July 19, 2023

```
[1]: import pandas as pd
     import numpy as np
     import matplotlib.pyplot as plt
     import seaborn as sns
     from sklearn.model_selection import train_test_split
     from LR import LinearRegression
```

0.1 Exploratory Data Analysis (EDA)

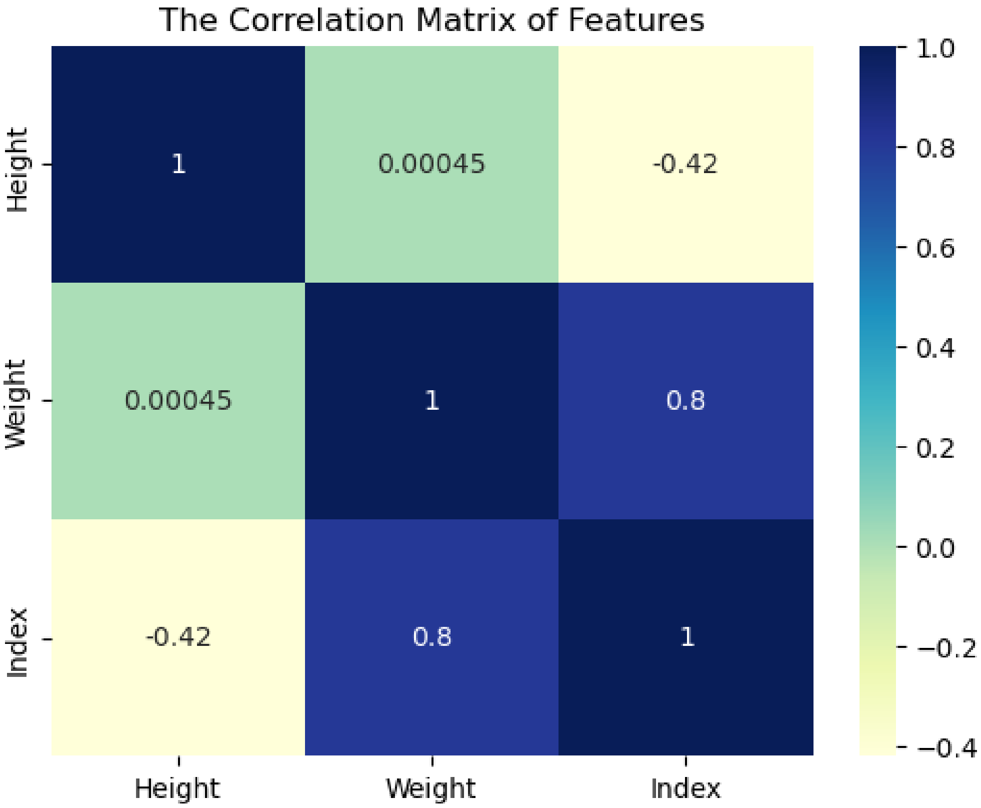
```
[2]: data = pd.read_csv('500_Person_Gender_Height_Weight_Index.csv')
     data = data.drop("Gender", axis=1)
     data.head()
```

```
[2]:    Height  Weight  Index
     0     174      96      4
     1     189      87      2
     2     185     110      4
     3     195     104      3
     4     149      61      3
```

```
[3]: data.describe()
```

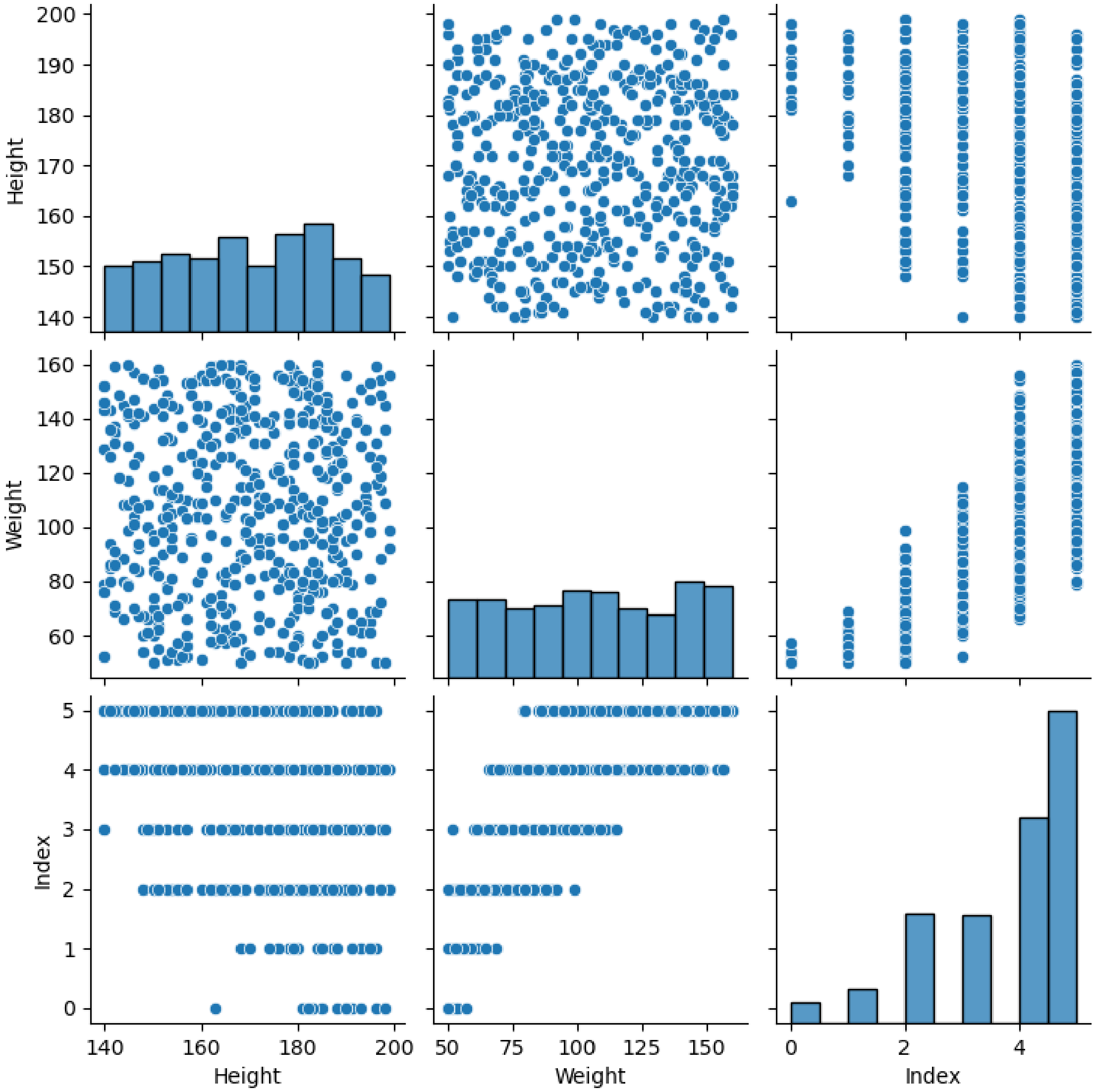
```
[3]:            Height      Weight       Index
     count  500.000000  500.000000  500.000000
     mean   169.944000  106.000000    3.748000
     std     16.375261   32.382607    1.355053
     min    140.000000   50.000000    0.000000
     25%    156.000000   80.000000    3.000000
     50%    170.500000  106.000000    4.000000
     75%    184.000000  136.000000    5.000000
     max    199.000000  160.000000    5.000000
```

```
[4]: matrix = data.corr()
     sns.heatmap(matrix, annot=True, cmap='YlGnBu')
     plt.title('The Correlation Matrix of Features')
     plt.show()
```



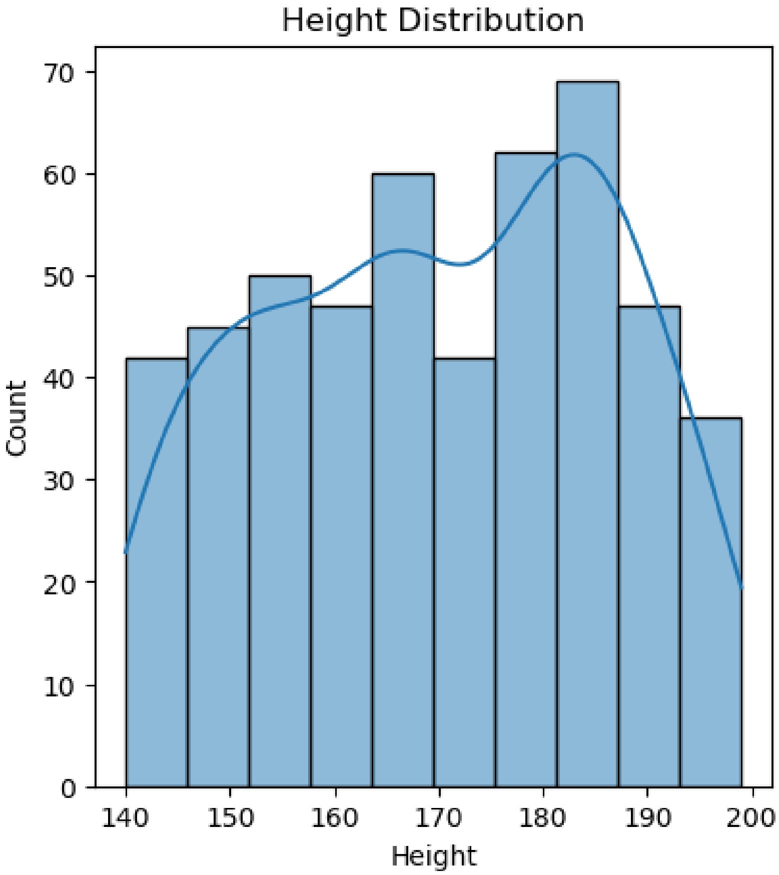
[5]:

```
sns.pairplot(data.loc[:, ['Height', 'Weight', 'Index']])
plt.show()
```



