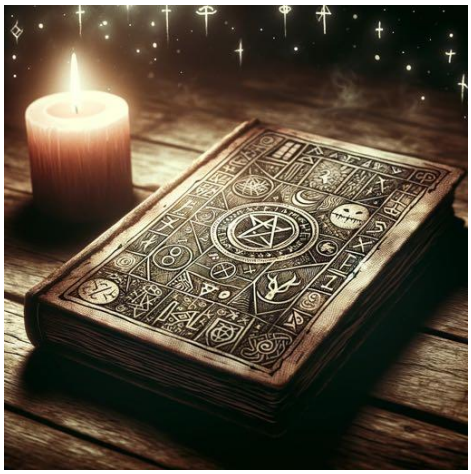
Software Engineering Department

Braude College

Capstone Project Phase A – 61998

TaleWeaver



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https://github.com/Seth7171/TaleWeaver

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Abstract

In the realm of digital gaming, engaging the younger audience has become increasingly challenging due to a decline in interest towards traditional storytelling methods. "TaleWeaver" emerges as an innovative solution, leveraging the Unity engine to craft a dynamic, AI-driven narrative experience. This project integrates advanced AI storytelling and text recognition to adapt the game environment in real-time, offering a unique, interactive story with each playthrough. By prompting players to input their desired adventure, the game generates personalized story pages, each presenting a distinct dilemma or event, enriched with AI-generated images and text. This paper delves into the development process of "TaleWeaver," highlighting its use of the DALL·E and ChatGPT 4 APIs for image and text generation, respectively. It also explores the game's approach to thematic consistency through keyword analysis and background adaptation, providing a seamless, immersive experience. "TaleWeaver" not only represents a significant advancement in personalized gaming but also sets a new standard for incorporating AI in interactive storytelling.

1. Introduction

The digital age presents an ever-evolving challenge in maintaining the interest of younger audiences in traditional forms of storytelling. A noticeable decline in engagement has been observed [0], attributed to the static and predictable nature of conventional narrative experiences. This diminishing interest underscores the need for innovative solutions that captivate and sustain the attention of children and young adults alike.

Current attempts to address this challenge include platforms like AI Dungeon, a text-based, AI-generated fantasy simulation offering infinite possibilities for interactive storytelling. However, while AI Dungeon represents a significant step forward in interactive entertainment, it primarily focuses on text-based engagement without integrating visual storytelling elements or personalized thematic environments.

"TaleWeaver" aims to bridge this gap by introducing a game that combines AI storytelling and text recognition with dynamic visual environments, offering a more immersive and engaging storytelling experience. Utilizing the Unity engine, "TaleWeaver" invites players to craft their adventure by typing a desired journey into a magical book. The game then generates a personalized story across ten pages, each presenting unique dilemmas, events, or encounters. These narratives are enhanced with AI-generated images and thematic text, created using advanced AI technologies like DALL·E for image generation and ChatGPT 4 for text creation. This approach ensures each story is not only unique to the player's input but also visually and thematically cohesive.

By analyzing keywords from the player's input and generated story pages, "TaleWeaver" adapts the game's background and music to match the ongoing theme, further personalizing the experience. This innovative use of technology aims to rekindle interest in storytelling by making each game session a unique adventure, tailored to the player's imagination.

The primary stakeholders of "TaleWeaver" include children and adults seeking engaging, thematic adventures that go beyond traditional storytelling methods. By providing a platform that combines interactive storytelling with visual and thematic customization, "TaleWeaver" promises to offer a

novel experience that is as educational as it is entertaining. This project not only aims to capture the waning interest of younger audiences but also to set a new standard for narrative engagement in the digital era, offering a solution that is both innovative and inclusive.

"TaleWeaver" addresses the pressing issue of declining interest in traditional storytelling among young audiences by offering a dynamic, engaging, and personalized narrative experience. Through the integration of AI-driven text and image generation, along with adaptive environments, "TaleWeaver" presents a new frontier in interactive entertainment that promises to captivate and inspire players of all ages.

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[0] Christina C, “Children and young people’s reading in 2019” National Literacy Trust research report

2. Related Work

Reflecting on the advancements in digital interactive fiction, [1] delves into the evolution of this medium from traditional 'Choose Your Own Adventure' books to sophisticated digital formats. The study outlines a categorization of digital interactive fiction based on the modalities offered and the potential skills enhanced through their use, emphasizing the significant yet unexplored potential in educational settings. This exploration highlights a burgeoning field ripe for further research to fill existing knowledge gaps and expand the application of digital storytelling in education.

In the domain of AI-enhanced reading experiences, [2] investigates the role of AI-powered chatbots as companions in reading activities, evidencing the positive impact these chatbots have on maintaining student interest in reading. The study underscores the potential of AI chatbots to foster a high level of social connection, anthropomorphism, intelligence, and likability, suggesting a promising avenue for enhancing student engagement and situational interest in reading through social reading practices facilitated by AI.

Digital storytelling, as discussed in [3], has emerged as a compelling method for presenting narratives, leveraging visual, interactive, and multimodal elements to create immersive and engaging stories. This method's application across various domains underscores its versatility and impact, with technology such as VR, AR, and AI further enhancing storytelling possibilities. Despite its potential, the study also points to challenges such as information

overload and ethical considerations, indicating the need for careful navigation as the field progresses.

The study in [4] presents digital story writing as an effective pedagogical tool to develop AI literacy among students, showcasing how students positively perceive and engage with this learning process to achieve a higher cognition level in understanding AI concepts and skills. This pedagogical approach not only facilitates learning but also encourages the application of AI knowledge, emphasizing the importance of incorporating AI ethics and social impact considerations into educational narratives.

Exploring the intersection of creative writing and AI, [5] offers insights into the implementation of AI in story writing processes, highlighting the potential benefits and challenges of integrating AI into creative writing pedagogies. The study reflects on the impact of AI-assisted writing on student creativity and provides practical suggestions for educators looking to incorporate AI tools on their creativity in their story writing, emphasizing the need for future research to explore the broader effects of AI on writing development.

In analyzing the application and challenges of digital storytelling with AI in language education, [6] reveals the promising role of AI in revolutionizing language learning through personalized and interactive experiences. While highlighting the benefits, the study also discusses the challenges faced in integrating AI into educational storytelling, pointing towards the necessity for continuous improvement and ethical considerations in algorithm development.

Lastly, [7] explores the concept of AI authorship in narrative creation, examining the implications of AI-generated narratives in commercial and creative contexts. This investigation into AI's role in storytelling anticipates future directions and ethical considerations in AI-driven narrative creations, urging a thoughtful examination of how AI can complement rather than replace human creativity in storytelling endeavors.

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[1] Harshitha H, "Choose Your Own Adventure: The Evolution of Digital Interactive Fiction and Its Use in Language Pedagogy."

[2] Chen-Chung Liu, "An analysis of children’s interaction with an AI chatbot and its impact on their interest in reading."

[3] Mohammad Javad Bakhtiary, "Digital Storytelling: Unleashing the Power of Narrative in the Digital Age."

[4] Davy Tsz Kit Ng, "Using digital story writing as a pedagogy to develop AI literacy among primary students."

[5] David James Woo, "Writing creative stories with AI: learning designs for secondary school students."

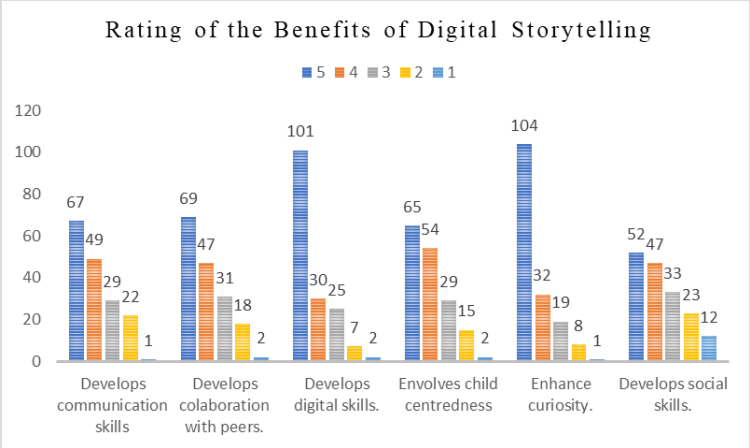
[6] Fatin Nadifa Tarigan, "Application and Challenges of Digital Storytelling Based Artificial Intelligence for Language Skills: A Narrative Review."

[7] Sarah Thorne, "Hey Siri, tell me a story: Digital storytelling and AI authorship."

3. Background

3.1 Interactive Storytelling and Digital Engagement

In the contemporary digital landscape, interactive storytelling emerges as a potent vehicle for educational engagement, particularly among younger audiences. The shift towards digital platforms for entertainment and learning has accelerated, driven by technological advancements and the increasing accessibility of digital devices. Interactive storytelling, which combines narrative content with user interaction, offers a compelling alternative to traditional learning methods by embedding educational content within engaging stories and games. This approach not only captures the attention of children but also enhances their cognitive, linguistic, and social skills through immersive experiences. Recent empirical research, as discussed in the study [8] , has provided quantifiable insights into the benefits of digital storytelling within educational settings. The survey conducted in the study demonstrates a notable enhancement in student engagement and learning outcomes when interactive digital storytelling is utilized. Specifically , as shown in Figure (a), it reported an increase in comprehension skills by 75%, memory retention by 80%, and motivation to learn by 85% among students who participated in digital storytelling activities. These statistics highlight the significant impact that platforms like "TaleWeaver" can have on enhancing cognitive, linguistic, and social skills through immersive storytelling experiences, thus validating the effectiveness of interactive storytelling as a powerful educational tool.



