Optimizing an Automatic Text Analysis Model with Generative Artificial Intelligence System for Gaming Strategic Behaviors

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Abstract

ChatGPT, as an important system of Generative Artificial Intelligence (GenAI), has had a profound impact on various fields, and has the potential for processing textual dialogues regarding gaming behavior analysis. Therefore, this study aims to build an automatic text analysis model for gaming strategic behaviors by enhancing its objectivity and efficiency. Three stages of tests were conducted to optimize its function for achieving comprehensive understanding of using GenAI. Behavior coding with clear definition, gaming contexts, and analysis goals are all important factors. Through the analysis model, we can ensure the capability of the analysis accuracy. By using GenAI, researchers significantly reduce the time and cost associated with manual analysis that enables the process of large volumes of textual dialogue data.

Keywords: Generative Artificial Intelligence, ChatGPT, Text Analysis, Gaming Strategic Behaivors

1   Introduction

1.1   Research Goals

In today's rapidly developing digital gaming industry, games have surpassed mere entertainment activities and evolved into complex and rich social scenes and cultural phenomena. With the advancement of Internet technology and the diversification of gaming platforms, interactions between players have extended beyond traditional game forms to more diverse content of dialogue and communication. The interaction encompasses not only in-game character conversations but also extends to real-time communication, collaboration, and competition among players which reflects on their dialogues. These dialogues reveal their personalities, emotions, intentions, and behavioral characteristics, thus conducting comprehensive and accurate analysis of dialogues in games is not an easy task; it faces more challenges and difficulties. Natural language processing (NLP) focuses on language use without considering dialectic context. Dialogues in games often exhibit diverse language styles and ambiguous vocabulary usage, making traditional natural language processing techniques difficult to reach optimized analysis accuracy. Furthermore, dialogues in games often contain a large amount of non-standard

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language and emotional expressions, making the understanding of dialogue meaning and emotional analysis more complex. Additionally, dialogues in games are influenced by the game context and the identities of the characters, which means that dialogue analysis needs to consider more contextual information and situational factors.

Therefore, the analysis of game dialogues requires the integration of multidisciplinary expertise and technical means to ensure the accuracy and comprehensiveness of dialogue information. When conducting analysis, it's necessary to have a deep understanding of players' behavior patterns in the game, including their communication styles, interaction habits, and emotional expressions. Especially in the design and evaluation of educational games, the analysis of dialogue behavior plays a crucial role. Through in-depth research and analysis of players' dialogues in games, we can better understand their interaction patterns, thus guiding game designers to develop more attractive and educationally valuable game content. This analysis also helps evaluate the effectiveness and outcomes of games, thereby continuously improving and optimizing the design of educational games.

Since the introduction of ChatGPT, generative artificial intelligence (GenAI) has had a significant impact on various fields, attracting global attention. It has now permeated various sectors of our lives, including applications in education [1] [2], finance [3], engineering [4], healthcare [5] , and other industries. It has highlighted GenAI as a potentially powerful tool in processing textual dialogues for automatic behavior analysis. GenAI excels in creating diverse personalized educational materials, significantly enriching learning resources [6]. In the context of educational games, GenAI systems can analyze players' dialogue behaviors in games to understand their learning needs, interests, and learning strategies. This personalized analysis helps game designers better adjust game content to provide a more effective teaching experience, thereby enhancing the educational effectiveness of educational games.

This study utilizes GenAI with the ChatGPT system to establish an automatic text analysis model for gaming strategic behaviors, helping researchers reduce the time and cost required for manual analysis, thus enabling the handling of large volumes of textual dialogue data.

1.2   Research Questions

In the past, analysis of game dialogues has always been a challenging task due to its the significant amount of time and effort such undertakings require [7]. The analysis is also susceptible to subjective influences, and even with high interrator validity, there is still potential to a lack of objectivity in the analysis results. To overcome these issues, this study utilized the ChatGPT system to establish a model for automatically analyzing textual gaming behaviors. Throughout the process of building the model, continuous optimization and adjustments of prompts were made to enhance the understanding and analytical capabilities regarding game dialogues. Therefore, the research question of this study is how to establish a GenAI analysis model to optimize the automatic text analysis effectiveness for gaming strategic behaviors.

