

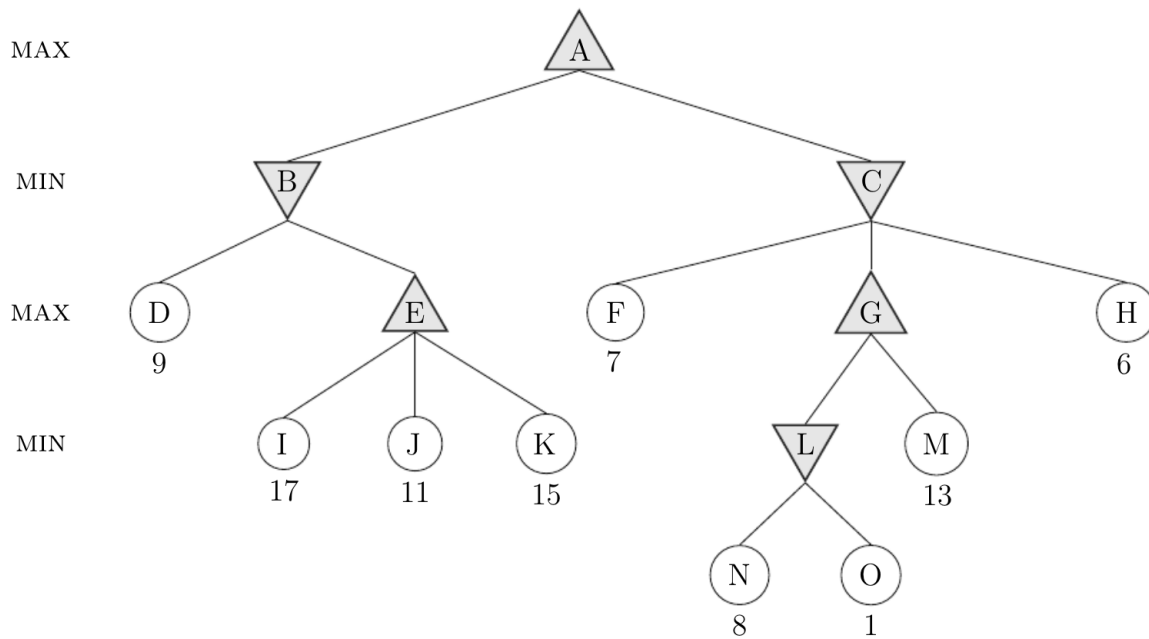
Foundations of Artificial Intelligence: Homework 2

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Problem 1

(10 points)

Consider the MAX-MIN game tree shown below where the numbers underneath the leaves of the tree are utility values from the first player's point of view (**MAX**).



a) Draw a copy of the tree on paper and perform the **minimax** algorithm on it by hand. Write the resulting minimax values next to every node

b) Do the same, but with **left-to-right alpha-beta** pruning. Write the final values for α and β next to every node, and indicate which nodes are not examined due to pruning.

c) Do the same, but with **right-to-left alpha-beta** pruning. Write the final values for α and β next to every node, and indicate which nodes are not examined due to pruning.

Problem 2

(10 points)

Consider a vocabulary with the following symbols:

- $Occupation(x, y)$: Predicate. Person x has occupation y .
- $Customer(x, y)$: Predicate. Person x is a customer of person y .
- $Boss(x, y)$: Predicate. Person x is a boss of person y .
- $doctor, surgeon, lawyer, actor$: Constants denoting occupations.

- *emily, joe*: Constants denoting people.

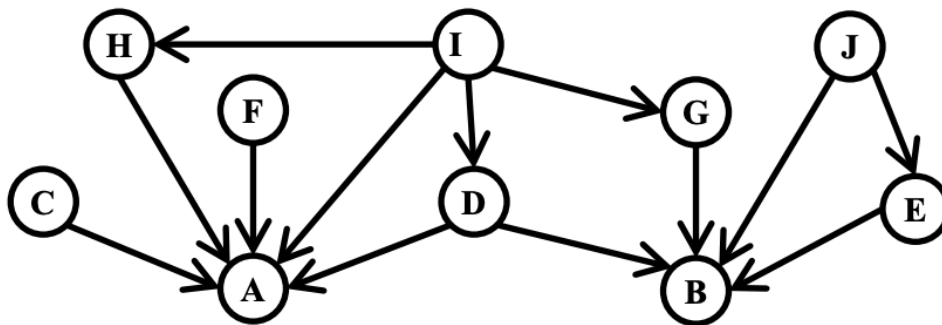
Use these symbols to write the following assertions in first-order logic:

- Emily is a surgeon. or a lawyer.
- Joe is an actor, but he also holds another job.
- All surgeons are doctors.
- Joe does not have a lawyer (i.e., is not a customer of any lawyer).
- Emily has a boss who is a lawyer.
- There exists a lawyer all of whose customers are doctors.
- Every surgeon has a lawyer.