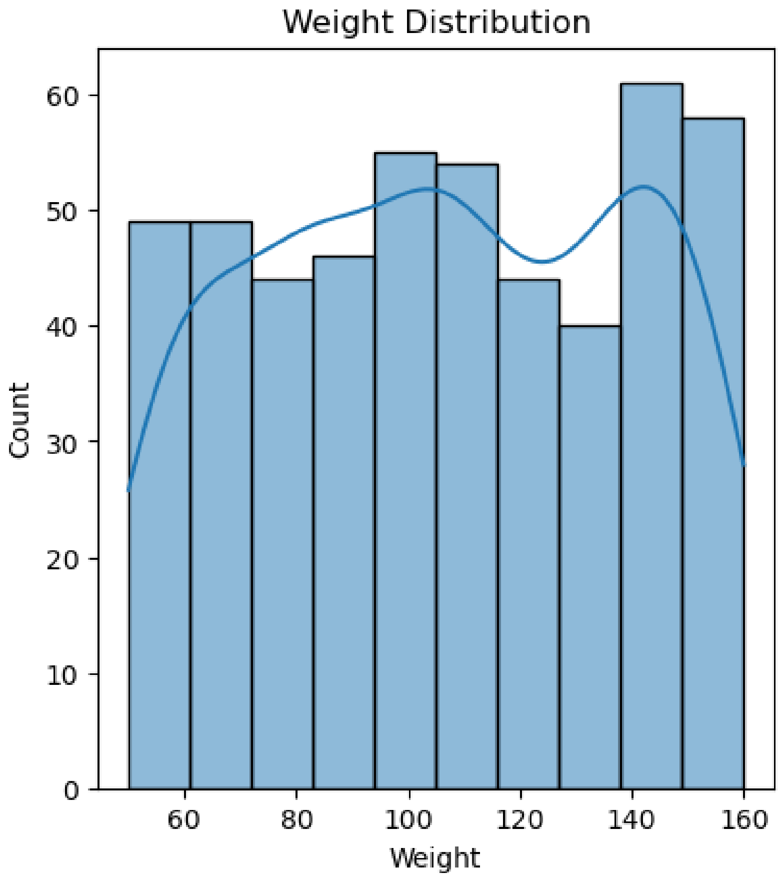
```
[6]: plt.figure(figsize=(10, 5))
     plt.subplot(1, 2, 1)
     sns.histplot(data["Height"], kde=True)
     plt.xlabel("Height")
     plt.title("Height Distribution")
```

```
[6]: Text(0.5, 1.0, 'Height Distribution')
```



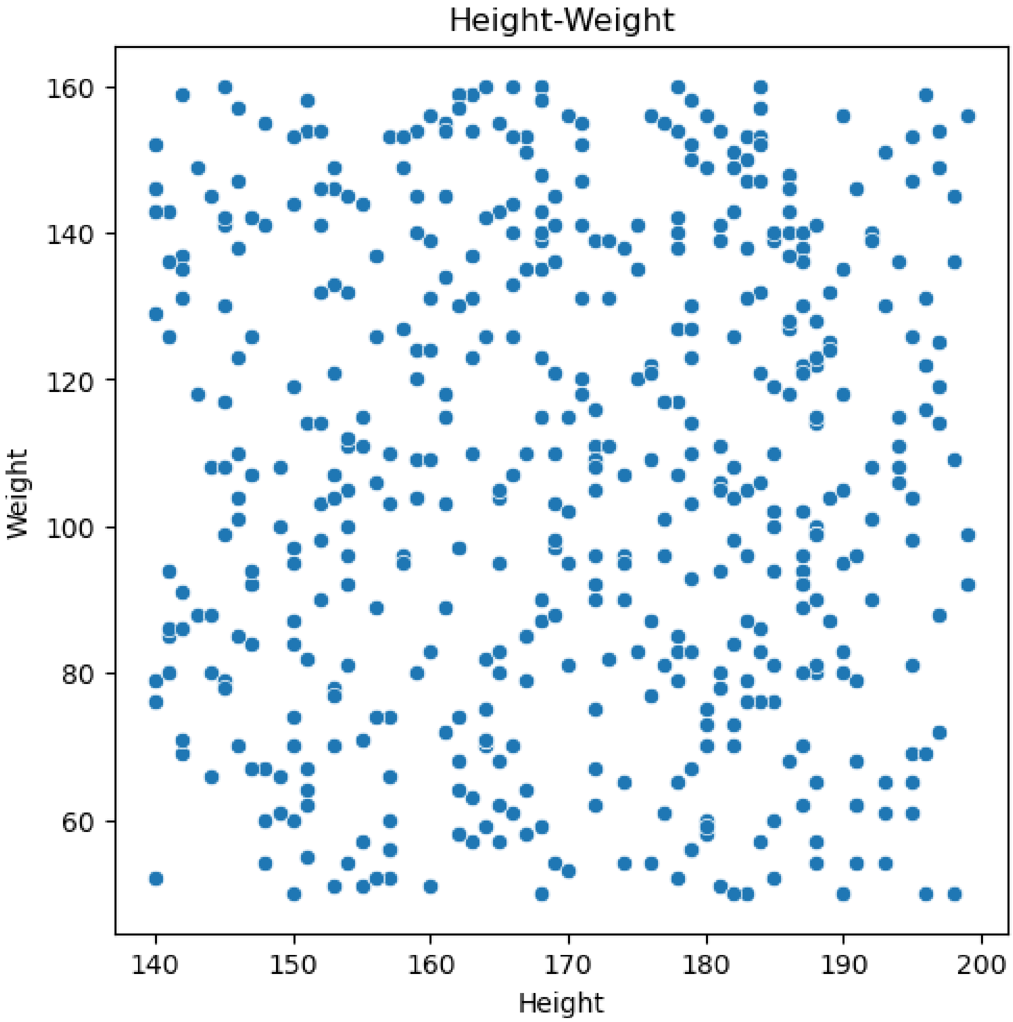
[7]:
```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
sns.histplot(data["Weight"], kde=True)
plt.xlabel("Weight")
plt.title("Weight Distribution")
```

[7]:
```
Text(0.5, 1.0, 'Weight Distribution')
```



[8]:

```
plt.figure(figsize=(6, 6))
sns.scatterplot(x="Height", y="Weight", data=data)
plt.xlabel("Height")
plt.ylabel("Weight")
plt.title("Height-Weight")
plt.show()
```



0.2 Train the Classifier

[9]:

```
lr = LinearRegression(learning_rate=0.000005, epoch=1000)
```

[10]:

```
X = data.values.tolist()
y = []

for row in X:
    y.append(int(row[2]))
    del row[2]

X = pd.Series(X)
y = pd.Series(y)
```

```
x_train, x_test, y_train, y_test = train_test_split(X, y, test_size=0.5,␣
 ↪shuffle=True)

X_train_list = x_train.values.tolist()
y_train_list=y_train.values.tolist()
X_test_list=x_test.values.tolist()
y_test_list=y_test.values.tolist()
```

[11]:

```
x_train = [sublist[0] for sublist in X_train_list]
y_train = [sublist[1] for sublist in X_train_list]
z_train = y_train_list

x_test = [sublist[0] for sublist in X_test_list]
y_test = [sublist[1] for sublist in X_test_list]
z_test = y_test_list
```

[12]:

```
lr.fit(x_train, y_train, z_train)
```

```
Epoch: 0
coeff 1: 1, coeff 2: 2, constant: 0
Epoch: 50
coeff 1: -0.4140654571525574, coeff 2: 0.6772336189194014, constant:
-0.008536714145641807
Epoch: 100
coeff 1: -0.28529156667097527, coeff 2: 0.47754112760707973, constant:
-0.00798271695653313
Epoch: 150
coeff 1: -0.19667677047380175, coeff 2: 0.34012414881271397, constant:
-0.007593272658731868
Epoch: 200
coeff 1: -0.13569717033365838, coeff 2: 0.24556162249992833, constant:
-0.007317064300116048
Epoch: 250
coeff 1: -0.09373453446095738, coeff 2: 0.18048908387782367, constant:
-0.007118778483837168
Epoch: 300
coeff 1: -0.06485828774219322, coeff 2: 0.13570987123790626, constant:
-0.00697411454618167
Epoch: 350
coeff 1: -0.04498734695337792, coeff 2: 0.10489536701832176, constant:
-0.006866350157676294
Epoch: 400
coeff 1: -0.031313343603706884, coeff 2: 0.08369057790587416, constant:
-0.0067839779658343076
Epoch: 450
coeff 1: -0.02190371882405806, coeff 2: 0.06909864612355113, constant:
-0.006719079267614588
```

```
Epoch: 500
coeff 1: -0.015428595928073916, coeff 2: 0.059057305236080444, constant:
-0.006666204863652964
Epoch: 550
coeff 1: -0.01097282970120217, coeff 2: 0.052147421214922766, constant:
-0.006621604926034858
Epoch: 600
coeff 1: -0.007906669451285306, coeff 2: 0.0473924270382266, constant:
-0.0065826990372623165
Epoch: 650
coeff 1: -0.005796756703661005, coeff 2: 0.044120305032545375, constant:
-0.0065477115013259255
Epoch: 700
coeff 1: -0.004344878895960745, coeff 2: 0.0418686109996628, constant:
-0.006515420385604136
Epoch: 750
coeff 1: -0.003345823167345248, coeff 2: 0.040319117242728145, constant:
-0.006484984825825268
Epoch: 800
coeff 1: -0.0026583737423308126, coeff 2: 0.039252837627990464, constant:
-0.006455826187201306
Epoch: 850
coeff 1: -0.0021853539860618417, coeff 2: 0.038519078399847265, constant:
-0.006427546286304539
Epoch: 900
coeff 1: -0.0018598924861233988, coeff 2: 0.038014140718611165, constant:
-0.006399871116031671
Epoch: 950
coeff 1: -0.0016359721540969755, coeff 2: 0.03766666496284662, constant:
-0.006372612120336809
```

