CS 404 – Artificial Intelligence
HW 2 – Blind Search – AIMA– Chp. 3

75pt
Late homeworks accepted for 2 days (no penalty in the first late day; -10pts off when late for 2 days)

Please type your answers and use only the allocated space.
You may color your answers blue for easy grading.

Objective: To depend the understanding of time and space complexity in search algorithms and deciding on suitable algorithms for a given problem.

Type your answers, but you can draw any illustrations by hand (if so you can send the scanned document).

1) 30pts –Answer the following using the general Tree Search algorithm (remove front node from the fringe/queue – goal test – expand).

Reminder: You can use the following equality for compactness:

$1 + b + b^2 + \ldots b^d = (b^{d+1}-1)/(b-1)$

a) 15pt - How many nodes are ***visited*** (chosen from the queue, goal tested and expanded) in the worst case using Breadth-First search, when the solution is at depth d, and the branching factor is b, and the depth of the maximum branch is m?

Give a formula.

Nodes that are visited are also nodes contained in the memory.The space complexity of the breadth first search is O(b^d) (keeps every node in memory, either in fringe or on a path to fringe).

$$1 + b + b^2 + \ldots + b^d = \frac{(b^{d+1}-1)}{(b-1)}$$

b) 15pt- How many nodes are ***generated*** (added to the queue as a result of expanding the parent) in the worst case using Breadth-First search, when the solution is at depth d, and the branching factor is b, and the depth of the maximum branch is m?

For breadth-first search,every node generated states in the memory. O(b^{d+1})

$$1 + b + b^2 + \ldots + (b^{d+1} - b) = \frac{(b^{d+1}-1)}{(b-1)} + (b^{d+1} - b)$$

2) 45pt – You are given the problem of finding whether 6-degrees of separation holds between a particular 2 people in the world. E.g. given two people – say you and your favorite celebrity - the software should decide whether they are connected in at most 6 friendship edges (e.g. you-f1-f2-f3-f4-f5-celebrity).

Let`s assume you have the list of all friendships for all people in the world and that everyone has exactly b=100 friends and that there are 6 billion people in the world.

a) **18pts)** State **whether the following algorithms are <u>complete</u>** (if there is a up to 6-degree path, does it find it?) **and <u>optimal</u>** (defined here as 'does it find the shortest path connecting two people') **for this problem**.

b) **12pts) If an algorithm is BOTH complete AND optimal, comment on its time and space complexity with a one line summary about its suitability (e.g. "will take too much time/space: O(b^d)").** If an algorithm would take too much time or space to be feasible, indicate as such; if it is suitable but is an overkill, you should indicate that also.

Algorithm	**Complete (answer as Yes or No)**	**Optimal (answer as Yes or No)**	**Feasibility (add a one line comment)**
Breadth first search	Yes (When b is finite)	Yes (When cost per step's are identical)	Time: $O(b^d)$ Space: $O(b^d)$ The algorithm takes $O(b^d)$ for space complexity which is a problem. From book Figure 3.13 Depth = 16 Memory = 10 exabytes
Depth first search without repeated state checking	No	No	Time: $O(b^m)$ Space: $O(bm)$ Without the repeated state checking,this algorithm tends to enter a loop if there is a cycle among nodes.
Depth first search with repeated state checking	Yes	No	Time: $O(b^m)$ Space: $O(bm)$ With repeated state checking,this algorithm tends to be complete since it does not enter a loop(due to repeated state check) but still not optimal.
Depth limited search DFS with a depth limit of $\ldots l \ldots\ldots\ldots$	Yes	No	Time: $O(b^l)$ Space: $O(bl)$ Might find the possible Goal State(if there exist one with l=6) but can not guarantee that it can do it in a performance wise manner.

Iterative deepening DFS	Yes (When b is finite)	Yes (All step costs are identical)	Time: $O(b^d)$ Space: $O(bd)$ Iterative deepening search combines strongest features of BFS(complete when b is finite) and DFS(memory requirements).
Bidirectional search	Yes (b is finite and both from goal to start and start to goal uses breadth first search)	Yes (All step costs are identical)	Time: $O(b^{d/2})$ Space: $O(b^{d/2})$ Applicable when forward and backward search are same(very much like the same).

c) **15pts) Which blind search algorithm** (among the ones listed above**) would be best for this problem? Explain your answer.** Consider space, time complexities and completeness and optimality.

If two algorithms are the same or similar, you may choose the one which is easier to implement or state that they are both as good / suitable.

Iterative Deepening DFS would be better since it shows better space complexity and shows the same time complexity when compared with other algorithms.(There exists only one algorithm that shows better time complexity than Iter. Deepening DFS which is Bidirectional Search which is hard to implement)

Finite condition of b is a feature asked by every blind search algorithm in order to achieve the Completeness and identical cost condition is asked by every blind search algorithm (except Uniform Cost which is cost sensitive) in order to obtain Optimality.