Homework 1

Instructions
This homework contains **4** concepts and **5** programming questions. In MS word or a similar text editor, write down the problem number and your answer for each problem. Combined all answers for concept questions in a single PDF file. Export/print the Jupyter notebook as a PDF file including the code you implemented and the outputs of the program. **Make sure all plots and outputs are visible in the PDF.**

Combine all answers into a single PDF named andrewID_hw1.pdf and submit it to Gradescope before the due date. Refer to the syllabus for late homework policy. Please assign each question a page by using the "Assign Questions and Pages" feature in Gradescope.

Here is a breakdown of the points for programming questions:

Name	Points
M1_HW1	30
M1_HW2	30
M1_L1_p1	10
M1_L2_p1	10
M1_L2_p2	10

Problem 1 [2 Points]
Two problems will be described, with data samples shown. For each, please answer whether it is a **classification problem** or a **regression problem**. (You do not need to train the model)

a. An airfoil has two characteristic dimensions ‘d1’ and ‘d2’, and an angle of attack ‘AA’. The lift-to-drag ratio ‘LD’ is measured for several combinations of these inputs. Train a model to predict ‘LD’.

'd1'	'd2'	'AA'	'LD'
0.4	2.0	3.0	6.5
0.8	2.0	3.0	10.5
0.4	4.0	3.0	8.0
0.8	4.0	3.0	7.0
0.4	2.0	6.0	9.5
0.8	2.0	6.0	12.5
0.4	4.0	6.0	10.5
0.8	4.0	6.0	8.0

'L'	'w'	'Q'	'R'
1.8	4.5	16	La
1.8	4.5	24	Tr
1.8	4.5	16	La
1.8	9.0	24	Tr
1.8	9.0	16	La
1.8	9.0	24	Tu

b. Fluid flows through a rectangular pipe. Multiple pipe lengths ‘l’, pipe widths ‘w’, and flow rates ‘Q’ are tested, and the resulting flow regime ‘R’ is recorded as laminar (“La”), transitional (“Tr”), or turbulent (“Tu”). Train a model to predict ‘R

Problem 2 [5 Points]
Click the following link to the TensorFlow Neural Network Playground:

You will be training a neural network for regression on the "reg-gauss" dataset with six distinct clusters of points. Use a learning rate of 0.01, an activation of ReLU, and no regularization. The link should set each of these correctly.

Now, we can tweak a few aspects of the network to get different results. These are input features, number of hidden layers, and number of neurons per hidden layer. In this problem, you will see what happens when you change these. In addition to reporting changes in the test loss, also pay attention to how long each network takes to train.

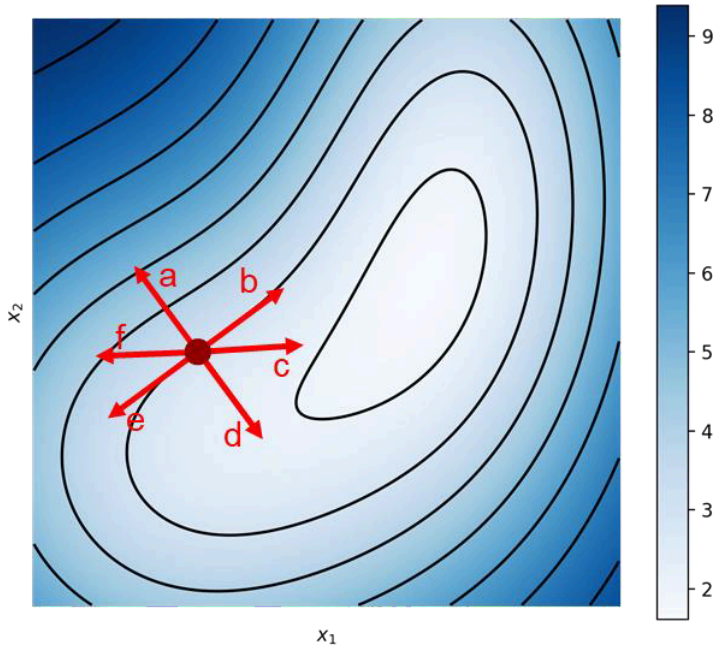
a. First, create a network with features X1 and X2 only, with 1 hidden layer of 2 neurons. Press the play button to train the network. Slowly, a function that approximates the data will be learned, and the loss will be minimized. Because the network is very small, it may not do a great job. Report the test loss for this case after it stabilizes.

b. Now increase the network size to 3 hidden layers with 3 neurons each. What is the test loss now (it should have decreased)?

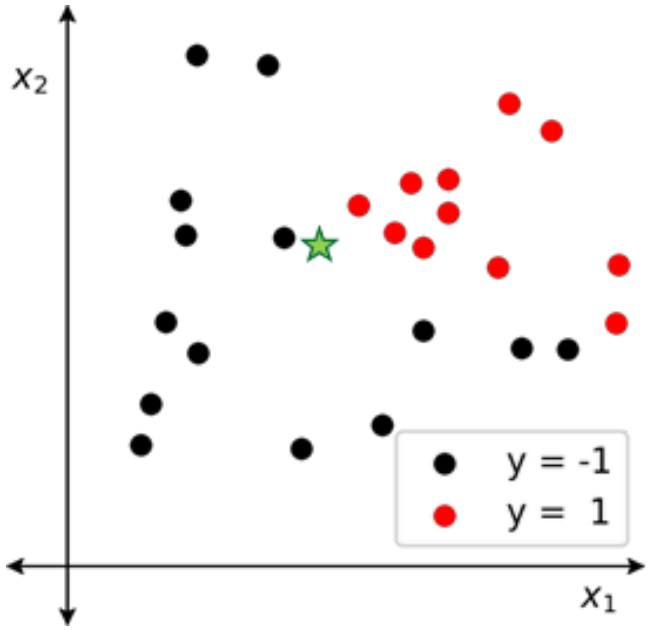
c. Finally, keep this network size, but expand the features. Add sin(X1) and sin(X2) to the feature set. Train the network and report the test loss value:

Backup address for Playground:
https://playground.tensorflow.org/#activation=relu&batchSize=10&dataset=gauss&regDataset=reg-gauss&learningRate=0.01&regularizationRate=0&noise=0&networkShape=&seed=0.31155&showTestData=false&discretize=false&percTrainData=50&x=true&y=true&xTimesY=false&xSquared=false&ySquared=false&cosX=false&sinX=false&cosY=false&sinY=false&collectStats=false&problem=regression&initZero=false&hideText=false

Problem 3 [1 Point]
Which of the following vectors in the figure is in the direction of gradient descent?



Problem 4 [2 points]
Consider the dataset shown in the figure. There are two input variables (x1 and x2) and two output classes “B” (black) and “R” (red). Observe the location of the test point, the green star, (answer each question with “Class B” or “Class R”)



a) Using a 1-nearest neighbor classifier, to which class does the test point belong?

b) Using a 3-nearest neighbors classifier, to which class does the test point belong?