[9] Figure (a)

[8] Horatiu C, "Using Digital Storytelling In Early Childhood Education To Promote Child Centredness"
[9] https://arshren.medium.com/a-basic-understanding-of-the-chatgpt-model-92aba741eea1

3.2 Unity Engine

Unity, as shown in Figure (b), is a cross-platform game engine developed by Unity Technologies, first released in 2005. It provides a comprehensive set of software solutions to create, run, and monetize interactive, real-time 2D and 3D content for mobile phones, tablets, PCs, consoles, and augmented and virtual reality devices.

Primarily, Unity is used for the development of video games for web plugins, desktop platforms, consoles, and mobile devices. Beyond gaming, it is increasingly utilized for creating simulations, training and educational programs, interactive art, and virtual reality experiences. Unity's versatility allows developers to deploy their creations across more than 25 platforms, including iOS, Android, Windows, and Mac, making it a highly sought-after tool for wide-reaching applications.

Main Features Unity Provides:

Unity offers a broad array of features that cater to the needs of both novice and experienced developers:

- Cross-Platform Development: One of Unity's hallmark features is its ability to allow developers to create their applications once and deploy them across multiple platforms.
- Asset Store: An online marketplace where developers can buy and sell assets, including 3D models, textures, scripts, and entire project examples, which accelerates the development process.
- Physics Engine: Unity incorporates PhysX, a powerful physics engine, which enables the simulation of realistic object movements and interactions.
- Graphics: It supports both 2D and 3D graphics with features such as dynamic shadows, rendering, and custom shaders to create detailed and immersive environments.
- Animation: The engine includes a comprehensive animation system that allows for the creation and manipulation of complex animations.
- Scripting: Unity uses C# for scripting, offering a versatile and user-friendly programming language for game logic and interaction.

Thematic in Unity

Unity's thematic capabilities extend far beyond mere game development. Its engine is capable of rendering high-quality visuals that are being used in the creation of films and animations. This thematic versatility enables creators to produce content that is not only interactive but also visually engaging, with the ability to convey complex narratives and themes across various genres and media formats.

API Interaction in Unity

Unity's flexibility extends to its ability to interact with external APIs, including those provided by OpenAI. This capability enables Unity developers to integrate cutting-edge AI technologies like natural language processing (NLP) and generative image models into their projects. Here's how Unity can interact with APIs like ChatGPT and DALL·E:

ChatGPT in Unity

ChatGPT, powered by OpenAI, offers sophisticated NLP capabilities that can be integrated into Unity applications for a variety of purposes, such as: Dynamic Dialogue Systems, Content Creation, Educational Applications.

DALL·E in Unity

DALL·E, also by OpenAI, is a state-of-the-art image generation model capable of creating images from textual descriptions. When integrated into Unity, it can be used for: Dynamic Content Generation, Concept Art Creation, Interactive Art Installations.

[10] Figure (b)

[10] https://medium.com/@mikeyoung_97230/what-are-the-basic-topics-i-need-to-learn-to-be-successful-as-a-unity3d-game-developer-e4858c1b6a66

3.3 AI in Storytelling: Enhancing Personalization and Engagement

Artificial Intelligence (AI) has revolutionized the landscape of digital storytelling, introducing levels of personalization, creativity, and engagement previously unimaginable. At the forefront of this revolution are advanced AI models such as ChatGPT for text generation and DALL·E for image creation, which leverage deep learning, a subset of machine learning, to generate content that adapts dynamically to user inputs.

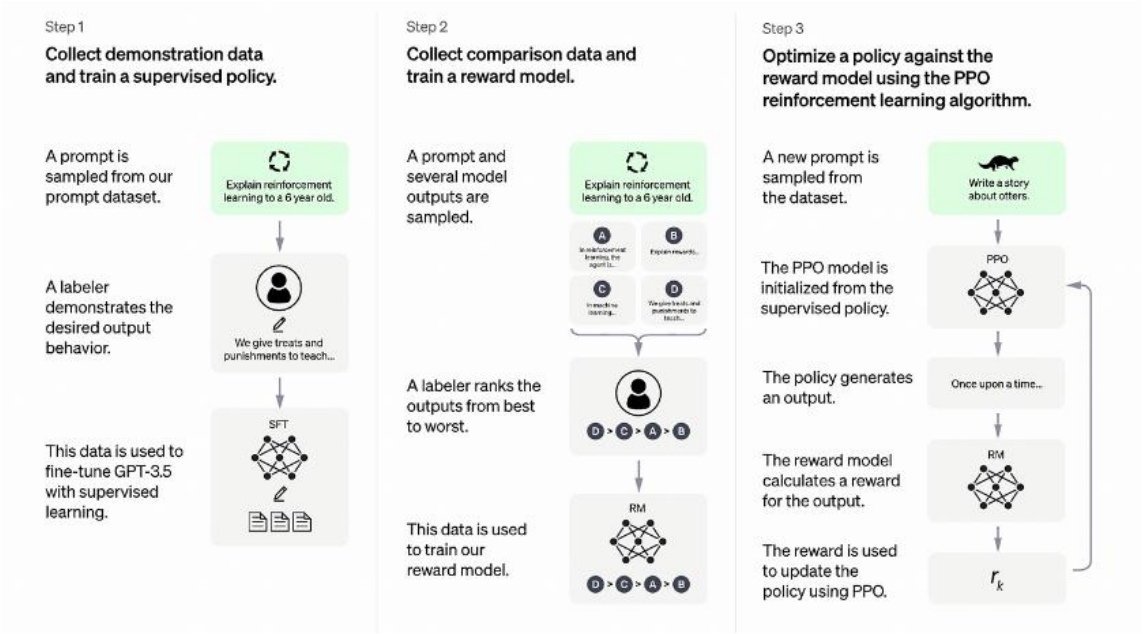
Deep Learning and Generative Models

Deep learning, a specialized form of machine learning, teaches computers to learn from data through artificial neural networks designed to mimic human decision-making. Unlike traditional machine learning algorithms, which require explicit instructions to perform tasks, deep learning algorithms automatically learn and improve from experience. This capability is particularly impactful in AI-driven storytelling, where the richness and diversity of narrative content can be significantly enhanced.

ChatGPT: Revolutionizing Textual Content Generation

ChatGPT, built on the foundation of the Generative Pre-trained Transformer (GPT) architecture, represents a leap forward in natural language processing (NLP). It utilizes deep learning to understand and generate human-like text based on given prompts, enabling the creation of detailed and coherent narrative content. Through iterative training on vast datasets of textual content, ChatGPT learns to mimic various writing styles and tones, allowing for highly customized storytelling experiences. Its ability to generate contextually relevant and engaging text makes it an invaluable tool in interactive storytelling, where the narrative can branch in myriad directions based on user decisions.

Figure (c) below, illustrates the outline of the three-step process for training a machine learning model, ChatGPT.

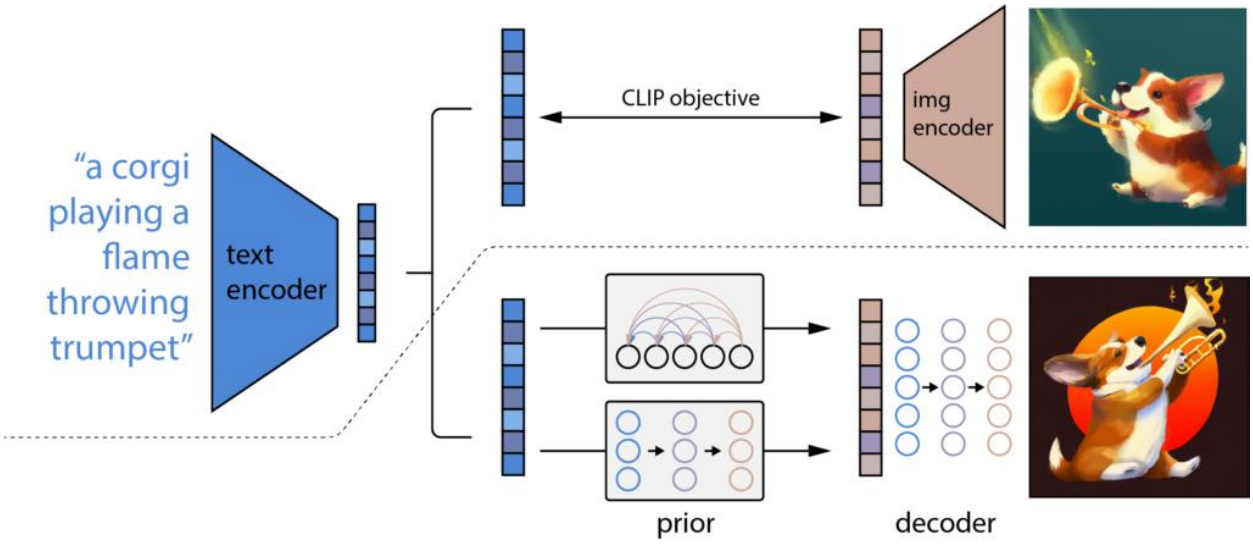


[11] Figure (c)

DALL·E: Pioneering Visual Creativity

DALL·E, another groundbreaking AI model, specializes in generating original, high-quality images from textual descriptions. This model extends the capabilities of AI in storytelling to the visual domain, allowing for the creation of images that perfectly complement the narrative text. DALL·E interprets and visualizes complex descriptions with surprising creativity and accuracy, bringing stories to life with visuals that are tailored to the narrative's theme and mood. The synergy between textual and visual content generation models like ChatGPT and DALL·E enriches the digital storytelling experience, offering a seamless integration of narrative and imagery.

