FACULTY OF ENGINEERING, ALEXANDRIA UNIVERSITY
ELECTRONICS AND COMMUNICATIONS ENGINEERING DEPARTMENT

Computational Mathematics

Project Report

Part II: Numerical Methods

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Contents

1 Matlab Code

- Taking the inputs from the user:

```
X=input('please enter the values of x: ');
Y=input('please enter the values of y: ');
z=menu('Enter your required model.:','A) the linear','B)
exponential','c) power','d) growth rate model');
```

- Choosing the model:

```
switch z
    case 1  %the linear
        x=X;
        y=Y;

    case 2  %exponential
        x=X;
        y=log(Y);

    case 3  %power
        x=log10(X);
        y=log10(Y);

    case 4  %growth rate model
        x=1./X;
        y=1./Y;
end
```

- To find a and b:

```
23 n=length(x);
24 sum_x=sum(x);
25 sum_y=sum(y);
26 sum_x2=sum(x.^2);
27 sum_xy=sum(x.*y);
28 y_y=sum_y./n;
29         % to find: a&b
30 eq1=[n sum_x; sum_x sum_x2];
31 eq2=[sum_y ;sum_xy];
32 A=linsolve(eq1,eq2);
33
34 switch z
35     case 1  %the linear
36         a=A(1)
37         b=A(2)
38
39     case 2  %exponential
40         a=exp(A(1))
41         b=A(2)
42
43     case 3  %power
44         a=10.^A(1)
45         b=A(2)
46
47     case 4  %growth rate model
48         a=1./A(1)
49         b=A(2)./A(1)
50 end
```

- To find the coefficient of determination (r^2):

```
st=sum((y-y_y).^2);
sr=sum((y-A(1)-x.*A(2)).^2);
coefficient_of_determination=(st-sr)./st
```

- The Linear Model:

```
x_1=X;
y_1=Y;
sum_x_1=sum(x_1);
sum_y_1=sum(y_1);
sum_x2_1=sum(x_1.^2);
sum_xy_1=sum(x_1.*y_1);
eq1_1=[n sum_x_1; sum_x_1 sum_x2_1];
eq2_1=[sum_y_1 ;sum_xy_1];
A_1=linsolve(eq1_1,eq2_1);
a_1=A_1(1);
b_1=A_1(2);
y_y=sum_y_1./n;
st_1=sum((y_1-y_y).^2);
sr_1=sum((y_1-A_1(1)-x_1.*A_1(2)).^2);
r2_1=(st_1-sr_1)./st_1;
Y1=a_1+b_1.*X;
figure;
subplot(2,2,1)
 plot(X,Y,'o');
 hold on;
 plot(X,Y1,'-');
 hold off;
 xlabel('x');
 ylabel('y');
 title('Linear modle');
```

- The Exponential Model:

```
x_2=X;
y_2=log(Y);
sum_x_2=sum(x_2);
sum_y_2=sum(y_2);
sum_x2_2=sum(x_2.^2);
sum_xy_2=sum(x_2.*y_2);
eq1_2=[n sum_x_2; sum_x_2 sum_x2_2];
eq2_2=[sum_y_2 ;sum_xy_2];
A_2=linsolve(eq1_2,eq2_2);
a_2=exp(A_2(1));
b_2=A_2(2);
y_y=sum_y_2./n;
st_2=sum((y_2-y_y).^2);
sr_2=sum((y_2-A_2(1)-x_2.*A_2(2)).^2);
r2_2=(st_2-sr_2)./st_2;
Y2=a_2.*exp(b_2.*X);
subplot(2,2,2)
 plot(X,Y,'o');
 hold on;
 plot(X,Y2,'-');
 hold off;
 xlabel('x');
 ylabel('y');
 title('exponential modle');
```

