Assignment 9

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ECE 309

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**Main Script**

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

% Program Name: test.m

% Author: Juan Silva Last Modified: April 25, 2018

% Description: This program will ask the user to enter

% an experiment number and output a graph showing the

% best fit curve for that experiment.

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

clear, clc, close all,

format short, format compact

%Prompt user to enter experiment type.

in = input('Enter an experiment number: ');

[bestCurve, bestFit] = BestCurve(in);

%Print best curve type from values found in BestCurve function.

fprintf('\t\tThe Best Fit is: %s Curve with SSE of %5.3f.\n', bestCurve, bestFit)

**Function Script**

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

% Program Name: BestCurve.m

% Author: Juan Silva Last Modified: April 25, 2018

% Description: This function will read data from an excel

% sheet, calculate the SSE values using two methods,

% call a function to create a table to display the SSE

% values, and produce the graphs for each case.

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

function [bestCurve, bestFit] = BestCurve(in)

%-----------------------------------

%Part 1 - Obtain Experiment Values

%-----------------------------------

%Initialize x and y from Experiment Data

FILE1 = 'DATA\_NewCurveFit.xlsx'; %Load data for Experiments 1 - 3

FILE2 = 'DATA\_MyExperiment.xlsx'; %Load data for Experiments 4 - 5

%Assign Experiment data based on user's input number.

switch in

case 1

Exp = xlsread(FILE1, 1, 'A:B'); % Experiment # Data

ExpTitle = 'Experiment 1'; % Update graph title

cf = [2.037 2.423 10.64]; % Assign cftool SSEs

t\_num = 1; % table #

p\_num = 1; % data pair #

case 2

Exp = xlsread(FILE1, 1, 'C:D');

ExpTitle = 'Experiment 2';

cf = [163.8784 39.9325 142.4113];

t\_num = 1;

p\_num = 2;

case 3

Exp = xlsread(FILE1, 1, 'E:F');

ExpTitle = 'Experiment 3';

cf = [0.5952 1.15181 0.484];

t\_num = 1;

p\_num = 3;

case 4

Exp = xlsread(FILE2, 1, 'B:C');

ExpTitle = 'Experiment 4';

t\_num = 1;

p\_num = 1;

cf = [13.75 44.24 23.87];

case 5

Exp = xlsread(FILE2, 1, 'D:E');

ExpTitle = 'Experiment 5';

t\_num = 1;

p\_num = 2;

cf = [5.381 23.9 14.03];

otherwise

disp('Error! Invalid experiment number.')

return

end

%Contains original x and y values for given experiment.

%For Loop is used to handle varying array sizes

for i=1:length(Exp)

x(i) = Exp(i,1);

y(i) = Exp(i,2);

end

%Print table for original data values from specified experiment

fprintf('\n\tx1\t\ty1\n')

temp = [x; y];

fprintf('\t%3.2f\t%3.2f\n',temp)

%Set constant x-range for best curve graphs.

xmin = min(x);

xmax = max(x);

xdense = xmin: 0.1: xmax;

%-------------------------------------

%Part 2 - Solve SSE: Polynomial curve

%-------------------------------------

%Evaluate polynomial for least-squares fit line.

abc = polyfit(x,y,2);

ynew = polyval(abc, x);

%Polynomial curve: (y = ax^2 + bx + c)

a = abc(1);

b = abc(2);

c = abc(3);

%Set constant y-range for best polynomial curve graph.

ydense1 = a.\*xdense.^ 2 + b \* xdense + c;

%Polynomial SSE

SSE\_poly = sum((ynew - y).^2);

%Polynomial SSE (alternative method)

A = [x.^2; x; x.^0]';

x0 = [a b c]';

b = [y]';

AX\_poly = (A\*x0 - b)' \* (A\*x0 - b);

%---------------------------------------

%Part 3 - Solve SSE: Exponential curve

%---------------------------------------

%Modify y from original data to be log(y)

logy = log(y);

%Evaluate exponential for least-squares fit line.

MB = polyfit(x,logy,1);

M = MB(1);

B = MB(2);

%Exponential curve: (y = ce^ax)

C = exp(B);

a = M;

%Set constant y-range for best exponential curves graph.

ynew = C \* exp(a \* x);

ydense2 = C \* exp(a \* xdense);

%Exponential SSE

SSE\_exp = sum((ynew - y).^2);

%Exponential SSE(alternative method)

A = [x; x.^0]';

x0 = [M B]';

b = [logy]';

AX\_exp = (A\*x0 - log(b))' \* (A\*x0 - log(b));

%---------------------------------

%Part 4 - Solve SSE: Power curve

%---------------------------------

%Modify x from original data to be log(x)

logx = log(x);

%Evaluate power for least-squares fit line.

