INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

Department of Chemical Engineering

CL 651 – Foundations of Data Science for Engineers

Assignment-6 **Function Approximation Methods -II** **Date:25/04/2022**

Q1. Given 3 input features x1 = -3.2, x2 = 4.1 and x3 = 0.163, calculate y if a neural network with 1 hidden layer having (a) sigmoid (b) tanh (c)Relu activation function are used. Use two neurons in the hidden layer and the following weights

W1_11 = 0.1; w1_12 = 0.2; w1_31 = 0.5; w2_11 = 0.7;

w1_21 = 0.3; w1_22 = 0.4; w1_32 = 0.6; w2_21 = 0.8;

Q2. Given 3 input features x1, x2, x3 and a neural network with 1 hidden layer having 2 neurons, show the first iteration of parameter optimization using gradient descent algorithm. Use step length as 0.5. Use sigmoid activation function in the hidden layer and the weights given in Q1

Q3. Consider the following dataset. Assume that neural network with 1 hidden layer having 2

x_1	x_2	x_3	y
-3.2	*4.1*	*0.163*	*2*
-1.7	*3.9*	*1.35*	*6.2*
-4.16	*4.33*	*0.78*	*3.5*
-2.73	*3.14*	*1.07*	*4.2*

neurons is used to predict y using $x = [x1\ x2\ x3]$. Hidden layer has sigmoid activation function. Show 1 iteration of parameter optimization using gradient descent algorithm if step length is 0.05. Use the following weights as initial guess.

$$w_{1,11}^{[0]} = 0.1;\ w_{1,12}^{[0]} = 0.2;\ w_{1,31}^{[0]} = 0.5;\ w_{2,11}^{[0]} = 0.7;$$
$$w_{1,21}^{[0]} = 0.3;\ w_{1,22}^{[0]} = 0.4;\ w_{1,32}^{[0]} = 0.6;\ w_{2,21}^{[0]} = 0.8$$

Q4. Consider the data in Example Q3. Show 1 epoch (with whole data as a single batch) of parameter optimization using back propagation. Use η= 1.

Q5. Consider the following dataset.

Height, h	*1.5*	*1.7*	*1.6*	*1.5*	*1.4*	*1.6*	*1.4*	*1.9*	*2*	*1.4*	*1.8*	*1.5*
Weight, w	*71.1*	*103.3*	*26.4*	*27.8*	*21.8*	*94.9*	*90*	*98.3*	*108.1*	*91.9*	*61.5*	*90.2*
BMI, $(y = w/h^2)$	*31.6*	*35.74*	*10.31*	*12.36*	*11.12*	*37.07*	*45.92*	*27.23*	*27.23*	*46.89*	*18.98*	*40.09*

If this dataset is used as training set for k-NN, and the following test set is given,

Height h	*1.8*	*1*	*1.6*	*1.7*	*1.5*	*1.2*	*1.2*	*1.8*	*1.2*	*1.1*
Weight w	*81.7*	*105.8*	*20.4*	*66.1*	*93.1*	*95.1*	*85.0*	*46.3*	*102.6*	*84.3*
BMI $(y = w/h^2)$	*25.22*	*105.8*	*7.97*	*22.87*	*41.38*	*52.15*	*59.03*	*14.29*	*71.25*	*69.67*

Comment on the sensitivity of prediction quality to number of neighbours used in k-NN.

Q6. Consider the following data set

Sample No	1	2	13	4	5	6	7	8	9	10
Weight (w)	91.3	67.6	71.1	103.3	26.4	27.8	21.8	94.9	90	98.3
BMI (y)	40.58	23.39	27.77	45.91	13.47	10.86	11.12	26.29	22.5	50.15

Find the BMI corresponding to weights 35.2; 28 and 81.7 using a decision tree with a single decision, $w \leq 50$. Find the prediction error if the true BMI's are 10.86, 28 and 31.91.