CISC 484
Homework 1
Due 11:59pm Thursday March 9, 2023 on Canvas

Part 1: This part must be done individually.

Q1. (Linear Regression)
 Assume that a training set has been provided where the target value is specified by the target function $f(x) = 7x_1+3x_2-5x_3-1$, We wish to consider applying incremental linear regression training with initial values $w_0=0.5$ and $w_1=2$, $w_2= 4$, $w_3=1$ and $\eta=0.1$.

Assume the first training instance is given by <1,2,3>. If you apply the training algorithm on this one data point, what will the new weights be?

Q2. (Logistic Regression)
I surveyed the students who took CISC 684 last year and asked them about the number of hours they spent preparing for the final exam. Based on their answers and their grades in the exam, I used Logistic Regression to predict the probability of getting an A given the hours they spent in preparation. The resulting model had $w_0 = 0.32$ and $w_1 = 1.2$.

a. How does the odds of getting an A after studying for 6 hours compare with the odds of getting an A with 5 hours of study? (Hint. Consider the ratio between the two odds.)

b. What is the probability of getting an A after studying for 5 hours?

Q3. (Logistic Regression)

Assume that I am able to find the odds of success (Y=1) for a given instance (specified by air temperature, humidity, water temperature and chance of precipitation) as predicted by a logistic regression model. For a given instance, suppose the odds of success is 2. The only information I know about this instance is that the water temperature (one of the attributes) was 60 degrees. I was also told that the odds of success assigned by the same logistic regression model is 4 for another instance. The only information I have about the new instance is that the water temperature was 61 and all other attributes in the two instances were identical.

What can you say about the value of the weight associated with the "water temperature" attribute.

Also, what can you say about the odds of success if only the water temperature were changed to 59 and all other attribute values are kept the same.

Part 2: This part must be completed with your group members.

Q4. Linear Regression

Consider the following data for inducing a linear regressor.

x1	x2	x3	Target value y
2	1	3	6
5	2	7	11
2	-2	4	0
-3	1	-2	0
-5	3	-1	1

Implement a Batch (= training set) linear regression training algorithm. Train it on the above dataset. Start with $w_0 = 0.1$ w1=0.2, w2=0.1 and w3=0.1. Assume training rate η of 0.1.Train for 10 epochs or training error of 0, whichever comes first. Report the training error after each epoch.

Q5. Logistic Regression.

This involves using the Pima Indian dataset (all the data can be found in files with extension .pkl) and the logistic regression program on scikit-learn (see the Q5_readme file). See the HW_Q5.zip for the data files for this question.

1. Train on train_1 file and test on test_1 file. Which attribute/feature seems to have the greatest impact on the prediction?
2. Now train of train_2 file and test on test_2 file. This time, we have added a new feature and retained the others with the same values. Observe that the predictions of the model remain the same as in part a. Examine the data and the model parameters. What do you observe about the first (the new feature) feature's weight and that of others. Explain what you observe and why you obtain the same predictions.
3. Repeat a similar exercise as (b) on train_3 and test_3. These two sets have a new feature added to data from train_1 and test_1. (We are no longer concerned about the new feature in (b) and train_2 and test_2 datasets.)

Q6. Implement linear regression algorithm (batch=training set) for the dataset containing 8 points. Four data points have output value of 0 and are given by w1 values of -1,-2,-3 and -4. Similarly there are four data points have output value of 1 and are given by w1 values of 1,2,3 and 4. Assume initial weights of w0=0.1 and w1=0.1. Assume learning rate η of 0.2.

Train for 20 epochs or if error rate difference between two consecutive iterations (epochs) is less than 1.

Draw a graph indicating the eight training points and what the induced model looks like. On the same graph, show any linear separator that separates the instances with output value of 0 from the instances with output value of 1.