COMS 4701 Homework 3 Battle of the Gomoku Agents

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TO RUN:
Python player-kz2203.py [dimension] [chain-length] [time] [1 or 2] [mode 1 or 2 or 3]

Part 1. Algorithm Explanation

1. Evaluation Function

Evaluation function contains two part of score:

1) <u>State Type.</u>

Apparently, here are some special compositions(棋局). I calculate the amount of these special compositions to score a chessboard. These special compositions and its score are:

Entire evaluation part could been seen in 'evaluation'.

(take chain-length == 5 for example)

Five: 9999

Open-Four: 9990 One-side-Four: 9980 Open-Three & No-Four: 9950

One-side-Four & Open-Three : 9970

Two-Open-Three: 2000 One-Open-Three: 200 One-side-Three: 10

Open-Two: 4 One-side-Two: 1

There are also some other special compositions, described in my code.

2) <u>Position Weight</u>

As an experienced player, in my opinion, if an agent put its steps on centering positions, it always gain more advantages, especially when the dimension is small. So, I give different positions different weight value. Center has highest value equals to half of dimension, positions on four edges has value 0.

3) <u>Priority</u>

My agent is very intelligent on this degree. As common sense, if opponent is going to win, there's no need to search for several depth, in most situation, in order to prevent ourselves' lose, we have only one choice to put our step. So, if opponent score is near 9999, then we only need to search in the first layer. The same, when we are going to win, we only need to put our step on the position which will let us win.

However, if we are going to lose, my agent performs just like me, never give up! It will search all the possible steps to avoid lose, which might cost a little bit more time.

4) Efficiency

In order to improve efficiency, I reduced the children for each step. Actually, instead of considering all empty positions, I only considered two more points around present compositions. That's strongly reduced the amount of brunches.

Further, Position Weight described in '1' will also control the area of compositions in order to keep most steps near to each other.

Third, order of branches also influence the efficiency of pruning, so I sort the branches before pruning.

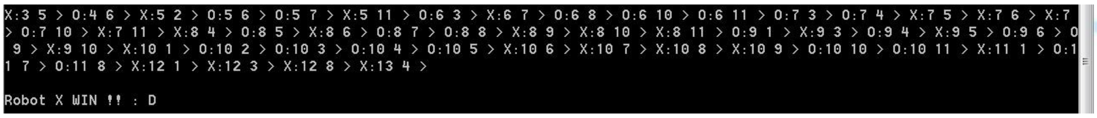
Time-Limit, I divided rest time equally for every branches.

Part 2. Additional Features

1. Friendly UI

Colorful Output, detailed index instructions, Round number.

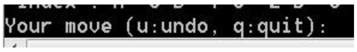
2. Record all previous steps



```
X:3 5 > O:4 6 > X:5 2 > O:5 6 > O:5 7 > X:5 11 > O:6 3 > X:6 7 > O:6 8 > O:6 10 > O:6 11 > O:7 3 > O:7 4 > X:7 5 > X:7 6 > X:7
> O:7 10 > X:7 11 > X:8 4 > O:8 5 > X:8 6 > O:8 7 > O:8 8 > X:8 9 > X:8 10 > X:8 11 > O:9 1 > X:9 3 > O:9 4 > X:9 5 > O:9 6 > O
 9 > X:9 10 > X:10 1 > O:10 2 > O:10 3 > O:10 4 > O:10 5 > X:10 6 > X:10 7 > X:10 8 > X:10 9 > O:10 10 > O:10 11 > X:11 1 > O:1
1 7 > O:11 8 > X:12 1 > X:12 3 > X:12 8 > X:13 4 >

Robot X WIN !! : D
```

