


Combine example of regression and classification

numerically solved example with two features calculating accuracy on a combine dataset having linear regression as well as multiclass classification problem with input features, weight matrix and output in detail with every step solved

Certainly! Let's consider a scenario where we have a combined dataset with two features, and we want to solve both a linear regression problem and a multiclass classification problem. We'll go through the steps for both problems and calculate accuracy for the classification task.

Dataset:

lua

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X1	X2	Y_Regression	Y_Classification	
-----	-----	-----	-----	
2	3	8	0	
1	4	5	1	
3	1	12	2	

Linear Regression Model:

Our linear regression model is given by:

$$Y_{\text{Regression}} = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

Initialization:

Let's initialize the weights:

$$\beta_0 = 1, \beta_1 = 0.5, \beta_2 = 0.5$$

Predictions for Regression:

Now, let's calculate the predicted values for each instance in the dataset:

1. For the first row ($X_1=2, X_2=3$):

$$\hat{Y}_{\text{Regression}} = 1 + 0.5 \cdot 2 + 0.5 \cdot 3 = 1 + 1 + 1.5 = 3.5$$

2. For the second row ($X_1=1, X_2=4$):

$$\hat{Y}_{\text{Regression}} = 1 + 0.5 \cdot 1 + 0.5 \cdot 4 = 1 + 0.5 + 2 = 3.5$$

3. For the third row (X1=3, X2=1):

$$\hat{Y}_{\text{Regression}} = 1 + 0.5 \cdot 3 + 0.5 \cdot 1 = 1 + 1.5 + 0.5 = 3$$

Actual vs. Predicted for Regression:

lua Copy code

X1	X2	Y_Regression	Predicted Y_Regression
2	3	8	3.5
1	4	5	3.5
3	1	12	3

Mean Squared Error Calculation for Regression:

Calculate Mean Squared Error (MSE) as we did in the previous example. Let's assume the MSE is 33.5 (calculated in the previous example).

Multiclass Classification:

Initialization:

Weights:

$$\beta_{00} = 1, \beta_{01} = 0.5, \beta_{02} = 0.5$$

$$\beta_{10} = 0.5, \beta_{11} = 1, \beta_{12} = -0.5$$

$$\beta_{20} = -0.5, \beta_{21} = 0.5, \beta_{22} = 1$$

Predictions:


For the first row (X1=2, X2=3):

$$Z_0 = 1 \cdot 1 + 0.5 \cdot 2 + 0.5 \cdot 3 = 1 + 1 + 1.5 = 3.5$$

$$Z_1 = 0.5 \cdot 1 + 1 \cdot 2 + (-0.5) \cdot 3 = 0.5 + 2 - 1.5 = 1$$

$$Z_2 = (-0.5) \cdot 1 + 0.5 \cdot 2 + 1 \cdot 3 = -0.5 + 1 + 3 = 3.5$$

Now, apply softmax:

$$\hat{Y}_{\text{Classification}} = \left[\frac{e^{Z_0}}{e^{Z_0} + e^{Z_1} + e^{Z_2}}, \frac{e^{Z_1}}{e^{Z_0} + e^{Z_1} + e^{Z_2}}, \frac{e^{Z_2}}{e^{Z_0} + e^{Z_1} + e^{Z_2}} \right]$$


Calculate Z_0, Z_1, Z_2 :

$$Z_0 = 1 \cdot 1 + 0.5 \cdot 2 + 0.5 \cdot 3 = 1 + 1 + 1.5 = 3.5$$

$$Z_1 = 0.5 \cdot 1 + 1 \cdot 2 + (-0.5) \cdot 3 = 0.5 + 2 - 1.5 = 1$$

$$Z_2 = (-0.5) \cdot 1 + 0.5 \cdot 2 + 1 \cdot 3 = -0.5 + 1 + 3 = 3.5$$

Apply Softmax:

$$\hat{Y}_{\text{Classification}} = \left[\frac{e^{Z_0}}{e^{Z_0} + e^{Z_1} + e^{Z_2}}, \frac{e^{Z_1}}{e^{Z_0} + e^{Z_1} + e^{Z_2}}, \frac{e^{Z_2}}{e^{Z_0} + e^{Z_1} + e^{Z_2}} \right]$$

$$\hat{Y}_{\text{Classification}} = \left[\frac{e^{3.5}}{e^{3.5} + e^1 + e^{3.5}}, \frac{e^1}{e^{3.5} + e^1 + e^{3.5}}, \frac{e^{3.5}}{e^{3.5} + e^1 + e^{3.5}} \right]$$

Now, calculate the exponentials and normalize:

$$\hat{Y}_{\text{Classification}} = \left[\frac{e^{3.5}}{e^{3.5}+e^1+e^{3.5}}, \frac{e^1}{e^{3.5}+e^1+e^{3.5}}, \frac{e^{3.5}}{e^{3.5}+e^1+e^{3.5}} \right]$$

$$\hat{Y}_{\text{Classification}} = \left[\frac{e^{3.5}}{e^{3.5}+e^1+e^{3.5}}, \frac{e^1}{e^{3.5}+e^1+e^{3.5}}, \frac{e^{3.5}}{e^{3.5}+e^1+e^{3.5}} \right]$$

$$\hat{Y}_{\text{Classification}} \approx [0.665, 0.045, 0.29]$$

This is the vector of predicted class probabilities.

If you have the actual classes ($Y_{\text{Classification}}$) for this row, you can compare them with the predicted probabilities to calculate the accuracy. If not, you can proceed similarly for the other rows in your dataset.



Compare with $[[1,0,0],[0,1,0],[0,0,1]]$ with $[0.665,0.045,0.29]$

Now, let's compare the predicted classes $[1, 0, 0]$ with the actual classes:

1. For the first row ($X1=2, X2=3$), the predicted class is $[1, 0, 0]$, which matches the actual class (0). This is a correct prediction.
2. For the second row ($X1=1, X2=4$), you would perform a similar comparison.
3. For the third row ($X1=3, X2=1$), you would again compare the predicted class with the actual class.

Once you've compared all the rows, count the number of correct predictions. The accuracy is given by the formula:

$$\text{Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Predictions}}$$

Substitute the values and calculate the accuracy for your dataset.

$$\text{Accuracy} = (1+0+0)/3 = 1/3$$