Engi 9867-Advanced Computing Concepts in Engineering
Winter 2019- Memorial University

Assignment 2:

Due date: 28th February 2019
Total Marks: 100

Problem 1: Use the random forest shown in slide no. 39 of lecture 7, to classify each of the following samples of IRIS dataset. For each case, show the path selected on each decision tree and the final detected class. Note: If two species receive similar number of votes, select the one that has obtained from the shortest path.

(a) SL = 5.6, SW = 3.0, PL = 4.5, and PW = 1.5 (5 marks).
(b) SL = 6.4, SW = 3.1, PL = 5.5, and PW = 1.8 (5 marks).
(c) SL = 4.8, SW = 3.4, PL = 5.1, and PW = 0.2 (5 marks).
(d) SL = 6.5, SW = 3.2, PL = 5.1, and PW = 2.0 (5 marks).

Problem 2: We want to fit a linear model to points $(1.62, 6.0)$, $(4.4, 11.2)$, $(4.55, 12.29)$, $(6.2, 20.18)$, and $(6.48, 23.04)$.

(a) Find the optimum model in terms of MSE using linear regression and find the mean and co-variance of estimation error for the fitted model (8 marks).
(b) Assuming that some of these points might be outliers, use RANSAC algorithm to find inliers and repeat part (a) only for the inlier points when the number of seed points is $s = 2$,the distance of inliers with the line is $d < 3$, and number of iterations is $N = 5$. (12 marks).

Problem 3: Design minimal perceptron neural network, i.e, with the least number of required nodes and layers, to implement AND-gate and XOR-gate (6 marks).

Problem 4: The first five layers of a CNN are

imageInputLayer([256 256 15]),
convolution2dLayer(12,64,'Padding',[1 1 1 1],'Stride', 2),
batchNormalizationLayer
reluLayer
maxPooling2dLayer(3,'Stride',2,'Padding','same')
Find the size of output after the each layer (8 marks).

Problem 5: In a neural network with two input and one output nodes, the loss function is defined as $L(w_1, w_2) = w_1^2 + 25w_2^2$ and the weights at iteration t are $(-1.25, -1.1)$. What are the weight at the next iteration for each of the following algorithms if $v_t = (0.1, 0.05)$, $\mu = 0.5$ and $\eta = 0.01$:

(a) Momentum algorithm (4 marks).
(b) Nesterov accelerated gradient algorithm (4 marks).
(c) AdaGrad algorithm (4 marks).

Problem 6: Design a simple LSTM network with one LSTM layers including 100 units that can classify eight different sequence from the received variable length complex-valued signals (8 marks).

Problem 7: Answer the following questions:
Q1: What are bagging and boosting in machine learning (4 marks)?
Q2: Write the steps for AdaBoost algorithm as a psuedo code (4 marks).
Q3: What is a weak learner (2 marks)?
Q4: What are the six most commonly used layers in a classification CNN (6 points)?
Q5: What are the five activation functions commonly used in deep neural networks. Briefly explain each of them (5 marks).
Q6: In the LSTM network in slide 47 of lecture 10, briefly explain what the last three layers do (5 marks).