3. Undo and Quit Function



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Your move (u:undo, q:quit):
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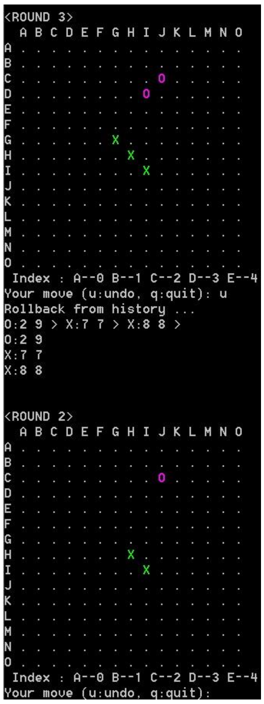
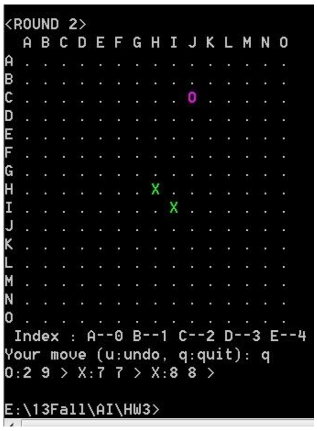
Left is undo and right is quit.



```
<ROUND 3>
  A B C D E F G H I J K L M N O
A . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . .
C . . . . . . . . . O . . . . .
D . . . . . . . . O . . . . . .
E . . . . . . . . . . . . . . .
F . . . . . . . . . . . . . . .
G . . . . . . X . . . . . . . .
H . . . . . . . X . . . . . . .
I . . . . . . . . X . . . . . .
J . . . . . . . . . . . . . . .
K . . . . . . . . . . . . . . .
L . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . . .
N . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . .
 Index : A--0 B--1 C--2 D--3 E--4
Your move (u:undo, q:quit): u
Rollback from history ...
O:2 9 > X:7 7 > X:8 8 >
O:2 9
X:7 7
X:8 8


<ROUND 2>
  A B C D E F G H I J K L M N O
A . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . .
C . . . . . . . . . O . . . . .
D . . . . . . . . . . . . . . .
E . . . . . . . . . . . . . . .
F . . . . . . . . . . . . . . .
G . . . . . . . . . . . . . . .
H . . . . . . . X . . . . . . .
I . . . . . . . . X . . . . . .
J . . . . . . . . . . . . . . .
K . . . . . . . . . . . . . . .
L . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . . .
N . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . .
 Index : A--0 B--1 C--2 D--3 E--4
Your move (u:undo, q:quit):
```



```
<ROUND 2>
  A B C D E F G H I J K L M N O
A . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . .
C . . . . . . . . . O . . . . .
D . . . . . . . . . . . . . . .
E . . . . . . . . . . . . . . .
F . . . . . . . . . . . . . . .
G . . . . . . . . . . . . . . .
H . . . . . . . X . . . . . . .
I . . . . . . . . X . . . . . .
J . . . . . . . . . . . . . . .
K . . . . . . . . . . . . . . .
L . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . . .
N . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . .
 Index : A--0 B--1 C--2 D--3 E--4
Your move (u:undo, q:quit): q
O:2 9 > X:7 7 > X:8 8 >

E:\13Fall\AI\HW3>
```

4. Comprehensive Error Reminder

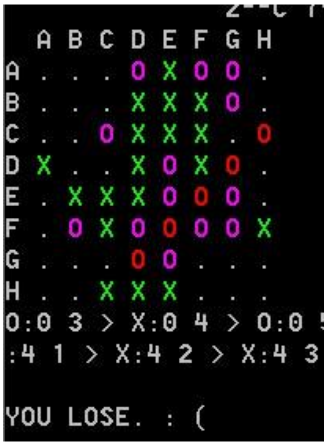
Part 3. Outcomes and Analysis

1. Mode 1 PLAY WITH OTHERS

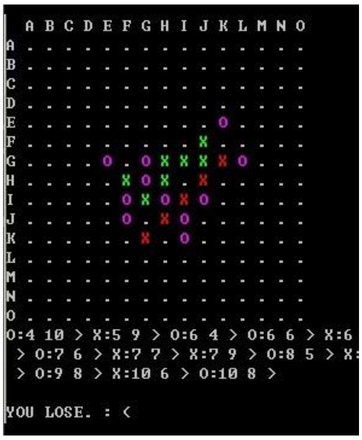
When I play with my robot, I always lose. : (no matter I'm first or second.

Maybe that's because I taught my robot all of my technics, so it can use these thickness play against me.

So, I only provided two pictures.



```
                 2--C
  A B C D E F G H
A . . . O X O O .
B . . . X X X O .
C . . O X X X . O
D X . . X O X O .
E . X X X O O O .
F . O X O O O O X
G . . . O O . . .
H . . X X X . . .
O:0 3 > X:0 4 > O:0
:4 1 > X:4 2 > X:4 3

YOU LOSE. : (
```

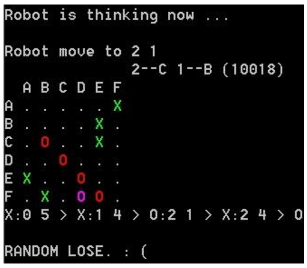


```
  A B C D E F G H I J K L M N O
A . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . .
C . . . . . . . . . . . . . . .
D . . . . . . . . . . . . . . .
E . . . . . . . . . . O . . . .
F . . . . . . . . . X . . . . .
G . . . . O . O X X X X O . . .
H . . . . . X O X . X . . . . .
I . . . . . O X O X O . . . . .
J . . . . . O . X O . . . . . .
K . . . . . . X . O . . . . . .
L . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . . .
N . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . .
O:4 10 > X:5 9 > O:6 4 > O:6 6 > X:6
 > O:7 6 > X:7 7 > X:7 9 > O:8 5 > X:
 > O:9 8 > X:10 6 > O:10 8 >

YOU LOSE. : (
```

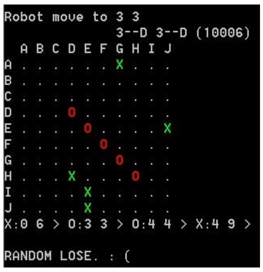
2. Mode 2 PLAY WITH RANDOM

My Agent will always win.

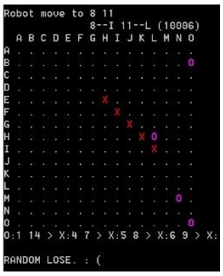
Here are five experiments with different dimension size, chain length, order.



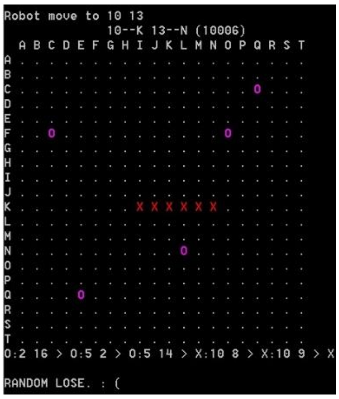
```
Robot is thinking now ...

Robot move to 2 1
                 2--C 1--B (10018)
  A B C D E F
A . . . . . X
B . . . . X .
C . O . . X .
D . . O . . .
E X . . O . .
F . X . O O .
X:0 5 > X:1 4 > O:2 1 > X:2 4 > O

RANDOM LOSE. : (
```



