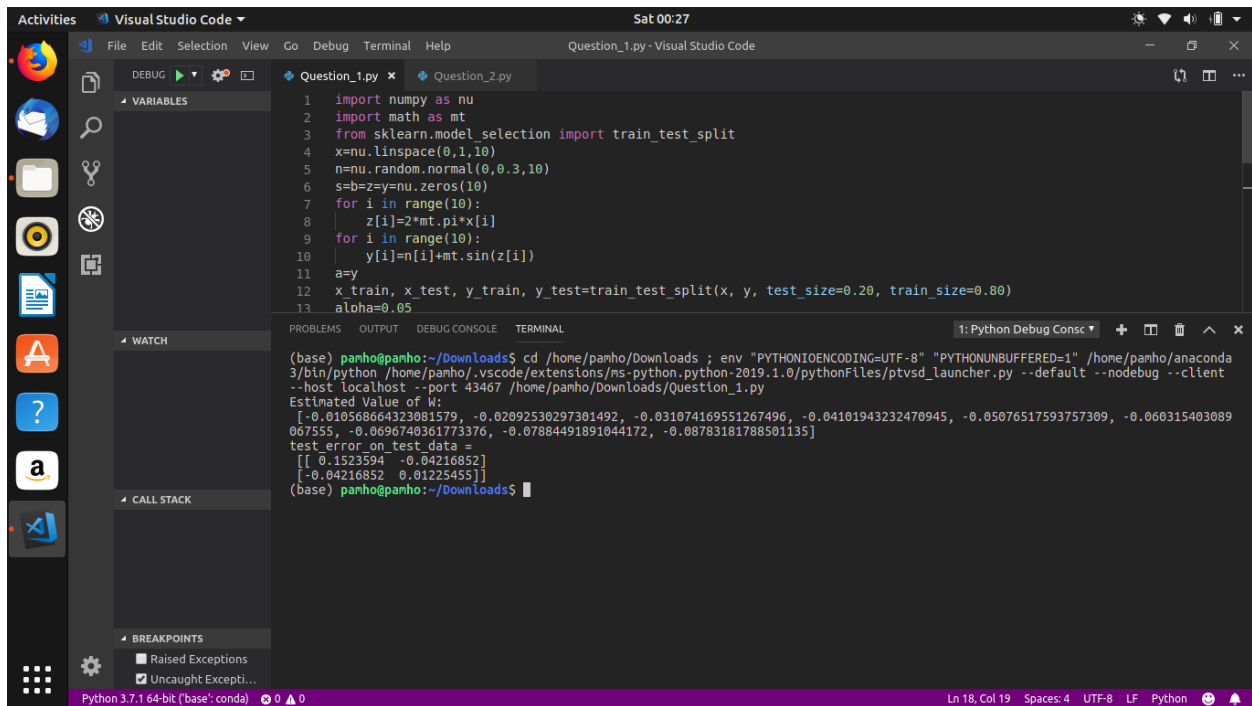


Q-1: Below is the output of the code where the estimated value of W and test error on test data are shown



