Simulation Assignment 4 – Technical Report

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1)

Code

```
load N:\ECE_204\Lab4\test1.txt;
M = load('test1.txt');
rows1 = length(test1);
% load N:\ECE_204\Lab4\test2.txt;
% N = load('test2.txt');
% rows2 = length(test2);

prompt = "Select the function to fit your data: \n1. Linear: y = a0 + a1x\n2. Polynomial: y = a0 + a1x + ...
+ amx^m\n3. Exponential: y = ae^(bx)\n4. Power: y = ax^b\n";
function_number = input(prompt);          % to accept choice

if function_number==1                     % linear regression
    x = M(:,1);
    y = M(:,2);
    format long;
    X = [ones(length(x),1) x];
    b = X\y;
    yCalc = X*b;
    scatter(x,y);                         % to plot (x,y) points
    hold on;
    plot(x,yCalc)                         % to plot curve
    xlabel('x');
    ylabel('y');
    title('Linear Regression Relation');
    grid on;
    a0 = b(1,1);
    a1 = b(2,1);
    Rsq = 1 - sum((y - yCalc).^2)/sum((y - mean(y)).^2);
    %Coefficient of determinant
    string = sprintf('y = %f + %fx, R^2 = %f', a0, a1, Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
end

if function_number==2                     % polynomial regression
    prompt2 = "Determine the degree of the polynomial: ";
    degree = input(prompt2);              % to accept degree
    A = zeros(degree+1, degree+1);
```

```
    Sol = zeros(degree+1, 1);
    x = M(:,1);
    y = M(:,2);
    format long;
    for i=1:degree+1
        for j=1:degree+1
                A(i, j) = sum(x.^(i+j-2));
        end
        Sol(i, 1) = sum((x.^(i-1)).*y);
    end
    coeff = A\Sol;
    i = [0:degree];
    xpoly = x.^i;
    y2 = xpoly*coeff;
    scatter(x,y);
    hold on;
    xlabel('x');
    ylabel('y');
    title('Polynomial Regression Relation');
    plot(x(:, 1),y2(:,1));
    St = sum((y - mean(y)).^2);
    Sr = sum((y-y2).^2);
    Rsq = 1-(Sr/St);
    string = sprintf('Order = %d, R^2 = %f', degree, Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
    fprintf("The coefficients are:\n");
    for counter=1:degree+1
    fprintf("a%d = %f \n", counter-1, coeff(counter));
    end
end

if function_number==3                          % exponential regression
    x = M(:,1);
    y = M(:,2);
    format long;
    Y = log(y);
    X = [ones(length(x),1) x];
    b = X\Y;
    YCalc = X*b;
    a0 = b(1,1);
    A = exp(a0);
```

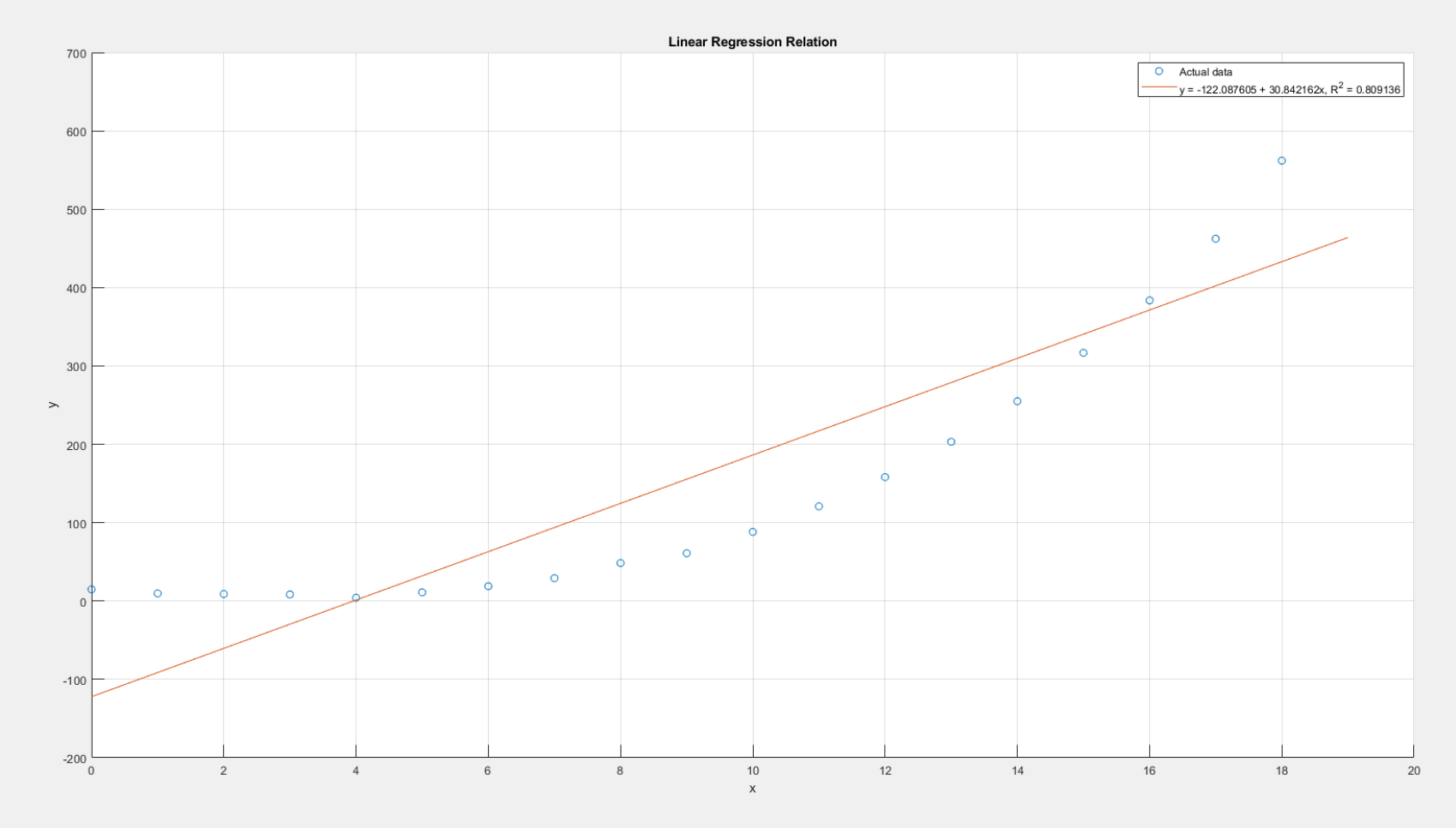
```
    a1 = b(2,1);
    y2 = A*exp(a1*x);

    scatter(x,y);
    hold on;
    xlabel('x');
    ylabel('y');
    title('Exponential Regression Relation');
    plot(x(:, 1),y2(:,1));
    St = sum((y - mean(y)).^2);
    Sr = sum((y-y2).^2);
    Rsq = 1-(Sr/St);
    string = sprintf('y = %fe^{%fx}, R^2 = %f', A, a1, Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
end

if function_number==4                          % power regression
    x = M(:,1);
    num = find(~x)
    x(num, :) = []
    y = M(:,2);
    y(num, :) = []
    format long;
    Y = log10(y);
    X = log10(x);
    new_X = [ones(length(X),1) X];
    b = new_X\Y;
    YCalc = new_X*b;
    a0 = b(1,1);
    A = 10^a0;
    a1 = b(2,1);
    A1 = a1;
    y2 = A*(x.^A1);

    scatter(x,y);
    hold on;
    xlabel('x');
    ylabel('y');
    title('Power Regression Relation');
    plot(x(:, 1),y2(:,1));
```