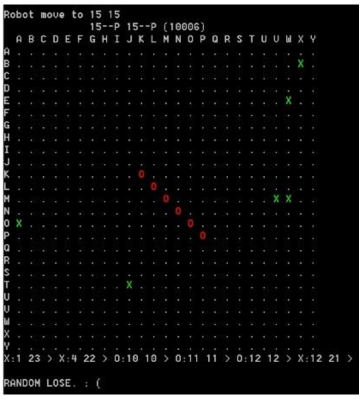
```
Robot move to 3 3
              3--D 3--D (10006)
  A B C D E F G H I J
A . . . . . . X . . .
B . . . . . . . . . .
C . . . . . . . . . .
D . . . O . . . . . .
E . . . . O . . . . X
F . . . . . O . . . .
G . . . . . . O . . .
H . . . X . . . O . .
I . . . . X . . . . .
J . . . . X . . . . .
X:0 6 > O:3 3 > O:4 4 > X:4 9 >

RANDOM LOSE. : (
```



```
Robot move to 8 11
              8--I 11--L (10006)
  A B C D E F G H I J K L M N O
A . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . O
C . . . . . . . . . . . . . . .
D . . . . . . . . . . . . . . .
E . . . . . . . X . . . . . . .
F . . . . . . . . X . . . . . .
G . . . . . . . . . X . . . . .
H . . . . . . . . . . X O . . .
I . . . . . . . . . . . X . . .
J . . . . . . . . . . . . . . .
K . . . . . . . . . . . . . . .
L . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . O .
N . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . O
O:1 14 > X:4 7 > X:5 8 > X:6 9 > X:

RANDOM LOSE. : (
```



```
Robot move to 10 13
              10--K 13--N (10006)
  A B C D E F G H I J K L M N O P Q R S T
A . . . . . . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . . . . . . .
C . . . . . . . . . . . . . . . . O . . .
D . . . . . . . . . . . . . . . . . . . .
E . . . . . . . . . . . . . . . . . . . .
F . . O . . . . . . . . . . . O . . . . .
G . . . . . . . . . . . . . . . . . . . .
H . . . . . . . . . . . . . . . . . . . .
I . . . . . . . . . . . . . . . . . . . .
J . . . . . . . . . . . . . . . . . . . .
K . . . . . . . . X X X X X X . . . . . .
L . . . . . . . . . . . . . . . . . . . .
M . . . . . . . . . . . . . . . . . . . .
N . . . . . . . . . . . O . . . . . . . .
O . . . . . . . . . . . . . . . . . . . .
P . . . . . . . . . . . . . . . . . . . .
Q . . . . O . . . . . . . . . . . . . . .
R . . . . . . . . . . . . . . . . . . . .
S . . . . . . . . . . . . . . . . . . . .
T . . . . . . . . . . . . . . . . . . . .
O:2 16 > O:5 2 > O:5 14 > X:10 8 > X:10 9 > X

RANDOM LOSE. : (
```



```
Robot move to 15 15
              15--P 15--P (10006)
  A B C D E F G H I J K L M N O P Q R S T U U W X Y
A . . . . . . . . . . . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . . . . . . . . . . X .
C . . . . . . . . . . . . . . . . . . . . . . . . .
D . . . . . . . . . . . . . . . . . . . . . . . . .
E . . . . . . . . . . . . . . . . . . . . . . X . .
F . . . . . . . . . . . . . . . . . . . . . . . . .
G . . . . . . . . . . . . . . . . . . . . . . . . .
H . . . . . . . . . . . . . . . . . . . . . . . . .
I . . . . . . . . . . . . . . . . . . . . . . . . .
J . . . . . . . . . . . . . . . . . . . . . . . . .
K . . . . . . . . . . O . . . . . . . . . . . . . .
L . . . . . . . . . . . O . . . . . . . . . . . . .
M . . . . . . . . . . . . O . . . . . . . . X X . .
N . . . . . . . . . . . . . O . . . . . . . . . . .
O X . . . . . . . . . . . . . O . . . . . . . . . .
P . . . . . . . . . . . . . . . O . . . . . . . . .
Q . . . . . . . . . . . . . . . . . . . . . . . . .
R . . . . . . . . . . . . . . . . . . . . . . . . .
S . . . . . . . . . . . . . . . . . . . . . . . . .
T . . . . . . . . . X . . . . . . . . . . . . . . .
U . . . . . . . . . . . . . . . . . . . . . . . . .
U . . . . . . . . . . . . . . . . . . . . . . . . .
W . . . . . . . . . . . . . . . . . . . . . . . . .
X . . . . . . . . . . . . . . . . . . . . . . . . .
Y . . . . . . . . . . . . . . . . . . . . . . . . .
X:1 23 > X:4 22 > O:10 10 > O:11 11 > O:12 12 > X:12 21 >

RANDOM LOSE. : (
```

3. Mode 3 PLAY ALONE

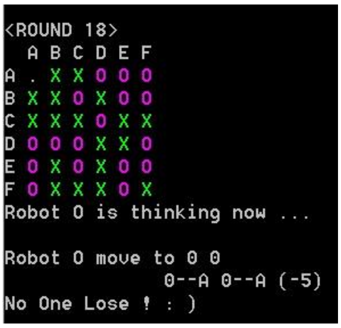
I find that, a) when dimension size is small, chessboard is easily full and there's no loser.

b) even dimension size is small, if length of chain is also small, one agent may win.

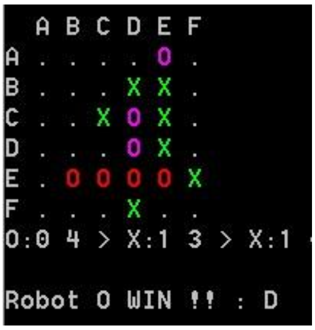
c) the bigger the dimension size is, the more probability for First Robot to win, the less probability for Second Robot to win. Mainly because of Position Weight.

d) commonly, when dimension size is around 10, sometimes first robot win, sometimes second robot win.

