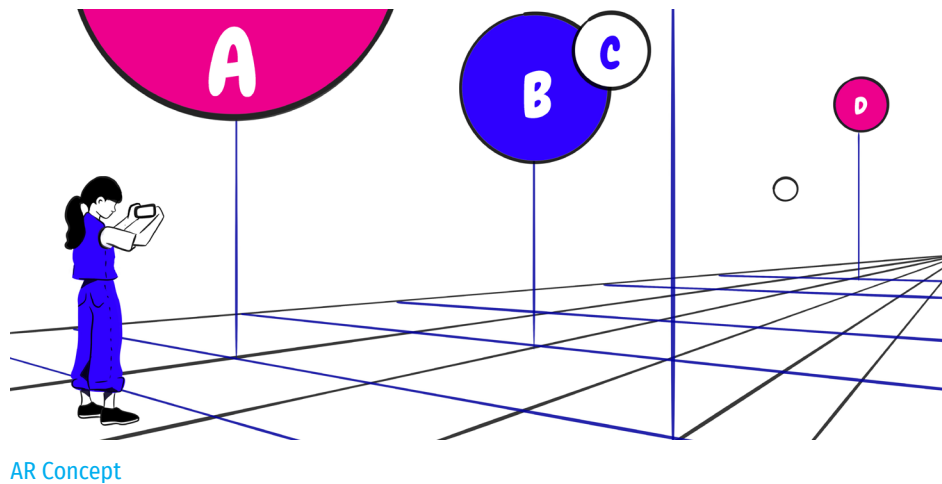
#### 4.1.1. Description

The core feature of this project is to map emotions onto physical locations. Agents can wander through the city and link their emotional states to those locations. These inputs are transformed into visually representations and displayed through augmented reality to other agents. Using their smartphones, agents can view and interact with these inputs once they visit their corresponding locations. While emotions are tied to spaces, they can also be observed from afar, sparking curiosity about them.

As discussed in the digital games analogy, intention plays a crucial role in driving engagement. The agent's intention to share their emotions acts as motivation. On one hand, by observing emotional markers from a distance without fully knowing their context, urban explorers may feel inspired to visit and interact with them. On the other hand, the app provides a platform of personal expression. Together these two elements, curiosity for significant discovery and ability to share one's own narrative, can motivate exploration.

More particularly, agents can access the app while walking through the city. Using their smartphones they can observe the urban environment with the integrated emotional data. These inputs are displayed as augmented reality (AR) markers on their screen and can be visible from a distance. The markers are acting as both visual cues and points of interaction. The agents may choose to approach these locations and engage with the emotional narratives that were tied to them.

Additionally, when agents identify a location that holds personal meaning, whether a harmonious park, a hidden alley or a crowded square, they can contribute their own emotional input. Through the app, they select an emotion and link it to the specific location. This emotion is then transformed into a visual AR marker, which becomes interactable to the agents who visit the location, as well as visible to those viewing it from afar.



## Target Audience

The target audience for the app is the inhabitants of the specific city in which it is implemented. While the app does not mean to exclude any groups, such as visitors, its primary focus remains on citizens. This focus is intentional, as the project aims to strengthen the relationship between residents and their city.

Urban residents are familiar with their city, shaped by their daily routines, cultural ties or memories. However, this familiarity can sometimes lead to disengagement, turning the city into just a functional space rather than an active place for connection. Focusing on citizens, the project aims towards long-term impact. As individuals who consistently interact with their city, residents can learn and associate with their surroundings by observing and personally analyzing the emotional outputs over time. Additionally, the collective analysis of the shared data can provide insights into potential challenges faced by the primary users of a city. This collective output can then be further examined, offering a deeper understanding of the urban environment.

The app achieves its goal of engaging urban inhabitants by focusing on emotional exploration rather than acting as a tourist guide, directing users to specific landmarks or attractions. By decentralizing focus away from specific points of interest, the app shares equally the urban experience, enabling all locations to hold value according to individual and collective input.

### 4. 1. 2. Visual Translation

When it came to defining the visual translation of emotional inputs, sky emerged as an inspiration. The sky has a symbolic meaning that mirrors the goals of the project. It serves as a unifying element, shared by all citizens within a city, regardless of their gender, age or status, symbolizing equality and collective existence. Furthermore, the sky and its components are timeless, linking

history, culture and memories with present experiences.

In more detail, by integrating the act of walking with emotional sharing, the concept of nodes emerged, as emotions are linked to significant locations that serve as focal points. This led to the concept of constellation-like forms: These focal points within the urban environment are visually connected through lines, resembling the way constellations are depicted on the night sky. With this visual approach, these location-specific inputted emotions act as nodes that form emotional “constellations”. Just like stars guide and inspire curiosity, the app encourages users to seek new knowledge and venture into unfamiliar spaces, mirroring the spirit of past exploration of being guided by the sky. Through this visualization, the project aims to highlight emotions as meaningful elements of urban life, while drawing parallels between the act of exploring the city and the exploratory activities of past ages.

Also, this visual representation allows these markers to be visible from afar, enabling users to view emotional inputs without interruptions caused by physical or visual disconnections. This approach emphasizes unity, making the emotional landscape a seamless part of urban life.



Paths And Constellations Visual Connection

### Case Study- Larissa Greece

In order to create the app in a real-world context, Larissa city (Greece) is selected as the initial site. Chosen by factors such as familiarity, medium urban scale and limited tourist activity. While Larissa serves as the starting point, the app is not designed to be site-specific. Instead, the same principles and functionalities can be adapted to different urban scenarios.

Larissa, with its medium scale, can serve as a pilot city for the app. Its manageable size allows for the identification of potential issues without requiring an overwhelming amount of work to map its locations. Additionally, Larissa's level of tourist activity ensures that the focus remains on its inhabitants and the analysis of the outputs can be concentrated on those.

Although the app comes with a site-agnostic aspect, it does not mean

that the project ignores the city's unique aspects. Its specific locations, urban artifacts and neighborhoods are considered and integrated into the app. However, this does not limit the app's adaptability. The methodology developed for Larissa can be applied to other cities, ensuring that their unique characteristics are equally considered. The app's framework is designed to take real-world characteristics from any city and translate them into their digital equivalents.

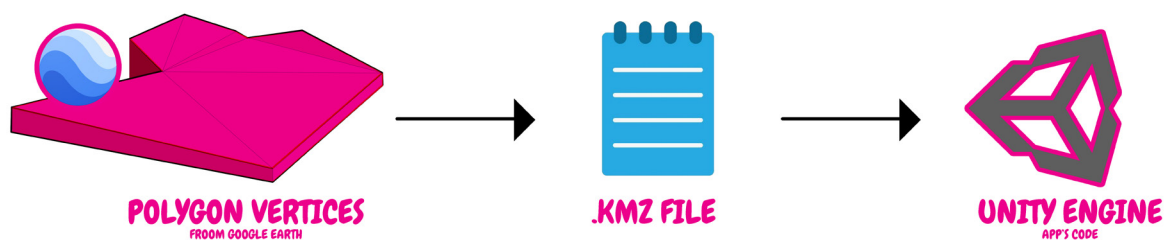
### 4. 1. 3. Unity Engine and AR Implementation

The app is developed using "Unity", a widely used game engine that provides tools for creating interactive and dynamic environments. Unity offers features which support 3D and AR experiences for multiple users. The engine's capabilities make it suitable for implementing the features required for this project, including a variety of tools for visualization and user interactions. The pilot version of this project focuses on features without the use of AR. In the future, the AR aspect of this project will be implemented.

## 4 2. Key Features and Functionality

### 4. 2. 1. Location-Based Interaction

One of the fundamental aspects of the app is its location-based interaction. To implement this, Larissa was divided into its regions and neighborhoods, through field analysis and research. These regions were defined using polygons created on Google Earth. The vertices of each polygon were exported as coordinates for use within the app's engine. This spatial data formed the foundation for mapping the city into distinct, interactable zones.



#### Coordinates Data Retrieve Method

In the app's code, a main class for regions and a subclass for subregions and landmarks were created to organize and handle this regional data. The main class includes attributes such as the vertices of the polygons, the name of each region, a unique index for organizational purposes and the land uses associated with the region that are results of field analysis.

This division was implemented to facilitate the analysis of

emotional patterns across the city and within its distinct regions. By examining these patterns, the app aims to identify potential issues or challenges that may be specific to a particular area. Additionally, through field analysis and the application of previously discussed concepts such as layout analysis (eg Space Syntax) and urban rhythms, deeper knowledge can be gained on how specific elements interact with the unique characteristics of each region.

Secondly, by integrating region-based information within the app, agents can engage more deeply with the emotional outputs of diverse regions. This feature not only makes the app more interactive but also enhances the sense of immersion, as users can connect with the unique emotional and cultural narratives tied to particular regions. Additionally, the app provides urban explorers with information about location characteristics, offering an informative aspect as a secondary feature. While this is not the app's primary goal, it adds an additional layer of context that helps enrich the user's engagement with the areas they explore.

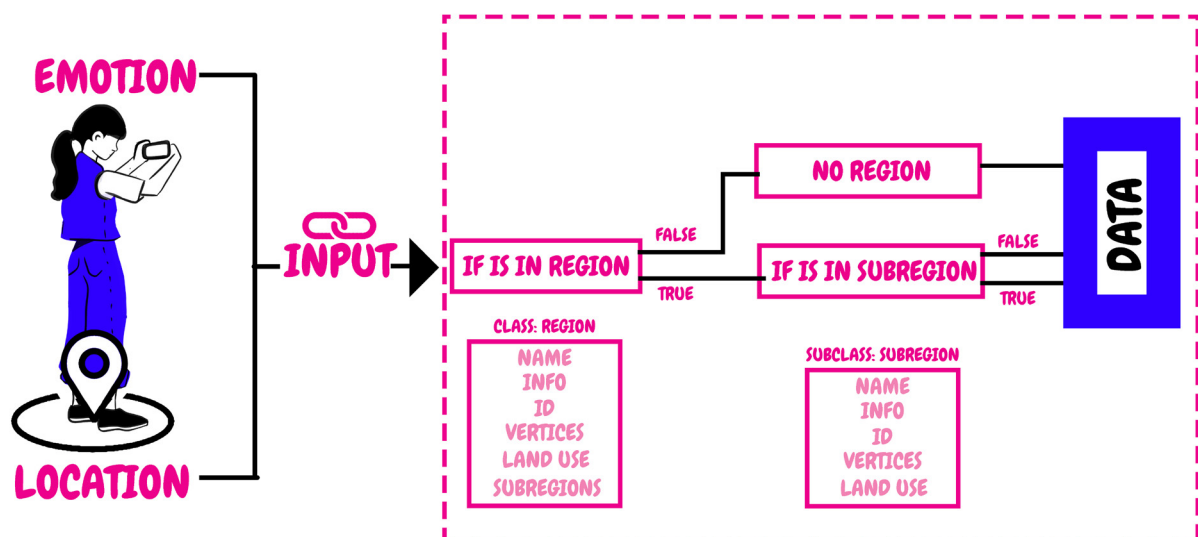
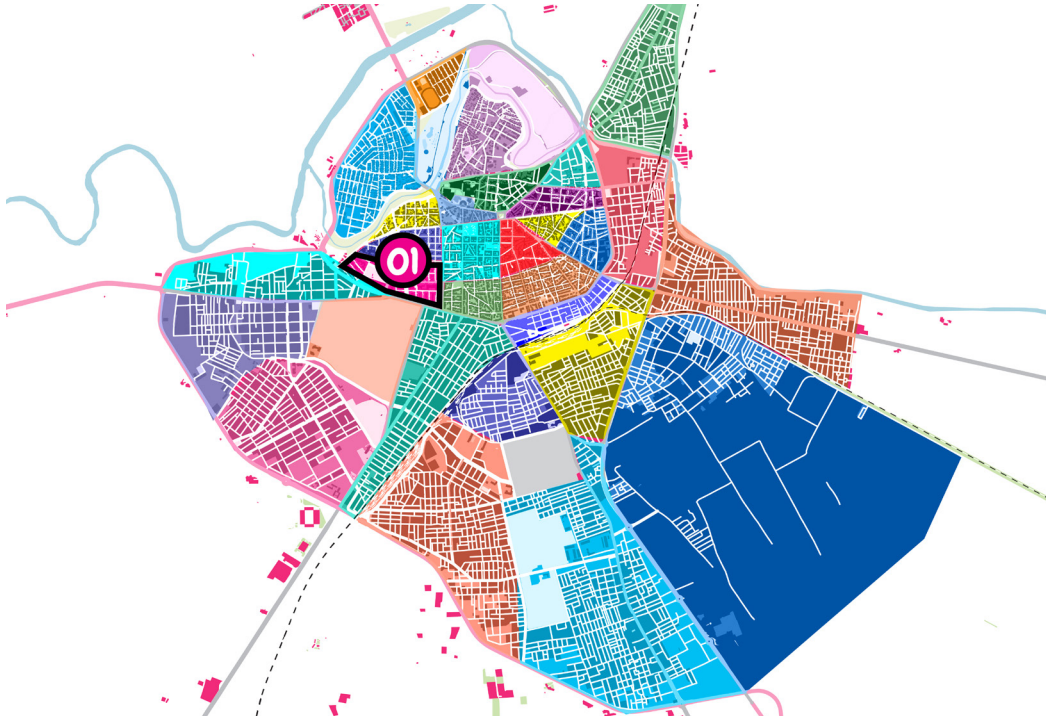


Diagram: From input to Location Data

For example, an agent is walking through the city of Larissa and arrives at the square of Agios Antonios neighborhood. The agent decides to interact with the app, selecting an emotion to link with their location. Upon this interaction, the app begins a process to confirm the agent's exact position within the predefined urban framework.

The app first checks if the agent is within one of the broader defined regions of the city. The system confirms that the agent is located within Region 01: Agios Antonios, a neighborhood of Larissa. Once this identification is made, the app progresses to check for subregions within Agios Antonios, as the system is designed to further refine the agent's location.



Larissa Region Map

The app verifies that the agent is within Agios Antonios Square, a subregion of the neighborhood that serves as a central gathering point for locals. Based on this identification, the system prepares to respond with relevant information and visualizations.

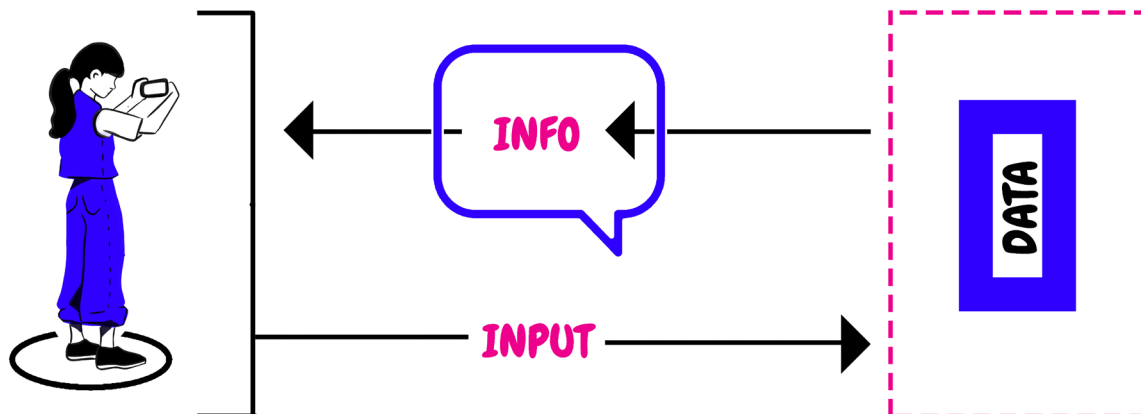


Diagram: Regional Text Info

#### 4.2.2. Emotional Mapping

As mentioned earlier, agents can choose specific emotions they feel and tie them to a location for others to see. Within the app, three emotional categories have been defined: positive, neutral and



negative. These categories serve as an organizing framework, as each one includes specific emotions available for agents to select.

A key concept of the app is the belief that all emotions serve a purpose and contribute to personal and societal growth. The app avoids stigmatizing any emotions by labeling them as "negative". While the categories are used as an organizational tool in the code, they are not presented to agents in the app interface. The goal is to avoid demotivating individuals and instead focus on promoting uncompromising emotional expression. Visual representations of emotions are implemented into the app to convey their presence without attaching these specific labels.



#### Emotions Visual Representation

One of the challenges with predefined emotions is that they can feel limiting. Not all emotions can be captured and presented as selectable options, as some individuals might feel that their more prominent emotions are excluded. However, as the app prioritizes the collective understanding of emotional data, predefined emotions were designed to act as a common language. With this approach, consistency in visual translation of all emotions is ensured and challenges or potential misunderstandings can be avoided, when agents view them through AR. This way, the app deliberately avoids offering a text input for agents to freely write their emotions. Instead, it provides a shared set of tools in order to maintain uniformity and collectible understanding.

On the other hand, while the predefined emotions provide uniform tools for emotional expression, the app recognizes the need for more personalized ways of interaction, as personal expression remains crucial. An additional feature has been created; a text input tool that allows individuals to write freely. This tool enables agents to share whatever they desire, whether it be a description of their day, a personal story, or even a poem. This process of narrative sharing is linked to the selected emotions and becomes part of the emotional map. Others can view these narratives alongside the visual emotional representations, creating a richer and more layered interaction.

## Optimistic Emotions

The emotions joy, hopefulness, calm, affection and trust were selected as predefined options in the optimistic category. Together, they provide a multidimensional understanding of "positive" emotions.

In the analysis below, when referring to "urban environments" or "elements", it is due to the influence of time on emotions, as it is not only places that influence them. Certain events or specific days can be emotional charged, shaping how places are perceived and experienced.

- Joy

Joy is chosen as a universally understood emotion that represents moments of happiness and fulfillment in the present moment. Including this emotion allows agents to share perspectives that inspire positivity. The inclusion of this emotion can highlight environments that bring pleasure.

- Hopefulness

Hopefulness symbolizes optimism and anticipation for a better future and is tied to feelings of transformation. Including hopefulness allows the identification of urban elements that inspire personal growth, providing insights into how specific environments can influence people's desire for change.

- Affection

Affection reflects a sense of love and care, either for a specific place, a memory or a shared experience. It often relates to past experiences or memories, as well as shared bonds with places that hold personal or cultural significance.

- Calm

Calm represents emotional peace, emphasizing the restorative aspects of a space or a moment within one. Including calm emphasizes the importance of identifying what promotes mental well-being.

