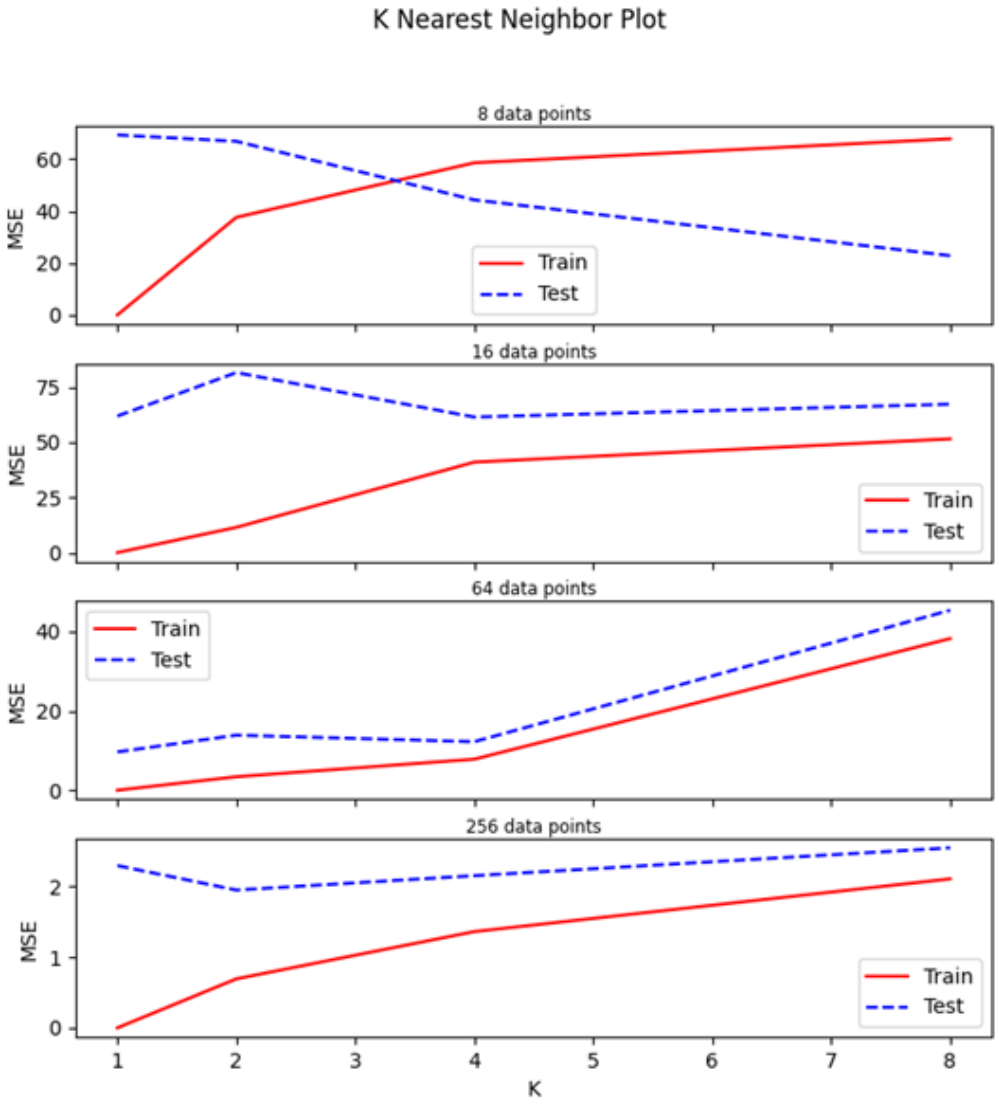
