CSCE 582 Fall 2003 Practice Questions for MT1

1. (From Chapter 12 of: Heuer, Richard. *Psychology of Intelligence Analysis.* Available at http://www.cia.gov/csi/books/19104/index.html.)

   > During the Vietnam War, a fighter plane made a non-fatal strifing attack on a US aerial reconnaisance mission at twilight. Both Cambodian and Vietnamese jets operate in the area. You know the following facts:
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   > (a) Specific case information: The US pilot identified the fighter as Cambodian. The pilot's aircraft recognition capabilities were tested under appropriate visibility and flight conditions. When presented with a sample of fighters (half with Vietnamese markings and half with Cambodians), the pilot made the correct identification 80 percent of the time and erred 20 percent of the time.
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   > (b) Base rate data: 85% of the jet fighters in that area are Vietnamese; 15% are Cambodian.
   >
   > Question: What is the probability that the fighter was Cambodian?

   Build a Bayesian network to describe the situation: draw the graph and specify the prior and conditional probability tables.

   Answer the question.

2. Define conditional independence. Start like this: "Variables A and B are conditionally independent given C if and only if" ...

3. The chain rule (decomposition theorem) for Bayesian networks is: Let BN be a Bayesian network over $U = \{A_1, \ldots, A_n\}$. Then the joint probability distribution $P(U)$ is $\prod_{i=1}^{n} P(A_i \mid pa(A_i))$, where $pa(A_i)$ is the set of parents of A_i.

   Prove the chain rule for Bayesian networks, starting from the definition of Bayesian networks given in class (adapted from [Neapolitan, 1990, pp. 158-159]), which is repeated here.

   Let V be a finite set of finite propositional variables defined on the same probability space, let $(\Omega, \mathcal{F}, P)$ be their joint probability distribution, and let $G = (V.E)$ be a directed acyclic graph (DAG). For each $v \in V$, let $c(v) \subseteq V$ be the set of all parents of v and $d(v) \subseteq V$ be the set of all descendants of v. Furthermore, for $v \in V$, let $a(v) \subseteq V$ be $V - (d(v) \cup \{v\})$.

   Suppose that for every subset $W \in a(v)$, W and v are conditionally independent given $c(v)$; i.e., if $P(c(v)) > 0$, then
   $P(v \mid c(v)) = 0$ or $P(W \mid c(v)) = 0$ or
   $P(v \mid W \cup c(v)) = P(v \mid c(v))$.

   Then, $C = (V, E, P)$ is called a *Bayesian network.* ($G = (V, E)$ is called a Bayesian network structure or, improperly, a Bayesian network.)

4. I recommend that you test your understanding of d-separation using the dyspnea (“Visit to Asia”) network as an example.