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20.75

IT549: Deep Learning

1st In-Semester Exam (7th FEB 2024)
DA-IICT, Gandhinagar
Time Duration: **60 Minutes**
Total Marks: 23

2.25

Q.1 (3 points)

Answere True or False. 0.5 points for the correct answer and, -0.25 for the wrong answer, 0 points if you do not attempt it.

(a) Output from the "ReLU" activation function is bounded between 0 to 1. false

(b) Logistic regression is a non linear regression model. Tave

(c) Gradient descent optimization always find the global minima in non-linear ANN model. False

(d) Softmax activation function take the vector as input and output the same size vector. Tave

(e) Minimum gradient value of Tenh activation function is -1. Tave

(f) Multiple polynomial regression (without regularizaiton) have a close form solution. Tave

Q.2 (4 points) ---------- 3 ----------

The confusion matrix for the testing outcome of the ANN based binary classification model for fault detection is given below. Compute accuracy, precision, sensitivity and specificity for fault detection.You need to write the formula and place the value

		Prediction	
	Classes	*fault(+v)*	*Normal(-ve)*
Actual	*fault(+v)*	100	300
	Normal(-ve)	200	1000

Precision = $\frac{TP}{TP+FP}$ = $\frac{100}{100+200}$ = $\frac{100}{300}$

Recall (Sensitivity) = $\frac{TP}{TP+FN}$ = $\frac{100}{100+300}$ = $\frac{100}{400}$

specificity = $\frac{TN}{TN+FP}$ = $\frac{1000}{1000+200}$ = $\frac{1000}{1200}$

accuracy = $\frac{TP+TN}{P+N}$ = $\frac{100+1000}{100+300}$ = $\frac{1100}{400}$

6.3

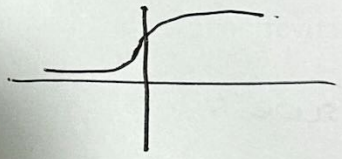
Q.3 (7 points)

Write the formulas and denote the each term.

(a) Sigmoid function and Draw function input output plot

$f(z) = \frac{1}{1+e^{-z}}$

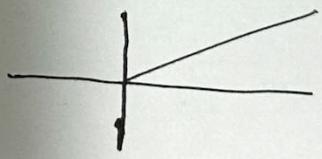
range (0, 1)



(b) Relu function and Draw function input output plot

$f(z) = \max(0, x)$

range $(0, x)$



(c) Multiple linear regession

$y = w_0 + \sum_{M=1}^{M} w_M x_M$

where y = output variable

x_M = input features

w_0 = bias term

w_M = weight.

(d) Logistic regression

$y(z) = \frac{1}{1+e^{-(w_0 + \sum_{M=1}^{M} w_M x_M)}}$

where z = sigmoid activation function

w_M = weight

w_0 = bias term

x_M = input features

(e) Mean square error

$\frac{-1}{n} \Sigma (y - \bar{y})^2$

y = target variable

n = no. of input variables

$\bar{y}$ = Predicted variable

(f) Binary cross entropy

$$h(y, \hat{y}) = -(y_n \log(\hat{y_n}) + (1 - \hat{y_n}) \log(1 - \hat{y_n}))$$

y_n = target variable

$\hat{y_n}$ = Predicted output variable

(g) Close-form solution for multiple linear regression

$$w^* = (x \cdot x^T)^{-1} x^T \cdot y$$

where w = weight y = Output

x = features

Q.4 (3 points)---------- 3

Fill the blank; MLP network with following scenario (you can specify some pre-processing of output data if you think so...)

a. Classification problem with ten classes; One hot encoding of output;
Preferable activation function at output layer: Soft Max
Preferable cost function: Cross entropy

b. Classification problem with two classes
Preferable Activation function at output layer: Sigmoid
Preferable cost function: Binary cross entropy

c. Regression problem with three output variable, output ranges unbounded.
Preferable Activation function at output layer: linear
Preferable cost function: MSE

Q.5 (3 points)---------- 3

Fill in the gap.

