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Adventure Quest: A Dynamic Interactive Game Using Factor Graphs for Decision-Making

Abstract

This report presents **Adventure Quest**, a dynamic, interactive game that integrates factor graphs for real-time decision-making within a narrative structure. Players embark on an adventure where each decision influences the storyline's direction and outcome. By employing factor graphs, this game enables diverse paths and outcomes, making each player's experience unique and engaging.

Introduction

Adventure Quest is a decision-based game where players make choices that impact the narrative. Traditional games use static decision trees, which often lead to predetermined outcomes. In contrast, this game leverages **factor graphs** in a Markov Network, providing an adaptable framework that shapes the storyline based on player choices. This innovative approach to decision-making makes the gameplay more realistic and engaging, offering an Immersive experience that adapts dynamically to player actions.

Methodology

The decision-making process in **Adventure Quest** relies on **Markov Networks** and **factor graphs** to model the player's progression. Key components of this methodology include:

1. **Markov Network**: A Markov Network represents relationships between decisions. Each decision is represented as a node, with edges connecting sequential or interdependent decisions.
2. **Factor Graphs**: Factor graphs are utilized to represent probabilities of outcomes at each decision point. For instance, nodes such as "start," "meet NPC," and "fight enemy" each have assigned success probabilities.
3. **Probabilistic Sampling**: Using discrete factors, each decision node is associated with a probability

distribution that determines the likelihood of success or failure in advancing the storyline. This randomness allows unique paths for each play-through.

4. **Narrative Flow** : As players advance, they encounter various scenarios (e.g., meeting NPCs, fighting enemies, searching for treasure) that affect the overall game narrative.

Code Overview

The primary game flow is as follows:

- **Initialization**: The Markov Network and factor graphs are initialized, representing the sequence of decisions and their probabilities.
- **Storyline Creation**: Nodes for each decision (e.g., "start," "meet NPC") are created, with factors defining the probability of success or failure.
- **Decision Sampling**: The sample decision function samples each decision node's outcomes, determining if the player succeeds or fails in a given scenario.

Features

The **Adventure Quest** game includes the following features:

1. **Dynamic Decision-Making**: Each player decision influences the narrative path, creating a unique experience.
2. **Probabilistic Outcomes**: Factor graphs introduce variability, leading to different story outcomes even with similar choices.
3. **Interactive Choices**: Players choose responses to NPCs and decide on actions, impacting the storyline and potential success.
4. **Randomized Scenarios**: The game's random outcomes ensure that each play through feels fresh, making replay-ability a key feature.
5. **Engaging Storyline**: The narrative includes encounters with NPCs, battles, and a treasure hunt, providing an engaging player journey.

Tools Used

The game was developed using the following libraries and frameworks:

- **Python**: The programming language used to implement the game logic and Markov Network.
- **Numpy**: For generating random outcomes in decision sampling, facilitating probabilistic modelling.
- **pgmpy**: A library for probabilistic graphical models in Python, used here to model the Markov Network and factor graphs.

Summary

Adventure Quest is an interactive adventure game that integrates factor graphs to create a dynamic and immersive experience. By utilizing probabilistic decision-making, the game allows for varied narrative paths, ensuring that each player's journey is unique. Through its adaptive structure, **Adventure Quest** demonstrates the potential of factor graphs in creating engaging, personalized gaming experiences. This report provides insights into the game's methodology, features, and technical design, illustrating how probabilistic modelling can enhance gameplay in narrative-driven games.