2   Related Works

The continuous progress and innovation in deep learning techniques have sparked significant transformations across various fields, and this change is particularly evident in the field of game development. The development of NLP technology has brought powerful advantages to the gaming industry, especially in the analysis of player dialogues [8]. Through the application of NLP technology, game developers can gain deeper insights into the needs and expectations of

players, thereby creating game experiences that are more closely aligned with the players' preferences. A significant advantage is that by analyzing player dialogues, games can more accurately identify and capture player intent. This means that games can provide customized experiences tailored to the individual needs of players, whether in the presentation of game content or in interactive methods, thus better meeting players' expectations. For example, when players ask questions or express opinions, NLP technology can assist the game in providing immediate and in-depth responses. This not only enhances the interactivity between players and the game world but also enriches the overall gaming experience and attractiveness.

NLP technology has achieved remarkable achievements, but it still faces some challenges, including semantic analysis and sentiment analysis [8]. The semantic structure of human language is often intricate and diverse, while emotions are often hidden behind language. Accurately understanding and interpreting these emotions is a deeper challenge for NLP systems, requiring overcoming many technical limitations and constraints.

In recent years, with the flourishing development of the gaming industry and the prevalence of online gaming, communication and interaction among players have increased its role in the games. This is evident not only in the social and multiplayer aspects of games but also in discussions among players regarding game experiences and content. Therefore, understanding and analyzing the dialogue and interaction among players have become an important research direction. With the continuous development of NLP technology, an increasing number of studies are adopting automated methods to analyze player behaviors in conversations. For example, Zagal, Tomuro, & Shepitsen [9] highlight three different types of NLP techniques: (1) readability analysis; (2) game description analysis; and (3) sentiment analysis to analyze online games, gaining valuable insights into players' views, preferences, and emotions towards the game. Pacella, & Marocco [10] show that employed NLP techniques to conduct a comprehensive analysis of pronouns, word frequency, and discourse usage. Through 3D game simulation scenarios, they collected negotiation data between players and non-player characters. They utilized this analysis method to discover that different types of players exhibit distinct communication styles and strategies in dialogues. These studies showcase the application and challenges of NLP technology in the field of game dialogue analysis, while also highlighting the need for more comprehensive and accurate analysis methods in this field.

However, analyzing player dialogues is not a straightforward task. Game dialogues often contain various forms of language expressions, including slang, abbreviations, emoticons, etc., which pose challenges to natural language processing. Understanding these messages requires more cultural and contextual knowledge. Additionally, player dialogues may involve sensitive information or inappropriate remarks, requiring dialogue analysis tools to possess adaptability and sensitivity. Furthermore, game dialogues are often dynamic, requiring real-time or near-real-time analysis and processing. These methods have limitations in understanding context and processing implicit messages [11]. These limitations include: (1) Difficulty in understanding the context of the text, leading to possible ignorance or misinterpretation of semantic relationships in dialogues. When handling dialogues, considering the overall context of the text is crucial for accurately understanding players' intentions and emotions. (2) It is challenging to process large volumes of text data, which may result in inefficiency and decreased system performance. For large-scale gaming platforms, efficient processing methods and optimized algorithms are necessary to handle dialogue data from thousands of players effectively. (3) Implicit messages in the text pose another challenge, as they may require deeper contextual understanding and reasoning capabilities. The presence of these limitations may lead to errors in natural language

processing technology when analyzing player dialogues, thereby affecting its accuracy and reliability.

With the emergence of GenAI technology, we have seen a potential solution. Since the introduction of ChatGPT, it has had a significant impact on various fields, such as generating coherent content and articles, language translation, question answering, and more [12]. GenAI is an emerging form of artificial intelligence that aims to achieve human-like creativity and comprehension abilities. It can explore more efficient semantic analysis models to enhance the system's understanding of language structures. Additionally, research in sentiment analysis can help the system better capture and understand players' emotional expressions. Compared to traditional deep learning models, GenAI technology places more emphasis on simulating human thought processes and emotional experiences. It can analyze more natural and diverse text and dialogue content.

