2. Linear Regression with Closed Form Solution

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Project due Oct 21, 2020 05:29 IST *Completed*

After seeing the problem, your classmate Alice immediately argues that we can apply a linear regression model, as the labels are numbers from 0-9, very similar to the example we learned from Unit 1. Though being a little doubtful, you decide to have a try and start simple by using the raw pixel values of each image as features.

Alice wrote a skeleton code `run_linear_regression_on_MNIST` in main.py, but she needs your help to complete the code and make the model work.

Closed Form Solution of Linear Regression

5.0/5.0 points (graded)

To solve the linear regression problem, you recall the linear regression has a closed form solution:

$$\theta = \left(X^T X + \lambda I\right)^{-1} X^T Y$$

where I is the identity matrix.

Write a function `closed_form` that computes this closed form solution given the features X, labels Y and the regularization parameter λ.

Available Functions: You have access to the NumPy python library as `np`; No need to import anything.

```
def closed_form(X, Y, lambda_factor):
    """
    Computes the closed form solution of linear regression with L2 regularization

    Args:
        X - (n, d + 1) NumPy array (n datapoints each with d features plus the bias feature in the first d
        Y - (n, ) NumPy array containing the labels (a number from 0-9) for each
            data point
        lambda_factor - the regularization constant (scalar)
    Returns:
        theta - (d + 1, ) NumPy array containing the weights of linear regression. Note that theta[0]
        represents the y-axis intercept of the model and therefore X[0] = 1
    """
    # YOUR CODE HERE
    try:
        X_Xtrans = np.dot(X.T,X)
```

Press ESC then TAB or click outside of the code editor to exit

Correct

Test results

```
CORRECT
```

See full output

See full output

Submit

You have used 1 of 25 attempts

Test Error on Linear Regression

1.0/1.0 point (graded)

Apply the linear regression model on the test set. For classification purpose, you decide to round the predicted label into numbers 0-9.

Note: For this project we will be looking at the error rate defined as the fraction of labels that don't match the target labels, also known as the "gold labels" or ground truth. (In other context, you might want to consider other performance measures such as precision and recall, which we have not discussed in this course).

Please enter the **test error** of your linear regression algorithm for different λ (copy the output from the `main.py` run).

$\mathrm{Error}|_{\lambda=1} =$ 0.7697 ✓

$\mathrm{Error}|_{\lambda=0.1} =$ 0.7698 ✓

$\mathrm{Error}|_{\lambda=0.01} =$ 0.7702 ✓

Submit You have used 1 of 20 attempts

What went Wrong?

1.0/1.0 point (graded)

Alice and you find that no matter what λ factor you try, the test error is large. With some thinking, you realize that something is wrong with this approach.

□ Gradient descent should be used instead of the closed form solution.

☑ The loss function related to the closed-form solution is inadequate for this problem.

□ Regularization should not be used here.

✓

Submit You have used 2 of 2 attempts

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Closed form solution 4

? Error in closed form function 4

? [staff] What went wrong? 6
Could you clarify whether each of the given options should be sufficient by itself to explain the wrong approach, and does the wrong...

? What went wrong 4
I don't know how to think through this problem at all. Can anyone point out what part of the course material is relevant for this prob...

? Need Help!!! 6
Getting memory error while i'm trying to return vector from my closed_form function in linear_regression.py file . The error says as : ...

NameError: name 'get_MNIST_data' is not defined 1
I get this error message when I run python3 main.py (or python main.py)

Memory error!! 3

? python version problem
Anybody else got the following error: Please note and check the following: * The Python version is: Python3.6 from "D:\Anaconda3\e... 1

💬 Singular Matrix? 12

💬 "get_MNIST_data" is not defined
A quick workaround for this issue is to change the Python file "utils.py" to "utilities.py" or any other name, then change the importin... 2

💬 "[...] you recall the linear regression has a closed form solution [...]"
The **Closed Form Solution for Linear Regression** question states: "*To solve the linear regression problem, **you recall the linea... 9

? [STAFF] Would yu please help me understand the following ? 3

💬 How we know when (X.T @ X + lambda*I) is invertible?
Is it always invertible or are there cases where closed form solution cannot be used? 4

💬 invalid syntax
try the code below, and I get the following error message: "dot =np.dot(np.transpose(X),Y). Syntaxerror: invalid syntax". I have check... 6

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