Contents


```
clc
format shortG
```

Part 1: first data set

data is given by an mx2 matrix with x-values in column 1 and y-values in column 2

```
data1=[ 1 8 ; 2 6 ; 4 5 ; 5 7 ; 8 16 ];
% extracts the x-values in column 1
x=data1(:,1);
% extracts the y-values in column 2
y=data1(:,2);
```

first model: linear y=a0+a1*x

constructs the design matrix which is the coefficient matrix of the system Ax=b obtained from plugging in data points into the model

```
A=[1 x(1) ;
   1 x(2) ;
   1 x(3) ;
   1 x(4) ;
   1 x(5) ]
% b vector is just the y-values
b=y;
% gets xhat least squares solution using fact that A has linearly
% independent columns so A^T*A is invertible - note A' is MATLAB transpose
xhat=inv(A'*A)*A'*b;
% extracts alpha and beta values from the xhat vector
a0=xhat(1);
a1=xhat(2);
% defines the function for plotting
% WARNING: you must use .* for 'times' and .^ for 'exponent' or else
% MATLAB will give an error code
f1=@(x) a0+a1.*x;
```

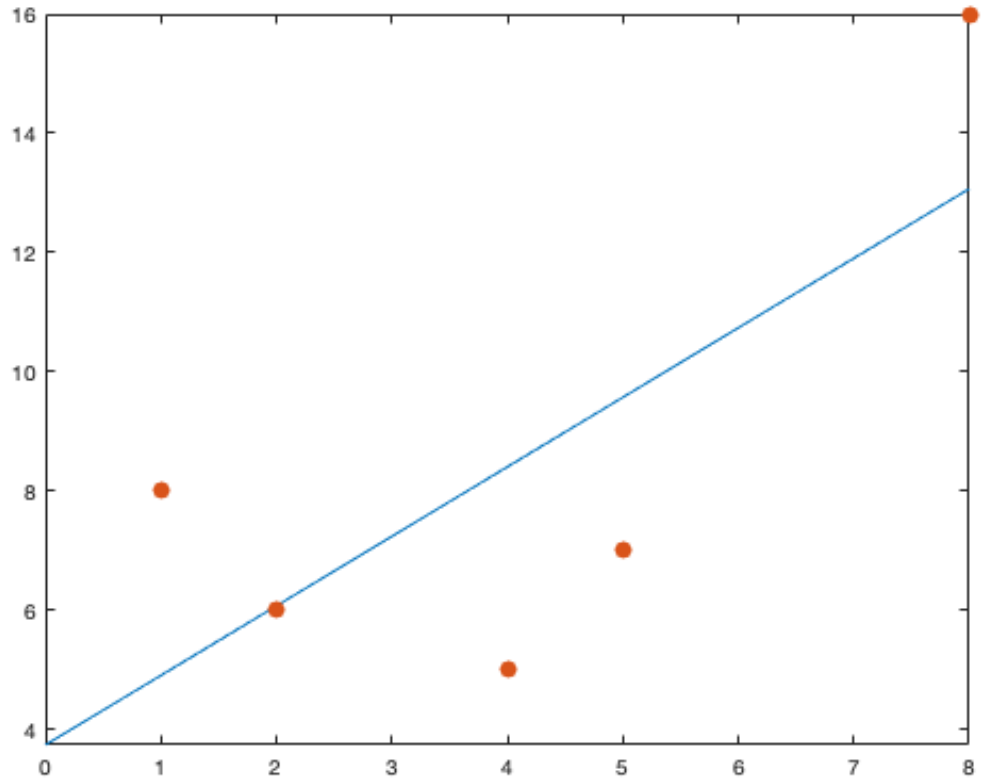
```
% compute the least squares error ||A*xhat-b||
errorLine=sqrt((A*xhat-b)'*(A*xhat-b))
% draws figure
figure(1)
fplot(f1,[0 8])
hold on
plot(x,y,'.','markersize',28)
hold off
```

```
A =

     1     1
     1     2
     1     4
     1     5
     1     8


errorLine =

    6.0305
```



second model: full quadratic y=a0+a1*x+a2*x^2

[STUDENT FILL IN:] student should construct the design matrix which is the coefficient matrix of the system Ax=b obtained from plugging in data points into the model

