Project Report : CS 5660

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Abstract

Interactive computational agents known as generative agents mimic human behavior in interactive settings. This study provides an agent architecture that supports action, reflection, and memory, and uses controlled end-to-end simulations to assess its effectiveness. Analyses are done on emerging social behaviors including friendship building and information dissemination. The outcomes show that coordination was successful, and the behaviors that were seen provided information about errors and boundary conditions. Applications include human-centered design and social prototyping. User-agent connections, hazards, and biases are all taken into account by ethical concerns. Subsequent efforts will focus on improving the architecture and assessing its long-term performance. This work lays the foundation for interactive, behavior-rich simulations by presenting a fresh approach to generative agents and highlighting possible applications..

1. Introduction/Background/Motivation

Creation of Computer Character: We devoted our skills to creating unique computer-based characters that are intended to realistically mimic human behavior in the setting of a game or simulation. Working together, we painstakingly created a thorough strategy or system for these characters. Our intention was to provide them the ability to recall events, think critically, and use that thinking to make decisions about what to do next. This calculated move was meant to increase their behavior's genuineness and make them behave more like actual humans. In our group, we carried out the following step, which involved submerging these computer characters in a virtual environment or video game. We all worked together to assess if these charac1
ters acted in a way that was realistic and consistent with the reactions and behaviors one might anticipate from actual people. We held deliberate talks to anticipate any issues or concerns that might develop with the employment of these computer characters. The potential for people to develop emotional relationships to the characters and the risk of character errors leading to issues were among the topics discussed. Our company gave careful thought to these moral issues when determining how to proceed with our research.

Our group's project was to create computer characters that accurately represent real individuals in a virtual environment. These characters were intended to resemble humans in that they had memories, learned from their experiences, and made decisions based on those lessons. Our goal was to see if these artificially intelligent characters might conduct in a way that would be consistent with human behavior in a game setting. We also thought about other problems, such people developing deep emotional attachments to these made-up characters and the errors they might make. Our joint objective was to create computer characters that mimic human behavior and watch how they do tasks while keeping in mind any possible drawbacks.

Creating computer-generated characters that behave like actual people in a game setting was our main goal for the project. Our goal was to investigate the potential for these virtual characters to learn from their experiences, retain information, and make judgments similar to those made by humans. In addition, we sought to find any problems or errors that these characters would run into when interacting with the game world.

Currently, when creating computer characters for simulations or games, the behavior and speech patterns of the characters are pre-planned. However, there's a problem: these characters don't learn from their experiences and are incapable of remembering past events. They so wind up performing the same things repeatedly, such as adhering to a predetermined plan. Because they are unable to respond creatively to many circumstances, they become less smart and fascinating.

Rather than acting like actual people would, their behavior becomes formulaic and quite dull.

For a more engaging gaming experience, game developers can employ it to create more realistic-looking game characters. Training groups can utilize this to create training scenarios that feel more realistic, much like in the military or the medical field. Tech Companies can use this research to improve the functioning of artificial intelligence (AI), which could impact the development of future technologies. Individuals who study Human-Computer Interaction may find that using computers feels more like natural human-computer interaction. Educators and Researchers may learn more about modeling human behavior in computers, which may be useful for research and education.

If successful, this research might completely change the behavior and speech of computer-generated characters in virtual environments, training sessions, and games. It might help characters learn from their mistakes, recall past events, and make decisions about their next course of action based on their knowledge. Interactions with these individuals would become more lively, adaptable, and genuine as a result. It might improve training simulations, increase the enjoyment of games, and enhance other computer programs that employ intelligent and realistic characters. It might give people the opportunity to engage in more engaging and customized pretend scenarios.

The information is about the town of Smallville. There are three agents: Isabella Rodriguez, Klaus Mueller, and Maria Lopez. The town includes various regions such as a house, park, supply stores, grocery and pharmacy, college dorm, co-living space, and so on. Each house has a living room, bathroom, kitchen, bedroom, garden, book shelves, and so on. The data used contains information about each individual such as their daily routines, personality traits, learned behaviors, current activities, and facts about their living space. There are also factors relating to thought processes, scheduling, reflection, and chat exchanges. The root node describes the entire world, children describe areas, and leaf nodes represent items. Agents remember a subgraph that reflects the areas of the world they have seen, maintaining their state as observed.

