National University of Computer & Emerging Sciences

(Karachi Campus)

Final Examination– Spring 2015

Artificial Intelligence (CS401)

Time Allowed: 180 minutes
Maximum Points: 100

Date: 08 December, 2015

Instructions: Attempt all questions, in order of appearance. Do not answer if you do not know the answer. Be succinct and clear.

Question No. 1 — Introduction + Intelligent Agents [10 Points] [Time: 15 Min.]

a. How do you define Artificial Intelligence according to CS401? State your choice among the 4 choices and say why. [4]

b. Design an autonomous fishing trawler according to the PEAS principles. Also categorize the environment. [6]

Question No. 2 — State Space Search [20Points] [Time: 35 Min.]

Consider our robot Roomba2 is standing at some point in a grid consisting of n*m cells, each cell having a distinct (i,j) value. Assume the bottom-left corner cell has index (1,1) . Roomba2 is standing at some start state (S) and needs to find a path to the goal state (G). Our Roomba2 can only move (UP, LEFT, and RIGHT) one cell at a time, with a cost of 1. There are some cells with a blockage (*) so Roomba2 has to detour around these cells. Consider the following example grid:

*		G		*
		*		
		*	*	
	*	S		*

a. Draw a state space tree for the given search problem using cell indexes as node label. For example the root of the search tree will be (3,1). Extend this root node to a depth- level =2 by using the allowable operators (UP, LEFT, and RIGHT). [4]

b. Give the sequence of cells explored (search path), if Roomba2 perform Breadth First Search (BFS) in this scenario. [4]

c. Give the sequence of cells explored (search path), if Roomba2 perform Depth First Search (DFS) in this scenario. [4]

d. Give the sequence of cells explored (search path) if our Roomba2 perform A* search in this scenario. Assume that the Manhattan distance can be used as the heuristic function- h(n) for any cell. The cost to reach a cell (i,j) = g(n)= min(i,j) that is the minimum of indexes i and j. Therefore, A* uses f(n)=g(n)+h(n); [4]

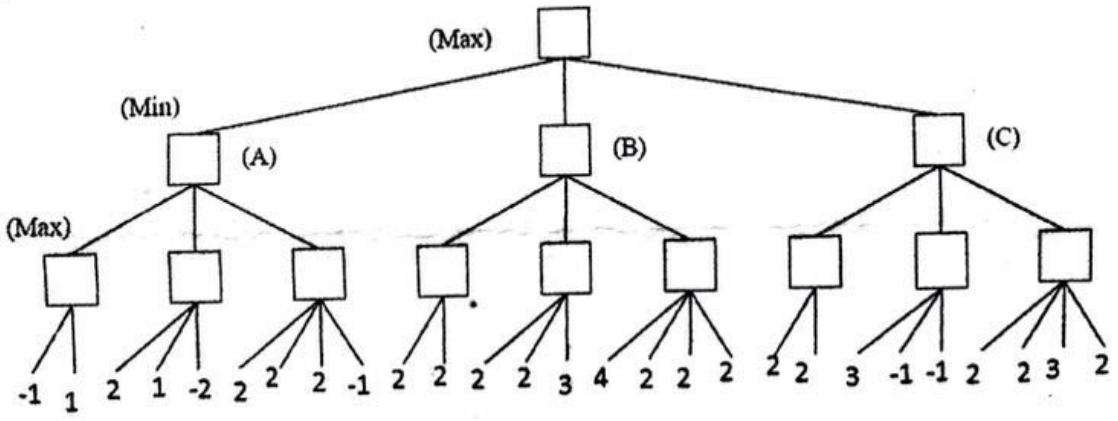
e. If UP costs twice as much as either LEFT or RIGHT, give the least-cost path from S to G? [4]

Question No. 3 — Beyond Classical Search [10Points] [Time: 15 Min]

a. Why property of the convergence of the search space onto the state space causes you to switch to approximative search aka local search methods? [4]
b. What is the generic solution for avoiding local optima. [2]
c. Identify what landmark corresponds on the cost terrain to: [4]
   i. A monotonic increase
   ii. A monotonic decrease
   iii. A deceleration followed by an acceleration
   iv. A monotonic isohypse (hyps, from Greek hupsos: height or top)

Question No. 4 — Adversarial Search [10Points] [Time: 14 Min]

a. Consider the following game tree, redraw on your answer scripts and fill in the blank boxes by using Mini-Max Search. [4]



b. Redraw and mark cut using Alpha-Beta pruning, how many branches will be prune at each level. [4]
c. What will be the best move for Max? [2]

Question No. 5 — Constraint Satisfaction [10Points] [Time: 10 Min]

Consider assigning colors to a checkerboard so that squares that are adjacent vertically or horizontally do not have the same color. We know that this can be done with only two colors, say red (R) and black (B).