- Trust

Trust signifies safety. It highlights environments where individuals feel secure. This emotion ties positivity to feelings of security.

By grouping these emotions, the app captures a spectrum of positive perspectives that ranges from immediate joy to future-focused hopefulness, as well as personal calm and societal trust. This



grouping enables a deeper analysis of how different aspects of positivity are distributed across a city.

## **Challenging Emotions**

The inclusion of sadness, anxiety, terror, rage and frustration as predefined emotional inputs aims to provide a comprehensive understanding of the more challenging experiences individuals may encounter.

- Sadness

Sadness can represent feelings of loss, loneliness, or melancholy. It can provide insights into urban elements that evoke those emotions due to personal memories or social isolation. Mapping sadness can highlight environments where people feel disconnected or unsupported.

- Anxiety

Anxiety reflects a state of unease or uncertainty. It may relate to environments that feel overwhelming, unsafe or chaotic. Including anxiety allows for the identification of urban elements that may contribute to stress.

- Terror

Terror signifies an extreme sense of fear or vulnerability. This emotion is particularly relevant in environments where individuals feel physically unsafe or threatened.

- Rage

Rage captures feelings of anger that can emerge from perceived injustices, systemic inequities or personal experiences in specific environments.

- Frustration

Frustration reflects dissatisfaction or irritation with a specific environment. It could arise from issues such as poor urban planning or unmaintained facilities.

By grouping these challenging emotions, the app can uncover patterns that indicate challenging emotional states within the city. Additionally, these emotions encourage empathy among urban inhabitants and potentially sparking community-driven solutions.

## **Reserved Emotions**

This category includes emotions that do not lean strongly toward

“positive” or “negative” experiences. The inclusion of neutrality and caution in this category captures emotions that reflect moments and environments that may create rather balanced emotions.

Including such a category might seem paradoxical at first, as it represents the least emotionally charged states and lacks the intensity that typically would drive the agent to include such emotion as a focal point. However, this category plays a role in capturing the full spectrum of human responses to urban spaces. Neutrality might reflect moments of detachment or observation, where individuals are simply processing their environment without having strong feelings. By including this category, the app acknowledges that not all responses to a space are intense, but their meaning cannot be excluded.

- Neutrality

Neutrality represents an emotional state where an individual feels neither strongly positively nor negatively about a place. It allows agents to share their observations or experiences that are balanced or detached, providing insights into environments that may not evoke strong emotional reactions.

- Caution

Caution reflects a more alert and mindful emotional state. It may be linked to unfamiliar spaces where individuals are hesitant to form immediate emotional judgments. Including caution allows for the identification of areas where users might feel the need to be more aware or careful, which can reveal patterns of perceived safety or uncertainty within the city.

By incorporating these “neutral” emotions, the app provides a broader spectrum of emotional input, capturing moments that fall outside the extremes of positive or negative experiences.

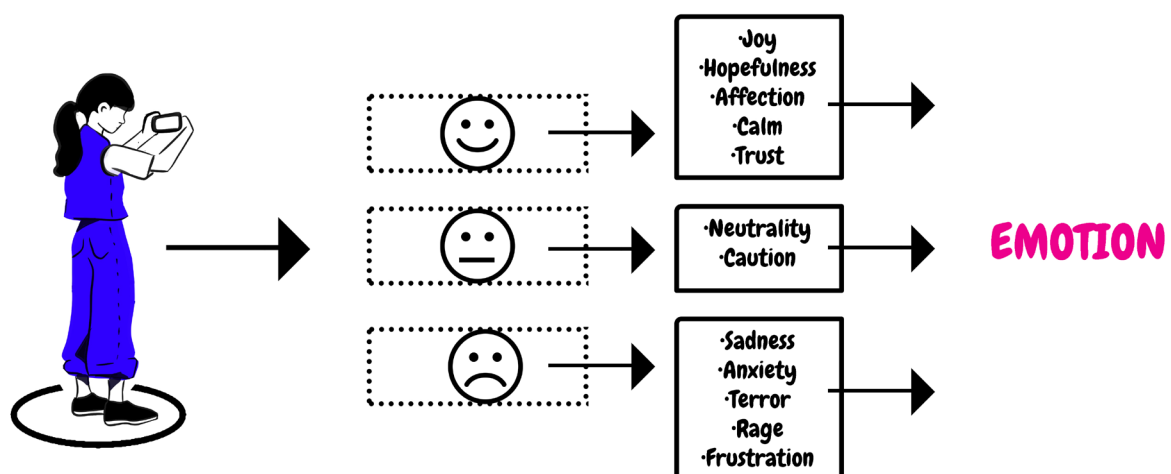


Diagram: Emotion Input Framework

## Predefined Emotions

Although these emotions have been selected to represent a range of human narratives, they are not fixed and can be revised over time. The chosen emotions serve as a foundation and a starting point for the project. Emotions are complex and multilayered and the need to change in the future might occur. As the app develops and gathers feedback from users, there will be room to incorporate additional emotions or eliminate others in order to capture the diversity of human experiences.

### 4 3. Visual Translation

#### 4.3.1. Color Translations

In the visual translation of emotional inputs, a color coding method has been selected in order to create a coherent visual language. Colors serve as identifiers, allowing users to intuitively understand and interpret emotions linked to specific locations. However, it is acknowledged that the association between colors and emotions may vary between individuals. For example, the color green, might symbolize calmness for one person but anxiety for another. The app focuses on creating a shared emotion to color translation. This approach aligns with the project's goal to foster collective and intuitive understanding and create a common vocabulary for expressing and interpreting narratives.

To achieve this, warm-toned colors are assigned to optimistic emotions, while cooler tones are used for challenging ones, following collective associations for ease of recognition. For example, optimistic feelings are represented with shades of orange or yellow, while challenging emotions are visualized in blue or purple. However, this does not apply to all emotions. For instance, rage is often associated with red. Regardless of that, the project intentionally creates this translation color scheme in order to promote a clear and defined tool for agents to use. This approach prioritizes simplicity, ensuring that the emotional environment of the city is easily interpretable by all users, regardless of individual views in color association.



For example, as presented in the diagram below, if an agent selects the emotional category of challenging emotions, a particle-node is spawned at the exact location they have linked this emotion to. This particle-node adopts the color corresponding to the selected emotion, as indicated in the predefined color scheme. In this instance, the agent has chosen "terror" as their emotional input, therefore, the emotion is visually represented in the world as a blue particle.

This particle not only serves as a visual representation of the agent's emotional state but also acts as an interactive element within the augmented reality (AR) environment. Other users passing through or observing the area can see the blue particle, instantly understanding the emotional atmosphere on that specific location.

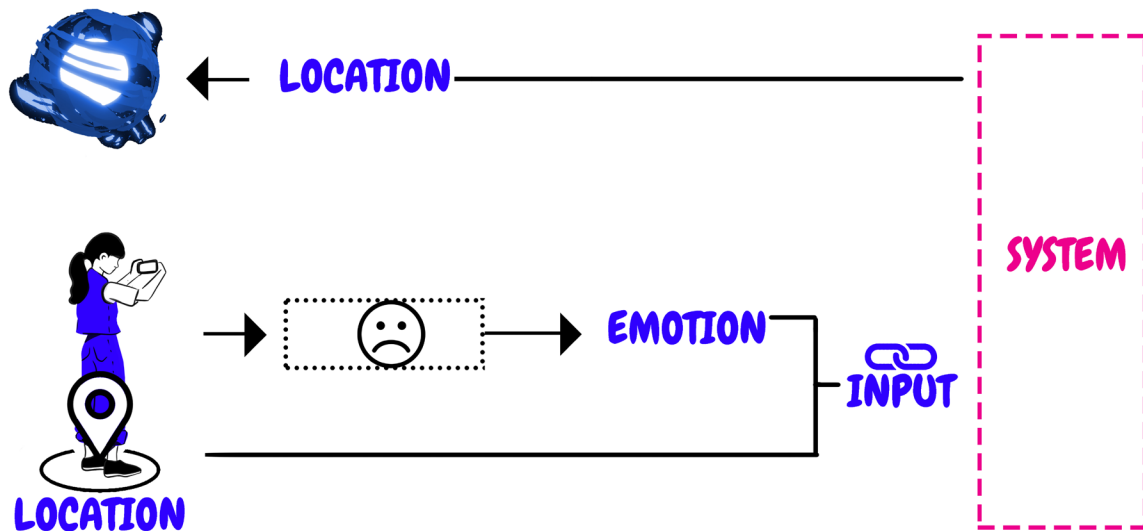


Diagram: Particle Location and Color Attributes

#### 4.3.2. Constellation Inspired Visual Translation

As already discussed, the sky-dome serves as a key visualization concept for this project. Specifically, as sky constellations are visually depicted by lines connecting nodes which represent planets, this visualization is mirroring paths and nodes of urban exploration. In this context, focal points are represented by the emotional inputs. From this perspective, emotions are visualized as "planets" or particles in the sky, in order to symbolize the emotionally significant worlds that emerge within the digital layer of the city. These elements partake on a spherical form in order to emphasize this connection.

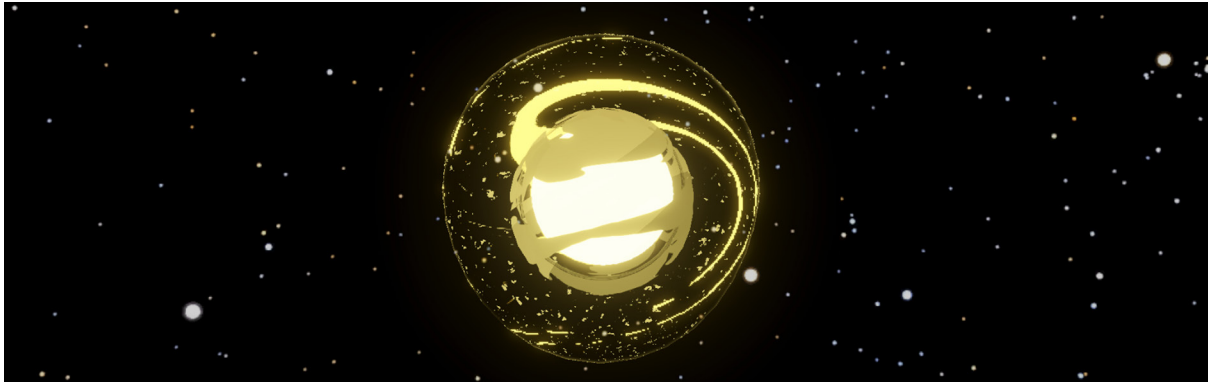


Image From Prototype: Joy Particle

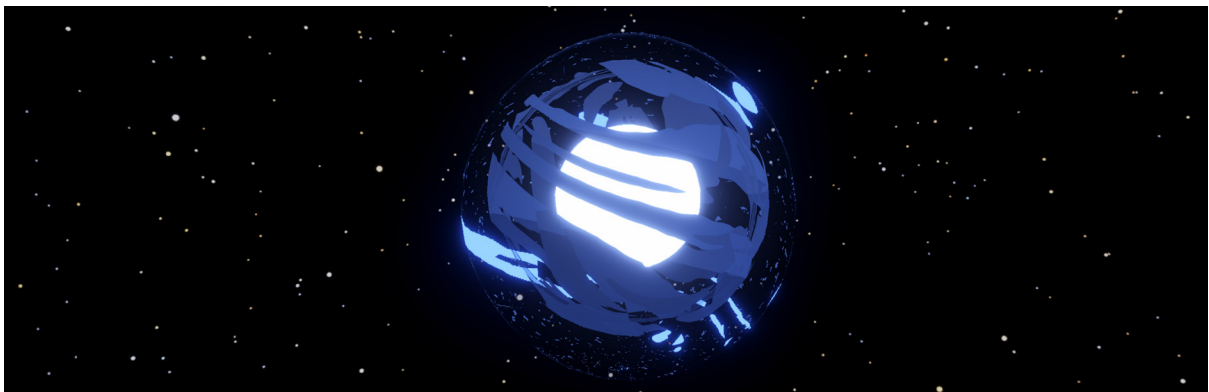


Image From Prototype: Terror Particle

Additionally, lines connecting the nodes of each individual's input form a personal "constellation" in the urban sky, representing the emotional journey of the agent. These "constellations" are unique to each agent, forming a visual narrative that reflects their emotional experiences throughout the city. They are entirely agent-specific, meaning they cannot be alike, as they are shaped by the distinct paths and emotions of each individual.

These lines are further enhanced by a gradient color scheme that transitions between the colors of the first and last node—"planet". This blending of colors visually represents the emotional journey of the individual. The specific use of colors is using the color scheme that was mentioned earlier.

Each agent's "constellation" becomes a personalized map of their interaction with the urban space, symbolizing their unique perspective and emotional engagement. The "constellations" are designed to grow as more inputs are added, evolving in real-time to capture the ongoing relationship between the agent and the city.



Image From Prototype: Constellation

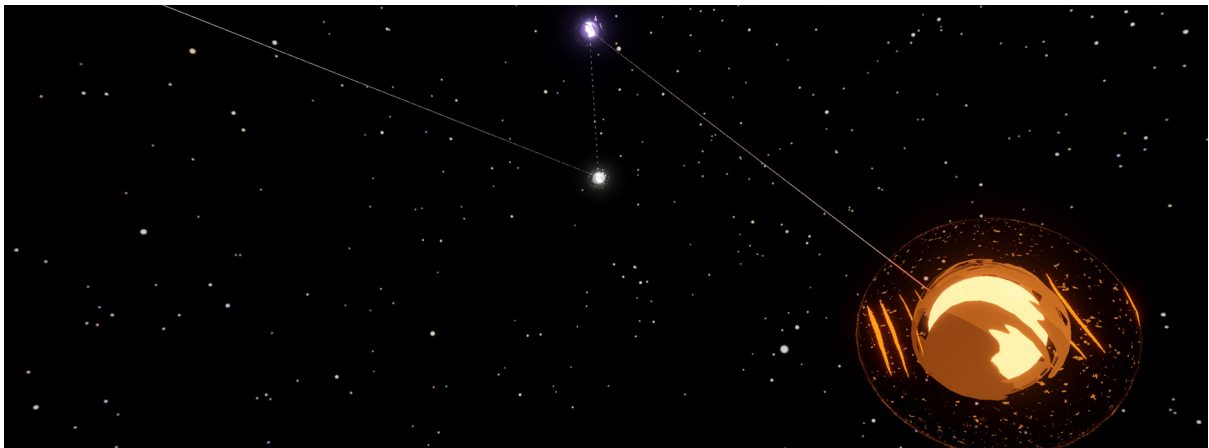


Image From Prototype: Constellation

#### 4 4. Clustering of Data

When collecting emotional inputs for visual translation and analysis purposes, clustering and grouping this data is essential for achieving both clarity and meaningful results.

The clustering method within the app involves grouping emotional inputs within a specific area, based on the population parameter of this data. In specific, if within a location that covers a diameter of up to 150 meters (approximately two average city blocks) and the calculated emotions are above 15, a cluster will form. This clustering indicates that the area is emotionally charged. These clusters are not limited to regions, as a single region can contain multiple clusters. Instead, this method focuses on identifying smaller spaces with a high concentration of emotional input.

The numbers for this clustering of data were chosen as a starting point. The clustering threshold focuses on an area of approximately 18,000 square meters. This area was chosen as it offers a manageable size of land within the urban environment, allowing the app to identify emotionally charged subspaces. Urban spaces often contain distinct areas, such as parks and squares with unique atmospheres. By clustering data at this smaller scale, the app provides a way to highlight these differences and uncover patterns that might be overlooked when focusing only on larger regions. By targeting areas

of this size, the app introduces a new analytical method that compliments the larger regional framework already incorporated.

The threshold of 15 emotional inputs for creating clusters was chosen to set a balance between identifying areas with emotional activity but avoid resorting to overly broad or narrow criteria. This number ensures that clusters represent spaces with high levels of engagement. Setting the number too low might result in the creation of too many clusters, minimizing their importance. On the other hand, a higher threshold could overlook important subspaces where meaningful emotional activity is occurring.

These numbers are flexible and can be adjusted according to application and testing. They serve as a starting point, emphasizing the design intention of clustering data. The chosen numbers are not definitive but act as a foundation. As agents interact with the app, these thresholds can be reevaluated to accommodate a variety in scales of activity, density or cultural contexts.

More specifically, a more dynamic way to identify clusters could be introduced in future, making thresholds adaptable based on parameters such as land use, time of day, weather and season. These parameters, already incorporated into the app, can be combined with field analysis and observation of the app's generated data to create new dynamic thresholds. Given that the above parameters significantly influence urban experiences, dynamic calculation of thresholds would allow the app to better account for the unique characteristics of different locations. For instance, the city center on a sunny spring Saturday might require a higher threshold for clustering due to anticipated high activity levels, while a park on a snowy winter day might have a lower threshold. This flexible approach would allow for a more dynamic clustering process.

In terms of visualization, the clusters are integrated into the sky-dome concept and represented as larger "planets" that combine within their visual appearance the colors of the emotional inputs that formed them. These planets are dynamic, with their surfaces designed to reflect and distort in real time their environment. So, each cluster's planet visually incorporates the colors of the inputted emotions, symbolizing the collective emotional state of that specific area.

The planet's surface reflects the colors of the emotions in real time, allowing for a dynamic and evolving representation. If certain emotions dominate the cluster, their corresponding colors are more prominently displayed on the planet's surface, offering a visual cue of the emotional responses within the cluster.

This design decision highlights the app's foundational concept that all emotions serve a purpose, with each input contributing to the planet's formation and color reflection. The concept draws inspiration from the moon, which reflects the light of the sun, symbolizing how one element forms its identity influenced by others.

Just as the moon does not emit light on its own but instead reflects the light it receives, the planet-like clusters visually represent the emotional input of the agents, showcasing the collective emotional dynamics in real time.

By reflecting and distorting the colors of the contributing particles, the clusters emphasize that individual emotions interconnect within a shared space. This analogy aligns with the app's theme of shared experiences, as the planets become both a visual and symbolic representation of the collective emotional landscape.

