**NAME:**

**COLLABORATOR(S):**

**CS 583 – Assignment 6**

1. **Single-variable – Binomial**

You are given a single binary variable: with domain {T, F}. . Here are the counts for a dataset .

|  |  |
| --- | --- |
|  | Counts |
| T | 10 |
| F | 20 |

* 1. What is the MLE estimate for ?
  2. Assuming a uniform prior (i.e., assuming )
     1. What is ?
     2. What is ?
  3. Assuming
     1. What is ?
     2. What is ?

1. **Singe-variable – Multinomial**

You are given a single multinomial variable: with domain {R, G, B}. . Here are the counts for a dataset .

|  |  |
| --- | --- |
|  | Counts |
| R | 10 |
| G | 20 |

(Note that if a count is zero for a case, it is not listed. In this case, X=B has zero count.)

* 1. What is the MLE estimate for ?
  2. Assuming a uniform prior (i.e., assuming )
     1. What is ?
     2. What is ?
  3. Assuming
     1. What is ?
     2. What is ?

1. **Multiple variables**

We have three variables: X, Y, and Z. X and Z are binary with domain {T, F} and Y has three possible values: {R, G, B}. The Bayesian network has the following structure: . Here are the counts for a dataset D. If a count is zero, it is not listed.

|  |  |  |  |
| --- | --- | --- | --- |
| X | Y | Z | Counts |
| T | R | T | 10 |
| T | R | F | 20 |
| T | B | T | 30 |
| F | R | F | 40 |
| F | B | T | 50 |

Note that we need to estimate , , and for this network.

* 1. What are the MLE estimates?
  2. Assuming a uniform prior and K2 approach to Bayesian estimation, what are the predictive probabilities for next X, Y|X, and Z|Y?
  3. Assuming a |D’| = 12, and P’ is uniform, and a BDe approach to estimation, what are the predictive probabilities for next X, Y|X, and Z|Y?

1. **Missing data**

We have three variables: X, Y, and Z. All variables are binary with domain {0, 1}. The Bayesian network has the following structure: . Assume we initialize these distributions as follows:

Here is a sample dataset, where each row indicates an instance and ? indicates a missing value for that variable for that instance.

|  |  |  |
| --- | --- | --- |
| X | Y | Z |
| 0 | 0 | ? |
| 0 | ? | 1 |
| ? | 1 | 0 |
| ? | ? | 0 |
| ? | 1 | ? |

* 1. Perform the expectation step of EM and calculate the necessary counts, i.e., counts(X), counts(Y, X), and counts(Z, Y).
  2. Perform the maximization step of EM and reestimate P(X), P(Y|X), and P(Z|Y) using the counts from part a.