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EXPERIMENTATION – ALDS ASSIGNMENT 2

INTRODUCTION

This project main objective is to build an AI for 2048 games to get score more than 5000. The main technique used to develop this AI was to generate every state possibility up to specified depth, then choose the first move that leads to the highest score. There are 2 modes/propagation to choose highest priority, such as maximum and average. Maximum propagation will use the highest value as parameter to decide movement. As for average propagation, it will use the average of all first depth children to decide movement. The AI that has been used to test these data was created using the given pseudocode, with another extra heuristic such as giving bonus value when the board has more empty space. Reason for this heuristic is to make sure that move which gives more empty space will be preferred over move which gives less empty space for better board condition. This experimentation will be discussed in 4 main sections. First section of the experimentation will show the data result from 10 test for a particular propagation and depth. Second part of the experimentation will show the summary table of mean and standard deviation for particular propagation and depth. Third part will display 2 graph with the y axis as mean score and x axis as depth for both propagations. Last part will discuss mainly about observation and conclusion of this project.

TABLE FOR MAXIMUM PROPAGATION

Depth: 0	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	1388	128	0
2	1380	128	0
3	984	64	0
4	2276	256	0
5	1544	128	0
6	436	32	0
7	1236	128	0
8	600	64	0
9	1284	128	0
10	1240	128	0
Mean Score :	1236.8		
Score Deviation:	508.8786801		
Mean Max Tile:	118.4		
Max Tile Deviation	60.43398602		

Depth: 1	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	1308	128	0
2	2812	256	0
3	2832	256	0
4	1756	128	0
5	1820	128	0
6	1712	128	0
7	1960	128	0
8	5868	512	0
9	1392	128	0
10	3436	256	0
Mean Score :	2489.6		
Score Deviation:	1374.490386		
Mean Max Tile:	204.8		
Max Tile Deviation	123.6597482		

Depth: 2	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**

1	7260	512	0
2	15036	1024	0
3	6296	512	0
4	7296	512	0
5	3108	256	0
6	13196	1024	0
7	8136	512	0
8	6784	512	0
9	5396	512	0
10	7580	512	0
Mean Score :	8008.8		
Score Deviation:	3540.806587		
Mean Max Tile:	588.8		
Max Tile Deviation	242.8629243		

Depth: 3	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	7496	512	0.01
2	7304	512	0
3	16244	1024	0.01
4	13060	1024	0
5	15708	1024	0.01
6	27492	2048	0
7	16508	1024	0.01
8	16076	1024	0
9	7360	512	0.02
10	14264	1024	0.01
Mean Score :	14151.2		
Score Deviation:	6078.554448		
Mean Max Tile:	972.8		
Max Tile Deviation	448.3046583		

Depth: 4	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	16476	1024	0.04
2	14728	1024	0.08
3	16532	1024	0.12
4	14792	1024	0.06
5	15816	1024	0.07
6	15960	1024	0.12

7	23492	2048	0.03
8	7140	512	0.06
9	16608	1024	0.11
10	27732	2048	0.1
Mean Score :	16927.6		
Score Deviation:	5453.409111		
Mean Max Tile:	1177.6		
Max Tile Deviation	485.7258486		

Depth: 5	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	16596	1024	0.92
2	27864	2048	1.2
3	16748	1024	0.87
4	16544	1024	0.82
5	30976	2048	1.35
6	15712	1024	0.81
7	27848	2048	1.28
8	6860	512	0.28
9	14560	1024	0.74
10	31048	2048	1.07
Mean Score :	20475.6		
Score Deviation:	8289.547142		
Mean Max Tile:	1382.4		
Max Tile Deviation	593.6649261		

Depth: 6	Propagation: Max		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	27196	2048	4.22
2	17260	1024	3.1
3	56312	4096	6.78
4	60748	4096	8
5	12140	1024	2.32
6	33260	2048	4.14
7	12240	1024	2.24
8	15908	1024	2.63
9	22920	2048	3.67
10	24424	2048	3.31
Mean Score :	28240.8		
Score Deviation:	17326.31415		

Mean Max Tile:	2048		
Max Tile Deviation	1182.413351		

TABLE FOR AVERAGE PROPAGATION

Depth: 0	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	1232	128	0
2	796	64	0
3	940	128	0
4	1216	128	0
5	768	64	0
6	1384	128	0
7	2436	256	0
8	776	64	0
9	604	64	0
10	844	64	0
Mean Score :	1099.6		
Score Deviation:	531.3712241		
Mean Max Tile:	108.8		
Max Tile Deviation	60.71573108		