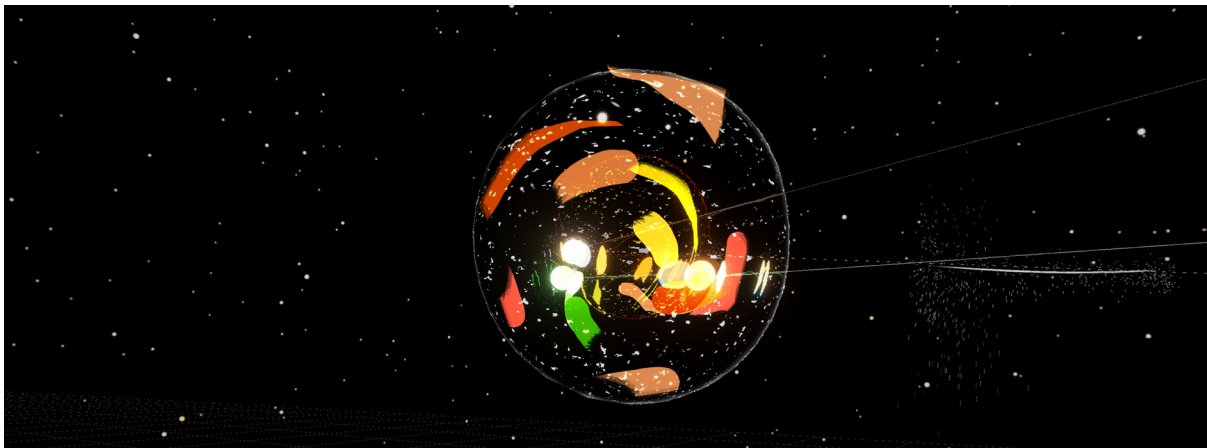


Image From Prototype: Cluster

## 4 5. Designed interactions

### 4.5.1. Parameter of Population

#### Individual Particles

Individual particles-nodes are calculated in real-time based on the emotions. Specifically, the collected emotional data is measured and categorized according to their corresponding emotional categories rather than individual emotions. This approach ensures greater readability, as it keeps visualization simple and easy to understand. By focusing on the three categories, the output remains rather clean and can provide an understandable overview of the emotional landscape of the city.

More specifically, the system identifies whether a single category is the most prominent, whether there is a balance among all categories, or whether equality exists in the least or most inputted categories. Based on this evaluation, the visualization adapts dynamically.

The most prominent emotional category is displayed lower in altitude, closer to the agent, as it is observed through augmented reality (AR). In parallel, less prominent categories are displayed



at higher planes. For instance, if the optimistic category is perceived as the most dominant one, its corresponding particles will appear lower in the AR interface, creating a closer connection with the agent, while other categories are elevated higher up in the virtual space.

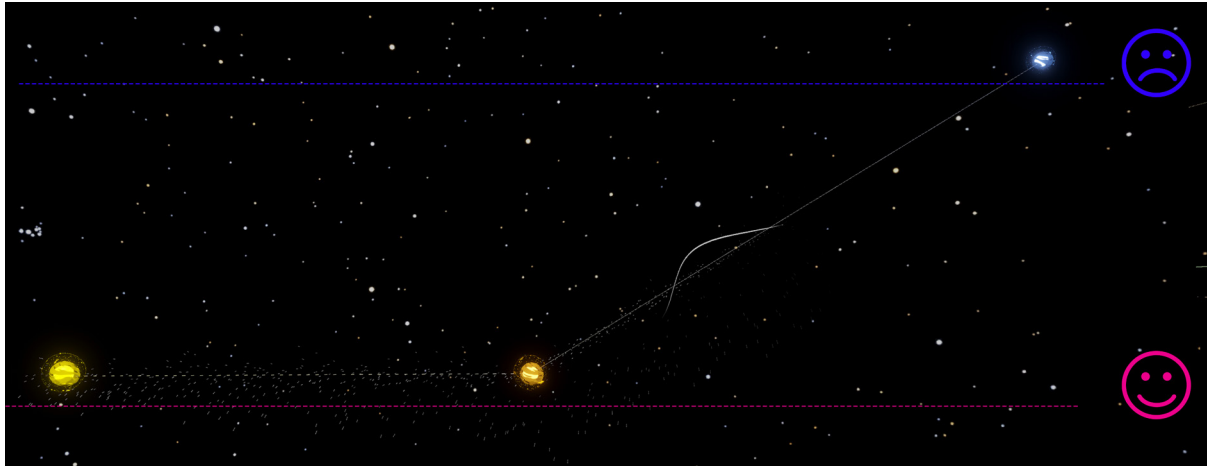


Image From Prototype: Elevation Distribution

This method was designed to prioritize the emotions most relevant to the current emotional state of the city, providing a realistic representation of the collective emotional data. By presenting the most prominent emotions at a closer proximity, it is ensured that people learn and engage with the most influential emotional data in their environment. The reason behind this decision is rooted in its capacity to create a clear and dynamic visualization. Furthermore, this parametrized method allows the app to present the collective emotional reality in a way that is both visually impactful but can be analyzed both by agents and researchers.

This visualization approach creates a universal method that applies to the entire city. Instead of calculating emotions on specific areas, by categorizing emotional inputs across the entire city, the project avoids to divide the emotional landscape into isolated zones. This ensures that the emotional representation is not confined to specific neighborhoods or regions, but reflects the collective experience of the city as a whole.

Although the data from specific areas and their corresponding emotional categories is collected, it is not visualized for agents but remains available for study. This approach aims for a unified emotional landscape while allowing researchers or urban analysts to examine area-specific tendencies. Additionally, the scale of Larissa makes this method suitable, as the city is organized around one common center and lacks highly distinct areas with great differences. For larger scale cities, a separate visual representation of the dominant category may be necessary in order to address potential inequalities.

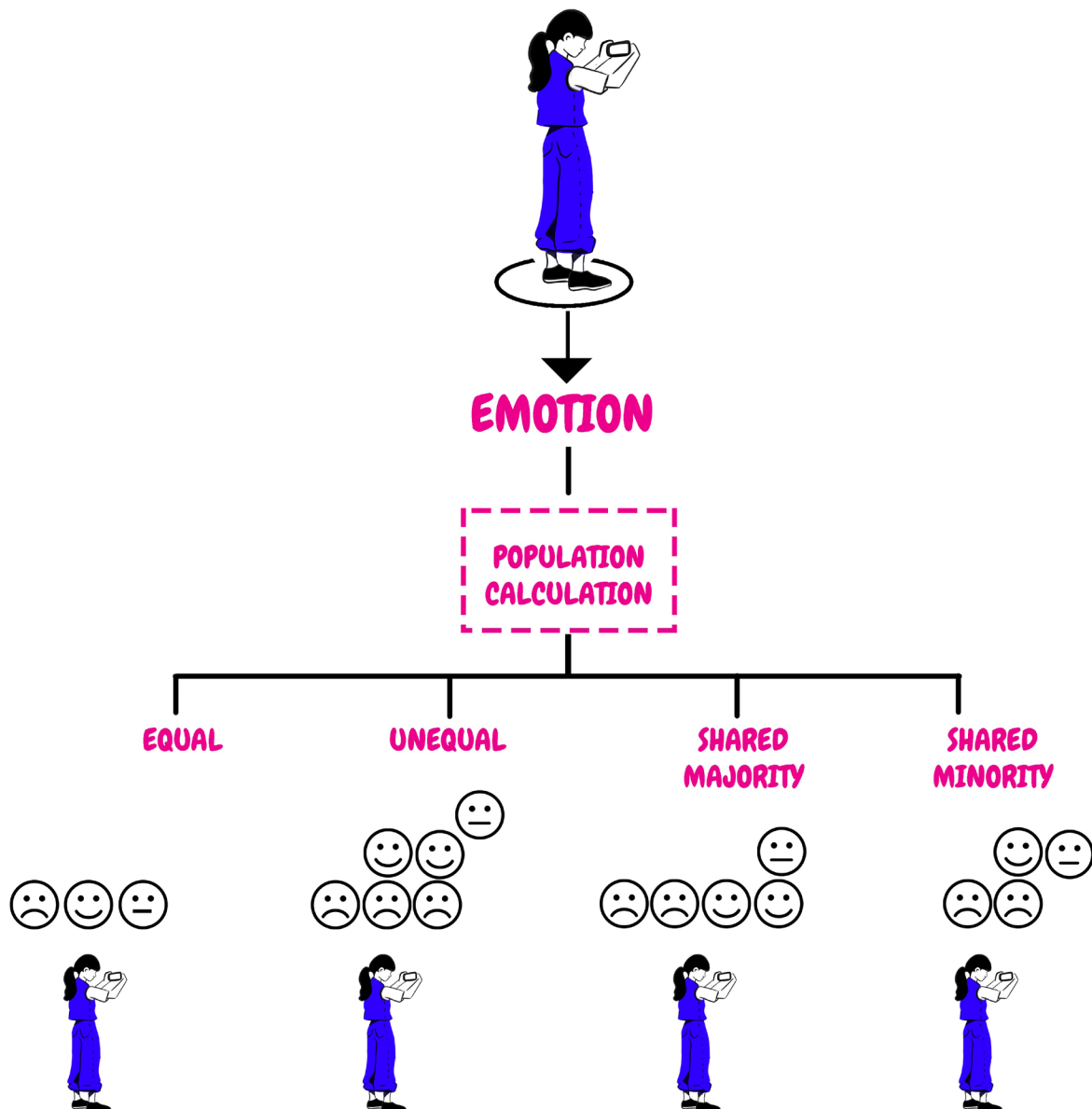


Diagram: Example of Elevation Distribution

Distribution of emotion groups need to go through some analysis, which will characterize one of them as the dominant one, according to the percentages of the respective emotions inputted. There may appear to be a nearly-equal distribution of emotion groups or not.

## Clusters

In parallel, the most prominent emotions within clusters are calculated and used to label each cluster based on its dominant emotional category. Following the same logic, the elevation of these clusters is dynamically adjusted in the app. For instance, if the dominant emotional category of a cluster is among the least calculated in the entire city, the cluster's particles are elevated higher in the virtual space. Additionally, cases of equality between emotional categories are also accounted for, with the system evaluating these distributions in the visual representation.

Following the same logic, each created “planet”, representing a cluster, adjusts its size with the use of a multiplier, according to the number of emotion inputs that belong to it. This means clusters with a higher number of emotional inputs result in larger planets, ensuring their visibility is enhanced. This approach emphasizes the significance of clusters with greater participation, drawing more attention to emotionally charged areas.

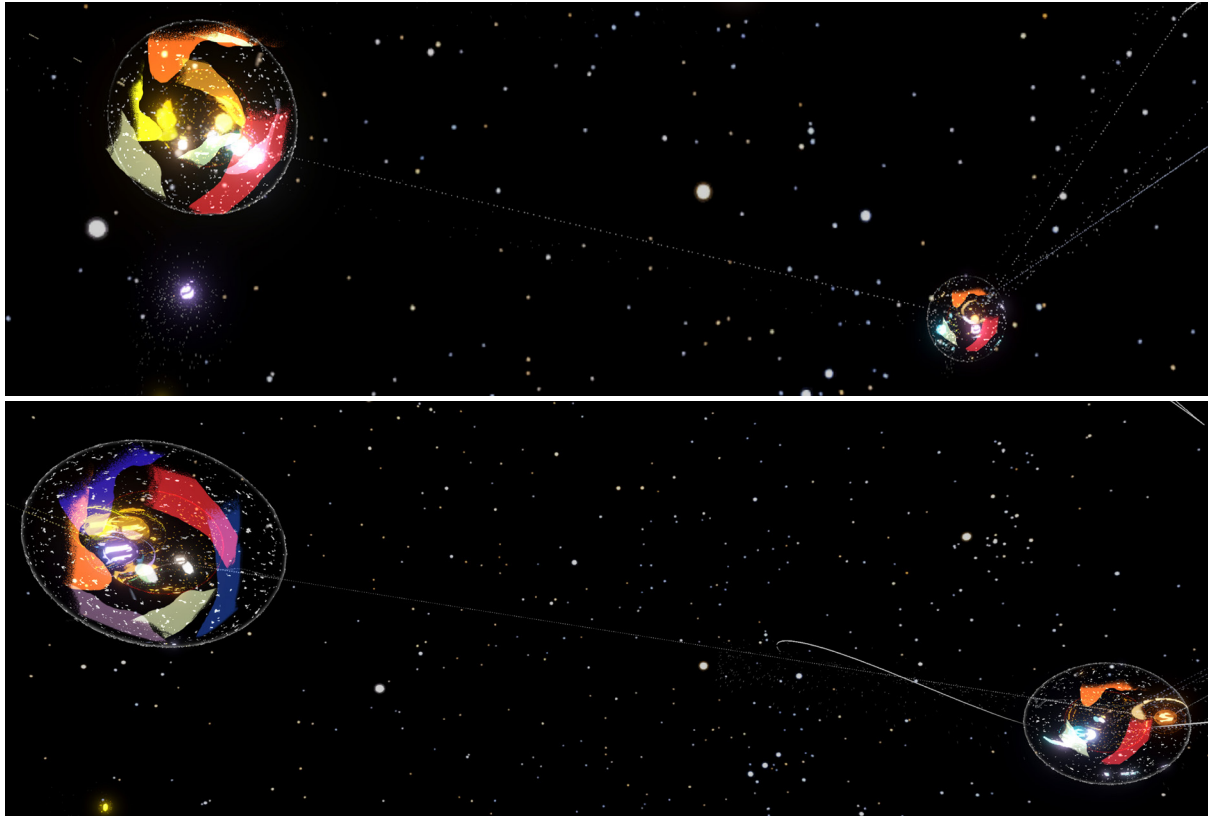


Image From Prototype: Elevation Distribution

In parallel, particles within each cluster are also organized dynamically. The most prominent emotions within a cluster are positioned lower, while those with fewer inputs are displayed at higher elevations within the cluster's structure. This additional visual cue provides a clearer understanding of the emotional composition of a particular cluster, offering an intuitive way to interpret the data.

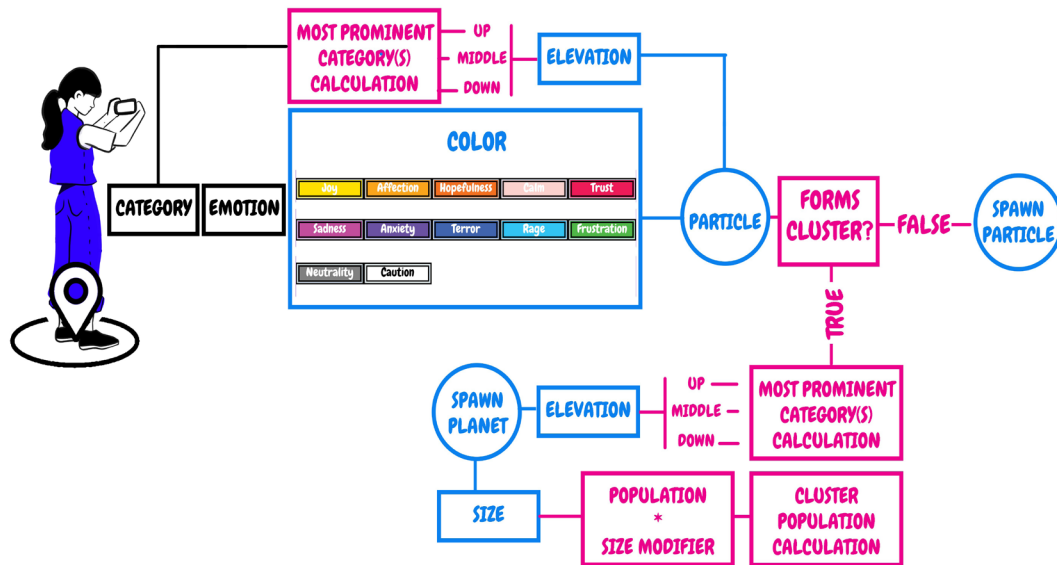


Diagram: Spawning Main Logic

## AR interface

As the most prominent emotional categories are calculated, an additional visual cue is integrated into the app's interface to enhance clarity and immersion. This cue takes the form of a particle effect that visually represents the dominant emotional state of the city. Unlike the constellation-based particles-nodes, this effect consists of free-flowing particles colored according to the scheme of the dominant emotional category.

For instance, if optimistic emotions are the most dominant, warm toned particles will appear dynamically in the app's interface while users view the real world through augmented reality. These moving particles are designed to indicate the prevailing emotional atmosphere of the city, providing users with a sense of the collective emotional landscape.

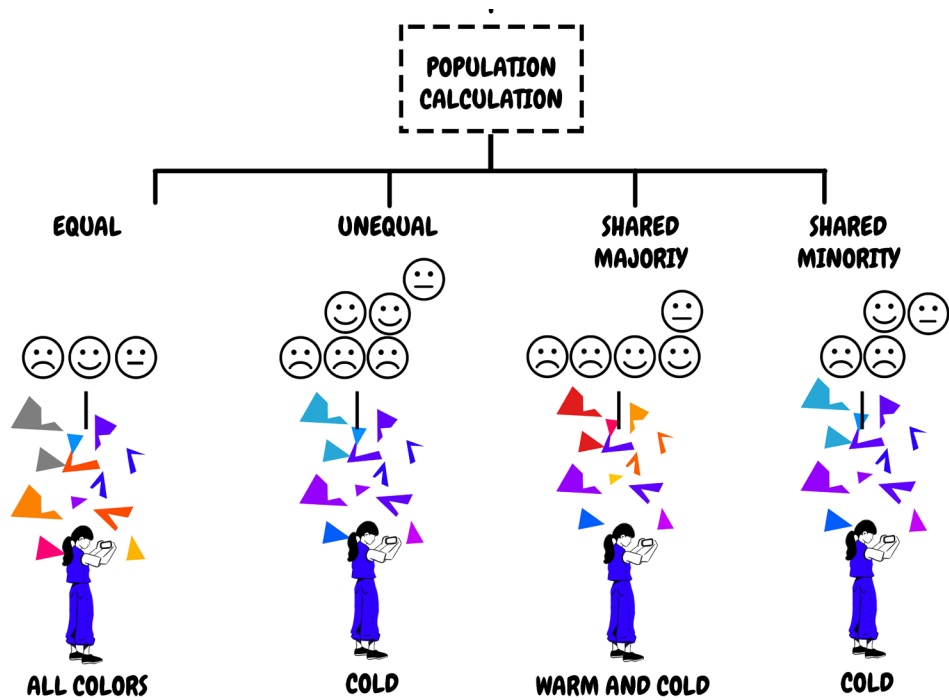


Diagram: Universal Particle Effect-Coloring Approach



Mockup Picture: Example of Particle Effect



Mockup Picture: Example of Particle Effect

#### 4.5.2. User-Defined Parameters

As previously mentioned, the app incorporates an additional way for agents to input their personal narratives. An element is created directly at the agent's location when they input their emotions, if the agent decides to. So, a "trace" is generated at the location where the input occurred. This trace visually reflects the color of the corresponding emotion, linking it thematically to the planet-node that was created above.

