

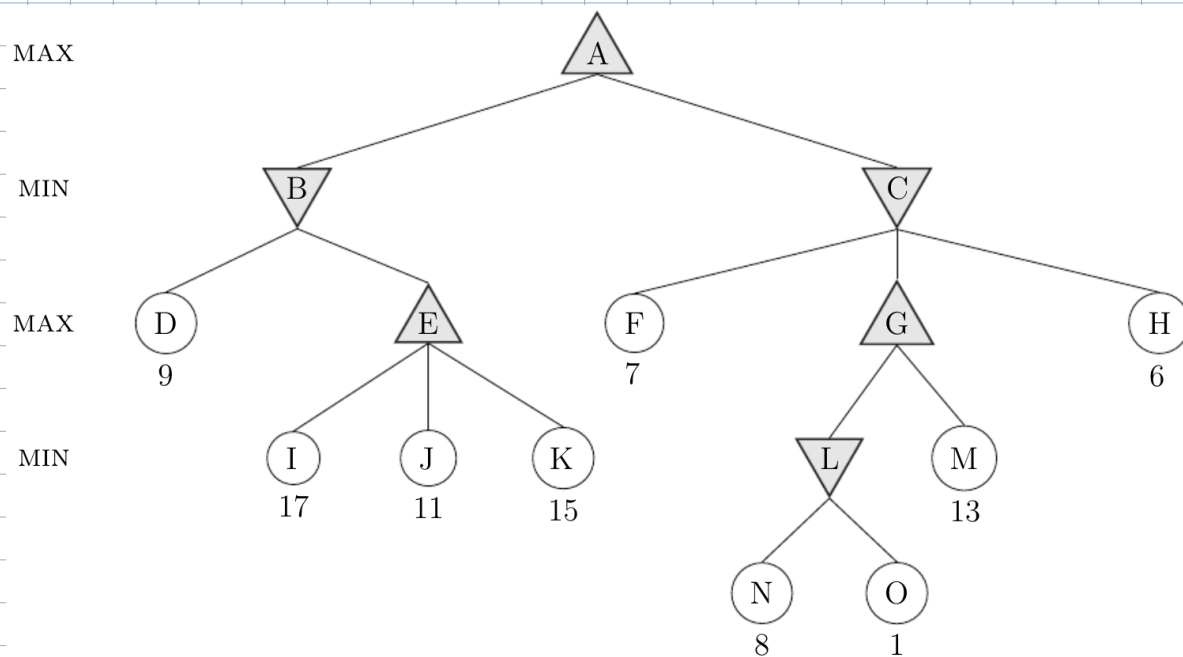
Foundations of Artificial Intelligence: Homework 2

Instructor: Shang-Tse Chen & Yun-Nung Chen

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).