[13]:

```python
test_predictions = [int(x) for x in lr.predict(x_test, y_test)]
train_predictions = [int(x) for x in lr.predict(x_train, y_train)]
```

[14]:

```python
print("Test Features Expected Classification")
print(z_test)
print("Prediction")
print(test_predictions)

print("Train Features Expected Classification")
print(z_train)
print("Prediction")
print(train_predictions)
```

```
Test Features Expected Classification
[5, 5, 5, 3, 0, 3, 5, 4, 3, 5, 3, 3, 5, 5, 5, 5, 1, 0, 5, 5, 5, 5, 4, 2, 5, 4,
5, 5, 5, 4, 4, 4, 3, 2, 5, 4, 5, 1, 1, 5, 1, 4, 5, 3, 2, 5, 4, 4, 4, 1, 4, 4, 4,
2, 4, 0, 1, 5, 3, 5, 4, 0, 5, 4, 4, 5, 5, 5, 5, 5, 5, 5, 3, 4, 5, 3, 4, 5, 5, 2,
2, 2, 3, 5, 4, 5, 5, 3, 5, 5, 2, 2, 0, 5, 2, 5, 2, 3, 2, 3, 5, 5, 4, 1, 5, 4, 4,
4, 2, 5, 4, 5, 5, 5, 4, 5, 5, 0, 3, 5, 4, 0, 5, 4, 3, 4, 0, 4, 5, 2, 3, 5, 1, 5,
2, 4, 5, 1, 5, 3, 2, 5, 4, 5, 5, 4, 4, 4, 0, 4, 2, 5, 1, 5, 4, 4, 4, 2, 4, 2, 5,
5, 3, 4, 5, 1, 1, 5, 2, 5, 5, 3, 4, 5, 3, 2, 2, 3, 5, 5, 5, 5, 5, 3, 4, 2, 3, 5,
5, 4, 3, 4, 5, 5, 2, 5, 5, 5, 2, 5, 5, 5, 2, 5, 4, 4, 5, 4, 4, 4, 3, 3, 5, 2, 3,
1, 2, 3, 4, 5, 2, 5, 4, 5, 4, 2, 2, 5, 1, 4, 4, 5, 2, 5, 2, 4, 5, 4, 4, 4, 4, 4,
5, 4, 0, 5, 4, 3, 3, 1]
Prediction
[5, 4, 5, 2, 1, 3, 5, 4, 2, 5, 2, 2, 4, 5, 4, 3, 1, 1, 3, 4, 4, 5, 4, 1, 5, 3,
5, 4, 5, 4, 2, 3, 3, 3, 5, 3, 4, 1, 1, 4, 1, 4, 5, 3, 1, 5, 3, 3, 4, 1, 4, 3, 2,
2, 4, 1, 2, 4, 3, 2, 4, 1, 3, 4, 3, 4, 3, 4, 3, 4, 4, 5, 3, 2, 4, 2, 4, 5, 4, 1,
1, 1, 2, 4, 3, 4, 5, 3, 4, 4, 1, 1, 1, 4, 2, 5, 2, 3, 2, 3, 4, 3, 4, 1, 4, 5, 4,
2, 1, 5, 2, 4, 4, 5, 3, 5, 5, 1, 2, 5, 3, 1, 4, 4, 2, 3, 1, 4, 5, 2, 3, 4, 2, 4,
2, 4, 3, 2, 3, 2, 2, 5, 2, 5, 4, 5, 4, 5, 1, 2, 2, 4, 1, 3, 4, 2, 3, 2, 3, 2, 5,
4, 3, 4, 5, 2, 1, 4, 1, 2, 3, 2, 2, 4, 2, 1, 1, 2, 4, 4, 3, 4, 5, 3, 3, 2, 3, 5,
4, 2, 3, 4, 4, 5, 1, 5, 4, 4, 2, 5, 5, 3, 2, 5, 2, 3, 5, 4, 4, 2, 2, 3, 5, 1, 2,
