Assignment 4
Foundations of Machine Learning

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Questions: Programming

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5. Logistic Regression: *(7 marks)*

Implementation contains a class of Logistic Regression with methods that calculate y ,sigmoid, error , loss, updation of weights for iteration .b ,w, learning rate, iterations can be specified as hyper parameters .Implementation also contains normalization of features it tries to fit the given model and hyper parameters and learn b and w here it is θ_0 , θ_1 , θ_2 , and use sigmoid of $f_\theta(x_1, x_2) = \theta_0 + \theta_1 x_1 + \theta_2 x_2$.

If sigmoid >0.5 then class is predicted as 1 otherwise it is 0.

(a) *(3 marks)* Implement your own code for a logistic regression classifier, which is trained using gradient descent and cross-entropy error as the error function.

Index	x_1	x_2	y
1	0.346	0.780	0
2	0.303	0.439	0
3	0.358	0.729	0
4	0.602	0.863	1
5	0.790	0.753	1
6	0.611	0.965	1

Index	x_1	x_2	y
1	0.959	0.382	0
2	0.750	0.306	0
3	0.395	0.760	0
4	0.823	0.764	1
5	0.761	0.874	1
6	0.844	0.435	1

Table 1: Train SetTable 2: Test Set

(b) Consider the training set and test set given in Tables 1 and 2. We use the linear model $f_\theta(x_1, x_2) = \theta_0 + \theta_1 x_1 + \theta_2 x_2$ and the logistic regression function $\sigma(f_\theta(x_1, x_2)) = \frac{1}{1+\exp^{-f_\theta(x_1, x_2)}}$. Consider the initial weights as $\theta_0 = -1$, $\theta_1 = 1.5$, $\theta_2 = 0.5$, and learning rate as 0.1 (for gradient descent).

i. *(1 mark)* What is the logistic model $P(\hat{y} = 1|x_1, x_2)$ and its cross-entropy error function?

As we know the logistic model for P(ˆy = 1|x1, x2) by substituiting θ,θ1,θ2 given a s -1,1.5,0.5

fθ(x1, x2)=1.5* x1 + 0.5* x2 -1

Cross Entropy Error Function is

loss=(-target * np.log(actual) - (1 - target) * np.log(1 - actual)).mean() where target is the desired value and actual is the value from model i.e. yhat

ii. *(1 mark)* Use gradient descent to update θ_0, θ_1, θ_2 for one iteration. Write down the updated logistic regression model.

As we can see after one iteration values of W=[1.51234756, 050790003]) and b= -0.9980220558745176

Hence model before first iteration is

fθ(x1, x2)=1.5* x1 + 0.5* x2 -1

After first iteration it is

fθ(x1, x2)=1.51234756 * x1 + 0.50790003 * x2 - 0.9980220558745176

iii. *(2 mark)* At convergence of gradient descent, use the model to make predictions for all the samples in the test dataset. Calculate and report the accuracy, precision and recall to evaluate this model.

```
Accuracy :
0.6666666666666666
Precision :
0.6
Recall :
1.0
```