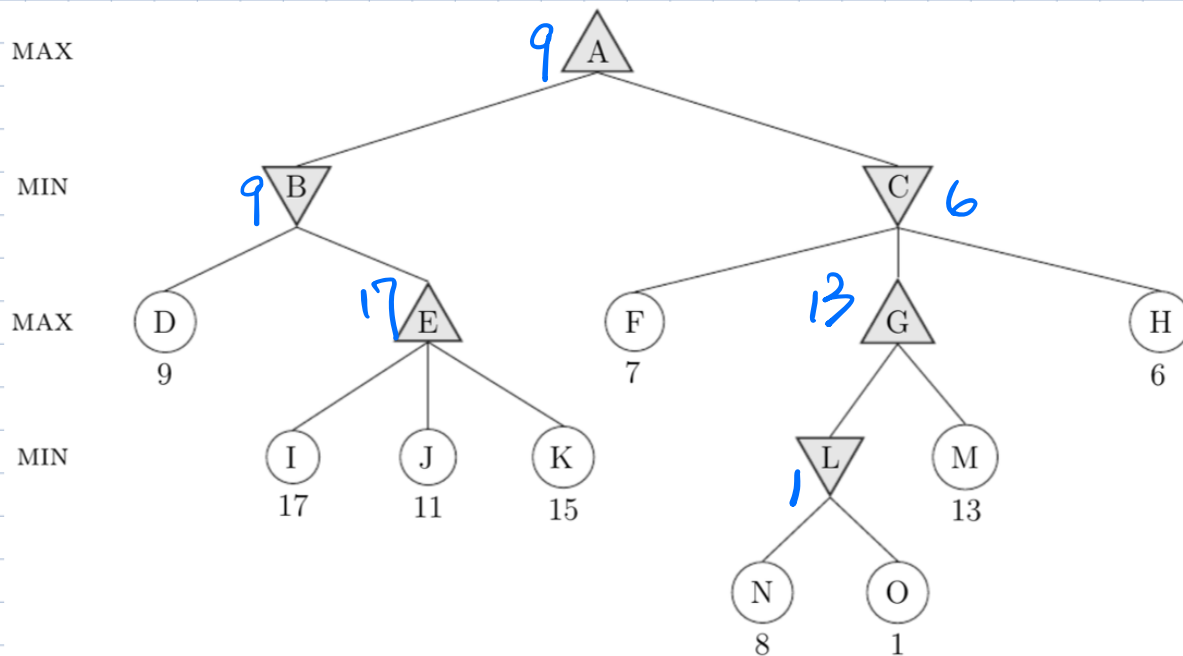


- Draw a copy of the tree on paper and perform the **minimax** algorithm on it by hand. Write the resulting minimax values next to every node.
- Do the same, but with **left-to-right alpha-beta** pruning. Write the final values for α and β next to every node, and indicate which nodes are not examined due to pruning.
- 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 1

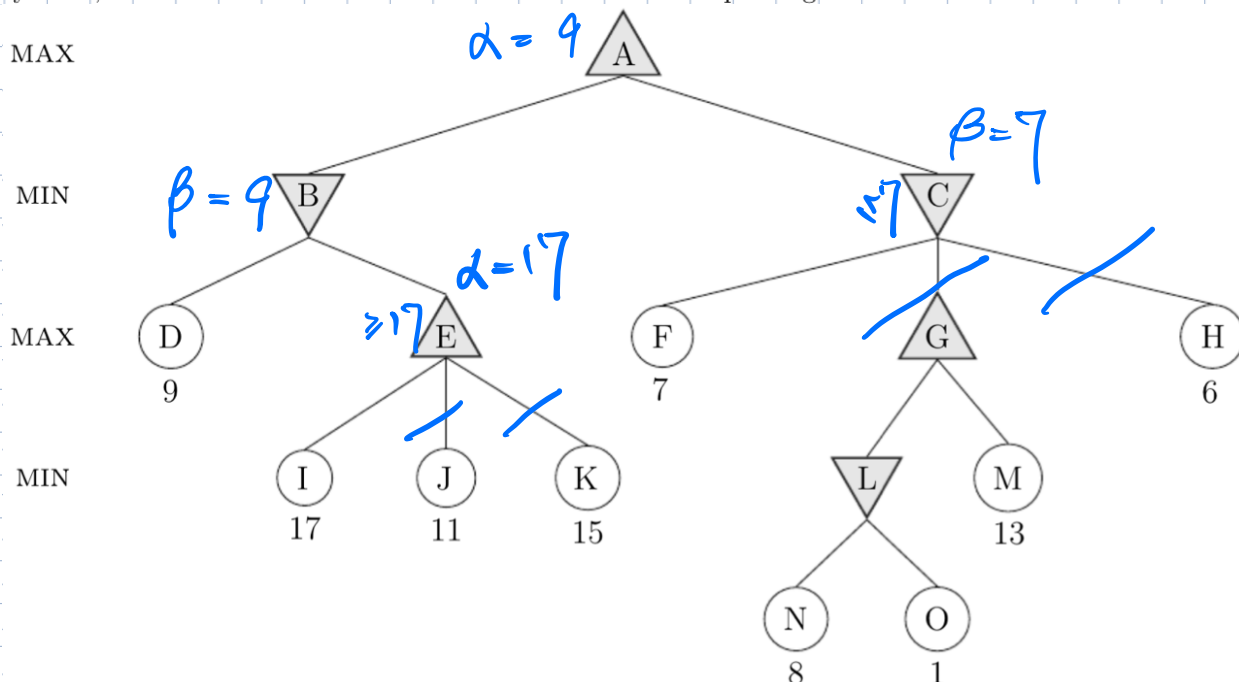
(10 points)

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).



