Date: 18/09/2017

Ahsanullah University of Science and Technology

Department of Computer Science & Engineering

4^{th} year, 1^{st} semester — Final Examination, Spring 2017

Course No: **CSE 4107** — Course Title: **Artificial Intelligence**

Time: 3 hours — Full Marks: 70

[Answer any 5(five) questions from the 7(seven) questions]
[Marks allotted are indicated in the right margin]

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1. a) Draw the flow chart of *genetic algorithm*. What happens when you use only : 3+3
   i. Selection.
   ii. Mutation.
   iii. Selection + Crossover.

   b) In an 8-queen problem, how many ways can you represent an individual? Give examples of them. How does *simulated annealing* work? How does it improve over *hill climbing algorithms*? 2+3

   c) Write short notes on: 3
   i. Goal-based Agents.
   ii. Utility-based Agents.
   iii. Memory-based Agents. 4

2. a) Represent the following facts (using functions, quantifiers, variables etc.) : 4
   i. Marcus was a Pompeian.
   ii. Marcus was born in 40 A.D.
   iii. All men are mortal.
   iv. All Pompeians died when the volcano erupted in 79 A.D.
   v. No mortal lives longer than 150 years.
   vi. It is now 2011.
   vii. Alive means not dead.
   viii. If someone dies, he is dead in all later times.

   b) Use *resolution algorithm* (with equality and reduce) on axioms of 2(a) to find out whether Marcus is alive or not. You must show the conversion of the axioms into clause form first. 8

   c) Give two examples of each of the following: 2
   i. Fully-observable environment.
   ii. Partially-observable environment.

3. a) In figure 1 (see last pages), straight-line distance among different cities of Romania is given. Also, in the graph the cities are represented as nodes. The edges indicate the existing paths among different cities. The cost to move from one city to another is also given. Draw simulations for finding the cost of moving from Arad to Bucharest for the following algorithms (Only write first three letters of city names., I.E., Bucharest -> Buc): 4+4
   i. Greedy Best-First Search Algorithm.
   ii. A* Search Algorithm.

   b) Write the pseudo-code of *Iterative Deepening Search (IDS)* (you can use depth-limited 2+2 search directly). Demonstrate it in three iterations upto depth-limit 2 on a binary tree (The root of the tree is at depth 0).

c) Derive the time-complexity of IDS. For branching factor, b = 10 and depth, d = 5, compare the number of nodes that will be generated in their expansion of search tree between IDS and BFS. 2

4. a) For the table(1) given below, calculate conditional probability P(toothache|cavity) using *Normalization technique* only. 3

	toothache		¬toothache	
	catch	¬catch	catch	¬catch
cavity	0.108	0.012	0.072	0.008
¬cavity	0.016	0.064	0.144	0.576

Table 1: A full joint distribution of toothache, cavity and catch world

b) Derive the formula for P(cavity | toothache ∧ catch), when toothache and catch are not independent. 3
Now, consider that toothache and catch are independent. What will be the new formula given this new condition?

c) Draw a *Bayesian network* considering the following cases of a car's system: 4
   i. When ignition occurs within an engine and there is gas present, a car starts.
   ii. The car can not move unless it starts first.
   iii. For ignition to occur, the battery needs to be active.
   iv. You can listen to the radio too, if the battery is active.

Here, the nodes of the network are: Moves, Gas, Ignition, Battery, Starts, Radio. How many independent variables are there in your Bayesian Network?

d) Write notes (with figures) on : 4
   i. Singly Connected Network.
   ii. Multiply Connected Network.

5. a) What do you understand by *minimax algorithm*? Demonstrate it in a two ply game tree. Then, write down the following properties of minimax algorithm : 4+2
   i. Completeness.
   ii. Optimality.
   iii. Time Complexity.
   iv. Space Complexity.

b) Define *alpha-beta pruning*. What is the purpose of it? Demonstrate alpha-beta pruning in the given figure 2 (see last pages). 4

c) How does modern chess engines calculate such good moves in short times despite the search space being huge beyond imagination? 2+2
Suppose in a multiplayer game, your program A is up against B, C and D in a four-way battle. Only one player can be the winner.
Write multiple points on how you will program A.

6. a) Use *decision-tree-learning algorithm* in figure 3 (see last pages) to draw a learned tree for 2

(toothache ∧ catch) = P(toothache)

P(catch

P(B|A

$P(b)\,P(a|b) = \frac{P(a \wedge b)}{P(b)}$

$P(A \cup B) = \frac{P(B|A)P(A)}{P(A)} = P(A|B)P(B)$

b

prediction whether tennis should be played. Use the weather conditions as features.

b) Calculate the following: 4

   i. Information gain(S, Wind).
   ii. Information gain(S,Humidity).

