National University of Computer and Emerging Sciences, Lahore Campus

Course:	Artificial Intelligence	Course Code:	CS401
Program:	BS(Computer Science)	Semester:	Spring 2017
Duration:	1 hour	Total Marks:	25
Paper Date:	07-04-17	Weight	15%
Section:	Only for D and E	Page(s):	2

Exam:	Mid Term II	Reg. No(Sec)	( )

Instruction/Notes:

- *One hand written A4 cheat sheet is allowed.*
- *Show all working. No credit will be given without correct working.*
- *Using incorrect formula will result in zero marks, as you are allowed a cheat sheet.*
- *All the questions should be solved on Answer sheet*

Question 1: (10)

Use perceptron rule to train a single perceptron for training data given in table 1. Perform only one iteration i.e. Go once through each training instance and shown the updating of weights.

- Use following activation function.

$$f_{AN}(net) = \begin{cases} 1 & \text{if } net \geq 0 \\ -1 & \text{if } net < 0 \end{cases}$$

- Consider Bias as w_0
- All the weights are initially zero
- Learning Rate =1

After you have completed one iteration draw the decision boundary on the figure 1, is there a need for more iterations if goal is to achieve 100% accuracy on training data?

x1	x2	y(label)
0	0	1
0.5	0	1
1	0	1
0.5	1	-1
1	1	-1
0	1	1

Table 1: Training data for Question1. X1 and X2 Are features and y is the label.

Figure 1: Graphical representation of Training data for Question 1.

Question 1:-

w_0	w_1	w_2
0	0	0

Train 1 1 0 0 net = 0 $\hat{y} = 1$ $y = 1$
no error.

Train 2:- 1 0.5 0 net = 0 $\hat{y} = 1$ $y = 1$
no error

Train 3:- 1 1 0 net = 0 $\hat{y} = 1$ $y = 1$
no error

Train 4:- 1 as 1 net = 0 $\hat{y} = 1$ $y = -1$
error, update weights using perceptron rule

$w_0 = w_0 + \alpha(y)\, x_0 = 0 + 1(-1)(1) = -1$
$w_1 = w_1 + \alpha(y)\, x_1 = 0 + 1(-1)0.5 = -0.5$
$w_2 = w_2 + \alpha(y)\, x_2 = 0 + 1(-1)1 = -1$

w_0	w_1	w_2
-1	-0.5	-1

Train 5 1 1 1 net = -2.5 $\hat{y} = -1$ $y = -1$
no error

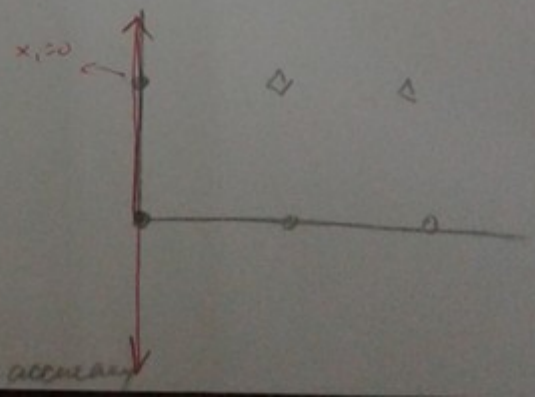
Train 6 1 0 1 net = -2 $\hat{y} = -1$ $y = 1$
error, updating weights using perceptron rule.