This feature introduces a more personal and interactive dimension to the app, allowing agents to share their stories and experiences. These "traces" serve as dynamic points within the urban space, enabling others to interact with them and experience the shared narrative of another individual. This creates a sense of connection and dialogue between agents. Additionally, these traces support multimedia inputs, such as photos or videos, alongside text. For instance, an agent might document a moment of joy by sharing a description of their experience, complimented by a photo. Another example could include a video capturing the atmosphere of a space linked to an emotion of calm.

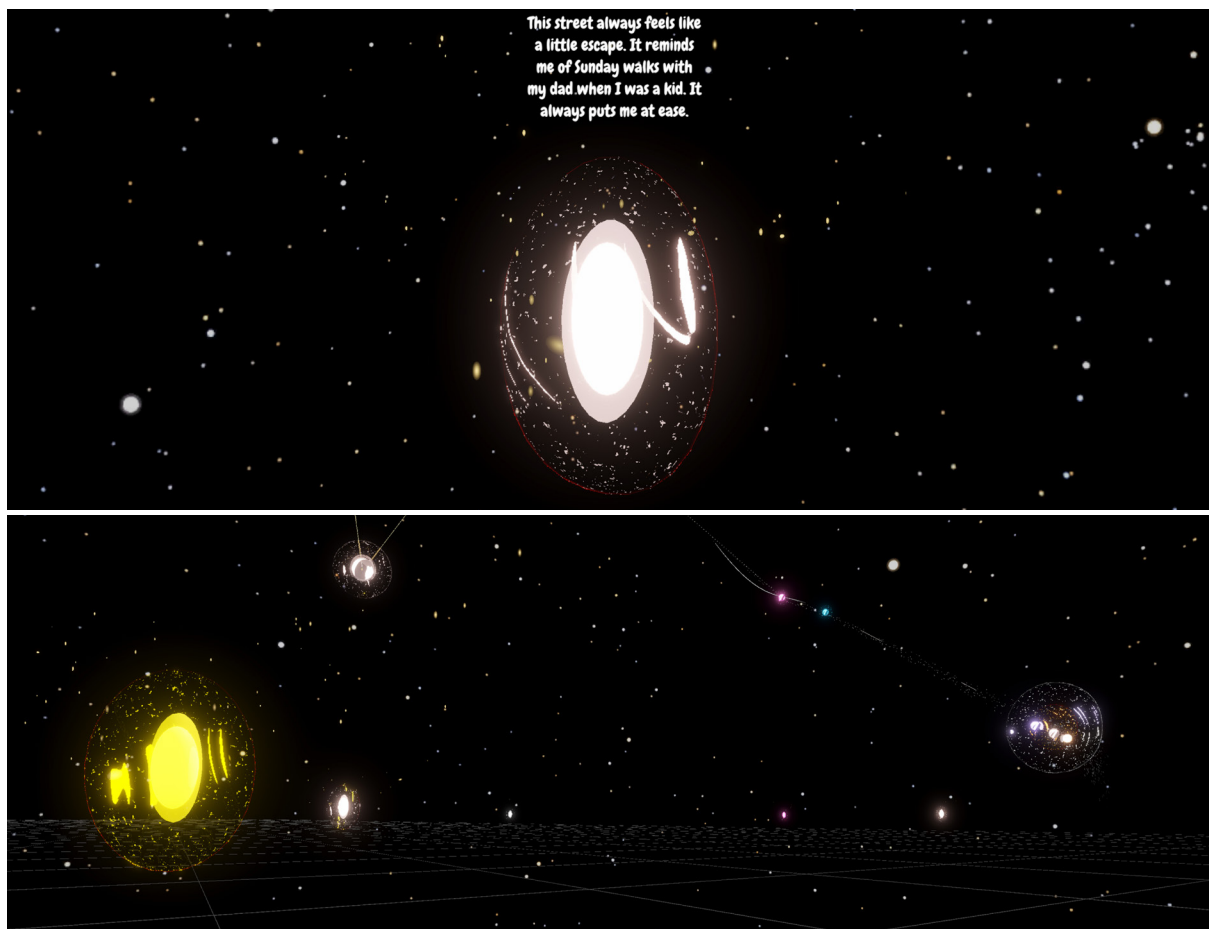
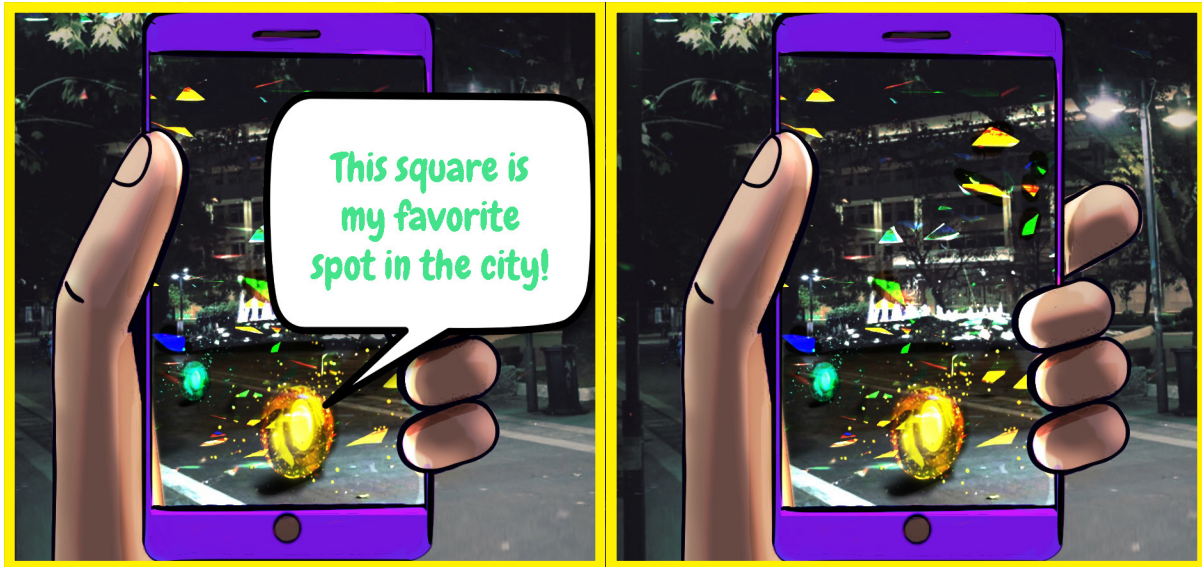


Image from Prototype: Example of Agent Trace





Mockup: Example of Trace Visualization

The app incorporates a mechanism where agents can view emotional traces when they come within a proximity. More specifically, when an agent is within the range of 3 meters, the trace becomes interactable, displaying the associated text narrative or multimedia, such as photos or videos, that the other agent has shared.

While these traces can be viewed from a distance, they become fully interactable when an agent comes within a range of 3 meters. This design choice aims to foster a deeper connection between agents, as the proximity creates an opportunity for interaction and engagement with the narrative shared by another individual.

This mechanism emphasizes the shared significance of the location, linking two agents through the space they both inhabit. By requiring physical closeness for interaction, the app focuses on the idea that emotional narratives are tied to specific places, encouraging agents to experience the environment in a more personal and meaningful way.

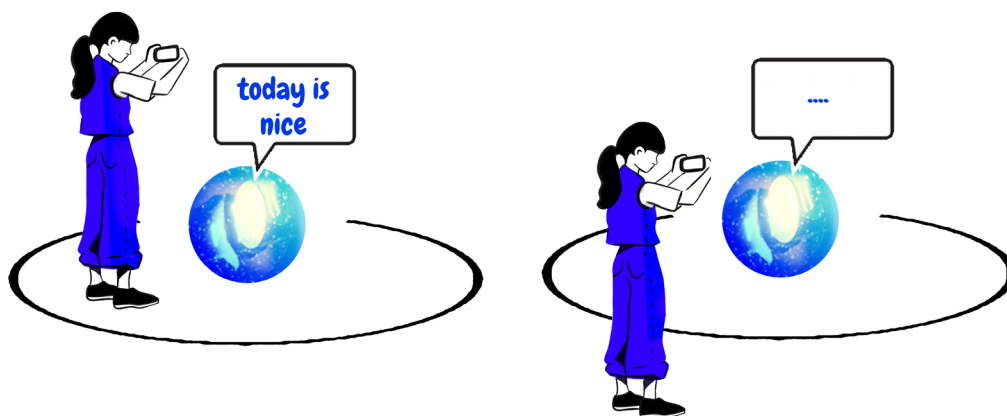


Diagram: Interaction Radius Threshold

### 4.5.3. Location Parameters

With the incorporation of the regional information the app can determine whether an agent is within a predefined region. So, when an agent enters one, the app spawns a character within the AR interface to provide contextual information specific to that region. This character serves as an interactive guide, offering insights into the area's context. This feature adds an informative layer, enhancing the agent's understanding of the environment they are exploring.

When clusters are formed in regions defined by distinct land uses, clusters are behaving accordingly. As clusters create force fields that influence the movement of particles, these fields are designed to reflect the character of the area in which the clusters are located. This dynamic interaction ensures that the visual aspects of the app align with the specific nature of each region.

### Environmental Regions

In areas with a strong environmental elements, the force field features natural-looking and fluid types of movement, mimicking the flow of water, the rustling of leaves or the sway of grass. The particles move organically.

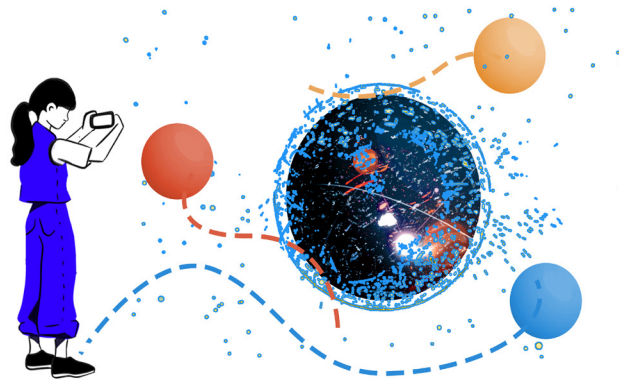


Diagram: Environmental Forces

### Commercial Regions

In commercial zones, the particle movement becomes more dynamic and fast-paced, reflecting the hustle and activity of marketplaces or business areas. The force field mimics bursts and has energetic movement to capture the vibrant and competitive atmosphere.



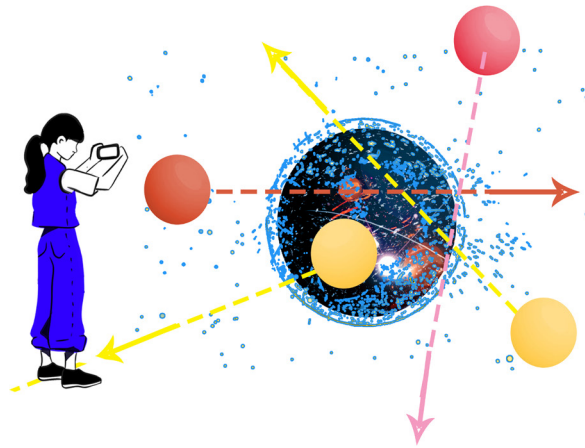


Diagram: Commercial Forces

## Historical Regions

In historically significant areas, the particles adopt a deliberate, rhythmic motion, moving in a consistent clockwise direction to symbolize the passing of time.

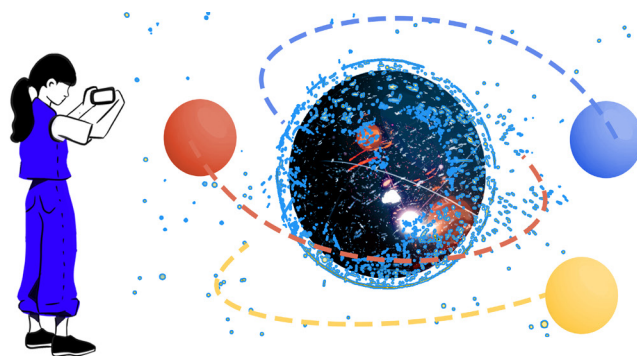


Diagram: Historical Forces

## Residential Regions

In residential zones, the force fields create softer, more contained movements, with particles gently moving inwards and outwards in a rhythmic pattern, mimicking the flow of life within a home or community.

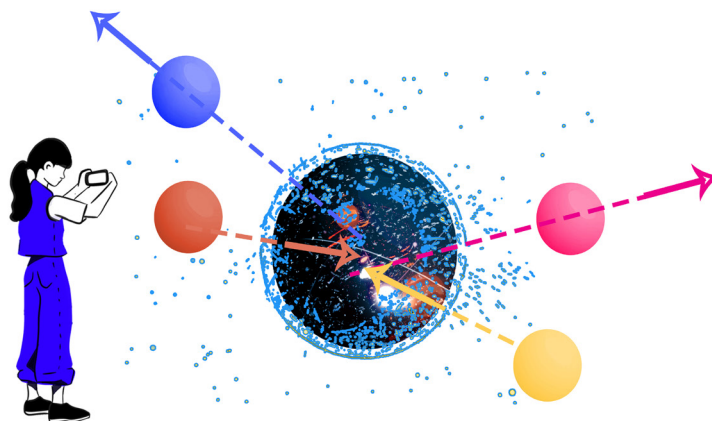


Diagram: Residential Forces

#### **4.5.4. Time Parameters**

The app is designed to operate in real-time, creating a seamless and dynamic experience. As agents walk through the city, they can engage live with emotional inputs. In this manner, the app incorporates an immediate way for users to experience and respond to the emotional landscape of the city.

The app refreshes the emotional data on a daily basis in order to provide agents with an accurate, real-time emotional landscape. This ensures that agents interact with the most current emotional inputs, keeping their exploration relevant and timely.

In addition to daily updates, the app incorporates an archive feature that tracks and visualizes emotional information over time. This archive allows users and analysts to observe how emotions shift across days, weeks or months. By accessing the archive, emotional patterns or transformations within the city can be uncovered. In the future, the app's update period may be adapted based on feedback. If changes are introduced, the clustering thresholds will adjust accordingly to ensure accuracy and valid representation of emotionally charged areas.

The app incorporates parameters such as day and time, as these elements are crucial for understanding and analyzing emotional inputs. Certain days and times can carry unique emotional charge that may not necessarily be tied to a specific place, such as holidays. In other cases, the emotional charge can directly relate to a location if an event or public interaction is taking place there. By keeping in mind those temporal aspects, it is acknowledged that time and place are deeply intertwined in shaping experiences. While these factors are integrated into the analysis of the output, they do not directly impact the app's visualizations, ensuring that the user experience remains focused on the spatial and emotional elements.

#### **4.6. Final Description**

In summary, the app is a real-time, location-based platform that uses augmented reality (AR) to map emotions onto the urban environment. Users can link their emotions to specific locations, which appear as AR nodes that form constellations and clusters in a sky-like interface. Emotions are grouped into optimistic, challenging, and reserved categories, represented by color-coded particles. Areas with high emotional input create larger planets that showcase the overall emotional state of the space. The app also adapts visuals and particle movements based on regional features like land use or historical context. Emotional data refreshes daily, while an archive tracks changes over time, capturing the city's evolving emotional patterns.

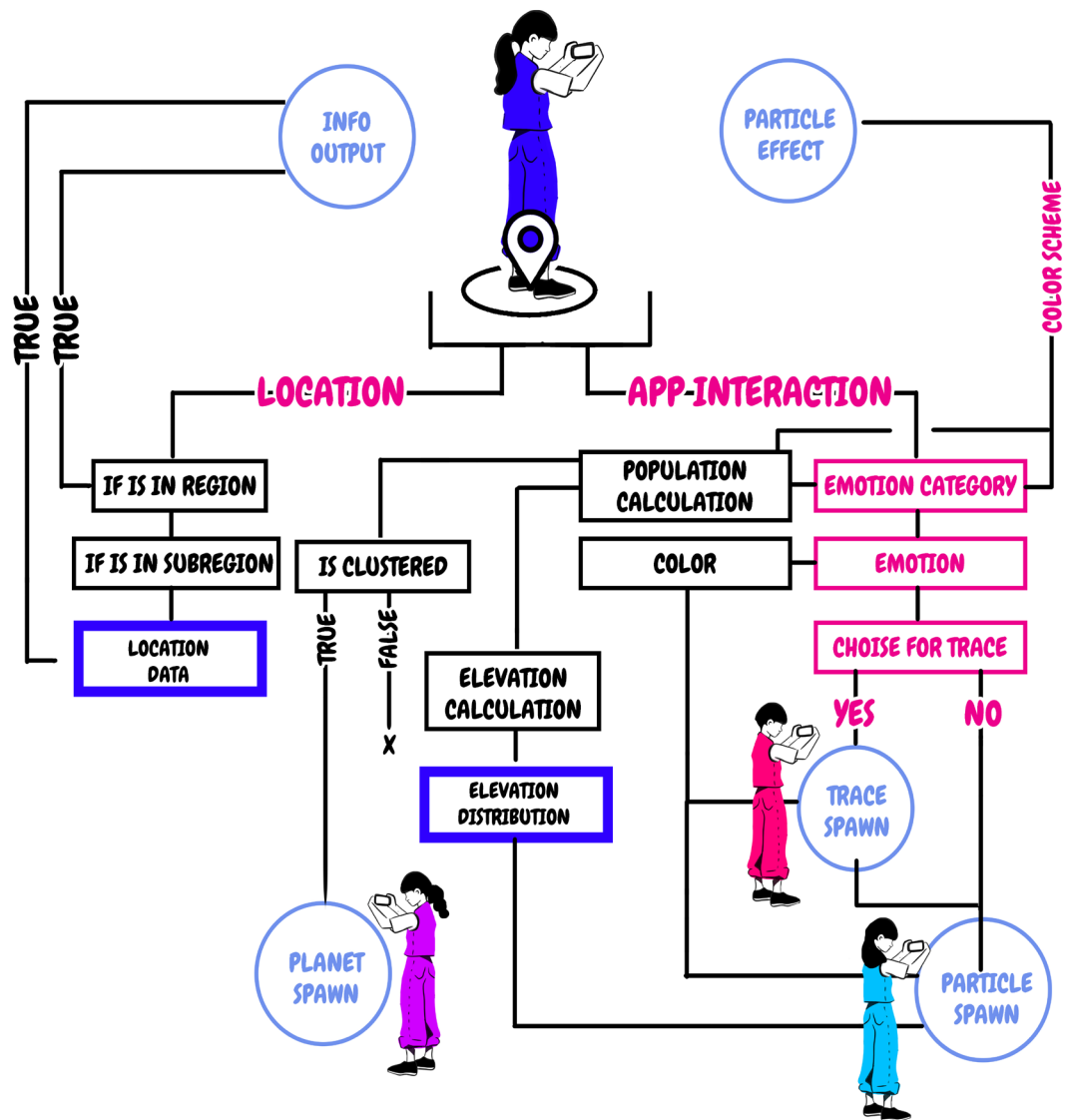


Diagram: Final Application's Framework



Mockup: Visual Representation



Mockup: Visual Representation





Mockup: Visual Representation

## 4 7. Outputs and Analytical Potential

The app generates a wide range of outputs that provide valuable insights into the emotional dynamics of urban spaces. One of the core outputs is the creation of emotional maps, which highlight emotionally charged areas within the city. These maps visually represent clusters of emotions tied to specific locations, enabling the identification of spaces that carry significant emotional weight. This mapping offers a tangible way to understand how people collectively perceive and interact with their environment.

