上海科技大学
ShanghaiTech University

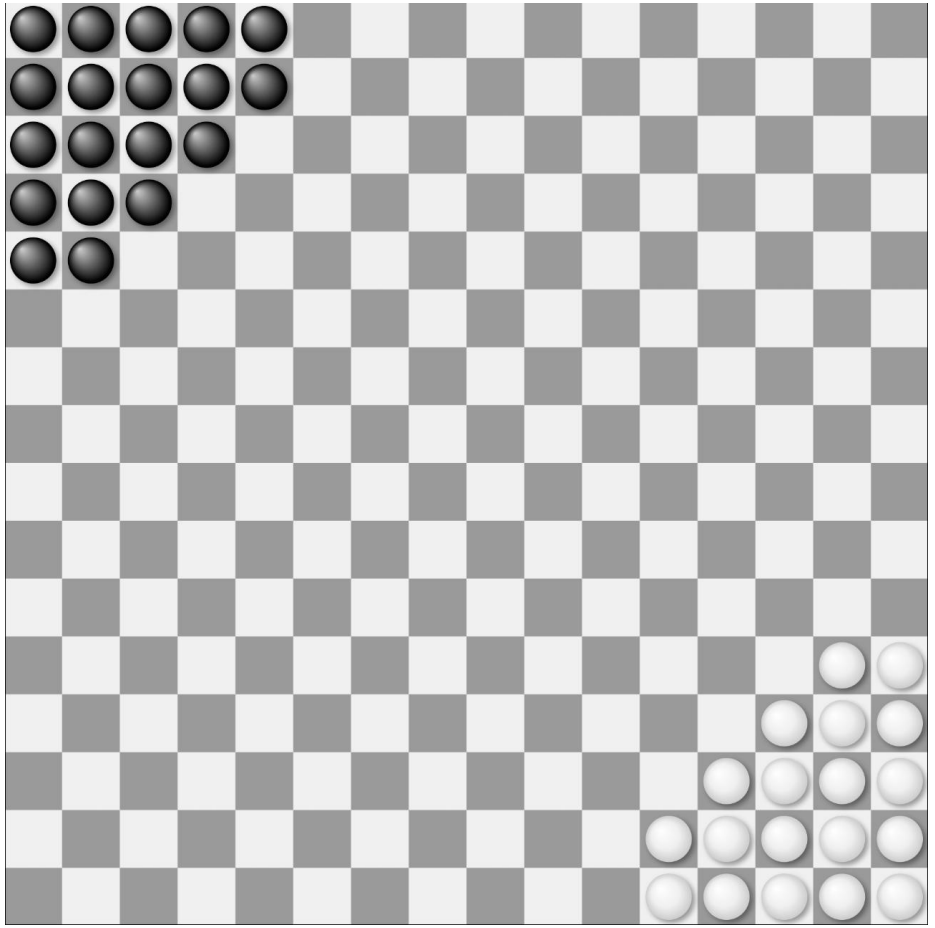
Halma

Proposal for CS181 project

Team: 熊章智 杨天倪 冯令康

立志成才报国裕民

Introduction to Halma



Halma(正方跳棋) is a strategy board game invented in 1883 or 1884 by George Howard Monks, an American thoracic surgeon at Harvard Medical School.

The gameboard is checkered and divided into 16×16 squares. Pieces may be small checkers or counters, or wooden or plastic cones or men resembling small chess pawns.

Piece colors are typically black and white for two-player games, and various colors or other distinction in games for four players.

Source: https://en.wikipedia.org/wiki/Halma

Rule of Halma

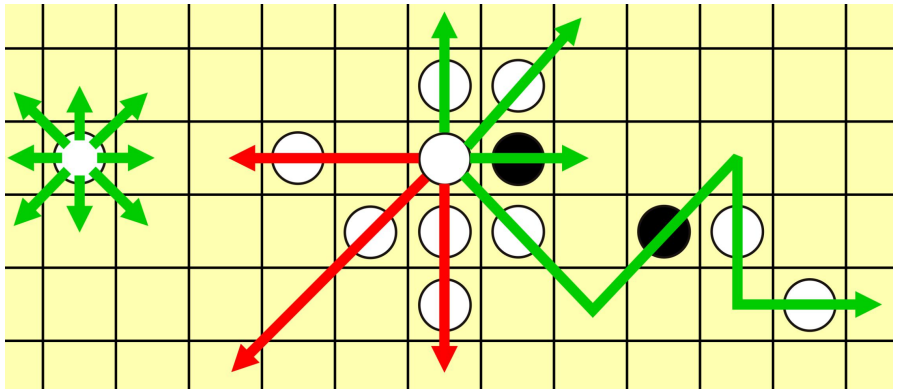


Image Source:
https://en.wikipedia.org/wiki/Halma#/media/File:Halma_game_2.svg

Similar to Chinese checkers(中国跳棋).

The board size can be 8*8, 10*10, or 16*16.

The goal is to move all your pawns to the diagonal corner.

Movement Rule:

Single-step move:

A pawn can move one space to an adjacent square (horizontally, vertically, or diagonally).

