Question 5 from Assignment: RegressionProblems

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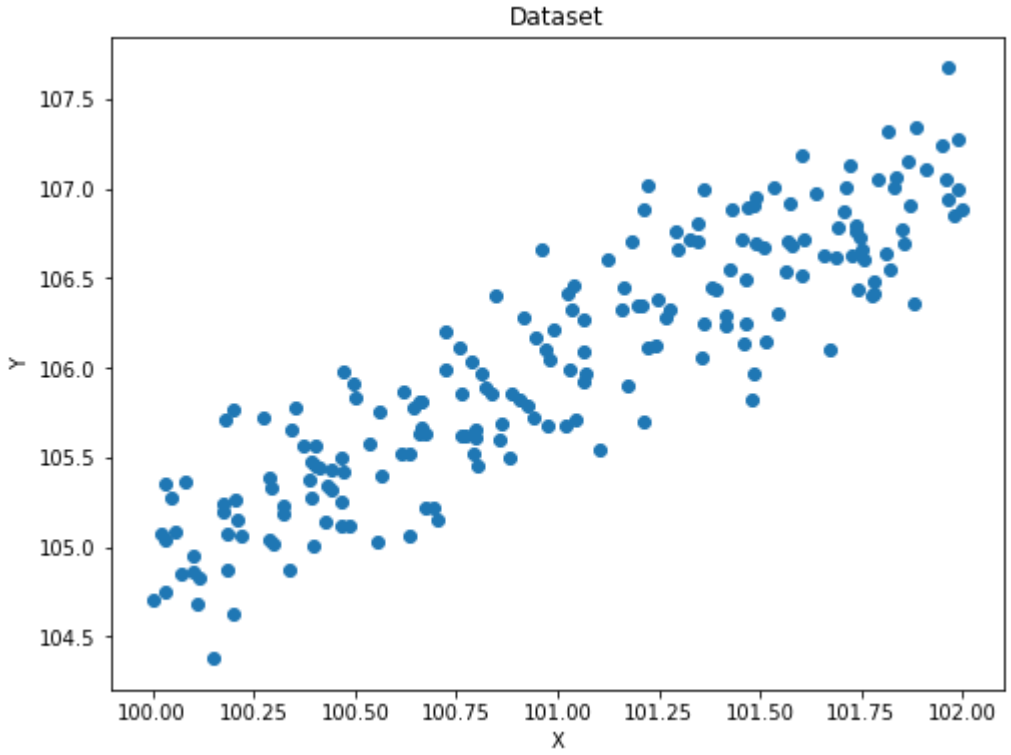
In [40]:
```
import numpy as np
import matplotlib.pyplot as plt
from tqdm import tqdm
from math import sqrt
```

In [41]:
```
# Global variables
m, w, b, sigma_square = 200, 1, 5, 0.1

# Creating data
def create_data(m, w, b, sigma_square):
    x = [0]*m
    x_minus = [0]*m
    y = [0]*m

    for i in range(m):
        x[i] = np.random.uniform(low=100, high=102)
        x_minus[i] = x[i] - 101
        y[i] = x[i]*w + b + np.random.normal(loc=0, scale=sqrt(sigma_
square))

    return x, y, x_minus
```

In [42]:
```
# Plotting x and y data points
def plot(x, y):
    fig = plt.figure(figsize=(8,6))
    plt.scatter(x, y)
    plt.title("Dataset")
    plt.xlabel("X")
    plt.ylabel("Y")
    plt.show()

def plot_line(x, w, b):
    temp = np.linspace(min(x), max(x), 100)
    temp_y = [temp[i]*w + b for i in range(len(temp))]
    fig = plt.figure(figsize=(8,6))
    plt.scatter(x, y)
    plt.plot(temp, temp_y, color='g')
    plt.title("Predicted Line")
    plt.xlabel("X")
    plt.ylabel("Y")
    plt.show()
```

In [43]:
```
x, y, x_minus = create_data(m, w, b, sigma_square)

plot(x, y)
```



In [44]:
```
def calculate_w_b(x, y, m):
    e_xy = [x[i]*y[i] for i in range(m)]
    w = (np.mean(e_xy) - np.mean(x)*np.mean(y))/np.var(x)
    b = np.mean(y) - w*np.mean(x)

    return w, b
```

In [45]:
```
def multiple_runs(m):
    runs = 1000
    expected_w = []
    expected_b = []
    expected_w_m = []
    expected_b_m = []
    for i in tqdm(range(runs)):
        x, y, x_minus = create_data(m, w, b, sigma_square)
        w_pred, b_pred = calculate_w_b(x, y, m)
        w_pred_minus, b_pred_minus = calculate_w_b(x_minus, y, m)
        expected_w.append(w_pred)
        expected_b.append(b_pred)
        expected_w_m.append(w_pred_minus)
        expected_b_m.append(b_pred_minus)

    print("Expected values: Actual: w = {} : b = {}".format(np.mean(e
xpected_w), np.mean(expected_b)))
    print("Expected values: Shifted: w = {} : b = {}".format(np.mean(
expected_w_m), np.mean(expected_b_m)))
    print("Variance values: Actual: w = {} : b = {}".format(np.var(ex
pected_w), np.var(expected_b)))
    print("Variance values: Shifted: w = {} : b = {}".format(np.var(e
xpected_w_m), np.var(expected_b_m)))
```

In [46]:
```
multiple_runs(m)
```

```
100%|██████████| 1000/1000 [00:01<00:00, 690.31it/s]

Expected values: Actual: w = 0.9998925919715734 : b = 5.0112432870395
69
Expected values: Shifted: w = 0.9998925919716923 : b = 106.0003950761
6847
Variance values: Actual: w = 0.0015460865723564505 : b = 15.770557625
701565
Variance values: Shifted: w = 0.0015460865723534495 : b = 0.000501777
0669806238
```

This practical example aligns with what has been shown mathematically in the assignment.