1, 2, 2, 3, 3, 2, 5, 3, 5, 4, 2, 1, 3, 2, 3, 4, 5, 2, 2, 2, 4, 5, 4, 3, 4, 3, 3,
5, 4, 1, 5, 4, 2, 2, 1]
Train Features Expected Classification
[1, 3, 2, 4, 5, 5, 5, 3, 5, 4, 4, 3, 3, 5, 2, 1, 5, 4, 5, 2, 4, 4, 4, 4, 5, 3,
5, 2, 3, 5, 3, 3, 1, 2, 2, 5, 4, 3, 5, 4, 5, 3, 5, 4, 2, 3, 2, 5, 5, 4, 5, 4, 2,
5, 4, 4, 5, 5, 2, 5, 4, 2, 3, 4, 5, 5, 4, 5, 4, 5, 3, 5, 5, 3, 5, 5, 3, 5, 2, 5,
4, 2, 3, 4, 4, 5, 4, 3, 5, 2, 4, 4, 5, 5, 2, 2, 5, 5, 4, 5, 5, 4, 4, 5, 5, 4, 3,
4, 5, 2, 5, 5, 5, 3, 4, 5, 1, 5, 4, 2, 4, 5, 3, 2, 4, 5, 5, 4, 4, 4, 4, 2, 3, 3,
5, 2, 0, 2, 4, 5, 4, 5, 4, 2, 2, 3, 3, 3, 3, 4, 4, 2, 5, 5, 5, 4, 4, 2, 5, 5, 5,
3, 4, 4, 4, 5, 5, 3, 5, 1, 5, 3, 4, 5, 2, 3, 5, 4, 4, 4, 4, 3, 5, 1, 2, 3, 5, 4,
5, 5, 2, 4, 4, 5, 5, 4, 3, 5, 0, 5, 5, 5, 5, 5, 5, 4, 5, 3, 5, 5, 3, 2, 4, 5, 5,
2, 5, 1, 5, 0, 4, 5, 5, 5, 3, 5, 5, 5, 4, 2, 5, 5, 2, 5, 5, 4, 4, 2, 5, 4, 5, 4,
3, 5, 2, 5, 4, 5, 2, 5]
Prediction
[2, 2, 2, 4, 4, 4, 5, 2, 5, 4, 3, 2, 2, 5, 2, 1, 5, 4, 5, 2, 3, 3, 4, 3, 4, 2,
5, 2, 2, 5, 3, 3, 1, 1, 2, 4, 5, 1, 4, 3, 3, 4, 4, 3, 2, 2, 3, 5, 3, 4, 5, 4, 2,
3, 3, 2, 5, 5, 2, 5, 3, 2, 2, 4, 4, 3, 3, 4, 3, 3, 3, 3, 3, 2, 5, 3, 3, 3, 2, 5,
2, 2, 3, 4, 2, 4, 4, 3, 5, 1, 3, 3, 4, 4, 2, 2, 4, 4, 2, 5, 5, 4, 3, 5, 4, 4, 2,
4, 4, 2, 4, 3, 5, 3, 2, 5, 1, 5, 3, 2, 5, 5, 3, 1, 4, 5, 5, 5, 2, 3, 2, 2, 2, 3,
5, 3, 1, 3, 2, 5, 2, 3, 3, 2, 2, 3, 3, 2, 3, 4, 4, 1, 5, 5, 4, 2, 3, 1, 5, 2, 5,
2, 3, 4, 2, 4, 3, 3, 4, 2, 5, 3, 3, 5, 2, 3, 3, 3, 4, 4, 3, 3, 5, 1, 2, 2, 4, 3,
5, 5, 1, 4, 3, 4, 3, 3, 3, 5, 1, 5, 3, 5, 5, 5, 4, 3, 3, 3, 5, 3, 3, 2, 2, 3, 3,
2, 5, 2, 3, 1, 4, 5, 5, 5, 3, 5, 5, 3, 3, 2, 5, 3, 2, 3, 5, 3, 2, 2, 4, 2, 3, 4,
2, 5, 2, 4, 3, 5, 2, 3]
```

0.3 Results

```
[15]: def loss_function(predictions, z_test):
          test_loss = []

          for i in range(len(z_train)):
```