- The Power Model:

```
x_3=log10(X);
y_3=log10(Y);
sum_x_3=sum(x_3);
sum_y_3=sum(y_3);
sum_x2_3=sum(x_3.^2);
sum_xy_3=sum(x_3.*y_3);
eq1_3=[n sum_x_3; sum_x_3 sum_x2_3];
eq2_3=[sum_y_3 ;sum_xy_3];
A_3=linsolve(eq1_3,eq2_3);
a_3=10.^A_3(1);
b_3=A_3(2);
y_y=sum_y_3./n;
st_3=sum((y_3-y_y).^2);
sr_3=sum((y_3-A_3(1)-x_3.*A_3(2)).^2);
r2_3=(st_3-sr_3)./st_3;
Y3=a_3.*(X).^b_3;
subplot(2,2,3)
 plot(X,Y,'o');
 hold on;
 plot(X,Y3,'-');
 hold off;
 xlabel('x');
 ylabel('y');
 title('power modle');
```

- The Growth Rate Model:

```
137 x_4=1./X;
138 y_4=1./Y;
139 sum_x_4=sum(x_4);
140 sum_y_4=sum(y_4);
141 sum_x2_4=sum(x_4.^2);
142 sum_xy_4=sum(x_4.*y_4);
143 eq1_4=[n sum_x_4; sum_x_4 sum_x2_4];
144 eq2_4=[sum_y_4 ;sum_xy_4];
145 A_4=linsolve(eq1_4,eq2_4);
146 a_4=1./A_4(1);
147 b_4=A_4(2)./A_4(1);
148 y_y=sum_y_4./n;
149 st_4=sum((y_4-y_y).^2);
150 sr_4=sum((y_4-A_4(1)-x_4.*A_4(2)).^2);
151 r2_4=(st_4-sr_4)./st_4;
152 Y4=(a_4.*X)./(b_4+X);
153 subplot(2,2,4)
154 plot(X,Y,'o');
155 hold on;
156 plot(X,Y4,'-');
157 hold off;
158 xlabel('x');
159 ylabel('y');
160 title('growth rate model');
```

- Choosing which model best fits the data:

```
r2=[r2_1 r2_2 r2_3 r2_4];
r2_of_four_models=[r2_1 r2_2 r2_3 r2_4]
TBM=0;
index=0;
for i=1:4
    if TBM <= r2(i)
        TBM=r2(i);
        index=i;
    else
        TBM=TBM;
        index=index;
    end
end
fprintf('The highest correlation coeffecient is %d ', TBM);
fprintf('and its index is %d\n', index);
```

2 Test Cases

■ Test Case 1: Linear Model

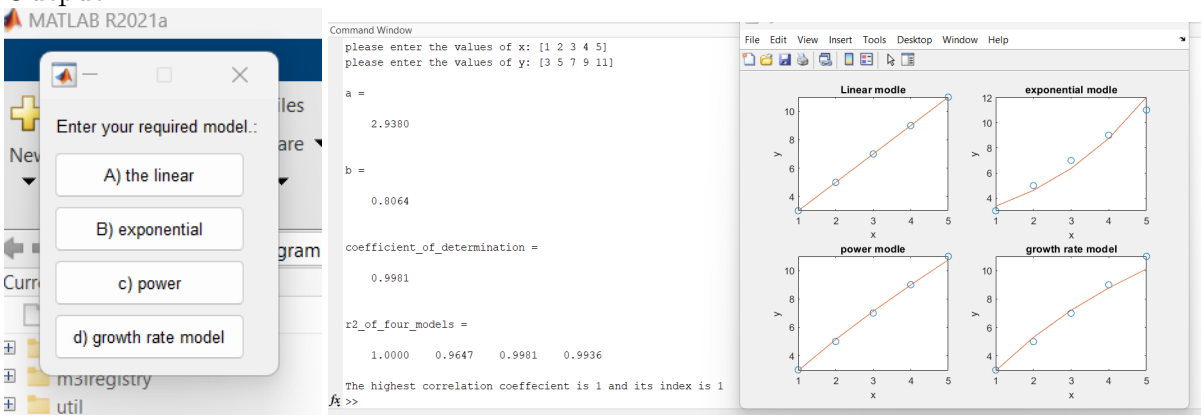
- Input

  x = [1, 2, 3, 4, 5]

  y = [2, 4, 6, 8, 10]