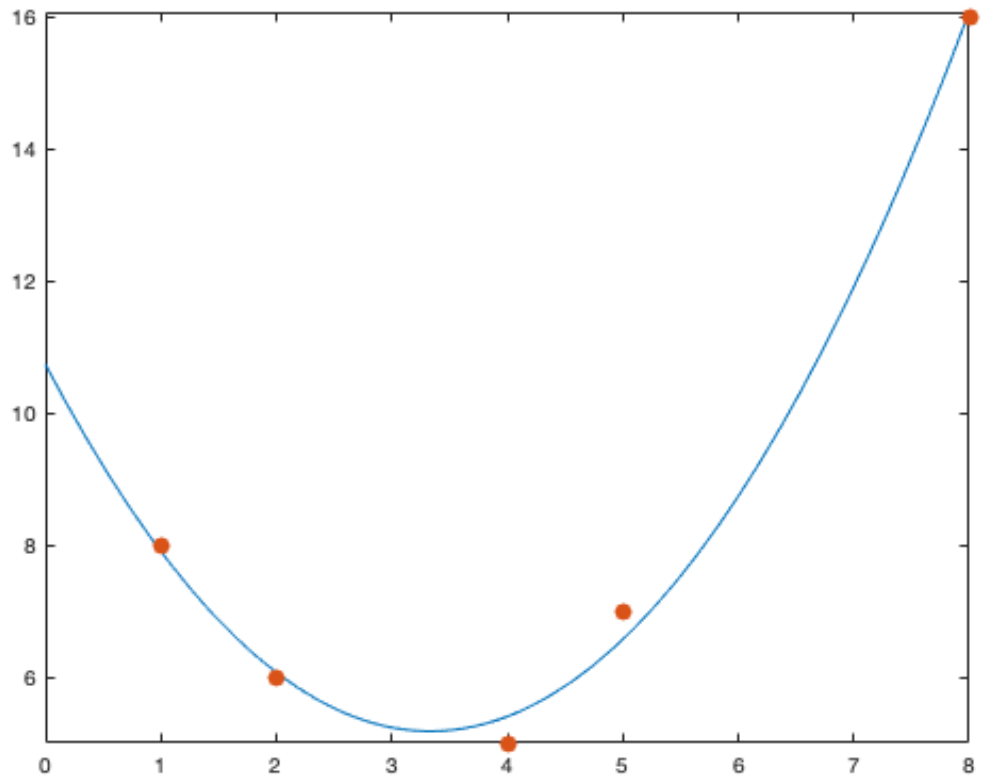
```
A=[1 x(1) x(1)^2 ;
   1 x(2) x(2)^2 ;
   1 x(3) x(3)^2 ;
   1 x(4) x(4)^2 ;
   1 x(5) x(5)^2 ]
% copy-pasted/modified code from part 1
b=y;
xhat=inv(A'*A)*A'*b;
a0=xhat(1);
a1=xhat(2);
a2=xhat(3);
% defines the function for plotting
% WARNING: you must use .* for 'times' and .^ for 'exponent' or else
% MATLAB will give an error code
f2=@(x) a0+a1.*x+a2.*x.^2;
% least squares error ||A*xhat-b||
errorQuad=sqrt((A*xhat-b)'*(A*xhat-b))
% draws figure
figure(2)
fplot(f2,[0 8])
hold on
plot(x,y,'.','markersize',28)
hold off
```

```
A =

     1     1     1
     1     2     4
     1     4    16
     1     5    25
     1     8    64


errorQuad =

      0.60553
```



third model: [STUDENT FILL IN:] linear+cosine y=a0*x+a1*cos(x)