Figure (d) below, demonstrate the architecture that consists of 3 different models working together to achieve the desired result – a DALL·E generated photo.



[12] Figure (d)

AI in Enhancing Storytelling Dynamics

The integration of AI technologies like ChatGPT and DALL·E in storytelling platforms introduces a new dimension of interactivity and immersion. These models enable stories to evolve in real-time, responding to user inputs with personalized text and images that reflect the ongoing narrative thread. This dynamic interaction ensures that each storytelling experience is unique, enhancing user engagement and investment in the story.

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[11] https://arshren.medium.com/a-basic-understanding-of-the-chatgpt-model-92aba741eea1

[12] https://learnopencv.com/mastering-dall-e-2/

3.4 Keyword Extraction Algorithms: Enhancing Thematic Consistency in Digital Storytelling

Keyword extraction algorithms are pivotal in identifying and extracting crucial words or phrases from text, providing insights into its primary themes and subjects. This process, a critical component of natural language processing (NLP), utilizes advanced computational techniques to discern patterns, frequencies, and semantic relationships within a body of text. The outcome of keyword extraction is a distilled set of terms that encapsulate the essence of the text, enabling automated systems to categorize content, understand context, and maintain thematic consistency across various applications, particularly in interactive narratives and digital storytelling.

The Mechanisms of Keyword Extraction

Keyword extraction operates through several stages, each designed to analyze the text to determine its most significant elements. Initially, the text undergoes preprocessing to normalize its structure, including tokenization (breaking the text into individual words or phrases) and stemming (reducing words to their root forms). Following this, the algorithm employs statistical and linguistic methods to evaluate the importance of each word or phrase. Techniques such as Term Frequency-Inverse Document Frequency (TF-IDF) and Rapid Automatic Keyword Extraction (RAKE), are commonly used.

Machine learning models, particularly those employing supervised or unsupervised learning approaches, have also been developed to enhance the accuracy and context-awareness of keyword extraction. These models can learn from annotated datasets to identify keywords based on contextual cues and the relationships between words, leading to more nuanced and accurate extraction.

The Role of Keyword Extraction in Digital Storytelling

In the context of digital storytelling, keyword extraction algorithms play a crucial role in maintaining thematic consistency and enriching narrative experiences. By analyzing user inputs or narrative content to extract key themes and subjects, these algorithms enable storytelling platforms to adapt narratives, visual elements, sound elements and interactions to reflect the user's interests and choices. This dynamic adaptation ensures that the story remains coherent and aligned with the user's expectations and contributions, enhancing engagement and immersion.

4. Expected Achievements

4.1 Outcomes

"TaleWeaver" aims to redefine interactive storytelling and digital gaming by providing a unique, AI-driven narrative experience. Through dynamic and personalized storytelling, the initiative seeks to engage players deeply, allowing for a rich, customized journey with every play. This innovative approach is expected to elevate player engagement and set new standards for narrative depth and interactivity in games.

Our action approach involves the seamless integration of cutting-edge AI technologies within the Unity engine, enhancing the storytelling experience with AI-generated text and matching visuals and audio through word extraction algorithm. This not only aims to create a more believable and coherent narrative environment but also sets a benchmark for future integrations of AI in gaming. The strategic use of AI for thematic consistency and adaptive gameplay environments further aims to ensure a fully immersive gaming experience.

In conclusion, "TaleWeaver" aspires to not only entertain but also educate, harnessing the power of AI to offer thematic adventures that stimulate creativity, critical thinking, and language skills. The project's emphasis on scalability and content creation promises a continuously evolving game that remains engaging and relevant. Through these achievements, "TaleWeaver" aims to redefine what is possible in interactive storytelling, paving the way for future innovations in the field.

4.2 Unique Features

4.2.1. AI-Driven Narrative Guidance

"TaleWeaver" will incorporate AI-driven narrative guidance to assist players throughout their storytelling journey. By analyzing player inputs and behaviors, the game will dynamically adjust the narrative flow, offering tailored tips and suggestions to enhance the player's experience.

4.2.2. Dynamic Visual and Thematic Elements

Leveraging DALL·E and ChatGPT 4, "TaleWeaver" will dynamically generate visual and thematic elements to complement the narrative. From AI-generated images to thematic text overlays, the game aims to create a visually stunning and thematically rich storytelling environment.

[13] Figure (e)

[13] OpenAI DALLE image generator - https://openai.com/index/dall-e-3

4.2.3. Adaptive Environments

Through keyword analysis and background adaptation algorithms, "TaleWeaver" will adapt its environments to match the ongoing narrative theme. From changing backgrounds to thematic music, the game will provide a seamless and immersive experience that evolves with the player's choices.

4.3 Criteria for Success

The success of "TaleWeaver" will be evaluated based on several key criteria:

1. **Ease of Navigation and Understanding**: Players should be able to navigate through the game easily, understand the mechanics, and access in-game features without confusion.
2. **Engaging Visual and Audio Design**: The visual and audio design should be pleasing and engaging, enhancing the overall gaming experience.
3. **Effectiveness of AI Integration**: The AI-driven narrative guidance and dynamic elements should enhance player engagement and satisfaction, contributing to a more immersive experience.

4. **Balanced Gameplay**: The game mechanics should ensure balanced and fun gameplay.
5. **Motivating Reward System**: An effective reward system should motivate players, encourage continued play, and provide meaningful goals.
6. **Innovative Gameplay Mechanics**: "TaleWeaver" should introduce innovative gameplay mechanics and features that set it apart from other games, providing a unique gaming experience.
7. **Stability and Performance**: The game should provide a stable and bug-free experience, with real-time performance and responsive interfaces.
8. **Scalability**: The game allows seamless integration of new thematic elements and audio tracks, ensuring that developers can expand the game's universe with ease and players can experience a growing variety of narratives and immersive soundscapes.
9. **Instant Processing**: Actions, interactions, and updates should be processed instantly, providing a seamless and immersive gaming experience.
10. **Feedback Mechanisms**: The game's interface should provide appropriate feedback to players, enhancing user satisfaction and contributing to the game's success.

These criteria will serve as benchmarks for evaluating the achievement of "TaleWeaver's" goals and objectives, ensuring a high-quality and impactful gaming experience for players.

5. Engineering Process

5.1 Research - Unity and game development

The journey to developing "TaleWeaver" began with an in-depth exploration of the Unity engine, underpinned by a strong foundation in both software engineering principles and a passion for gaming. Recognizing the importance of a solid groundwork, we embarked on an educational journey through various Unity tutorials and resources. This initial phase was crucial for acquiring a holistic understanding of the engine's capabilities, particularly its versatility in creating both 2D and 3D environments, as well as its powerful scripting features using C#.

Drawing upon our playing expertise in Unity games such as "Valheim" and "V-Rising," we decided to develop our game using the Unity engine. This endeavor was driven by our aspiration to conceive a game capable of dynamically generating narratives, visuals, and SFX in response to player interactions.

Guided by recommendations from seasoned developers and our academic advisors, we delved into Unity’s extensive online documentation and community forums. Additionally, we completed several beginner to intermediate courses, culminating in the creation of mini-games

inspired by popular titles such as "Vampire Survivors" and "Galaxy Shooter." These projects were instrumental in honing our skills in scene creation, asset management and interactivity.

5.1.1 Constraints and Challenges

During the early stages of "TaleWeaver," we encountered considerable challenges with Unity's programming and operations. Despite our strong background in software engineering, applying these concepts within Unity was not straightforward, due in part to its distinct C# scripting and interface. The complexity of creating a non-linear, interactive game demanded a deeper understanding of Unity's features, such as scene composition, leading us to frequently consult tutorials and forums to solidify our foundational knowledge.

Developing "TaleWeaver" involved venturing into new ground as we sought to blend AI-driven storytelling with user interaction smoothly. This innovative approach meant we faced challenges in conceptualizing an architectural framework that could accommodate dynamic content while ensuring an engaging experience. Extensive research and planning were essential as we navigated uncharted territory, balancing creativity with technical feasibility to realize our vision for a novel form of interactive storytelling.

