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Artificial Intelligence Method Applications on Developing Role-Playing Games

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Abstract. There are numerous inconveniences during the traditional developing stages of Role-Playing Games (RPGs), such as inflexible narrative designs and lack of immersive interactions. However, the great development of Artificial Intelligence (AI) methods like Natural Language Processing (NLP) and Machine Learning (ML), provides brand new solutions for tackling those issues happening in the RPG developing workflow. This article looks up surveys and research about connections between AI methods and RPGs of recent years, collects new approaches and summarizes them as implementations AI technologies have made in RPG scope so far. The overall contents contain three separate parts, including Procedural Content Generation (PCG), Dynamic Narrative, and Non-Player Character (NPC) interactions. Each of them is internally subdivided into different implementations depending on its usage scenarios, covering improvements in storytelling, resource management and judgement for game developers, and better immersion and gameplay optimization for players. This review shows broad prospects of how AI technology assists RPG developing with latest methodologies.

Keywords: Artificial Intelligence, Role-Playing Games, Procedural Content Generation, Dynamic Narrative

1. Introduction

RPGs, one of the main types of video games, are always defined by assuming a specific role and engaging in various interactions within a narrative framework, which have continuously attracted players with elaborate and immersive experiences. Over the years, RPGs have been subdivided into different genres, including Action RPGs (ARPGs) featuring real-time actions and Japanese RPGs (JRPGs) well-known for storytelling. However, with the evolution of the gaming industry, RPGs have increasingly imposed higher demands on narrative design and plot construction, placing considerable pressure on game developers.

In recent years, with the rapid advancement of technologies such as ML and NLP, AI has achieved noticeable improvement in PCG, unstructured language understanding and Human-Computer Interaction (HCI). And as the RPGs are narrative-focused games, highly pre-defined scripts, fixed character behaviors and limited interaction patterns have gradually become prominent bottlenecks in traditional developing process. In the current situation, the breakthroughs of AI in these workflow processes provides new directions for optimizing in-game interaction designs and

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diversifying narrative expressions in RPGs and greatly expands the application scope of AI in the game industry.

With the support of AI technologies, the workflow of RPGs has achieved further improvements and advancements in various aspects. From the perspective of storytelling, Procedural Content Generation via Machine Learning (PCGML) uses ML models to train on existing RPG contents and generate new contents, such as game maps and interactive fiction stories, creating branching options [1]. Large Language Models (LLMs) can also generate cohesive, meaningful in-game stories and deriving diverse narrative variations, which facilitates the creation of game scripts [2]. To design better game flow management, Soares de Lima et al. proposed a method using genetic algorithms and automated planning to programmatically generate game tasks, creating a coherent and natural game experience [3]. Together with analyzing behavioral patterns, skill levels and gameplay preferences of players, Agent-Based Procedural Level Generation (PLG) can dynamically adjust game difficulty to optimize the overall player experience [4]. For developers, Deep Learning (DL) can automatically identify and classify NPC behavioral patterns, helping the developers in differentiating between intended and possibly abnormal behaviors [5]. As a result, AI demonstrates great potential for further growth in the RPG sector.

The aim of this paper is to summarize the current progress of AI applications in RPGs, and the remainder of the review is organized as follows. First, it explores the implementation of AI within crucial aspects of RPG development. Then, it discusses the existing obstacles and developmental possibilities of AI in the RPG domain. Finally, it concludes the overall integration status and puts forward prospects for future development.

2. The implementation of AI in RPG development

Research by Dennis and Matt pointed out that in RPGs players act as a fancy role under the framework of games and become liminal between virtuality and reality when immersing in interactions [6], which is corresponding to PCG, dynamic narration and NPC interaction where current AI technologies aim to develop RPGs. As mentioned above, the implementation will be stated in the three subjects separately.

2.1. Procedural content generation

2.1.1. General content generation

To generate more general game content efficiently, Yu et al., targeting at drawbacks of traditional VR/AR content generations, proposed an adaptive algorithm called AI-PCG. This algorithm framework contains three modules, including AI controller, PCG modules and integration layer, with three contributing algorithms of Adaptive Spatial Partitioning (ASP), Multi-Modal GAN and RL for real-time generation, coherent content and difficulty adjustment separately. The experiment examines the algorithms under the scenarios of terrain, urban, dungeon etc. on different VR/AR platforms. The result shows that content generation is sped up by 2.6 times with outstanding performance compared to traditional methods, and player experience determined by content presence and user immersion reaches hand-crafted methods, proving the feasibility of this research to generate large-scale interactive content efficiently [7].