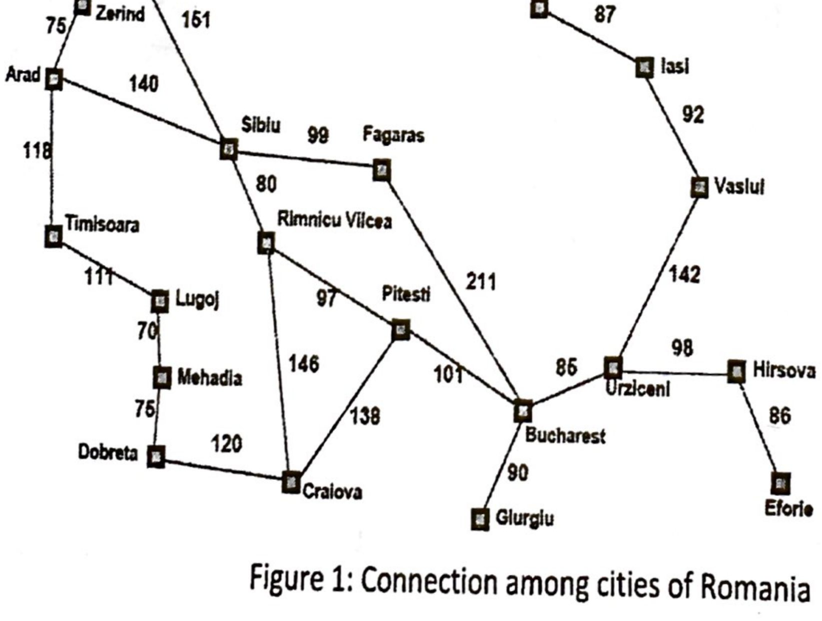
c) Derive the *stochastic gradient ascent rule* (to update the value of Θ) in logistic regression. What do you understand by *hypothesis* in machine learning? 4+2

d) Demonstrate how *k-means clustering* works. 2

7. a) Discuss the following: 6

   i. Minimum Remaining Value Heuristic.
   ii. Least Constraining Value Heuristic.
   iii. Forward Checking.

b) What is *min-conflicts heuristic*? Demonstrate the difference *between min-conflicts heuristic and backtracking algorithm* for 8-queen problem (use figures). 6+2
Also, Demonstrate with figures how *cycle-cut* can be used in constraint satisfaction problems (CSP).



Straight−line distance to Bucharest

Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

Figure 1: Connection among cities of Romania

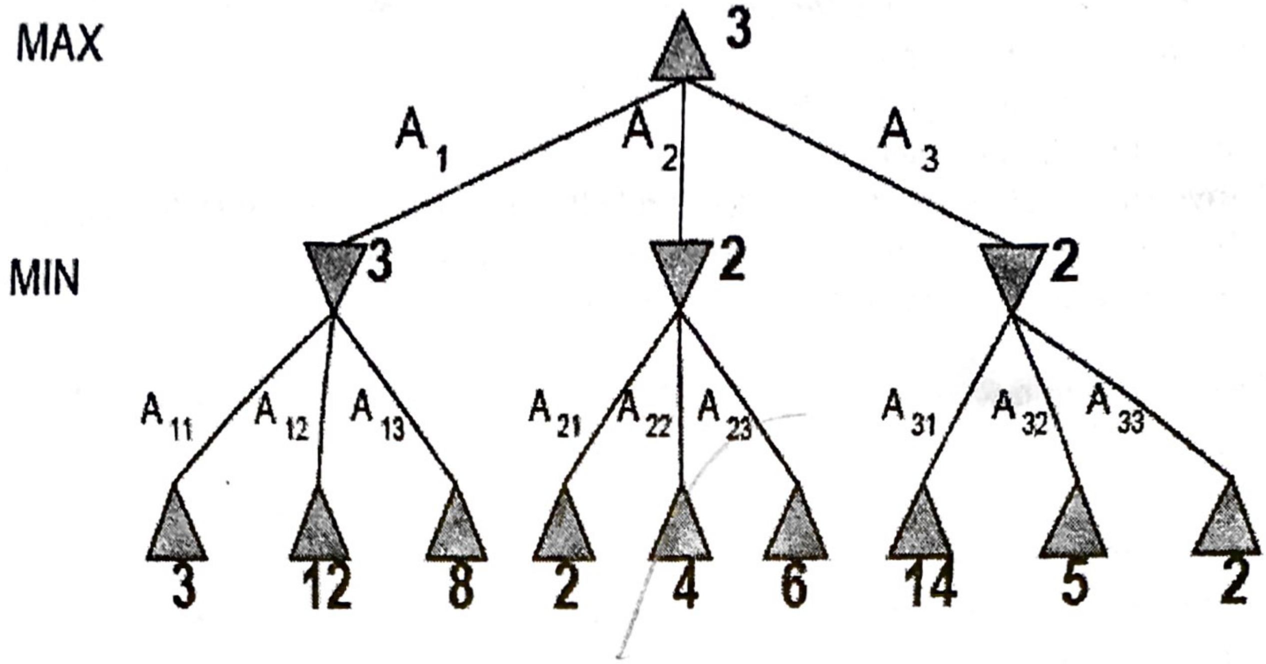


Figure 2: Game tree for optimal decision making in minimax

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

Weak
Strong

Figure 3: Data for predicting suitability for playing tennis based on weather features

Play Yes 3