(a) A logistic regression model with 10-dimensional input features has 11 number of learnable parameters, and multiple linear regression has 11 number of learnable parameters.

(b) How many parameter in ANN modlel that contains five neuron in input layers, five neuron in hidden layer and three neuron in output layer. $(5 \times 5 + 5) + (5 \times 3 + 3)$

$= 30 + 18$

$= 48$

(c) Gradient value of ReLu activation function for positive input is 1 and for negative input value is 0.

Q.6 (3 points) 3

Given a following matrix; compute the performance measures e.g. **precision, recall, and specificity** for *'Neutral'* class from following confusion matrix.

		Predicted		
	classes	*Like*	*Neutral*	*Dislike*
Actual	*Like*	210	25	25
	Neutral	50	400	50
	Dislike	40	50	150

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{400}{400 + (25 + 50)}$$

$$= \frac{400}{475}$$

$$\text{Recall} = \frac{TP}{TP + FN} = \frac{400}{400 + (50 + 50)}$$

$$= \frac{400}{500}$$

$$\text{Specificity} = \frac{FP}{FP + TN} = \frac{(25 + 50)}{(25 + 50) + (210 + 40 + 25 + 150)}$$

$$\text{Specificity} = \frac{TN}{TN + FP} = \frac{(210 + 40 + 25 + 150)}{(210 + 40 + 25 + 150) + (25 + 50)}$$

$$= \frac{425}{500}$$

Q.1 (3 points)

Answere True or False. 0.5 points for the correct answer and, -0.25 for the wrong answer, 0 points if you do not attempt it.

(a) Output from the "ReLU" activation function is bounded between 0 to 1. F

(b) Logistic regression is a non linear regression model. T

(c) Gradient descent optimization always find the global minima in non-linear ANN model. F

(d) Softmax activation function take the vector as input and output the same size vector. F

(e) Minimum gradient value of Tenh activation function is -1. T

(f) Multiple polynomial regression (without regularizaiton) have a close form solution. T

Q.2 (4 points) ----------

The confusion matrix for the testing outcome of the ANN based binary classification model for fault detection is given below. Compute accuracy, precision, sensitivity and specificity for fault detection. You need to write the formula and place the value

		Prediction	
	Classes	fault(+v)	Normal(-ve)
Actual	fault(+v)	100	300
	Normal(-ve)	200	1000

400

~~2100~~ 1200

300

~~3100~~ 1300

1600

$$\text{Accuracy} = \frac{TP + TN}{P + N} = \frac{1100}{1600} = 11/16$$

Accuracy = 0.6875

$$\text{Sensitivity} = \frac{TP}{TP + FN} = \frac{100}{400}$$

Sensitivity = 0.25

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{100}{300}$$

Precision = 0.333

$$\text{specificity} = \frac{TN}{TN + FP} = \frac{1000}{1200}$$

Specificity = 0.833

5.3

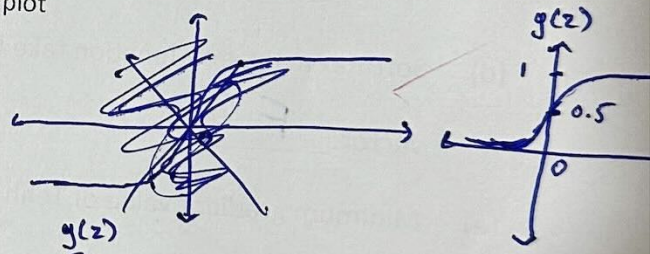
Q.3 (7 points) ----------

Write the formulas and denote the each term.

