Abstract

This study presents two distinct research projects: the development of an AlphaZero-based Heian Shogi AI system and the optimization of a resignation mechanism in Shogi AI.

The first project focuses on reconstructing and analyzing Heian Shogi, an early form of Shogi, using reinforcement learning through self-play. Unlike modern Shogi, Heian Shogi features different board sizes, unique piece types, and alternative movement rules, making it an intriguing subject for AI-based historical game studies. To model strategic decision-making in this variant, the Heian Shogi AI employs deep residual networks and Monte Carlo Tree Search (MCTS), allowing it to learn optimal strategies from self-play without human game data. The effectiveness of this AI is evaluated using key performance metrics, including game length, branching factor, and strategic depth, contributing to a deeper understanding of how historical game mechanics influenced strategic evolution.

The second project investigates the integration of an optimized resignation mechanism into modern Shogi AI. Existing Shogi AI systems often struggle to determine appropriate resignation points, either resigning prematurely or prolonging lost positions. This study proposes a resignation threshold based on the maximum advantageous score achieved by the losing side, ensuring that AI resigns at a moment that aligns with strategic decision-making principles. The evaluation framework leverages the Suisho5-YaneuraOu engine and Game Refinement (GR) theory to analyze key factors such as game length, acceleration of uncertainty resolution, and strategic balance. Experimental results demonstrate that higher-skill AI players with the resignation mechanism exhibit more efficient decision-making, reducing unnecessary game prolongation while maintaining competitive depth.

Through rigorous experimentation and analysis, this research contributes to AI development in strategic board games from both historical and modern perspectives. The Heian Shogi AI project enhances our understanding of ancient game strategies, while the resignation mechanism project improves AI decision-making in competitive play. Future research will explore the generalizability of these findings across other board games, further advancing AI applications in game theory, historical simulation, and strategic decision-making.

Keyword: Shogi AI ; Resignation Mechanism; Human and AI Resignation Behaviors; Game Refinement Theory; Machine Learning