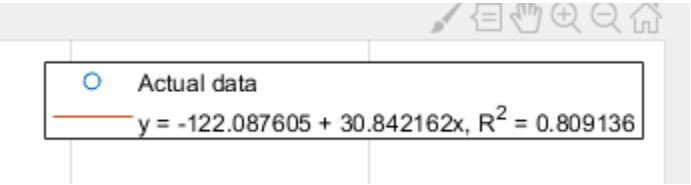
```
    St = sum((y - mean(y)).^2);
    Sr = sum((y-y2).^2);
    Rsq = 1-(Sr/St);
    string = sprintf('y = %fx^{%f}, R^2 = %f', A, A1, Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
end
```

Output

Test 1

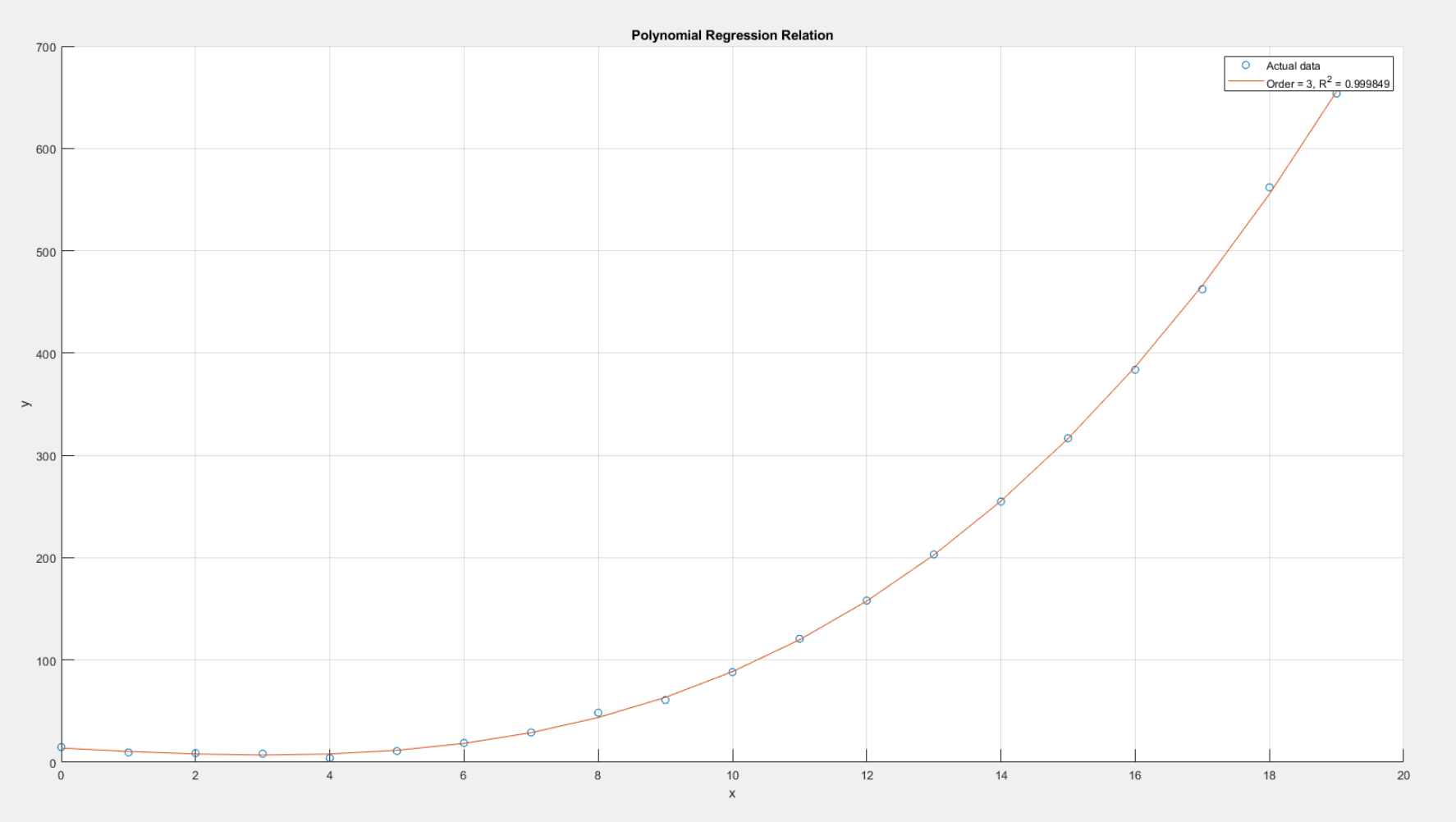
1) Linear

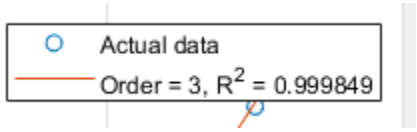




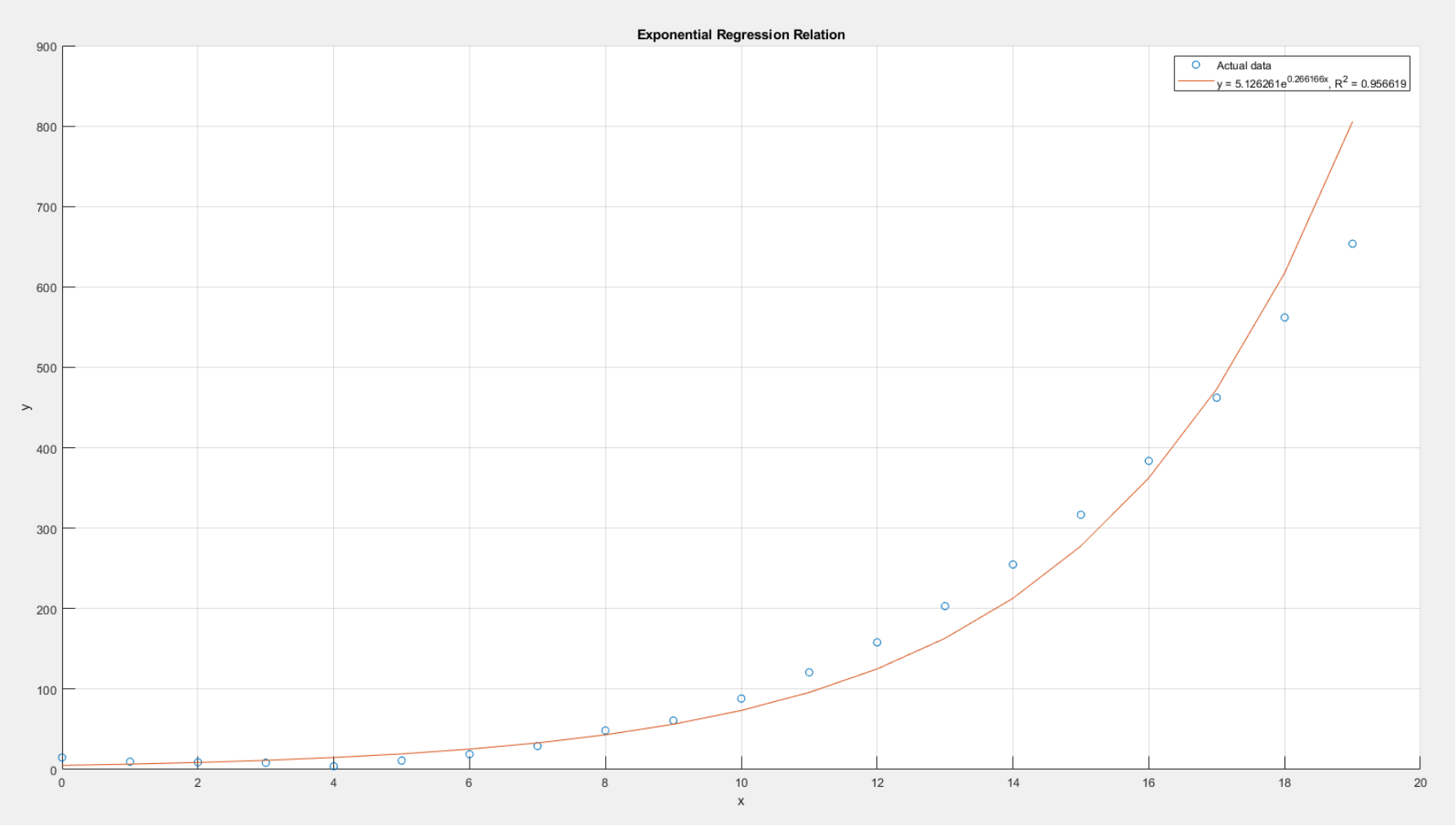
2) Polynomial

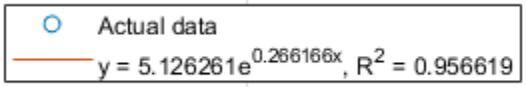
```
>> Question1
Select the function to fit your data:
1. Linear: y = a0 + a1x
2. Polynomial: y = a0 + a1x + ... + amx^m
3. Exponential: y = ae^(bx)
4. Power: y = ax^b
2
Determine the degree of the polynomial: 3
The coefficients are:
a0 = 13.932134
a1 = -3.567570
a2 = 0.146677
a3 = 0.095711
>>
```


Polynomial Regression Relation
Actual data
Order = 3, R2 = 0.999849
y
x
0
100
200
300
400
500
600
700
0
2
4
6
8
10
12
14
16
18
20