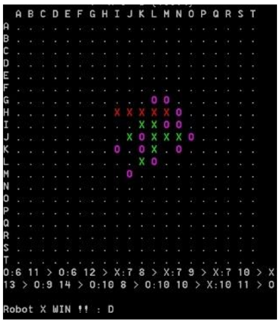
Following 5 images are from a) to d), d) has two images.



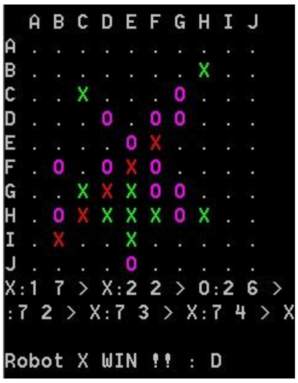
```
<ROUND 18>
  A B C D E F
A . X X O O O
B X X O X O O
C X X X O X X
D O O O X X O
E O X O X O O
F O X X X O X
Robot O is thinking now ...

Robot O move to 0 0
              0--A 0--A (-5)
No One Lose ! : )
```



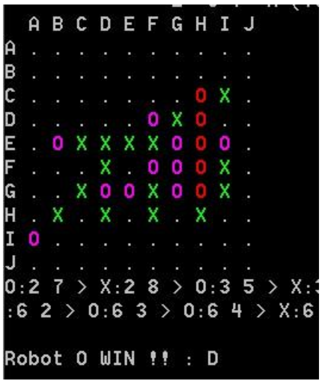
```
  A B C D E F
A . . . . O .
B . . . X X .
C . . X O X .
D . . . O X .
E . O O O O X
F . . . X . .
O:0 4 > X:1 3 > X:1

Robot O WIN !! : D
```



```
  A B C D E F G H I J K L M N O P Q R S T
A . . . . . . . . . . . . . . . . . . . .
B . . . . . . . . . . . . . . . . . . . .
C . . . . . . . . . . . . . . . . . . . .
D . . . . . . . . . . . . . . . . . . . .
E . . . . . . . . . . . . . . . . . . . .
F . . . . . . . . . . . . . . . . . . . .
G . . . . . . . . . . . O O . . . . . . .
H . . . . . . . . X X X X X O . . . . . .
I . . . . . . . . . . X X O O . . . . . .
J . . . . . . . . . X O X X X O . . . . .
K . . . . . . . . O . O X . O . . . . . .
L . . . . . . . . . . X O . . . . . . . .
M . . . . . . . . . O . . . . . . . . . .
N . . . . . . . . . . . . . . . . . . . .
O . . . . . . . . . . . . . . . . . . . .
P . . . . . . . . . . . . . . . . . . . .
Q . . . . . . . . . . . . . . . . . . . .
R . . . . . . . . . . . . . . . . . . . .
S . . . . . . . . . . . . . . . . . . . .
T . . . . . . . . . . . . . . . . . . . .
O:6 11 > O:6 12 > X:7 8 > X:7 9 > X:7 10 > X
13 > O:9 14 > O:10 8 > O:10 10 > X:10 11 > O

Robot X WIN !! : D
```



```
  A B C D E F G H I J
A . . . . . . . . . .
B . . . . . . . X . .
C . . X . . . O . . .
D . . . O . O O . . .
E . . . . O X . . . .
F . O . O X O . . . .
G . . X X X O O . . .
H . O X X X X O X . .
I . X . . X . . . . .
J . . . . O . . . . .
X:1 7 > X:2 2 > O:2 6 >
:7 2 > X:7 3 > X:7 4 > X

Robot X WIN !! : D
```



```
  A B C D E F G H I J
A . . . . . . . . . .
B . . . . . . . . . .
C . . . . . . . O X .
D . . . . . O X O . .
E . O X X X X O O O .
F . . . X . O O O X .
G . . X O O X O O X .
H . X . X . X . X . .
I O . . . . . . . . .
J . . . . . . . . . .
O:2 7 > X:2 8 > O:3 5 > X:
:6 2 > O:6 3 > O:6 4 > X:6

Robot O WIN !! : D
```