DPP 01

Data Science & Artificial Intelligence

Artificial Intelligence

Logics

Q1 What does logical entailment imply in the context of probabilistic reasoning?
(A) Direct causation
(B) Correlation between variables
(C) Inference of a proposition given the truth of another proposition
(D) Independence of variables

Q2 Which notation correctly represents the conditional independence of variables X and Y given Z?
(A) $X \perp Y$
(B) $X \perp Y \mid Z$
(C) $X \rightarrow Y \mid Z$
(D) $X \leftrightarrow Y \mid Z$

Q3 Which property is not a fundamental property of conditional independence?
(A) Symmetry
(B) Decomposition
(C) Contraction
(D) Multiplication

Q4 What does a node in a graphical model typically represent?
(A) A conditional probability
(B) A variable or a set of variables
(C) A constant value
(D) An operation or function

Q5 In a Bayesian Network, what does it mean if there is no direct path between two nodes?
(A) The nodes represent the same variable
(B) The nodes are conditionally independent given their parents
(C) The nodes are dependent on each other

(D) The nodes must be observed variables

Q6 What is the primary purpose of the variable elimination algorithm in probabilistic graphical models?
(A) To identify the most important variables
(B) To simplify the model by removing nodes
(C) To efficiently compute marginal distributions
(D) To restructure the network

Q7 Which statement best exemplifies logical entailment in probability theory?
(A) If event A occurs, then event B must also occur.
(B) Events A and B occur simultaneously.
(C) Event A occurring increases the likelihood of event B.
(D) Event A and event B are mutually exclusive.

Q8 In a probability distribution, what does $P(X \mid Y, Z) \neq P(X \mid Z)$ imply about X and Y given Z?
(A) X and Y are conditionally independent given Z.
(B) X and Y are conditionally dependent given Z.
(C) X and Y are mutually exclusive given Z.
(D) X and Y are correlated given Z.

Q9 Which is a true statement about the symmetry property of conditional independence?
(A) If X is conditionally independent of Y given Z, then Z is conditionally independent of Y given X.

(B) If X is conditionally independent of Y given Z, then Y is conditionally independent of X given Z.

(C) If X is conditionally independent of Y given Z, then X is also conditionally independent of Z given Y.

(D) Symmetry property applies only when X, Y, and Z are mutually independent.

Q10 What does an edge in an undirected graphical model (Markov network) signify?
(A) A causal relationship between two variables.
(B) A conditional dependency between two variables.
(C) A marginal association between two variables.
(D) A potential function between two sets of variables.

Q11 In a Bayesian Network, what does a 'd-separation' imply?
(A) Direct connection between two nodes.
(B) Dependence between two sets of nodes.
(C) Conditional independence between two sets of nodes.
(D) A deterministic relationship between two nodes.

Q12 What is a key challenge addressed by the variable elimination algorithm in probabilistic graphical models?
(A) Reducing the size of the graphical model.
(B) Minimizing the computational complexity of inference.
(C) Eliminating irrelevant variables from the model.
(D) Finding the most probable explanation for observed data.

Q13 In logical entailment, if P → Q is true, what can be inferred if P is false?
(A) Q must also be false.
(B) Q must be true.
(C) Nothing can be inferred about Q.
(D) Q is independent of P.

Q14 If $X \perp Y \mid Z$, which of the following is true?
(A) X and Y are independent without any conditions.
(B) X and Y are dependent without any conditions.
(C) Knowing Z makes X and Y independent.
(D) Knowing Z makes X and Y dependent.

Q15 In a Bayesian Network, what does a directed edge from node X to node Y represent?
(A) Correlation between X and Y.
(B) Conditional independence of X and Y.
(C) Causal influence of X on Y.
(D) Mutual exclusivity of X and Y.

Q16 In a Markov Random Field, two nodes X and Y are connected directly. What does this imply?
(A) X and Y are conditionally independent.
(B) X and Y are conditionally dependent given all other nodes.
(C) X and Y are unconditionally independent.
(D) X and Y are unconditionally dependent.