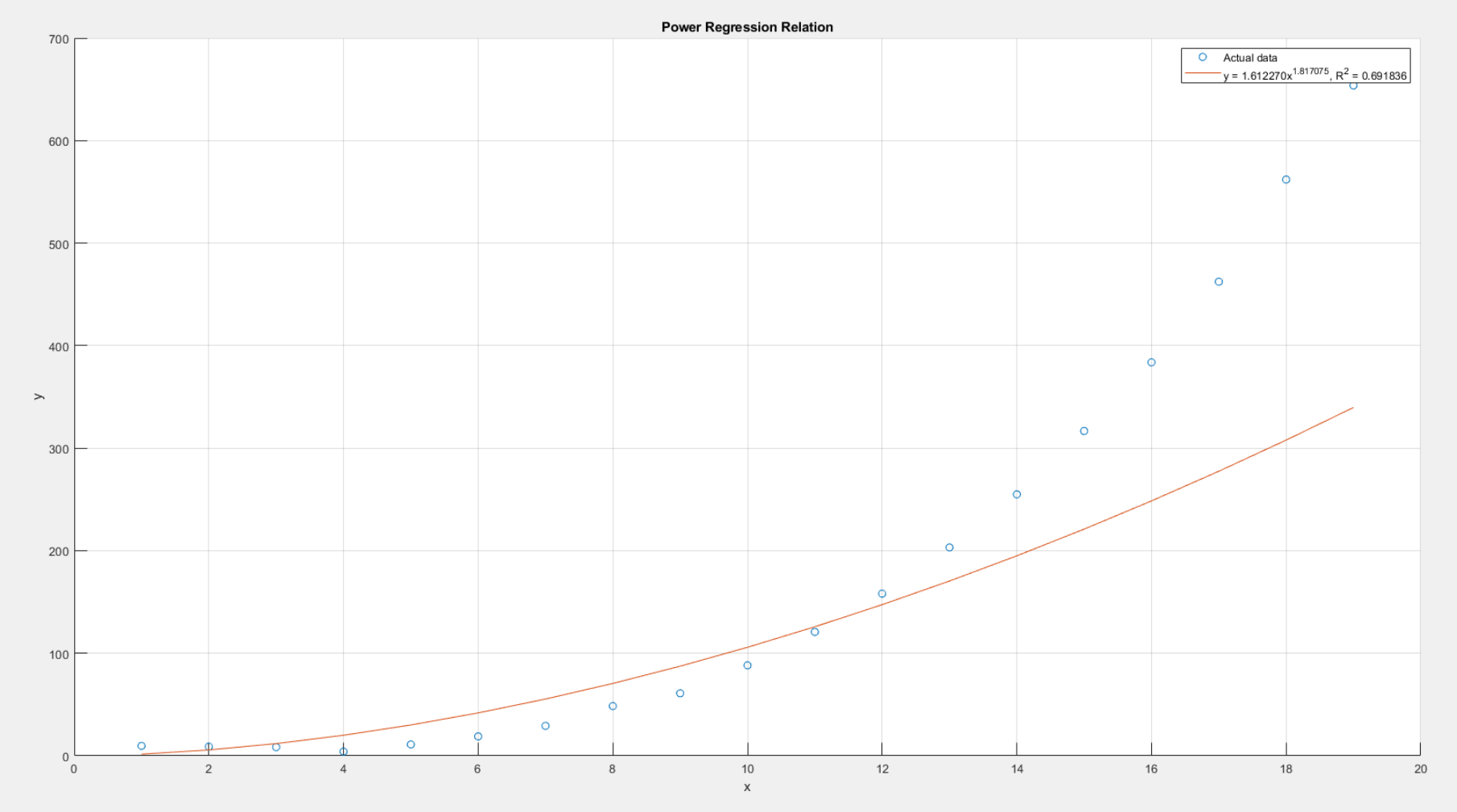

Actual data
Order = 3, R2 = 0.999849

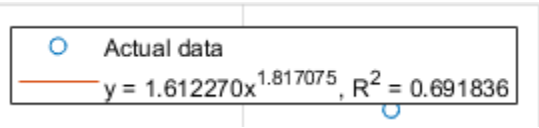
3) Exponential





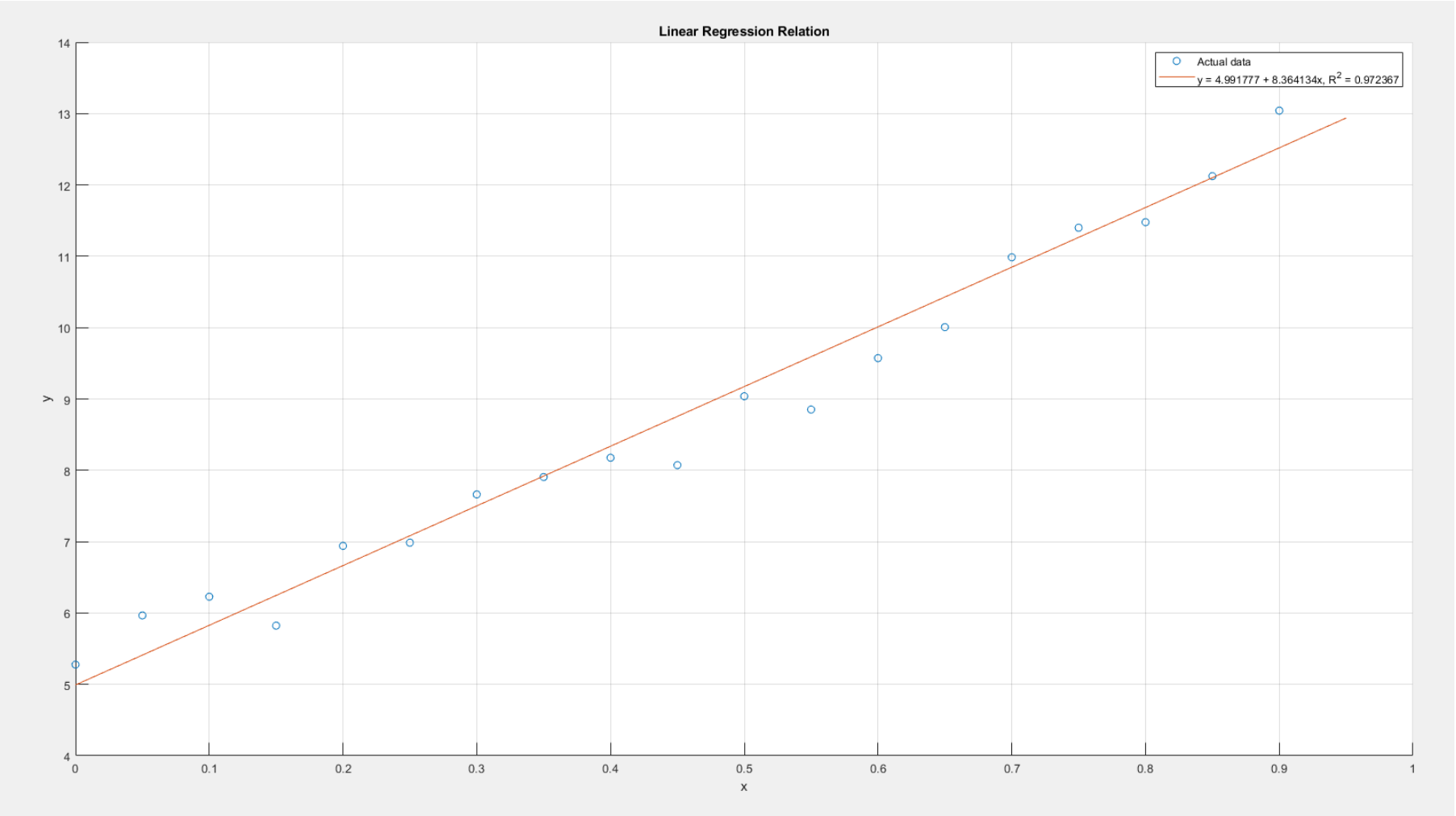
4) Power

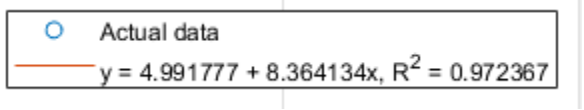

Power Regression Relation
Actual data
y = 1.612270x^1.817075, R^2 = 0.691836
y
x
0
100
200
300
400
500
600
700
0
2
4
6
8
10
12
14
16
18
20