MB = polyfit(logx,logy,1);

M = MB(1);

B = MB(2);

%Exponential power: (y = cx^a)

C = exp(B);

a = M;

%Set constant y-range for best power curves graph.

ynew = C \* x.^a;

ydense3 = C \* xdense.^a;

%Power SSE

SSE\_pow = sum((ynew - y).^2);

%Power SSE (alternative method)

A = [x; x.^0]';

x0 = [M B]';

b = [logy]';

c = inv(A'\*A) \* (A'\*b);

b2 = exp(c(2));

AX\_pow = (A\*x0 - log(b2))' \* (A\*x0 - log(b2));

%Open cftool to verify graph and SSE values

cftool(x,y)

%-------------------------------

%Part 5 - Determine Best Curve

%-------------------------------

%Place SSEs in an array and sort them

%First value is best fit, third value is worst fit

SSE\_temp = [SSE\_poly SSE\_exp SSE\_pow];

SSE = sort(SSE\_temp);

%Best fit located in SSE(1), first value in SSE array

switch SSE(1)

case SSE\_poly

bestFit = SSE\_poly; %Assign best fit

y\_best = ydense1; %y values based on curve type

bestCurve = 'Polynomial'; %Best fit string for "Phrase"

leg\_best = 'Best Fit: Polynomial'; %Label for legend

case SSE\_exp

bestFit = SSE\_exp;

y\_best = ydense2;

bestCurve = 'Exponential';

leg\_best = 'Best Fit: Exponential';

otherwise

bestFit = SSE\_pow;

y\_best = ydense3;

bestCurve = 'Power';

leg\_best = 'Best Fit: Power';

end

%Next fit located in SSE(2), second value in SSE array

switch SSE(2)

case SSE\_poly

nextFit = SSE\_poly;

y\_next = ydense1;

nextCurve = 'Polynomial';

leg\_next = 'Next Fit: Polynomial';

case SSE\_exp

nextFit = SSE\_exp;

y\_next = ydense2;

nextCurve = 'Exponential';

leg\_next = 'Next Fit: Exponential';

otherwise

nextFit = SSE\_pow;

y\_next = ydense3;

nextCurve = 'Power';

leg\_next = 'Next Fit: Power';

end

%Worst fit located in SSE(3), third value in SSE array

switch SSE(3)

case SSE\_poly

worstFit = SSE\_poly;

y\_worst = ydense1;

worstCurve = 'Polynomial';

leg\_worst = 'Worst Fit: Polynomial';

case SSE\_exp

worstFit = SSE\_exp;

y\_worst = ydense2;

worstCurve = 'Exponential';

leg\_worst = 'Worst Fit: Exponential';

otherwise

worstFit = SSE\_pow;

y\_worst = ydense3;

worstCurve = 'Power';

leg\_worst = 'Worst Fit: Power';

end

%---------------------------

%Part 6 - Create the Graph

%---------------------------

%Plot the graps based on switch cases in Part 5

plot(xdense, y\_best, 'g', xdense, y\_next, '--b', xdense, y\_worst, ':k', x, y, 'ro')

grid

title(ExpTitle)

xlabel('x1')

ylabel('y1')

legend(leg\_best, leg\_next, leg\_worst, 'Original Data')

%Call tables function to create a table using SSE values

Tables(SSE\_poly, SSE\_exp, SSE\_pow, AX\_poly, AX\_exp, AX\_pow,p\_num,t\_num,cf)

end

**Function Script**

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

% Program Name: Tables.m

% Author: Juan Silva Last Modified: April 25, 2018

% Description: This function will produce a table using

% SSE values passed from the BestCurve function.

