Servo Prediction using Linear Regression

Insights of Data set

What Is Servo: In control engineering a servomechanism, usually shortened to servo, is an automatic device that uses error-sensing negative feedback to correct the action of a mechanism. On displacement-controlled applications, it usually includes a built-in encoder or other position feedback mechanism to ensure the output is achieving the desired effect. The term correctly applies only to systems where the feedback or error-correction signals help control mechanical position, speed, attitude or any other measurable variables. For example, an automotive power window control is not a servomechanism, as there is no automatic feedback that controls position-the operator does this by observation. By contrast a car's cruise control uses closed-loop feedback, which classifies it as a servomechanism.

A data frame with 167 observations on 5 variables, 4 nominal and 1 as the target class. This data set is from a simulation of a servo system involving a servo amplifier, a motor, a lead screw/nut, and a sliding carriage of some sort. It may have been on of the translational axes of a robot on the 9th floor of the Al lab. In any case, the output value is almost certainly a rise time, or the time required for the system to respond to a step change in a position set point. The variables that describe the data set and their values are the following:

1. MOTOR A,B,C,D,E
2. Screw A,B,C,D,E
3. Pgain 3,4,5,6
4. Vgain 1,2,3,4,5,6
5. Class 0.13 to 7.10

Import Library

```
import pandas as pd

import numpy as np
```

Import SCV as DataFrame

Use URL of the directly

```
dataframe = pd.read_csv(r'https://github.com/YBI-Foundation/Dataset/raw/main/Servo%20Mechanism.csv')
```

First Five Rows of Dataframe

```
dataframe.head()
```

```
  Motor Screw  Pgain  Vgain  Class
0     E     E      5      4      4
1     B     D      6      5     11
2     D     D      4      3      6
3     B     A      3      2     48
4     D     B      6      5      6
```

Info of Dataframe

```
dataframe.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 167 entries, 0 to 166
Data columns (total 5 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   Motor   167 non-null    object
 1   Screw   167 non-null    object
 2   Pgain   167 non-null    int64 
 3   Vgain   167 non-null    int64 
 4   Class   167 non-null    int64 
dtypes: int64(3), object(2)
memory usage: 6.6+ KB
```

Summary of Stats

```
dataframe.describe()
```

```
            Pgain       Vgain       Class
count  167.000000  167.000000  167.000000
mean     4.155689    2.538922   21.173653
std      1.017770    1.369850   13.908038
min      3.000000    1.000000    1.000000
25%      3.000000    1.000000   10.500000
50%      4.000000    2.000000   18.000000
75%      5.000000    4.000000   33.500000
max      6.000000    5.000000   51.000000
```

column Names

```
dataframe.columns
```

```
Index(['Motor', 'Screw', 'Pgain', 'Vgain', 'Class'], dtype='object')
```

Shape of DataFrame

```
dataframe.shape
```

```
(167, 5)
```

Categories and Counts of Categorical Variables

```
dataframe[['Motor']].value_counts()
```

```
Motor
C        40
A        36
B        36
E        33
D        22
dtype: int64
```

```
dataframe[['Screw']].value_counts()
```

```
Screw
A        42
B        35
C        31
D        30
E        29
dtype: int64
```

Encoding of Categorical Features

```
dataframe.replace({'Motor':{'A':0, 'B':1, 'C':2, 'D':3,
'E':4}},inplace=True)
```

```
dataframe.replace({'Screw':{'A':0, 'B':1, 'C':2, 'D':3,
'E':4}},inplace=True)
```

Define y (dependent or target variable) and X (independent or features or attribute Variable)

```
y = dataframe['Class']
```

```
y.shape
```

```
(167,)
```

```
y
```

```
0       4
1      11
2       6
3      48
4       6
       ..
162    44
163    40
164    25
165    44
166    20
Name: Class, Length: 167, dtype: int64
```

```
X = dataframe[['Motor', 'Screw', 'Pgain', 'Vgain']]
```

or use.drop fumction to define X

```
X = dataframe.drop('Class', axis=1)
```

```
X.shape
```

```
(167, 4)
```

```
X
```

```
     Motor  Screw  Pgain  Vgain
0        4      4      5      4
1        1      3      6      5
2        3      3      4      3
3        1      0      3      2
4        3      1      6      5
..     ...    ...    ...    ...
162      1      2      3      2
163      1      4      3      1
164      2      3      4      3
165      0      1      3      2
166      0      0      6      5

[167 rows x 4 columns]
```

Train Test Split

```
from sklearn.model_selection import train_test_split
```

```
X_train, X_test, y_train, y_test = train_test_split(X,y,
test_size=0.3, random_state=2529)

X_train.shape, X_test.shape, y_train.shape, y_test.shape

((116, 4), (51, 4), (116,), (51,))
```

Train the model

```
from sklearn.linear_model import LinearRegression

lr = LinearRegression()

lr.fit(X_train, y_train)

LinearRegression()
```

