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CS 6364
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AI - Project Report

Improvement of Static Function:

Example 1:

MiniMaxOpening:

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxopening.py board1.txt board2.txt 1
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------W
Input Board Position:   xWWBxBxxxxxxxWxBxWxx
Static Estimate 2
Output Board Position:  WWWBxBxxxxxxxWxBxWxx
Positions Evaluated 14
Output Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------W
PS C:\Users\ukken\Projects\AI> |
```

The white was placed on the bottom left corner using normal static function.
The improved static function takes into consideration the number of potential mills by checking incomplete mill positions. If two of the three are filled with white it is considered as a white potential mill position.
This helps in improving the position. The improved code keeps the White in the top right position from where we have a guaranteed mill position. (Please find the screenshot below)

MiniMaxOpeningImproved:

```
PS C:\Users\ukken\Projects\AI> python3 .\MiniMaxOpeningImproved.py board1.txt board2.txt 1
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------W
Input Board Position:   xWWBxBxxxxxxxWxBxWxx
Static Estimate 2100
Output Board Position:  xWWBxBxxxxxxxWxBxWxW
Positions Evaluated 14
Output Board:
W-----x-----W
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------W
PS C:\Users\ukken\Projects\AI>
```

Example 2:

MiniMaxGame:

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxgame.py board3.txt board4.txt 1
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-W
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------x
Input Board Position:   xxWBxBxxxxxWxxWxBxWxx
Static Estimate 958
Output Board Position:  xxxBxBxWxxxWxxWxBxWxx
Positions Evaluated 8
Output Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-W-x   x-x-W
| | |   | | |
| | x---B | |
| |       | |
| x-------B |
|           |
x-----------x
```

Here we can see white moved from 2 to 7. This does not create any mills in near future.

But in the MiniMaxImproved program we make use of the improved static function which gives weightage to the potential mills. The move made by the Improved is from 11 to 20 which gives a potential mill with 19 alone missing.

MiniMaxGameImproved

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxgameimproved.py board3.txt board4.txt 1
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-W
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------x
Input Board Position:   xxWBxBxxxxxWxxWxBxWxx
Static Estimate 2958
Output Board Position:  xxWBxBxxxxxxxWxBxWxW
Positions Evaluated 8
Output Board:
W-----x-----W
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------x
```

Therefore we can conclude that the static function has been improved

Improvement of Alpha-Beta over MiniMax:

Example 1:

MiniMaxOpening:

ABOpening:

Positions evaluated dramatically reduced from 182 to 26.

Example 2:

MiniMaxGame:

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxgame.py board1.txt board2.txt 2
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------W
Input Board Position:   xWWBxBxxxxxxxxWxBxWxx
Static Estimate 952
Output Board Position:   WxWBxBxxxxxxxxWxBxWxx
Positions Evaluated 294
Output Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------x
```

ABOpening:

```
PS C:\Users\ukken\Projects\AI> python3 .\abgame.py board1.txt board2.txt 2
Input Board:
W-----x-----x
W     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
x-----------W
Input Board Position:   xWWBxBxxxxxxxxWxBxWxx
Static Estimate 952
Output Board Position:   WxWBxBxxxxxxxxWxBxWxx
Positions Evaluated 197
Output Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------x
PS C:\Users\ukken\Projects\AI> python3 .\minimaxgame.py board1.txt board2.t
```

Moves reduced from 294 to 197.
Both the examples exemplifies how pruning saves computations

Playing as Black:

MiniMaxOpeningBlack:

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxopeningblack.py board1.txt board2.txt 2
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------W
WWWBxBxxxxxxxxWxBxWxx
-2
WWWBxBBxxxxxxxWxBxWxx
192
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
B-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------W
PS C:\Users\ukken\Projects\AI>
```

MiniMaxGameBlack:

```
PS C:\Users\ukken\Projects\AI> python3 .\minimaxgameblack.py board1.txt board2.txt 2
Input Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
x-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------B |
|           |
W-----------x
Input Board Position:  WxWBxBxxxxxxxxWxBxWxx
Static Estimate -1007
Output Board Position:  WxWxxBBxxxxxxxWxBxWxx
Positions Evaluated 287
Output Board:
W-----x-----x
|     |     |
| x---B---x |
| |   |   | |
| | x-x-W | |
| | |   | | |
B-x-x   x-x-x
| | |   | | |
| | x---B | |
| |       | |
| W-------x |
|           |
W-----------x
```

Additional Program Outputs

1. ABOpening

```
PS C:\Users\ukken\Projects\AI> python3 .\abopening.py board1.txt board2.txt 5
Input Board:
x-----B-----W
|     |     |
| B---x---W |
| |   |   | |
| | x-x-x | |
| | |   | | |
x-B-x   x-x-W
| | |   | | |
| | x---W | |
| |     | |
| W-------x |
|           |
B-----------x
Input Board Position:  BxWxxWxBxxxWxxxBxWxBW
Static Estimate 4
Output Board Position:  BxWxxWxBxWxWxxxBxWxBW
Positions Evaluated 5919
Output Board:
x-----B-----W
|     |     |
| B---x---W |
| |   |   | |
| | x-x-x | |
| | |   | | |
x-B-x   W-x-W
| | |   | | |
| | x---W | |
| |     | |
| W-------x |
|           |
B-----------x
PS C:\Users\ukken\Projects\AI> |
```

2. ABGame

```
PS C:\Users\ukken\Projects\AI> python3 .\abgame.py board1.txt board2.txt 3
Input Board:
x-----W-----W
|     |     |
| x---x---x |
| |   |   | |
| | B-W-x | |
| | |   | | |
B-B-x   x-x-W
| | |   | | |
| | x---x | |
| |     | |
| x-------W |
|           |
B-----------B
Input Board Position:  BBxWxxBBxxxWBWxxxxxWW
Static Estimate -1004
Output Board Position:  BBWxxxBBxxxWBWxxxxxWW
Positions Evaluated 190
Output Board:
x-----W-----W
|     |     |
| x---x---x |
| |   |   | |
| | B-W-x | |
| | |   | | |
B-B-x   x-x-W
| | |   | | |
| | x---x | |
| |     | |
| W-------x |
|           |
B-----------B
```