5.2 Research - Game Development with Keyword Extraction Algorithm

The incorporation of a Keyword Extraction Algorithm into "TaleWeaver" is pivotal for enabling the dynamic content generation that lies at the heart of the game's innovative storytelling approach. Keyword extraction allows the game to analyze text inputs from players (such as descriptions of desired adventures) and ChatGPT narratives to dynamically adjust game content such as backgrounds, game objects, and SFX based on these inputs. We researched various methods to harness this capability effectively within the Unity engine, focusing on algorithms that could reliably extract relevant keywords from short player inputs. Our approach involved leveraging these keywords to trigger changes in the game's state, adapting visual and narrative elements on-the-fly to align with the player's journey. The algorithm needed to be efficient enough to run in real-time without impacting the game’s performance, suggesting a need for a streamlined and optimized NLP solution that could operate within the computational constraints of typical gaming hardware.

During our exploration of suitable NLP techniques, we evaluated several popular keyword extraction methods, including TF-IDF (Term Frequency-Inverse Document Frequency) and RAKE (Rapid Automatic Keyword Extraction). TF-IDF, while powerful for understanding word relevance in larger documents, proved to be less suited for the brief and highly dynamic text inputs typical in gaming. RAKE, on the other hand, emerged as the more appropriate choice due to its simplicity and effectiveness in extracting keywords from small blocks of text. RAKE operates by analyzing phrases and word co-occurrences within a set context [14], making it ideal for real-time applications like "TaleWeaver" where immediate keyword extraction from concise player inputs is crucial. This choice underscored our commitment to creating a responsive and immersive player experience, where the game's content fluidly adapts to each player's narrative choices. As we move forward, our research will continue to refine the integration of RAKE, ensuring that it effectively supports the thematic and narrative dynamics of "TaleWeaver."

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[14] J.S. Baruni, "Keyphrase Extraction from Document Using RAKE and TextRank Algorithms"

5.2.1 Constraints and Challenges

Integrating the keyword extraction algorithm, specifically RAKE, into "TaleWeaver" posed significant challenges, primarily due to the need for precise and contextually appropriate keyword detection from diverse player inputs and ChatGPT nerratives. Adapting RAKE to function efficiently within the Unity engine involved overcoming its initial inability to distinguish crucial keywords from ancillary text, which was vital for triggering accurate game content changes. This process required extensive testing and refinement to optimize for real-time performance, ensuring that gameplay remained seamless and immersive despite the computational demands of processing dynamic textual inputs on-the-fly.

5.3 Research - Integrating OpenAI APIs with Unity

The integration of OpenAI's APIs into the Unity engine represented a pivotal component of our project, aiming to fuse advanced AI capabilities with interactive gaming. This endeavor required us to delve into the complexities of incorporating external APIs, specifically ChatGPT for text generation and DALL·E for image creation, into a Unity-based environment. The process involved navigating the intricacies of API communication,

managing asynchronous data flows, and ensuring the generated content seamlessly blended into the game's narrative and visual elements.

Initially, our research focused on understanding the technical requirements and limitations of OpenAI's APIs, including authentication processes, request formatting, and rate limiting. We consulted extensive documentation and community forums, seeking insights from developers who had undertaken similar integrations. This foundational knowledge was crucial for establishing a robust communication bridge between Unity and OpenAI.

5.3.1 Constraints and Challenges

Integrating OpenAI's APIs with Unity introduced complex challenges, notably in understanding authenticated API communication and optimizing the cost of development. Initial hurdles included navigating OpenAI's technical documentation for correct API request formatting and grappling with request limits and data quotas using Image generation and Assistant API [15]. These challenges necessitated efficient API call management to prevent budget overruns. Additionally, the high frequency of API requests during development posed a significant risk of inflating costs. To mitigate this, we adopted a strategy of using POSTMAN (API platform for building and using APIs) and saving the API responses in JSON format for reuse, significantly decreasing the need for repeated calls.

Additionally, managing asynchronous data flow within the Unity environment proved to be a significant challenge. Ensuring that the game's performance remained unaffected while waiting for API responses required us to explore Unity's asynchronous programming capabilities.

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[15] OpenAI developer platform - https://platform.openai.com/docs/introduction

We had to develop a deep understanding of Unity's coroutine system and asynchronous tasks to maintain a seamless gameplay experience. Balancing the technical requirements of API integration with the goal of creating an engaging and immersive game environment was a constant juggling act, pushing us to innovate and find creative solutions to these challenges.

5.4 Methodology and Development Process

For the development of "TaleWeaver," we have adopted the Agile methodology, recognizing its advantages in fostering a flexible and iterative approach to software development. This methodology supports continuous integration and frequent iteration, which are crucial given the experimental nature of integrating advanced AI within a dynamic gaming environment. Agile will allow us to adapt quickly to changes and incorporate feedback effectively throughout the development process.

The development process will be structured into several distinct phases:

1. Initial Setup using Unity:
    - **Environment Setup**: Establish the basic Unity project and configure essential settings and assets.
    - **Scene Construction**: Develop the initial game scene with a static setup that includes the interactive book and the dark room environment.
2. Prototype Development:
    - **Basic Input Handling**: Implement the functionality to capture and process user inputs through the interactive book interface.
    - **AI Narrative Integration**: Integrate ChatGPT and DALL-E to process user inputs and generate narrative content dynamically. This text will serve as the basis for subsequent keyword-driven content adjustments.
3. Dynamic Content Adjustment:
    - **Keyword Extraction Setup**: Incorporate the RAKE algorithm to extract keywords from the ChatGPT-generated narratives to guide dynamic content generation.
    - **Content Generation**: Implement the extracted keywords to trigger changes in game elements such as backgrounds, sound effects, and game objects, aligning with the narrative themes.
4. Game Mechanics:
    - **Narrative Logic Implementation**: Script the core mechanics that link the player's choices and player’s state outcomes.

- **Event Handling**: Script interactions and events based on player decisions and actions in the room.

5. User Interface Development:
    - **Interface Design**: Create a user-friendly interface that allows for easy navigation and minimal user input to maximize engagement.
    - **Feedback Integration**: Implement feedback mechanisms to provide visual and textual responses to user inputs and actions.
6. Expansion and Scalability:
    - **Adding More Scenes**: Gradually introduce more scenes and backgrounds to increase the variety and depth of narratives available, using the keyword extraction framework to integrate new thematic elements dynamically.
    - **Saving Mechanism**: Develop a feature to save the narratives (books) created by the players at the end of each game, allowing them to revisit their stories or share them with others in the future.
7. Testing and Iteration:
    - **Functional Testing**: Conduct thorough testing of all functions and integrations, ensuring they perform as expected without errors.
    - **User Experience Testing**: Refine gameplay based on feedback from test users to improve the interactive experience and narrative flow.
8. Final Adjustments and Polishing:
    - **Performance Optimization**: Enhance the game's performance to ensure smooth operation across all supported platforms.
    - **Content Expansion**: Continue to add additional content, such as more backgrounds and narrative possibilities, to keep the game environment dynamic and engaging.

Throughout these phases, regular evaluations will be conducted to assess progress and integrate incremental improvements or necessary pivots based on feedback and test results. This adaptive process is designed to refine game mechanics, enhance AI integrations, and ensure the game not only meets but exceeds user expectations for a unique and engaging narrative experience.

6. Product

6.1 Requirements

6.1.1 Table 1: Functional Requirements

ID	Requirement Description
FR1	The game must provide a 3D environment that users can navigate and interact with.
FR2	The system must accept textual inputs from users to initiate and guide the narrative generation process.
FR3	The game will have a logic mechanism for encounters (separate from the narrative).
FR5	The system will send the user input and the chosen encounter logic to ChatGPT and DALL-E models to generate narrative and a corresponding image.
FR6	The system will extract keywords from generated narratives using the RAKE algorithm to influence game dynamics.
FR7	The game must dynamically alter visuals, sound, and backgrounds based on extracted keywords.
FR8	The game will manage scene transitions smoothly to maintain user engagement without perceivable delays.
FR9	The system will offer an interactive and intuitive user interface that facilitates easy navigation and input.
FR10	The game must provide real-time feedback (visual and textual) based on the user's interactions and choices.
FR11	The system must provide a mechanism for users to save their game narratives for future access.

6.1.2 Table 2: Non-Functional Requirements

ID	Requirement Description
NFR1	The game must offer a balanced and fun experience.
NFR2	The game must perform efficiently with minimal load times.
NFR3	The system should scale seamlessly to accommodate an increasing number of scenes, backgrounds, and user inputs.
NFR4	The game interface must be intuitive and user-friendly, minimizing the learning curve and maximizing user engagement.
NFR5	The system must operate reliably, producing consistent and accurate outputs for the provided inputs.
NFR6	The codebase should be well-organized and documented, simplifying maintenance and future enhancements.
NFR7	The aesthetics of the game, including visuals and audio design, must be appealing and enhance the gameplay experience.
NFR8	The game should respond promptly to user inputs, ensuring quick and smooth actions and scene transitions.

6.2 Architecture overview

Our architecture is composed of several essential components:

● Unity game application (including Keyword extract algoritm).

● Local Database to handle saved adventures and store user data.

● API controllers for OpenAI to send and fetch essential data for the game.

data and progress.