Sequential jumps:

If a pawn has an adjacent pawn (ally or enemy) and an empty space directly beyond it in the same line, it can jump over the pawn to land in the empty space.

Multiple jumps can be chained in a single turn (no limit on jumps per turn).

Problem Formulation

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Basic Settings:

8*8 grids, 20 pawns (10 per side)

Goal for one player:

Move all your pawns to the diagonal corner regions.

Problem:

Design an agent with win rate as high as possible!

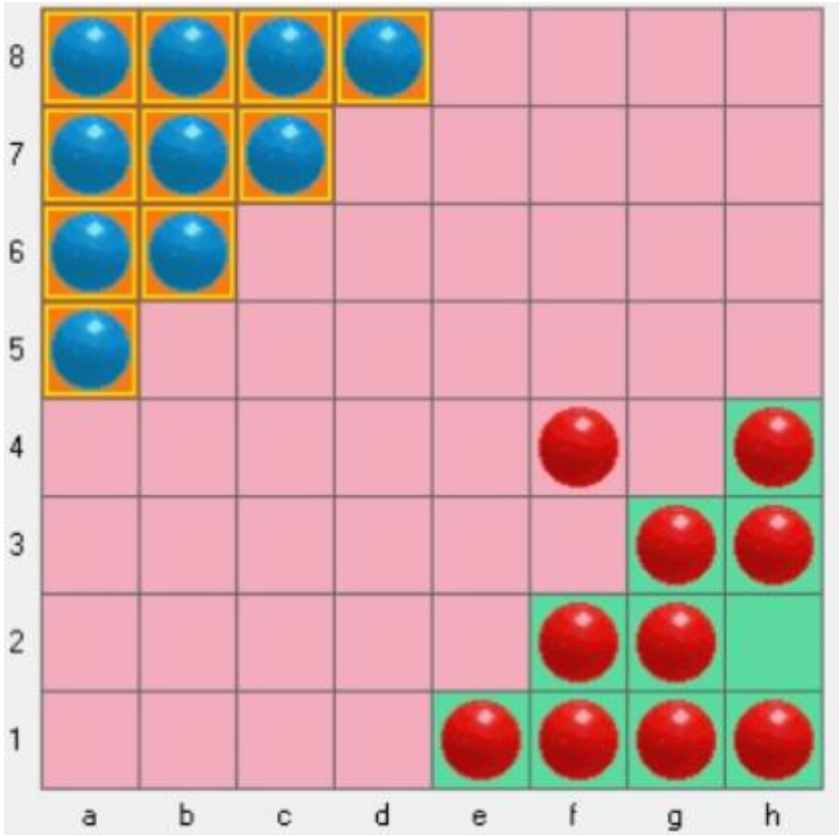


Image Source:
https://hwiegman.home.xs4all.nl/hhalma.html

Solution: Implement Agents

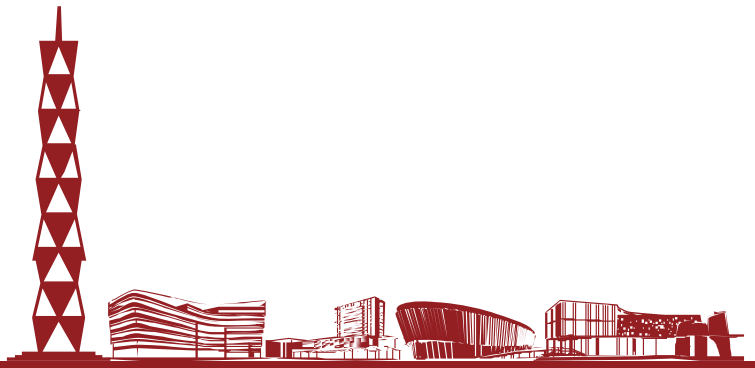
- Search (DFS, BFS, Greedy, Heuristics, etc.)
- Adversarial Search (Minimax, α-β pruning, MCTS)
- Reinforcement Learning (Q-learning)

Related Work

Though being a niche game, there are still a few works & repo from others on this.

- Basic game implementation
- Game GUI
- Almost all agents deployed are simply (vanilla) minimax

Very few agents design outside of minimax!



Novelty

Here are some probable novel technical contribution we propose:

- More agents available
- More game settings available and further discussion on the impact of changes in game settings
- Innovation on game rules (e.g. jump in a row can earn more points and victory is worth large number of points, we can even set total step limitation and the player with higher score wins, etc.), and discussion on the potential policy change due to the game rules innovation
- Neural network approach for approximate Q-learning

Comparative experiments

- Horizontally:

Under one rule or game setting, two different or identical agents can fight against each other and we can collect the win rate.

- Vertically:

Under different rules or game settings, for the same agent, are there any notable changes in policy?

Or any interesting phenomena?

Also, we may compete with other researchers' agents on halma (if exists).

Expected Outcome & Contribution

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- The performance of different agents are waited to tested and validated.
- Our expected contribution is to implement as many agents we learned in CS181 as possible, and further implement our probable novel technical points.


Thank you!