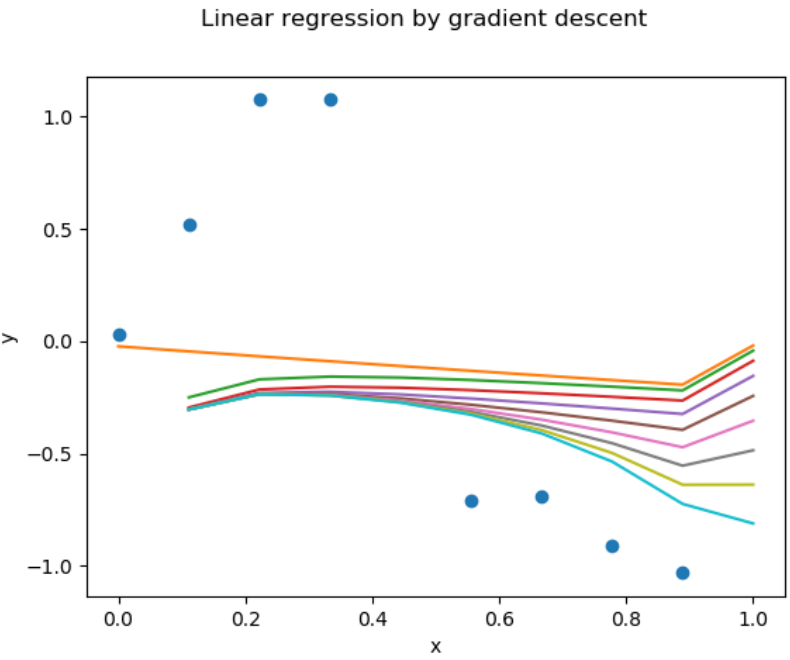
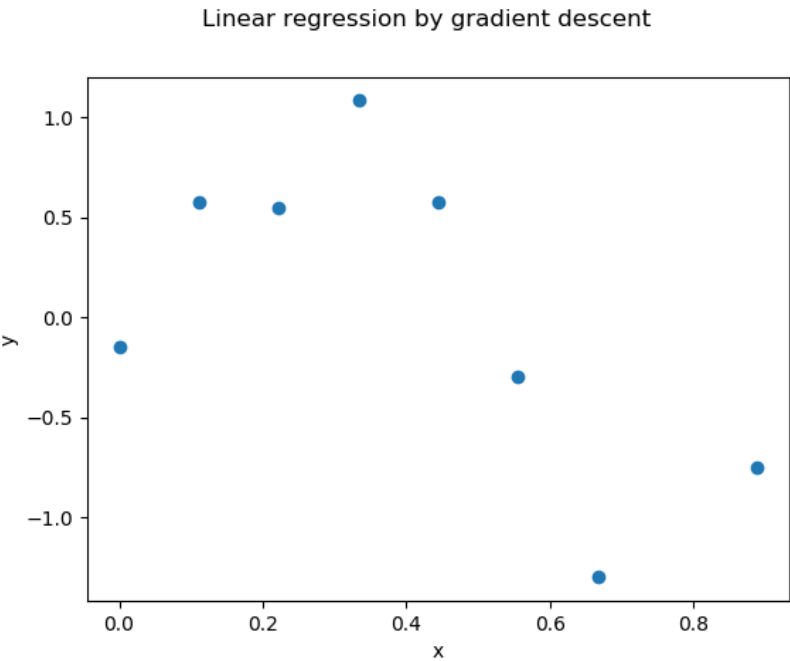
The screenshot shows the Visual Studio Code interface with a Python file named `Question_1.py` open. The code defines a dataset `x` and `y`, splits them into training and testing sets, and prints the estimated value of `W` and the test error on test data.

```
1 import numpy as nu
2 import math as mt
3 from sklearn.model_selection import train_test_split
4 x=nu.linspace(0,1,10)
5 n=nu.random.normal(0,0.3,10)
6 s=b=z=y=nu.zeros(10)
7 for i in range(10):
8     z[i]=2*mt.pi*x[i]
9 for i in range(10):
10    y[i]=n[i]+mt.sin(z[i])
11 a=y
12 x_train, x_test, y_train, y_test=train_test_split(x, y, test_size=0.20, train_size=0.80)
13 aloha=0.05
```