In addition to spatial mapping, the app collects data that can be analyzed using statistical methods. Emotional inputs can be organized by categories, regions, and clusters, allowing for comparisons across various parameters. For example, the data can be examined to identify trends in emotional responses based on time of day, day of the week, or season. Similarly, demographic data, such as age, gender, or cultural background can be integrated into the analysis, offering insights into how different groups experience urban spaces.

These outputs can also be organized into patterns that uncover underlying meanings concerning the city. For instance, certain regions may consistently be described by optimistic emotions, while others may frequently evoke challenging ones. By identifying these patterns, urban planners, policymakers and researchers can better understand how spatial, social, and temporal factors influence emotional experiences. This analysis could inform decisions to

address issues within the urban context.

#### **4.7.1. A Bottom-Up Approach to Urban Dynamics**

The app features a bottom-up approach towards gathering data, as it collects it from individuals and their personal experiences of the city. This approach prioritizes the lived realities and emotions of citizens. Bottom-up translates into potential to redefine how cities are understood and managed. These insights, driven by citizen input, can help shape urban policies, improve public spaces and address inequalities within the city. Ultimately, the app empowers individuals to contribute to a collective understanding of their environment, ensuring that urban development aligns with the needs and emotions of those who live there.



5

The prototype

## 5. PROTOTYPE

### 5.1. Description

The pilot version of the app does not incorporate Augmented Reality (AR) technology. This feature will be added in future development. Additionally, the pilot is designed for single-agent interaction, but it incorporates mechanisms that simulate interactions between multiple agents.

Structurally, the pilot follows the same framework as the intended final application. One of its core features is the conversion of geographic coordinates. So, the pilot has the capability to convert Unity coordinates into the corresponding real-world coordinates and vice versa.

#### 5.1.1. Location Based Parameters

In the prototype the main designed interactions of agent and app are included, as they are the most important aspect of this project. The simulation of walks have been incorporated, but in the digital 3D world.

#### **City Grid Script**

At first, the virtual world is designed within the engine, using a grid structure. As in the AR, physical features of the city would be displayed, the digital world would only need the elements crucial to it, meaning planets and particles that are designed for interaction with the agent. So, the 3D world only needs to be defined by simple tools, such as a grid. As a result, a script was created by the name of CityGrid, that is responsible for creating a grid structure within Unity, which can visually represent a city's layout.

The main features of this script are:

##### 1. Grid Creation

The grid is generated based on the specified number of divisions (gridCount) and the distance between the grid lines (gridSize).

##### 2. Integration with the environment:

The grid has a customizable size (gridSize) and is connected to another script (coordinateConverter) that converts the actual coordinates into their unity corresponding ones.



```

@ Unity Script (1 asset reference) | 2 references
public class CityGrid : MonoBehaviour
{
    public float gridSize; // Distance between grid lines
    public int gridCount = 100; // Number of grid lines
    public Material lineMaterial; // Material for the lines
    public CoordinateConverter coordinateConverter; // Reference to CoordinateConverter to take the Unity length
    public Transform lineParent; // Reference to a parent transform for organizing lines
    // Dictionary to store grid points based on coordinates
    public Dictionary<Vector2, Vector3> gridCoordinates = new Dictionary<Vector2, Vector3>();

    1 reference
    public void CreateGrid()
    {
        gridSize = coordinateConverter.unityLength / gridCount;

        // Start creating lines from (0,0) outwards
        for (int i = 0; i <= gridCount; i++)
        {
            // Create vertical lines
            CreateLine(new Vector3(i * gridSize, 0, 0),
                new Vector3(i * gridSize, 0, gridCount * gridSize));


            // Create horizontal lines
            CreateLine(new Vector3(0, 0, i * gridSize),
                new Vector3(gridCount * gridSize, 0, i * gridSize));
        }
    }

    2 references
    void CreateLine(Vector3 start, Vector3 end)
    {
        GameObject line = new GameObject("Line");
        LineRenderer lr = line.AddComponent<LineRenderer>();
        lr.material = lineMaterial;
        lr.startWidth = 0.1f;
        lr.endWidth = 0.1f;
        lr.SetPosition(0, start);
        lr.SetPosition(1, end);
        lr.startColor = Color.grey;
        lr.endColor = Color.grey;

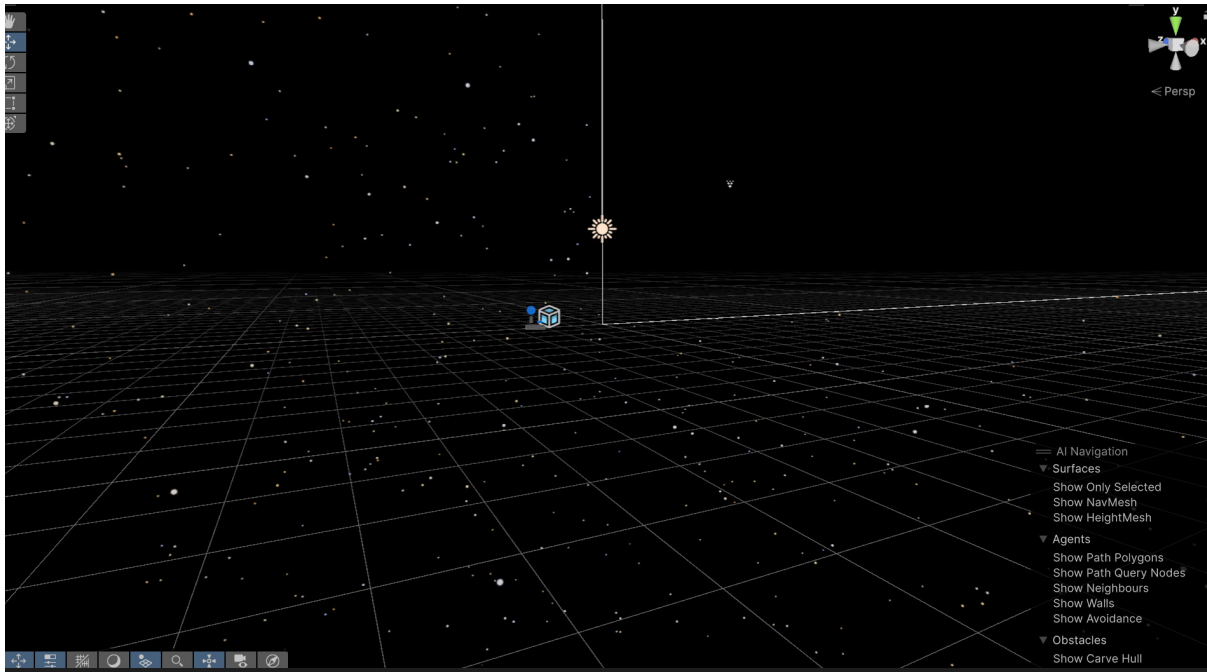
        // Set the line as a child of the line container
        line.transform.SetParent(lineParent.transform);
    }
}

```

The public variables are defined in Unity.

Grid Count	100
Line Material	 LineMaterial
Coordinate Converter	 Coordinate Converter (Coordinate Converter)
Line Parent	 lineParent (Transform)

Images from Prototype: Visual Studio with Unity Engine



Images from Prototype: Grid inside Unity's Environment

## Coordinate Converter Script

This script connects real-world coordinates and Unity's 3D coordinate system. The reverse translation is also incorporated in this script, meaning the conversion of Unity coordinates back to the real-world equivalences.

The main features of this script are:

### 1. Boundary Definition:

The real-world area is defined by four corner points (bottomLeftLatLong, bottomRightLatLong, topRightLatLong, topLeftLatLong), which form a geographic rectangle that includes the real world coordinates of the city of Larissa. These points are then mapped into Unity using bottomLeftUnity, bottomRightUnity, topRightUnity, and topLeftUnity.

### 2. Coordinate Conversion:

This script converts geographic coordinates into Unity's coordinate system, in order to place objects based on real-world locations. In parallel, it converts Unity coordinates into geographic latitude and longitude. This conversion has a crucial role for the pilot, as it bridges the digital grid with the real world coordinates.

### 3. User Integration:

The script tracks the user's Unity position and converts it into real-world coordinates. With this approach the pilot collects

location data and whether the user is within any defined regions.

#### 4. Scale:

A scale factor allows the Unity space to be adjusted in size, making it adaptable to project needs. The default scale level is set to 1:1.

```
Unity Script (1 asset reference) | 4 references
public class CoordinateConverter : MonoBehaviour
{
    [Header("Coordinate Boundaries (Longitude, Latitude)")]
    public Vector2 bottomLeftLatLong = new Vector2(22.36967880814947f, 39.59737493854134f);
    public Vector2 bottomRightLatLong = new Vector2(22.45775894534033f, 39.59737493854134f);
    public Vector2 topRightLatLong = new Vector2(22.45775894534033f, 39.66524442291073f);
    public Vector2 topLeftLatLong = new Vector2(22.36967880814947f, 39.66524442291073f);

    [Header("Unity Space Boundaries")]
    public Vector3 bottomLeftUnity;
    public Vector3 bottomRightUnity;
    public Vector3 topRightUnity;
    public Vector3 topLeftUnity;

    [Header("Scale Factor")]
    public float scale = 1f;
    public float unityLength;

    [Header("From player Coordinates")]
    public Vector2 realConvertedCoordinates;

    [Header("Random Generated Coordinates")]
    public Vector3 inputPosition;
    public Vector2 beforeConversion;

    1 reference
    public Vector3 ConvertToUnityPosition(Vector2 latLong)
    {
        // Normalize longitude (x) and latitude (y)
        float normalizedX = Mathf.InverseLerp(bottomLeftLatLong.x, bottomRightLatLong.x, latLong.x);
        float normalizedZ = Mathf.InverseLerp(bottomLeftLatLong.y, topLeftLatLong.y, latLong.y);

        // Convert normalized values to Unity position
        float unityX = Mathf.Lerp(bottomLeftUnity.x, bottomRightUnity.x, normalizedX) * scale;
        float unityZ = Mathf.Lerp(bottomLeftUnity.z, topLeftUnity.z, normalizedZ) * scale;

        return new Vector3(unityX, unityY, unityZ);
    }

    1 reference
    public Vector2 ConvertToRealCoordinate(Vector3 unityPosition)
    {
        // Unity X and Z coordinates based on Unity boundaries
        float normalizedX = Mathf.InverseLerp(bottomLeftUnity.x, bottomRightUnity.x, unityPosition.x / scale);
        float normalizedZ = Mathf.InverseLerp(bottomLeftUnity.z, topLeftUnity.z, unityPosition.z / scale);

        // Convert values back to latitude (Y) and longitude (X)
        float reallongitude = Mathf.Lerp(bottomLeftLatLong.x, bottomRightLatLong.x, normalizedX);
        float reallatitude = Mathf.Lerp(bottomLeftLatLong.y, topLeftLatLong.y, normalizedZ);

        return new Vector2(reallongitude, reallatitude);
    }
}
```

Images from Prototype: Visual Studio with Unity Engine

```

1 reference
public Vector2 GetPlayerRealCoordinates()
{
    // Find the player GameObject by its tag
    GameObject player = GameObject.FindWithTag("Player");
    if (player != null)
    {
        // Get the player's current Unity position
        Vector3 playerPosition = player.transform.position;
        // Convert to real-world coordinates
        Vector2 realCoordinates = ConvertToRealCoordinate(playerPosition);
        //Debug.Log("Player's Real-World Coordinates: Longitude: " + realCoordinates.x + ", Latitude: " + realCoordinates.y);
        realConvertedCoordinates= realCoordinates;
        return realCoordinates;
    }
    else
    {
        Debug.LogError("Player not found!");
        return Vector2.zero;
    }
}

```

Image from Prototype: Visual Studio with Unity Engine

## CityRegion and SubRegion Classes

The CityRegion and SubRegion classes are basic components of the pilot, as they define the urban areas and their subareas using polygonal boundaries.

```

37 references
public class CityRegion
{
    public string regionName; // Name of the region
    public int regionCode; // Code on google earth

    // Type of land use
    public int useRes;
    public int useCom;
    public int useEnv;
    public int useHist;
    public string regionInfo;

    public List<Vector2> polygonVertices; // List of points defining the polygon

    public List<SubRegion> subRegions; // List of subregions within this region

    // Constructor
    36 references
    public CityRegion(string name, int code, int useres, int usecom, int useenv, int usehist, string regioninfo, List<Vector2> vertices, List<SubRegion> subregions)
    {
        regionName = name;
        regionCode = code;
        useRes = useres;
        useCom = usecom;
        useEnv = useenv;
        useHist = usehist;
        regionInfo = regioninfo;
        polygonVertices = vertices;
        subRegions = subregions;
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

The CityRegion class defines the a primary regions within the city. Each region is identified by a name and a corresponding region code, which aligns with data edited on Google Earth. Additionally, the class incorporates land use as information in order to define the dominant use of that area, distinguishing between residential, commercial, environmental and historical functions. These variables are designed to accept values from 1 to 10, representing percentage-based distribution. CityRegion class includes an informational text attribute, providing descriptive text about the region. Its boundaries are determined using a list of points, forming a polygonal shape of each area. Furthermore, the class includes a variable for a list of SubRegion, which defines smaller areas within the main region.

```

public class SubRegion
{
    public string subRegionName; // Name of the subregion
    public int subRegionCode;
    public List<Vector2> subRegionVertices; // Vertices defining the subregion (polygon)

    // Constructor
    16 references
    public SubRegion(string name, int code, List<Vector2> vertices)
    {
        subRegionName = name;
        subRegionCode = code;
        subRegionVertices = vertices;
    }
}

```

### Images from Prototype: Visual Studio with Unity Engine

Each subregion is identified by a name (subRegionName) and a subregion code (subRegionCode), which help differentiate subregions within a main region.

To create its boundaries, the SubRegion class uses a polygonal boundary (subRegionVertices), which is represented as a list of points. These points define the shape and location of the subregion within the coordinate system.

As discussed before, this class in the intended app will have the same structure and variables as the CityRegion class, but as a starting point for the pilot these basic classification variables are incorporated.

## Region Manager Script

The RegionManager script creates city regions and their subdivisions within the application. Its primary function is to store, organize, and process geographic data, allowing the system to determine spatial relationships between user interactions and predefined urban areas.

It creates a list of CityRegion objects, each representing a specific area within the city. Each region is determined by the set of attributes defined by the CityRegion and SubRegion classes.

The main features of this script are:

### 1. Initialization (Start Method)

When the app starts running the regions are initialized.

Example: Agios Antonios Region



```

@ Unity Message | 0 references
public void Start()
{
    regions = new List<CityRegion>
    {
        new CityRegion(
            "AGIOS ANTONIOS",
            1, // Code for Region 01
            0, // Residential land use
            0, // Commercial land use
            0, // Environmental land use
            0, // Historic land use
            "Welcome to Agios Antonios",
            new List<Vector2>
            {
                new Vector2(22.41321502597983f, 39.63188643375276f),
                new Vector2(22.4131484608766f, 39.63575180061689f),
                new Vector2(22.40911742499063f, 39.63573642713428f),
                new Vector2(22.40735404608994f, 39.63576007021666f),
                new Vector2(22.40741995972978f, 39.63598236183018f),
                new Vector2(22.40573423349061f, 39.63610741742901f),
                new Vector2(22.40415811838712f, 39.63651389871843f),
                new Vector2(22.40329880224665f, 39.63605017855468f),
                new Vector2(22.40257334946239f, 39.63552671376826f),
                new Vector2(22.40235709544151f, 39.63511565655515f),
                new Vector2(22.403318466563f, 39.63461388299192f),
                new Vector2(22.40421917601977f, 39.63412805793784f),
                new Vector2(22.4052050188184f, 39.63370705984982f),
                new Vector2(22.40713069254036f, 39.63318426174438f),
                new Vector2(22.41321502597983f, 39.63188643375276f)
            }
        ),
        new List<SubRegion>
        {
            new SubRegion(
                "AGIOS ANTONIOS SQUARE",
                101,
                new List<Vector2>
                {
                    new Vector2(22.40782976431155f, 39.63486621001807f),
                    new Vector2(22.40765936703087f, 39.6350013488317f),
                    new Vector2(22.40551914903268f, 39.6356237199079f),
                    new Vector2(22.40491437838552f, 39.63458804233714f),
                    new Vector2(22.40564106353487f, 39.63446252753159f),
                    new Vector2(22.40749910458535f, 39.63386312745752f),
                    new Vector2(22.40782976431155f, 39.63486621001807f)
                }
            )
        }
    },
),

```

[Images from Prototype: Visual Studio with Unity Engine](#)

## 2. Checking Region and SubRegion (GetRegionAndSubRegion Method)

Another function of the RegionManager is to determine which region a given coordinate belongs to. It checks whether a coordinate falls within a particular region or subregion. This method allows for accurate spatial mapping and ensures that every coordinate is correctly associated with its corresponding region. When the user interacts with the app, the Unity coordinates are converted into real-world coordinates using the CoordinateConverter. These converted coordinates are then processed by the RegionManager, which checks whether the given coordinates are within a defined region or subregion and returns the corresponding location data.

