Servo Prediction using Linear Regression

Objective

Servo prediction using linear regression aims to predict the behavior or position of a servo motor based on various input parameters. This kind of problem can be approached by applying machine learning techniques, particularly linear regression, to model the relationship between the input features and the target variable.

Data Source

Import Library

```
import pandas as pd
import numpy as np
```

Import Data

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

Describe Data

```
df.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

Next steps: Generate code with df View recommended plots New interactive sheet

```
df.info()
```

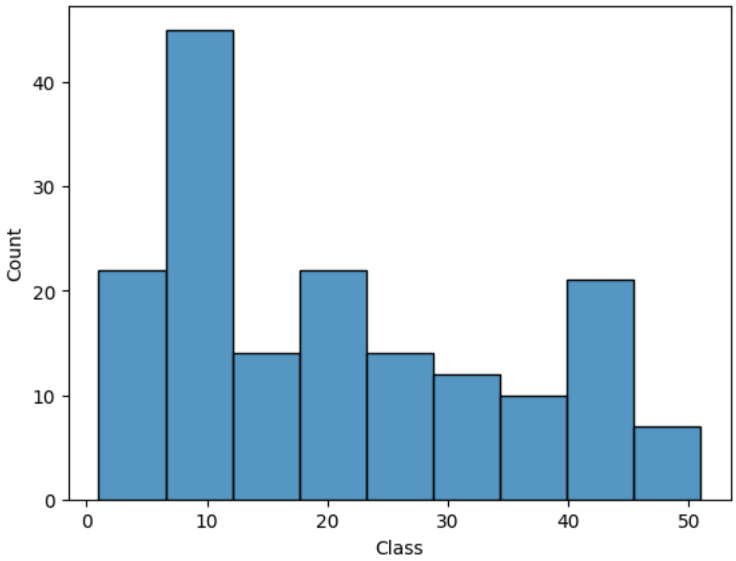
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 167 entries, 0 to 166
Data columns (total 5 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   Motor   167 non-null    object
 1   Screw   167 non-null    object
 2   Pgain   167 non-null    int64 
 3   Vgain  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

```
df.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

Data Visualization

```
import seaborn as sns
import matplotlib.pyplot as plt
sns.histplot(df['Class'])
plt.show()
```



Data Preprocessing

```
df.isnull().sum()
```

```
Motor    0
Screw    0
Pgain    0
Vgain    0
Class    0
dtype: int64
```

```
df = df.drop_duplicates()
```

Get Categories and counts of categorical values

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

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

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

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

Get Encoding Of Categorical Features

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

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

Define Target Variable (y) and Feature Variables (X)

```
y=df['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=df[['Motor','Screw','Pgain','Vgain']]
```

```
X = df.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 × 4 columns

Next steps: Generate code with X View recommended plots New interactive sheet

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,))
```

Modeling

```
from sklearn.linear_model import LinearRegression
```

```
model = LinearRegression()
```

```
model.fit(X_train, y_train)
```

```
▾ LinearRegression
LinearRegression()
```

Prediction

```
y_pred = model.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_absolute_error, mean_squared_error, r2_score
```

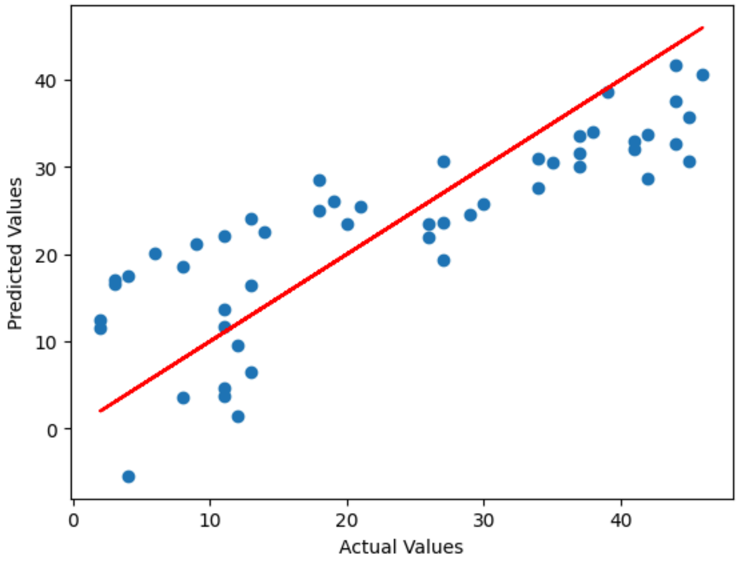
```
mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
```

```
print(f"Mean Absolute Error: {mae}")
print(f"Mean Squared Error: {mse}")
print(f"R-squared: {r2}")
```

```
Mean Absolute Error: 7.190539677251235
Mean Squared Error: 66.03589175595563
R-squared: 0.6807245170563927
```

Get Visualization of Actual vs predicted results

```
import matplotlib.pyplot as plt
plt.scatter(y_test,y_pred)
plt.plot(y_test,y_test,'r')
plt.xlabel('Actual Values')
plt.ylabel('Predicted Values')
plt.show()
```



Get Future Predictions

```
X_new = df.sample(1)
```

```
X_new
```

	Motor	Screw	Pgain	Vgain	Class
23	0	2	4	2	13

```
X_new.shape
```

```
(1, 5)
```

```
X_new = X_new.drop(['Class'],axis=1)
```

```
X_new
```

	Motor	Screw	Pgain	Vgain
23	0	2	4	2

```
X_new.shape
```

```
(1, 4)
```

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

```
y_pred_new
```

```
array([24.1198037])
```

Explanation

In summary, by following a structured approach to data preprocessing, model training, and evaluation, linear regression can be effectively used for servo prediction. Handling non-numeric values and ensuring data quality are critical steps to avoid errors and achieve reliable predictions. This methodology not only aids in understanding the servo behavior but also provides a foundation for further enhancements and more complex models in the future.