CSC242: Homework 3.5
AIMA 15-15.2

1. The basic approach to modeling uncertainty in a changing world is to view the world as a series of "snapshots" or time slices. Each time slice includes a set $\mathbf{X}$ of state variables assumed be unobservable, and a set $\mathbf{E}$ of evidence variables that can be observed.

   (a) Explain briefly what the (first-order) Markov assumption is and what it means for the state variables $\mathbf{X}$. Be formal.

   (b) Explain briefly what a stationary process assumption is and what it means for the state variables $\mathbf{X}$. Be formal.

   (c) Explain briefly what the (first-order) sensor Markov assumption means for the evidence variables $\mathbf{E}$. Be formal.

   (d) Explain briefly what a stationary process assumption means for the evidence variables $\mathbf{E}$. Be formal.

   (e) Give an example of a Bayesian network for a temporal model with a single state variable X and a single evidence variable E. Draw a picture. Include formulas describing the probabilities required by the network (no tables or numbers needed).

2. Consider the four inference tasks for temporal models identified in the textbook and discussed in class.

   (a) Identify the four tasks and give the posterior distribution that each task needs to compute (or estimate), using the standard notation as seen in class and in the textbook.

   (b) Can the basic temporal inference tasks on Bayesian networks be computed efficiently? Why or why not (very briefly)?

   (c) Why is this important? Be very brief.

3. Suppose you are modelling an industrial process and trying to monitor (estimate) the quality of the output as acceptable or not acceptable. You can't directly measure the quality, but you have two sensors, each of which have some likelihood of detecting acceptable and unacceptable products.

   (a) Develop a temporal model to describe this process. Draw a picture. Include any distributions needed by your model, but of course you don't have the numbers.

   (b) Explain how the assumptions underlying temporal models apply to this model and discuss whether they are reasonable (or not).

   (c) Give an explicit formula (no big sum or product symbols) for the full joint probability distribution of the model at time $t = 1$.

   (d) Give an explicit formula for the state of the process at time $t = 1$ given the observations at that time.

   (e) Which of the inference tasks for temporal models does this formula perform (compute)?