CS 731: Example Exam 1 (Note that Future Exams will not include Multiple Choice)

November 15, 2000

Part I (4 points per question): Circle the letter of the most appropriate answer

1. Propositions A and B are *independent* if and only if:

   a. $P(A \wedge B) = P(A|B)P(B)$
   b. $P(A \wedge B) = P(A)P(B)$
   c. $P(A) = P(B)$
   d. $P(A) = 1 - P(B)$

2. Propositions A and B are independent *given* C (*conditionally independent*) if and only if:

   a. $P(A \wedge B \wedge C) = P(A)P(B)P(C)$
   b. $P(A \wedge B) = 1 - P(C)$
   c. $P(A \wedge B|C) = P(A|C)P(B|C)$
   d. $P(A) = P(B) = P(C)$

3. Let $\langle X_1, ..., X_n \rangle$ be a total ordering of the variables in a Bayes Net, where for all $1 \leq i \leq n$ all the members of $Pa(X_i)$ appear before X_i in this ordering. The following defines the semantics of the Bayes Net.

   a. $\mathbf{P}(X_i) = \mathbf{P}(Pa(X_i))$
   b. $\mathbf{P}(X_i) = \mathbf{P}(X_j)$ for all X_j in $Pa(X_i)$
   c. $\mathbf{P}(X_i) = \mathbf{P}(X_j)$ for all X_j in the Markov Blanket of X_i
   d. $\mathbf{P}(X_1, ..., X_n) = \prod_{i=1}^{n} \mathbf{P}(X_i|Pa(X_i))$

4. The *Markov Blanket* of a variable X within a Bayes Net consists of exactly the:

   a. parents of X
   b. children of X
   c. parents and children of X
   d. parents of X, children of X, and other parents of the children of X

5. The version of Bayes' Rule *with normalization* is written as:

a. $P(A|B) = \alpha P(B|A)P(B)$
b. $P(A|B) = \alpha P(B|A)P(A)$
c. $P(A|B) = \alpha P(A)P(B)$
d. $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

6. *Decision Theory* seeks where possible to take the decision:

a. whose probable outcome can most accurately be estimated
b. that maximizes expected utility
c. that minimizes the probability of a loss
d. that best agrees with the axioms of probability

The remaining questions refer to the "Smoking" Bayes Net Used in the Lecture Notes

7. Imagine using Gibbs sampling with no observations. Given that all variables currently are set to *false*, suppose we wish to sample a next value for *Smoking*. The distribution to use for *Smoking* (of the form $\langle P(true), P(false)\rangle$) is:

a. $\langle \alpha(.8)(.4)(.2), \alpha(.2)(.6)(.8)\rangle$
b. $\langle \alpha(.2)(.4)(.2), \alpha(.8)(.9)(.9)\rangle$
c. $\langle \alpha(.8)(.9)(.9), \alpha(.8)(.4)(.2)\rangle$
d. $\langle \alpha(.2)(.6)(.8), \alpha(.8)(.1)(.1)\rangle$

8. Imagine using Gibbs sampling with no observations. Given that all variables currently are set to *false*, suppose we wish to sample a next value for *LungDisease*. The distribution to use for *LungDisease* (of the form $\langle P(true), P(false)\rangle$) is:

a. $\langle \alpha(.1)(.7), \alpha(.9)(.3)\rangle$
b. $\langle \alpha(.2)(.4)(.2), \alpha(.8)(.9)(.9)\rangle$
c. $\langle \alpha(.1)(.3), \alpha(.9)(.9)\rangle$
d. $\langle \alpha(.8)(.1)(.3), \alpha(.8)(.9)(.9)\rangle$

