Data Set: Use the dataset given with the project.
Assignment Algorithm: Linear Regression

Linear Regression:

Q1 Consider a simplified fitting problem in the frequency domain where we are looking to find the best fit of data with a set of periodic (trigonometric) basis functions of the form 1, sin(x), sin(k *x), sin(2 * k * x),..., where k is effectively the frequency increment. The resulting function for a given" frequency increment", k, and "function depth", d, and parameter vector Θ is then:

$$Y= \theta_0 * 1 + \sum_{i=1}^{d}(\theta_i * \sin(i * k * x))$$

Assume k=0.5. Try d from 0 to 3.
Following are different linear regression problem. Do separate problems
For example, if k = 0.5 and d = 0, your basis (feature) functions is: 1
  if k = 0.5 and d = 1, your basis (feature) functions are: 1, sin(0.5*x)
  if k = 0.5 and d = 2, your basis (feature) functions are: 1, sin(0.5*1*x), sin(0.5*2*x)
  if k = 0.5 and d = 3, your basis (feature) functions are: 1, sin(0.5*1*x), sin(0.5*2*x) , sin(0.5*3*x)
This means that this problem can be solved using linear regression as the function is linear in terms of the parameters Θ.

a) Implement a linear regression learner to solve this best fit problem for 1 dimensional data. Make sure your implementation can handle fits for different "function depths" (at least to "depth" 3) using scikit-learn and other libraries

b) Implement a linear regression learner to solve this best fit problem for 1 dimensional data. Make sure your implementation can handle fits for different" function depths" (at least to "depth" 3) in Python using only NumPy, math, matplotlib libraries. Essentially implement Linear Regression from scratch.

c) Apply your regression learner to the data set that was generated for Question 1b) and plot the resulting function for "function depth" 0, 1, 2, and 3. Plot the resulting function together with the data points. Results must include a plot.

d) Evaluate your regression functions by computing the error on the test data points that were generated for Question 1c) Which "function depth" would you consider the best prediction function and why? With which values of d do you get minimum error? Results must include a plot.

Some rules to follow:

1. **Handwrite, sign, and date (with date of submission) a copy of the Honor Code (shown below) and share the image as part of your project; a handwritten, signed, and dated (with the date of submission) copy of the Honor Code must be included with <u>every project and exam submission.</u> (Failing to include will cost 20 points)**
2. **Students are required to NOT share their project questions and solutions even after the semester is over or even after graduation. However, they can show their projects during their interviews. They are also required to not discuss the solution with others or use anyone else's solution. Any violation of the policy will result in a 0 for this project for all students concerned. Violations can cause students to lose their degree.**

HONOR CODE
I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.
I promise that I will submit only work that I personally create or that I contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code
I will not participate in any form of cheating/sharing the questions/solutions.