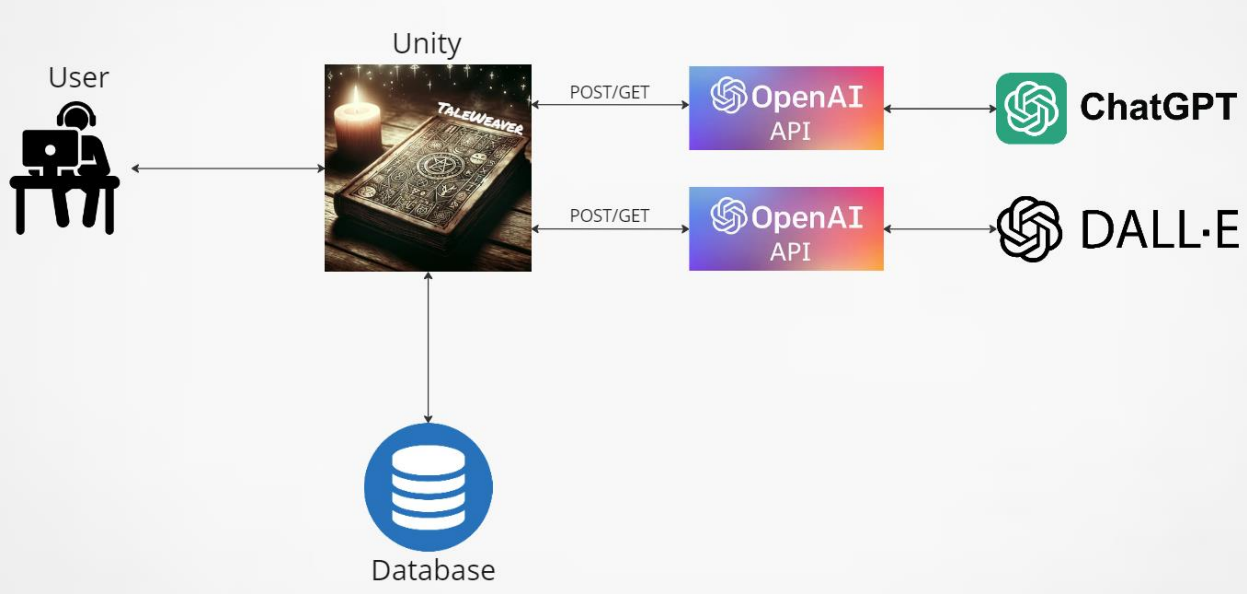


Figure (f)

6.3 Scenes and Flow (Prototype)

Main Menu Screen:

In the Main *Menu Screen* of "TaleWeaver" (Figure g), players are greeted with several options that guide them into the game's narrative universe. The primary choices available on this screen are "Start Game," "Settings," "Credits," and "Quit," each offering a different path for interaction.

Layout and Options:

Start Game: By selecting the "Start Game" button, brings up a new screen "*Start Game"* This button is the gateway to the game's immersive storytelling experience.

Settings: This option opens a settings menu where players can adjust various game parameters to suit their preferences.

Credits: The "Credits" button leads to a screen listing the developers, artists, and other contributors who worked on "TaleWeaver".

Quit: The "Quit" button allows players to exit the game.

Figure (g)

Start Game Screen:

In the "Start Game" screen of "TaleWeaver" (Figure h), players are presented with a visually rich interface where they can manage their adventure preferences and player profiles. This screen serves as a hub for personalizing gameplay and accessing various game-related functionalities.

Layout and Options:

Select Player: At the top of the screen, players have the option to choose between continuing with an existing player profile or creating a new one. This allows players to either dive back into the game with their customized settings and saved progress or start afresh with a new identity.

Start New Adventure: This option allows players to begin a new journey in the game, setting the stage for a fresh narrative experience. Selecting this will initiate a new storyline, by continuing to "*Start New Adventure" Screen*

View Previous Adventures: Players can revisit their past adventures by selecting this option. It displays a list of completed stories.

Delete Player: This option provides the ability to remove a player profile. It's a useful feature for players who wish to manage their saved data or clear old profiles that are no longer in use.

Back: Located at the bottom of the screen, the "Back" button allows players to return to the "Main Menu" Screen.

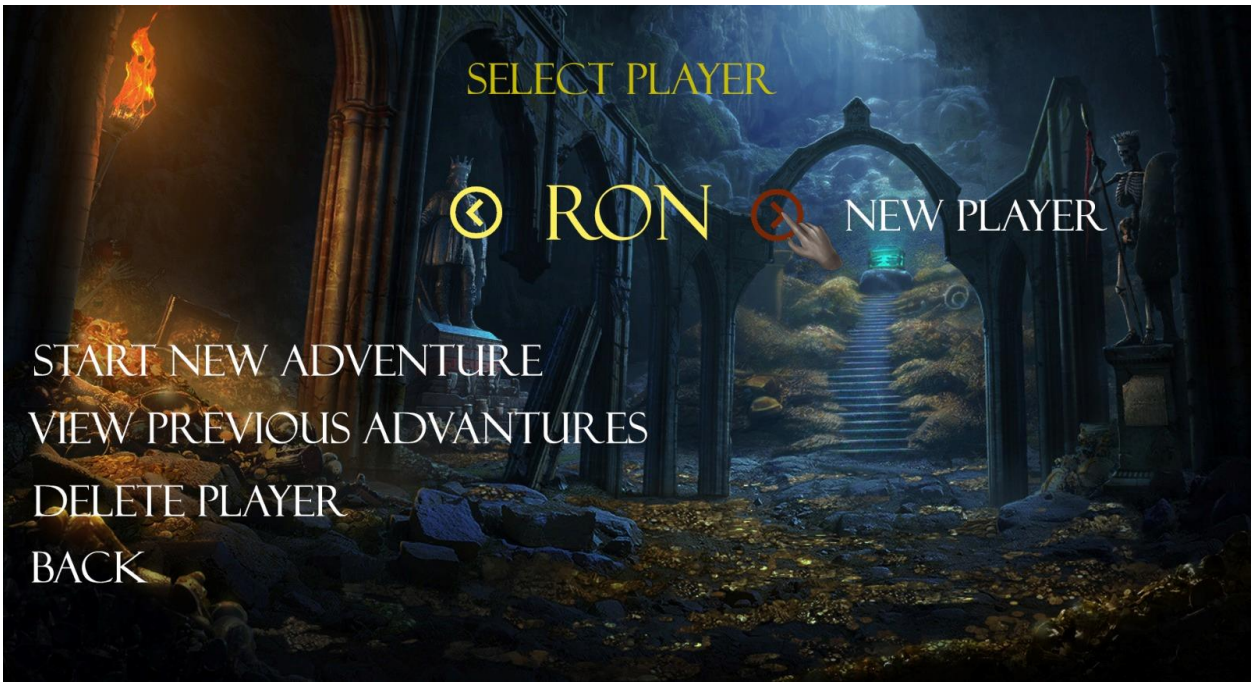


Figure (h)

Start New Adventure Screen:

In the *Start New Adventure Screen* of "TaleWeaver" (Figure i), players are invited to personalize their upcoming adventure by naming their story and deciding the theme of their narrative. This screen is designed like an open book, emphasizing the storytelling aspect of the game.

Layout and Options:

Book Name: At the top of the screen, players can enter the name of their adventure in the field labeled "Book Name." For this instance, the adventure is pre-named "Forest Roam," suggesting a journey through a mystical forest setting.

Narrative Prompt: Below the book name, there is a prompt asking, "What will be our narrative today?" This question encourages players to think creatively about the story they

want to unfold. There's a text box where players can input their desired adventure theme or a specific scenario. In this example, the player has typed "I would like to set on an adventure in a forest," indicating their preference for the setting and narrative focus.

Venture Forth Button: Beneath the narrative input, the "Venture Forth" button serves as the final step to start the adventure. Clicking this button will initiate the game based on the inputs provided, taking the player into the storytelling environment they have crafted.

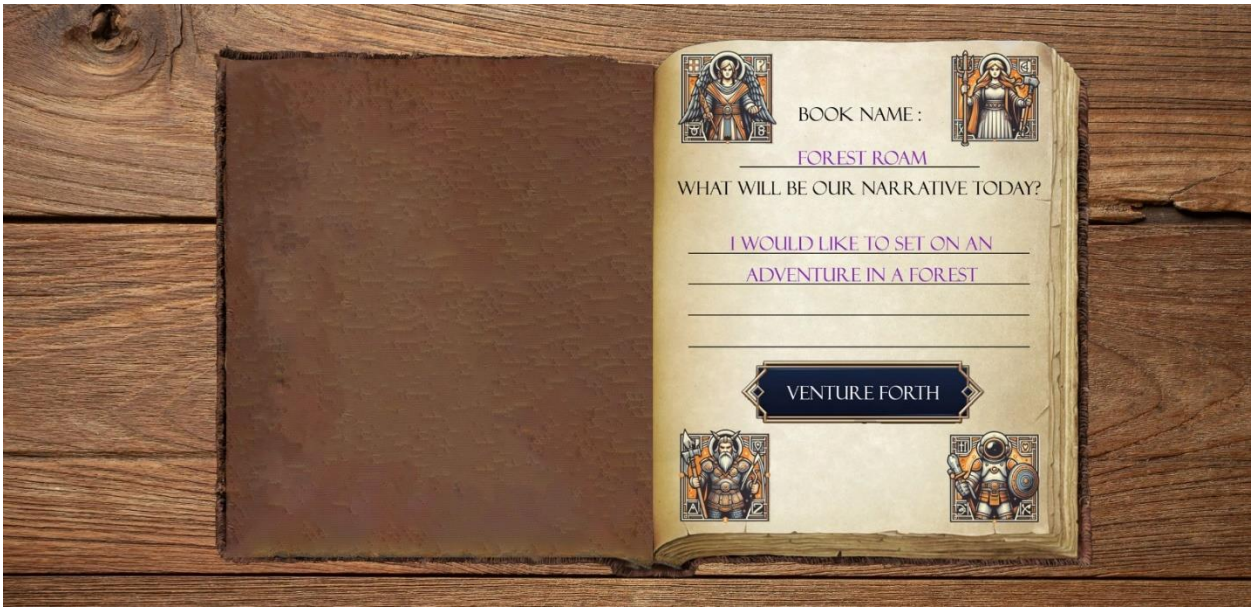


Figure (i)

Environment Exploration:

In this scene from "TaleWeaver" (Figure j), the player is immersed in an interactive storytelling environment that uniquely blends the virtual game world with narrative elements, illustrated by a book held in a first-person perspective.

