Utilizing Large Language Models as Interactive Dungeon Masters in Digital Role-playing Games

Robert Nasuti

Abstract

This paper delves deeper into the pioneering approach of harnessing a state-of-the-art Large Language Model (LLM) to act as a dynamic and interactive dungeon master for digital role-playing games. Building upon an initial proposal, we detail the development and refinement of a custom framework tailored to complement the LLM's narrative capabilities. This endeavor not only enriches digital gaming experiences but also underlines the expansive possibilities of LLMs in sculpting adaptive and responsive AI-driven systems. With advancements in memory management, user interface design, and evaluation techniques, we present a comprehensive overview of our journey in redefining digital role-playing.

Introduction

The allure of digital role-playing games (RPGs) has consistently stemmed from their promise of immersive universes, rich narratives, and the freedom for players to forge their own paths. The linchpin of many such experiences, especially in tabletop RPGs like Dungeons Dragons, is the dungeon master (DM) – an entity that meticulously crafts the narrative tapestry, molding it in real-time based on players' choices. While the role of a DM has traditionally been occupied by humans, the meteoric rise in the capabilities of Large Language Models (LLMs) prompts a fascinating question: Can we recreate the dynamism, creativity, and adaptability of a human DM using state-of-the-art AI?

Our prior work proposed the potential of LLMs in this realm, drawing parallels with their success in mimicking complex human behaviors and interactions. As we progress further into our research, this paper presents a detailed exploration of the strides made in realizing this vision. From building a robust framework that synergizes with the LLM's strengths to grappling with challenges in memory, user interface, and function calling, we offer a deep dive into the intricacies of crafting the ultimate digital DM. As the boundaries between human creativity and machine-generated content blur, our work stands at the forefront of this intersection, seeking to redefine interactive gaming experiences for the digital age.

Background

Interactive digital storytelling has been a focus of research for over a quarter-century, with works by Peinado and Gervás [?] and Smed [?] exploring its potential in shaping computer games and other applications. With advancements in technology, new avenues for immersive narrative experiences have emerged. With the advent of Large Language Models (LLMs), there's potential to push these boundaries even further. LLMs, like the models powering ChatGPT, are renowned for their capabilities in generating human-like text, offering a promising tool for interactive storytelling. Foundational works in automated storytelling, combined with recent advances in LLMs, lay the groundwork for the explorations proposed in this project.

Objective

- To implement an LLM as a dungeon master that can guide players through a pre-defined campaign.
- To explore the ability of the LLM to dynamically adapt the narrative based on player interactions and decisions.

Methodology

- **Framework Development:** The initial framework, developed to harness GPT's function calling capabilities, will be enhanced using the "LangChain" library. LangChain, specifically designed for applications powered by language models, offers both data-aware and agentic functionalities. Its modular components and structured chains make it ideal for this project, simplifying the development process while ensuring flexibility.
- **Campaign Integration:** Dungeons & Dragons campaigns often rely on pre-compiled sourcebooks, providing structure while maintaining adaptability.

This framework will equip the LLM with the capability to track player and NPC interactions, ensuring continuity in the game narrative.

- **Interaction Dynamics:** The LLM dungeon master is designed to offer players substantial agency within the game's narrative. From managing combat scenarios to facilitating intricate player-NPC interactions, the LLM-DM ensures a seamless and dynamic gameplay experience.

Potential Challenges

The endeavor to integrate a Large Language Model (LLM) as an interactive dungeon master in digital role-playing games, while promising, comes with its own set of challenges:

- **LLM Hallucinations**: One of the known issues with LLMs is the potential for generating "hallucinations" or outputs that might be factually incorrect or inconsistent with the game's lore. Ensuring the generated content aligns with the game's narrative and rules can be a significant challenge.
- **Context Window Limitation**: GPT-4 has a token limit of 8k for its context window. This means that if a game session's interactions and descriptions exceed this limit, the LLM might lose track of earlier events, potentially affecting the consistency and quality of the narrative.
- **Financial Constraints**: The continuous interaction with the OpenAI API can be costly. Being a project undertaken by a graduate student, there are inherent budget limitations that might affect the scalability and frequency of testing and iterations.
- **Function Calling Limitation**: Currently, function calling capabilities, a critical feature for this project, are limited to models provided by OpenAI. This restricts the usage of open-source alternatives like Falcon and Llama-2, potentially affecting the project's scalability and adaptability in the future.
- **Adaptability to Player Choices**: While LLMs are adept at generating human-like text, predicting and adapting to an infinite array of player choices in real-time can be challenging. Striking a balance between adhering to the campaign's structure and allowing player agency might require iterative refinements.
- **User Interface Development**: Creating an intuitive and user-friendly interface for interaction is crucial for the project's success. Leveraging the "Chainlit" library is the current plan for developing this UI. However, any potential limitations or challenges faced with this library could impact the ease of use and overall experience for users.