[STUDENT FILL IN:] student shout construct the design matrix which is the coefficient matrix of the system Ax=b obtained from plugging in data points into the model

```
A=[ x(1) cos(x(1)) ;
    x(2) cos(x(2)) ;
    x(3) cos(x(3)) ;
    x(4) cos(x(4)) ;
    x(5) cos(x(5)) ]
b=y;
xhat=inv(A'*A)*A'*b;
% [STUDENT FILL IN:] you may need to add/delete variables depending on how
% many terms your model has
a0=xhat(1);
a1=xhat(2);
% [STUDENT FILL IN:] define the function for plotting
% WARNING: you must use .* for 'times' and .^ for 'exponent' or else
% MATLAB will give an error code
f3=@(x) a0.*x+a1.*cos(x) ;
% least squares error is ||A*xhat-b||
errorStudentModelforData1=sqrt((A*xhat-b)'*(A*xhat-b))
% draws figure
figure(3)
fplot(f3,[0 8])
```

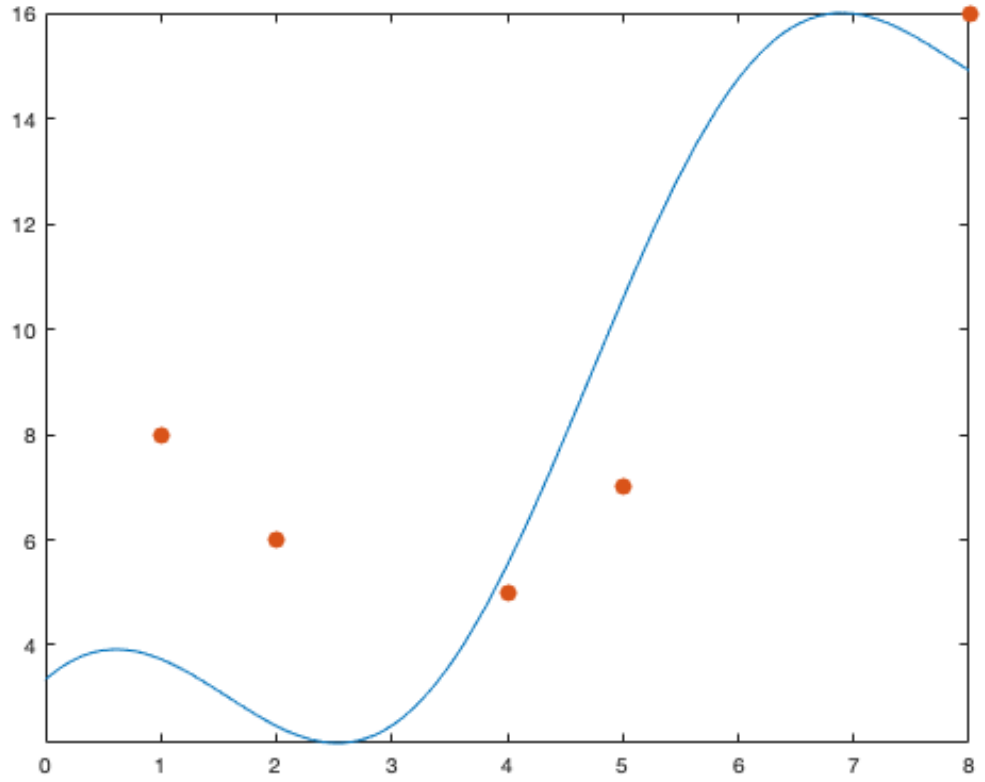
```
hold on
plot(x,y,'.','markersize',28)
hold off
```

```
A =

     1       0.5403
     2     -0.41615
     4     -0.65364
     5      0.28366
     8      -0.1455


errorStudentModelforData1 =

    6.7064
```



answer questions: [STUDENT FILL IN:] answer questions as comments

Q1: which model has the best error (smallest error value)? Ans1: Q2: what does the value of the error `|A*hat-b|` represent geometrically? Ans2:

Part 2: student created data set must have at least 6 data points

[STUDENT FILL IN:] create a data2 matrix where the data is given by an mx2 matrix with m>5 (at least 6 data points) with x-values in column 1 and y-values in column 2

```
data2=[ 1 1 ; 2 3 ; 4 5 ; 6 7 ; 7 10 ; 8 12 ];
% extracts the x-values in column 1
x=data2(:,1);
% extracts the y-values in column 2
y=data2(:,2);
```

fourth model: [STUDENT FILL IN:] log+exponential y=a0*log(x)+a1*exp(x)