Therefore, the study reported herein aims to establish a GenAI system to better analyze the diversity and complexity of dialogues in issue-based games, assisting in the automatic text analysis model for gaming strategic behaviors for dialogue data.

3   Research Methods

3.1 Gameplay and Game System Logs

This study utilized the game data from the Online Summit Game System (OSGS) developed by [13] for text dialogue analysis. During player participation in the game, their dialogue content is done on the OSGS for communicative purposes. Their textual interactions are automatically recorded and stored. Set in the 17th century Age of Discovery, this game depicts a period where European voyagers traversed the world, initiating cultural and trade exchanges between East and West. The story revolves around the theme of spice trade, allowing players to engage in trading and negotiations, solving challenges within the game through various contextual settings. These dialogue data include player interactions, negotiations, strategy formulation, and problem-solving processes. In this game, there are two main objectives: first, all nations have to increase their total assets, and secondly, all nations have to resolve crises reasonably. Where there are interests, there are conflicts, and each country needs to resolve the crises it faces. Players are divided into five groups representing five countries that are prominent in the Age of Discovery: England, France, the Netherlands, Spain, and Portugal. Three players as a team, each be assigned a game role: Captain, Diplomat, and Trader. The captain is responsible for representing the country and delivering each round's declaration content. The Diplomat is responsible for international negotiations, drafting new rules, and confirming the final version of the agreement. The Trader is responsible for settling the spice and income from the previous game day. Indeed, with each member playing a distinct role, close collaboration within the team becomes imperative for making decisions that benefit their own group.

In terms of gaming procedure, during each turn of the game, there are primarily four phases: internal affairs, diplomacy, declaration, and divine judgment. During the internal affairs phase, the team discusses internally to make strategic plans to solve the problem. During the diplomacy phase, players engage in diplomatic negotiations with other countries to gain mutual benefits through rolling corrections. The declaration phase is when each country announces the results and resolutions of their negotiations. If there are conflicts, they can be resolved through debate. Finally, in the divine judgment phase, the game master determines whether the crisis has been reasonably resolved. If the event remains unresolved, the issue is then carried on to the next round.

The game goes for three rounds, with one crisis event designated in each round. After three rounds, the success of each country in achieving the game objectives is evaluated.

The game consists of five events. Event one: Preemption. The initial resource disparities between countries drive the competition for colonial dominance, forcing each country to strategize in resource allocation, spice selection, etc., forming the critical momentum in the early stages of the game. Event two: Scurvy. Long sea voyages can lead to disease, and the only treatment available is lemon with limited provision by England and the Pope. This event emphasizes the importance of international cooperation, including fund allocation, personnel management, and spice trading, as part of the crisis management strategy in the game. Event three: The Treaty of Tordesillas. Disputes between Portugal and Spain led to the establishment of the Prime Meridian, dividing the territories of the two countries. In such condition, countries must consider how to handle different interests and establish a more complex trade system. Event four: The Hundred-year Hatred. Long-standing animosity between England and France has resulted in a large-scale war. This event requires the negotiation skills of the two countries to reach the disrupted balance of the entire international system. Event five: The truth is revealed. At the last event of the game, a fictional situation was set up to include the Netherlands in the gaming situation. Information from the Pope reveals the truth behind the long-standing conflicts, involving a conspiracy in the Netherlands. Countries must uphold their reputations and interests in this complex situation.

This game revolves around the core theme of spice trade. When the game begins, the game master issues tasks at each round respectively. These tasks may involve trade disputes, diplomatic conflicts, scarce resource allocation, and other issues. Players need to communicate internally and formulate strategies with other members within their group through internal text conversations on domestic discussion boards, while also negotiating and bargaining with representatives from other countries through text conversations on diplomatic boards. In these text conversations, diplomats play a crucial role. They must be adept at using language skills, strategies, and wisdom to persuade representatives from other countries to reach agreements favorable for common welfare. The system automatically records and stores their conversations in the system, which not only includes communication between players but also reflects the negotiation process, strategy formulation, and problem-solving solutions. Players need to continuously assess the situation and find the best solutions amidst the intertwining of trade and diplomacy to achieve ultimate victory.