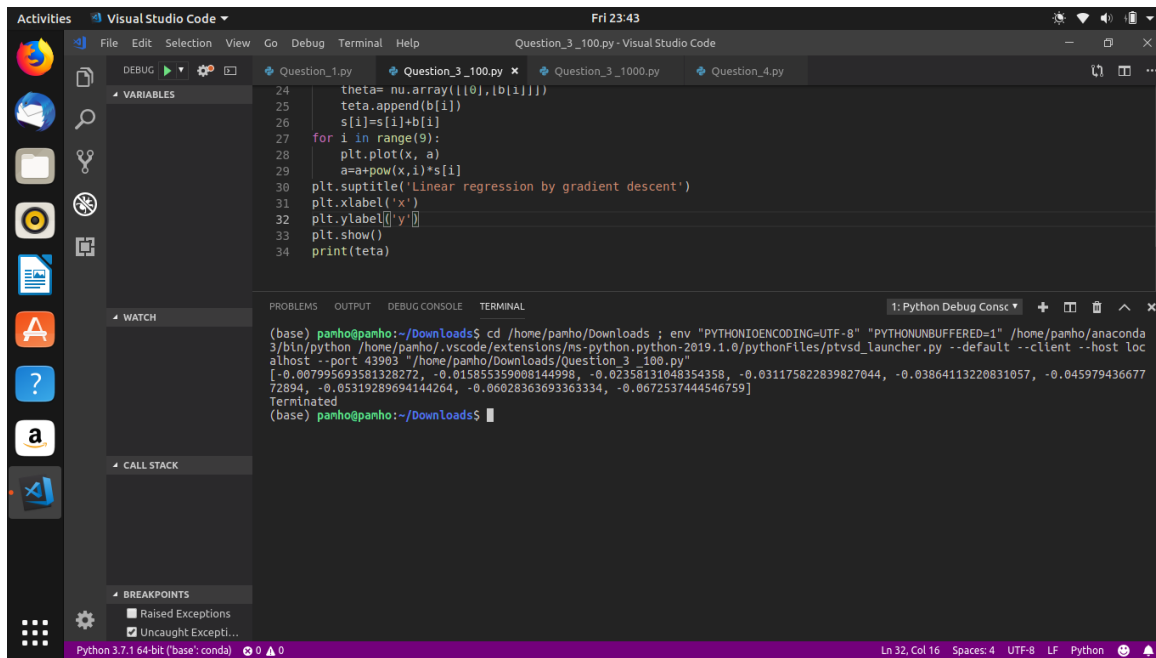
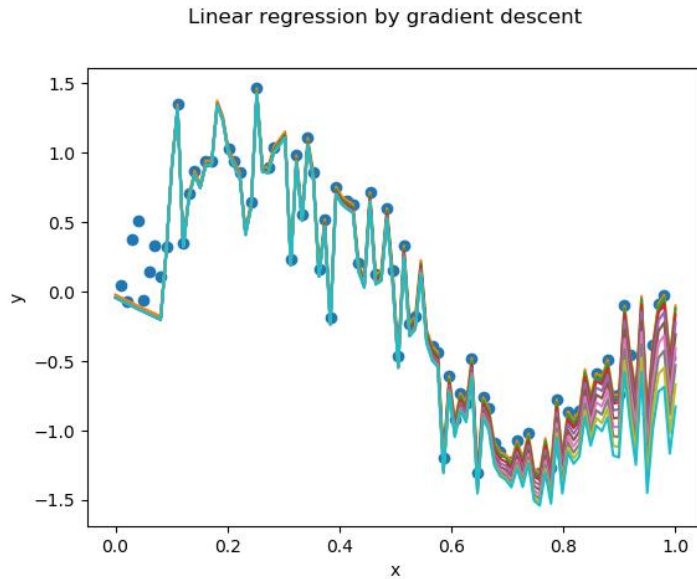
The terminal output shows the execution of the script, displaying the estimated value of `W` and the test error on test data.

```
(base) panho@panho:~/Downloads$ cd /home/panho/Downloads ; env "PYTHONIOENCODING=UTF-8" "PYTHONUNBUFFERED=1" /home/panho/anaconda3/bin/python /home/panho/.vscode/extensions/ns-python.python-2019.1.0/pythonFiles/ptvsd_launcher.py --default --nodebug --client --host localhost --port 43467 /home/panho/Downloads/Question_1.py
Estimated Value of W:
[-0.010568664323081579, -0.02092530297301492, -0.031074169551267496, -0.04101943232470945, -0.05076517593757309, -0.060315403089
067555, -0.0696740361773376, -0.07884491891044172, -0.08783181788501135]
test_error_on_test_data =
[[ 0.1523594 -0.04216852]
 [-0.04216852  0.01225455]]
(base) panho@panho:~/Downloads$
```

