CISC 3410 - Final Exam

Name:_____

1 Q1

Circle (O) the true statements, and cross (X) the false statements.

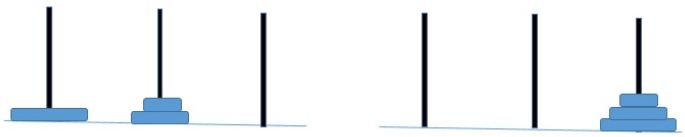
1. Breadth-first search is a special form of uniform-cost search where the cost g(n) is the number of steps from the initial state to state n.
2. Depth-first tree search is complete if the state space is finite.
3. Backtracking search is a variant of depth-first search which generates only one successor at a time rather than all successors.
4. A heuristic function h(n) is said to be admissible if it never exceeds the real optimal cost from n to any goal state. Therefore, h(n) = 0 is always admissible.
5. Uniform-cost search is a special form of A* search.
6. If event `a` is independent of event `b`, then `P(a | b,c) = P(a|c)` for any event `c`.
7. A Bayesian network (BN) is a concise representation of a full joint probability distribution. Given a BN, the full joint probability distribution represented by the BN can be reconstructed.
8. In decision-tree learning, the information gain from a selected attribute can never be 0.
9. Although linear regression problems can be solved analytically, it is more practical to use gradient descent learning to obtain parameters when data matrices are large.
10. All Boolean functions are linearly separable, and therefore all basic Boolean functions (and, or, not, xor, and equiv) can be represented by one-layer neural networks.

2 Q2

Consider the Tower of Hanoi problem as a search for a plan in the state space that transforms a given initial state into a specified goal state. The actions in the plan must satisfy the following rules:

1. Only one disk may be moved at a time.
2. Only the top disk on any peg may be moved.
3. A larger disk may not be placed on top of a smaller disk.

Apply the A* algorithm to the following problem instance, using the number of misplaced disks as the heuristic function. After three node expansions, show the states in the frontier and the corresponding $f(n)$ values for each state.



Initial state

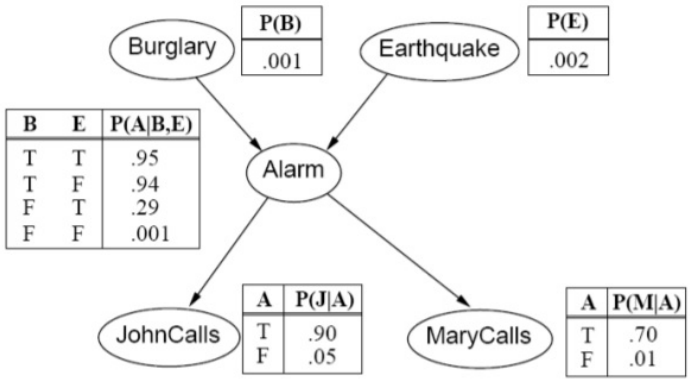
Goal state

3 Q3

Consider the knapsack problem described below. A smuggler has a knapsack with a capacity of 9 units. He can smuggle bottles of whiskey (size 4 units), bottles of perfume (size 3 units), and cartons of cigarettes (size 2 units). The profit from smuggling a bottle of whiskey, a bottle of perfume, and a carton of cigarettes is 15, 10, and 7 units, respectively. If the smuggler can make only one trip, how can he maximize his profit? Model the problem as a constraint optimization problem and implement the model.

4 Q4

Consider the following Bayesian network:



Give a formula for computing each of the following:

1. P(Burglary = true, Earthquake = true, Alarm = true)
2. P(Burglary | Alarm = true)

5 Q5

Consider the following training set used for learning a decision tree. The target attribute is *PlayTennis*, which can take the values `Yes` or `No`. Each instance is described by three attributes: *Outlook*, *Temperature*, and *Wind*.

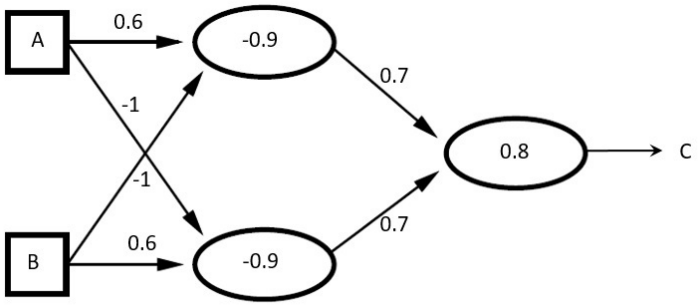
ID	Outlook	Temperature	Wind	PlayTennis
1	Sunny	Hot	Weak	No
2	Sunny	Hot	Strong	No
3	Overcast	Hot	Weak	Yes
4	Rain	Mild	Weak	Yes
5	Rain	Cool	Weak	Yes
6	Rain	Cool	Strong	No
7	Overcast	Mild	Strong	Yes
8	Sunny	Cool	Weak	No

Assume that decision tree learning uses *information gain* based on entropy as the attribute selection criterion.

1. Compute the information gain for each attribute: *Outlook*, *Temperature*, and *Wind*.
2. Which attribute should be chosen as the root of the decision tree? Justify your answer.

6 Q6

Consider the neural network shown below, in which each unit (except the input units) has an associated threshold, and each connection has an associated weight. Assume that the activation function is a hard threshold (also known as a step function): it outputs 1 if the weighted sum of the inputs is greater than or equal to the threshold, and outputs 0 otherwise.



1. Specify the Boolean function from the inputs A and B to the output C represented by the neural network (as a truth table or a formula).
2. Modify the link weights and the unit thresholds such that the output C is always the same as the input A.