(a) Sigmoid function and Draw function input output plot

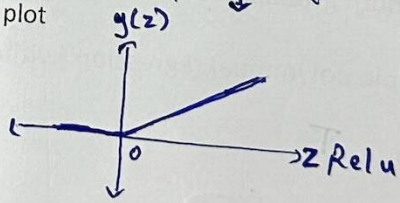
$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

$$z = wx + b$$



(b) Relu function and Draw function input output plot

$$g(z) = \begin{cases} 0 & z \leq 0 \\ z & z > 0 \end{cases}$$



(c) Multiple linear regession

$$y = w^T x + b$$

OR $$y = w_1 x_1 + w_2 x_2 + w_3 x_3 + \dots + w_m x_m + b$$

(d) Logistic regression

$$y = \frac{1}{1 + e^{-(w^T x + b)}}$$

(e) Mean square error

$$MSE = \frac{1}{m} \sum_{i=1}^{m} (y_i - \hat{y}_i)^2$$

(f) Binary cross entropy

$$E = -y \log(\hat{y}) - (1-y)\log(1-\hat{y})$$

(g) Close-form solution for multiple linear regression

$$\omega^* = (A^T A)^{-1} A^T Y$$

3

Q.4 (3 points)----------

Fill the blank; MLP network with following scenario (you can specify some pre-processing of output data if you think so...)

a. Classification problem with ten classes; One hot encoding of output;
Preferable activation function at output layer: Softmax
Preferable cost function: cross Entropy

b. Classification problem with two classes
Preferable Activation function at output layer: Sigmoid
Preferable cost function: binary cross entropy

c. Regression problem with three output variable, output ranges unbounded.
Preferable Activation function at output layer: linear
Preferable cost function: MSE

3

Q.5 (3 points)----------

Fill in the gap.

(a) A logistic regression model with 10-dimensional input features has 11 number of learnable parameters, and multiple linear regression has 11 number of learnable parameters.

(b) How many parameter in ANN modlel that contains five neuron in input layers, five neuron in hidden layer and three neuron in output layer. 48

25 + 5 = 30
15 + 3 = 18
48

(c) Gradient value of ReLu activation function for positive input is 1 and for negative input value is 0.

Q.6 (3 points)----------

Given a following matrix; compute the performance measures e.g. **precision, recall, and specificity** for '*Neutral*' class from following confusion matrix.

		Predicted			
	classes	*Like*	*Neutral*	*Dislike*	
Actual	*Like*	210	25	25	260
	Neutral	50	400	50	500
	Dislike	40	50	150	240
		300	475	225	1000

Predicted

Actual		+ve	-ve	Total
	+ve	400 TP	100 FN	500
	-ve	75 FP	425 TN	500
Total		475	525	1000

Precision

$$P_r = \frac{TP}{TP+FP}$$

$$= \frac{400}{475}$$

Precision = 0.8421

Recall

$$R = \frac{TP}{TP+FN}$$

$$= \frac{400}{400+100} = \frac{400}{500}$$

Recall = 0.8

Specificity

$$S = \frac{TN}{TN+FP}$$

$$= \frac{425}{425+75} = \frac{425}{500}$$

Specificity = 0.85

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20

Q.1 (3 points) 3

Answere True or False. 0.5 points for the correct answer and, -0.25 for the wrong answer, 0 points if you do not attempt it.

(a) Output from the "ReLU" activation function is bounded between 0 to 1. False

(b) Logistic regression is a non linear regression model. True

(c) Gradient descent optimization always find the global minima in non-linear ANN model. False

(d) Softmax activation function take the vector as input and output the same size vector. True

(e) Minimum gradient value of Tenh activation function is -1. False

(f) Multiple polynomial regression (without regularizaiton) have a close form solution. True

Q.2 (4 points) 4

The confusion matrix for the testing outcome of the ANN based binary classification model for fault detection is given below. Compute accuracy, precision, sensitivity and specificity for fault detection.You need to write the formula and place the value

		Prediction	
	Classes	***fault(+v)***	***Normal(-ve)***
Actual	***fault(+v)***	100 TP	300 FN
	Normal(-ve)	200 FP	1000 TN

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} = \frac{100 + 1000}{100 + 1000 + 300 + 200} = \underline{0.6875}$$

