# Math Homework 5

CS540

June 20, 2019

## 1 Instruction

Please submit your answers on Canvas → Assignments → M5. Late submission will not be accepted.
Please add a file named "comments.txt", and in the first line of the file, grade yourself: $1, 1.5, 2$ (for the entire homework, not for individual questions). In your submission, please do not write your name if you do not want other students to see it (in the case it is posted as a sample solution).

| Grade | Meaning |
|---|---|
| 1 | You attempted something but mostly incorrect. |
| 1.5 | You attempted something but there are mistakes. |
| 2 | You have the correct answers + permission to post as a sample solution. |

You can put 2.5 if you already got 2 in the Quizzes for the week.

## 2 Questions

### 2.1 Question 1

Given the training data "I am Iron Man", "I love you 3000", "I love you mom", "Tell my family I love them", 18 words in total. With the unigram model, what is the probability of observing a new sentence "I love"? With the bigram model, what is the probability of observing a new sentence "I love"?

### 2.2 Question 2

Fall 2018 Midterm Q12.
Given a vocabulary of $10^6$, a document with $10^{12}$ tokens with $c_{\text{zoodles}} = 3$. What is the MLE estimation of $\mathbb{P}\{\text{ zoodles }\}$ with and without Laplace smoothing?

## 2.3 Question 3

Fall 2017 Final Q20
Two documents $A$ and $B$. Suppose $\hat{\mathbb{P}}\{H|A\} = 0.1$ in $A$ and $\hat{\mathbb{P}}\{H|B\} = 0.8$ in $B$ without Laplace smoothing. One document is taken out at random (with equal probability), and one word is picked out at random (all words with equal probability). The word is $H$. What is the probability that the document is $A$?

## 2.4 Question 4

2017 Fall Final Q3
Given the counts, find the MLE (no smoothing) of $\mathbb{P}\{$ saw sheep $|\neg$ rainy $, \neg$ warm $\}$.

| rainy | warm | sheep | count | rainy | warm | sheep | count |
|---|---|---|---|---|---|---|---|
| N | N | N | 1 | Y | N | N | 1 |
| N | N | Y | 0 | Y | N | Y | 1 |
| N | Y | N | 0 | Y | Y | N | 1 |
| N | Y | Y | 4 | Y | Y | Y | 2 |

## 2.5 Question 5

2005 Fall Final Q20, 2006 Fall Final Q20
Suppose $A$ is the common cause of $B$ and $C$. All variables are binary. What is $\mathbb{P}\{C = 1|B = 1\}$ and what is $\mathbb{P}\{B = 1|C = 1\}$?

$$\mathbb{P}\{A = 1\} = 0.4, \mathbb{P}\{B = 1|A = 1\} = 0.9, \mathbb{P}\{B = 1|A = 0\} = 0.8$$
$$\mathbb{P}\{C = 1|A = 1\} = 0.5, \mathbb{P}\{C = 1|A = 0\} = 0.2$$