RunProblem

April 9, 2019

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In [1]: #Anusha Gururaja Manur
        #unity id :  amanur

        import numpy as np
        import matplotlib.pyplot as plt
        import pandas as pd

        # Function that creates the X matrix as defined for fitting our model
        def create_X(x,deg):
            X = np.ones((len(x),deg+1))
            for i in range(1,deg+1):
                X[:,i] = x**i

            return X

        # Function for predicting the response
        def predict_y(x,beta):
            return np.dot(create_X(x,len(beta)-1),beta)

        # Function for fitting the model
        def fit_beta(df,deg):
            return np.linalg.lstsq(create_X(df.x,deg),df.y,rcond=None)[0]

        # Function for computing the MSE
        def mse(y,yPred):
            return np.mean((y-yPred)**2)

        # Loading training, validation and test data
        dfTrain = pd.read_csv('Data_Train.csv')
        dfVal = pd.read_csv('Data_Val.csv')
        dfTest = pd.read_csv('Data_Test.csv')

        ############ TRAINING A MODEL

        # Fitting model
        deg = 1
        X = create_X(dfTrain.x,deg)
        beta = fit_beta(dfTrain,deg)
        # Computing training error
        yPredTrain = predict_y(dfTrain.x,beta)
        err = mse(dfTrain.y,yPredTrain)
        print('Training Error = {:2.3}'.format(err))

        # Computing test error
        yPredTest = predict_y(dfTest.x,beta)
        err = mse(dfTest.y,yPredTest)
        print('Test Error = {:2.3}'.format(err))
```

```
Training Error = 0.0258
Test Error = 0.0154
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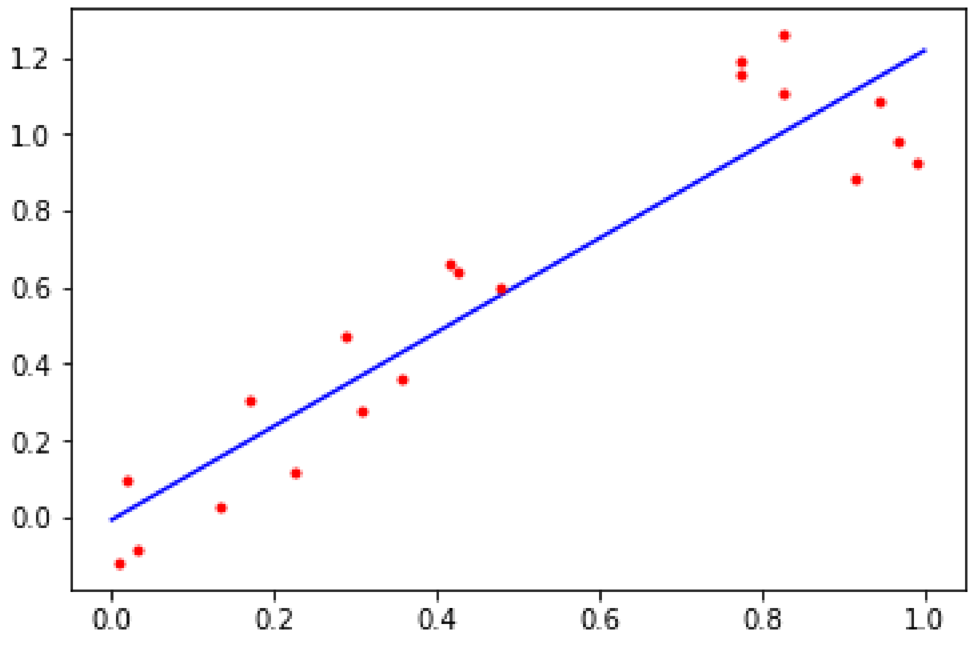
In [2]: ############ PLOTTING FITTED MODEL
        x = np.linspace(0,1,100)
        y = predict_y(x,beta)

        plt.plot(x,y,'b-',dfTrain.x,dfTrain.y,'r.')
        plt.show()
```



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In [3]: ############ HYPER-PARAMETER TUNING

        # Initializing range of degree values to be tested and errors
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degRange = list(range(1,11))
errTrain = np.zeros(len(degRange))
errVal = np.zeros(len(degRange))

# Computing error as a function of degree
# ...
for i,degree in enumerate(degRange):
    beta = fit_beta(dfTrain,degree)
    print ("Degree: ", degree)

    # Computing training error

    yPredTrain = predict_y(dfTrain.x,beta)
    err_train = mse(dfTrain.y,yPredTrain)
    print('Training Error = {:2.3}'.format(err_train))
    errTrain[i]=err_train

    #beta = fit_beta(dfVal,degree)
    # Computing val error
    yPredVal = predict_y(dfVal.x,beta)
    err_val = mse(dfVal.y,yPredVal)
    print('Validation Error = {:2.3}'.format(err_val))
    errVal[i]=err_val
    print ()

# Plotting training and validation errors
plt.plot(degRange,errTrain,'b-',degRange,errVal,'r-')
plt.legend(('Training Error','Validation Error'))
plt.savefig('error.png')
plt.show()
plt.close()
```

```
Degree:  1
Training Error = 0.0258
Validation Error = 0.0249

Degree:  2
Training Error = 0.0188
Validation Error = 0.0186

Degree:  3
Training Error = 0.00967
Validation Error = 0.00843

Degree:  4
Training Error = 0.00929
Validation Error = 0.00934
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Degree:  5
Training Error = 0.00902
Validation Error = 0.0109

Degree:  6
Training Error = 0.00874
Validation Error = 0.0108

Degree:  7
Training Error = 0.00873
Validation Error = 0.0109

Degree:  8
Training Error = 0.00873
Validation Error = 0.0111

Degree:  9
Training Error = 0.00823
Validation Error = 0.0152

Degree:  10
Training Error = 0.00673
Validation Error = 0.0392
```