Q-2: Below is the plots of the datasets and the 9 fitted curves



Q-3: Below is the output and plot of 100 datasets



```
24 ttheta= nu.array([0],[0])
25 teta.append(b[i])
26 s[i]=s[i]+b[i]
27 for i in range(9):
28     plt.plot(x, a)
29     a=a+pow(x,i)*s[i]
30 plt.suptitle('Linear regression by gradient descent')
31 plt.xlabel('x')
32 plt.ylabel('y')
33 plt.show()
34 print(teta)
```

(base) panho@panho:~/Downloads\$ cd /home/panho/Downloads ; env "PYTHONIOENCODING=UTF-8" "PYTHONUNBUFFERED=1" /home/panho/anaconda3/bin/python /home/panho/.vscode/extensions/ms-python.python-2019.1.0/pythonFiles/ptvsd_launcher.py --default --client --host localhost --port 43903 "/home/panho/Downloads/Question_3_100.py"

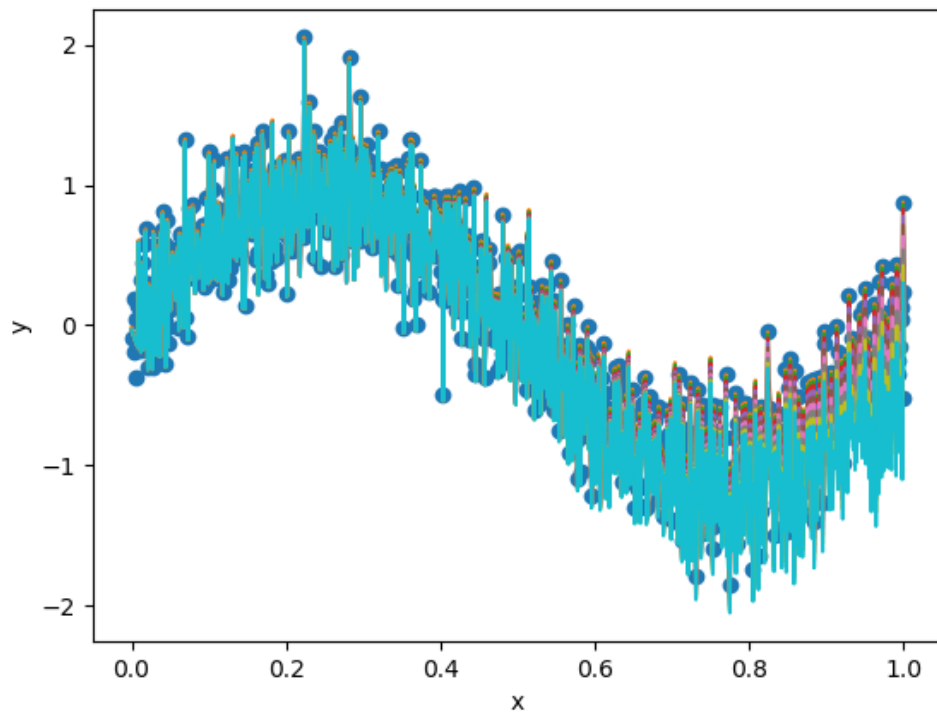
[-0.007995693581328272, -0.015855359008144998, -0.02358131048354358, -0.031175822839827044, -0.03864113220831057, -0.0459794366772894, -0.05319289694144264, -0.06028363693363334, -0.0672537444546759]