[STUDENT FILL IN:] student should construct the design matrix which is the coefficient matrix of the system Ax=b obtained from plugging in data points into the model NOTE: do ***not*** use any of the previous models 1 through 3

```
A=[ log(x(1)) exp(x(1)) ;
    log(x(2)) exp(x(2)) ;
    log(x(3)) exp(x(3)) ;
    log(x(4)) exp(x(4)) ;
    log(x(5)) exp(x(5)) ;
    log(x(6)) exp(x(6)) ]
b=y;
xhat=inv(A'*A)*A'*b;
% [STUDENT FILL IN:] you may need to add/delete variables depending on how
% many terms your model has
a0=xhat(1);
a1=xhat(2);
% [STUDENT FILL IN:] define the function for plotting
% WARNING: you must use .* for 'times' and .^ for 'exponent' or else
% MATLAB will give an error code
f4=@(x) a0.*log(x)+a1.*exp(x) ;
% least squares error is ||A*xhat-b||
errorStudentModelforData2=sqrt((A*xhat-b)'*(A*xhat-b))
% draws figure
% [STUDENT FILL IN:] You may need to modify the range of the fplot second
% argument [0 8] if your x-values go outside the range 0 <= x <= 8
figure(4)
fplot(f4,[0 8])
hold on
plot(x,y,'.','markersize',28)
hold off
```

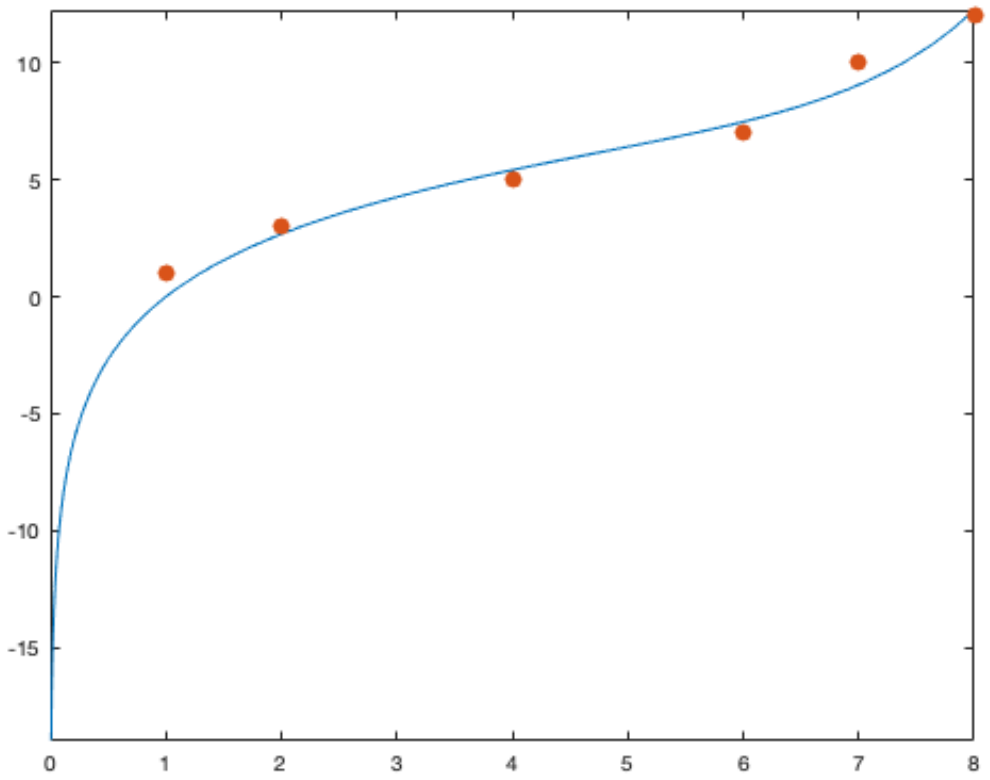
```
A =

         0       2.7183
   0.69315       7.3891
    1.3863       54.598
    1.7918       403.43
```

```
    1.9459       1096.6
    2.0794         2981
```

```
errorStudentModelforData2 =

    1.5649
```



Published with MATLAB® R2021a