2. Approach

We cloned the code from GitHub in our project to create generative agents. There was an issue with how frequently the agents could communicate with the OpenAI system when we executed the code. We modified the code, particularly the section referred to as the ”get embedding function” of the GPT structure, in order to resolve this prob-

```
>>     raise self.handle_error_response(
>> openai.error.RateLimitError: Rate limit reached for text-embe
dding-ada-002 in organization org-y9rxGp6zGJ4PwSrQu7RoLCsG on re
quests per min (RPM): Limit 3, Used 3, Requested 1. Please try a
gain in 20s. Visit https://platform.openai.com/account/rate-limi
ts to learn more. You can increase your rate limit by adding a p
ayment method to your account at https://platform.openai.com/acc
ount/billing.
>> Error.
```

Figure 1. Error occured during first attempt

lem. In order to help the code handle issues such as the rate limit error when communicating with the OpenAI system, we added a try-catch block. With this modification, the application can manage these problems and continue to function properly.

Our intention was to address the rate limit issue by implementing modifications directly in the function that communicates with the OpenAI API. We wanted to address any problems that might arise as a result of the API’s rate constraints in a controlled and seamless manner, so we came up with a new idea of adding error handling via a try-catch block.

We anticipated certain challenges, such as rate limitations and token expiration, which deal with how long a particular code is valid and how quickly we may use the system. As anticipated, on our first attempt, we encountered a difficulty when we exceeded the system’s maximum usage speed. The primary challenge was figuring out how to deal with the rate restrictions (API) on how frequently we could use the system. As a result, several of our queries to the system did not function as intended.

No, initially, there was an issue when attempting to get it to function because it reached its maximum. We then adjusted a few things to better address this problem. We concentrated on the program’s interface with the OpenAI system and included error-handling features to ensure that malfunctions won’t prevent the entire system from operating.

We concentrated on modifying the GitHub codebase that we had copied. In particular, we focused on the GPT structure’s get embedding function to address issues brought about by encountering the rate limit error when utilizing the OpenAI API. The intention was to improve the code’s ability to handle rate limit-related problems while interacting with the API.

3. Experiments and Results

3.1. Measurement of Success

We assess generative agents’ performance by observing how well they can mimic human behavior in various contexts. We assess their consistency, ability to adapt their behavior to suit various contexts, and ability to make sense in a variety of scenarios—all of which people would find appealing. The degree of accuracy, consistency, and contextual relevance with which these agents respond to different scenarios and interview questions serves as a gauge of their effectiveness. It all comes down to ensuring that they can convincingly mimic human behavior in a variety of contexts.

3.2. Experiments Conducted

We conducted one-on-one interviews with the computer characters to assess their level of performance. We questioned them extensively about various aspects of their fictional personas. We sought to find out whether they could recall information, comprehend who they were, organize their activities, respond appropriately to various circumstances, and engage in meaningful thought. To improve the characters, we made some structural adjustments to their design that should help them remember and behave consistently when we speak with them. They engage with us more consistently and sensibly as a result of this.

3.3. Qualitative and Quantitative Results

The major criteria we use to assess the agents' performance are the quality of their responses in both interviews and role-played dialogues. The review does not concentrate on particular figures or data. Rather, it assesses how well the agents seem credible and make sense while responding. The findings demonstrate that various agents differ in their degrees of plausibility for acting like humans and coherence, or how well their responses fit together. This gives us an idea of how well they resemble human behavior even though we aren't able to assess them precisely or quantify their performance.

3.4. Success or Failure and Justification

The project succeeded in creating generative agents that behave somewhat like actual people. A subset of these agents performed exceptionally well; they responded to shifts in context, behaved consistently across scenarios, and functioned logically. However, we also saw a few problems. Occasionally, the agents exhibited imperfect behavior or encountered difficulties in specific scenarios, indicating that further development is still necessary. This implies that achieving total credibility may be difficult, but there are still certain areas where we may improve.

3.5. Justification and Evidence

The primary method by which we assess the agent's performance is through the analysis of their interview responses. It is clear that the agents are effectively replicating real behavior when they provide thorough and consistent descriptions of their interactions, routines, and reactions. Conversely, inaccuracies or disparities indicate places in need of development or boundaries on the plausibility of the material.