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{100}{100 + 200} = \underline{0.333}$$

$$\text{Recall (Sensitivity)} = \frac{TP}{TP + FN} = \frac{100}{100 + 300} = \underline{0.25}$$

$$\text{Specificity} = \frac{TN}{TN + FP} = \frac{1000}{1000 + 200} = \underline{0.833}$$

$(\because TP = 100,\ TN = 1000,\ FN = 300,\ FP = 200)$

5.5

Q.3 (7 points) ----------

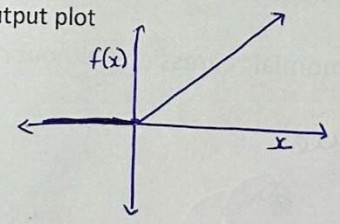
Write the formulas and denote the each term.

(a) Sigmoid function and Draw function input output plot

$$f(x) = \frac{1}{1 + e^{-x}}$$

(b) Relu function and Draw function input output plot

$$f(x) = \begin{cases} 0 & ; \text{if } x \leq 0 \\ x & ; \text{if } x > 0 \end{cases}$$



(c) Multiple linear regession

$$f(x) = w_0 + \sum_{i=1}^{n} w_i x_i$$

(d) Logistic regression

$$f(x) = \begin{cases} 1 & ; \text{if } \frac{1}{1+e^{-x}} > 0.5 \\ 0 & ; \text{if } \frac{1}{1+e^{-x}} < 0.5 \end{cases}$$

($\because 0.5$ is considered as boundry for classification)

(e) Mean square error

$$\text{Error} = \frac{\sum_{i=1}^{n} (y_i - \hat{y})^2}{n}$$

where y_i is actual value
$\hat{y}$ predicted value
n is number of datapoints.

Specif.

(f) Binary cross entropy

$$BCE = y_i \log y_i - (1-y_i)\log(1-y_i)$$

(g) Close-form solution for multiple linear regression

$$\min \frac{1}{n}\sum_{i=1}^{n}\left[y_i - \{w_{0i} + \sum_{j=1}^{m} w_{ji}\, x_{ji}\}\right]^2$$

where m = no. of features
n = no. of data samples

3

Q.4 (3 points)----------

Fill the blank; MLP network with following scenario (you can specify some pre-processing of output data if you think so...)

a. Classification problem with ten classes; One hot encoding of output;
Preferable activation function at output layer: Softmax
Preferable cost function: Cross Entropy.

b. Classification problem with two classes
Preferable Activation function at output layer: Sigmoid
Preferable cost function: ~~Binary~~ Cross Entropy

c. Regression problem with three output variable, output ranges unbounded.
Preferable Activation function at output layer: Linear Activation function
Preferable cost function: ~~MSE~~ Least Square Error

1.5

Q.5 (3 points)----------

Fill in the gap.

(a) A logistic regression model with 10-dimensional input features has 0 number of learnable parameters, and multiple linear regression has 11 number of learnable parameters.

(b) How many parameter in ANN modlel that contains five neuron in input layers, five neuron in hidden layer and three neuron in output layer. 75

(c) Gradient value of ReLu activation function for positive input is 1 and for negative input value is 0.

Q.6 (3 points)

Given a following matrix; compute the performance measures e.g. **precision, recall, and specificity** for '***Neutral***' class from following confusion matrix.

		Predicted		
	classes	***Like***	***Neutral***	***Dislike***
Actual	***Like***	210	25	25
	Neutral	50	400	50
	Dislike	40	50	150

	Predicted.	
	+ve	-ve
+ve	400_{TP}	100_{FN}
Actual -ve	75_{FP}	425_{TN}

$$\text{Precision} = \frac{TP}{TP + FP} = \frac{400}{400 + 75} = 0.8421$$

$$\text{Recall} = \frac{TP}{TP + fN} = \frac{400}{400 + 100} = 0.8$$

$$\text{Specificity} = \frac{TN}{TN + fP} = \frac{425}{425 + 75} = 0.85$$