CECS 451
Assignment 11
Total: 30 Points

General Instruction

- I recommend you can write your answer using LaTeX.
- Submit a PDF file in the Dropbox folder via BeachBoard (Not email).
- Simple reasoning is required, otherwise you will get half of the points.

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1. (6 points) In Figure 1, suppose we observe an unending sequence of days on which the umbrella appears. As the days go by, the probability of rain on the current day increases toward a fixed point, we expect that $\vec{P}(R_t|u_{1:t}) = \vec{P}(R_{t-1}|u_{1:t-1}) = \langle \rho, 1-\rho \rangle$. Find ρ with a scale of 4, i.e., 0.1234. You may use a quadratic equation solver.

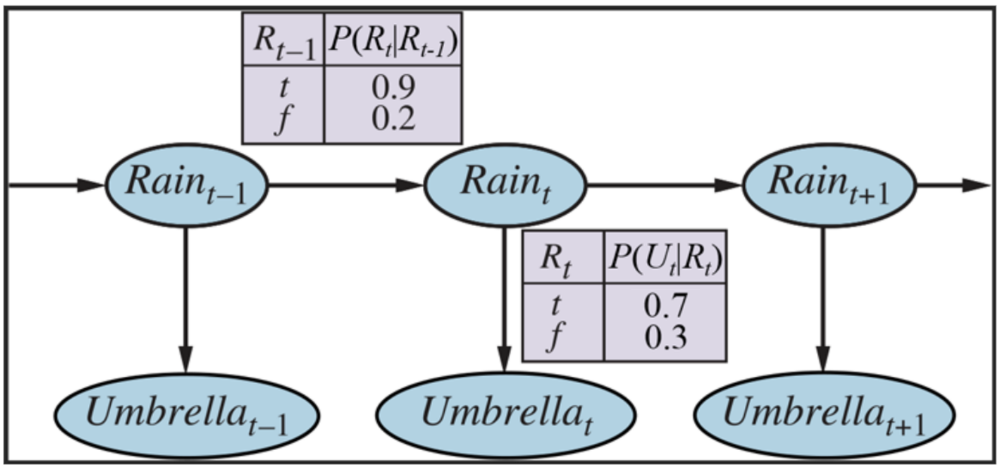

Figure 1: Bayesian network structure and conditional distributions describing the umbrella world. The transition model is $\vec{P}(R|R_{t-1})$ and the sensor model is $\vec{P}(U|R_t)$.

2. A professor wants to know if students are getting enough sleep. Each day, the professor observes whether they have red eyes. The professor has the following domain theory:
   - The prior probability of getting enough sleep, with no observations, is 0.7.
   - The probability of getting enough sleep on night t is 0.8 given that the student got enough sleep the previous night, and 0.3 if not.
   - The probability of having red eyes is 0.2 if the student got enough sleep, and 0.7 if not.

   (a) (6 points) Formulate this information as a hidden Markov model. Give a Bayesian network and conditional distributions.

(b) (8 points) Consider the following evidences, and compute $\vec{P}(ES_2|e_{1:2})$ with a scale of 4, i.e., 0.1234.

- e_1 = red eyes
- e_2 = not red eyes

3. Consider the 101×3 world shown in Figure 2. In the start state the agent has a choice of two deterministic actions, Up or Down, but in the other states the agent has one deterministic action, Right. Assuming a discounted reward function.

(a) (4 points) Compute the utility of each action as a function of γ.

(b) (4 points) Draw the utility of each action for the range $0 \leq \gamma < 1$ using a numerical analysis software.

(c) (2 points) For $\gamma = \frac{1}{2}$, which action is recommend? Why?

+50	-1	-1	-1	...	-1	-1	-1	+10
Start				...				
-50	+1	+1	+1	...	+1	+1	+1	-10

Figure 2: 101×3 world