Su20 - AI Project Report

MORRIS GAME – NINE MEN VARIANT

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Part 1: MiniMax

The **MiniMaxOpening.py** program plays a move in the opening phase of the game using MiniMax algorithm. The **MiniMaxGame.py** program plays in the midgame/endgame phase using MiniMax algorithm.

P1. MiniMaxOpening

Depth1: 3
Input1: WBWxxxWBBBBWxWBWxWxBBxW
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 1158
MINIMAX Estimate: 3

Depth2: 2
Input2: WWxBWWxxxWxxWBWBxBxBBxx
Board Position: WWWBWWxxxWxxWBWBxxxBBxx
Position evaluated by Static Estimation: 213
MINIMAX Estimate: 2

P2. MiniMaxGame

Depth1: 4
Input1: WxxBBWWBxxxxxxBWxWxBBWx
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 19713
MINIMAX Estimate: 989

Depth2: 3
Input2: BxxWxxWBxxWxxxWxxBxxxxW
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 2892
MINIMAX Estimate: 1955

Part 2: Alpha-Beta
The **ABOpening.py** program plays the opening game for white player using Alpha-Beta Pruning Algorithm. The **ABGame.py** program plays in the midgame/endgame phase using Alpha-Beta Pruning Algorithm.

P1. ABOpening
Depth1: 3
Input1: WBWxxxWBBBBWxWBWxWxBBxW
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 150
MINIMAX Estimate: 3

Depth2: 2
Input2: WWxBWWxxxWxxWBWBxBxBBxx
Board Position: WWWBWWxxxWxxWBWBxxxBBxx
Position evaluated by Static Estimation: 51
MINIMAX Estimate: 2

P2. ABGame
Depth1: 4
Input1: WxxBBWWBxxxxxxBWxWxBBWx
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 1460
MINIMAX Estimate: 989

Depth2: 3
Input2: BxxWxxWBxxWxxxWxxBxxxxW
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 302
MINIMAX Estimate: 1955

Part 3: Game for Black

The **MiniMaxOpeningBlack.py** program plays a move in the opening phase of the game, as Black, using MiniMax algorithm. The **MiniMaxGameBlack.py** program plays in the midgame/endgame phase, as Black, using MiniMax algorithm.

P1. MiniMaxOpeningBlack

Depth1: 3
Input1: WBWxxxWBBBBWxWBWxWxBBxW
Board Position: WBWBxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 638
MINIMAX Estimate: 0

Depth2: 2
Input2: WWxBWWxxxWxxWBWBxBxBBxx
Board Position: xWxBWWxxxWxxWBWBxBBBBxx
Position evaluated by Static Estimation: 214
MINIMAX Estimate: 0

P2. MiniMaxGameBlack

Depth1: 4
Input1: WxxBBWWBxxxxxxBWxWxBBWx
Board Position: WxxBBWWBxxxxxxBWxWBxBWx
Position evaluated by Static Estimation: 16685
MINIMAX Estimate: -13

Depth2: 3
Input2: BxxWxxWBxxWxxxWxxBxxxxW
Board Position: xxBWxxWBxxWxxxWxxBxxxxW
Position evaluated by Static Estimation: 15584
MINIMAX Estimate: -1048

Part 4: Improved Static Estimation

The improved static estimation function provides better results as compared to the algorithms using the default static estimation function. The improved static estimation function gives more weight to positions that are likely to form a mill, thus reducing the number of steps. Please refer to the code for the logic.

P1. MiniMaxOpeningImproved

Depth1: 2
Input1: WBWxxxWBBBBWxWBWxWxBBxW
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 100
MINIMAX Estimate: 2

Depth2: 2
Input2: WWxBWWxxxWxxWBWBxBxBBxx
Board Position: WWWBWWxxxWxxWBWBxBxxBxx
Position evaluated by Static Estimation: 213
MINIMAX Estimate: 3

P2. MiniMaxGameImproved

Depth1: 2
Input1: WxxBBWWBxxxxxxBWxWxBBWx
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 157
MINIMAX Estimate: 991

Depth2: 2
Input2: BxxWxxWBxxWxxxWxxBxxxxW
Board Position: BxxWxxWBxWxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 315
MINIMAX Estimate: 1955

MiniMax Opening vs Alpha-Beta Opening

Depth: 3
Input: WBWxxxWBBBBWxWBWxWxBBxW

Result: MiniMaxOpening
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 1158
MINIMAX Estimate: 3

Result: ABOpening
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 150
MINIMAX Estimate: 3

Depth: 2
Input: WWxBWWxxxWxxWBWBxBxBBxx

Result: MiniMaxOpening
Board Position: WWWBWWxxxWxxWBWBxxxBBxx
Position evaluated by Static Estimation: 213
MINIMAX Estimate: 2

Result: ABOpening
Board Position: WWWBWWxxxWxxWBWBxxxBBxx
Position evaluated by Static Estimation: 51
MINIMAX Estimate: 2

MiniMax Game vs Alpha-Beta Game

Depth: 4
Input: WxxBBWWBxxxxxxBWxWxBBWx

Result: MiniMaxGame
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 19713
MINIMAX Estimate: 989

Result: ABGame
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 1460
MINIMAX Estimate: 989

Depth: 3
Input: BxxWxxWBxxWxxxWxxBxxxxW

Result: MiniMaxGame
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 2892
MINIMAX Estimate: 1955

Result: ABGame
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 302
MINIMAX Estimate: 1955

Static Estimation Opening vs Improved Static Estimation Opening

Input: WBWxxxWBBBBWxWBWxWxBBxW

Result: MiniMaxOpening
Depth: 3
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 1158
MINIMAX Estimate: 3

Result: MiniMaxOpeningImproved
Depth: 2
Board Position: WxWWxxWBBBBWxWBWxWxBBxW
Position evaluated by Static Estimation: 100
MINIMAX Estimate: 2

Input: WWxBWWxxxWxxWBWBxBxBBxx

Result: MiniMaxOpening
Depth: 2
Board Position: WWWBWWxxxWxxWBWBxxxBBxx
Position evaluated by Static Estimation: 213
MINIMAX Estimate: 2

Result: MiniMaxOpeningImproved
Depth: 2
Board Position: WWWBWWxxxWxxWBWBxBxxBxx
Position evaluated by Static Estimation: 213
MINIMAX Estimate: 3

Static Estimation Game vs Improved Static Estimation Game

Input: WxxBBWWBxxxxxxBWxWxBBWx

Result: MiniMaxGame
Depth: 4
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 19713
MINIMAX Estimate: 989

Result: MiniMaxGameImproved
Depth: 2
Board Position: WxxxBWWBxxxxxxBWxxWBBWx
Position evaluated by Static Estimation: 157
MINIMAX Estimate: 991

Input: BxxWxxWBxxWxxxWxxBxxxxW

Result: MiniMaxGame
Depth: 3
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 2892
MINIMAX Estimate: 1955

Result: MiniMaxGameImproved
Depth: 2
Board Position: BxxWxxWBxWxxxxWxxBxxxxW
Position evaluated by Static Estimation: 315
MINIMAX Estimate: 1955

Conclusion

1. The Alpha-Beta algorithm computes the same results by estimating lesser nodes as compared to the MiniMax algorithm.
2. The Improved Static Estimation function, finds better positions at lesser depths and needs significantly lesser position estimates. In some cases, it finds better Board positions as compared to the normal ones.

References

1. Handout Notes and Function algorithms.
2. https://en.wikipedia.org/wiki/Nine_men%27s_morris