

ESO 208A: Computational Methods in Engineering
Programming Assignment 3: *Least Squares and Interpolation*

Due date: Thursday, 24th October 24:00 mid-night

Input: Read a set of data points $\{x_k, y_k\}; k = 0, 1, 2, \dots, n$ from an *input file*. The input file should contain the data set in two columns separated by 'tab' or 'comma'.

Write a computer program with the following options sequence:

Asks the user, "What do you want to do?"

- A. Fit a least square polynomial
 - a. If chosen, asks the user to specify the order of the polynomial (an integer $< n$).
 - b. Output is sent to a file and consists of the equation of the polynomial; a plot of the data (scatter) and the fitted polynomial; and the r^2 value.
- B. Fit a Lagrange Interpolation Polynomial
 - a. Output is sent to a file and consists of the equation of the polynomial and a plot showing the data (scatter) and the fitted polynomial
- C. Fit a Newton's Interpolation Polynomial
 - a. Output is sent to a file and consists of the equation of the polynomial and a plot showing the data (scatter) and the fitted polynomial
- D. Fit Cubic splines:
 - a. Gives the options to choose:
 - i. Linear spline
 - ii. Quadratic spline
 - iii. Natural Spline
 - iv. Not-a-knot
 - v. Periodic
 - vi. Clamped Spline: if chosen, ask for two first derivative values at two end points.
 - b. Output is sent to a file and consists of the equation of the polynomial in each interval (coefficients in a tabular form); values of the first derivative and the 2nd derivative at each node; a plot showing the data (scatter) and the fitted polynomials

Test Problems: Use the data in Problems 6 of Tutorial 8 and Problems 1-4 of Tutorial 9.

Due date: Thursday, October 24th, 2019, 24:00 midnight

Make a single zip folder with all your program file(s) name it roll_number.zip (e.g., If your roll no. is 123456, the folder name should be 'P3_123456.zip'). The folder should include -

- (i) All the computer program file(s), input file(s) and output file(s)
- (ii) A PDF file of the plots and the solution of the test cases given in this assignment.

Send the zip file by e-mail to: eso208.sec*@gmail.com, where * is section number 1-10.
Example: for section O5, it is eso208.sec5@gmail.com; for section O10, it is eso208.sec10@gmail.com

Additional Test Data: Part A:

Sample input file

0.051	0.287
0.073	0.983
0.089	0.857
0.798	9.997
0.943	18.345
0.684	6.233
0.132	0.994
0.723	6.805
0.110	0.845
0.117	1.578
0.641	4.122
0.329	1.633
0.654	5.462
0.749	7.621
0.583	4.249
0.740	7.610
0.235	0.935
0.735	7.564
0.971	20.224
0.867	12.940

Sample output files

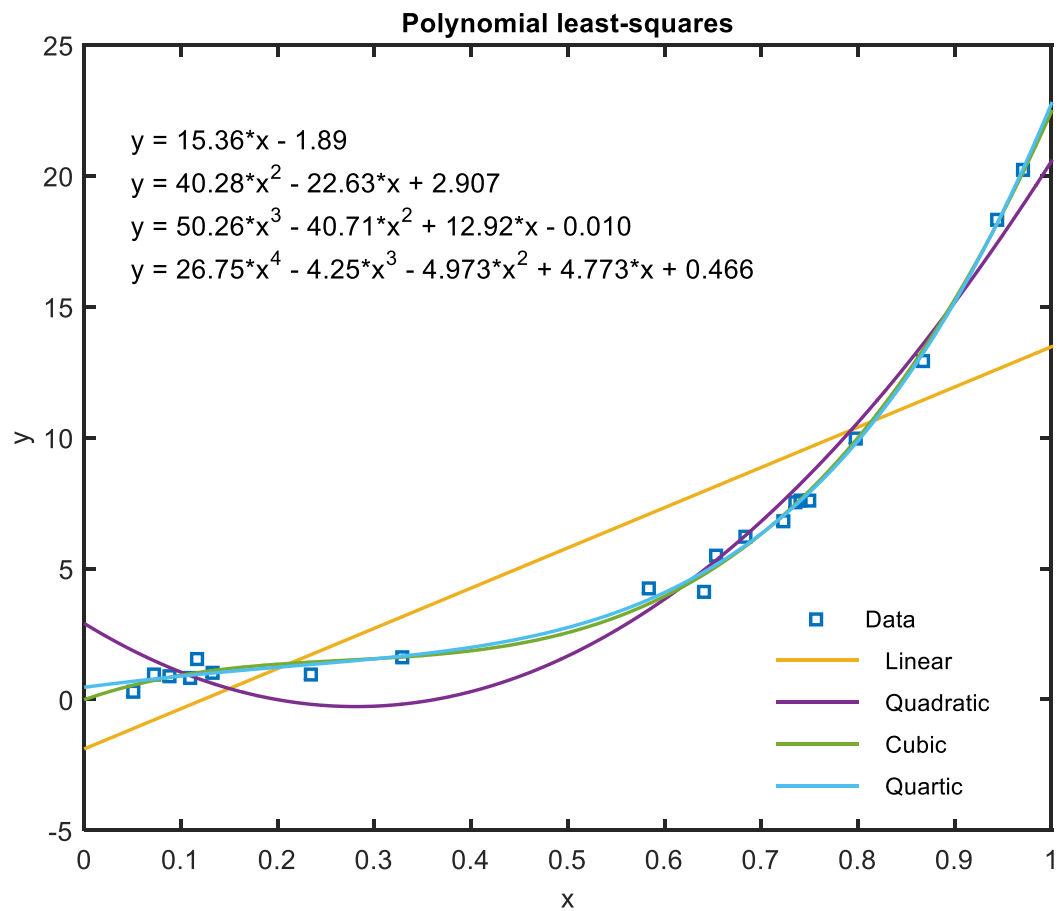
Linear : coefficients -1.890 15.364
 : R-sq = 0.7572

Quadratic : coefficients 2.907 -22.626 40.279
 : R-sq = 0.9765

Cubic : coefficients -0.010 12.917 -40.710 50.262
 : R-sq = 0.9965

Quartic : coefficients 0.466 4.773 -4.973 -4.250 26.747
 : R-sq = 0.9968

Sample Figure



Part D:

Sample input file

input x and y

-1.000	0.0385
-0.500	0.1379
0.000	1.0000
0.500	0.1379
1.000	0.0385

points where function has to be evaluated (x^*)

-0.8000
-0.2000
0.2000
0.8000

slope at the first (s_0) and the last node (s_n)

-1.0000	1.5000
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Sample output files

Interpolated values y^* at give x^*

Linear spline

-0.800	0.0782
-0.200	0.6552
0.200	0.6552
0.800	0.0782

Quadratic spline

-0.800	0.0782
-0.200	0.4721
0.200	1.2520
0.800	-0.7016

Natural spline

-0.800	-0.0363
-0.200	0.7716
0.200	0.7716
0.800	-0.0363

Not-a-knot spline

-0.800	-0.2520
-0.200	0.8024
0.200	0.8024
0.800	-0.2520

Periodic spline

-0.800	0.0042
-0.200	0.7658
0.200	0.7658
0.800	0.0042

Clamped spline

-0.800	-0.0793
-0.200	0.7748
0.200	0.7868
0.800	-0.1222

Sample Figure