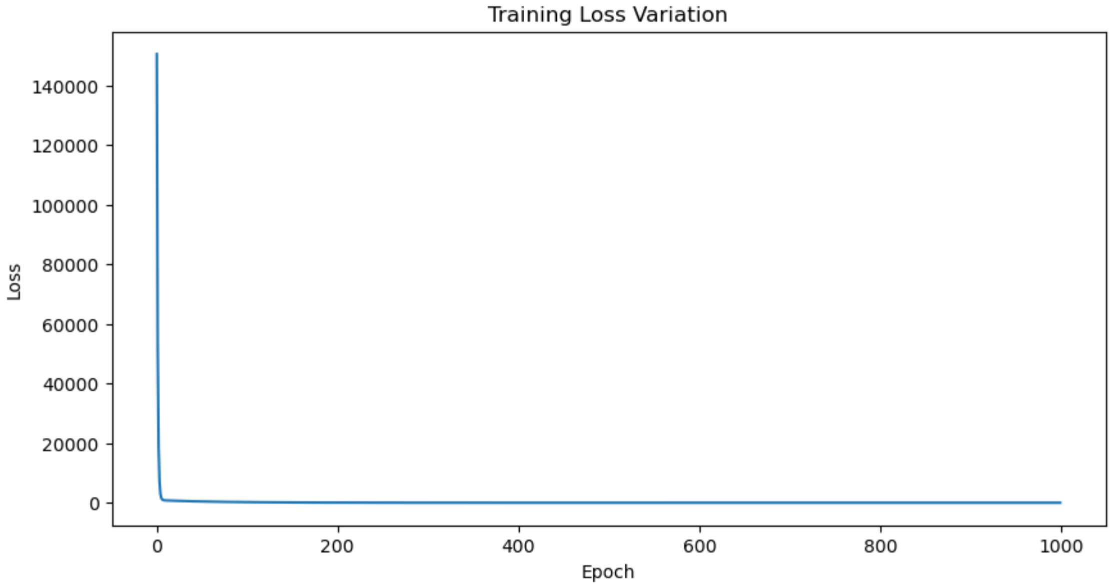
```
        error = (z_test[i] - predictions[i]) ** 2
        test_loss.append(error)

    return test_loss
```

[16]:

```
train_loss = lr.train_losses
test_loss = loss_function(test_predictions, z_test)
```

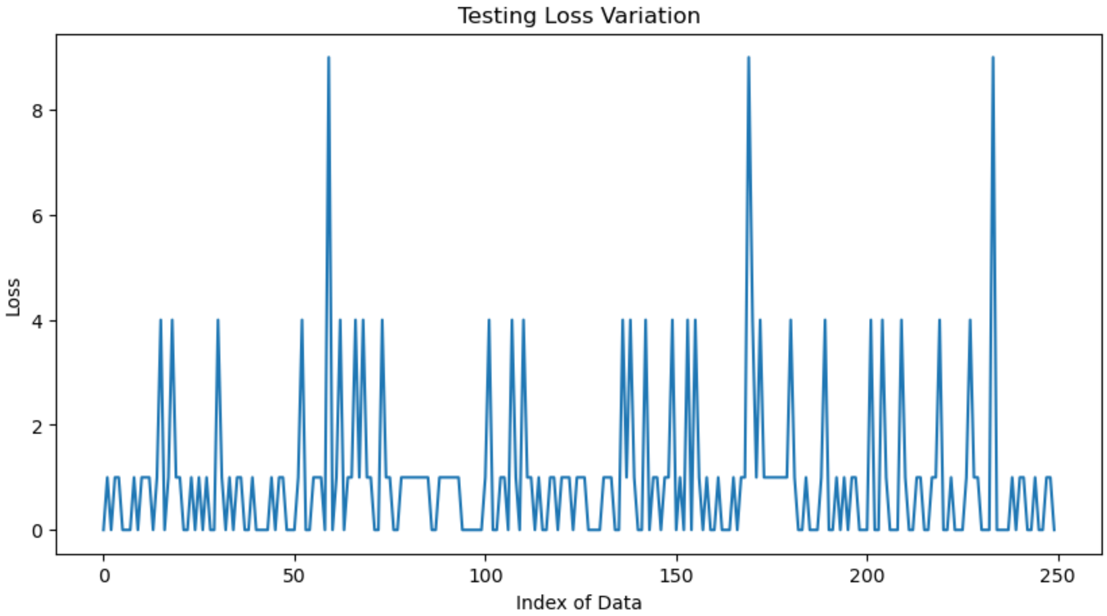
[17]:

```
plt.figure(figsize=(10, 5))
plt.plot(train_loss)
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.title("Training Loss Variation")
plt.show()
```



[18]:

