Hex Game

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Abstract—This paper presents the development and evaluation of agents for playing the Hex board game. In a first step, two heuristic, rule-based agents were crafted to provide strong, interpretable baselines; these agents rely on explicit patternmatching for tactics such as bridging, blocking, and chain extension. They then served as opponents during reinforcement learning experiments. The main objective was to train a Proximal Policy Optimization (PPO) agent that outperforms these rulebased baselines and field our best agent in a class-wide 7x7 Hex board game competition against agents from other teams. While the PPO agent successfully learned to beat random and our rule-based opponents, mastering complex strategies and adapting to stronger opponents remained a challenge: it struggled with defensive awareness as the RL agent sees offence and defence through the same reward lens and thus finds it difficult to decide when to sacrifice progress for an urgent block. Additionally, the RL agent lacked multi-turn strategic planning, often reacting only to the current board state without maintaining continuity in its intended strategies across multiple moves. This work lays the foundation for future improvements through hybrid learning approaches and enhanced evaluation pipelines. The project also included the integration of an interactive visualization framework supporting multiple play modes (human vs. machine, machine vs. machine).

Index Terms-rule-based, ppo, reinforcement learning

I. INTRODUCTION

Hex is a deterministic, turn-based connection game with a rich space of possible states, making it a compelling environment for reinforcement learning (RL). Our project aimed to explore two approaches to building agents for Hex:

- Rule-based agents inspired by human reasoning and heuristics.
- A learning-based PPO agent trained using self-play and various opponent configurations.

This two-fold approach allowed for both interpretable baselines and adaptive learning, which we evaluated in different scenarios.

II. GAME ENGINE AND VISUALISATION

The project included a custom hexPosition class handling the game rules, win conditions, and board representation. A modular visualization framework allowed humans to play against agents, observe matches between agents, and export videos for evaluation. It supported modes like:

• Human vs. Rule-Based Agent

Identify applicable funding agency here. If none, delete this.

- PPO Agent vs. Rule-Based Agent
- PPO Agent vs. Random/Scripted/Past Agents

The GUI was helpful for debugging agent behavior and qualitatively assessing learned strategies.

TODO(insert graphics)

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Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections III-A–III-E below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads— LATEX will do that for you.

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

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- The word "data" is plural, not singular.
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- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited,

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- A graph within a graph is an "inset", not an "insert". The
 word alternatively is preferred to the word "alternately"
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An excellent style manual for science writers is [7].

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TABLE I
TABLE TYPE STYLES

Table	Table Column Head		
Head	Table column subhead	Subhead	Subhead
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^aSample of a Table footnote.

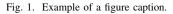


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ACKNOWLEDGMENT

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REFERENCES

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