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2.1.2. Level generation

Specific to level generation, Nam and Ikeda proposed using RL methods to diversify level generation compared with traditional methods that produce simple levels in low efficiency and great need of sufficient data. At first the research points out main sections of RPG battles and standards of desired levels, and a simplified platform is created to provide an appropriate environment. Four stages are defined for building Markov Decision Process (MDP), and two RL methods, Deep Q-Network (DQN) and Deep Deterministic Policy Gradient (DDPG), are introduced to generate RPG levels under random initial stage and stochastic noise policy and evaluated with a target of 30% winning rate. The result shows that DDPG with a 0.85 average rank has a better performance than DQN with 0.78, successfully obtained various RPG levels [8].

2.1.3. Numerical design judgement

RPG numerical designs can also be helped with PCG techniques. A recent study by Jolanta investigated using DL for ordinal techniques to estimate new enemies and their affections to existing levels to improve efficiency, taking a Tabletop RPG (TTRPG) called Pathfinder 2e as the example. The study models several key attributes of monsters as features and uses ordinal regression to predict the monster ratings. A dedicated dataset of 2,637 monster entries with 32 features is built to support the estimation, with time-based splits to ensure generalization. Several traditional regression models with rounding strategies and ordinal models are evaluated in this study, and the results prove that tree-based models have the best performances and great efficiency at evaluating monster levels, decreasing development cycles and speeding up numerical designs [9].

2.2. Dynamic narrative

2.2.1. Immersive narrative

For single-player RPGs, LLMs assist players as Game Master AI (GM AI). In the research by Jørgensen et al. a ChatRPG system is developed to extend LLMs to support interactive narratives and provide adaptive, coherent and immersive game experience. It is designed in two phases, single LLM managing narrative generation and game status simultaneously for v1 phase, and two LLM agents with respective tasks for v2 phase. In v2 phase, the Narrator agent serves as the storyteller, responsible for engaging narratives; while the Archivist agent stores the game memory and ensures narrative coherence. The two agents are under the ReAct framework for reasoning and decision-making by Thought-Action-Observation trajectory to generate complex responses. The final user experience analysis of 12 TRPG gamers shows that ChatRPG v2 does better at providing thematic and vibey content, demonstrating more realisms for players [10].

2.2.2. Consistent narrative

The research of Steph et al. aiming turn-based RPG introduces Procedural Artificial Narrative using Generative AI (PANGeA) approach to keep narrative consistency while remaining dynamic based on LLM. This approach uses prompt schemas of commands, rules, contexts and examples in initialization and gameplay. After initialization the memory system based on Atkinson-Shiffrin model stores metadata for various LLM memories. Then the validation system generates constraints according to the prompt and judges the input text. If the text does not break any rules the system response directly, otherwise the self-reflection chained prompt technique is expanded to correct the

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text to prevent from exceeding the scope. In this research the game Dark Shadow is tested, and under the new system Llama-3(8B) and GPT-4 show remarkable improvement in accuracy and consistency [11].

2.3. NPC interaction

2.3.1. Contextual dialog

To make NPC contextual dialogs more adaptive and creative, a research themed open world RPG by Mika and Khalid proposes an adaptive framework from Computational Creativity (CC) to diversify NPC dialogs. The whole experiment is based on Fallout 4. First the game data is captured through a Papyrus script and is sent to a generative Python script to generate dialogs. Then the game dialogs from Fandom Wiki are fetched and filtered for further adaptations. To achieve sentence changes, a trained Neural Machine Translation (NMT) model with Bidirectional Recurrent Neural Network (BRNN) based encoder is used to analyze syntax and output 5 paraphrases for every sentence. Then the outputs are related semantically to current game context through a pretrained FastText model. Lastly the outputs are ranked and selected by a 3-gram language model trained on KenLM. Evaluated by BLEU, PINC and human judges, the result is considered to have different forms while sharing similar meanings, showing good performance in dynamic dialog adjustments of NPCs [12].

2.3.2. Cognitive thinking

LLMs are also applied in NPCs to make them more realistic. Du et al. proposed a framework called HER to simulate the thinking of roles from a cognitive level. HER introduces Dual-layer Thinking, splitting LLM role-play tasks into system thinking and role thinking. According to this, HER dataset is constructed through three stages of reversed thinking and context augmentation. With a trained GenRM as the reward model and human preferences as signals, Qwen3-32B is trained under the cold start of Supervised Fine-Tuning (SFT) and RL optimization. Through the evaluation from benchmark scores from CoSER Test and Minimax Role-Play, HER models reach a 30.26% and 14.97% improvement respectively, which shows HER gives a potential method to make models think like their roles [13].

