Project 4 - Neural Networks

Total pts.: 50
Due: April 6, 2020

Introduction:

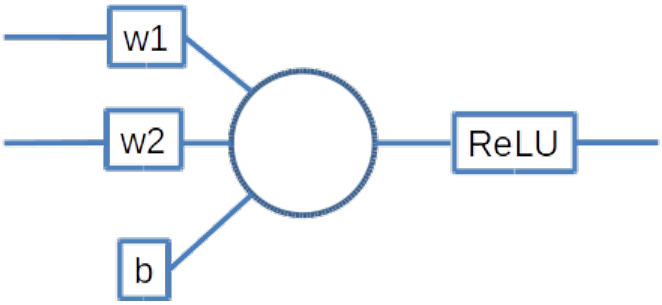
The purpose of this project is to familiarize you with neural networks.

Description:

You will answer some general questions about single neurons, and then use playground.tensorflow.org to explore deep neural nets.

You will summarize these answers in a short report.

1) Single Neuron:



a) For an artificial neuron with the form above, what will the output be for:

i) x1 = -1, x2 = 4, w1 = 2, w2 = 1, b = -5?

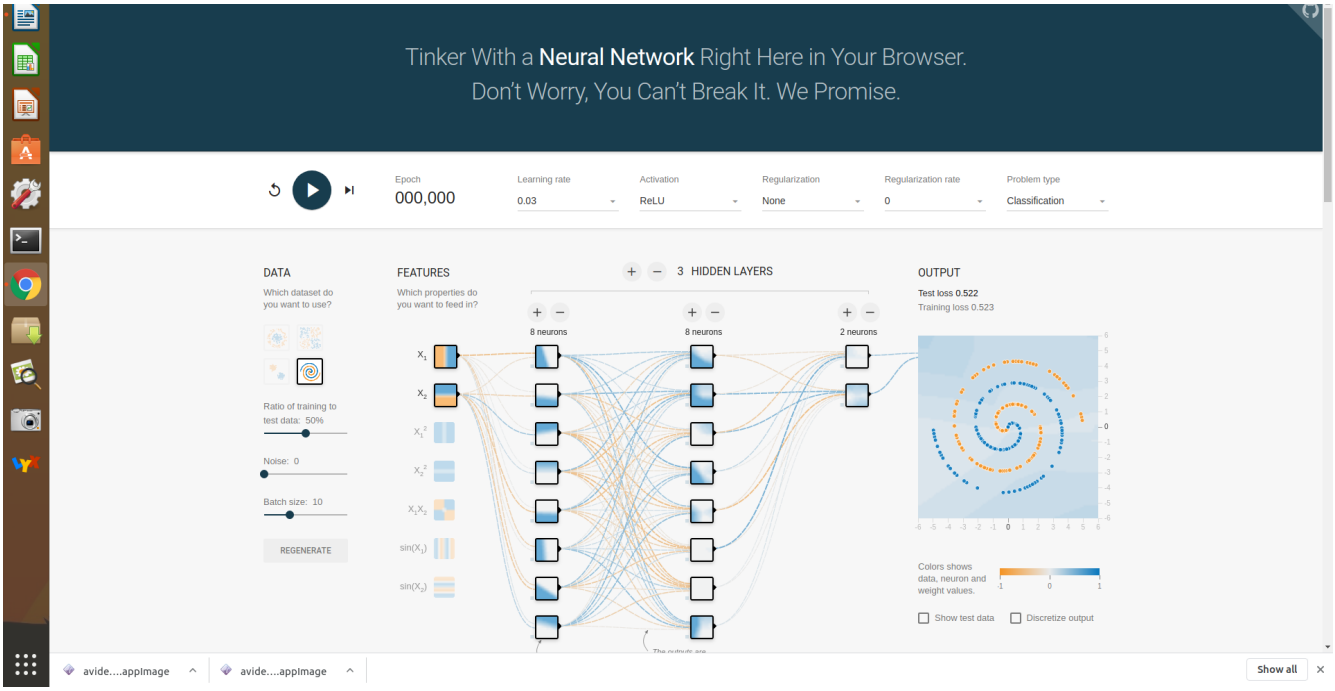
ii) x1 = 3, x2 = 5, w1 = -2, w2 = 3, b = 8?

b) Can the output of the neuron ever be negative?

c) What is a mathematical formula (representing the inputs and weights as vectors/matrices) that would correspond to the calculations you just performed?

2) TensorFlow Playground

TensorFlow playground is a visualization tool that allows you to change various aspects of a neural net and observe the results. Play around with it, and then answer the following questions:



If used as a classifier:

a) How many classes are there?
b) What is the default learning rate?
c) What is the default number of input features?
d) What does the "discretize output" checkbox do?
e) When you check the "show test data" checkbox how can you tell the training data from the test data?
f) Assuming accuracy = 1 - loss, why does the untrained network initially have a loss near 0.5?
g) Starting from the default network configuration, how many epochs does it take to reach an accuracy of 0.9? (try this a few times - answer will vary depending on initial random values assigned to weights)
h) How can I reduce the number of epochs required (what hyperparameter(s) could I change)? Try it.
i) What is the hardest dataset to model?
j) What do the images associated with the features show? (do we need 2-D images for all of them?)
k) Observe the images associated with the hidden layer neurons. What do they mean? Why are they changing as we train?
l) Try to find a network that does reasonably on the "spiral" dataset. What hyperparameters (learning rate, model architecture, input features, etc.) did you select for that?
m) Include a screen shot of that "best" network for the spiral dataset in your report.

Deliverables:

2-3 page report, submitted in Canvas in pdf format.