CST 383: Intro to Data Science
Dr. Glenn Bruns

# MLE, MAP, and Bayes' Law

**Instructions**: Answer the following questions by editing file bayes.txt with a text editor. Be sure to save your edited file as a .txt file. Don't change the file name.

The table below shows the results of looking at 700 random emails. The random variable 'spam' is 1 if the email is spam, and 0 if not. The random variable 'money' is 1 if the email contains the word 'money', and 0 if not.

| | money=0 | money=1 |
|---|---|---|
| spam=0 | 500 | 60 |
| spam=1 | 40 | 100 |

1. What's the probability that an email contains the word 'money' given that it's not spam? In other word, what is P(money = 1 | spam = 0) ?
2. What's the probability that an email contains the word 'money' given that it **is** spam?
3. What's the probability that an email is not spam given that it contains the word 'money'?
4. What's the probability that an email is spam given that it contains the word 'money'?
5. Using the MLE method, and using the data in the table, which hypothesis is preferred if an email contains the word 'money'?
    a. the email is spam
    b. the email is not spam
6. Using the MAP method, and using the data in the table, which hypothesis is preferred if an email contains the word 'money'?
    a. the email is spam
    b. the email is not spam
7. Using the table, what is P(spam = 0 | money = 0) + P(spam = 1 | money = 0)?
8. Using the table, what is P(spam = 0 | money = 0) + P(spam = 0 | money = 1)?
9. Suppose X and Y are both discrete random variables. Is it always true that P(X = a | Y = b) + P(X != a | Y = b) is 1? You may want to use the table above to help think about this.
10. Some people have a medical condition called 'conditionitis'. The test for conditionitis is pretty good. If you have conditionitis, there is a 95% chance the test result will be positive. If you don't have conditionitis, there is a 90% chance the test will be negative. Also, 98% of people don't have conditionitis. Using Bayes' Law, what is the probability that you have conditionitis given that your test result is positive?
11. Continuing the previous problem, what is the probability that you have conditionitis given your test result is negative?

**Submission**. Submit your edited bayes.txt on Canvas.