Contents

CS375 HW12

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```
clear all;
clc;
close all;
```

Problem 2c

```
A= [1 -1;2 3];
b=[1;1];

qr_solve(A,b)
```
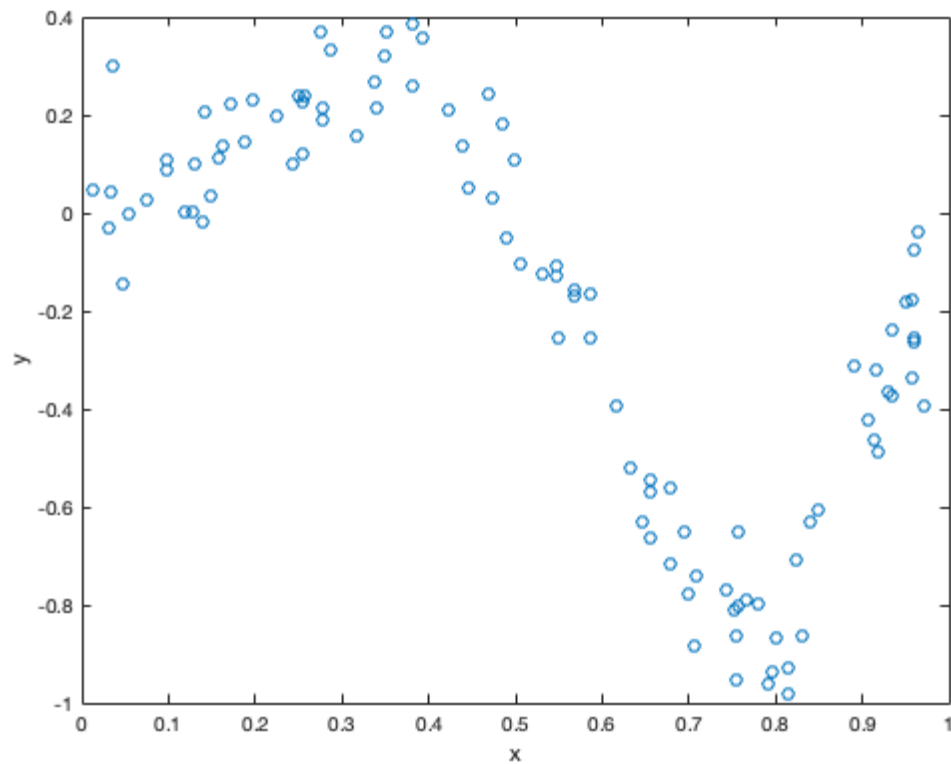
```
ans =

    0.8000
   -0.2000
```

Problem 3a

```
N=100;

[x,y] = generate_ls_data(N);

figure();
plot(x,y,'o');
xlabel('x');
ylabel('y');
```

Problem 3b

```matlab
% A'Ax=A'b

V=Vandermonde(x);

AtA=V'*V;
AtB=V'*y;
c=AtA\AtB;

coefficients = c;
coefficients=rot90(coefficients);
coefficients=rot90(coefficients);

xfine = linspace(0,1,1000);
yfine = polyval(coefficients,xfine);

figure();
plot(x,y,'o');
hold on
plot(xfine,yfine);
xlabel('x');
ylabel('y');