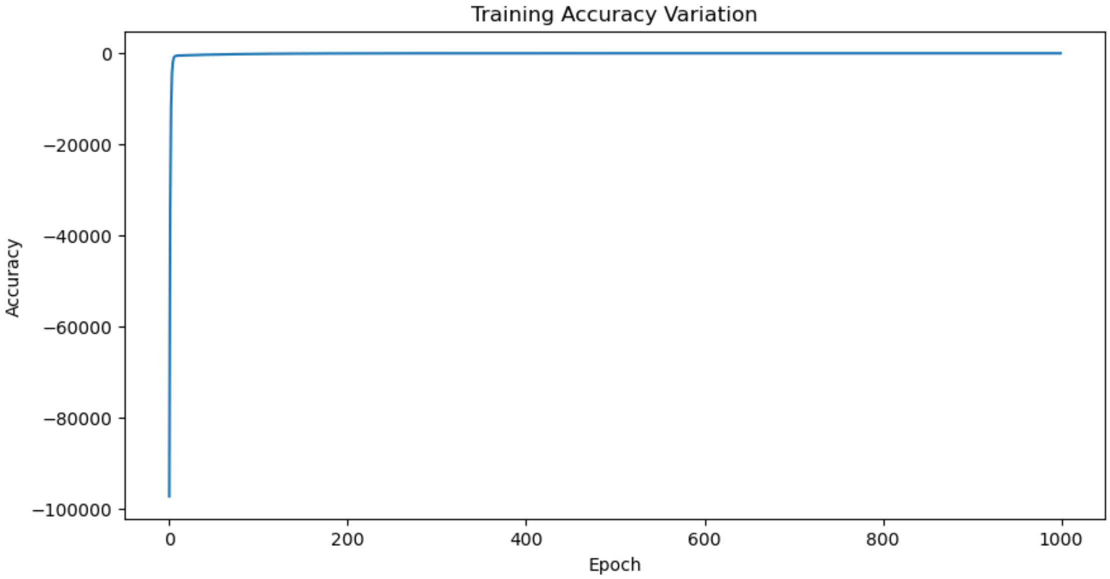
```
plt.figure(figsize=(10, 5))
plt.plot(test_loss)
plt.xlabel("Index of Data")
plt.ylabel("Loss")
plt.title("Testing Loss Variation")
plt.show()
```



[23]:
```
def r2_score(y_true, y_pred):
        residual_sum_of_squares = (y_true - y_pred) ** 2

        r2 = 1 - (residual_sum_of_squares)
        return r2
```

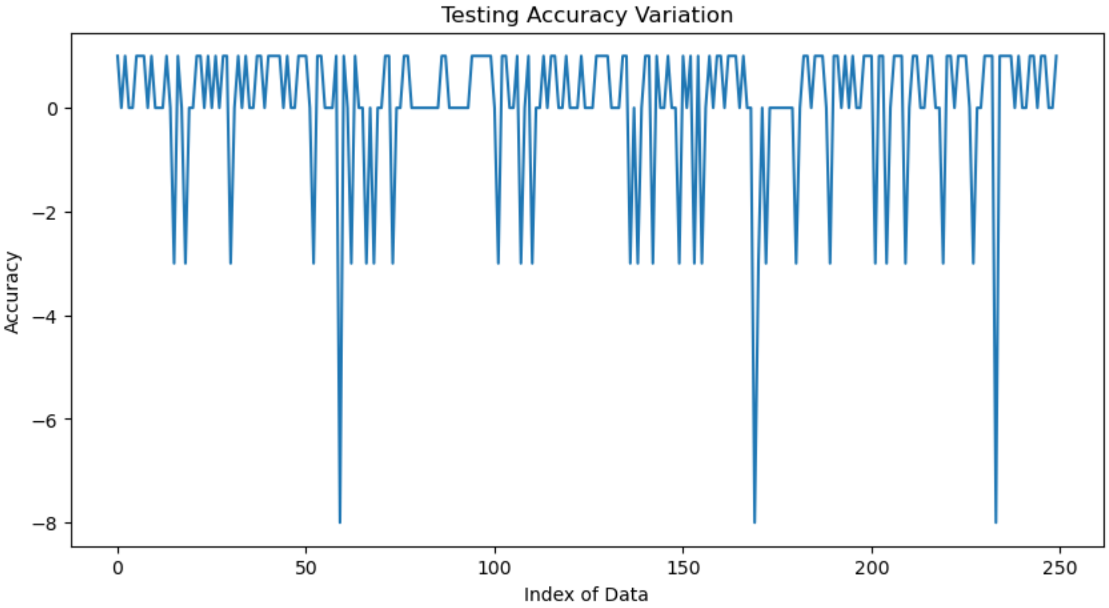
[24]:
```
test_accuracy = []
for i in range(len(z_test)):
    test_accuracy.append(r2_score(z_test[i], test_predictions[i]))
```

[25]:
```
train_accuracy = lr.train_r2_scores
plt.figure(figsize=(10, 5))
plt.plot(train_accuracy)
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.title("Training Accuracy Variation")
plt.show()
```



[30]:

```
plt.figure(figsize=(10, 5))
plt.plot(test_accuracy)
plt.xlabel("Index of Data")
plt.ylabel("Accuracy")
plt.title("Testing Accuracy Variation")
plt.show()
```



When the training loss is analysed, it is seen that it decreases as the number of epochs increases.

This is an expected situation. In the test data, there is no specific trend since the error value is calculated separately for each data.

R2-Score was used as an accuracy measure here. When we talk about the accuracy graph, since R2-Score is used as a criterion, the accuracy increases as the epoch increases in the training phase. In the test part, since the accuracy value of each data is calculated separately, there is no specific trend.