Actual data
y = 1.612270x^1.817075, R^2 = 0.691836

Test 2

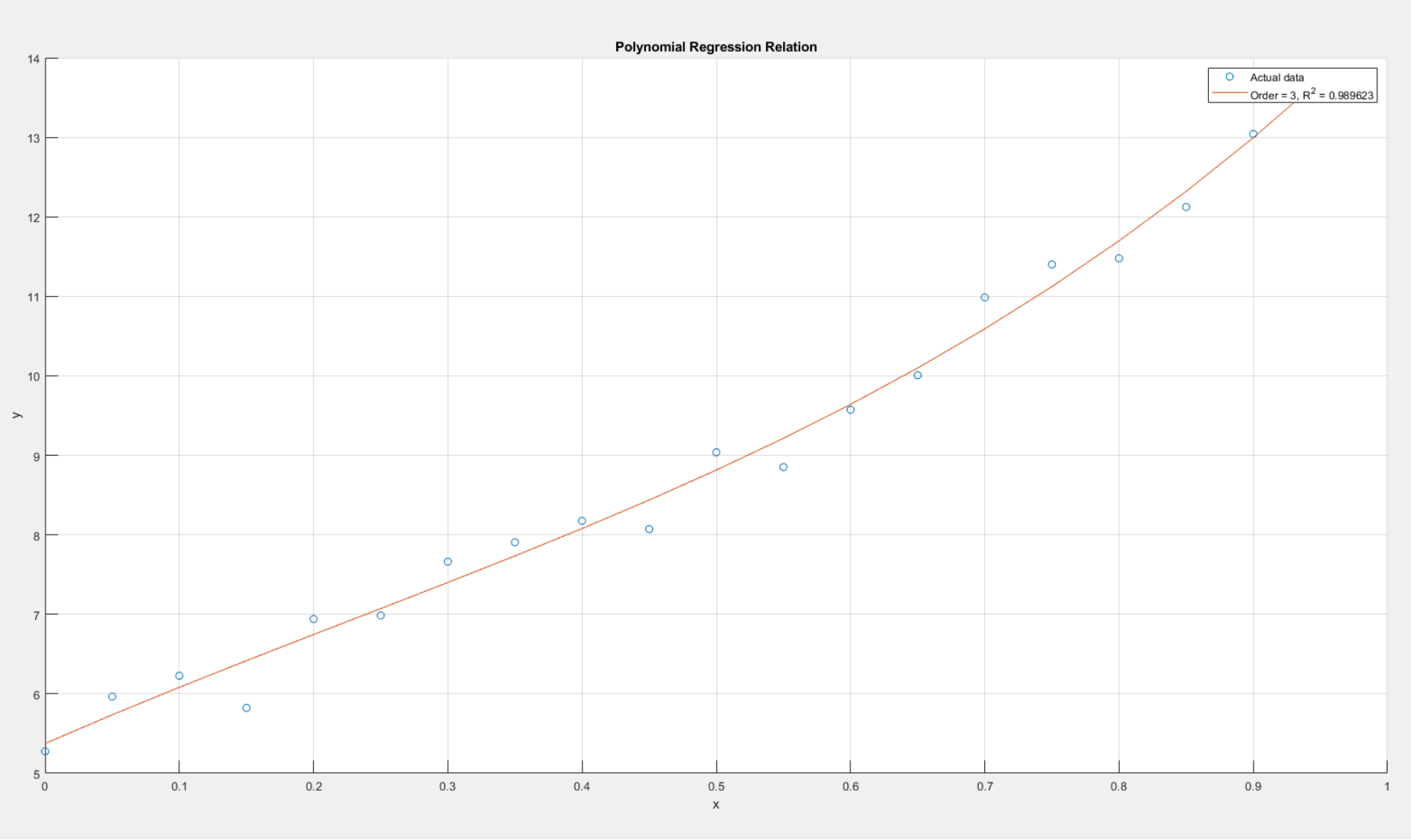
1) Linear

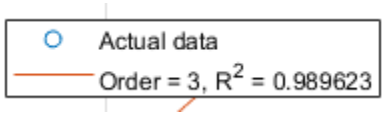




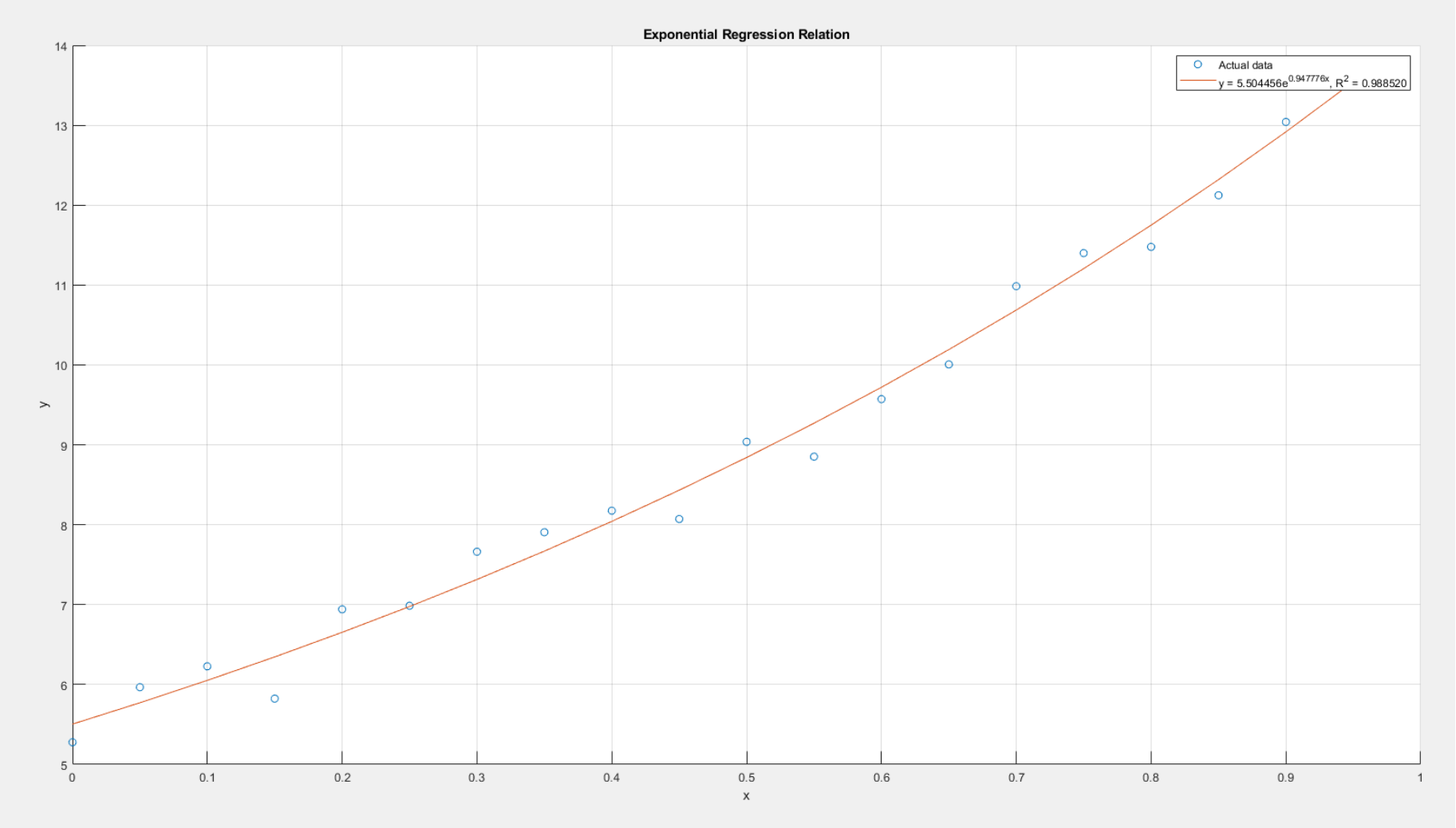
2) Polynomial

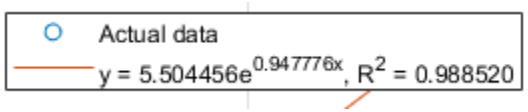
```
>> Question1
Select the function to fit your data:
1. Linear: y = a0 + a1x
2. Polynomial: y = a0 + a1x + ... + amx^m
3. Exponential: y = ae^(bx)
4. Power: y = ax^b
2
Determine the degree of the polynomial: 3
The coefficients are:
a0 = 5.375421
a1 = 7.391490
a2 = -3.803128
a3 = 5.551593
>>
```


Polynomial Regression Relation
Actual data
Order = 3, R^2 = 0.989623
y
x
14
13
12
11
10
9
8
7
6
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

