CS 495 & 540: Problem Set 1

Section: MW 10-11:50 am

Total: 150pts Due: 02/10/2016

Instructions:
1. I leave plenty of space on each page for your computation. If you need more sheet, please attach your work right behind the corresponding problem. If your answer is incorrect but you show the computation process, then partial credits will be given. Please staple your solution and use the space wisely.

2. This assignment contains two parts. Part I, due on Feb. 10 at the beginning of the class, is the written part while Part II, due on Feb. 13 at midnight on blackboard, is the programming part. Part I counts for 100/150 of the first assignment. You are allowed to work on the homework in a group of size up to two. No late assignment is accepted. Identical solutions (same wording, paragraph, code), turned in by different groups (persons), will be considered cheating.

3. Full credit will be given only to the correct solution which is described clearly. Convoluted and obtuse descriptions might receive low marks, even when they are correct. Also, aim for concise solutions, as it will save you time spent on write-ups, and also help you conceptualize the key idea of the problem.

First Name:

Last Name:

Group ID:

Score: /

Problem 1 Concept: BFS, DFS, Iterative Deepening: 20pts

Given a balanced tree with branching factor $= b$ and height $= m$. Please draw a simple graph (along with some brief description) for each sub question:
(a) BFS outperforms DFS in terms of time complexity

(b) DFS outperforms BFS int terms of time complexity

(c) Iterative Deepening gets defeated by DFS in terms of time complexity

(d) Iterative Deepening outperforms DFS in terms of time complexity

Problem 2 Tracing: BFS, DFS, Iterative Deepening : 16pts

Consider a state space where the start state is number 1 and each state k has two successors: numbers $2k$ (left child) and $2k+1$ (right child).
(a) Draw the portion of the state space for states 1 to 15.

(b) Suppose the goal state is 11. List the order in which the nodes will be visited by
(I) BFS

(II) DFS

(III) iterative deepening search (6pts)

(c) Call the action going from k to $2k$ Left and the action going to $2k+1$ Right. Can you find an algorithm that outputs the solution to this problem without any search at all?

Problem 3 Heuristic Path Algorithm: 20pts

The **heuristic path algorithm**(Pohl. 1977) is a best-first search in which the evaluation function is $f(n) = (2 - \omega)g(n) + \omega h(n)$.
(a) For what values of ω is this **complete**?

(b) For what value is it **optimal**, assuming that h is admissible?

(c-e) What kind of search does this perform for
(c) $\omega = 0$

(d) $\omega = 1$

(e) $\omega = 2$?

Problem 4 Heuristics Admissibility: Tree and Graph: 24 pts

Consider the unbounded version of the regular 2D grid shown in Figure3.9 in the textbook. The start state is at the origin $(0, 0)$ and the goal state is at (x, y).
(a) What is the branching factor b in the state space?

(b) How many distinct states are there at depth k (for $k > 10$)?

(c) What is the maximum number of nodes expanded by breadth-first tree search?

(d) What is the maximum number of nodes expanded by breadth-first graph search?

(e) is $h = |u - x| + |v - y|$ an **admissible** heuristic for a state at (u, v)? Explain.

(f) How many nodes are expanded by A* graph search using h?

(g) Does h remain admissible if some links are removed?

(h) Does h remain admissible if some links are added between nonadjacent states?

Problem 5 Heuristics: Application & Design: 20pts

n vehicles occupy squares $(1,1)$ through $(n,1)$ of an $n \times n$ grid. The vehicles must be moved in reverse order, so the vehicle i that starts in $(i,1)$ must end up in $(n-i+1,n)$. On each time step, every one of the n vehicles can move one square up, down, left or right or just stay put; but if a vehicle stays put, one other adjacent vehicle (but not more than one) can hop over it. Two vehicles cannot occupy the same square.

(a) Calculate the size of the state space as a function of n.

(b) Calculate the branching factor as a function of n

(c) Suppose that vehicle i is at (x_i, y_i); write a nontrivial admissible heuristic h_i for the number of moves it will require to get to this goal location $(n-i+1,n)$, assuming no other vehicles are on the grid.

(d) Which of the following heuristics are admissible for the problem of moving all n vehicles to their destinations? Explain

(i) $\sum_{i=1}^{n} h_i$

(ii) $\max\{h_1, \cdots, h_n\}$

(iii) $\min\{h_1, \cdots, h_n\}$

Problem 6 Programming Assignment I: 50pts

This part of programming is getting you familiar with Python. Please refer to http://inst.eecs.berkeley.edu/~cs188/pacman/tutorial.html for the tutorial. Upon finishing the tutorial, you should be able to accomplish project 0, which includes
(a) running autograder
(b) finishing addition.py (10pts), buyLotsOfFruit.py (15pts) and shopSmart.py (25pts).
Please turn in those three python files and I will test them using autograder.