fprintf("the coefficients are: \n")
coefficients
```
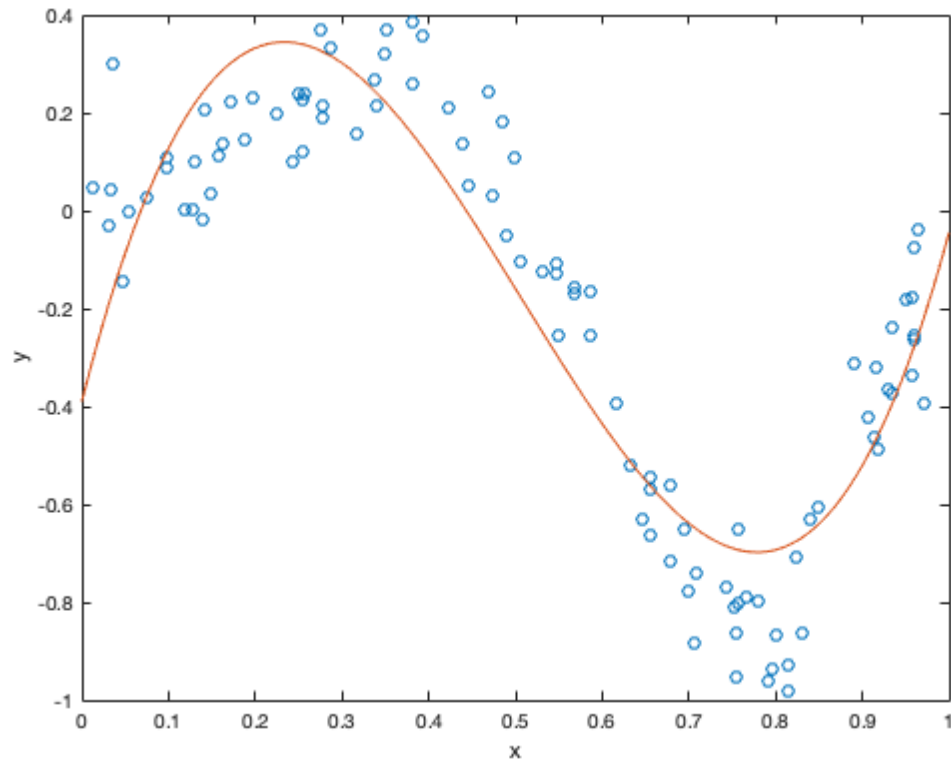
the coefficients are:

coefficients =

```
   12.8410
  -19.4916
    6.9961
   -0.3899
```


Problem 3c

```matlab
b=y;
c2=qr_solve(V,b);

coefficients2 = c2(1:4);
coefficients2=rot90(coefficients2);
coefficients2=rot90(coefficients2);

xfine = linspace(0,1,1000);
yfine = polyval(coefficients2,xfine);

figure();
plot(x,y,'o');
hold on
plot(xfine,yfine);
xlabel('x');
ylabel('y');

fprintf("the coefficients are: \n")
coefficients2
```
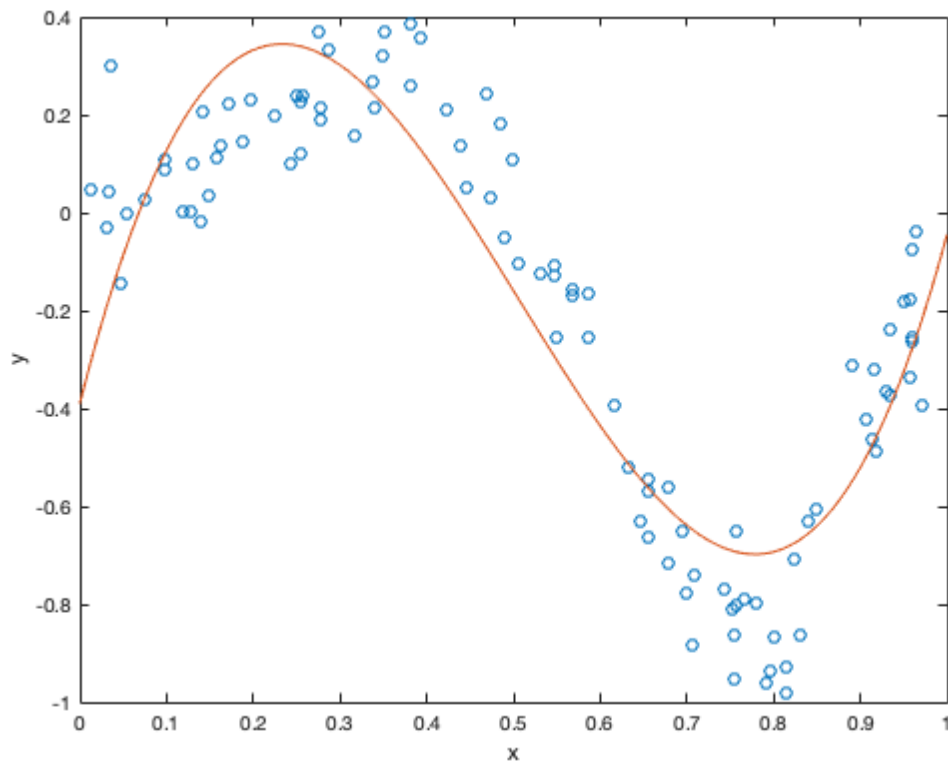
the coefficients are:

coefficients2 =