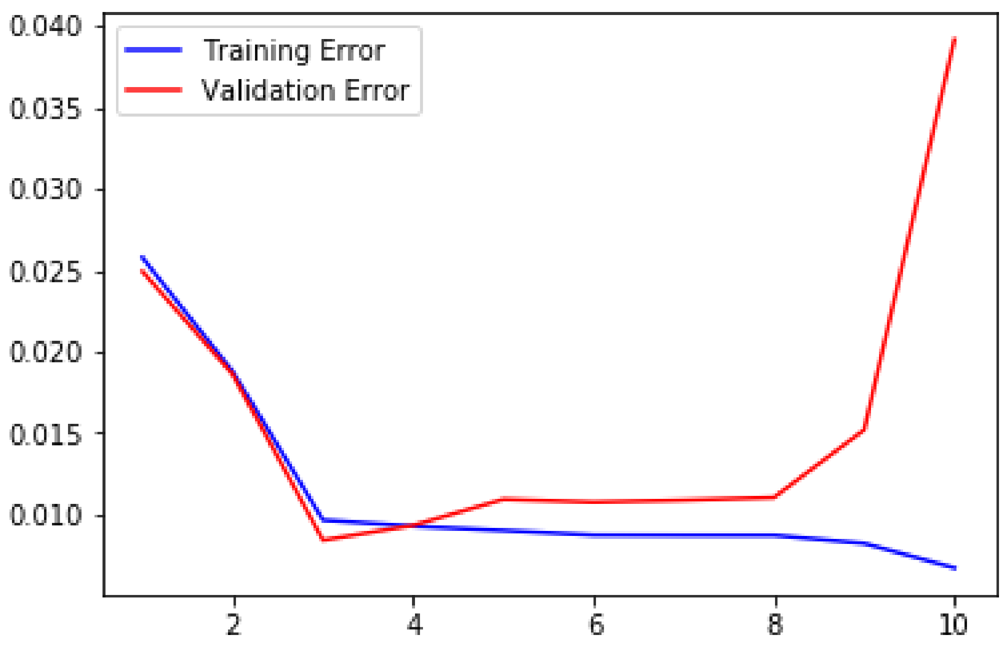

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In [5]: ############ TRAINING SELECTED MODEL

        # Concatenating data training and validation data frames
        df =  pd.concat([dfTrain, dfVal], ignore_index=True)

        # Fit model using the optimal degree found in the previous cell

        #Optimal degree is 3 as this is where the validation error starts increasing
        degOpt = 3

        # Compute and print training and test errors
        beta = fit_beta(df,degOpt)

        # Computing training error
        yPred = predict_y(df.x,beta)
        err = mse(df.y,yPred)
        print('Training Error = {:2.3}'.format(err))

        # Computing test error
        yPredTest = predict_y(dfTest.x,beta)
        err = mse(dfTest.y,yPredTest)
        print('Testing Error = {:2.3}'.format(err))
```

```
Training Error = 0.0087
Testing Error = 0.0108
```

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In [6]: ############ PLOTTING FITTED MODEL
        # Plot the fitted model as in the second cell
        x = np.linspace(0,1,100)
        y = predict_y(x,beta)

        plt.plot(x,y,'b-',df.x,df.y,'r.')

        plt.savefig('deg3.png')
        plt.show()
        plt.close()
```

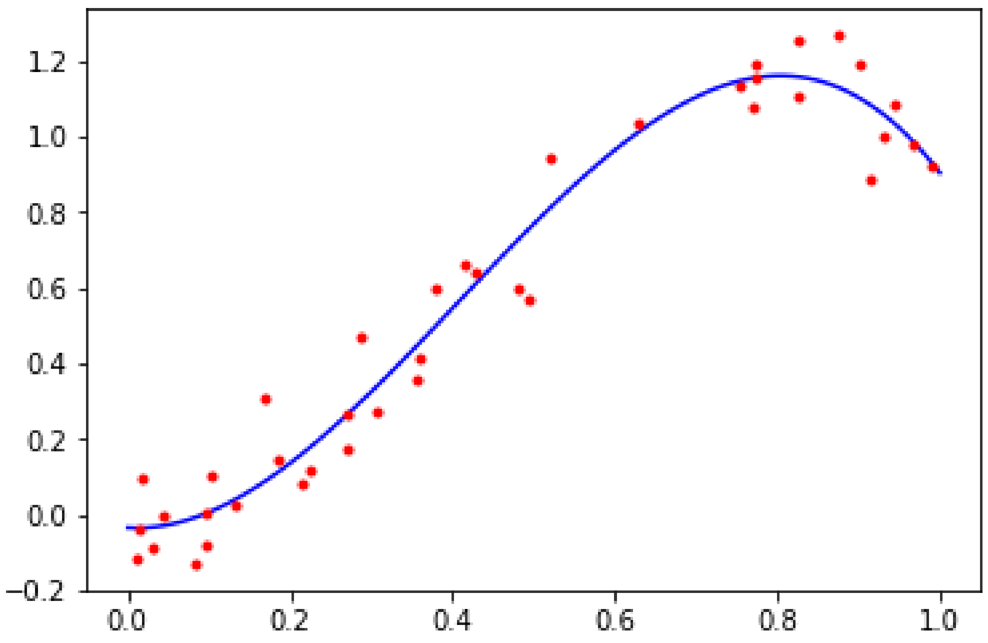

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In [ ]:
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