Assignment 1

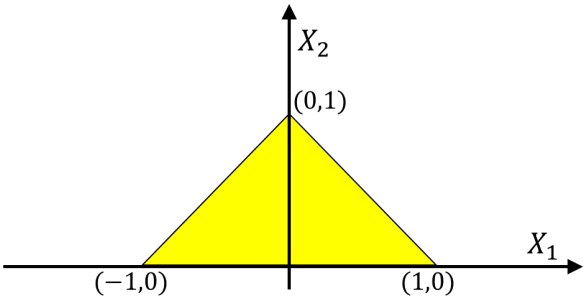
CSCE 5013-002

Deadline: Tuesday October 1, 2019

Where: In the class (Before the class begin)

Problem 1 (10 points)

We want to build an MLP that composes the decision boundary shown in the figure below. The output of the MLP must 1 in the yellow regions and 0 elsewhere



The MLP we design is suboptimal and has the structure and weights shown in the figure below, where each perceptron computes the function.

$$y = \begin{cases} 1 \;\; if \;\; \sum_i weight_i . input_i + bias_i \geq 0 \\ 0 \; else \end{cases}$$

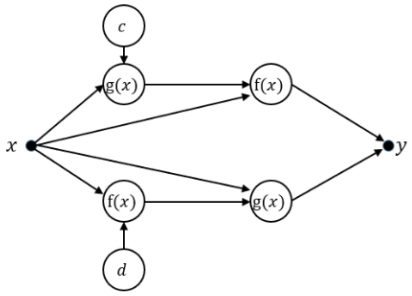
Problem 2 (10 points)

We are given the relationship

$$y = f(\mathbf{x}, g(\mathbf{x}, c))g(\mathbf{x}, f(\mathbf{x}, d))$$

Where **x** is a vector. $f(.)$ and $g(.)$ are both scalar functions which take a vector and a scalar as inputs. What is $\frac{dy}{dx}$?

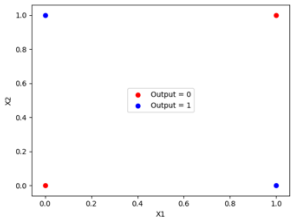
Note that the relationship between x, f(.) and g(.) is presented as following figure and we use dx for full derivate and ∂x for partial derivative



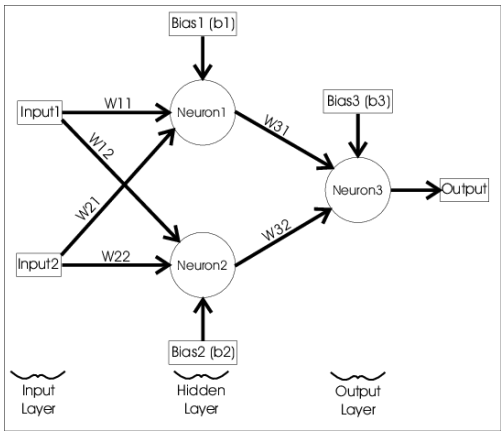
Problem 3 (40 points)

Manually design MLP network to perform the XOR Gate with the truth table and its plot on 2D as follows:

X1	X2	Y
0	0	0
0	1	1
1	0	1
1	1	0



The goal of the neural network is to classify the input patterns according to the above truth table. As mentioned in the class, the network is designed in similar following architecture



Where:

inputs = ([[0,0],[0,1],[1,0],[1,1]])

expected_output ([[0],[1],[1],[0]])

Start with uniform random initialization for parameters w_{ij} . Perform forward and backward pass in the following case:

1. Activation function is (a) Sigmod (b) ReLu, (c)Tanh
2. Divergence is defined as (a) L2_norm, (b) cross entropy
3. Train the network for 2 iterations (3 forward pass and 2 backward pass)

Please report the parameters and actual output from the MLP in each iteration

Problem 4 (40 points)

Building a MLP with one hidden layer to perform classification task with the following description:

+ Training data (X, Y):

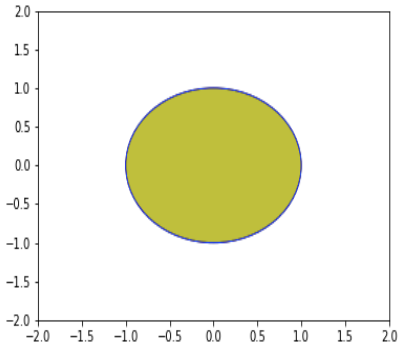
Training data contains N_1 = 10,000 points in 2-dimentional space and are followed by the uniform radius between 0 and 2 and its label is 1 is it is inside the yellow circle, otherwise it is 0

+ Validation data (X, Y):

Validation data contains N_2 = 2,000 points in 2-dimentional space and are followed by the uniform radius between 0 and 2 and its label is 1 is it is inside the yellow circle, otherwise it is 0

+ Testing data (X, Y):

Testing data contains N_2 = 2,000 points in 2-dimentional space and are followed by the uniform radius between 0 and 2 and its label is 1 is it is inside the yellow circle, otherwise it is 0



Assume that we use CrossEntropyLoss (nn. CrossEntropyLoss) and GradientDescent(torch.optim.SGD) with lr = 0.01

Report the training loss, validation loss, testing accuracy (in number and visualized by figure) in the following case

+ Train the MLP with 10 iterations
+ Train the MLP with 100 iterations
+ Train the MLP with 1000 iterations

Note: use import **matplotlib.pyplot** to plot figures