We do not limit our discussion to five squares on a 3x3 board, but go onto include sqare numbered 9:

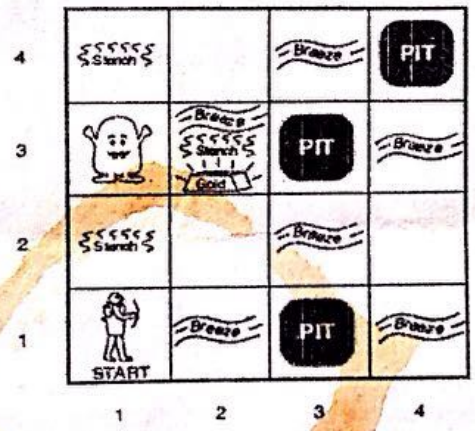
1 | 2 | 3
---
4 | 5 | 6
---
7 | 8 | 9

a. Develop the CSP formulation of this problem and indicate the initial state. [4]
b. If the initial domain of variable 5 is restricted to { B }, with the other domainsas before. If we now run full constraint propagation, what are the resulting domains of the variables? [4]
c. If in the initial state (all variables have domains { R, B }), we assign variable 1 to R and do forward checking, what are the resulting domains of the other variables? [4]

Logical Agents

Question No. 6 [12Points] [Time: 25 Min.]

Our Agent, having perceived nothing in [1,1], a breeze in [2,1], and a stench in [1,2], is now concerned with the contents of [1,3], [2,2], and [3,1]. Each of these can contain a pit, and at most one can contain a Wumpus.

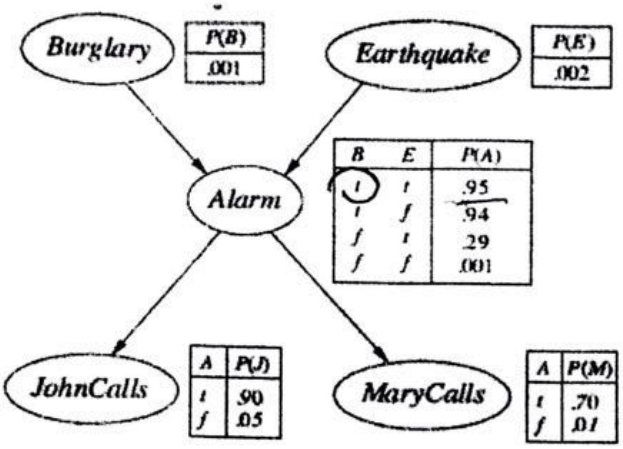


a. Construct the possible set of models (worlds) correspond to the case where [1,3], [2,2], and [3,1] may contains Pits and [1,1], [1,2] and [2,1] are explored cells. You can use propositional logic literals/formulas or diagram to represent world. [4]
b. Going forward from part (a), lets construct the possible set of models (worlds) correspond to the case where we came to know that [2,2] has no pit. You can use propositional logic literals/ formulas or diagram to represent world. [4]
c. Does your model work for cases where you are unsure of which of [2,1] or [1,2] contains a breeze and which a stench? Reason. [4]

Quantifying uncertainty + Probabilistic reasoning

Question No. 7 [16Points] [Time: 20 Min.]

Consider the graphical model from your text:



Calculate the following probabilities [4,4,4,4]:

a. P(Alarm)
b. P(Burglary | Alarm==t)
c. P(JohnCalls | Alarm ==f)
d. P(MaryCalls | JohnCalls)

Machine learning

Question No. 8 [10Points] [Time: 20 Min.]

a. Use the k-means algorithm and Euclidean distance to cluster the following 6 examples into 2 clusters: A1=(2,10), A2=(2,5), A3=(8,4), A4=(5,8), A5=(7,5), A6=(6,4)

The distance matrix based on the Euclidean distance is given below:

	A1	A2	A3	A4	A5	A6
A1	0	$\sqrt{25}$	$\sqrt{36}$	$\sqrt{13}$	$\sqrt{50}$	$\sqrt{52}$
A2		0	$\sqrt{37}$	$\sqrt{18}$	$\sqrt{25}$	$\sqrt{17}$
A3			0	$\sqrt{25}$	$\sqrt{2}$	$\sqrt{2}$
A4				0	$\sqrt{13}$	$\sqrt{17}$
A5					0	$\sqrt{2}$
A6						0

Suppose that the cluster centers are A1, A4. Run the k-means algorithm for 1 epoch only. At the end of this epoch show using a cartesion/co-ordinate plane: [2,2,2]

i) The new clusters (i.e. the examples belonging to each cluster)
ii) The centers of the new clusters

b. The model accuracy has to be checked on testing data rather than training data. Why or why not? [2]

c. When would you prefer k-fold cross validation over train-validate-test method? [2]

BEST OF LUCK