$w_0 = w_0 + \alpha(y)\, x_0 = -1 + 1(+1)(1) = 0$
$w_1 = w_1 + \alpha(y)\, x_1 = -0.5 + 1(+1)(0) = -0.5$
$w_2 = w_2 + \alpha(y)\, x_2 = -1 + 1(+1)1 = 0$

w_0	w_1	w_2
0	-0.5	0

Decision boundry

$w_0 x_1 + w_1 x_1 + w_2 x_2 = 0$
$0 - 0.5 x_1 + 0 = 0$
$0.5 x_1 = 0$
$x_1 = 0$



we need more iterations to get 100% accuracy

Question 2: (2+5)

Give the training data in table 2, a partial tree has been designed as given in figure 2.

i. Identify whether x1 and x2 are pure or not?

ii. At this given stage of tree, what are the possible options to split the node x1 and x2 (if they are not pure)? NOTE: You don't have to give the best option, you only have to identify all the options

Gender	Age	Blood Pressure	Chest Pain	Diagnose (Label)
1	30	High	1	+
1	34	High	1	+
0	47	low	1	+
0	90	low	0	-
0	60	normal	0	-
0	30	normal	0	-

Table 2: Heart Decease Training data for Question 2

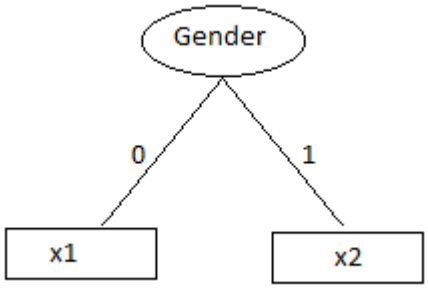
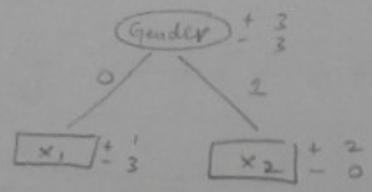


Figure 2: Partial Decision Tree for Question 2

Question 2:-

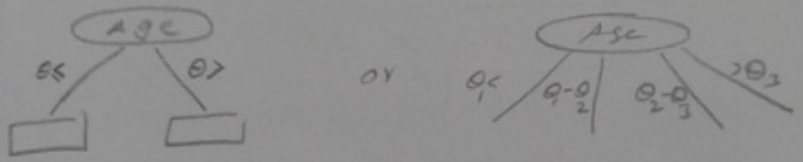


X_2 is pure

X_1 is not pure

Options to split X_1

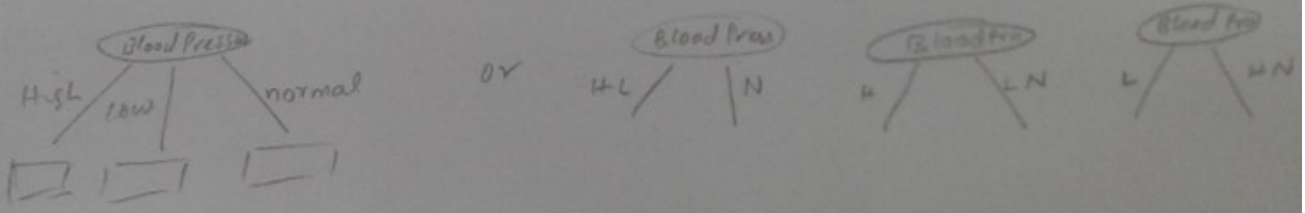
On age



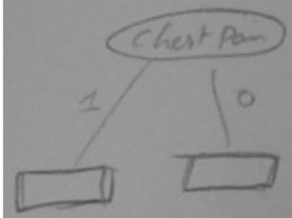
where θ will be some threshold

where $\theta_1, \theta_2, \theta_3$ are bucket limits

On Blood Pressure



On Chest Pain



Question 3: (3+5)

After performing linear regression analysis on training data we obtained the following weight vector. Training data consisted 3 features (predictors) X1, X2, X3 and one response Y.

i. Write an equation for estimating y ($\hat{y}$) using these weights.