After the game, the dialogue data generated by players in the game serve as test data for establishing a GenAI text analysis model. These dialogue data encompass player interactions, negotiations, strategy formulation, and problem-solving processes, covering diverse contexts and emotions. By optimizing the GenAI system's prompts, our aim is to increase the understanding of dialogue content, response accuracy, and adaptability to different scenarios.

3.2 Gaming Behavior Coding

The 13 behavior codes used in this study provide the basis for testing prompts of the GenAI system. These codes have been revised and adjusted based on actual game scenarios to ensure their accuracy and applicability [14], that play a crucial role in dialogue analysis. They are not just classifications of dialogue content; more importantly, they provide a framework for interpreting and understanding player behavior patterns. The application of these codes makes the analysis of dialogue content more systematic and actionable, providing an effective tool for understanding the behavioral characteristics and patterns of players in the game.

Table 1: Strategic Behavior Coding Table

Behavior	Definition
1. Deception	Spreading False Information
2. Profitability	Attracting Other Nations with Conditions
3. Cooperation	Collaborating Towards a Common Goal
4. Goodwill	Demonstrating a Friendly, Cordial Attitude
5. Negotiation	Discussing and Planning Future Actions
6. Suggestion/Sharing	Sharing Personal Views and Experiences
7. Ask	Inquiring, Seeking Opinions
8. Criticize	Highlighting Flaws in Something
9. Coercion	Coercing Others Against Their Will
10. Order	Requesting Someone to Do Something
11. Arbitrariness	Expressing Subjective Opinions
12. Emotional blackmail	Controlling or Persuading Others with Desired Outcomes
13. Perfusion	Being Noncommittal or Reluctantly Accommodating
14. Deception	Spreading False Information

3.3 Establishment and Optimization Process of Analysis Model

To effectively enhance the analysis of player dialogue behavior, we developed a GenAI model tailored for automated text analysis of gaming strategic behavior. The establishment and execution process are illustrated in the diagram below (Figure 1). This process consists of three stages, each adding in different factors to improve the analysis model. At the end of each stage, an evaluation was done comparing the classification results generated by the GenAI system with those manually classified. This allows researchers to understand the accuracy of the model and identify areas where performance is strong and where improvement is needed.
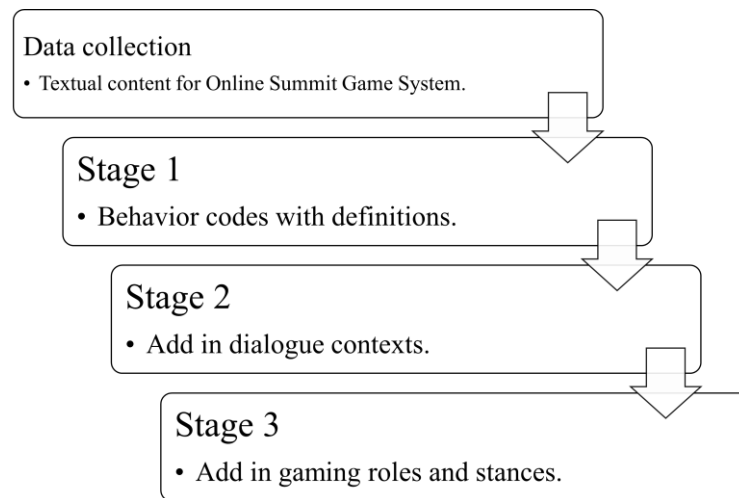
Figure 1: Analysis model establishment and execution process

First, text content was collected from OSGS. Then, data was cleaned by removing invalid sentences that lack substantial content, and integrated dialogues with logical sequence into single sentences. This was done to ensure that the data used for testing is clean and meaningful, thus enhancing the accuracy and reliability of the test results.

Stage One involved providing the GenAI system with 13 behavior codes and their corresponding definitions, used to classify and categorize players' textual dialogue to identify their strategic behaviors. The main objective of this stage was to conduct an initial evaluation of the prompt by confirming its functionality and responsiveness. The focus is on ensuring the accuracy and consistency of the system's analysis to lay a solid foundation for subsequent optimization efforts.