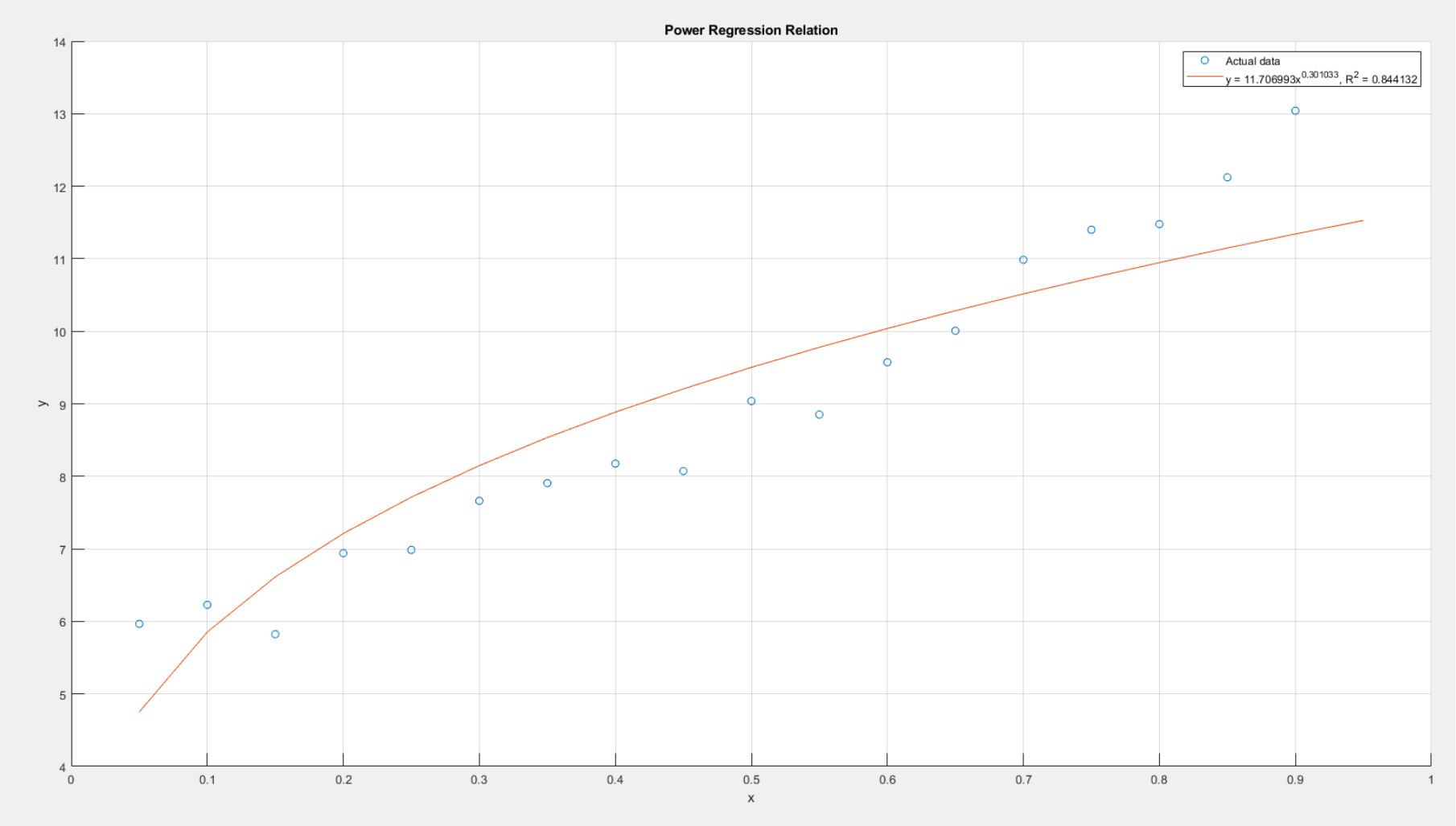

Actual data
Order = 3, R^2 = 0.989623

3) Exponential





4) Power



Actual data
y = 11.706993x^0.301033, R^2 = 0.844132

2)

Code

```
load N:\ECE_204\Lab4\test1.txt;
M = load('test1.txt');
rows1 = length(test1);
% load N:\ECE_204\Lab4\test2.txt;
% M = load('test2.txt');
% rows1 = length(test2);


x = M(:,1);
y = M(:,2);
format long;


% Linear regression
X1 = [ones(length(x),1) x];
b1 = X1\y;
yCalc = X1*b1;
l_a0 = b1(1,1);
l_a1 = b1(2,1);
Linear_Rsq = 1 - sum((y - yCalc).^2)/sum((y - mean(y)).^2);


% Polynomial
tol = 0.01;
normVal = Inf;
degree = 1;
old_Polynomial_Rsq = 0;
Polynomial_Rsq = 0;


while normVal>tol
    old_Polynomial_Rsq = Polynomial_Rsq;
    degree = degree + 1;
    A2 = zeros(degree+1, degree+1);
    Sol = zeros(degree+1, 1);
    for i=1:degree+1
        for j=1:degree+1
                A2(i, j) = sum(x.^(i+j-2));
```

```
        end
        Sol(i, 1) = sum((x.^(i-1)).*y);
    end

    coeff = A2\Sol;
    i = [0:degree];
    xpoly = x.^i;
    p_y2 = xpoly*coeff;
    St2 = sum((y - mean(y)).^2);
    Sr2 = sum((y-p_y2).^2);
    Polynomial_Rsq = 1-(Sr2/St2);

    normVal=Polynomial_Rsq-old_Polynomial_Rsq;
    %find the relative error between old and updated current values
end

degree = degree - 1;
A2 = zeros(degree+1, degree+1);
Sol = zeros(degree+1, 1);
for i=1:degree+1
        for j=1:degree+1
                A2(i, j) = sum(x.^(i+j-2));
        end
        Sol(i, 1) = sum((x.^(i-1)).*y);
end

coeff = A2\Sol;
i = [0:degree];
xpoly = x.^i;
p_y2 = xpoly*coeff;
St2 = sum((y - mean(y)).^2);
Sr2 = sum((y-p_y2).^2);
Polynomial_Rsq = 1-(Sr2/St2);

%Exponential Regression
Y3 = log(y);
X3 = [ones(length(x),1) x];
b3 = X3\Y3;
```

```
e_a0 = b3(1,1);
e_A = exp(e_a0);
e_a1 = b3(2,1);
e_y2 = e_A*exp(e_a1*x);
St3 = sum((y - mean(y)).^2);
Sr3 = sum((y-e_y2).^2);
Exp_Rsq = 1-(Sr3/St3);

%Power Regression
x = M(:,1);
num = find(~x);
x(num, :) = [];
y = M(:,2);
y(num, :) = [];
format long;
Y4 = log10(y);
X4 = log10(x);
new_X = [ones(length(X4),1) X4];
b4 = new_X\Y4;
pow_a0 = b4(1,1);
pow_A = 10^pow_a0;
pow_a1 = b4(2,1);
pow_A1 = pow_a1;
pow_y2 = pow_A*(x.^pow_A1);
St4 = sum((y - mean(y)).^2);
Sr4 = sum((y-pow_y2).^2);
Power_Rsq = 1-(Sr4/St4);

x = M(:,1);
y = M(:,2);
format long;

Max_matrix = [Linear_Rsq Polynomial_Rsq Exp_Rsq Power_Rsq];
max_Rsq = max(Max_matrix);
if max_Rsq==Linear_Rsq
    disp("The most efficient method is Linear Regression");
    scatter(x,y);
    hold on;
```