Visual Elements:

Environment Exploration: The player finds themselves in an environment matches their previous adventure input in "*Start New Adventure" Screen*. In this example, a lush, dense forest, vividly rendered.

Open Book: Player holding object, this book serves as an interactive tool for the player to engage with the ongoing story. Scrolling the mouse will bring the book closer to the screen and will allow us to read and interact with it (*Book Interaction* scene).

Figure (j)

Book Interaction:

This scene (Figure k) exemplifies the innovative approach to interactive storytelling in "TaleWeaver," where the game seamlessly combines generated textual narrative and generated image with interactive elements within a dynamic environment. The player is engaged through a physical book (by scrolling the mouse wheel) interface that acts as a pivotal element for narrative progression and decision-making.

Section 1: Narrative Introduction or Continuation

Purpose: This section serves as either an introduction to the adventure if it's the first page or a continuation of the previous section's outcomes. It sets the stage for the encounter ahead, providing context and summarizing events that have led to the current moment.

Content: Typically contains a descriptive narrative that enhances the setting, introduces pivotal events that have just occurred. This part of the text helps to immerse the player in the storyline and build a connection to the unfolding events.

Section 2: Encounter Number and Title

Purpose: Marks the specific encounter within the broader narrative, serving as a waypoint or chapter marker for the player.

Content: This is usually a short, bolded line that includes the encounter number and a title that hints at the theme or challenge of the upcoming interaction, such as "ENCOUNTER 1: THE WHISPERING TREES."

Section 3: Current Encounter Description

Purpose: Provides detailed information about the current scenario or challenge facing the player.

Content: Describes the immediate environment, notable objects, potential threats, or characters the player is interacting with. This section is crucial for setting up the choices that will follow and framing the stakes of the encounter.

Section 4: Illustration Generated by DALL·E

Purpose: Visually represents elements of the current encounter, enhancing immersion and aiding in storytelling by giving a visual reference for the narrative described.

Content: Features an image relevant to the encounter, such as a depiction of a significant location, character, or object. The image serves to anchor the player's imagination, complementing the textual description and enriching the overall narrative experience.

Section 5: Health Points (HP) Bar

Purpose: Provides a gameplay mechanic that reflects the player's current state of well-being within the narrative.

Content: Displays an HP bar near the image, indicating the amount of health the player has left. If the HP reaches zero, the session will end, adding a layer of strategy and consequence to the gameplay decisions.

Section 6: Decision Point or Dilemma

Purpose: Engages the player in the narrative by requiring them to make a decision that will affect the storyline's progression.

Content: Positioned below the image, this section presents a dilemma or a set of options the player must choose from to proceed. The decision could lead to different narrative paths, resulting in varying consequences and further encounters.

Figure (k)

Pause Menu Screen:

The pause menu in "TaleWeaver" (Figure l) appears overlayed on the game by pressing Esc button. Layout and Options:

Settings: Opens a settings menu where players can adjust various game parameters.

Back to Main Menu: Enables players to return to the main menu of the game.

Quit: Allows players to exit the game.

Close Menu: Closes the pause menu and resumes the game.

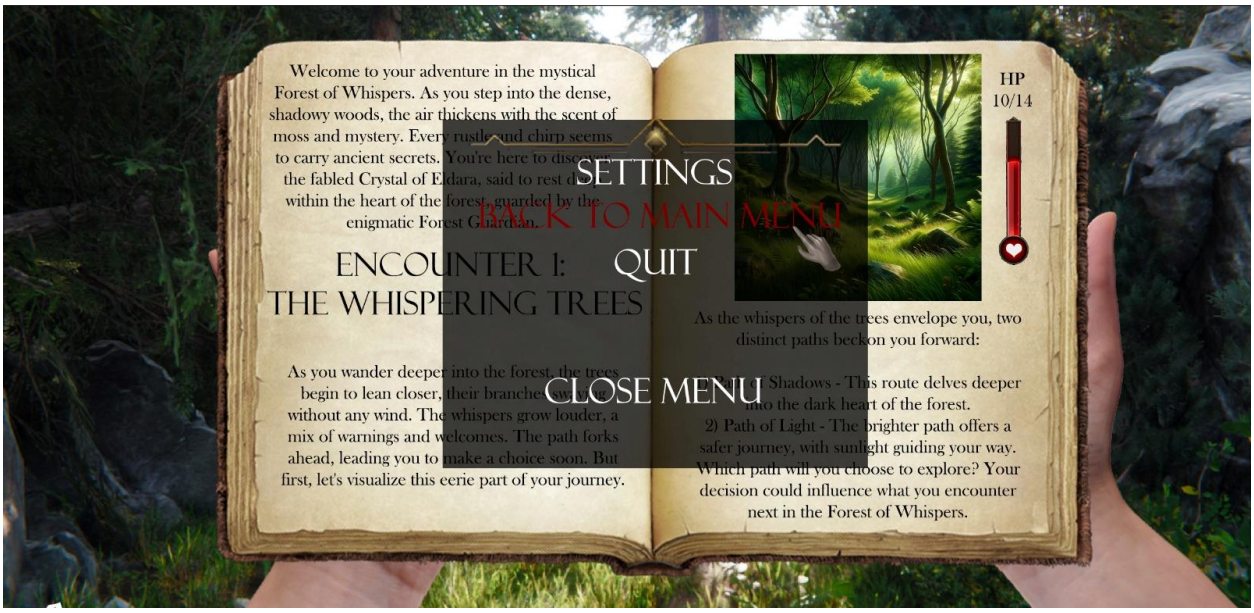


Figure (l)

6.4 Data Storage

In "TaleWeaver," each player begins their journey by creating a profile, which is stored as a JSON object containing a unique Player ID. This ID is crucial for associating completed adventures with the correct user profile.

Data Structure and Storage:

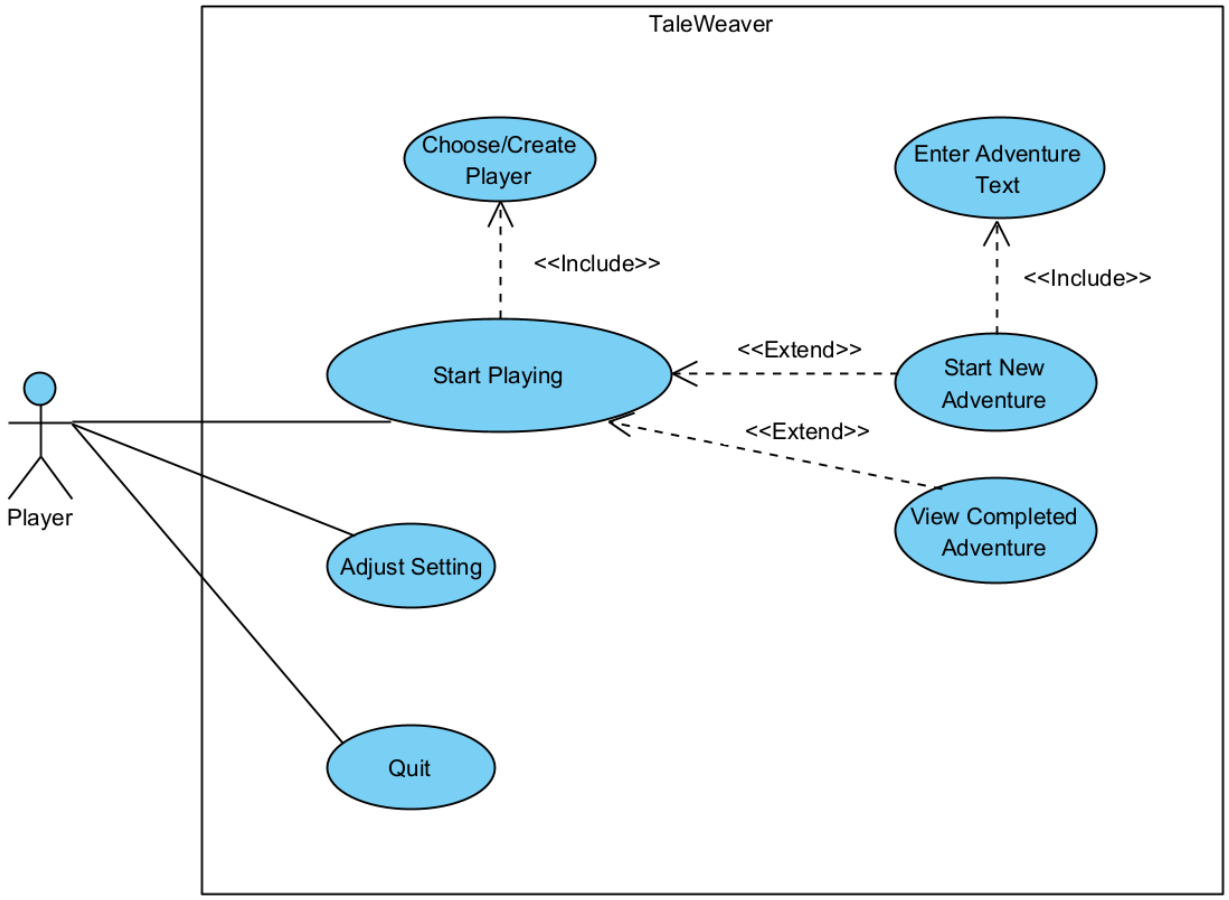
- **Player Profile**: Stored locally as a JSON object, each profile includes the Player ID and a list of completed adventures. This structured format ensures efficient data management and quick access.
- **Completed Adventures**: Each completed adventure is also stored as a JSON object. This object contains the full narrative text generated by ChatGPT and links to the .png files of images generated by DALL·E, encapsulating the entire adventure in a self-contained record. These JSON objects capture the entirety of the player's experience in each session, preserving the narrative flow and visual elements that defined their journey.