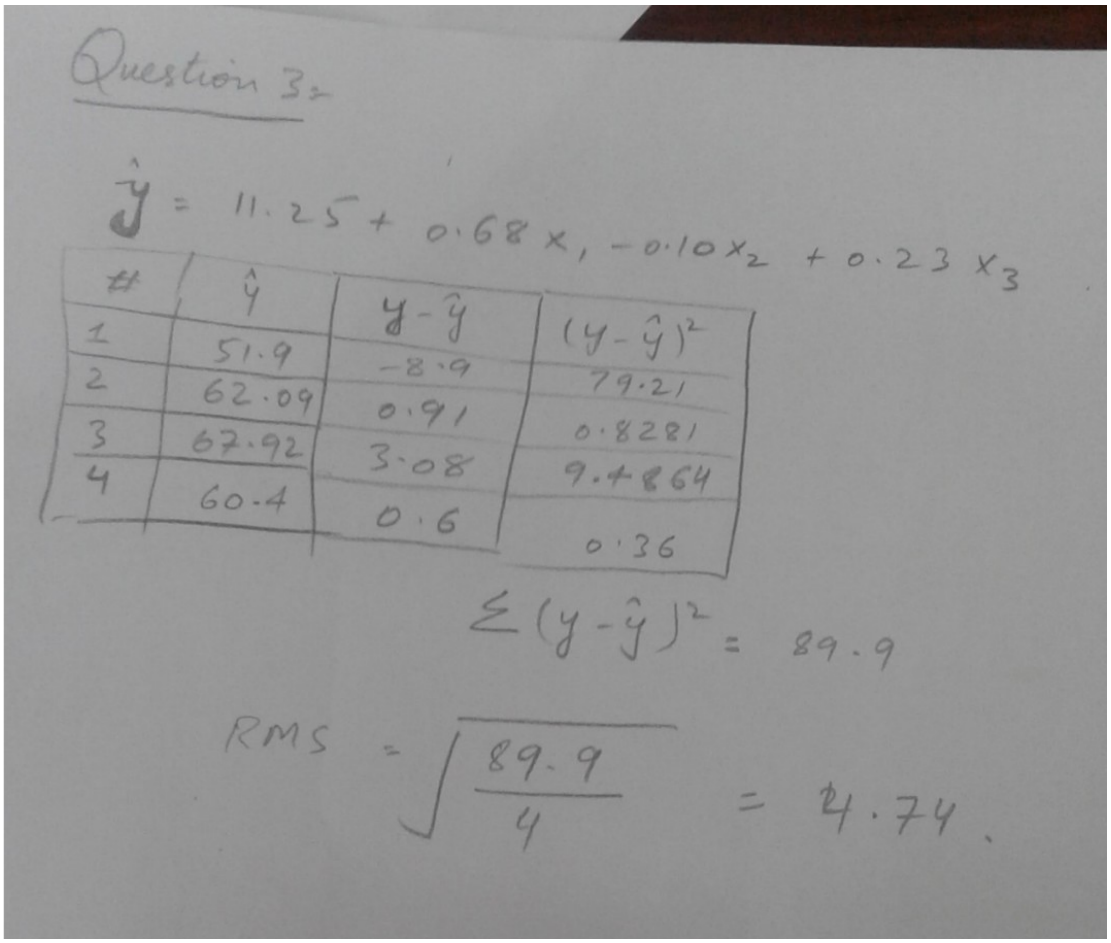
ii. Find the RMS error using the weights W for test data given in table 3.

$$W = \begin{bmatrix} 11.25 \\ 0.68 \\ -0.10 \\ 0.23 \end{bmatrix}$$

Figure 3: Weight vector after performing regression

X1	X2	X3	Y
51	30	39	43
64	51	54	63
70	68	69	71
63	45	47	61

Table 3: Test data for Question 3



Question 3:

$\hat{y} = 11.25 + 0.68x_1 - 0.10x_2 + 0.23x_3$

#	$\hat{y}$	$y - \hat{y}$	$(y - \hat{y})^2$
1	51.9	-8.9	79.21
2	62.09	0.91	0.8281
3	67.92	3.08	9.4864
4	60.4	0.6	0.36

$\Sigma (y - \hat{y})^2 = 89.9$

$RMS = \sqrt{\frac{89.9}{4}} = 4.74.$