CS-171, Intro to A.I., Fall Quarter, 2013 — Quiz # 1 — 20 minutes

1. NAME: _____

YOUR ID: _____ ID TO RIGHT:_____ ROW:_____ NO. FROM RIGHT:_____

2. (30 pts total, 2 pts each) For each of the following terms on the left, write in the letter corresponding to the best answer or the correct definition on the right. The first one is done for you as an example.

A	Agent	A	Perceives environment by sensors, acts by actuators
	Percept	B	All states reachable from the initial state by a sequence of actions
	Performance Measure	C	Guaranteed to find a solution if one is accessible
	Rational Agent	D	Process of removing detail from a representation
	State Space	E	Maximum number of successors of any node
	Search Node	F	Set of all pending nodes available for expansion at any given time
	Link between nodes	G	Estimates cost of cheapest path from current state to goal state
	Path	H	Guaranteed to find lowest cost among all accessible solutions
	Abstraction	I	Represents a state in the state space
	Optimal Search	J	Sequence of states connected by a sequence of actions
	Complete Search	K	Agent's perceptual inputs at any given instant
	Expand a state	L	Agent that acts to maximize its expected performance measure
	Frontier	M	Apply each legal action to a state, generating a new set of states
	Search Strategy	N	Represents an action in the state space
	Branching Factor	O	How a search algorithm chooses which node to expand next
	Heuristic Function	P	Evaluates any given sequence of environment states for utility

3. (5 pts each, 25 pts total) Recall that
- True path cost so far to node n = $g(n)$.
- Estimated optimal cost to goal from node n = $h(n)$.
- Estimated total cost of optimal path through node n = $f(n) = g(n) + h(n)$.

The following is a proof that A* tree search (queue sorted by f(n)) is optimal if the heuristic is admissible. The lines of the proof have been labeled A through G. Unfortunately, the lines have been scrambled. Let *ng* be the first goal node popped off the queue. Let *no* be any other node on the queue. We wish to prove that *no* can never be extended to a path to any goal node that costs less than the path to *ng* that we just found.

    A : true total cost of optimal path to *ng*
    B : $\leq f(no)$ // because queue is sorted by *f()*
    C : $\leq g(no)$ + true cost to goal from *no* // because *h()* is admissible
    D: = $f(ng)$ // by definition of *f(ng)* with *h(ng) = 0* because *ng* is a goal node
    E: = $g(no) + h(no)$ // by definition of *f()*
    F: = $g(ng)$ // because *ng* represents a complete path
   *G* : = true total cost of *no*

Fill in the blanks with the letters B, C, D, E, and F to prove that the true total cost of *ng* $\leq$ true total cost of *no*. The first and last letters, A and G, are done for you as an example.

    A   _____ _____ _____ _____ _____   **G**

5. (45 pts total, 9 pts each) Execute Tree Search through this graph (i.e., do not remember visited nodes). Step costs are given next to each arc. Heuristic values are given next to each node (as h=x). The successors of each node are indicated by the arrows out of that node. Successors are returned in left-to-right order.

For each search strategy below, show the order in which nodes are expanded (i.e., to expand a node means that its children are generated), ending with the goal node that is found. Show the path from start to goal, or write "None". Give the cost of the path found. The first one is done for you as an example.

S   h=10
7   4
A   h=3   B   h=7
C
h=3
10   G   4   4
h=0
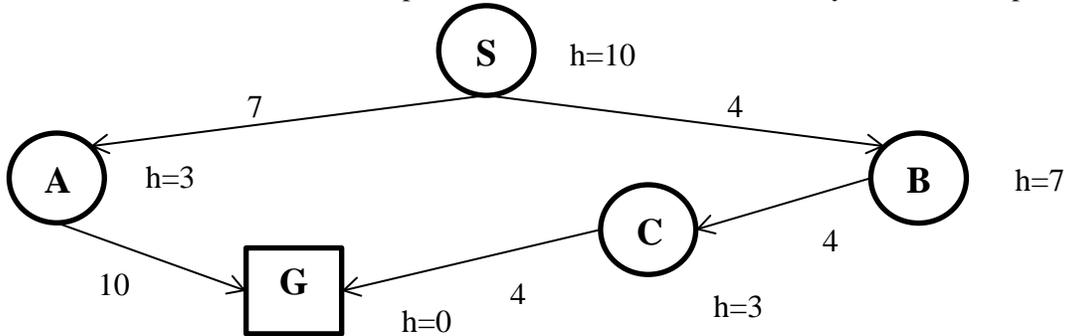
5.a. DEPTH FIRST SEARCH.

Order of node expansion: S A G

Path found: S A G   Cost of path found: 17

5.b. (9 pts) BREADTH FIRST SEARCH.

Order of node expansion:

Path found: Cost of path found:

5.b. (9 pts) UNIFORM COST SEARCH.

Order of node expansion:

Path found: Cost of path found:

5.c. (9 pts) GREEDY (BEST-FIRST) SEARCH.

Order of node expansion:

Path found: Cost of path found:

5.d. (9 pts) ITERATED DEEPENING SEARCH.

Order of node expansion:

Path found: Cost of path found:

5.e. (9 pts) A* SEARCH.

Order of node expansion:

Path found: Cost of path found:

Is the heuristic admissible (Yes or No)?