Stage Two retained the coding definitions from the previous stage and further improved the prompts, focusing on enabling the GenAI system to more accurately assess dialogue behavior based on the context of player conversations with game scenarios. The goal was to enhance the coherence and relevance of the players' dialogue while striving to understand the background and intentions behind player conversations, thereby improving the system's analytical capabilities and responsiveness.

Stage Three integrated the optimization results from the previous two stages. Additionally, we introduced guidance on topics and national stances to enable the system to comprehensively analyze and understand players' behavioral intentions. The objective was to equip the system with the ability to recognize specific thematic events and respond to corresponding national stances, thereby enhancing the system's contextual understanding and analytical capabilities. Through this series of optimization measures, the system's performance continues to improve.

The goal of these tests was to enable the system to more accurately capture and interpret the patterns of players behaviors in the game, ensuring its effectiveness in dealing with diverse and complex dialogue scenarios (Figure 2). Ultimately, it aims to achieve a level of accuracy comparable to manual assessment, thereby enhancing its accuracy and reliability compared to manual evaluation.
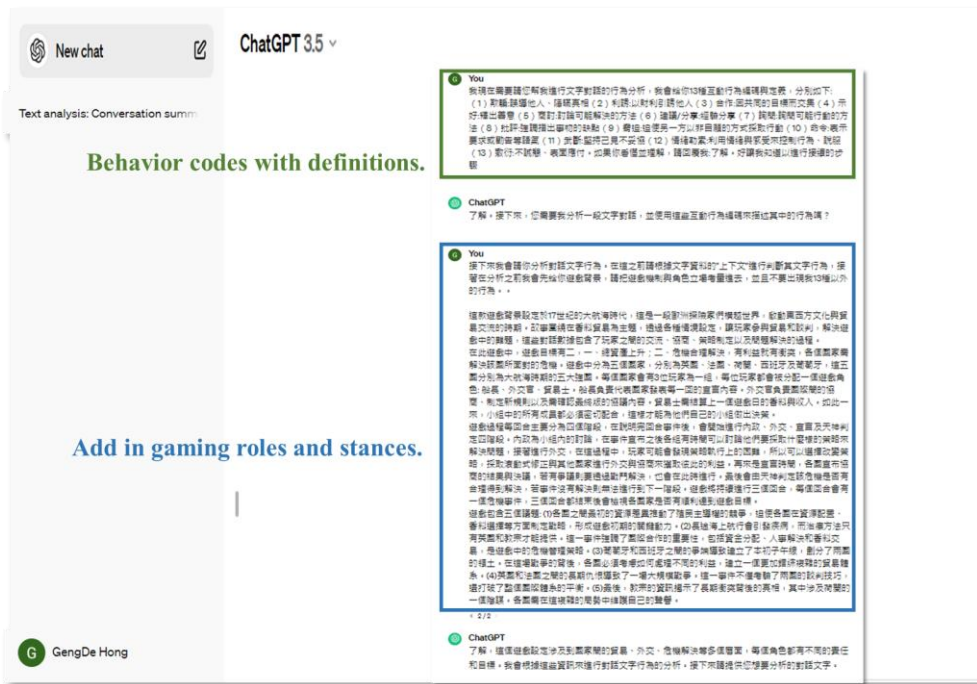
Figure 2: Integrated the optimization results

