MATLAB Programming NYCU Fall 2024 LAB#3 2024/9/26

For this lab, you will write a script that does function approximation and plot the results. Let the approximation function $y=f(x)$ be a polynomial of degree r, so it has $r+1$ coefficients. You need to find these coefficients using the matrix-division operator (****) given a set of sample points $\{(x_i,y_i)\}$.

- Generate the sample points from a polynomial function plus small random numbers. Example:

```
xi = -9:3:9;  yi = -.04*xi.^2 + .1*xi + 2 + 1*(rand(1,length(xi))-.5);
```

- Now our goal is to fit these points to the equation $y=f(x)=a_0+a_1x+...+a_rx^r$. This leads to the following over-specified set of linear equations (n = the number of sample points):

$$\begin{bmatrix} 1 & x_1 & \cdots & x_1{}^r \\ 1 & x_2 & \cdots & x_2{}^r \\ \cdots & & & \\ 1 & x_n & \cdots & x_n{}^r \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_r \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}$$

- Use the matrix-division operator (****) to solve for the coefficients in minimum-squared-error manner. (Check previous lecture slides for the explanation.) Note: You are NOT allowed to use the `poly*` functions in this lab.
- Plot the function $y=f(x)$ with the estimated coefficients by sampling the function to get the predicted y values for different values of x. Notes: (1) You can do this polynomial evaluation with one single operation of matrix multiplication using the equation above; (2) For smoother outputs, sample x using a fine grid, such as `-10:.1:10`.
- Plot the sampled (x_i,y_i) pairs together with the estimated function. You need to use `hold on`.
- In addition, add vertical line segments that connect the sample points and their predicted positions. (Note: You can use a single statement to plot all the vertical segments in one plot. Check the method#1 in the slide about "Multiple 2-D Plots in One Axes".)
- After doing these steps successfully, repeat them using polynomials of different degrees. At least do polynomials with degrees of 1, 2, and 4. Plot them all in the same figure using `subplot`.
- Add titles to the subplots.
- Display the root-mean-square (rms) error within each subplot. Check the documentation to see how to specify the location and alignment when using function `text`.
- Use function `sprintf` to create the strings to display. The usage of `sprintf` is similar to that of `fprintf`, but it returns a vector of type `char`, which you can display as text.

Sample output: