Australian National University

ASSIGNMENT COVER SHEET

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Course Code & Name	COMP1100 - Programming as Problem Solving		
Assignment Topic	Technical Report for Assignment 3 Backgammon Bot		
Lab Time	Monday 16:00 – 18:00		
Tutor	Jack Kelly <jack@jackkelly.name>		
Word count	1100	Due Date	25 May 2018
Last Edited	25 May 2018	Extension Granted	

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Initials DF

For group assignments, each student must initial.

Technical Report for Assignment 2

Danny Feng

1. Introduction

This assignment is to implement A.I algorithm into the game Backgammon. In this report, I'm going to outlining not only the ideas, structure and solutions of my Backgammon Bot but also sharing my developing process includes the design decision and things I improved.

2. Reflection

Before I started doing it, I spent some time reading instructions, exploring the game rules and analyzing the given program function. I started the game one week after it released, and I successfully finished 1) my legal move bot that can pick a random position to move, 2) my greedy bot V1 that picks a best move based on position indexes from current state, 3) my greedy bot V2 that picks a best move based on scoring from all the current legal move, it's updated version 3 that fixed a move matching bug using a slightly different method, 4) my minimax bot V1 that inspired from lecturer's code and 5) my minimax bot V2 that looks into the future state without using lecturer's structure.

I used bottom-up design strategies when I was developing. When it came a problem, I broke it to several small function and then built an overall function that calls them. For example, function scoreBeenEaten, scoreEat, scoreGoodMove and scorePoint are to calculates the scores for different parts of the state. Then they are called by scoreState to give out a final score of the state they evaluate.

I also tried to do the expectiminimax with probability involved in the minimax. But since I started the assignment a little bit late, I haven't finished it. This is a lesson for me to start the assignment as earlier as possible in my future course.

3. Heuristics

About my evaluation of a given board. I gave the priority to the (bPips – wPips), I wanted this value the greater the better. Pips is the total pieces distance from home. I found out that given a high weight of this result in a stronger bot that is eager to widen differences between its opponent. Besides, based on many tests I ran, I found out that if I make the bot prefer to move the piece to the point which only has one friendly piece on it then the win rate will increase. So I made my heuristics check Just(White,1) and Just (Black,1) that focus on blot and block more. What's more, I also made my bot prefer to move its furthest piece to make my bot move all pieces back home faster.

The search method is a topic I really want to share. In my first greedy bot, I didn't use evaluation things at all! You might think that is not a good idea. But I will say, it is actually good for the greedy algorithm but bad for the later task like minimax. Firstly, it is efficient. My greedy bot V1 only check what properties that current state has. If there is a friendly piece alone on the board, it just picks a legal move that can go there. If not, it will check if there is an enemy piece alone, if not, it will just move the furthest piece. Compared to my later greedy bots that use a scoring idea that everybody has, it doesn't need to perform every legal move to evaluate all the possible states. Therefore, it only takes half of the memory as V2. Secondly, I used this version to join the tournament and the result is quite good.

```
*PlayAsWhite> greedyBotV1 (stateAfterDiceRoll (initialState White) (4,3))
[(24,4),(24,3)]
(0.01 secs, 1,445,160 bytes)
```

```
*PlayAsWhite> greedyBotV2 (stateAfterDiceRoll (initialState White) (4,3))
[(24,4),(24,3)]
(0.01 secs, 2,776,968 bytes)
```

4. A.I Performance

Due to the limited hardware resources, the performance of any software does matter. A program is not efficient if it runs slow and occupy too many CPU or memory. As I said above, my greedy bot V2 perform twice worse than V1 because it calculates all the legal moves. For my minimax bot, it runs fourth slower than greedy bot because it has a list structure (rose tree) that looks into all the future state. The fact is that, the rose tree of Backgammon is huge after two level. If the lookahead is greater, it needs a long time to perform move and it will be killed by program. But if the lookahead is just 1, the minimax bot cannot beat greedy bot. Thus, it's hard to keep a balance between this so I don't think a normal minimax is perform well in Backgammon. For my minimax, I believe I write the algorithm correctly. The player switch from max to min each time. It looks to the lookahead level and comes back to the root node level by level.

The pictures below are my A.I performance in the tournament. I uploaded my greedy Bot V1 on 21st May 2018 and these were the result at that time. My tournament ID is 1980, it ranked 15 with a win ratio 0.771. I opted out after that to update my bot to a next intelligence level. To be honest, I don't think my greedy Bot V1 is not that strong. The reason of its success at that point of time was mainly that most of the students just uploaded their legal move bot.

Player Details: 1980

Back to Player Ranking and Reports

Student ID	Status	Errors	Points	Completed Matches	Running Matches	Score Difference	Win Ratio	Last Submission
1980	N/A	N/A			N/A	N/A	0.771	N/A

Opponent	Result	Score (player - opponent)
1001	W	3 - 0
1379	L	0 - 3
1440	W	3 - 0
1449	W	3 - 1
1600	L	0 - 3
1689	L	1 - 3
1805	W	3 - 0
1900	W	3 - 1
2203	W	3 - 0
2308	W	3 - 1
2309	W	3 - 0
2669	L	0 - 3
2715	W	3 - 0
2802	W	3 - 2
2841	L	1 - 3
2881	L	2 - 3
2939	L	0 - 3
3020	W	3 - 0
3289	W	3 - 1
3329	L	1 - 3
3692	W	3 - 0
3909	L	1 - 3
3983	W	3 - 2
4150	W	3 - 2
4183	L	1 - 3
4315	L	0 - 3
4388	L	2 - 3
4449	L	1 - 3
4761	W	3 - 1
4776	W	3 - 2
4983	W	3 - 0
5071	W	3 - 1
5091	W	3 - 0
7032	W	3 - 2
7890	W	3 - 0

Updated: 2018-05-21 11:33:09.215396

Player Ranking

All Matches

Match Count: 834

Matches Remaining: N/A

Statistics: N/A

Rank	ID	Status	Errors	Points	Matches	Running	Score Sum	Win Ratio	Last Submission
1	3909	N/A	N/A	52	35	N/A	N/A	1.486	N/A
2	5071	N/A	N/A	47	35	N/A	N/A	1.343	N/A
3	4449	N/A	N/A	44	35	N/A	N/A	1.257	N/A
4	4150	N/A	N/A	42	35	N/A	N/A	1.2	N/A
5	1689	N/A	N/A	40	35	N/A	N/A	1.143	N/A
6	4315	N/A	N/A	37	35	N/A	N/A	1.057	N/A
7	1379	N/A	N/A	36	35	N/A	N/A	1.029	N/A
8	1900	N/A	N/A	33	35	N/A	N/A	0.943	N/A
9	2939	N/A	N/A	32	35	N/A	N/A	0.914	N/A
10	2669	N/A	N/A	31	35	N/A	N/A	0.886	N/A
11	1449	N/A	N/A	30	35	N/A	N/A	0.857	N/A
12	2841	N/A	N/A	30	35	N/A	N/A	0.857	N/A
13	4776	N/A	N/A	29	35	N/A	N/A	0.829	N/A
14	1600	N/A	N/A	28	35	N/A	N/A	0.8	N/A
15	1980	N/A	N/A	27	35	N/A	N/A	0.771	N/A
16	3329	N/A	N/A	27	35	N/A	N/A	0.771	N/A
17	3289	N/A	N/A	26	35	N/A	N/A	0.743	N/A
18	2802	N/A	N/A	25	35	N/A	N/A	0.714	N/A
19	2715	N/A	N/A	23	35	N/A	N/A	0.657	N/A

I let greedy bot V1 V2 V3, minimax bot V1 V2 and legal move bot played against each other. The result is somehow confusing but interesting. When they fight against legal move bot, greedy V3 is always the strongest, followed by greedy V1. However, when greedy V1 and greedy V3 fight together, greedy V1 is often a little bit better than greedy V3. I think this is because pips strategies will not become that strong when its opponent always like to blot and

block. Besides, when fighting with a legal move bot, all my greedy bots perform better than minimax bots. I think this is because the minimax algorithm always assumes that its opponent will always make a best move. But legal move does not.

Reference

1. ‘GameTree.hs’ 2018, in ANU College of Engineering & Computer Science, viewed 23 May 2018, <https://cs.anu.edu.au/courses/comp1100/lectures/11/>.

2. ‘Game Playing AI’ 2018, in ANU College of Engineering & Computer Science, viewed 24 May 2018, <https://cs.anu.edu.au/courses/comp1110/lectures/pdf/Z01.pdf>.