Q17 In the context of variable elimination, what is the role of 'factors' in the algorithm?
(A) They represent variables to be eliminated.
(B) They are used to simplify the network structure.
(C) They represent the conditional probabilities and dependencies in the network.
(D) They are the final output of the algorithm.

Answer Key

Q1	(C)		Q10	(B)
Q2	(B)		Q11	(C)
Q3	(D)		Q12	(B)
Q4	(B)		Q13	(C)
Q5	(B)		Q14	(C)
Q6	(C)		Q15	(C)
Q7	(A)		Q16	(B)
Q8	(B)		Q17	(C)
Q9	(B)			

Hints & Solutions

Q1 **Text Solution:**
Logical entailment in probabilistic reasoning refers to the scenario where the truth of one proposition (hypothesis) allows for the inference of another proposition (conclusion), based on logical reasoning.

Q2 **Text Solution:**
The notation $X \perp Y \mid Z$ represents that variables X and Y are conditionally independent given variable Z. This means that once Z is known, X and Y do not provide additional information about each other.

Q3 **Text Solution:**
Symmetry, decomposition, and contraction are fundamental properties of conditional independence. The multiplication property does not apply in this context.

Q4 **Text Solution:**
In graphical models, nodes usually represent variables or sets of variables. These can be either observed data, latent variables, or parameters of the model.

Q5 **Text Solution:**
In Bayesian Networks, a lack of direct path between two nodes indicates that they are conditionally independent given their parents. This is a fundamental aspect of the representation of conditional dependencies in these models.

Q6 **Text Solution:**
The variable elimination algorithm is used to efficiently compute marginal distributions in probabilistic graphical models. It systematically sums out variables, reducing the computational complexity.

Q7 **Text Solution:**
Logical entailment in probability theory implies a direct inference relationship where the occurrence of one event (A) logically implies the occurrence of another (B).

Q8 **Text Solution:**
The fact that P(X|Y, Z) is not equal to P(X|Z) implies that the probability of X depends on Y even when Z is given, indicating conditional dependence between X and Y given Z.

Q9 **Text Solution:**
The symmetry property of conditional independence states that if X is conditionally independent of Y given Z, then Y is also conditionally independent of X given Z. This is a fundamental aspect of conditional independence.

Q10 **Text Solution:**
In undirected graphical models (Markov networks), an edge signifies a conditional dependency between the two variables it connects. This indicates that the variables are related in some manner within the context of the network.

Q11 **Text Solution:**
'd-separation' in a Bayesian Network is a criterion used to determine conditional independence between two sets of nodes. If two sets of nodes are d-separated by a third

set, they are conditionally independent given that third set.

Q12 Text Solution:

The variable elimination algorithm addresses the challenge of minimizing the computational complexity involved in performing inference in probabilistic graphical models. It does this by systematically removing variables, simplifying the computation of marginal or conditional probabilities.

Q13 Text Solution:

Logical entailment P → Q only specifies what happens when P is true. If P is false, there are no implications for the truth value of Q.

Q14 Text Solution:

The notation X ⊥ Y | Z means that X and Y are conditionally independent given Z. This implies that once Z is known, X and Y do not influence each other.

Q15 Text Solution:

In Bayesian Networks, a directed edge from node X to node Y represents a causal influence of X on Y. It signifies that the probability of Y depends on the state of X.

Q16 Text Solution:

In Markov Random Fields, a direct connection between two nodes implies conditional dependence given all other nodes. This means the relationship between X and Y can be understood fully only by considering the states of all other nodes in the network.

Q17 Text Solution:

In the variable elimination algorithm, 'factors' are used to represent the conditional probabilities and dependencies within the network. They play a crucial role in the algorithm by summarizing the relationships between variables, which are then manipulated to perform efficient inference.