CECS 451
Assignment 6
Total: 54 Points

General Instruction

- Submit your work in the Dropbox folder via BeachBoard (Not email or in class).
- Submit the separate files as they are. (no zip file)

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1. (10 points) Implement a program to compute π value using Monte Carlo simulation method. Use `Python 3` and the name `pi.py`
   (a) The program should generate n points to compute π for $n \in \{10^3, 10^4, 10^5, 10^6\}$.
   (b) You can use `math.pi` to compute error rates.
   (c) Please follow the output format. (Fix precisions using `"0:.nf".format`)

```
n = 10 ^ 3  pi =  3.096000  error =  1.4513 %
n = 10 ^ 4  pi =  3.136800  error =  0.1526 %
n = 10 ^ 5  pi =  3.145280  error =  0.1174 %
n = 10 ^ 6  pi =  3.140568  error =  0.0326 %
```

2. Consider Figure 1, and implement a program to answer the query $\vec{P}(C|\neg s, w)$ by using Gibbs (MCMC) sampling. The program should generate $1,000,000$ samples to estimate the probability. Use `Python 3` and the name `gibbs.py`
   (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 `"0:.nf".format`)

```
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) = <..., ...>
```

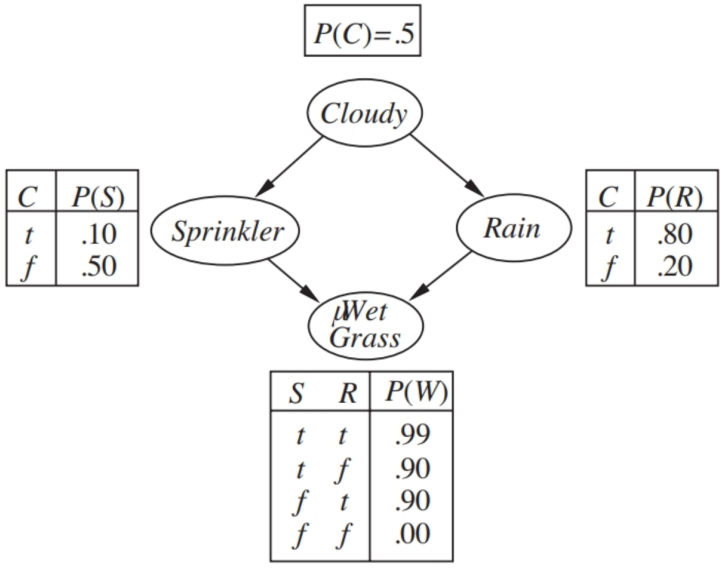

Figure 1: A multiply connected network with conditional probability tables

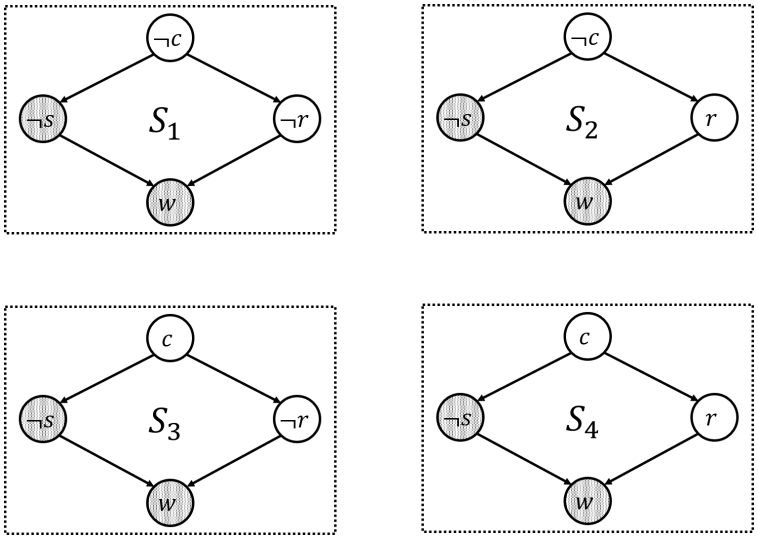

Figure 2: Possible states diagram