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CMPT 317 Assignment 5 Question 1

Question 1.

- (a) What are the Conditional Probability Distributions implied by the network diagram? List them using the notation $P(\dots)$. You do not need to indicate any probabilities. Just provide the notation.

Solution: We know that X_2, X_3, X_4, X_5 are both independent to each other, and both X_2, X_3, X_4, X_5 are dependent X_1 , and X_1 is independent is the graph, so the CPDs are:

- $P(X_1)$
- $P(X_2 | X_1)$
- $P(X_3 | X_1)$
- $P(X_4 | X_1)$
- $P(X_5 | X_1)$

- (b) Assume that each variable X_i has 10 domain values. How many entries in each Conditional Probability table that you listed? In other word, how many numbers would be required if you were to fill in each table (which you thankfully don't have to do). What's the total number of entries, when you add up all the entries for all the CPDs?

Solution: Since X_2, X_3, X_4, X_5 are both independent to each other, and they are both dependent on X_1 . Then we can have that each CPD

- $P(X_1)$: 10
- $P(X_2 | X_1)$: $10 * 10 = 100$
- $P(X_3 | X_1)$: $10 * 10 = 100$
- $P(X_4 | X_1)$: $10 * 10 = 100$
- $P(X_5 | X_1)$: $10 * 10 = 100$

Then we can calculate total CPDs which are $10 + 100 + 100 + 100 + 100 = 410$

- (c) Express the Joint Probability Distribution in terms of the Conditional Probability Distributions you outlined above.

Solution: JPD is calculate by multiply each CPD:

$$\text{JPD: } P(X_1) \bullet P(X_2 | X_1) \bullet P(X_3 | X_1) \bullet P(X_4 | X_1) \bullet P(X_5 | X_1)$$

- (d) Derive a formula for the query $P(X_1 | X_2, X_3, X_4)$.

Solution: Since X_1 is independent to X_2, X_3, X_4, X_5 , then the answer should be X_1 itself. So, we can have $P(X_1 | X_2, X_3, X_4) = P(X_1)$