```

references
public (CityRegion, SubRegion) GetRegionAndSubRegion(Vector2 coordinate)

{
    foreach (var region in regions)
    {
        if (IsCoordinateInPolygon(coordinate, region.polygonVertices))
        {
            // Check if it falls within any subregion
            foreach (var subRegion in region.subRegions)
            {
                if (IsCoordinateInPolygon(coordinate, subRegion.subRegionVertices))
                {
                    Debug.Log($"Coordinate is inside subregion: {subRegion.subRegionName}");
                    return (region, subRegion); // Return both the region and subregion
                }
            }
        }

        Debug.Log($"Coordinate is inside region: {region.regionName}");
        return (region, new SubRegion("None", -1, new List<Vector2>())); // If no subregion is found, return null for subregion
    }
}

```

### Images from Prototype: Visual Studio with Unity Engine

In terms of location, the pilot creates a digital representation of the city by generating a virtual grid within Unity. It then maps real-world coordinates retrieved from Google Earth into Unity's coordinate system. When the user interacts within a digital region, their Unity coordinates are converted back into real-world coordinates. If these coordinates match a predefined region, the system stores the data accordingly.

#### 5.1.2. Designed Interactions

##### Particle Data Class

The ParticleData class defines the emotional and visual characteristics of each particle. It includes an emotion attribute that represents the specific emotion linked to a particle. The category variable refers to the broader emotional categories that are defined, such as positive, negative and neutral. The color attribute defines the visual appearance of the particle based on the assigned emotion and the index serves as an identifier for each particle, ensuring that every instance is traceable within the system. Finally, the input text attribute stores the additional information provided by the user, associated with the emotion, if the user chooses to further interact with it.

```

24 10:10:10
public class ParticleData
{
    public string emotion;
    public string emotionCategory;
    public Color color;
    public int index;
    public string inputText;

    // Constructor to initialize the data
    1 reference
    public ParticleData(string emotion, string category, Color color, int index, string inputText)
    {
        this.emotion = emotion;
        this.emotionCategory = category;
        this.color = color;
        this.index = index;
        this.inputText = inputText;
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

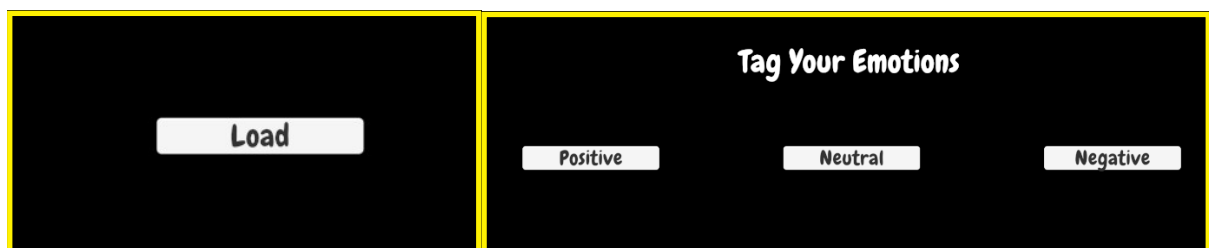
## Spawn Manager

The SpawnManager is responsible for managing the spawning and behavior of the user and particles within the prototype. It ensures that particles are spawned at specific locations. Additionally, it handles interactions between the user, particles and emotional tagging within the pilot application.

The main features of this script are:

### 1. User and Particle Spawning

The script spawns the user at predefined locations on the grid. Particles, which represent user interactions are spawned at the user's location, when a button is clicked.



Images from Prototype: User Interface



```

references
public void SpawnParticle()
{
    // Check if the interaction button is clicked
    if (buttonClickManager.IsSpawnButtonClicked())
    {
        // Find the player GameObject by its tag
        GameObject player = GameObject.FindWithTag("Player");
        if (player != null)
        {
            // Get the player's current Unity position and adjust Y coordinate
            Vector3 particlePosition = player.transform.position;
            particlePosition.y = coordinateConverter.unityY;

            // Get the region based on the player's real-world coordinates
            Vector2 regionCoordinate = coordinateConverter.realConvertedCoordinates;
            CityRegion region = regionManager.GetRegion(regionCoordinate);

            // Log the region information if available
            if (region != null)
            {
                Debug.Log($"Player's position is in region: {region.regionName} (Code: {region.regionCode}) at {regionCoordinate}");
            }
            else
            {
                Debug.Log("Player is not inside any defined region.");
            }

            // Instantiate the particle prefab at the calculated Unity position
            GameObject particle = Instantiate(particlePrefab, particlePosition, Quaternion.identity);
            spawnedParticles.Add(particle);
            OnParticleSpawned?.Invoke();
            //Debug.Log($"Particle spawned at Unity Position: {particlePosition}");
            buttonClickManager.ResetSpawnButtonClick();
        }
        else
        {
            Debug.LogError("Player not found!");
        }
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

## 2. Emotional Tagging

A key feature of this class is the interaction between emotions and particles. When a user submits an emotional tag for a particle, the class assigns the corresponding color and category to it. This is happening through EmotIotionalTaggingUI script that handles the user interface for the emotional selections.

```

public void StartEmotionTag()// On click Event
{
    ...
    emotionalTaggingUi.StartEmotionTagging();
}

```

Images from Prototype: Visual Studio with Unity Engine

## 3. Line Rendering Between Particles

The class visually connects spawned particles using lines, mimicking constellations. Each time a new particle is spawned, a line is drawn between that particle and the previous one

```

2 references
private void DrawLineBetweenParticles()
{
    if (spawnedParticles.Count == 0) return;

    int currentLineIndex = 0; // Tracks which line renderer we are using

    int startIndex = 0;

    // Loop through walk segments to create a line for each walk
    foreach (int segmentEnd in walkSegments)
    {
        CreateOrUpdateLineForSegment(startIndex, segmentEnd - 1, currentLineIndex);
        currentLineIndex++;
        startIndex = segmentEnd; // Move to the next segment
    }

    // Handle the particles after the last segment, if any
    if (startIndex < spawnedParticles.Count)
    {
        CreateOrUpdateLineForSegment(startIndex, spawnedParticles.Count - 1, currentLineIndex);
        currentLineIndex++;
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

A way to simulate different user interactions is by creating a button that concludes a particular walk, meaning it stops the continuous drawing of lines and commences a new sequence. With this approach, the prototype can simulate different agent interactions, but asynchronously. These segments are stored in a list to track different “walks” through the environment.



Images from Prototype: User Interface

## Emotional Tagging UI

The EmotionalTaggingUI script manages the user interface for emotional tagging. It allows users to select emotion category and specific emotion, as well as provide additional input through text.

The script includes various UI elements such as buttons for emotion selection, panels for displaying different steps in the selection process and an input field for user-generated text. The class uses events to communicate the selected emotion and user input to other scripts of the app.

The main features of this script are:

### 1. Emotion Selection Process

The emotion selection process allows users to choose from three main emotion categories: Positive, Neutral and Negative. Each category contains specific emotions. When a user selects an emotion, the system triggers an event that stores their choice, ensuring that the emotional input is recorded and can be used for further processing.

```
public Dictionary<string, string[]> emotionsByCategory = new Dictionary<string, string[]>
{
    { "Positive", new string[] { "Joy", "Hopefulness", "Calm", "Affection", "Trust" } },
    { "Neutral", new string[] { "Neutrality", "Caution" } },
    { "Negative", new string[] { "Sadness", "Anxiety", "Terror", "Rage", "Frustration" } }
};
```

Unity Message | 0 references

```
private void Start()
{
    emotionalUi.SetActive(false);
    emotionButtons.SetActive(false);
    questionUi.SetActive(false);
    inputTextUi.SetActive(false);

    positiveButton.onClick.AddListener(() => ShowEmotions("Positive"));
    neutralButton.onClick.AddListener(() => ShowEmotions("Neutral"));
    negativeButton.onClick.AddListener(() => ShowEmotions("Negative"));
}
```

1 reference

```
public void OnEmotionSelected(string emotion)
{
    selectedEmotion = emotion;
    //Debug.Log($"Emotion Tagged: {selectedEmotionCategory} - {selectedEmotion}");

    // Trigger the event
    OnEmotionSelectedEvent?.Invoke(selectedEmotionCategory, selectedEmotion);

    SaveEmotionData();
    ShowQuestionUi();
}
```

## Images from Prototype: Visual Studio with Unity Engine

### 2. Text Input

After selecting an emotion, a question panel is presented to the users, asking them to provide additional context. The user can then enter text into an input field, offering further details about their state. Once submitted, the input text is stored and sent through an event, ensuring that the information is processed and incorporated into the system.

```
public void SubmitText()// on click event
{
    if (inputField != null && inputField.text != "")
    {
        string submittedText = inputField.text; // Get the text from the input field
        OnInputTextSubmitted?.Invoke(submittedText); // Trigger the event with the text
        inputField.text = ""; // Clear the input field after submission
    }

    ResetUI();
    HideAllUI();
}
```



Images from Prototype: User Interface

## Particle Emotion

The ParticleEmotion script is responsible for handling the attributes of ParticleData class. The class cooperates with the EmotionalTaggingUI to receive user-selected emotions and input text, storing these details in a list of ParticleData objects.

The main features of this script are:

### 1. Data Storage

Each particle is uniquely identified using a particleId, which corresponds to its index in the particleDataList. If the user provides additional text input, this input is stored and linked to the respective particle for further analysis.

```
// Store the emotion data
ParticleData newData = new ParticleData(selectedEmotion, selectedCategory, color, particleId, inputText);

// Add the new particle data to the list
particleDataList.Add(newData);
```

### 1. Apply color

When an emotion is assigned, the particle's color is determined based on predefined mappings of emotions to colors.

```
1 reference
private Color GetPositiveColor(string emotion)
{
    switch (emotion)
    {
        case "Joy": return new Color(1f, 0.87f, 0f); // Hex FEDF00
        case "Hopefulness": return new Color(0.95f, 0.44f, 0.13f); // Hex F37121
        case "Calm": return new Color(0.99f, 0.82f, 0.80f); // Hex FBD1CD
        case "Affection": return new Color(0.98f, 0.64f, 0.10f); // Hex FAA41A
        case "Trust": return new Color(0.93f, 0.11f, 0.35f); // Hex ED1B58
        default: return new Color(0.984f, 0.996f, 0.863f); // Hex fbfedc
    }
}
```

## Mark Interaction

This script enables user interaction with the traces that are created if the user chooses to input text in the app. When the user enters the trigger area, the script detects their presence and allows them to interact with the text that was previously inputted when tagging the corresponding emotion. Upon interaction, a panel appears, displaying the submitted text message. The script modifies the mark's color based on the emotion assigned to the associated particle, retrieving this information from the ParticleEmotion.particleDataList.

```
Unity Message | 0 references
private void OnTriggerEnter(Collider other)
{
    // Check if the player enters the trigger area
    if (other.CompareTag("Player"))
    {
        isPlayerNearby = true;
        //Debug.Log("Player Entered");
    }
}

Unity Message | 0 references
private void OnTriggerExit(Collider other)
{
    // Check if the player leaves the trigger area
    if (other.CompareTag("Player"))
    {
        isPlayerNearby = false;
    }

    textUi.SetActive(false);
}

1 reference
void Interact()
{
    textUi.SetActive(true);
    onScreenText.text = submittedText;
}
```

Images from Prototype: Visual Studio with Unity Engine

### 5.1.3. Cluster Mechanism

#### Particle Cluster Manager

The ParticleClusterManager script is responsible for detecting, managing and processing particle clusters in the Unity scene. It identifies groups of particles that are close to each other, assigns them to clusters and determines their behaviors. When a cluster reaches a sufficient size, the script spawns a corresponding cluster planet, positioning it at the centroid of the cluster. In terms of

simplicity, as the prototype is interactable by one user the defined cluster size decreased to 3 particles within a radius of 75 meters.

The main features of this script are:

### 1. Detection of Clusters

To detect clusters, the script calculates the distances between particles and groups them based on a predefined radius threshold. These clusters are stored in particleClusters list, which tracks their members. The clustering process is determined by calculating the centroid of a potential cluster. If the distance between particles falls within the threshold, a new cluster is formed. If a cluster already exists, the script recalculates the centroid by considering the new particle. If the updated centroid remains within the defined threshold, the particle is added to the existing cluster.

```
1 reference
private void FilterParticlesWithinRadius(List<Vector2> particles, float radius)
{
    // Stores all connections per particle in a dictionary
    Dictionary<int, List<int>> clusterPairs = new Dictionary<int, List<int>>();

    for (int i = 0; i < particles.Count; i++)
    {
        List<int> clusterIndices = new List<int>();
        int count = 0;

        for (int j = 0; j < particles.Count; j++)
        {
            if (i != j) // Don't compare the point to itself
            {
                float distance = Vector2.Distance(particles[i], particles[j]);
                if (distance <= radius)
                {
                    count++;
                    clusterIndices.Add(j);
                }
            }
        }

        if (count >= minParticlesInCluster - 1)
        {
            clusterPairs.Add(i, clusterIndices);
        }
    }
}
```

Images from Prototype: Visual Studio with Unity Engine

```

1 reference
private bool IsParticleValidForCluster(List<int> cluster, Vector2 newParticlePosition, List<Vector2> particles, float radius)
{
    if (cluster.Count == 0) return true;

    // Calculate the new centroid
    Vector2 sum = Vector2.zero;
    foreach (int index in cluster)
    {
        sum += particles[index];
    }
    sum += newParticlePosition; // Add the new particle to the sum
    Vector2 newCentroid = sum / (cluster.Count + 1);

    // Check if all old particles are still within the radius
    foreach (int index in cluster)
    {
        float distance = Vector2.Distance(newCentroid, particles[index]);
        if (distance > radius)
        {
            return false; // Old particle is outside the valid radius
        }
    }

    return true;
}

```

Images from Prototype: Visual Studio with Unity Engine

## 2. Cluster Size

Once a planet is created, its size adjusts based on the number of particles in its cluster, using a size multiplier. Each cluster of particles is parented to its corresponding planet, ensuring organization and smooth movement of clustered elements.

```

1 reference
private void UpdatePlanetSize(GameObject planet, int clusterSize, int minClusterSize, int planetIndex, List<int> previousIndicesCount)
{
    if (previousIndicesCount[planetIndex] == clusterSize)
    {
        return;
    }
    else
    {
        // get the default scale
        Vector3 originalScale = planet.transform.localScale;

        // Calculate the new size based on the cluster size
        float scaleModifier = 1 + ((clusterSize - minClusterSize) * planetSizeMultiplier);
        Vector3 newScale = scaleModifier * originalScale;
        planet.transform.localScale = newScale;
        previousIndicesCount[planetIndex] = clusterSize;
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

## 3. Force Assignment

The script supports orbital motion, assigning particles within a cluster to orbit around their respective planets. In the prototype, only orbital motion has been included, similar to the historical land use force discussed in previous chapter.



```

1 reference
public void AssignParticlesToOrbit(List<GameObject> planet, List<List<int>> particleIndices)
{
    for (int i = 0; i < planet.Count; i++) // Loop through each planet
    {
        foreach (int particleIndex in particleIndices[i]) // Access each particle index for the current planet
        {
            // Get the particle GameObject using the particle index
            GameObject particle = spawnManager.GetParticleByIndex(particleIndex);

            if (particle != null) // If the particle exists
            {
                // Add the ParticleOrbit script to the particle
                ParticleOrbit orbitScript = particle.AddComponent<ParticleOrbit>();

                // Set up the orbital parameters
                orbitScript.planet = planet[i].transform; // Assign the planets transform to the orbit script
                orbitScript.particle=particle.transform;
                orbitScript.orbitRadius = Random.Range(10f, 50f); // Random orbit radius
                orbitScript.orbitSpeed = Random.Range(0.1f, 1f); // Random orbit speed
            }
            else
            {
                Debug.LogWarning($"Particle at index {particleIndex} not found.");
            }
        }
    }
}

CreateParent(particleIndices):

```

Images from Prototype: Visual Studio with Unity Engine

#### 4. "Planet" Vertical Movement

Additionally, the script manages the movement of "planets" in the vertical axis based on the collective emotional input population calculation. This calculation is handled by another script, but in this script the movement is managed, as the spawning of these elements is being handled by it.

```

11 references
public void MovePlanetsBasedOnEmotion(List<int> planetsToMove, float directionMultiplier)
{
    if (planetsToMove.Count < 1) return;

    for (int i = 0; i < planetsToMove.Count; i++)
    {
        int index = planetsToMove[i]; // Retrieve the index to move
        if (index >= 0 && index < previousIndicesCount.Count) // Ensure the index is valid
        {
            GameObject planet = existingPlanets[index];

            // Modify the y-coordinate of the particle's position
            Vector3 newPosition = planet.transform.position;
            newPosition.y = coordinateConverter.unityY + (directionMultiplier * aloneParticlesYMovementAmount);
            planet.transform.position = newPosition;
        }
        else
        {
            Debug.LogWarning($"Invalid index {index} for spawnedParticles list.");
        }
    }
}

```

Images from Prototype: Visual Studio with Unity Engine

## Cluster Emotions

The ClusterEmotions script is responsible for analyzing and processing the emotional calculation of particles and clusters. It awaits for updates from both the ParticleClusterManager and ParticleEmotion classes, ensuring that clusters are evaluated whenever a new particle is spawned and an emotion is assigned.

The main features of this script are:

### 1. Population Calculation

When a cluster update is detected, the script counts the emotions of all particles and determines the most prominent emotion category. This process involves counting each emotion, sorting them and categorizing them into positive, neutral, and negative groups.

```
1 reference
private void CountEmotions(List<int> updatedCluster)
{
    // Dictionary to count emotions in the updated cluster
    Dictionary<string, int> emotionCounts = new Dictionary<string, int>();

    // Get the count of particles in the particle data list
    int totalParticles = ParticleEmotion.particleDataList.Count;

    // Go through each particle index in the updated cluster
    foreach (var particleIndex in updatedCluster)
    {
        // Ensure the index is valid
        if (particleIndex >= 0 && particleIndex < totalParticles)
        {
            var particleData = ParticleEmotion.particleDataList[particleIndex];

            if (particleData != null)
            {
                string emotionCategory = particleData.emotionCategory;

                // Count emotions
                if (!emotionCounts.ContainsKey(emotionCategory))
                {
                    emotionCounts[emotionCategory] = 0;
                }
                emotionCounts[emotionCategory]++;
            }
            else
            {
                Debug.LogWarning($"ParticleData at index {particleIndex} is null.");
            }
        }
        else
        {
            // Log the invalid index and also the count of the available particle data
            Debug.LogWarning($"Invalid particle index: {particleIndex}. Available particles: {totalParticles}");
        }
    }
}
```

Images from Prototype: Visual Studio with Unity Engine

## 2. Vertical Movement Management

Additionally, the script influences the vertical movement of particles and planets based on their dominant emotional category. If a certain emotion is the most prominent, its associated particles or planets would be positioned higher or lower in the scene.

