CSE 4/587 - Practice Midterm Exam #1

Below you will find questions taken from the FA22 midterm and final exams that relate to the content we've covered in SP23 thus far. These questions should be used to familiarize yourself with the styles of questions asked in this class. **It is by no means an exhaustive list of content that may show up on the midterm, nor is it indicative of the length of the midterm.** Additionally, some questions may contain content that has not been covered yet in this semester's offering of the course.

Name: _____ Person #: _____

UBIT: _____ Seat #: _____

Academic Integrity

My signature on this cover sheet indicates that I agree to abide by the academic integrity policies of this course, the department, and university, and that this exam is my own work.

Signature: _____ Date: _____

Instructions

1. This exam contains 9 total pages (including this cover sheet). Be sure you have all the pages before you begin.
2. Clearly write your name, UBIT name, person number, and seat number above. **Additionally, write your UBIT name at the top of every page now.**
3. You have 50 minutes to complete this exam. Show all work where appropriate, but keep your answers concise and to the point.
4. After completing the exam, sign the academic integrity statement above. Be prepared to present your UB card upon submission of the exam paper.
5. You must turn in all of your work. No part of this exam booklet may leave the classroom.

DO NOT WRITE BELOW

Q1	Q2	Q3	Q4	Total
20	15	35	10	70

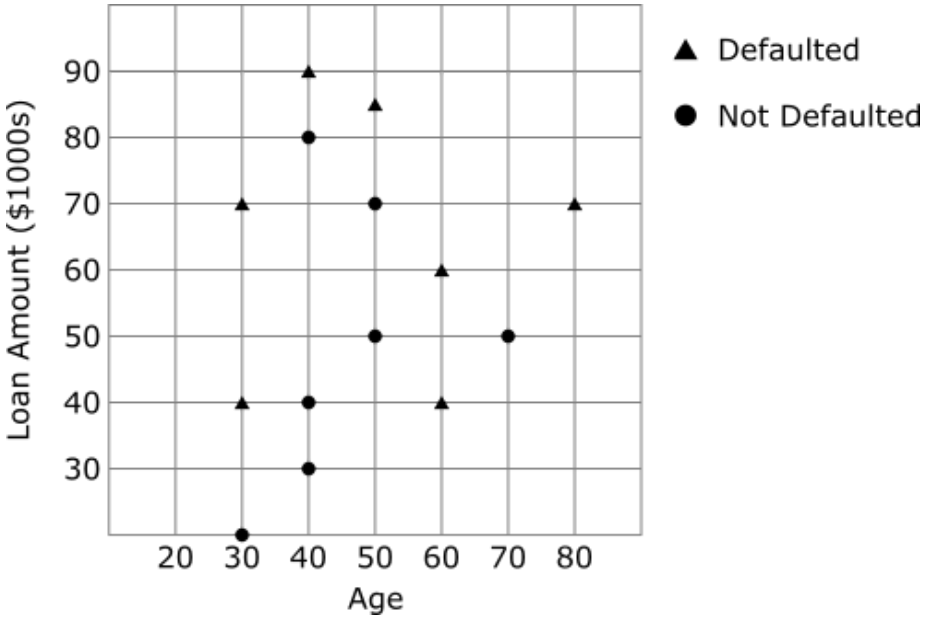
Question 1 - Modeling and Algorithms [20 Points]

a. How can we help ensure that our supervised learning models are not overfit? [4 points]

b. In linear regression, what does the error term, ε, capture? What about R^2? [4 points]

c. Name the four parameters we need to define in order to fully specify and evaluate a K-NN model for a given dataset. [4 points]

Below is a plot containing a number of data points with a known classification.
The x-axis represents a person's age, and the y-axis represents a loan amount in thousands of dollars. Each point is classified as ● or ▲. Points classified as ▲ represent people that have defaulted on their loan (did not pay it back). Points classified as ● represent people who have not.



d. If we assume euclidean distance determines the similarity of two points, does K-NN predict that a 40 year old client with a loan of $70k will default for k=3? What about for k=5? [4 points]

e. Explain what would happen if we give the loan amount in terms of dollars instead of thousands of dollars. Based on that explanation, what would our model predict for the same client from part (d) with k=3? [4 points]

Question 2 - Classifiers [15 Points]

a) Name the three classification algorithms we described in lecture. For each algorithm state whether it is a structural classifier, or statistical classifier. [6 points]

b) In the second half of the class we used two motivating examples when discussing classifiers: spam email classification, and ad click probability. State what was used as the features for each example, and give one reason why k-NN may not be effective for these two use cases. [4 points]

c) Naive bayes is an exceedingly simple algorithm. Name one reason why it can still be effective for something like spam classification. [2 points]

d) How can we adapt binary classifiers to multi-class problems? [3 points]

Question 3 - Naive Bayes [35 Points]

The faculty and staff at UB receive a lot of emails every day, but many of these emails are actually spam. We'd like to use our knowledge from CSE 4/587 to automatically detect spam emails and filter them out. In order to do so, we've already collected a large sample of emails and classified them as spam or not spam, and ran a word counting algorithm over the dataset.

The dataset contains 1000 emails
300 of these emails are categorized as spam

a) Based on our word count analysis, the word "buy" shows up in 75 emails. 70 of these emails that contain the word "buy" are categorized as spam. Given these counts, use Bayes Law to determine the probability that an email containing the word "buy" is spam. [10 points]

b) Assume we have done similar computations as in part (a) to determine that the probabilities that "computer", "won", "faculty", and "meeting" show up in a spam email are 0.1, 0.85, 0.01, and 0.05 respectively. Now we have an uncategorized email that contains the words "computer", "buy", and "meeting", and does not contain "won", or "faculty". Use the principles we've discussed in class to determine the probability that this exact set of words show up in an email that is **known to be spam**. [10 points]

c) Given your answer from part (b), if we have determined that the probability that that exact combination of words shows up in any email is 0.02, what is the probability that our uncategorized email containing those words is spam? [6 points]

d) Let's assume that based on our word count analysis, the word "professor" does not show up in any spam emails in our dataset. This would result in the probability that an email is spam if it contains the word "professor" to be 0.0, which may have a negative impact on our implementation of Naive Bayes. Name **two** ways we could address this potential problem. [4 points]

e) We've deployed our spam filter but now there seems to be a problem… We've received some complaints from faculty that they are still receiving almost as many spam emails as they were before. When we look into these complaints, we realize that these complaints are mostly coming from female faculty members. Note that female faculty make up around 16% of the total faculty in the CSE department. Give one possible explanation as to why our model is more effective at filtering out spam targeted at male faculty but not those targeting female faculty. [5 points]

Question 4 - Misc [10 Points]

a) What are the four Vs of data intensive computing? [2 points]

b) Name two sources of uncertainty in data. [2 points]

c) Briefly explain why fault tolerance in distributed systems is important. [2 points]

d) Name one concrete example of a data intensive application that you interact with on a frequent basis. [2 points]

e) Name two solutions you could employ if the dataset you are working on becomes too big to store/process in a timely manner. [2 points]

Scrap Paper