CS347 SP2005 Exam 1 Key

This is a closed-book closed-notes exam. The *only* items you are permitted to bring are writing implements. Mark every sheet of paper you use with your name and the string "cs347sp2005 exam1" (omittance, even if it is partial, will be penalized at 1 point per sheet). If you are caught cheating, you will receive a zero grade for this exam. The max number of points per question is indicated in square brackets after each question. The sum of the max points is 75 (excluding the 5 bonus points). You have 75 minutes to complete this exam. Good luck!

1. Define in a single sentence what a rational agent is. [5]

   A rational agent is one who selects an action that is expected to maximize its performance measure given the percept sequence and any built-in knowledege.

2. What is "Lady Lovelace's Objection"? [5]

   Ada Byron said a machine has no ability to create anything, but can only do what is programmed into it.

3. Give the PEAS description for the Plank Puzzle. [5]

   Performance If goal node reachable, get to it in the least number of moves possible.

   Environment The game board with planks, stumps, start & goal stump, and player location.

   Actuators Functions to move a single plank or the player (hands or mechanical actuators for physical game).

   Sensors Functions to capture the state of the game board in terms of plank locations, player location, stump locations, start & goal stump (eyes or computer vision for physical game).

4. Classify the Plank Puzzle task environment according to the following properties and explain your answers: [6]

   - Fully observable/partially observable

     Fully observable, because all items in the environment are visible at all times.
   - Deterministic/stochastic

     Deterministic, because for any given state the exact result of an action is known.
   - Episodic/sequential

     Sequential, because the environment in any given state is dependent on the actions in previous states (e.g., moving a plank in one state affects what moves are possible in a subsequent state).

5. Give a formal description of the Plank Puzzle by defining the initial state, successor function, goal test, and path cost function. [8]

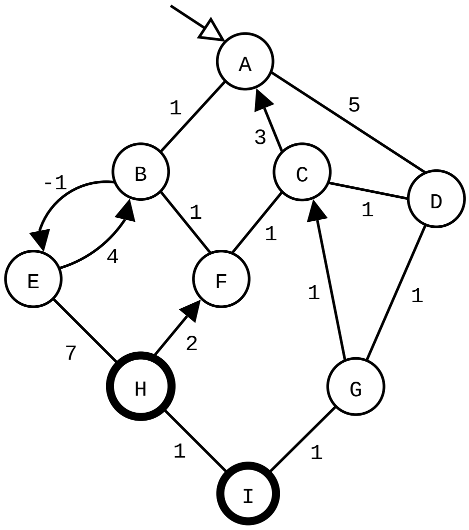
   Initial State A predetermined configuration of planks and stumps (including start and goal stumps), with the player located on the start stump.

   Successor Function Returns a list of (action,state) pairs, where the set of actions consists of all legal plank moves from the reachable stumps and the states are the result of applying one of those actions to the current state.

   Goal Test The player's location is the goal stump (or can reach the goal stump without making any plank moves).

   Path Cost Function The path cost can be defined as the number of actions/moves from the initial state to the current state.

   All the following questions are about the following state space graph, with A being the start state and H & I being goal states. The order in which successors are generated is counterclockwise, ending at exactly 9 o'clock. Example: C generates first F, then D, and finally A. When sorting by path-cost, nodes with equal path-cost are ordered such that the earlier a node is generated, the higher its priority. Nodes already on the open list have higher priority than newly added nodes with equal path-cost.



6. Give the execution trace of ID-DFTS. [12]

depth-limit=0

open	eval
A	A

depth-limit reached and no goal found

depth-limit=1

open	eval
A	A
BD	B
D	D

depth-limit reached and no goal found

depth-limit=2

open	eval
A	A
BD	B
EFAD	E
FAD	F
AD	A
D	D
GAC	G
AC	A
C	C

depth-limit reached and no goal found

depth-limit=3

open	eval
A	A
BD	B
EFAD	E
HBFAD	H

goal found; solution=ABEH; path-cost(ABEH)=7

7. Give the execution trace of UCGS. [10]

open	closed	eval
A0	-	A0
B1D5	A	B1
E0F2D5	AB	E0
F2D5H7	ABE	F2
C3D5H7	ABEF	C3
D4H7	ABEFC	D4
G5H7	ABEFCD	G5
I6H7	ABEFCDG	I6

goal found; solution = ABFCDGI; path-cost(ABFCDGI)=6

8. Give the execution trace of GBeFGS employing as heuristic $h(n)$ = the minimal number of steps from node n to the nearest goal node. [8]

open	closed	eval
A3	-	A3
B2D2	A	B2
E1D2F3	AB	E1
H0D2F3	ABE	H0

goal found; solution=ABEH; path-cost(ABEH)=7

9. Is UCGS optimal for this problem? Explain your answer! [5]

   Yes, because the negative step cost from B to E did not cause a negative cycle which would have prevented UCGS from completing and the solution it found is optimal because the only other possible paths via B would either involve useless loops with positive cost, EH which has a higher path-cost than the solution found, or start with either ADC or ADG which is already as expensive as the solution found.

10. Is GBeFGS employing the above described heuristic $h(n)$ optimal for this problem? Explain your answer! [2]

    No, because it found a solution with higher path-cost than the one found by UCGS.

11. Is ID-DFTS optimal for this problem? Explain your answer! [2]

    No, because it found a solution with higher path-cost than the one found by UCGS.

12. Are there depths l for which DLTS would be incomplete for this problem? If yes, give those depths; otherwise explain why not. [2]

    Yes, for $l \leq 2$ DLTS is incomplete.

13. Is there a step cost associated with a *single* action that can be changed in the state space graph which would make ID-DFTS not complete? (Note: bidirectional edges represent two separate actions, each with their own step cost). If yes, then give the action and new step cost; otherwise, explain why not. [3]

    No, because ID-DFTS does not take step costs into account.

14. Is there a step cost associated with a *single* action that can be changed in the state space graph which would make UCGS not complete? (Note: bidirectional edges represent two separate actions, each with their own step cost). If yes, then give the action and new step cost; otherwise, explain why not. [2]

    No, because UCGS is a graph search algorithm and will therefore not revisit nodes, so negative cycles cannot affect its completeness.

BONUS Are there state spaces for which DLTS with $l < diameter$ is optimal? Explain your answer! [5]

Yes. For instance, consider a state space where the start state is a goal and has at least one successor; then the diameter is greater or equal to one and DLTS with $l = 0 < diameter$ is optimal. Or, alternatively, consider a state space with branching factor equal to one and positive step costs, which contains three states. If the first state reached from the start state is a goal state, then DLTS with $l = 1 < 2 = diameter$ is optimal.