  z = c

- Output



■ Test Case 2: Exponential Model

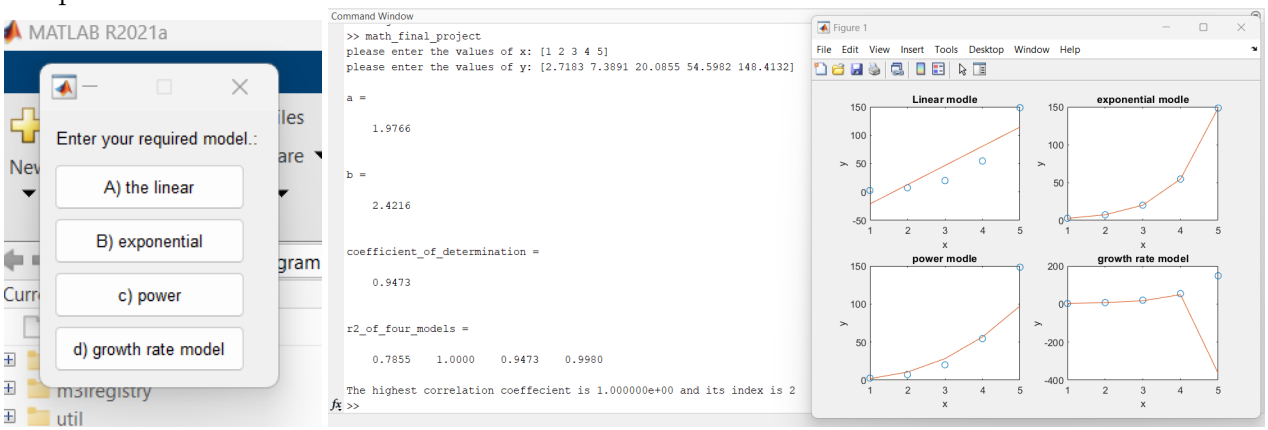
- Input

  x = [1, 2, 3, 4, 5]

  y = [2.7183, 7.3891, 20.0855, 54.5982, 148.4132]

  z = c

- Output



■ Test Case 3: Power Model

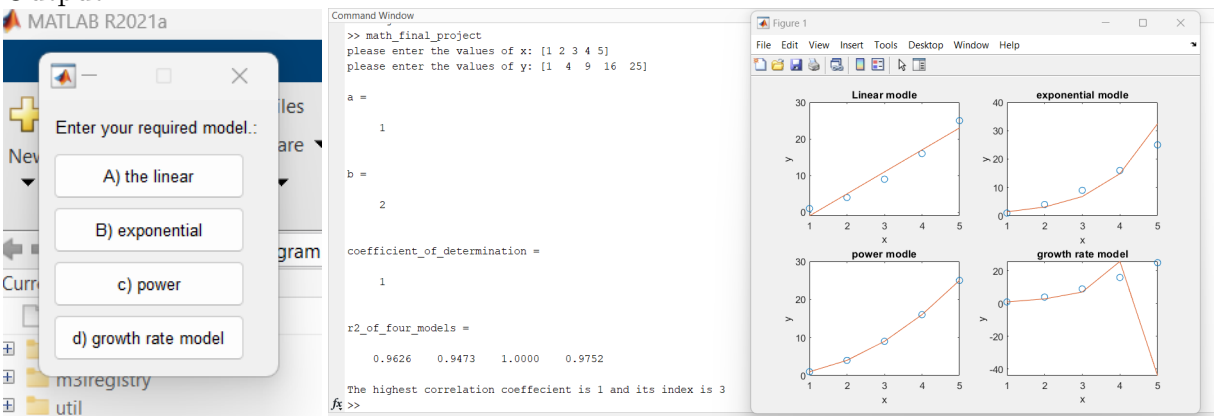
- Input

  x = [1, 2, 3, 4, 5]

  y = [1, 4, 9, 16, 25]

  z = c

- Output



■ Test Case 4: Growth Rate Model

- Input

  x = [1, 2, 3, 4, 5]

  y = [100, 200, 400, 800, 1600]

  z = B

- Output