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AI Project Report

All programs were written and tested in Python (version 3.9.7)

Outputs:

(*All commands are of the format : python {program_name} {input_file} {output_file} {max_depth}*)

- MiniMax Opening:
    - ***Test 1: python MiniMaxOpening.py board1.txt board2.txt 1***
        - Input Board = WxxxxxxxxxBxxxxBxxxxxx
        - Output Board Position: WWxxxxxxxxBxxxxBxxxxxx
        - Positions evaluated by static estimation: 19.
        - MINIMAX estimate: 0
    - ***Test 2: python MiniMaxOpening.py board1.txt board2.txt 2***
        - Input Board = WxxxxxxxxxBxxxxBxxxxxx
        - Board Position: WxxxxxxWxxBxxxxBxxxxxx
        - Positions evaluated by static estimation: 360.
        - MINIMAX estimate: -1
    - ***Test 3 (Community Sourced): python MiniMaxOpening.py board1.txt board2.txt 2***
        - Input Board = WWxxxxxWWWWBBBBxxBWBxB
        - Board Position: WWWxxxxWWWWxBBBxxBWBxB
        - Positions evaluated by static estimation: 444.
        - MINIMAX estimate: 0
- MiniMax Game:
    - ***Test 1: python MiniMaxGame.py board3.txt board4.txt 2***
        - Input Board = WWxxxxBWWWWBBBBWxxxxxx
        - Board Position: WWxxxxBWxWWBBBBWWxxxxx
        - Positions evaluated by static estimation: 52.
        - MINIMAX estimate: 1991
    - ***Test 2: python MiniMaxGame.py board3.txt board4.txt 2***
        - Input Board = BWxxxxBWWWWBBBBWxxWxxx
        - Board Position: BWxWxxBWxWWBBBBWxxWxxx
        - Positions evaluated by static estimation: 54.
        - MINIMAX estimate: 990
- MiniMax Opening (Black):
    - ***Test 1: python MiniMaxOpeningBlack.py board1.txt board2.txt 1***
        - Input Board = WxxxxxxxxxBxxxxBxxxxxx
        - Board Position: xxxxxxxBxxBxxxxBxxxxxx
        - Positions evaluated by static estimation: 19.

        - MINIMAX estimate: 3
        - *As noticed in this test, Black forms a mill and removes a White piece*
    - ***Test 2: python MiniMaxOpeningBlack.py board1.txt board2.txt 2***
        - Input Board = WWxxxxxWWWWBBBBxxBWBxB
        - Board Position: WWBxxxxxWWWBBBBxxBWBxB
        - Positions evaluated by static estimation: 408.
        - MINIMAX estimate: 1
- MiniMax Game (Black):
    - ***Test 1: python MiniMaxGameBlack.py board3.txt board4.txt 2***
        - Input Board = WWxxxxBWWWWWBBBBWxxxxxx
        - Board Position: WWBxxxBWWWWWBxBBWxxxxxx
        - Positions evaluated by static estimation: 56.
        - MINIMAX estimate: -2014
    - ***Test 2: python MiniMaxGameBlack.py board3.txt board4.txt 2***
        - Input Board = BWxxxxBWWWWWBBBBWxxWxxx
        - Board Position: BWBxxxBWWWWWBxBBWxxWxxx
        - Positions evaluated by static estimation: 57.
        - MINIMAX estimate: -1013
- AB Opening:
    - ***Test 1: python ABOpening.py board1.txt board2.txt 2***
        - Input Board = Same as MiniMax Opening test 2
        - Board Position: WxxxxxxWxxBxxxxBxxxxxx
        - Positions evaluated by static estimation: 79.
        - AB estimate: -1
    - ***Test 2: python ABOpening.py board1.txt board2.txt 2***
        - Input Board = Same as MiniMax Opening test 3
        - Board Position: WWWxxxxWWWWWxBBBxxBWBxB
        - Positions evaluated by static estimation: 80.
        - AB estimate: 0
    - **As seen in both the examples, the number of positions evaluated using Alpha-Beta pruning is significantly lesser than MiniMax for the same input**
- AB Game:
    - ***Test 1: python ABGame.py board3.txt board4.txt 2***
        - Input Board = Same as MiniMax game test 1
        - Board Position: WWxxxxBWxWWBBBBWWxxxxx
        - Positions evaluated by static estimation: 41.
        - AB estimate: 1991
    - ***Test 1: python ABGame.py board3.txt board4.txt 2***
        - Input Board = Same as MiniMax game test 2
        - Board Position: BWxWxxBWxWWBBBBWxxWxxx
        - Positions evaluated by static estimation: 42.
        - AB estimate: 990

        - **As seen in both the examples, the number of positions evaluated using Alpha-Beta pruning is significantly lesser than MiniMax for the same input**
- MiniMax Opening with improved static estimation function:
    - ***Same as Test 3 from MiniMax Opening:***
        - Board Position: WWWxxxxWWWWBBxBxxBWBxB
        - Positions evaluated by static estimation: 444.
        - MINIMAX estimate: -6
- MiniMax Game with improved static estimation function:
    - **Same as Test 1 from MiniMax Game**
        - Board Position: xWxxxxBWWWWBBBBWxxxWxx
        - Positions evaluated by static estimation: 52.
        - MINIMAX estimate: -1

My static evaluation function v/s given static evaluation function:

- In my static evaluation function (*staticEstimationV2*), I am considering four additional metrics about the board, which improve the overall strategy:
    - **numWhitePiecesAtCorners & numBlackPiecesAtCorners**
        - As corner pieces have the highest freedom of movement on the board, it is an advantage to occupy corners of the board at indices *0,2,3,5,6,7,etc.*
    - **numOfBlackPiecesBlocked & numOfWhitePiecesBlocked**
        - If we are playing as white, then we want a maximum number of black pieces blocked or surrounded by white pieces, so that it limits the ability of black to form a mill, and vice-versa.
        - These are calculated with the help of the neighbors list, if at least two neighbors of a black piece are white, then it is advantageous and vice versa if playing for black.