Key Features of the Storage System:

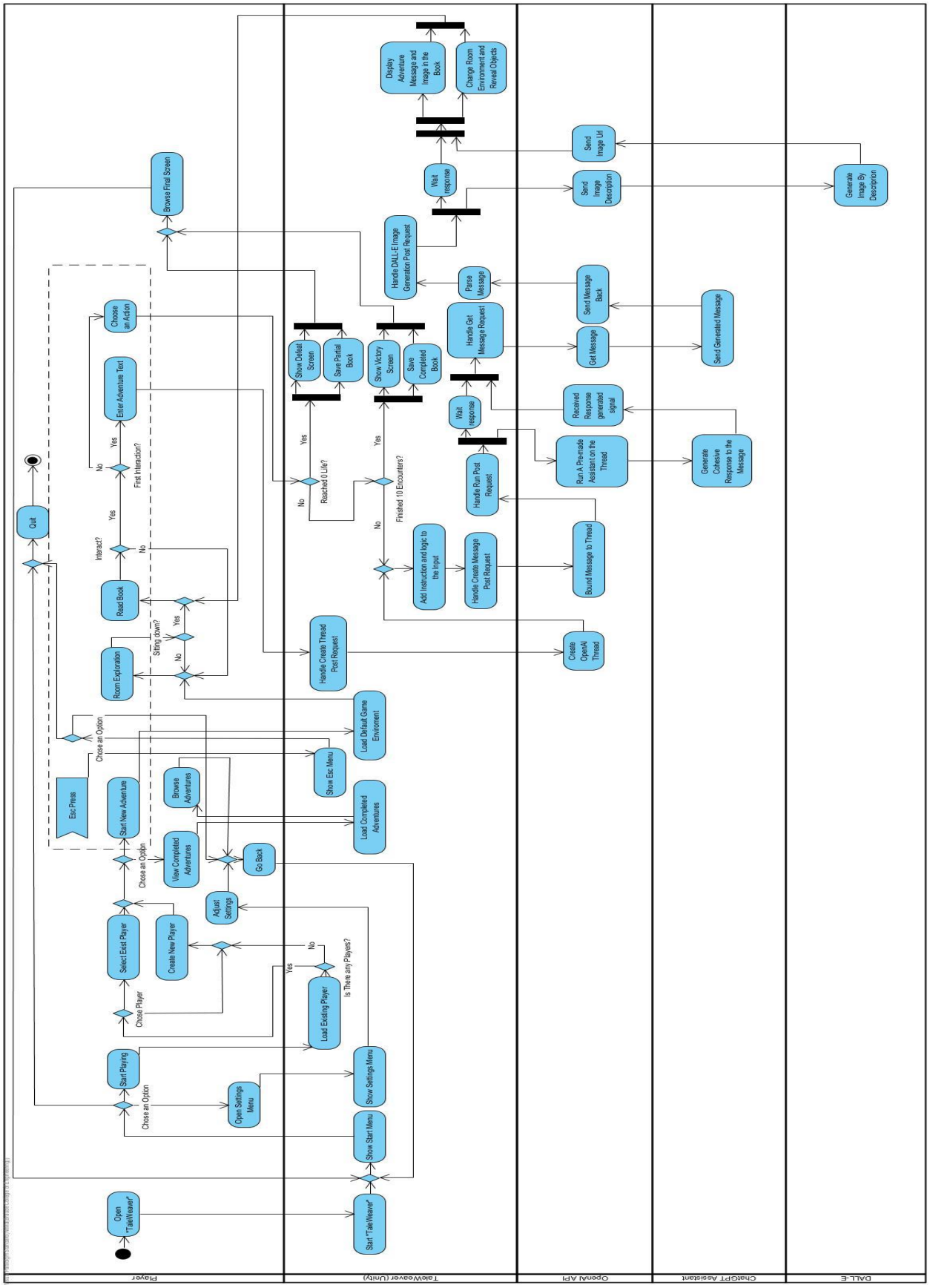
- **Simplicity & Integrity**: The use of JSON for storing completed adventures ensures that each narrative and its corresponding visual data remain linked and intact, facilitating an organized and reliable way to revisit past adventures.
- **Privacy & Security**: By utilizing local storage, "TaleWeaver" enhances data security, keeping all player information and game history confined to the user’s device.
- **Performance & Reliability**: Local storage ensures optimal performance with no dependency on internet connectivity, providing a seamless and uninterrupted gaming experience.
- **Scalability**: The JSON format is lightweight and scalable within the storage capabilities of typical personal devices, suitable for the game’s episodic content.

