CECS 451
Assignment 9
Total: 44 Points

General Instruction

- Submit uncompressed file(s) in the Dropbox folder via BeachBoard (Not email).
- Use `Python 3`, any other programming language is not acceptable.
- You can import modules in the Python Standard Library (please check the full list *here*). If you want to use any other library, please consult with the instructor or TA.
- Your submission may be evaluated automatically using a script file, so if you would not follow the output format, you may receive zero point even though your program outputs correct answers.

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1. Consider Figure 1 (notice that some of the probabilities are different with the figure in the textbook), and implement a program to answer the query $\vec{P}(C|\neg s, w)$ by using MCMC sampling. The program should generate $1,000,000$ samples to estimate the probability. To answer (a) and (b), you can prepare the answers with scratch paper and print-out them (hard coding is fine). However, you are asked to implement a simulation program to answer (c). Please use the filename `mcmc.py`. You may want to verify your estimated probability with the one computed by using `bayes.jar`.
   (a) (8 points) Show $\vec{P}(C|\neg s, r), \vec{P}(C|\neg s, \neg r), \vec{P}(R|c, \neg s, w), \vec{P}(R|\neg c, \neg s, w)$.
   (b) (16 points) Show the transition probability matrix $Q \in \mathbb{R}^{4\times 4}$ where q_{ij} = transition probability from S_i to S_j in Figure 2.
   (c) (20 points) Show the probability of the query $\vec{P}(C|\neg s, w)$
   (d) Please follow the output format. (Fix precisions using `"{:.4f}".format`)

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Part A. The sampling probabilities
P(C|-s,r) = <..., ...>
P(C|-s,-r) = <..., ...>
P(R|c,-s,w) = <..., ...>
P(R|-c,-s,w) = <..., ...>

Part B. The transition probability matrix
       S1      S2      S3      S4
S1      .       .       .       .
S2      .       .       .       .
S3      .       .       .       .
S4      .       .       .       .

Part C. The probability for the query
P(C|-s,w) = <..., ...>
```

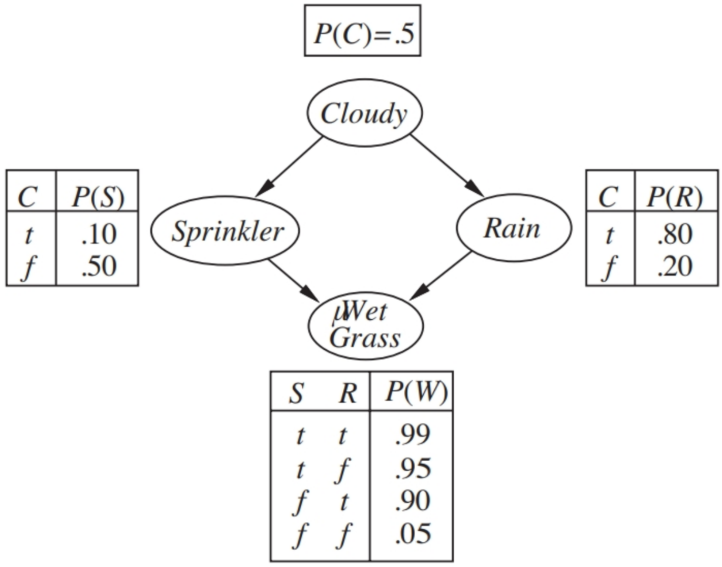

Figure 1: A multiply connected network with conditional probability tables. Note that the probabilities are slightly different than the lecture notes and the text book example.

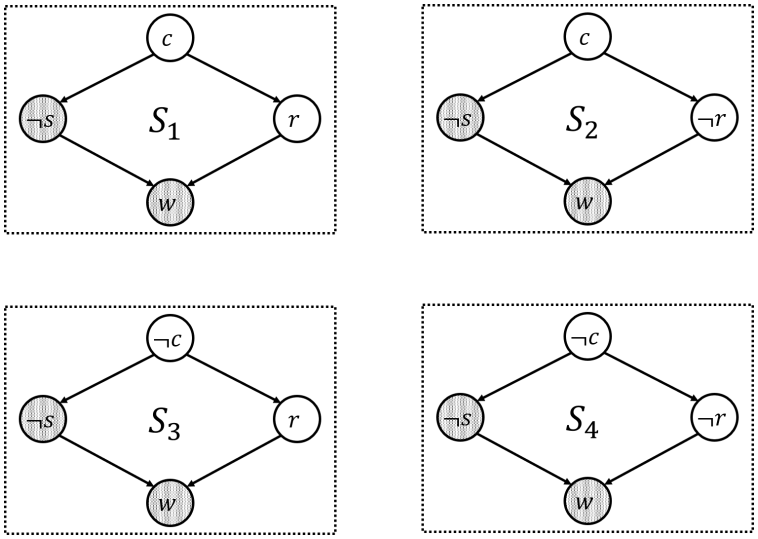

Figure 2: Possible states diagram