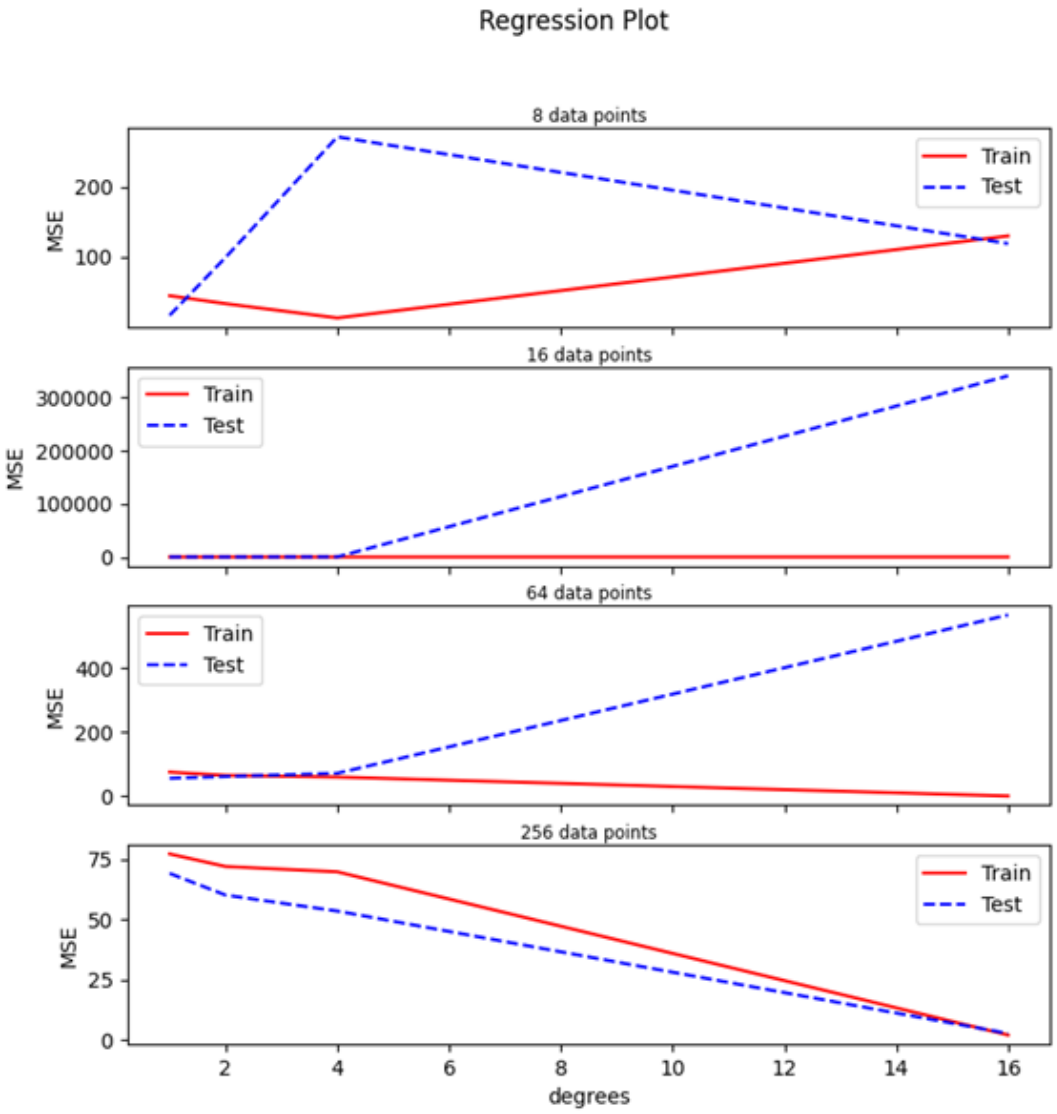
1.
a)