```
   12.8410
  -19.4916
    6.9961
   -0.3899
```


Problem 3d

```
A=V;

[U,S,V] = svd(A);
sigma=inv(S(1:4,1:4));
c3=zeros(4,1);

Ut=U';

for i=1:4
    c3(i)=sum((sigma(i,i)*Ut(i,i).*b)*V(i,i));
end


coefficients3 = c3(1:4);
coefficients3=rot90(coefficients3);
coefficients3=rot90(coefficients3);


xfine = linspace(0,1,1000);
```

```
yfine = polyval(coefficients3,xfine);

figure();
plot(x,y,'o');
hold on
plot(xfine,yfine);
xlabel('x');
ylabel('y');

fprintf("the coefficients are: \n")
coefficients3
```
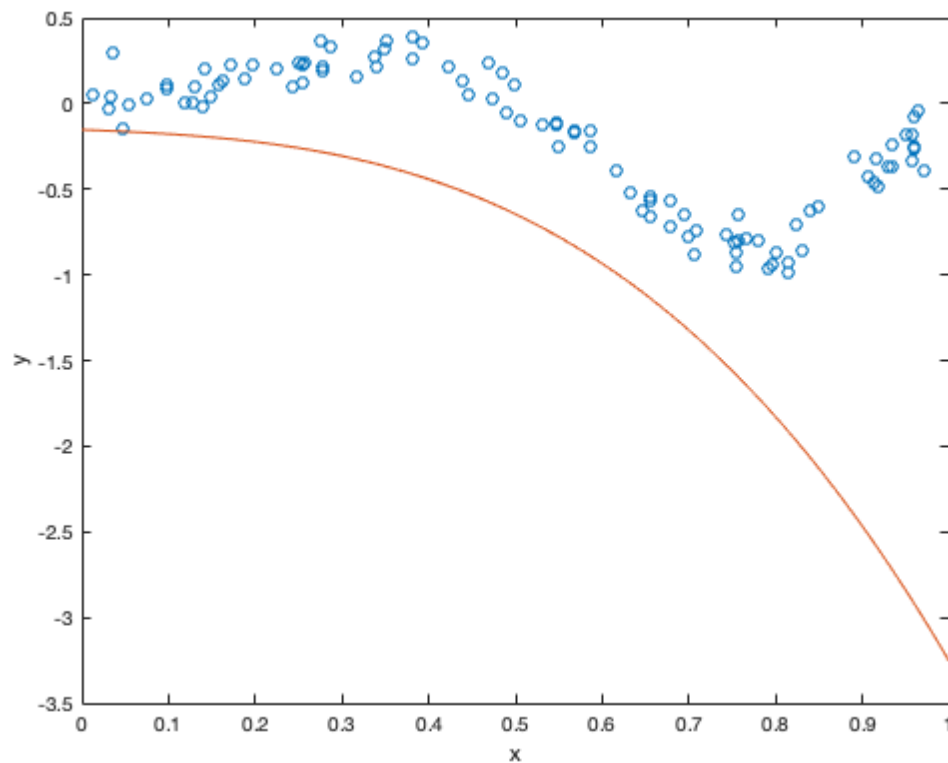
```
the coefficients are:

coefficients3 =

    -2.6596
    -0.2422
    -0.2000
    -0.1527
```


Problem 4c

```
f=@(u,t) -u^2 - 2*sin(2*t) + (cos(2*t))^2;

a=0;
b=1;
u0=1;
```

```
n = [10, 20, 40, 80];
error=zeros(length(n),1);
valAt1=zeros(length(n),1);
h = (b-a)./n;

p=zeros(length(n),1);

for i=1:length(n)
    y=euler(n(i),a,b,u0,f);
    valAt1(i)=y(end);
    error(i)=abs(cos(2*1)-valAt1(i));
    if(i>1)
        p(i)=log(error(i)/error(i-1))/log(h(i)/h(i-1));
    end
end

fprintf("h\t\t approximation t=1\t error\t\t order of convergence p\n");
fprintf("%1.6f\t %1.6f\t\t %1.10f\t %2.3f\n",[h ;valAt1'; error'; p'])
```

```
h                  approximation t=1      error              order of convergence p
0.100000           -0.166287              0.2498599583       0.000
0.050000           -0.293181              0.1229661619       1.023
0.025000           -0.355195              0.0609516664       1.013
0.012500           -0.385809              0.0303381381       1.007
```