

CS 3346A / CS 3121A Assignment 3

Due: Thursday, Dec. 5th, 2019 (midnight)

Total Weight: 15%

Silent Policy: A silent policy will take effect 24 hours before this assignment is due, i.e. no question about this assignment will be answered, whether it is asked on the discussion board, via email or in person.

Submission

Please submit your final answers in a **PDF** file through the OWL.

Please note you will not receive grades if TA can not recognize your handwriting, please finalize your solutions clearly and neatly and transform it to be a PDF version.

Q1: [Probability] From [Textbook 3E](#): Q13.8. (20 pts)

13.8 Given the full joint distribution shown in [Figure 13.3](#), calculate the following:

- a. $P(\text{toothache})$.
- b. $P(\text{Cavity})$.
- c. $P(\text{Toothache} \mid \text{cavity})$.
- d. $P(\text{Cavity} \mid \text{toothache} \vee \text{catch})$.

	<i>toothache</i>		\neg <i>toothache</i>	
	<i>catch</i>	\neg <i>catch</i>	<i>catch</i>	\neg <i>catch</i>
<i>cavity</i>	0.108	0.012	0.072	0.008
\neg <i>cavity</i>	0.016	0.064	0.144	0.576

Figure 13.3 A full joint distribution for the Toothache, Cavity, Catch world.

*[Hint] The main point of this exercise is to understand the various notations of **uppercase versus lowercase variable names**.*

Q2: [Probability and Bayes rule] From [Textbook 3E](#): Q13.13. (20 pts)

13.13 Consider two medical tests, A and B, for a virus. Test A is 95% effective at recognizing the virus when it is present, but has a 10% false positive rate (indicating that the virus is present, when it is not). Test B is 90% effective at recognizing the virus, but has a 5% false positive rate. The two tests use independent methods of identifying the virus. The virus is carried by 1% of all people. Say that a person is tested for the virus using only one of the tests, and that test comes back positive for carrying the virus. Which test returning positive is more indicative of someone really carrying the virus? Justify your answer mathematically.

Q3: [Probability and Bayes theorem] (20 pts)

After conducting a blood test, the doctor told you that you were tested positive for a fatal disease. Worse, the test is quite accurate: the probability of false-positive (one is tested positive without the disease) is 0.05, and the probability of false-negative (one is tested negative with the disease) is 0.02. Seeing that you are desperate, the doctor told you that overall the disease is rather rare, only 1 in 10,000 people.

- (a). What is the chance now that you have the disease?
- (b). Naturally, the doctor orders a retest on you. The result of the second independent test is still positive. What is now your chance of having the disease?
- (c). If you have done a total of k independent tests, and the results are all positive (quite depressive indeed!), what is your chance of having the disease, expressed in k ?

Q4: [Naive Bayes Classifier] (20 pts)

Given the training data in the below table, predict if Bob will default his loan.

Bob:

Homeowner: No
 Marital status: Married
 Job experience: 3
 Answer:

Home owner	Marital Status	Job experience (1-5)	Defaulted
Yes	Single	3	No
No	Married	4	No
No	Single	5	No
Yes	Married	4	No
No	Divorced	2	Yes
No	Married	4	No
Yes	Divorced	2	No
No	Married	3	Yes
No	Married	3	No
Yes	Single	2	Yes

Q5: [Deep Neural Network] (20 pts)

A deep neural network with given weights and biases is shown in the top figure. The activation function is the ReLU function (see the insert). When $(x_1, x_2) = (0, 1)$ and $(1, -1)$, what will the outputs (z_1, z_2) be, respectively? (Note: to show your work, also write down the hidden layer output (y_1, y_2) , and (y_3, y_4) in your solutions).