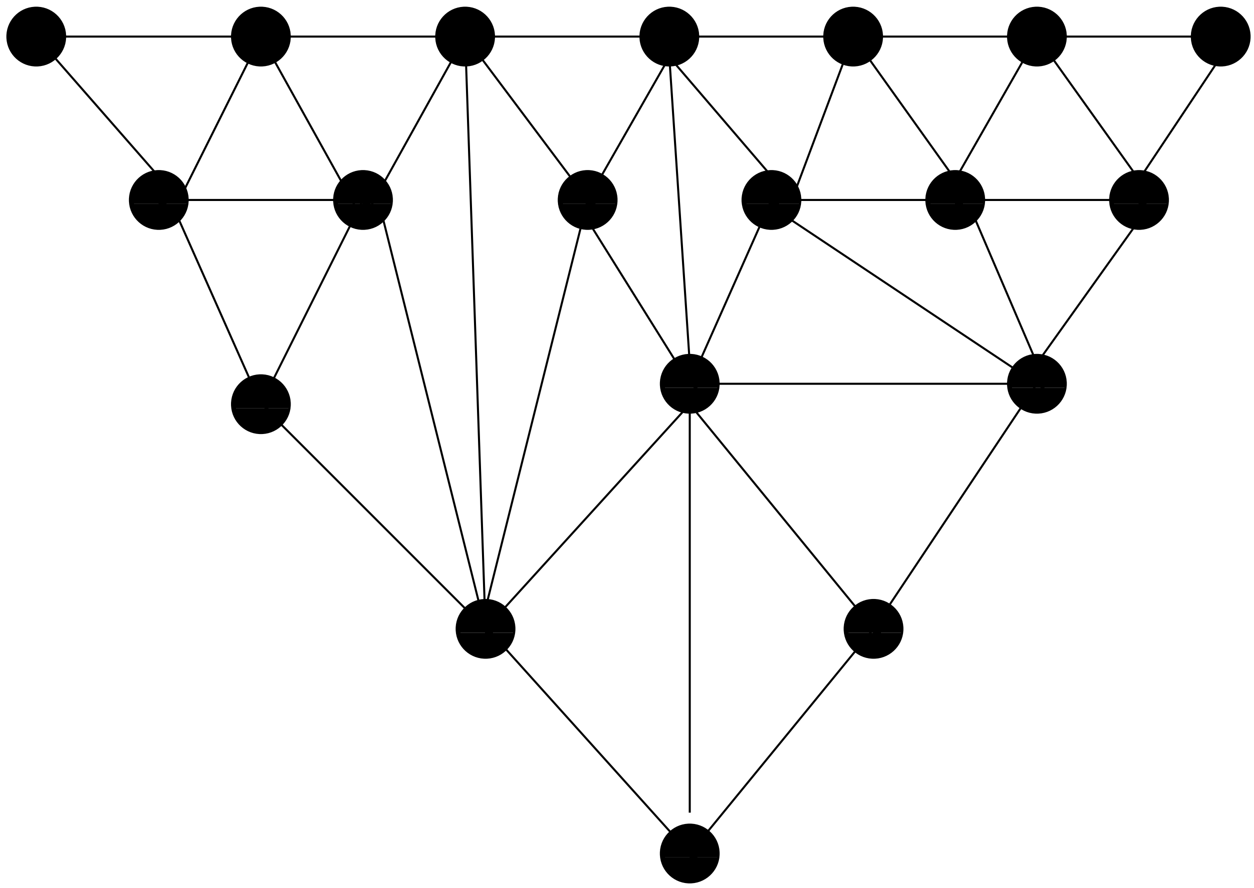
9. Imagine using Gibbs sampling with no observations. Given that all variables currently are set to *true*, suppose we wish to sample a next value for *Smoking*. The distribution to use for *Smoking* (of the form $\langle P(true), P(false)\rangle$) is:

a. $\langle \alpha(.8)(.4)(.2), \alpha(.2)(.6)(.8)\rangle$
b. $\langle \alpha(.2)(.4)(.2), \alpha(.8)(.9)(.9)\rangle$
c. $\langle \alpha(.8)(.9)(.9), \alpha(.8)(.4)(.2)\rangle$
d. $\langle \alpha(.2)(.6)(.8), \alpha(.8)(.1)(.1)\rangle$

10. Imagine using Gibbs sampling with no observations. Given that all variables currently are set to *true*, suppose we wish to sample a next value for *LungDisease*. The distribution to use for *LungDisease* (of the form $\langle P(true), P(false) \rangle$) is:

a. $\langle \alpha(.2)(.4)(.2), \alpha(.8)(.9)(.9) \rangle$
b. $\langle \alpha(.1)(.3), \alpha(.9)(.9) \rangle$
c. $\langle \alpha(.8)(.9), \alpha(.2)(.8) \rangle$
d. $\langle \alpha(.8)(.1)(.3), \alpha(.8)(.9)(.9) \rangle$

Part II (20 points): Is the following graph triangulated? Support your answer by numbering the nodes according to MaximumCardinalitySearch. If this fails, circle the first offending node (and/or draw a missing edge).



Part III (20 points): Consider again the "Smoking" Bayes Net in the Lecture Notes. Suppose we know a person has heart disease but we have no other observations. Calculate the probability this person has shortness of breath (answer the query P(*ShortnessOfBreath* | *HeartDisease=true***) using** *Variable Elimination*. **Eliminate** *Smoking*, **then** *HeartDisease*, **then** *LungDisease*.

Part IV (20 points): Consider again the "Smoking" Bayes Net in the lecture notes. Draw the *junction tree* for this net. Choose a root and populate the junction tree with the CPTs. Answer the queries P(*ShortnessOfBreath* | *HeartDisease=true*), P(*Smoking* | *HeartDisease=true*), and P(*LungDisease* | *HeartDisease=true*) using the junction tree. Please note that because the evidence is the same for all three queries, you only have to perform the upward and downward passes *once*.