4   Results

The tests were presented alongside selected excerpts from the game to showcase evaluation comparing the classification results generated by the GenAI and their gaming strategic behaviors (Figure 3).
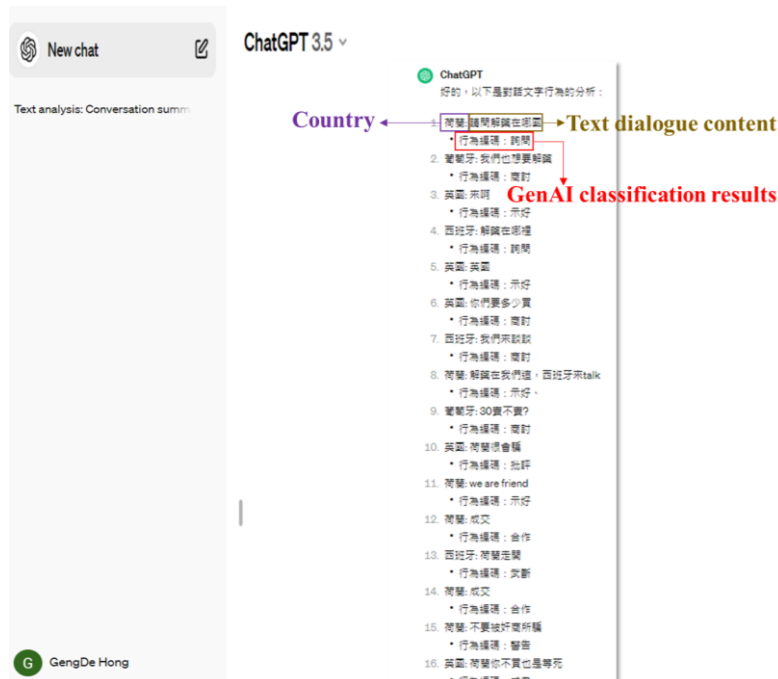

Figure 3: Classification results generated by the GenAI system

In this study, the level of performance in analyzing behavioral text through our automated analysis model was documented by comparing the results generated by ChatGPT with manually classified results (Figure 4). The test findings revealed accuracy rates of 47%, 55%, and 73% in the three tests respectively. These data reflect the improvement in model performance at different stages, particularly in the latter two tests where the accuracy rates notably increased. This indicates that the system's capability in conducting dialogue behavior analysis has been effectively enhanced with appropriate factors.
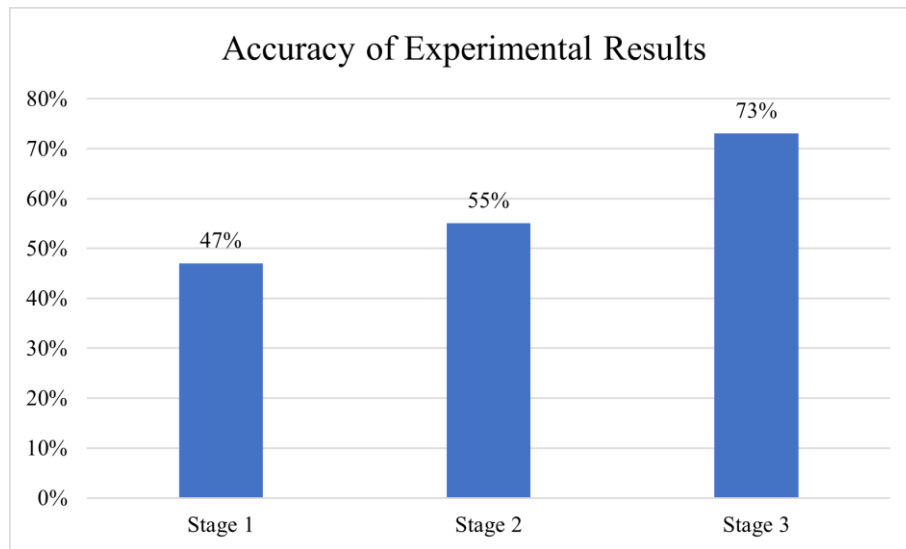

Figure 4: Accuracy of Test Results of the Three Stages

In the first stage, an accuracy rate of 47% was found. This relied solely on the 13 behavior codes for text classification. The system made judgments based exclusively on the literal meaning of the text to determine the behavior code. This single classification approach limited the understanding and interpretation of the dialogue content, resulting in poor performance. At this stage, researchers believed that the system had not yet fully considered the completeness of the dialogue, thus leading to lower accuracy in analyzing player dialogue behavior.

In the second stage, to address the issue identified in Stage One, prompts for contextual understanding of the dialogue was introduced. The accuracy rate was improved to 55%. Although there was an improvement in accuracy in this test, it was found that the system still struggled with interpreting the dialogue intentions. For example, the system might misclassify "deceptive dialogue" as "friendly behavior" or misclassify "friendly gestures" displayed by countries during negotiations as "discussion behavior". This occurred mainly due to the lack of understanding of the game background and relevant country information in issue-based games, leading to misinterpretation of dialogue content.