Significance in the Context of Deep Learning

In deep learning, projects often involve either creating or interacting with advanced models. This project focuses on the latter, leveraging established Large Language Models like GPT-3.5 and GPT-4. Harnessing pre-trained models allows for rapid prototyping and deployment, while also benefiting from their broad training data and generalization capabilities.

Advantages of leveraging pre-trained models include:

- Time Efficiency: Bypassing the extensive requirements of training deep models from scratch.
- Robustness: Benefiting from diverse training data, ensuring dynamic and rich storytelling.
- Cost-effectiveness: Avoiding the high computational costs of fresh model training.

LLMs like GPT-3.5 and GPT-4 showcase the power of deep learning. Their ability to generate human-like text, understand context, and adapt to nuanced requirements signifies the progress made in deep learning. This project explores the potential of LLMs beyond text generation: crafting narratives, adapting to user input, and facilitating immersive experiences. It underscores the vast possibilities deep learning offers across various domains.

Expected Outcomes and Evaluation

Expected Outcomes

The primary objective is for the LLM to serve as a dynamic dungeon master in the "Curse of Strahd" campaign's first chapter [**?**]. Anticipated outcomes include:

- Effective navigation and description of the chapter's environment and events.
- Dynamic narrative adaptation based on player decisions.
- Persistent recall of player and NPC interactions, shaping the evolving story.
- Integration of core RPG mechanics into the narrative.

Evaluation

Evaluation will be hands-on, starting with personal playtest sessions to assess the LLM's proficiency in guiding the narrative. Metrics for evaluation include:

- Narrative consistency with the source material.
- Ability to recall and integrate past interactions.
- Depth and quality of responses to unforeseen player choices.

A future goal is to develop a LangSmith evaluation set for automated performance assessments, further refining the LLM's capabilities.

Conclusion

Computers have long facilitated gaming, but tabletop RPGs present a unique challenge due to their expansive possibility space and player agency. This project bridges the divide between structured computer games and the boundless world of tabletop RPGs using an

LLM. Success here implies more than a technological advancement; it indicates the potential for AI to understand and adapt to intricate human behaviors in diverse contexts. This aligns with discussions on AGI alignment, emphasizing AI models that can synergize with human users across multifaceted settings [**?**]. As highlighted in recent literature, while advanced AI models promise immense benefits, it's essential to proactively manage potential risks to ensure public safety and ethical considerations [**?**]. Ultimately, this endeavor seeks to integrate advanced AI into complex human activities, broadening horizons for AI-human collaboration.

Acknowledgments

References

[Anderljung, Barnhart et al.(2023)] Anderljung, M.; Barnhart, J.; et al. 2023. Frontier AI Regulation: Managing Emerging Risks to Public Safety. *ArXiv*, abs/2307.03718.

[ChatGPT(2023)] ChatGPT. 2023. Conversations and Assistance in Formatting, Editing, and LaTeX. Available at OpenAI.

[Junprung(2023)] Junprung, E. 2023. Exploring the Intersection of Large Language Models and Agent-Based Modeling via Prompt Engineering. *ArXiv*, abs/2308.07411.

[Park, O'Brien et al.(2023)] Park, J. S.; O'Brien, J. C.; et al. 2023. Generative Agents: Interactive Simulacra of Human Behavior. *ArXiv*, abs/2304.03442.

[Peinado and Gervás(2007)] Peinado, F.; and Gervás, P. 2007. Automatic Direction of Interactive Storytelling: Formalizing the Game Master Paradigm. In *International Conference on Virtual Storytelling.*

[Perkins, Lee et al.(2016)] Perkins, C.; Lee, A.; et al. 2016. *Curse of Strahd*. Wizards of the Coast. Lead Designer: Christopher Perkins. Creative Consultants: Tracy and Laura Hickman. This book is based on the 32-page D&D adventure Ravenloft published in 1983 by TSR, Inc.

[Smed(2014)] Smed, J. 2014. Interactive Storytelling: Approaches, Applications, and Aspirations. *Int. J. Virtual Communities Soc. Netw.*, 6: 22–34.