
CS161: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

Fall 2016

Assignment 7. Due Thursday, November 17, 2016, 11:55pm

Please submit your solutions on CCLE. The submitted file should be in a text or pdf file named hw7.txt or hw7.pdf.

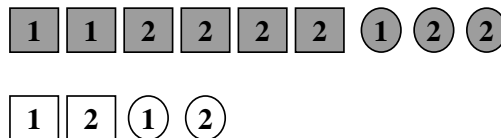
1. Prove:

Generalized product rule: $P(A, B | K) = P(A | B, K)P(B | K)$.

Generalized Bayes' rule: $P(A | B, K) = P(B | A, K)P(A | K)/P(B | K)$.

2. An oil well may be drilled on Mr. Y's farm in Texas. Based on what has happened to similar farms, we judge the probability of oil being present to be .5, the probability of only natural gas being present to be .2, and the probability of neither being present to be .3. If oil is present, a geological test will give a positive result with probability .9; if only natural gas is present, it will give a positive result with probability .3; and if neither are present, the test will be positive with probability .1. Suppose the test comes back positive. What's the probability that oil is present?

3. (From Bayesian Networks by R. Neapolitan) Consider the set of objects below.



Mr. Y picked up an object at random from the above set. We want to compute the probabilities of the following events:

α_1 : the object is black;

α_2 : the object is square;

α_3 : if the object is one or black, then it is also square.

Construct the joint probability distribution of this problem. Use it to compute the above probabilities by explicitly identifying the worlds at which each α_i holds. Identify two sets of sentences α, β, γ such that α is independent of β given γ with respect to the constructed distribution.

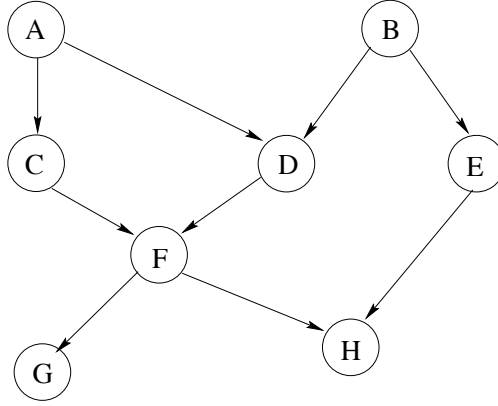


Figure 1: The DAG of a Bayesian network.

4. Consider the DAG in Figure 1:

- List the Markovian assumptions asserted by the DAG.
- True or false? Why?
 - $d_separated(A, BH, E)$
 - $d_separated(G, D, E)$
 - $d_separated(AB, F, GH)$
- Express $P(a, b, c, d, e, f, g, h)$ in factored form using the chain rule for Bayesian networks.
- Compute $P(A = 0, B = 0)$ and $P(E = 1 \mid A = 1)$. Justify your answers.

$P(A = 0)$	$P(A = 1)$
.8	.2

$P(B = 0)$	$P(B = 1)$
.3	.7

	$P(E = 0 \mid B)$	$P(E = 1 \mid B)$
$B = 0$	.1	.9
$B = 1$	.9	.1

	$P(D = 0 \mid A, B)$	$P(D = 1 \mid A, B)$
$A = 0, B = 0$	.2	.8
$A = 0, B = 1$	.9	.1
$A = 1, B = 0$	.4	.6
$A = 1, B = 1$	.5	.5