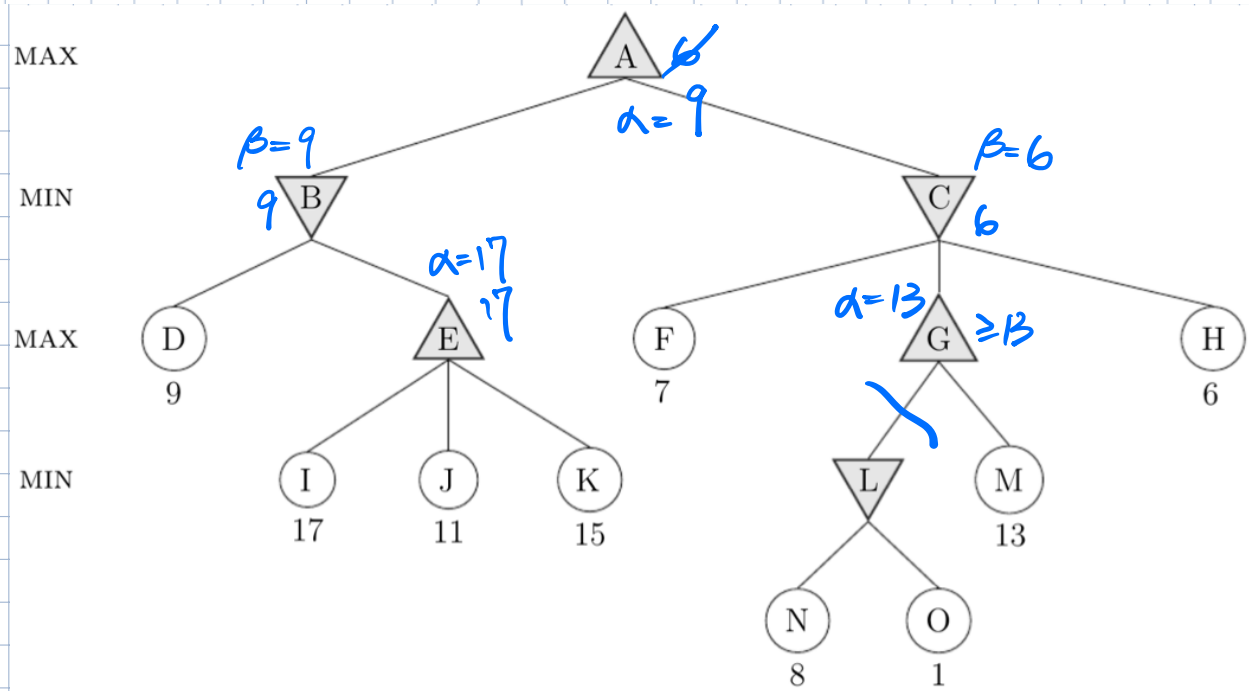
a) Draw a copy of the tree on paper and perform the **minimax** algorithm on it by hand. Write the resulting minimax values next to every node

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.



NOT examined: J, K, G, L, N, O, M, H #

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.