```
reference
public void MoveAloneParticles(List<string> sortedEmotions, bool isMinValuesEqual, bool isMaxValuesEqual, bool isAllValuesEqual)
{
    List<int> minEmotionsToMove = new List<int>();
    List<int> medEmotionsToMove = new List<int>();
    List<int> maxEmotionsToMove = new List<int>();
    List<int> particlesInsideClusters = new List<int>();

    if (sortedEmotions.Count == 3)
    {
        if (isMinValuesEqual) ...
        else if (isMaxValuesEqual) ...
        else if (!isAllValuesEqual) ...
    }

    else if (sortedEmotions.Count == 2)
    {
        if (isMaxValuesEqual || isMinValuesEqual) ...
        else ...
    }

    minEmotionsToMove.Clear();
    medEmotionsToMove.Clear();
    maxEmotionsToMove.Clear();
}
```

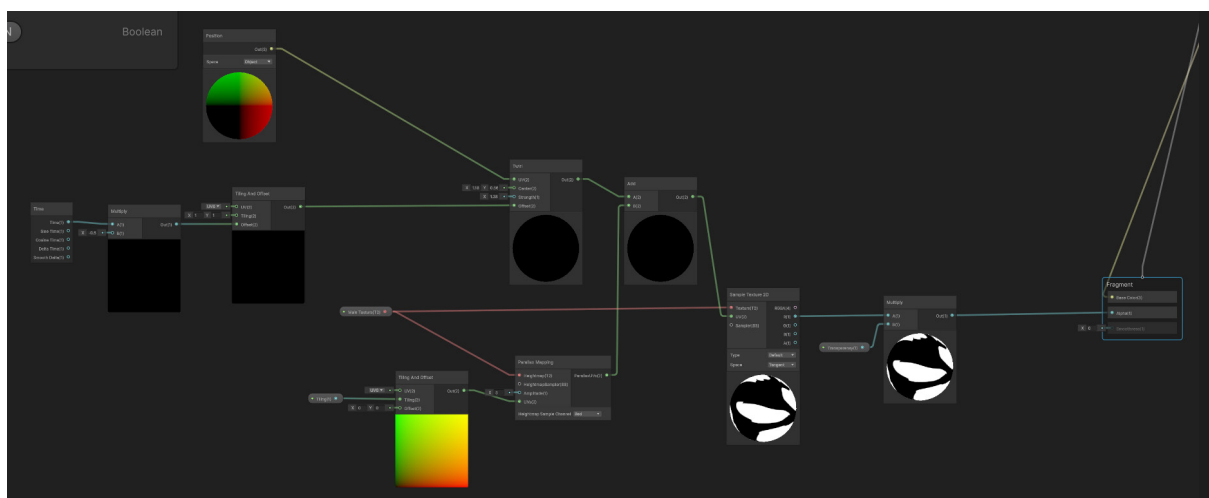
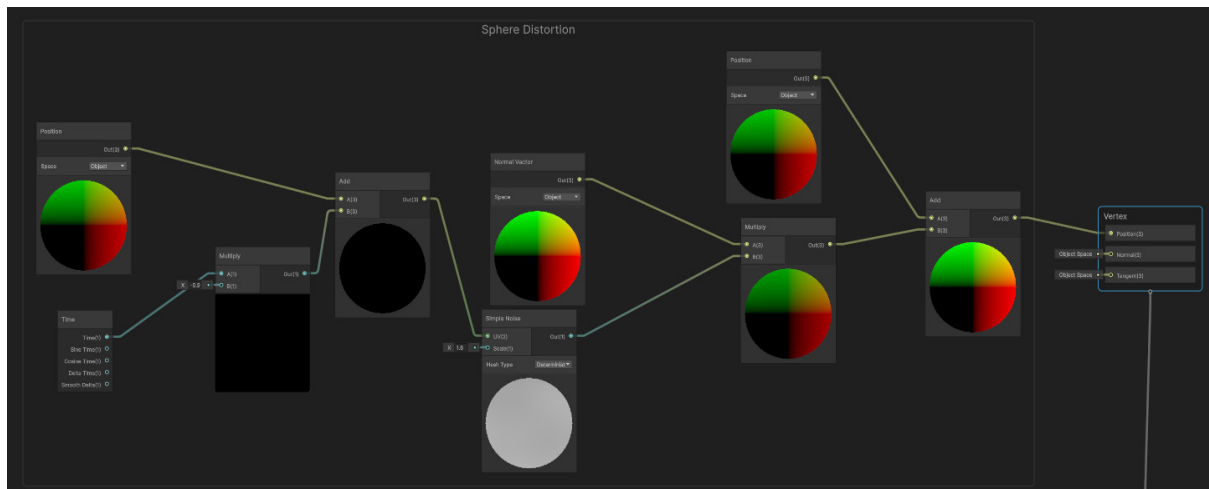
Images from Prototype: Visual Studio with Unity Engine

### 5.1.4. Graphics

In terms of graphics, three types of elements have been created using the shader graph tool in Unity. These graphics are also incorporated into the intended app mockups that were presented previously.

#### Particles

The appearance of the particles is defined through the Shader Graph, that also incorporates animation logic. As shown in the images below, two parts of the shader are defining the final graphic appearance of each particle, the vertex distortion and fragment, meaning the final color of each pixel. Each one of those is time analogous, meaning it has motion.



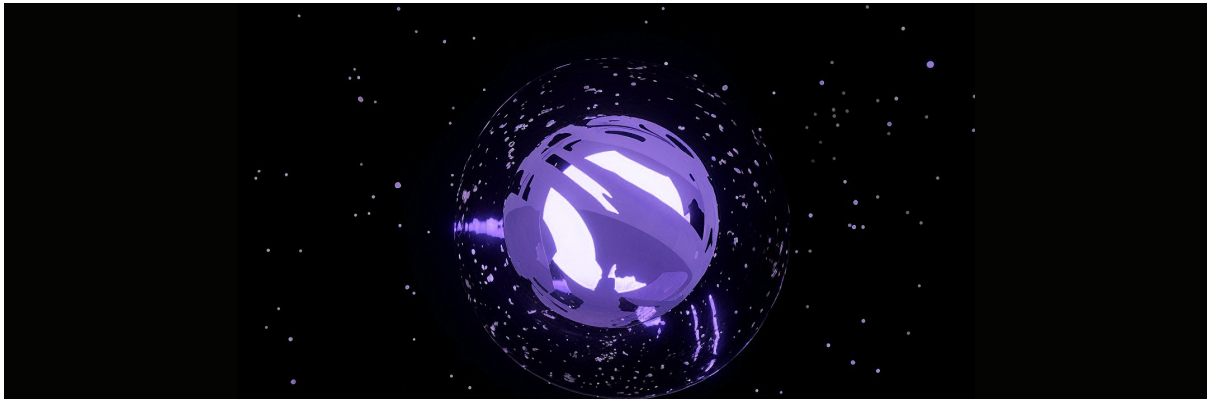
Images from Prototype: Unity's Shader Graph

Finally, the shader has some properties that depend on variables within the code, in order to assign the color and texture. (In future versions could be defined by the user, via an urban image.)



Images from Prototype: Unity's Shader Graph

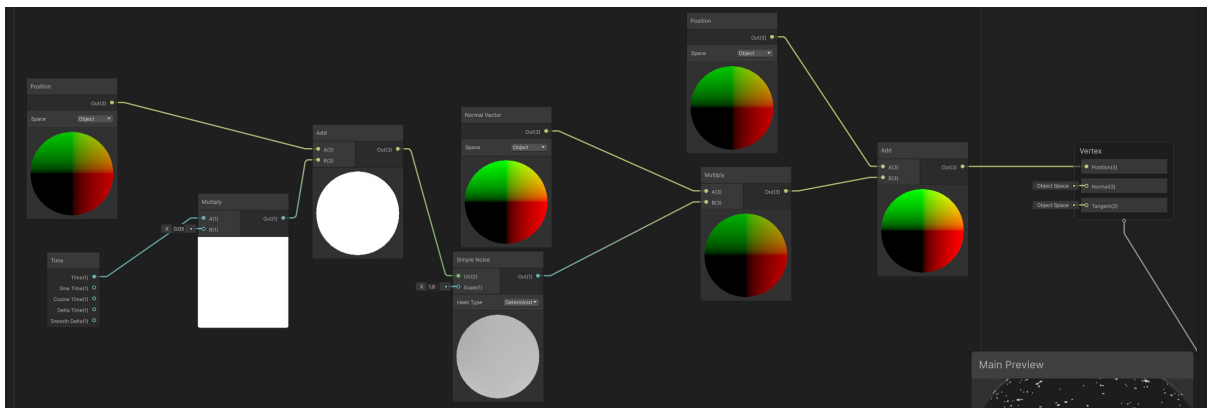
Final Result:



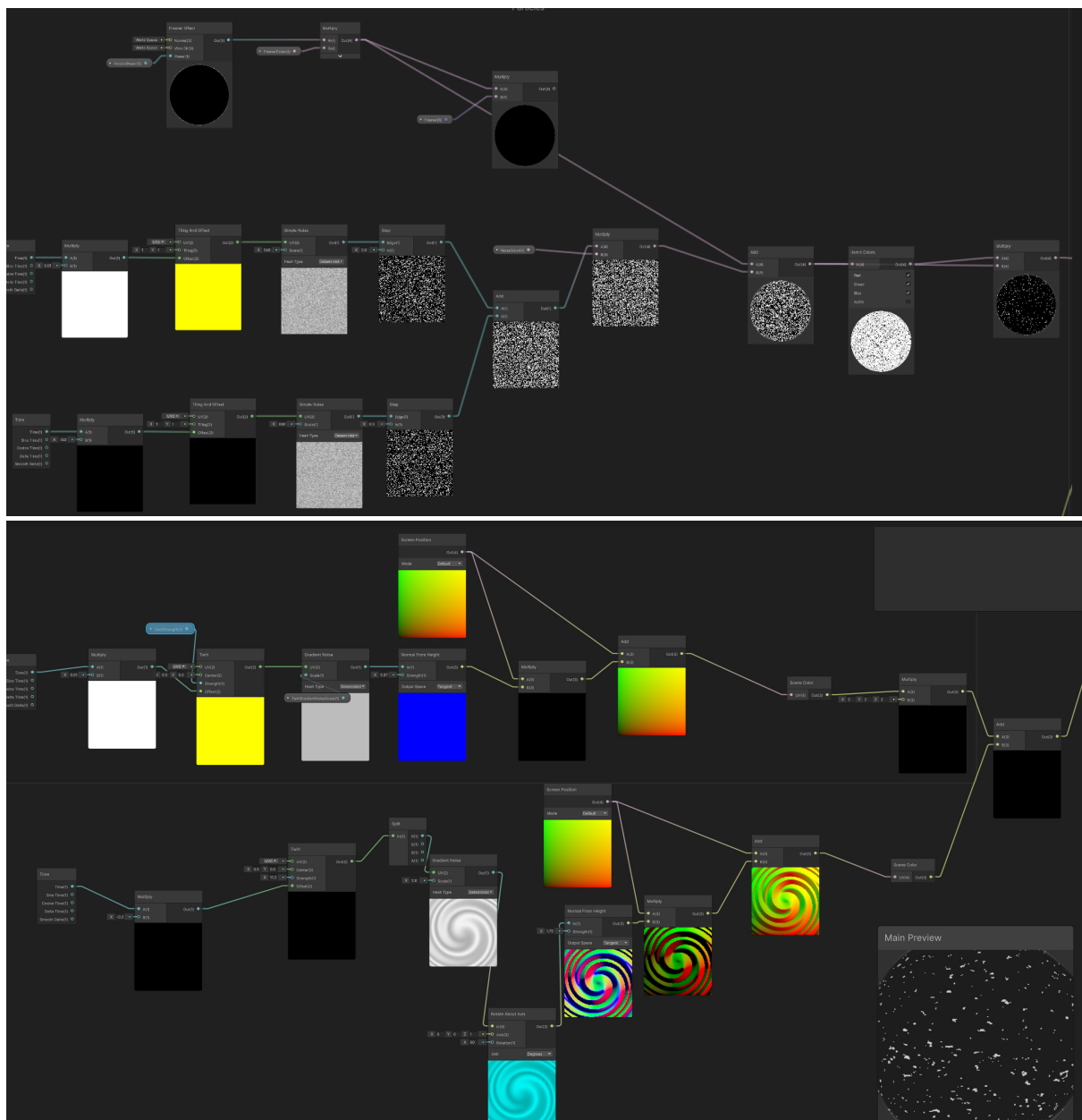
Images from Prototype: Final Particle Graphics

## Planets

Similarly to particles, the planet's shader applies a distortion effect to its vertices. The sphere itself is populated by small animated particles that lack individual color properties, as the primary focus is on the collective visualization of the emotional particles that formed it. Additionally, a twirl effect has been implemented, distorting the screen's UV to create the appearance of moving brush strokes. These strokes take on the colors of the surrounding particles.

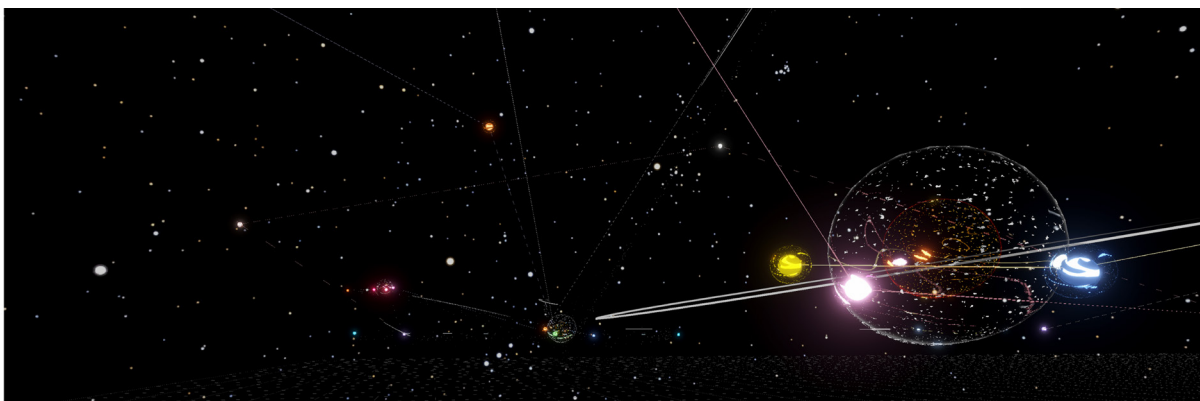


Images from Prototype: Unity's Shader Graph



Images from Prototype: Unity's Shader Graph

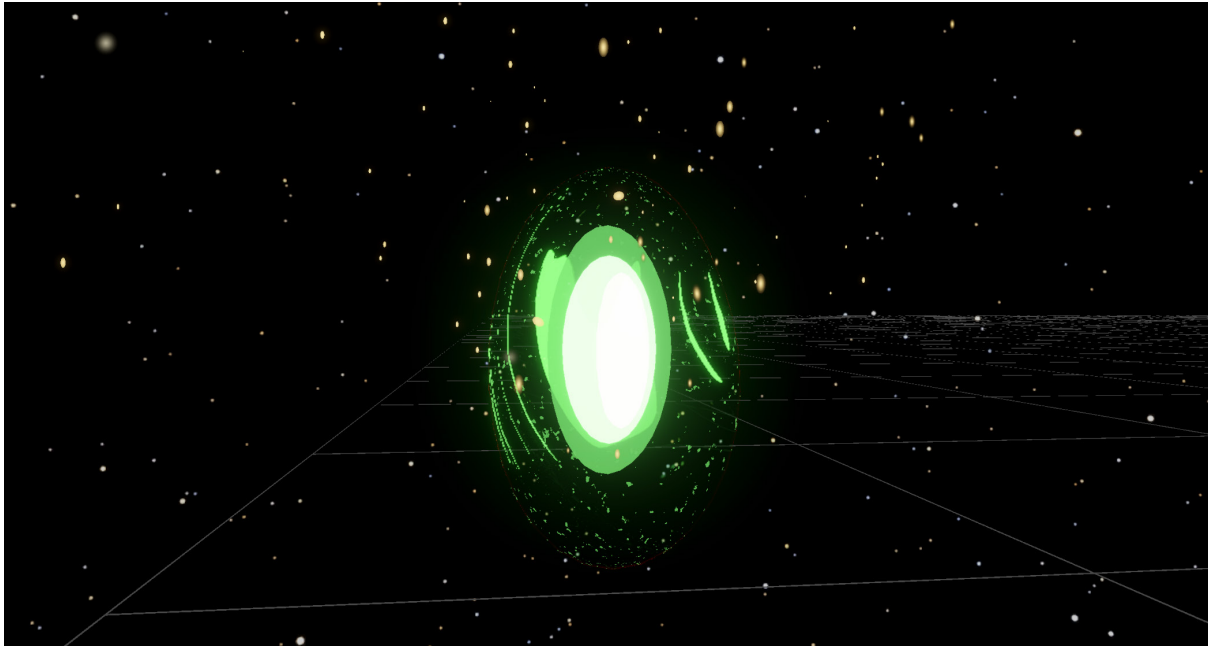
Final Result:



Images from Prototype: Final Cluster Graphics

## User Traces-Marks

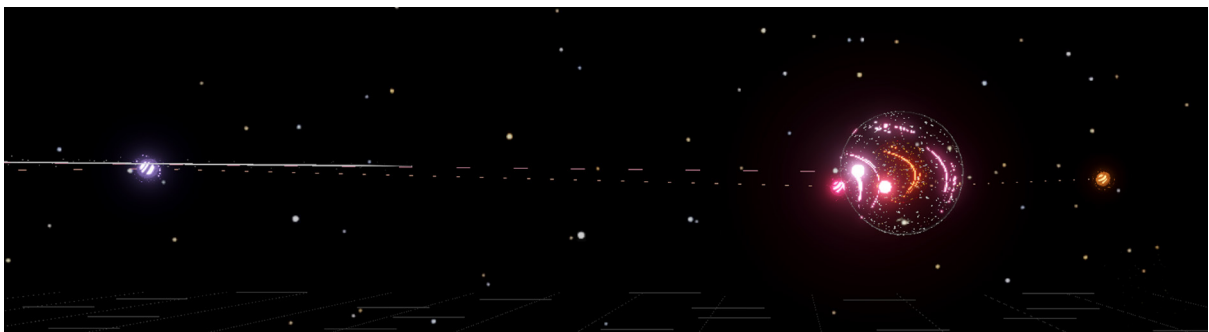
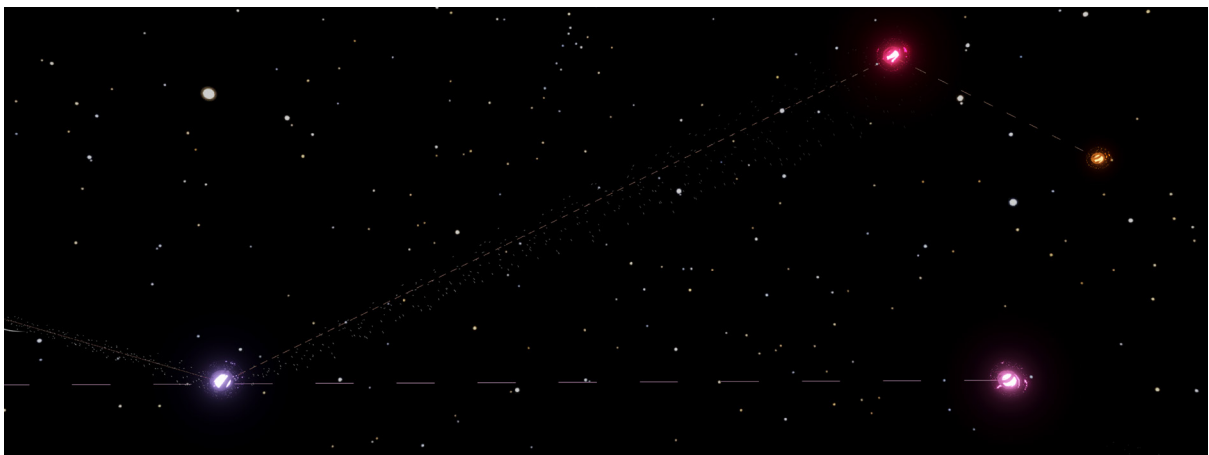
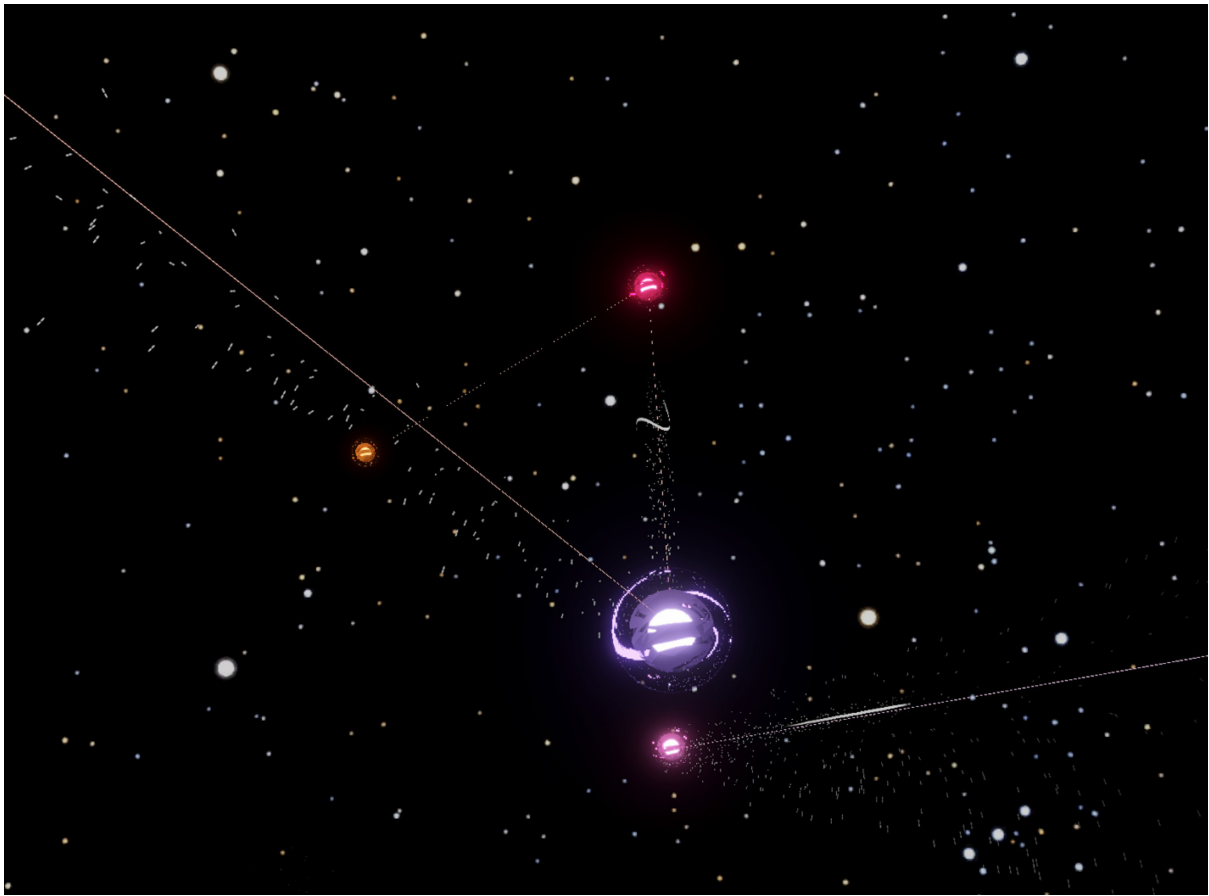
The same shader used for the planets is also applied to the mark of the text input. However, unlike with planets, this mark inherits its color directly from the emotion linked to it. To enhance its visual appearance, especially since it is viewed up close by the user, an additional visual effect with flowing particles has been created, adding a sense of movement.

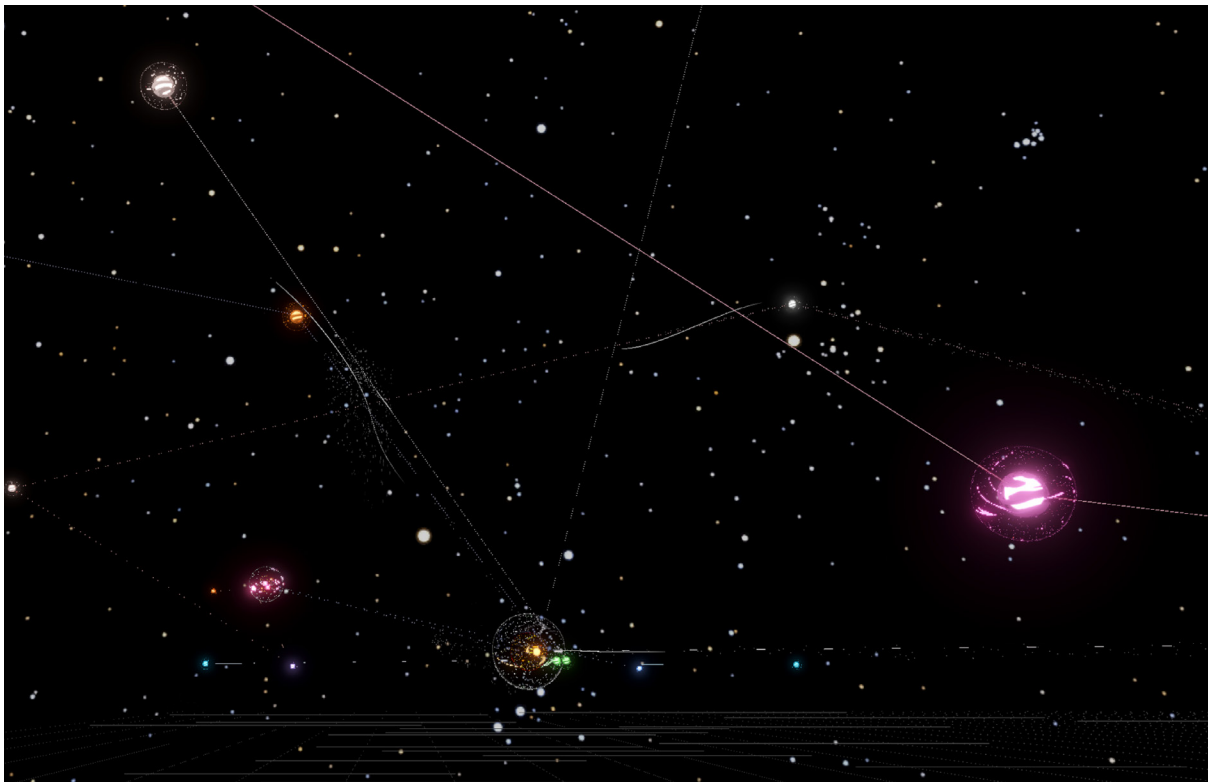
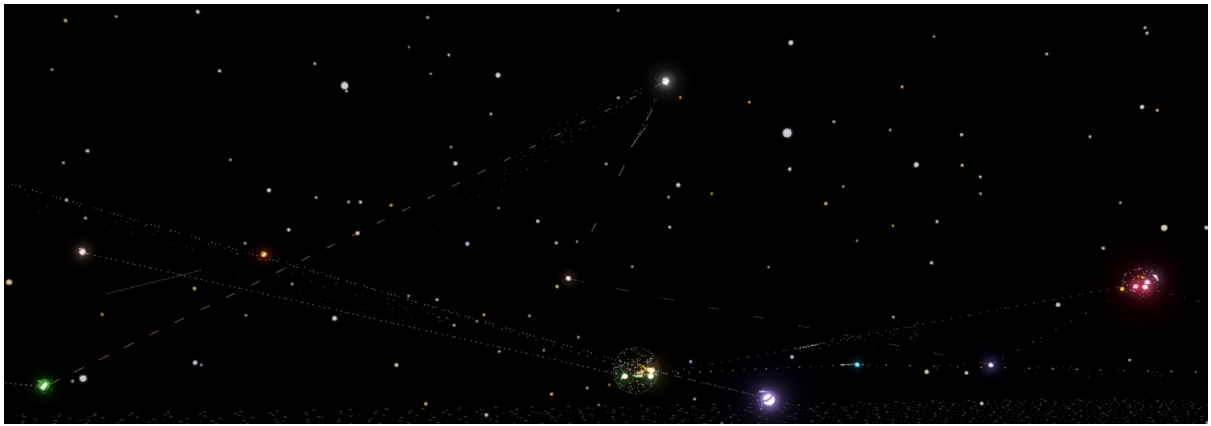
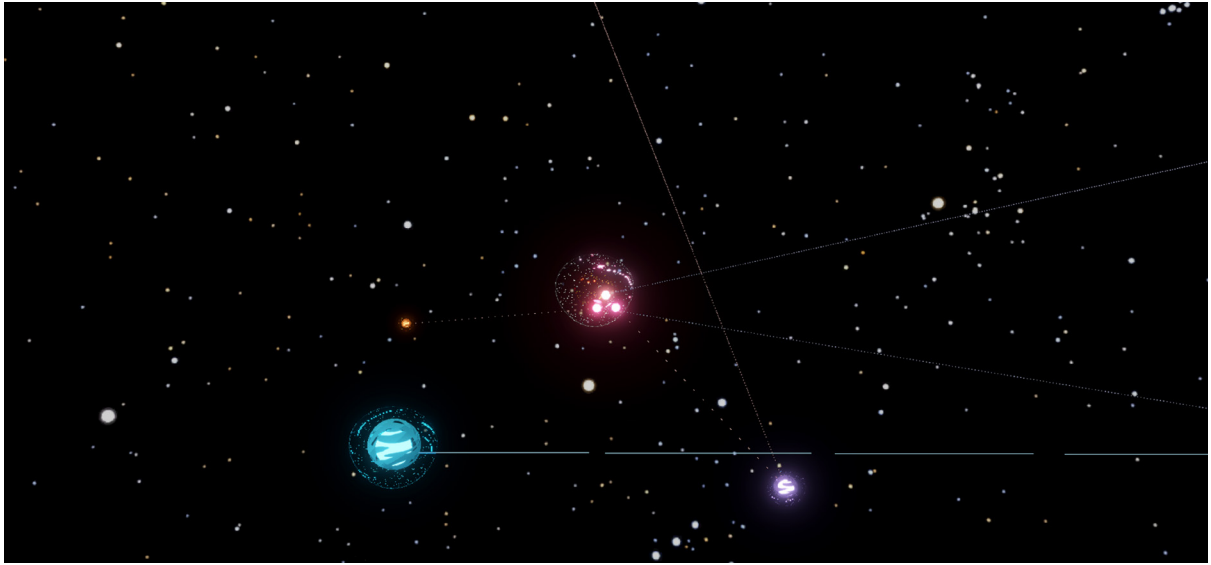


Images from Prototype: Final Trace Marker Graphics



### 5. 1. 5. Final Screenshots







6