Terminated

(base) panho@panho:~/Downloads\$

Q-3: Below is the output and plot of 1000 datasets

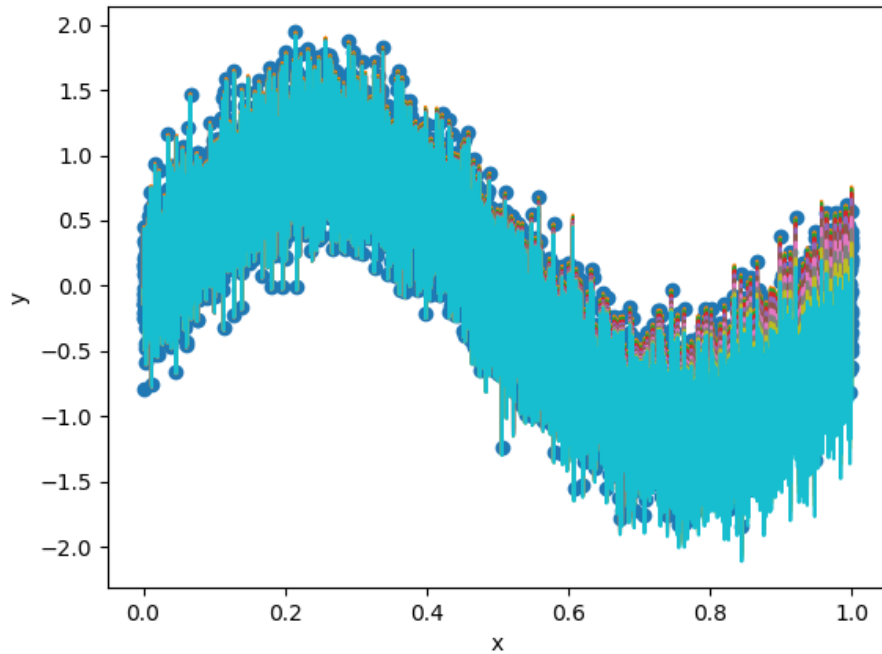
Linear regression by gradient descent



```
Visual Studio Code
Fri 23:46
Question_3_1000.py - Visual Studio Code
Question_3_1000.py x Question_4.py
DEBUG
1 import numpy as np
2 import math as mt
3 import matplotlib.pyplot as plt
4 from sklearn.model_selection import train_test_split
5 x=np.linspace(0,1,1000)
6 n=np.random.normal(0,0.3,1000)
7 s=b=z=y=np.zeros(1000)
8 for i in range(1000):
9     z[i]=2*mt.pi*x[i]
10 for i in range(1000):
11     y[i]=n[i]+mt.sin(z[i])
12 a=y
13 x_train, x_test, y_train, y_test=train_test_split(x, y, test_size=0.20, train_size=0.80)
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
1: Python Debug Console
(base) panho@panho:~/Downloads$ cd /home/panho/Downloads ; env "PYTHONIOENCODING=UTF-8" "/home/panho/anaconda3/bin/python" /home/panho/.vscode/extensions/ms-python.python-2019.1.0/pythonFiles/ptvsd_launcher.py --default --client --host localhost --port 38951 /home/panho/Downloads/Question_1.py
[-0.004966306290088228, -0.00983719512136226, -0.014614499745924318, -0.019300018193671872, -0.02389551394902057, -0.0284027166146253, -0.0328233225623492, -0.037158995571725625, -0.04141136745615338]
Terminated
(base) panho@panho:~/Downloads$
```