Figure 2. Frontend Overview

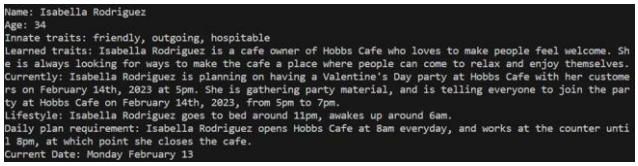

Figure 3. Training Data

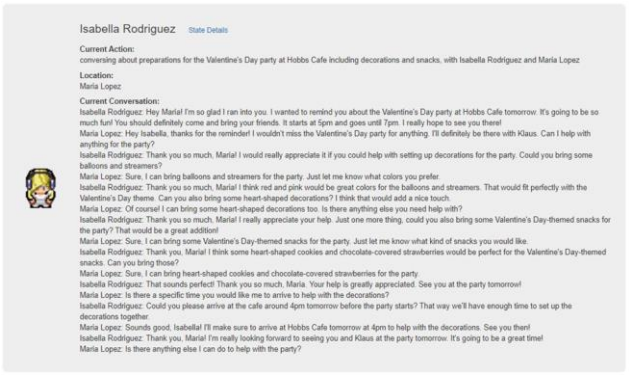

Figure 4. Conversation of agents

4. Other Sections

It discusses the development and testing processes for the generating agents. The paper should be understandable to someone familiar with Deep Learning. The study provides sufficient details on the development, testing, and outcomes of the generative agents. Hence,it appears that the paper covers everything by itself.

This study discusses the assessment of the performance of generative agents in five key domains: self-awareness, memory, planning, response to inputs, and reflection. The paper's approach or model is organized in a way that makes sense for the issue it seeks to address. For each of these locations, they created distinct pieces of the model. The model includes parts on information retrieval, response generation, and action planning based on the agent's thoughts and memory.

The paper does not include specific details about the model's architecture or the components that have been

trained. However, it describes how to use a language model to create unique vectors for memory objects and use cosine similarity to determine their significance. It is likely that the language model and related components have acquired new skills over time, such as improving at a particular task. However, subsequent steps—like determining the significance of something—might not need learning new information.

The precise input and output that the neural network requires are not explained in detail in the paper. However, it discusses how to use a language model to generate unique vectors for the inquiries and memories the computer has. After creating these unique vectors for the queries and memories, they prepare the data by determining the relative importance of each memory. Based on this information, they retrieve the most significant memories.

A straightforward structure is used in the design of generative agents to store vital information about the agent, such as name, age, and personality characteristics. It also contains information on their occupation and sources of motivation. This summary is created on a regular basis and stored for easy access. We can inquire about the agent's primary characteristics, present activities, and recent experiences to learn more about them. We can simply gather the necessary information thanks to this clever structure, which enables the agent to behave credible.

In order for generative agents to behave in a sensible and credible manner, they must have plans. These plans specify the future actions that the agent should take, together with the where, when, and duration of each action. These plans are kept in the agent's memory, and they are considered in conjunction with the observations and considerations the agent makes while determining how to proceed. The agents can modify their plans in response to changing circumstances, ensuring that their actions remain plausible and engaging in light of the current circumstances.

A sort of memory exists in generative agents that records their experiences. This memory consists of memory objects, each of which has a regular language description, creation date, and most recent lookup time. Observations, or things the agent directly sees or experiences, are the building blocks of the memory. There is a function that locates and displays memories that correspond with the current situation in order to assist the agent in using this memory. In this manner, the agent might consider past experiences when making decisions.

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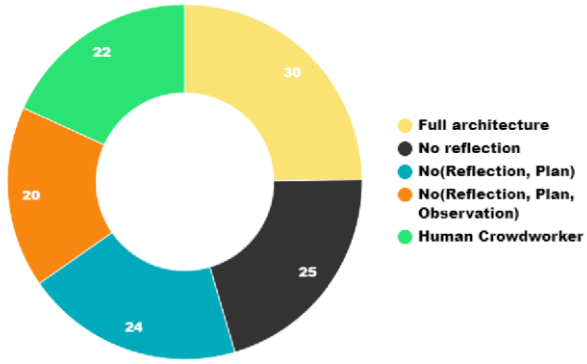
Figure 5. TrueSkill Rank Rating



ing blocks of the memory. There is a function that locates and displays memories that correspond with the current situation in order to assist the agent in using this memory. In this manner, the agent might consider past experiences when making decisions.

