



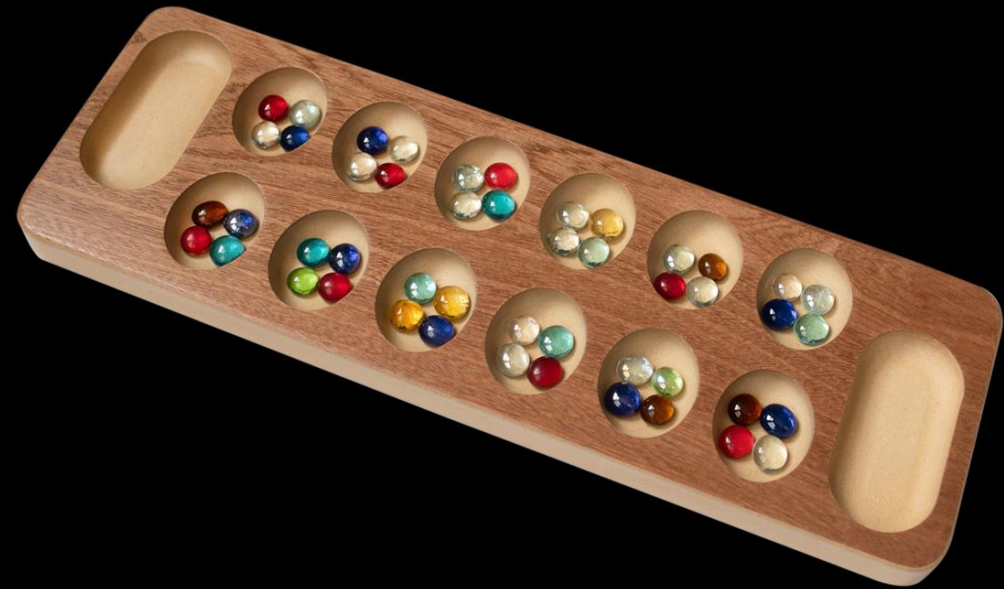
MANCALA PLAYING MACHINES

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THE GAME OF MANCALA

- Mancala is a very old game- originating in East Africa around 700 CE
- Played with 2 players
- Object of the game is to get the most stones into one's mancala- the long spaces at each end of the board
- Many variations- variation used in this project is called Continuous or Multi-Lap play with cross-capture
 - Significant first player advantage



THIS PROJECT

- Built Mancala playing infrastructure
- Built interface for human-machine play
- Built 4 machines:
 - Random player
 - Move Again Heuristic Player
 - Maximum Score Player
 - Minimax Player

HB	B6	B5	B4	B3	B2	B1	
	4	4	4	4	4	4	
0							
							0
	4	4	4	4	4	4	
	A1	A2	A3	A4	A5	A6	HA

HB	B6	B5	B4	B3	B2	B1	
	0	13	2	3	2	1	
13							
	1	1	0	0	0	3	9
	A1	A2	A3	A4	A5	A6	HA

Machine player's turn!

Minimax Player's selected move: (B2 B6 B3 B5 B2 B4 B6 B1 B6 B4)

Next move: B2

HUMAN VS MACHINE PLAYER- OBSERVATIONS

- Random player extremely easy for human player to beat
- Move Again Heuristic and Max Score Heuristic players more difficult but doable for someone with knowledge of game
- Minimax player extremely difficult to beat- requires significant knowledge of opening moves
 - Games against minimax player often decided in first or second turns

HB	B6	B5	B4	B3	B2	B1	
	1	1	0	0	1	0	
19							
							26
	0	0	0	0	0	0	
	A1	A2	A3	A4	A5	A6	HA

Final Score:
 Human Player: 26
 Machine Player: 22
 Human Player wins!

HB	B6	B5	B4	B3	B2	B1	
	1	1	1	0	0	0	
30							
							15
	0	0	0	0	0	0	
	A1	A2	A3	A4	A5	A6	HA

Last stone placed in player's mancala
 Final Score:
 Human Player: 15
 Machine Player: 33
 Machine Player wins!

MACHINE VS MACHINE-RESULTS

Player 1 Horizontal, Player 2 Vertical	Random Player	Move Again Heuristic	Max Score Heuristic	Minimax
Random Player	Player 1 wins: 49 Player 2 wins: 40 Ties: 11	Player 1 wins: 96 Player 2 wins: 2 Ties: 2	Player 1 wins: 85 Player 2 wins: 11 Ties: 4	Player 1 wins: 100 Player 2 wins: 0 Ties: 0
Move Again Heuristic	Player 1 wins: 17 Player 2 wins: 79 Ties: 4	Player 1 wins: 82 Player 2 wins: 12 Ties: 6	Player 1 wins: 28 Player 2 wins: 69 Ties: 3	Player 1 wins: 100 Player 2 wins: 0 Ties: 0
Max Score Heuristic	Player 1 wins: 19 Player 2 wins: 76 Ties: 5	Player 1 wins: 86 Player 2 wins: 11 Ties: 3	Player 1 wins: 82 Player 2 wins: 12 Ties: 6	Player 1 wins: 100 Player 2 wins: 0 Ties: 0
Minimax	Player 1 wins: 1 Player 2 wins: 97 Ties: 2	Player 1 wins: 48 Player 2 wins: 46 Ties: 6	Player 1 wins: 1 Player 2 wins: 98 Ties: 1	Player 1 wins: 100 Player 2 wins: 0 Ties: 0



REFLECTIONS

- Project goals accomplished
- Minimax more difficult than originally anticipated
- Potential future work:
 - Additional heuristic- longest move
 - Other variants of mancala
 - Additional testing data- number of moves, comparing final scores
 - Modify human-machine interface so human player isn't always first

THANK YOU!

Sources:

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