In the third stage, considerations for game issues and character perspectives to enhance the system's accuracy in interpreting dialogue content and intention. This optimization resulted in a significant improvement in accuracy, indicating a substantial enhancement in the system's ability to analyze dialogue content. Strategy games emphasize interactions and conflicts between different characters, each of whom has unique goals, values, and interests. Therefore, delving into analyzing the national positions and perspectives of each character in the dialogue was

necessary. For example, in trade negotiations, representatives of each country shall negotiate based on the interests of their own country and leverage their country's advantages to seek maximum benefits for individual nation as well as common welfare. In such dialogue scenarios, understanding the context of each country, and the perspectives of the roles is crucial to ensure the accuracy and comprehensiveness of dialogue behavior analysis. By incorporating these factors, our system is better able to understand the motivations and intentions behind dialogue behavior, leading to more precise and effective performance in dialogue behavior analysis. Therefore, integrating national backgrounds and character perspectives into the design considerations, especially in strategic games, is crucial for enhancing the applicability of GenAI systems in strategic gaming contexts.

In addition, researchers faced challenges in the classification results between manual and system categorization during these three tests. The manual classification process is prone to subjective influence, leading to potential differences in the classification results. In comparison, the system's judgment is based on pre-defined prompts for classification, making it relatively objective, and the results provided may be more accurate. Consequently, researchers made slight adjustments to the manual classification results to reconcile the differences with the system classification results, thereby maximizing consistency between the two. Such adjustments ensure consistency of results while effectively eliminating potential subjective biases in manual classification.

The test results of this study, through continuous optimization of the system design, especially the introduction of context and additional background information as well as character positions, have led to significant advancements in the analysis of player dialogue behavior by the GenAI system. These findings hold important reference value for future improvements and applications of GenAI systems, extending beyond educational games to other domains such as sentiment analysis.

5   Conclusion

The study reported here utilized GenAI with the ChatGPT system to establish an automated text analysis model for game behavior. Using ChatGPT to analyze textual dialogue content in topic-based games is a complex process that requires consideration of multiple factors, including system accuracy, efficiency, and comprehensive understanding of dialogue behavior.

Based on our research findings, some important implications and recommendations were concluded. When establishing an automatic text analysis model for game behavior in the context of strategic games, several key points need to be considered.

1. Identifying Dialogue Behaviors. It is essential to use behavior codes to identify and classify various dialogue behaviors, ensuring that the system covers various types of dialogue behaviors. This step is crucial as it lays down clear goals and directions for behavior analysis.
2. Context-Specific Prompts. Adopting context-specific prompts can enhance the accuracy of behavior analysis. These prompts provide clear and specific guidance, guiding the system to generate meaningful results. This approach considers both the textual content and its contextual relevance in the game, ensuring a comprehensive understanding of dialogue behaviors. This improves the accuracy and depth of the analysis results.
3. Scenario-based Backgrounds and Issue-based Conflicts Games. The system needs to

comprehend the conflicts and interests among different countries in the game. This includes providing relevant background information to better understand the relationships between countries and incorporating them into the analysis of dialogue behaviors.

Establishing an automatic text analysis model involves a systematic process, where these factors collectively contribute to the development of a robust model capable of accurately analyzing dialogue behavior within the gaming context. Therefore, the key to using the GenAI system for automatic text analysis of game behaviors lies in automating the encoding and classification of dialogue data. Utilizing the GenAI system significantly reduces the time cost of manual analysis, enhances the objectivity and efficiency of analysis, allowing researchers to process a large amount of dialogue data more quickly, thereby accelerating the understanding and exploration of game dialogue behaviors. Through this process, deeper insights into the patterns of player dialogue behaviors in the game was gained, further exploring the context and intentions behind the conversations. These achievements are significant for academic research, at the same time hold potential values for improving educational game design and teaching methods. The GenAI system helps researchers to better understand the language and behavioral patterns in group interactions in educational games, thereby enhancing the teaching effectiveness and learning experience of the games. This promotes the application of GenAI in the fields of gaming and semantic analysis, opening up new possibilities for improving future educational game design and teaching methods.

Acknowledgement

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