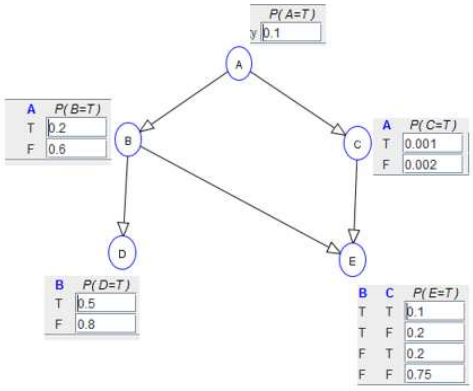
Intelligent Autonomous Agents and Cognitive Robotics
Exercise Sheet 5

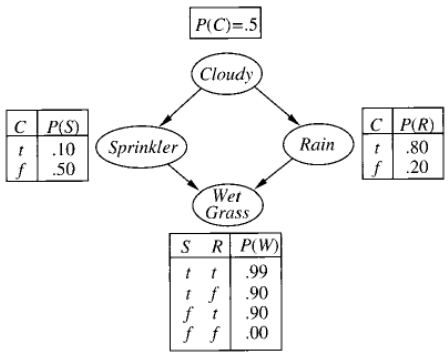
1. Compare and explain the different sampling methods by giving an example:
   a. Prior sampling
   b. Rejection sampling
   c. Weighted sampling

   and their differences.

2. Given the following network. Generate a possible example for P(A|C,¬D). Also compute all possible weights for examples generated with this observations. Are there any irrelevant attributes that would be pruned before evaluating the query with variable elimination?



3. Consider the query **P**(Rain| Sprinkler=true, WetGrass=true) (see figure below) and how Gibbs can answer it.



   d. How many states does the Markov chain have?
   e. Compute the sampling distribution for each variable, conditioned on its Markov blanket. Calculate the **transition matrix Q** containing q(y → y') for all **y, y'**.
      Hint: The probability that one of the two sampling variable is chosen is 0.5.
   f. What does Q^2 , the square of the transition matrix, represent?

4. Dynamic Bayesian Networks (DBN) can be used to model temporal aspects of the real world. Name and explain assumptions that can be made to reduce the potential complexity of arbitrary DBNs.

5. A professor wants to know if students are getting enough sleep. Each day, the professor observes whether the students sleep in class, and 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.
   - The probability of sleeping in class is 0.1 if the student got enough sleep, and 0.3 if not.

   Formulate this information as a dynamic Bayesian network that the professor could use to filter or predict from a sequence of observations

6. For the DBN of exercise 5 and for the evidence values
   e_1 = not red eyes, not sleeping in class
   e_2 = red eyes, not sleeping in class
   e_3 = red eyes, sleeping in class
   perform the following computation:
   a. State estimation: Compute P(*EnoughSleep*$_t$ | $e_{1:t}$) for each oft = 1, 2, 3.
   b. Reformulate the DB with only one evidence variable. Give the complete probability tables for the model.