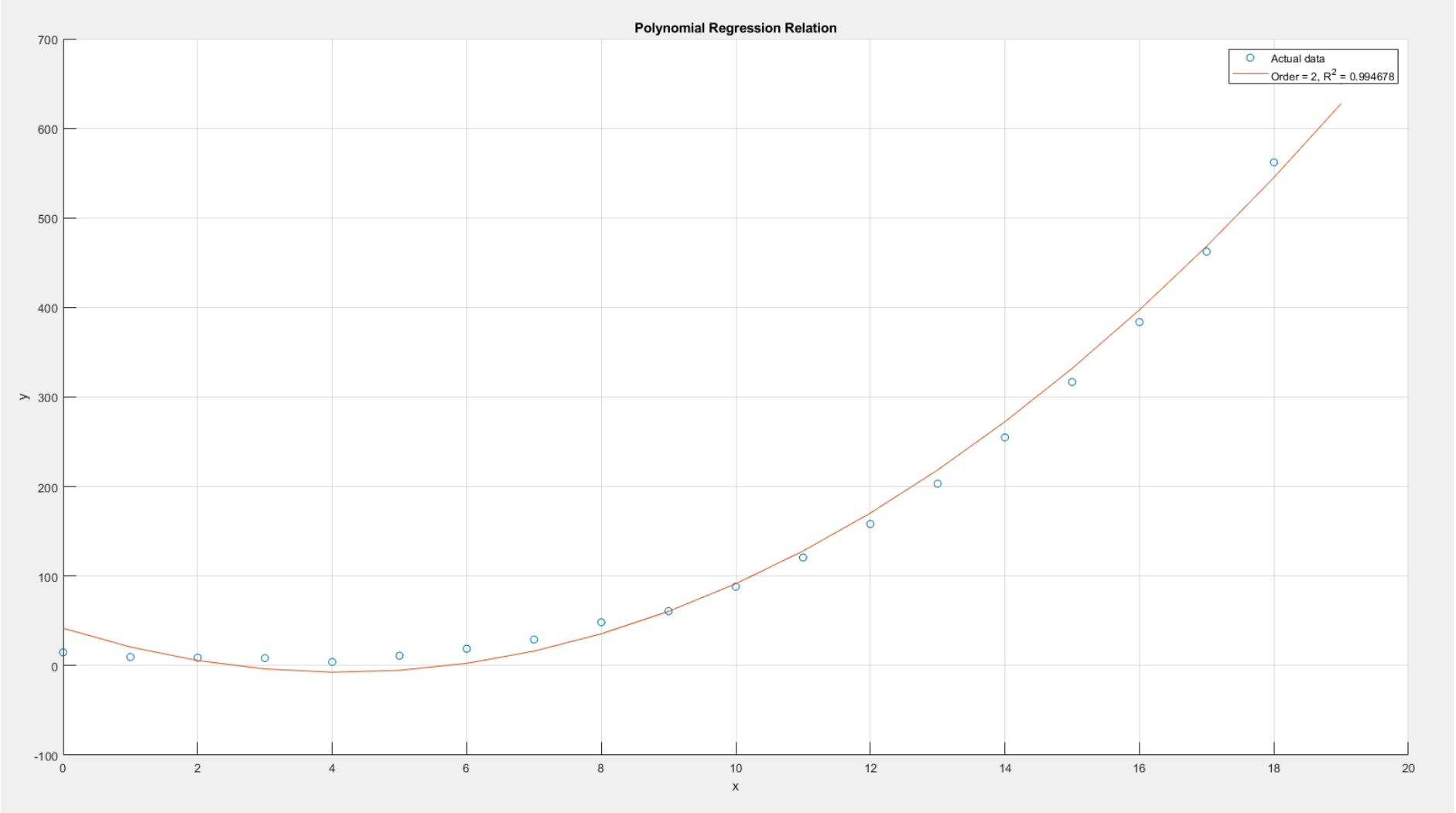
```
    plot(x,yCalc)
    xlabel('x');
    ylabel('y');
    title('Linear Regression Relation');
    grid on;
    string = sprintf('y = %f + %fx, R^2 = %f', l_a0, l_a1, Linear_Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
elseif max_Rsq==Polynomial_Rsq
    disp("The most efficient method is Polynomial Regression");
    scatter(x,y);
    hold on;
    xlabel('x');
    ylabel('y');
    title('Polynomial Regression Relation');
    plot(x(:, 1),p_y2(:,1));
    string = sprintf('Order = %d, R^2 = %f', degree, Polynomial_Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
    fprintf("The coefficients are:\n");
    for counter=1:degree+1
    fprintf("a%d = %f \n", counter-1, coeff(counter));
    end
elseif max_Rsq==Exp_Rsq
    disp("The most efficient method is Exponential Regression");
    scatter(x,y);
    hold on;
    xlabel('x');
    ylabel('y');
    title('Exponential Regression Relation');
    plot(x(:, 1),e_y2(:,1));
    string = sprintf('y = %fe^{%fx}, R^2 = %f', e_A, e_a1, Exp_Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
elseif max_Rsq==Power_Rsq
    disp("The most efficient method is Power Regression");
    scatter(x,y);
```

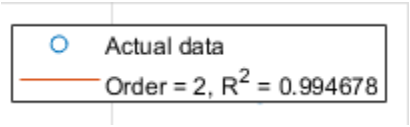
```
    hold on;
    xlabel('x');
    ylabel('y');
    title('Power Regression Relation');
    plot(x(:, 1),y2(:,1));
    string = sprintf('y = %fx^{%f}, R^2 = %f', pow_A, pow_A1, Power_Rsq);
    string2 = sprintf('Actual data');
    legend(string2, string);
    grid on;
end
```

Output

Test 1

```
>> Question2
The most efficient method is Polynomial Regression
The coefficients are:
a0 = 41.755283
a1 = -23.772134
a2 = 2.874437
>>
```


Polynomial Regression Relation
Actual data
Order = 2, R^2 = 0.994678
y
x
700
600
500
400
300
200
100
0
-100
0
2
4
6
8
10
12
14
16
18
20


Actual data
Order = 2, R^2 = 0.994678

Test 2

```
>> Question2
The most efficient method is Exponential Regression
>>
```