## **6. FINAL**

### **6 1. Future development**

As a potential future application, the app's conceptual framework could be extended beyond the digital realm into a tangible representation using Arduino technology. This physical visualizer would employ a grid-based lighting system to represent the app's emotional mapping in a dynamic way. Lights, such as LEDs, would be embedded beneath a transparent or semi-transparent surface, with each light corresponding to a specific urban location. These lights would dynamically respond to the emotional data collected from the app, using color coding to represent the optimistic, challenging, and reserved categories. The intensity, color and patterns of the lights could visually indicate the density of emotional inputs, clusters or significant emotional trends across the city.

This physical system would serve as a unique and tactile way to experience the emotional landscape of a city, offering an immersive and interactive perspective. For example, lights could brighten, pulse or change color to reflect areas of high emotional activity, making it easier to visualize emotionally charged spaces at a glance.

As a future development, this tangible visualizer would enhance the app's overall impact by transforming data into a sensory experience that bridges the gap between digital and physical interaction. By making the emotional data physically accessible, the system could foster deeper engagement with the emotional and social narratives of a city. This physical implementation would further emphasize the project's commitment to experience and interact with urban environments on multiple levels.

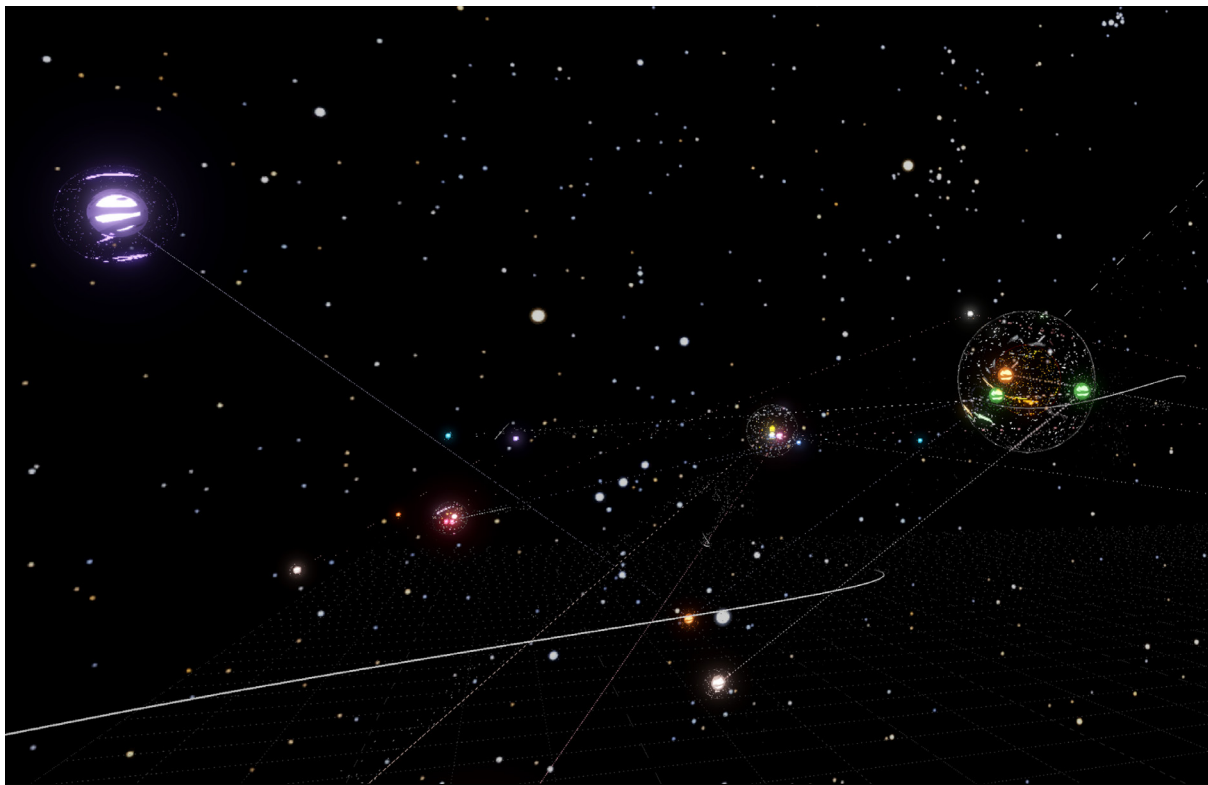
### **6 2. Final Thoughts**

From walking as a fundamental method of exploring the city to emotions as the final output, this project bridges the physical and digital realms to create a more meaningful connection between individuals and their urban environment. Walking serves as both a mode of exploration and a philosophical act, encouraging agents to engage and rediscover their surroundings. Through this process, emotions become the ultimate lens for understanding the city, a collective output shaped by diverse perspectives, personal narratives and shared experiences. By capturing, visualizing and analyzing these emotional inputs, the project aims to reveal hidden dynamics, uncover emotionally charged spaces and create a deeper understanding of urban life.

The app's goal is not just to create an engaging digital experience, but to inspire a new way of thinking about cities and their inhabitants. It provides a platform for individual expression while

also promoting a bottom-up approach to understanding urban dynamics. By allowing agents to share their emotions and narratives, it builds a collective emotional map that highlights the complexity and richness of urban life. This, in turn, enables the identification of patterns, the analysis of urban rhythms and the deduction of insights that can aid urban planning, design and policies.

At its core, this project seeks to blur boundaries between tangible and intangible, individual and collective, past and present. It invites individuals to view their city not as a static environment but as a living, breathing organism shaped by the emotions and interactions of its inhabitants. Through exploration, connection and shared understanding, the app envisions a city where emotional landscapes become as visible and influential as its physical ones, encouraging agents not only to navigate their city but to truly experience it.



Images from Prototype: Final Output

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