Model Prediction

```
y_pred = lr.predict(X_test)

y_pred.shape

(51,)

y_pred

array([24.55945258, 30.98765106, 18.54485477, 25.51524243,
38.56082023,
       23.52007775, 11.61947065, 20.03335614, 40.60404401,
41.7009556 ,
       13.66269443, 26.01242807, 16.50163099, 16.54663453,
21.92598051,
       22.52570646, -5.46449561, 30.68912392, 32.7323477 ,
1.41282941,
       33.97718702, 31.63543611, 33.52806048, 30.04133887,
19.38557109,
        6.49364826, 28.5528375 , 17.04382017, 25.06611589,
3.50411229,
       30.59606128, 23.67067716, 35.72188367, 32.08456265,
12.46018697,
        3.6547117 , 23.47201865, 33.03087484, 17.49294672,
37.61450804,
       27.54898855, 22.07657992, 11.51387478,  9.470651  ,
30.53852451,
       28.64590014, 33.67865989,  4.60102388, 24.1198037 ,
21.13026773,
       25.71390094])
```

Model Evaluation

```
from sklearn.metrics import mean_squared_error, mean_absolute_error,
r2_score
```

```
mean_squared_error(y_test, y_pred)
```

```
66.03589175595563
```

```
mean_absolute_error(y_test, y_pred)
```

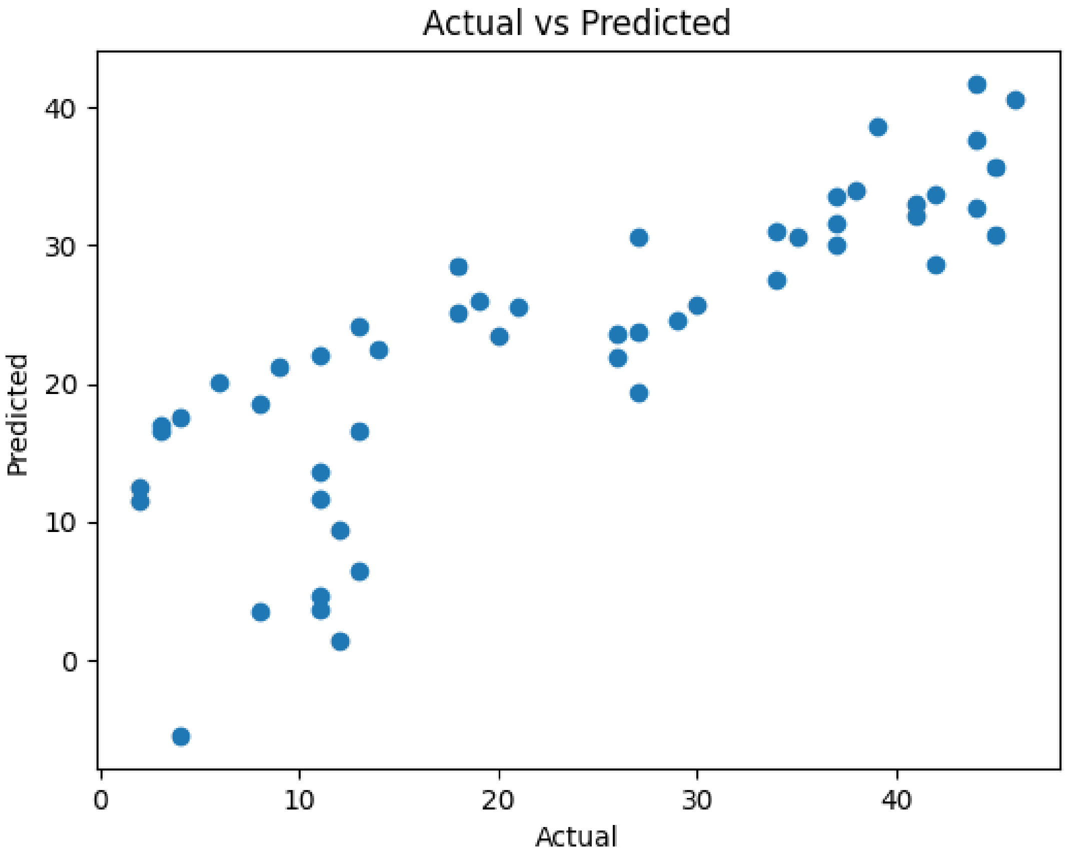
```
7.190539677251235
```

```
r2_score(y_test, y_pred)
```

```
0.6807245170563927
```

isualization of Actual Vs Predicted Results

```
import matplotlib.pyplot as plt
plt.scatter(y_test, y_pred)
plt.xlabel("Actual")
plt.ylabel("Predicted")
plt.title("Actual vs Predicted")
plt.show()
```



Future Predictions

select a random sample from the dataset as new value follow steps given below

1. Extract a random row using sample function
2. Separate X and y
3. Standardize
4. predict

```
X_new = df.sample(1)

X_new

     Motor  Screw  Pgain  Vgain  Class
153      4      1      3      1     35

X_new.shape

(1, 5)

X_new = X_new.drop('Class', axis = 1)

X_new
```

```
     Motor  Screw  Pgain  Vgain
153      4      1      3      1
```

```
X_new.shape
```

```
(1, 4)
```

```
y_pred_new = lr.predict(X_new)
```

```
y_pred_new
```

```
array([28.94442728])
```