Thesis Project Portfolio

Applying AI Algorithms to Physical Games: Proposing an Autonomous AI Robotic Foosball Player

(Technical Report)

The Human and Nonhuman World of Chess

(STS Research Paper)

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Contents of Portfolio

Executive Summary

Humans have the natural tendency to try to be the best, whether it be in school, work, sports, or board games. With the rise of artificial intelligence (AI), humans naturally felt the desire to apply these new AI algorithms to board games such as chess, poker, and Go to achieve the highest quality of play possible. These algorithms have not only satiated our intellectual curiosity about the most optimal ways to play these games, they have also allowed humans to improve their play through analysis using these algorithms. My technical project is an attempt to combine such algorithms with robotics to develop an AI-powered robotic foosball player that can surpass humans in ability. My STS research project focuses on the impact of such algorithms on the chess community, both positive and negative, and analyzes how to diminish the negative effects as much as possible.

Although AI has been used to achieve superhuman performance in games such as chess, poker, go, and StarCraft, these programs lack a physical component which prevents these algorithms from being able to play physical games, such as foosball, ping pong, or pool. For my technical project, A colleague and I have successfully designed an autonomous foosball playing robot. It consisted of several components. A camera mounted above the table captured images of the table, which was fed into a computer vision algorithm to continuously detect the location of the ball. Using the current and past coordinates of the ball, the ball's trajectory was calculated, taking into account bouncing off of walls. Finally, these calculations were used to determine how the robotics controlling the levers should position the players and the timing of their kicks. After completion, the robot was able to defeat novice human players. However, it could be improved with recently developed technologies like YOLO object detection and self-play reinforcement learning. These would allow the system to defeat more skilled human players and achieve superhuman level.

My STS research project analyzes the impact of AI on chess. AI has long surpassed humans in ability, which has brought complicated implications on how humans play chess. For example, humans can use these algorithms to analyze their games and accelerate their improvement. However, these algorithms often conflict with “human elements” of chess of creativity, individuality, uniqueness, and enjoyment because they only prioritize playing perfect moves. At the top level of chess, superhuman AI can be used for extensive preparation, which involves memorizing moves for commonly occurring positions. Based on my research, top chess professionals virtually unanimously agree that they have resulted in less creative and exciting games. Grandmaster Magnus Carlsen and other chess professionals have proposed many promising changes to the way top level chess should be played in order to maintain the aforementioned “human elements” while coexisting with superhuman AI. These involve shorter time controls for normal chess games and introducing variants such as Chess960 and no-castling chess so that the role of AI is diminished, the intuition and skill of the chess player can shine through, and games can be more dynamic and exciting.

Overall, I am pleased with the results of both my technical and STS research projects. The technical project was complete and could defeat novice players in foosball matches. However, it could have been further improved using more sophisticated algorithms. The goal of future work should be to replicate the strength of AI in games such as chess and Go and be able to defeat professional level players. The STS research project identifies several issues that the introduction of superhuman AI has brought about the chess community, and is thoroughly corroborated by chess professionals, who dedicate the most time and energy to chess and are most knowledgeable about the subject. The research culminates in specific proposals that are believed by top chess professionals to diminish the impact of superhuman AI on chess. Future

research could analyze the views of non-professional players, such as amateurs, or players of other games impacted by superhuman AI such as poker and Go.