Problem 3

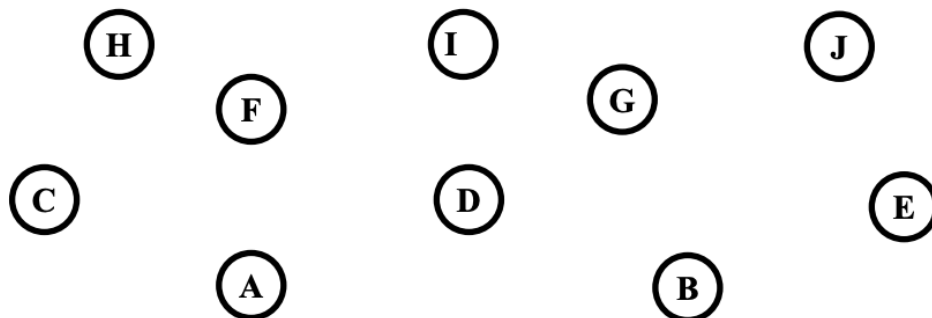
(10 points)

- Write down the factored joint probability distribution according to the following Bayesian Network.

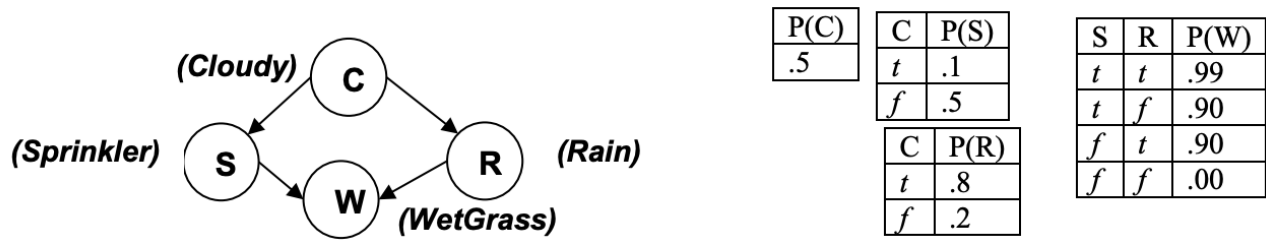


- Draw the Bayesian Network that corresponds to this conditional probability:

$$P(A|C, D, F, H)P(B|D, E, J)P(C|H)P(D|G, J)P(E)P(F|G, I)P(G|I, J)P(H)P(I)P(J)$$



(c) Below is the Bayesian network for the WetGrass problem.



Write down an expression that will evaluate to

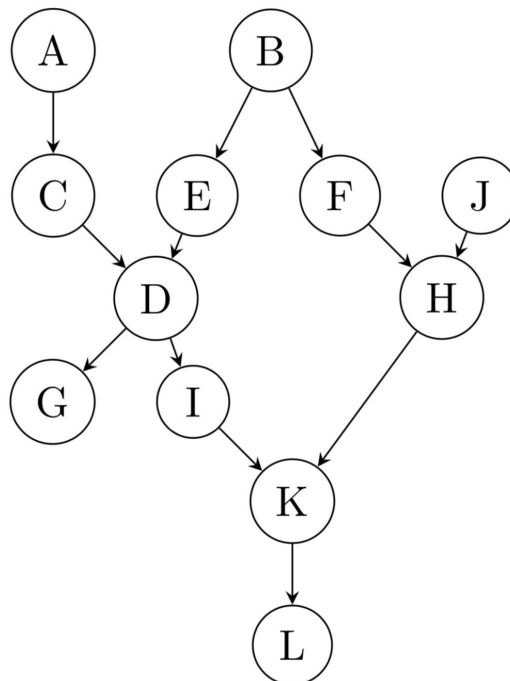
$$P(C = f \wedge R = f \wedge S = t \wedge W = t).$$

You do not need to carry out the multiplication to produce a single number (probability).

Problem 4

(10 points)

According to the following Bayesian Network,



(a) List all the variables that are d-separated from F given E.

(b) List all the variables that are d-separated from F given E and K.