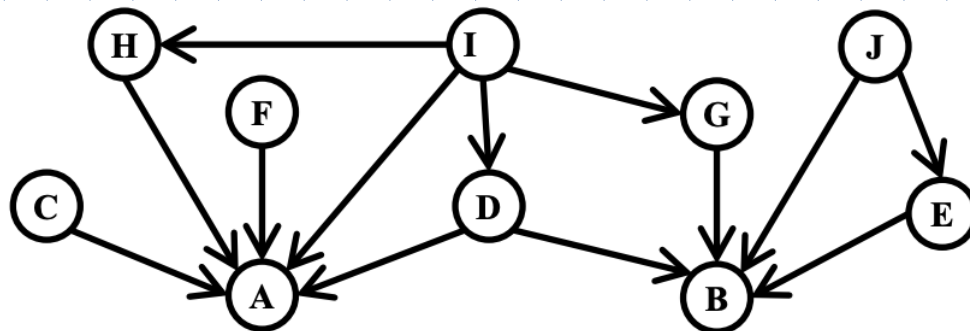


NOT examined: L, O, N_#

Problem 2

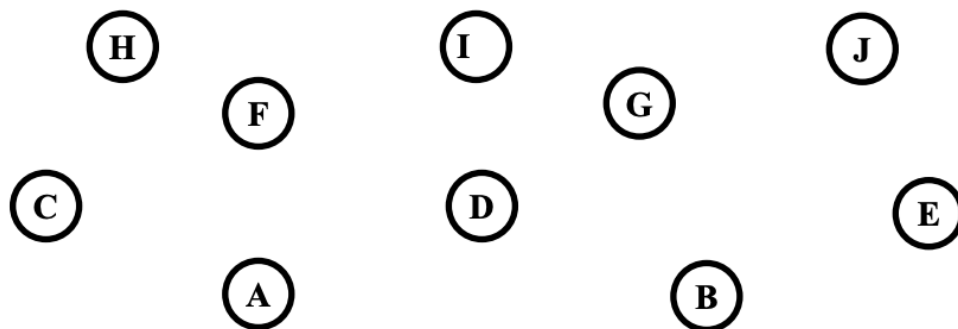
(10 points)

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

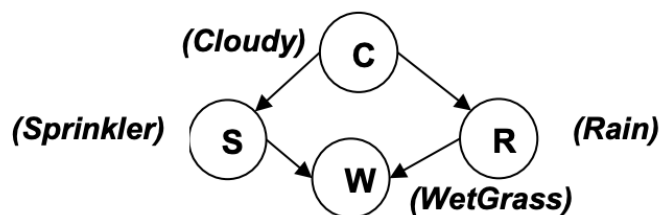


- (b) Draw the Bayesian Network that corresponds to this conditional probability:

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



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



P(C)
.5

C	P(S)
t	.1
f	.5

C	P(R)
t	.8
f	.2

S	R	P(W)
t	t	.99
t	f	.90
f	t	.90
f	f	.00

Write down an expression that will evaluate to

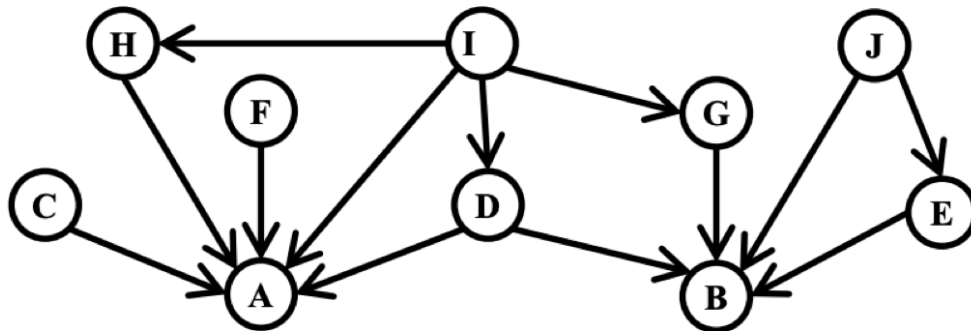
$$P(C = f \wedge R = f \wedge S = t \wedge W = t).$$

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

Problem 2

(10 points)