Depth: 1	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	1104	64	0
2	1946	256	0
3	19844	2048	0
4	1387	256	0
5	1740	128	0
6	3308	256	0
7	3736	256	0
8	1532	128	0
9	3788	256	0
10	736	64	0
Mean Score :	3912.1		
Score Deviation:	5704.134922		
Mean Max Tile:	371.2		
Max Tile Deviation	594.890242		

Depth: 2	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**

1	11836	1024	0
2	7296	512	0
3	7372	512	0
4	12468	1024	0
5	12364	1024	0
6	25216	2048	0
7	7472	512	0
8	16320	1024	0.02
9	5324	512	0
10	12396	1024	0
Mean Score :	11806.4		
Score Deviation:	5793.705765		
Mean Max Tile:	921.6		
Max Tile Deviation	470.4955307		

Depth: 3	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	14674	1024	0
2	15820	1024	0
3	23628	2048	0.01
4	12272	1024	0
5	5232	512	0.01
6	16040	1024	0
7	16272	1024	0.01
8	16004	1024	0
9	27924	2048	0.02
10	7276	512	0.01
Mean Score :	15514.2		
Score Deviation:	6715.077592		
Mean Max Tile:	1126.4		
Max Tile Deviation	528.7913262		

Depth: 4	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	14956	1024	0.05
2	26600	2048	0.11
3	12044	1024	0.07
4	12732	1024	0.09
5	7388	512	0.02
6	12012	1024	0.05

7	15128	1024	0.07
8	12416	1024	0.04
9	5708	512	0.01
10	15648	1024	0.07
Mean Score :	13463.2		
Score Deviation:	5628.809323		
Mean Max Tile:	1024		
Max Tile Deviation	418.0462494		

Depth: 5	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	12768	1024	0.64
2	14796	1024	0.66
3	7260	512	0.41
4	12104	1024	0.6
5	6448	512	0.33
6	3220	256	0.24
7	7576	512	0.42
8	5560	512	0.33
9	16736	1024	0.76
10	14860	1024	0.63
Mean Score :	10132.8		
Score Deviation:	4661.774502		
Mean Max Tile:	742.4		
Max Tile Deviation	306.4880639		

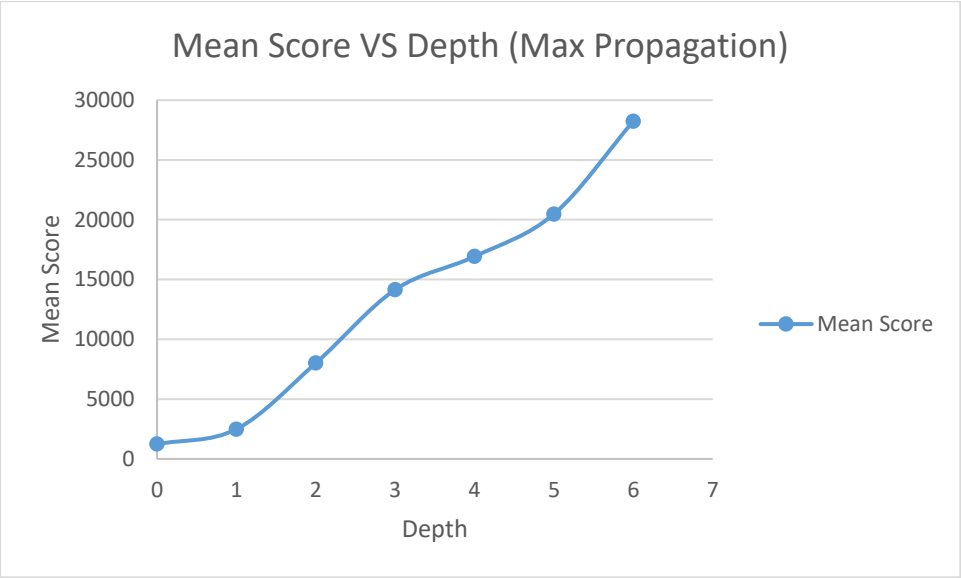
Depth: 6	Propagation: Avg		
No	**Score**	**Max Tile**	**Total Execution time (s)**
1	2964	256	0.63
2	7660	512	1.53
3	3352	256	0.9
4	7196	512	1.42
5	15688	1024	2.36
6	1336	128	0.46
7	13996	1024	2.34
8	3708	256	0.98
9	3244	256	0.86
10	5356	512	1.25
Mean Score :	6450		
Score Deviation:	4844.240658		

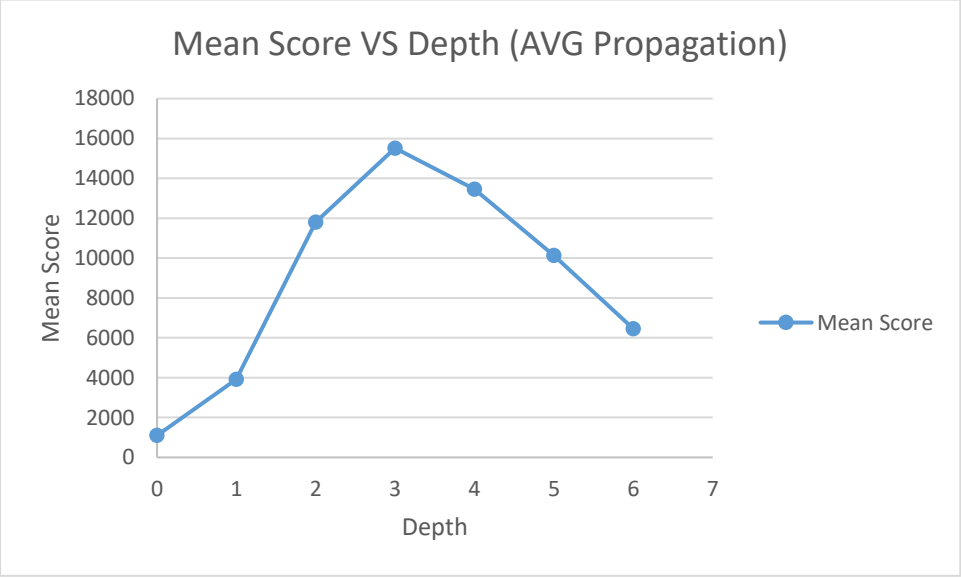
Mean Max Tile:	473.6		
Max Tile Deviation	319.5730485		

SUMMARY EXPERIMENTATION TABLE

Propagation	Depth	Mean Score	Score Deviation	Mean Max Tile	Max Tile Deviation	Total execution time
Max	0	1236.8	508.88	118.4	60.4	0
Avg	0	1099.6	531.37	108.8	60.72	0
Max	1	2489.6	1374.49	204.8	123.66	0
Avg	1	3912.1	5704.14	371.2	594.89	0
Max	2	8008.8	3540.8	588.8	242.86	0
Avg	2	11806	5793.71	921.6	470.5	0
Max	3	14151.2	6078.56	972.8	448.3	0.01
Avg	3	15514.2	6715.08	1126.4	528.79	0.01
Max	4	16927.6	5453.41	1177.6	485.73	0.1
Avg	4	13463.2	5628.81	1024	418.05	0.05
Max	5	20475.6	8289.55	1382.4	593.66	1
Avg	5	10132.8	4661.78	742.4	306.5	0.7
Max	6	28240.8	17326	2048	1182.4	3
Avg	6	6450	4844.2	473.6	319.57	1

SUMMARY EXPERIMENTATION DIAGRAM





CONCLUSION

For both max and average propagation with depth 0, the AI was programmed to give a random move, so we can expect that it will gives similar value which was shown on the table.

As for smaller depth, such as from depth 1 to depth 3, it can be observed that average and maximum propagation gives similar value. However, after depth 3 the average propagation keeps decreasing, while the maximum propagation continues to increase.

Possible reason why the average is decreasing is because as the depth increase, the number of nodes that are explored is increasing and therefore the best path which lead to highest score is shadowed by other suboptimal paths with the same first depth parents. For example, an optimal path that leads to highest score, might have neighbours (same parents) which are suboptimal, which drop the average value of that moves. On the other hand, paths with lots of normal priority, but no path leading to highest score might be chosen as the average is better than the paths which has possibility to lead to highest score with many suboptimal neighbours. Thus, due to this average calculation, we are not always choosing for the best possible paths for every moves, but choosing for the overall optimal paths.

As for maximum propagation, it only takes into account the best possible score that the first depth moves may lead to. In doing so, we just choose a path which possibly leads to the highest score.

Point worth noticing is that there are random tiles that get spawned after performing every moves. This random spawn gives a random factor and also one of the reason why average depth is worse than maximum depth. Based on the explanation of maximum and average, we know that we are trying to get overall optimality paths for the average, while for the maximum we just get the highest path that it could achieve. Important conclusion taken from this experimentation shows that choosing best possible paths is more important than choosing overall optimality path as best possible paths leads to higher score due to random factor. Another factor that occurs due to the random spawn for the maximum is that after certain level of depth, such as 8, the maximum will give the same result with depth 6 search as the randomness factor also grows.

In conclusion, for the best possible choice, it is better to use max propagation with depth 6 as it gives us optimal score based on the test data. In addition, after depth 6 the randomness factor is becoming bigger which therefore gives the same result with depth 6.