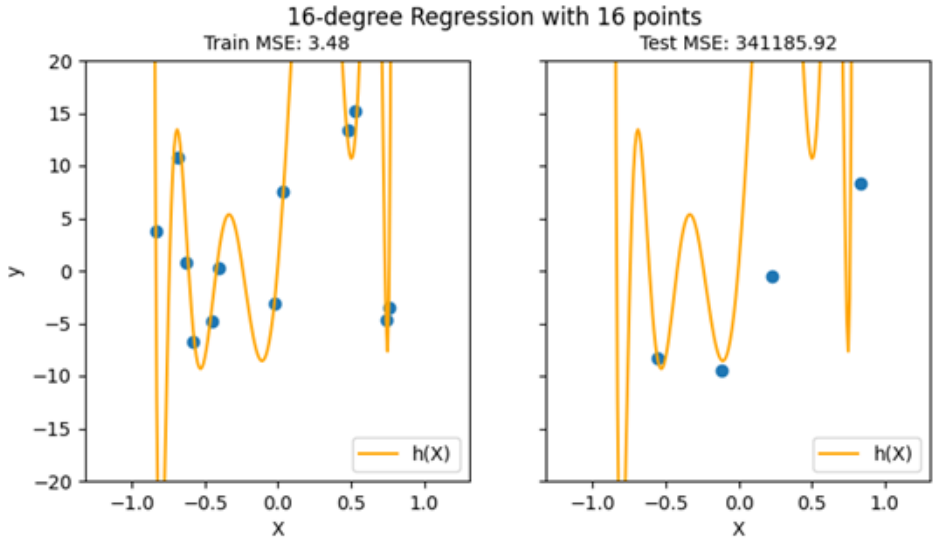


The KNN plot for K number of neighbors vs mean squared error for 8, 16, 64, and 256 data points used for training. As K increases, the difference in MSE between the training and test decreases, except when there are only 8 data points, and the hypothesis better matches with the data points.



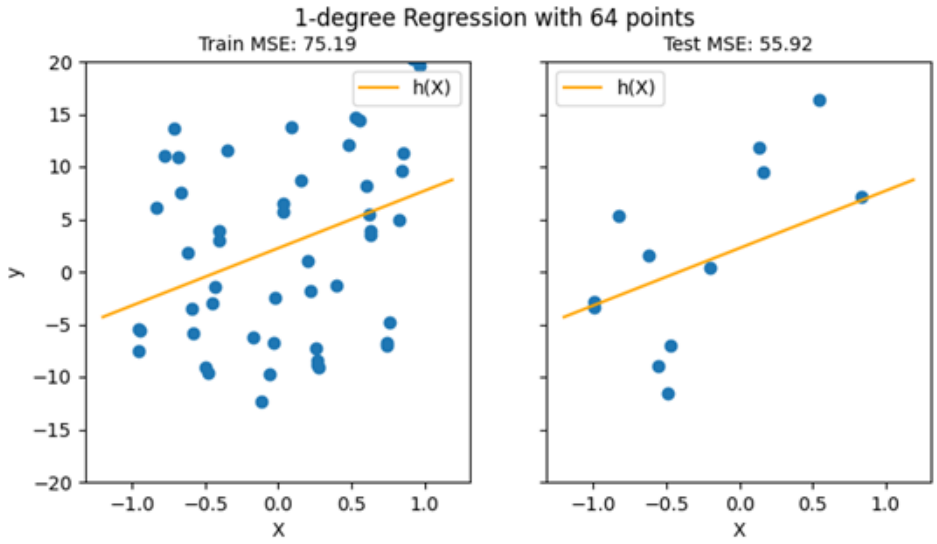
The polynomial regression plot for degree of polynomial vs mean squared error for 8, 16, 64, and 256 data points used for training. The difference in MSE for training and testing is pretty bad until 256 data points are used. At 256 data points, the MSE difference decreases and the hypothesis doesn't really match until the high degree polynomial with lots of data points.

b) Overfit:



The model is overfit because the 16 degree polynomial passes through every single point in the training set and incorrectly predicts the test set.

Underfit:



This model is underfit because the line hits almost no points in the training set and gives no indication of the trend of the points which is also seen in the test results.

c) Since f(x) is the true function, hypotheses are compared to f(x) to determine if it is overfitted or underfitted. If H is the hypothesis class, the space of this class is dependent on the type of algorithm you use. If you use KNN the space is proportional to the k amount of neighbors you use. For KNN, the lower k (aka the hypothesis class) is, the more likely the hypothesis will over fit. However, if k is increased with a small amount of training examples (n), then the hypothesis will likely be underfitted to f(x). The more that n increases, the better the hypothesis fits f(x). On the other hand, the hypothesis class for polynomial regression is proportional to the degree of your polynomial. If the degree of the polynomial is increased the hypothesis is likely to overfit. If you increase n with a high degree polynomial, the hypothesis will start to look more like f(x). However, if you have a small degree, the hypothesis will always be underfit even if you try to add more n.