2.3.3. Attack behavior

Targeting attack behaviors, in the field of RPGs on social networking platforms, Francisco and Eduard proposed a study employing Multi-Agent Reinforcement Learning (MARL) to enhance NPC interactive intelligence. This method replaces heuristics and finite state machine behaviors with autonomous interactive learning patterns. In this study three MARL algorithms, including DQN, PPO and QMIX, are evaluated under approaches of centralized, decentralized and Centralized Training with Decentralized Execution (CTDE), and are used to simulate individual and collaborative behaviors. Considering variations of strategies in cases, Francisco and Eduard split combat learning into two models, an active attack model with situation evaluation and a defensive model for responses to opponents. After training in 1v1, 4v4 and 7v7 fights, the MARL-powered NPCs dynamically adapt to environmental state and player strategies, demonstrating superior combat performances. Through Likert surveys it is confirmed that NPCs show realistic, challenging and non-repetitive behaviors, deepening immersion and enhancing quality of RPG interaction [14].

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3. Discussion

3.1. Limitations and challenges

Although AI is widely used to assist the development of RPGs, there are still several problems that deserve notice.

3.1.1. Limited games

For most current studies, it is common to take one specific game as the experimental subject to prove the feasibility of the research. On the one hand, for game developers, such scenarios under limited games are hard to extend to other cases because most solutions are highly restricted on the targeted game instead of based on a general workflow, leaving unknown threats for extending to actual game development process. For example, an agent-based level generation method is applied to Angry Birds PLG [4], but since it is heavily relied on the data structure of Angry Birds it still needs to be verified for other games. On the other hand, however, it is also not practical for researchers to examine all games with their proposals and risk leading to higher and possibly unnecessary costs. Such situation worths a two-sided balance between investigation and practical application.

3.1.2. Low reliability

There are several factors leading to low reliability in AI generation process. Firstly, not all AI models are evaluated with sufficient measures [5], restrained the research into a small range of special circumstances, not credible enough to prove a fully extensive scene. Secondly, most AI procedural methods for game levels prefer to generate solvable levels rather than strictly ensure the playability of generated levels [1], still relying on manual corrections. Thirdly, some AI models rely on limited baselines and external models, which may not cover all aspects of role-play estimation and additionally bring extra cost [15]. Then, the brainstorming capabilities for interactive narratives of most LLM-powered tools have possibilities to exhibit occasional hallucinations and generate problematic and erroneous plots, breaking the consistency of the original game [10]. Lastly, some research models are proposed theoretically instead of deploying to actual game development process, still in need of further examining [15].

3.1.3. Ethically ambiguous content

The generation of AI models can be good or bad, but the ethics behind generative content should always be considered. According to Dennis and Matt, individuals addicting to their roles may risk losing cognition between their person and persona [6], which could be an ethical concern. In addition, generating systems based on biased underlying LLMs may not be able to fully evaluate the outputs and cannot recognize potential hazardous contents and prevent them from the actual games [11]. Moreover, in multiplayer RPGs, AI models give players the chance to prompt and risk being manipulated by intentional misleading, causing possible cheating behavior and breaking rules and immersive RPG experience. With legality considered, copyright problems of AI generated content and unclear sources of training data can also be considered as a noticeable issue.

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3.2. Prospects

Although latest AI techniques have demonstrated significant improvement for RPG development workflow, there are still some future works that need to be worked on for handling current obstacles, preventing probable risks and further testing.

To ensure better data credibility and approach universality, a standardized system to comprehensively demonstrate metrics of influential factors based on research environment should be built to better estimate the result, and sufficient user samples and evaluations of players in different levels should also be considered. Works on extended verification to games belonging to the same genre are needed for methods already proved feasible on a specific game, and investigation and exploration to other types of RPGs is worth experimenting in the future as well.

Moreover, there may possibly be other new angles with other AI techniques applied. Transformer featuring cross-modal and flexible demand-based resource generation, and diffusion models highlighting accurate and controllable content generation can be extremely helpful for PCG workflow optimization; Multi-Model (MM) and Text-to-Speech (TTS), Speech-to-Text (STT) can increase immersion via adding more interactive mode to NPCs and contextual dialogs; appropriate constraints and introducing Mixture of Experts (MoE) architecture can also help with reasoning and adjustment of the quality and diversity in storytelling.

And of course, during further research and studies, AI utilization should be restricted under a comprehensive review mechanism to filter unsafe contents and prevent cheating from probable player behaviors.

4. Conclusion

In this review, the writer focuses on the latest approaches of AI on RPG workflow through three main perspectives in the order of PCG, dynamic narrative and NPC interactions. Firstly, to improve the quality and efficiency of generating general resources and levels and help with judging monster levels, several solutions of AI-PCG, DDPG and DL are listed out. Secondly, for the demand of immersion and consistency, a ChatRPG system and a PANGeA approach, all based on LLMs, are demonstrated to promise realisms and raise the accuracy of game narratives separately. Finally, cases of Neural Network, LLMs and RL are also shown to tackle the drawbacks with the conversation, thinking and attacking of NPCs. Providing multiple research projects, this article shows great potential of AI applications in refining the RPG workflow.

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