% \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

function Tables(SSE\_poly, SSE\_exp, SSE\_pow, AX\_poly, AX\_exp, AX\_pow, p\_num, t\_num, cf)

fprintf('\n\t\t\t|-----------------------------------------------|\n')

fprintf('\t\t\t| Poly. Curve | Exp. Curve | Power Curve |\n')

fprintf('\t|-------|---------------|---------------|---------------|\n')

%Print Row 1 containing SSE values calculated using Method 1

fprintf('\t|yNew\t|\t%5.3f\t\t|\t%5.3f\t\t|\t%5.3f\t\t|\n', SSE\_poly, SSE\_exp, SSE\_pow)

fprintf('\t|-------|---------------|---------------|---------------|\n')

%Print Row 2 containing SSE values calculated using Method 2

fprintf('\t|Ax - b\t|\t%5.3f\t\t|\t%5.3f\t\t|\t%5.3f\t\t|\n',AX\_poly,AX\_exp,AX\_pow)

fprintf('\t|-------|---------------|---------------|---------------|\n')

%Print Row 3 containing SSE values calculated using cftool

fprintf('\t|cftool\t|\t%5.3f\t\t|\t%5.3f\t\t|\t%5.3f\t\t|\n', cf)

fprintf('\t|-------------------------------------------------------|\n')

%Print data types.

fprintf('\t\t\t\t\t\tTable %d, Data Pair %d\n', t\_num, p\_num)

end

**Results  
  
Experiment 1:**

Enter an experiment number: 1

x1 y1

0.50 2.60

1.20 3.30

2.80 5.70

3.10 8.90

5.10 21.60

|-----------------------------------------------|

| Poly. Curve | Exp. Curve | Power Curve |

|-------|---------------|---------------|---------------|

|yNew | 2.037 | 3.710 | 64.968 |

|-------|---------------|---------------|---------------|

|Ax – b | 2.037 | 9.180 | 47.418 |

|-------|---------------|---------------|---------------|

|cftool | 2.037 | 2.423 | 10.640 |

|-------------------------------------------------------| Table 1, Data Pair 1

The Best Fit is: Polynomial Curve with SSE of 2.037.  
   


**Experiment 2:**

Enter an experiment number: 2

x1 y1

0.50 2.40

1.10 2.90

1.50 10.00

1.80 10.80

3.60 32.70

4.50 79.00

|-----------------------------------------------|

| Poly. Curve | Exp. Curve | Power Curve |

|-------|---------------|---------------|---------------|

|yNew | 163.878 | 53.065 | 669.434 |

|-------|---------------|---------------|---------------|

|Ax – b | 163.878 | 20.120 | 151.784 |

|-------|---------------|---------------|---------------|

|cftool | 163.878 | 39.932 | 142.411 |

|-------------------------------------------------------|

Table 1, Data Pair 2

The Best Fit is: Exponential Curve with SSE of 53.065.



**Experiment 3:**

Enter an experiment number: 3

x1 y1

3.90 24.00

5.60 26.20

9.40 29.50

8.60 28.90

11.00 30.60

11.20 30.00

13.10 32.00

|-----------------------------------------------|

| Poly. Curve | Exp. Curve | Power Curve |

|-------|---------------|---------------|---------------|

|yNew | 0.595 | 1.607 | 0.484 |

|-------|---------------|---------------|---------------|

|Ax – b | 0.595 | 32.218 | 26.850 |

|-------|---------------|---------------|---------------|

|cftool | 0.595 | 1.152 | 0.484 |

|-------------------------------------------------------|

Table 1, Data Pair 3

The Best Fit is: Power Curve with SSE of 0.484.



**Experiment 4:**

Enter an experiment number: 4

x1 y1

0.90 0.75

2.86 2.70

3.99 3.40

4.20 7.20

5.73 10.80

16.70 15.10

|-----------------------------------------------|

| Poly. Curve | Exp. Curve | Power Curve |

|-------|---------------|---------------|---------------|

|yNew | 13.749 | 110.722 | 62.271 |

|-------|---------------|---------------|---------------|

|Ax – b | 13.749 | 21.500 | 372.793 |

|-------|---------------|---------------|---------------|

|cftool | 13.750 | 44.240 | 23.870 |

|-------------------------------------------------------|

Table 1, Data Pair 1

The Best Fit is: Polynomial Curve with SSE of 13.749.



**Experiment 5:**

Enter an experiment number: 5

x1 y1

2.40 0.99

2.97 1.60

3.74 2.49

4.05 3.75

4.75 7.50

5.98 7.80

7.30 9.90

9.10 10.40

|-----------------------------------------------|

| Poly. Curve | Exp. Curve | Power Curve |

|-------|---------------|---------------|---------------|

|yNew | 5.381 | 63.395 | 32.062 |

|-------|---------------|---------------|---------------|

|Ax – b | 5.381 | 47.211 | 688.342 |

|-------|---------------|---------------|---------------|

|cftool | 5.381 | 23.900 | 14.030 |

|-------------------------------------------------------|

Table 1, Data Pair 2

The Best Fit is: Polynomial Curve with SSE of 5.381.

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