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CS 386

Question 1:

Note: b is the branching factor. d is the depth of the solution. n = $(1+C/\varepsilon)$ search tree. l is the depth limit.

Algorithm	**Time Complexity**	**Space Complexity**	**Complete?**	**Optimal**
BFS	$O(b^{(d+1)})$	$O(b^{(d+1)})$	Yes	Yes
UCS	$O(b^n)$	$O(b^n)$	Yes	Yes
DFS	$O(b^n)$	(O(bn))	No	No
DLS	$O(b^l)$	O(bl)	No	No
IDS	$O(b^d)$	O(bd)	Yes	Yes
A*	$O(b^d)$	$O(b^d)$	Yes	Yes

Question 2:
State Count w/ Tools:
- BFS: 42
- DFS: 18
- DLS: 18

State Count w/ Problem Decomposition:
- BFS: 33
- DFS: 87
- DLS: 20

Question 3:
State Count:
- A*: 33
- UCS: 33

Question 4: Constraints

Antenna1: f2
Antenna2: f1
Antenna3: f3
Antenna4: f3
Antenna5: f2
Antenna6: f2
Antenna7: f1
Antenna8: f3
Antenna9: f1

Question 5: Deep Blue vs AlphaZero

a) What were the engineering advances that led to Deep Blue's success? Which of them can be transferred to other problems, and which are specific to chess?

- The engineering advances that led to Deep Blue's success were the enhancement of the chess chip. The chess chip had a newly redesigned evaluation function with over 8000 features that were developed due to problems in previous chess games. The chip also added hardware repetition detection, numerous specialized move generation modes, and search speed efficiency improvements. While each advancement has its perks, I feel that repetition detection and search speed efficiency can expand and be transferred to other problems other than chess since repetition and searches are apart of many different problems. Meanwhile, the numerous specialized move generation modes are probably more suited and specific to chess, since the moves generated are most likely chess moves. Another advance they made was to double the number of chess chips in the system and use a newer generation of SP computer to support high demands. This advancement may be specific to chess since the demands are based on the game, but it could also expand to different problems based on the situation. They also had a change in the software tools used for debugging and match preparation which can definitely be expanded to other problems.

b) AlphaZero is compared to a number of modern game-playing programs, such as StockFish, which work similarly to Deep Blue. The paper shows that AlphaZero is able to defeat StockFish even when it is given only 1/100 of the computing time. Why is that? Please frame your answer in terms of search and the number of nodes evaluated.

- AlphaZero is able to defeat SotckFish even when it is given only 1/100 of the computing time because it is using the Monte-Carlo tree search algorithm which

allows its search to consist of a series of simulated games of self-play that traverses a tree from root to leaf. The simulation proceeds by selecting for each node a move with a low visit count, high move probability and high value. Since the search returns a vector representing a probability distribution over moves, it allows AlphaZero to effectively combine its neural network representations with a powerful domain-independent search.