6.5 Diagrams

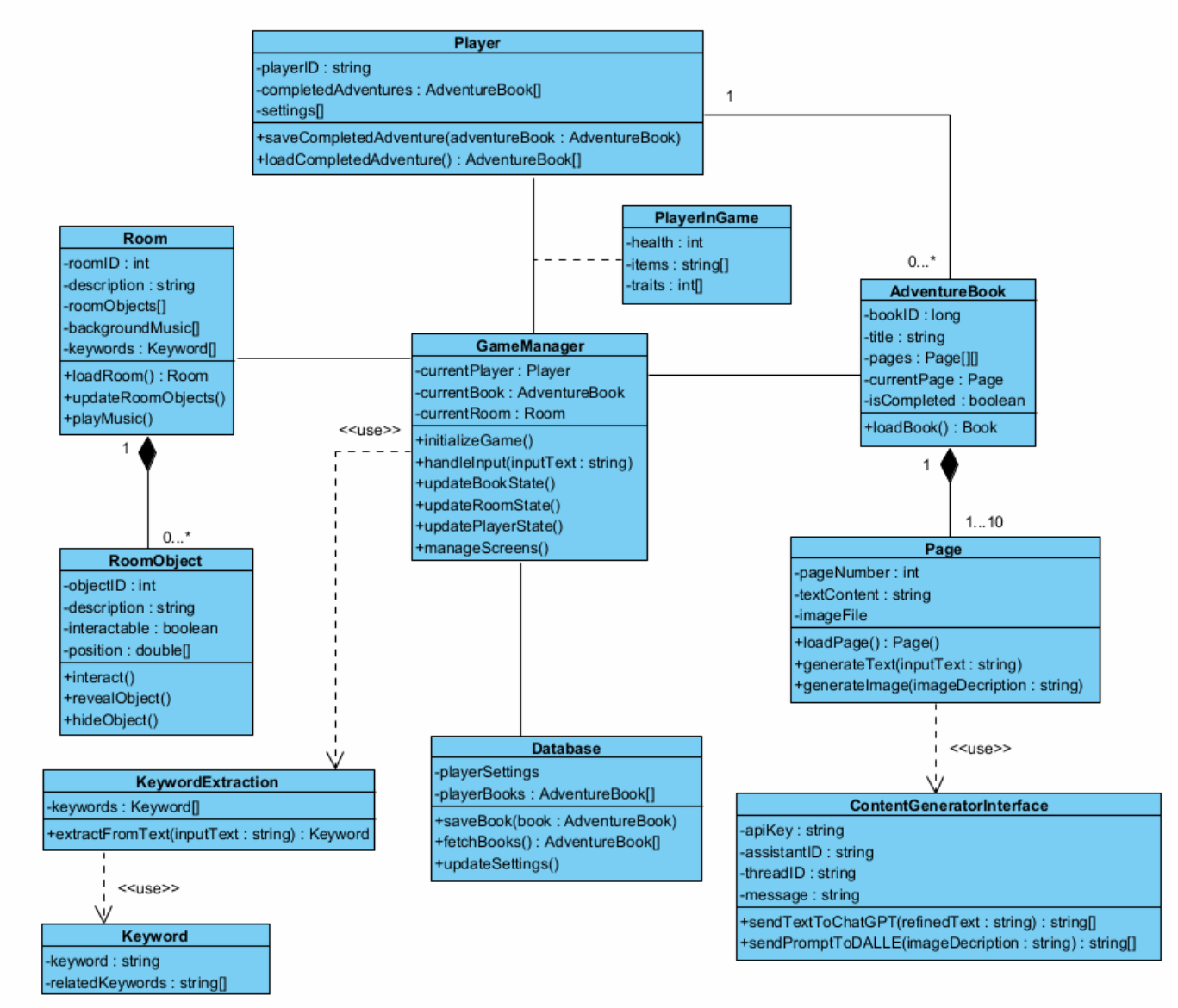
6.5.1 Use Case



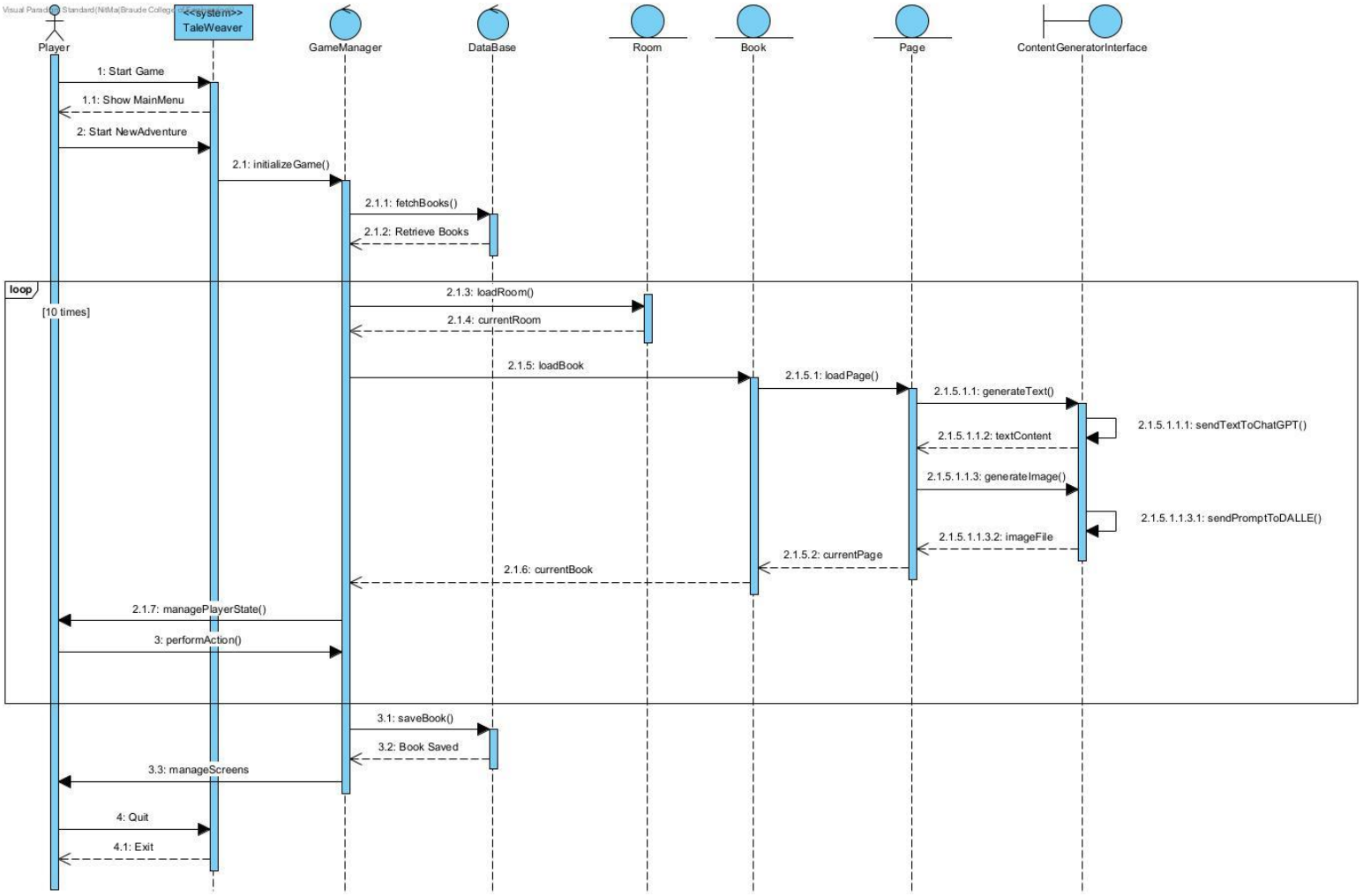
6.5.2 Activity



6.5.3 Class


Player
-playerID : string
-completedAdventures : AdventureBook[]
-settings[]
+saveCompletedAdventure(adventureBook : AdventureBook)
+loadCompletedAdventure() : AdventureBook[]
1
PlayerInGame
-health : int
-items : string[]
-traits : int[]
Room
-roomID : int
-description : string
-roomObjects[]
-backgroundMusic[]
-keywords : Keyword[]
+loadRoom() : Room
+updateRoomObjects()
+playMusic()
0...*
AdventureBook
-bookID : long
-title : string
-pages : Page[][]
-currentPage : Page
-isCompleted : boolean
+loadBook() : Book
GameManager
-currentPlayer : Player
-currentBook : AdventureBook
-currentRoom : Room
+initializeGame()
+handleInput(inputText : string)
+updateBookState()
+updateRoomState()
+updatePlayerState()
+manageScreens()
<<use>>
1
0...*
1
1...10
RoomObject
-objectID : int
-description : string
-interactable : boolean
-position : double[]
+interact()
+revealObject()
+hideObject()
Page
-pageNumber : int
-textContent : string
-imageFile
+loadPage() : Page()
+generateText(inputText : string)
+generateImage(imageDecription : string)
<<use>>
KeywordExtraction
-keywords : Keyword[]
+extractFromText(inputText : string) : Keyword
Database
-playerSettings
-playerBooks : AdventureBook[]
+saveBook(book : AdventureBook)
+fetchBooks() : AdventureBook[]
+updateSettings()
ContentGeneratorInterface
-apiKey : string
-assistantID : string
-threadID : string
-message : string
+sendTextToChatGPT(refinedText : string) : string[]
+sendPromptToDALLE(imageDecription : string) : string[]
<<use>>
Keyword
-keyword : string
-relatedKeywords : string[]

6.5.4 Sequence



7. Verification and Evaluation

7.1 Evaluation

Evaluation of "TaleWeaver" will be based on its ability to dynamically generate engaging and contextually appropriate narratives and visuals that adapt to the user input. The goal is to create an immersive storytelling experience that is unique for each player. Success will be measured by the coherence of the stories, the relevance of the AI-generated content to player input, and user satisfaction.

We will assess the accuracy of the keyword extraction algorithm and its effectiveness in altering the game environment to reflect the player's narrative. If the game consistently reveals rooms and objects associated with keywords and maintains player engagement, this will

indicate the product is performing well. User feedback and playtesting will provide additional insight into the experience's quality and identify areas for further development.

7.2 Verification

7.2.1 Testing Plan

Given the iterative nature of our development, we will conduct verification in three primary areas: Gameplay Mechanics, AI Integration, and User Interface. We plan to use a combination of automated and manual testing strategies.

Test	**Module**	**Tested Function**	**Expected Result**
1	Gameplay Mechanics	Input Processing	Accurate reflection of input in narrative
2	Gameplay Mechanics	Page Turning	Smooth transition to next page in < 1s
3	AI Integration	ChatGPT Integration	Relevant text generation for given prompts
4	AI Integration	DALL·E Integration	Accurate and timely image generation
5	AI Integration	Keyword Extraction	Correct keywords extracted from input
6	Game Environment	Room Update	Room adjusts based on keywords
7	Game Environment	Object Reveal	Objects reveal/hide in response to story
8	User Interface	Navigation	Intuitive and responsive UI navigation
9	User Interface	User Experience	Engaging and seamless player experience
10	User Interface	Accessibility	Accessibility features function correctly
11	Data Management	Adventure Book Saving	Correct saving of completed adventures
12	Data Management	Performance & Load Times	Game maintains >30fps, load times < 2s

8. AI Tools

Links to AI Tools:

ChatGPT: OpenAI ChatGPT

Prompts:

"Can you help fix the grammar in this paragraph?"

“how can we harness Key Word Extraction Algorithm into a keyword-driven dynamic content game”

"Explain the word extraction algorithm RAKE and how it can be used in our project."

"What can I add to my testing plan to make it more comprehensive?"

"Can you summarize this research paper for me?"

"How can I describe the hover tooltip feature for environment selection in our game?"

"Can you explain how to structure the data for storing completed adventure books?"

“if we have a local database should we add it to the Architecture overview diagram?”

"What should be included in a sequence diagram for our game’s narrative flow?"

"What are some design principles we should follow for creating an intuitive user interface?"

"How does the integration of the OpenAI API with Unity work?"

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