Q-3: Below is the output and plot of 10000 datasets

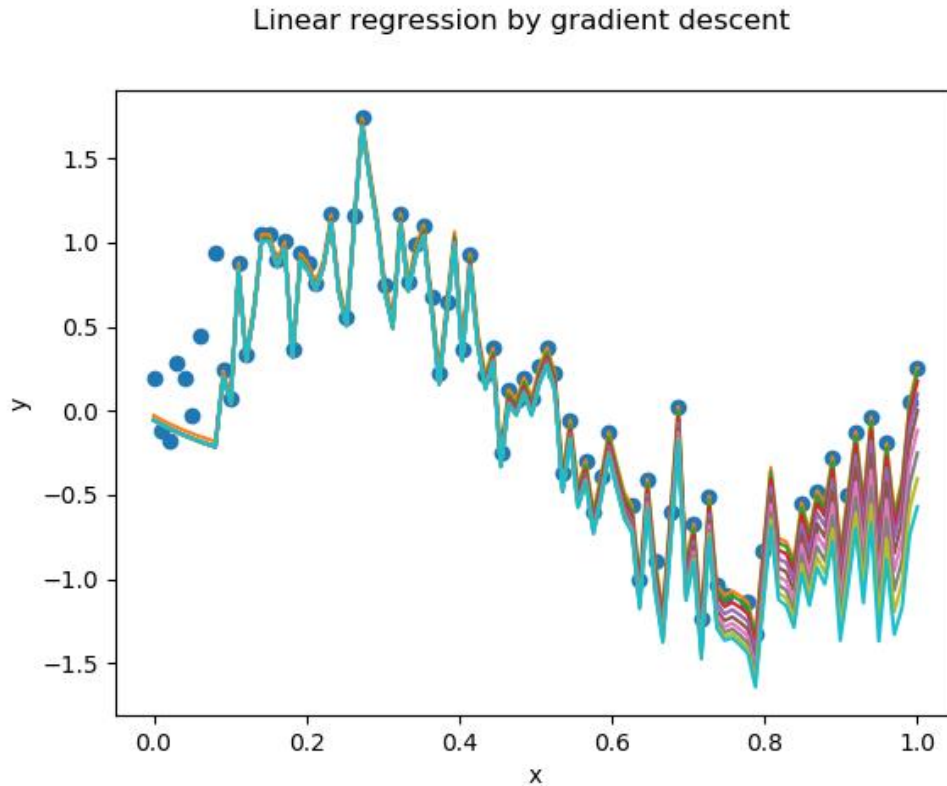
Linear regression by gradient descent



```
22 for i in range(9):
23     b[i]=nu.sum(theta[i] - alpha * (1/len(Y)) * nu.sum(nu.dot(X_i,(nu.dot(X,theta)-Y))))
24     theta= nu.array([[0],[b[i]]])
25     teta.append(b[i])
26     s[i]=s[i]+b[i]
27 for i in range(9):
28     plt.plot(x, a)
29     a=a+pow(x,i)*s[i]
30 plt.suptitle('Linear regression by gradient descent')
31 plt.xlabel('x')
32 plt.ylabel('y')
33 plt.show()
34 print(s)
```

Python 3.7.1 64-bit ('base': conda)

Q-4: Below is the output and plot of 100 datasets on modified cost function



```
Visual Studio Code
Sat 01:36
Question_4.py - Visual Studio Code
DEBUG
Question_4.py
22 for i in range(9):
23     b[i]=nu.sum(c[i] - alpha * (4/len(Y)) * nu.sum(nu.dot(X_1,(nu.dot(X,c)-Y)**3)))
24     c= nu.array([[0],[b[i]]])
25     W.append(b[i])
26     s[i]=s[i]+b[i]
27 for i in range(9):
28     plt.plot(x, a)
29     a=a+pow(x,i)*s[i]
30 plt.suptitle('Linear regression by gradient descent')
31 plt.xlabel('x')
32 plt.ylabel('y')
33 plt.show()
34
VARIABLES
WATCH
CALL STACK
BREAKPOINTS
Python 3.7.1 64-bit ('base': conda)
```

```
(base) panho@panho:~/Downloads$ cd /home/panho/Downloads ; env "PYTHONIOENCODING=UTF-8" "PYTHONUNBUFFERED=1" /home/panho/anaconda3/bin/python /home/panho/.vscode/extensions/ms-python.python-2019.1.0/pythonFiles/ptvsd_launcher.py --default --client --host localhost --port 40769 /home/panho/Downloads/Question_4.py
Estimated Value of W:
[[-0.013823171464417652, -0.026493309328230435, -0.0381280614086387, -0.04882968083612418, -0.0586875759677968, -0.06778035094679623, -0.07617745430023554, -0.08394052265359853, -0.09112448493008365]]
Terminated
(base) panho@panho:~/Downloads$
```