As of right now, we use small-window language models for creating generative agents such as ChatGPT. This implies that while determining how to behave, they can only take into account a restricted number of prior experiences. In the future, we could improve things by utilizing more recent language models, such as GPT-4. This has the potential to enhance the expressiveness and power of generative agents. The essential framework of these agents' operations, such as planning, remembering things, and considering what to do, is probably going to remain the same even with the adoption of these more recent models.

5. Work Division

Below table indicates the individual contributions in detail.

Student Name	Contributed Aspects	Details
Harshada Jadhav	Simulization of sensing and memorizing the data.	This module simulates the ability of a generative agent to sense and remember events and spaces in its surroundings which uses sensors or other input channels to get data. To understand and respond to its surroundings, the agent use a combination of prompt templates, GPT-based example models, and its memory.
Manjeet Khanna	Retreive information from the memory.	The primary purpose of this module is to retrieve relevant information based on a given persona's perception. The module provides a way for the agent to access information from its memory based on perceived events and ideas,considering the importance, and relevance. The collected data is later used by the generative agent.
Parth Barahate	Interaction within the maze.	This module is part of a simulation environment that incorporates interacting "personas" within a maze.The code replicates persona decision-making processes in a dynamic environment in which individuals plan actions, react to occurrences, and interact with one another within a maze.
Yash Divate	Reflection process for generative agents.	The purpose of this module is to define functions related to the reflection process within the agent. This module allows generative agents to reflect on their interactions, produce insights, and apply these insights to better future interactions.
Tej Tilekar	Execution of plans or actions for a given agent.	The module is intended to carry out plans or actions for a specified persona in a virtual environment. The module appears to be part of a bigger system in which generative agents navigate a maze-like environment and perform numerous behaviors.
Harsh Jadhav	Generating conversations for a agent.	The module deals with producing chat conversations and dealing with various parts of conversation generation, such as summarizing ideas, collecting information, and generating responses. The module also allows you to load agents history and start interactive chat sessions.

Table 1. Contributions of team members.

6. Benefits and Applications

6.1. Benefits

These agents can pass for humans well, which aids in our understanding of human behavior and desires. They are helpful for building things, generating immersive experiences, and testing out concepts in social systems. They can also contribute to research on the interactions between humans and AI and work on the creation of user-specific technologies. Long-Term Memory and Continuity: Improving the agents' ability to retain information over extended periods of time might provide more dependable and meaningful communication. They would come across as more credible if they could recall previous conversations and maintain consistent language.

6.1.1 Dynamic Adaptation

It's critical that the agents have the flexibility to change course during discussions or while speaking. This entails modifying their answers in reaction to criticism, picking up knowledge from continuing conversations, and changing their conduct as necessary.

6.1.2 Multiple Communication Channels

Agents should be able to communicate via multiple channels, such as text, graphics, and possibly even sound. As a result, the conversation may become more nuanced and resemble human speech.

6.1.3 Interactive Learning

Enabling these agents to learn and improve through realworld interactions or simulated scenarios might help them comprehend and adjust to human behavior.

6.1.4 Real-Time Interaction

By figuring out how to make these agents operate in realtime without lag, we can increase their usefulness and suitability for practical scenarios. As a result, they can function effectively in circumstances requiring them to engage in immediate human interaction.

6.1.5 Scalability and Efficiency

It is crucial to make these models more effective for a large number of users. We are looking for significant improvements, such as reducing the amount of computer power and time needed to train them while maintaining or improving their functionality.

These concepts include improving things from a technological standpoint, considering morality, and making them simpler to use. Making these agents more adaptable, sensitive, and consistent with societal norms and human behavior is the aim.

6.2. Applications

Generative agents have a wide range of possible applications, notwithstanding these difficulties. They are useful for a variety of tasks, such as creating user-friendly designs and online social scenario simulations. They might personalize technology for each user or behave like people in virtual reality.

7. References

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