

CSCE 478/878 Recitation 5 Handout

Probabilistic Inference on Bayesian Network & d-Separation Algorithm

February 12, 2019

Note: The grade for this recitation will be **completion based**. If you give answer to all questions, you will get full credit. If your answer is not correct, we will provide you feedback. You should explicitly mention each rule and type of conditional independence that you have used in the derivation for all questions.

Submission guideline:

Submit a pdf file of your solution via webhandin by **4.45 PM on February 12**.

1. Consider a joint distribution of five random variables a, b, c, d , and e . Show that

$$P(a, b, c | d, e) = P(a, b | c, d, e) P(c | d, e)$$

[6 pts]

2. Consider the joint distribution of three random variables a, b and c . Show that

$$P(a | b, c) = \frac{P(b | a, c) P(a | c)}{P(b | c)}$$

[6 pts]

3. Consider the full joint distribution table for the three random variables below. Compute the following conditional probability (Cavity = True & False):
 $P(\text{Cavity} | \neg \text{catch})$

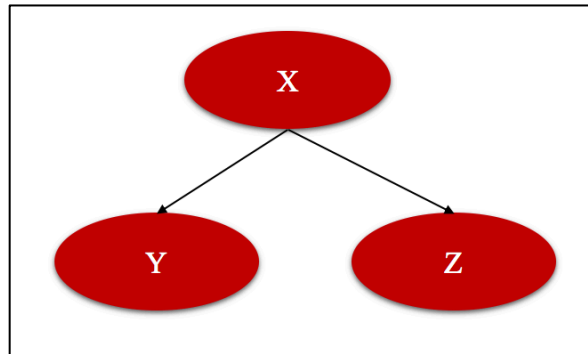
[6 pts]

	<i>toothache</i>		\neg <i>toothache</i>	
	<i>catch</i>	\neg <i>catch</i>	<i>catch</i>	\neg <i>catch</i>
<i>cavity</i>	0.108	0.012	0.072	0.008
\neg <i>cavity</i>	0.016	0.064	0.144	0.576

4. Consider the following Bayesian network and prove the following:

$$P(Y | X, Z) = P(Y | X)$$

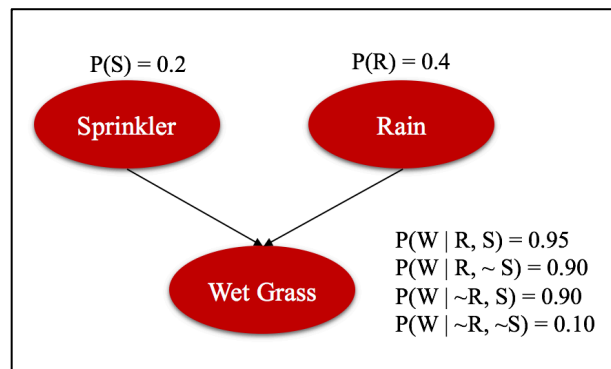
[5 pts]



5. Consider the following Bayesian network and compute the following conditional probability:

$$P(W \mid R)$$

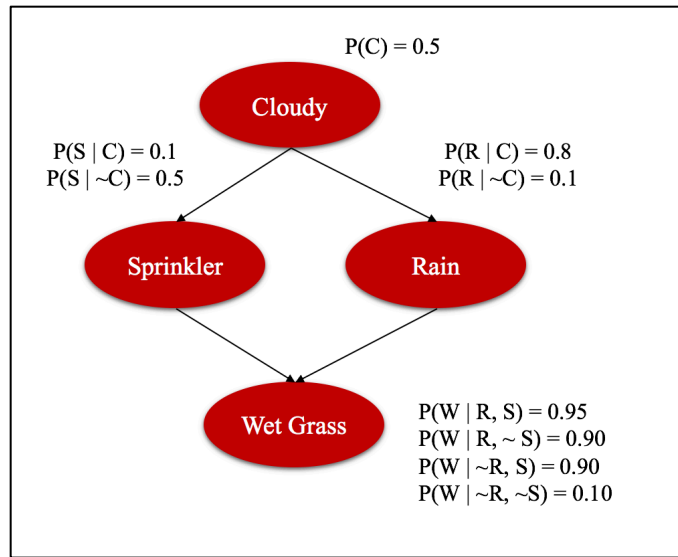
[12 pts]



6. Consider the following Bayesian network and compute the conditional probabilities:

- $P(W \mid \neg C, R)$
- $P(W \mid C, R)$

[10 + 5 pts]

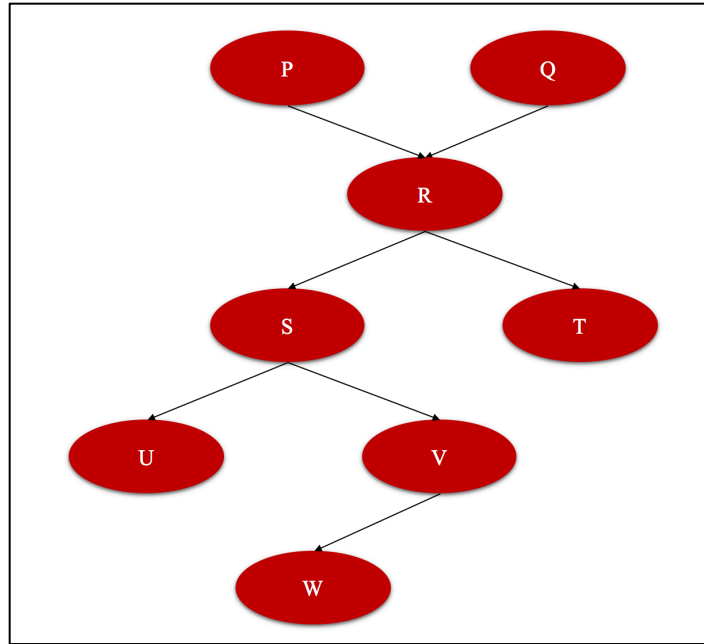


7. Consider the following Bayesian network and answer the following questions. For justification you must use the *d-separation* algorithm and specify which canonical case of conditional independence is in effect.

For example, if the question is: Are S and T conditionally independent given R? Justify.

Standard Answer: They are conditionally independent because S & T are in tail-to-tail connection (case 2) and R is in the path from S to T.

- Are P and Q conditionally independent given S? Justify.
- Are P and Q conditionally independent given V? Justify.
- Are P and W conditionally independent given R? Justify.
- Are S and T conditionally independent given P? Justify.
- Are U and W conditionally independent given V? Justify.



[50 pts]