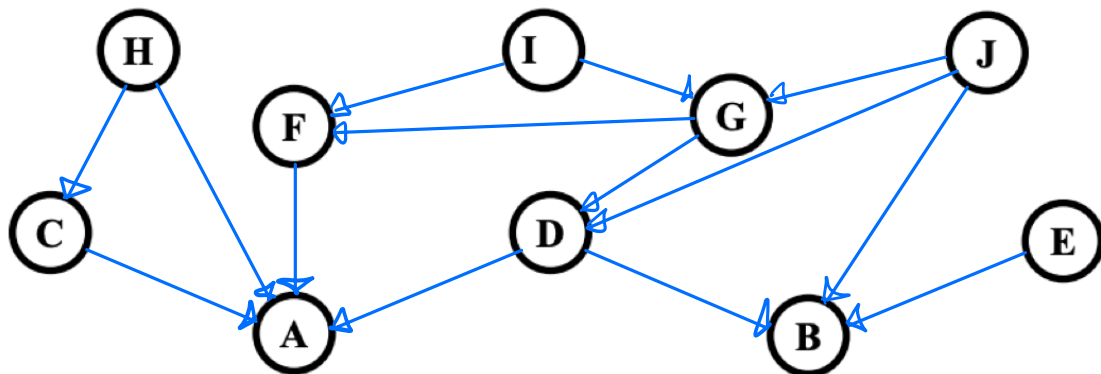
(a) Write down the factored joint probability distribution according to the following Bayesian Network.



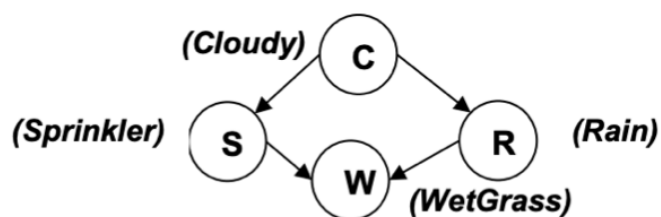
$$\begin{aligned}
 &P(J, E, B, I, G, D, H, A, F, C) \\
 &= P(J) \cdot P(E|J) \cdot P(B|J, E, G, D) \cdot P(I) \cdot P(G|I) \cdot P(D|I) \\
 &\quad \cdot P(H|I) \cdot P(C) \cdot P(F) \cdot P(A|D, I, F, H, C)
 \end{aligned}$$

(b) 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.



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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).

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

$$= P(C=f) \cdot P(S=t | C=f)$$

$$\cdot P(R=f | C=f) \cdot P(W=t | S=t, R=f)$$

$$= .5 \times .5 \times (1-.2) \times .9$$

$$= .5 \times .5 \times .8 \times .9$$

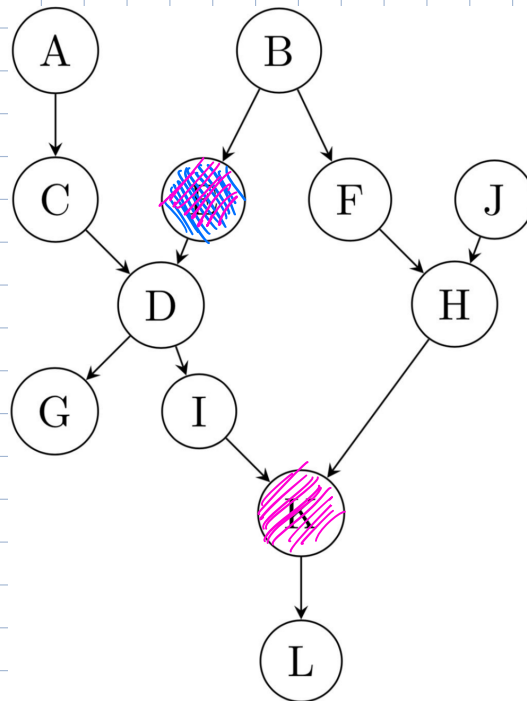
C	P(S)
t	.1
f	.5

C	P(R)
t	.8
f	.2

Problem 3

(10 points)

According to the following Bayesian Network,



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

J

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

None

Problem 4

(10 points)

Draw a Bayes net with four states $\{A, B, C, D\}$, that follows all of the independence constraints below.

- (a) $A \perp\!\!\!\perp B$
- (b) $A \not\perp\!\!\!\perp D \mid B$
- (c) $A \perp\!\!\!\perp D \mid C$
- (d) $A \not\perp\!\!\!\perp C$
- (e) $B \not\perp\!\!\!\perp C$
- (f) $A \not\perp\!\!\!\perp B \mid D$
- (g) $B \perp\!\!\!\perp D \mid A, C$

