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: