Basic operations

- **Logical Operation**

```
% equal '=='
1 == 2   % false
ans = 0
% not equal '~='
1 ~= 2   % true
ans = 1
% AND
1 && 0
ans = 0
% OR
1 || 0
ans = 1
xor(1, 0)  %XOR
ans = 1
```

- **Cryptical function (to simple prompt)**

```
octave:34> PS1('>> ');   % prompt sign changed to '>> '
>> a = 3
a = 3
>> a = 3;  % semicolon supressing output
>> disp(pi)   % show result without 'ans ='
 3.1416
```

- **miscellaneous**

```
>> b = 'hi';  % string
>> b
b = hi
>> pi    % pi
ans =  3.1416
>> disp(sprintf('2 decimals: %0.2f', pi))  % print string with float up
2 decimals: 3.14
```

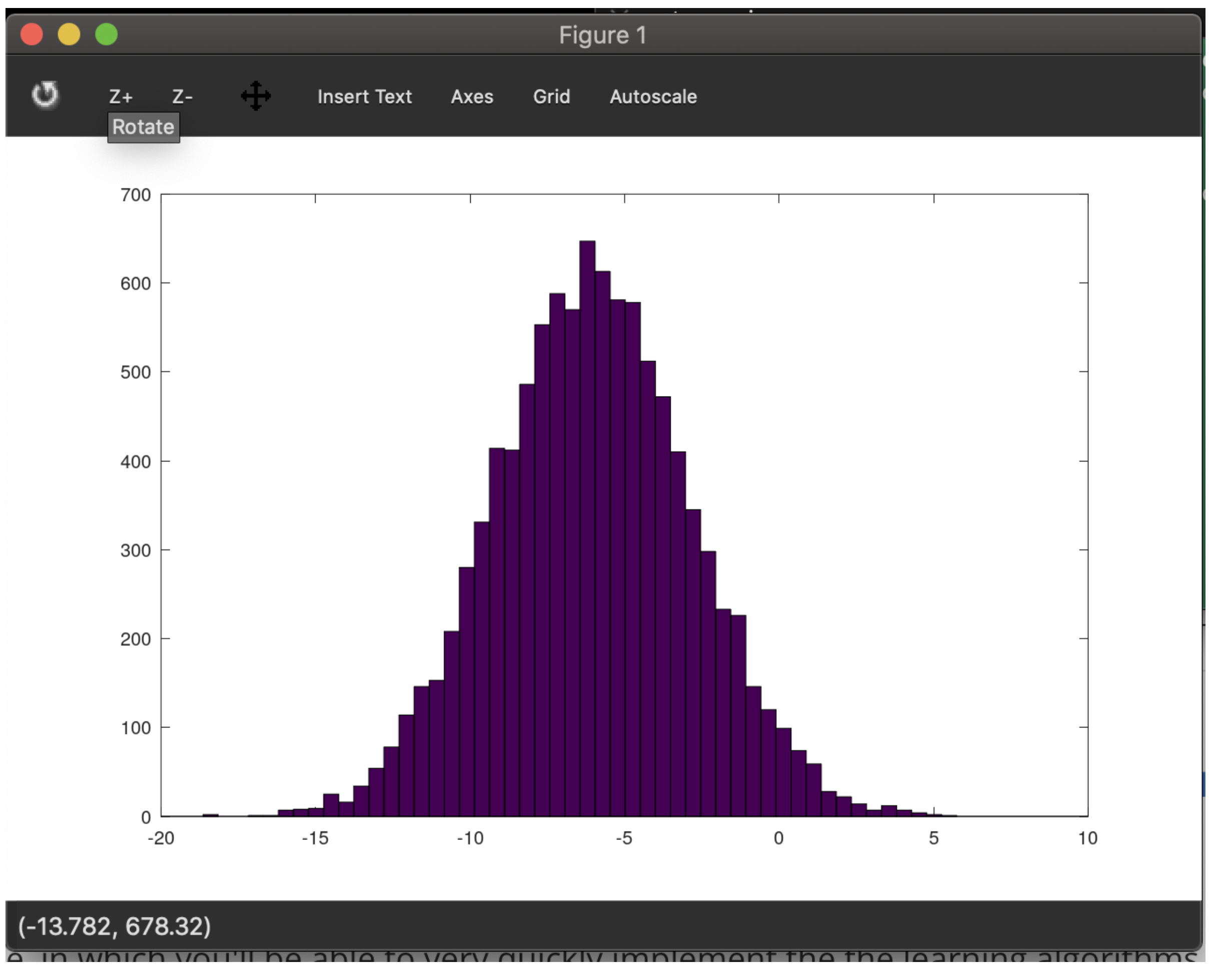
- **format**

```
>> format long
>> pi
ans =  3.141592653589793
>> format short
>> pi
ans =  3.1416
>> v = 1:0.1:2 % start from 1 to 2 increasing by 0.1
v =

    1.0000    1.1000    1.2000    1.3000    1.4000    1.5000    1.6000
```

Matrix

- **Matrix 1**

```
>> A = [ 1 2; 3 4; 5 6]
A =

   1   2
   3   4
   5   6

>> A = [1 2;
> 3 4;
> 5 6]
A =

   1   2
   3   4
   5   6

v = [1 2 3]   % a row vector
v =

 1   2   3

>> v = [1; 2; 3]  % a column vector
v =

   1
   2
   3

>> ones(2, 3)   % ones
ans =

   1   1   1
   1   1   1

 >> C = 2*ones(2,3)
C =

   2   2   2
   2   2   2

>> w = rand(1,3)    %  random matrix with uniform distribution between 0
w =

   0.115363   0.057313   0.849492

>> w = randn(1,3)   % random variables with Gaussian or normal distribut
w =

   1.43068   1.23386  -0.21462

w = -6 + sqrt(10)*(randn(1, 10000));
hist(w) % histogram of w with 50 bins. result is below.
```



- e in which you'll be able to very quickly implement the the learning algorithms

- Matrix 2

```
>> eye(4)       % identity matrix
ans =

Diagonal Matrix

   1   0   0   0
   0   1   0   0
   0   0   1   0
   0   0   0   1

help eye    % you can see explanation of the funcion after help keyword
```

Moving Data Around

- **Size and Length**

```
>> A = [ 1 2; 3 4; 5 6]
A =

   1   2
   3   4
   5   6

>> size(A)
ans =

   3   2

>> sz = size(A)
sz =

   3   2
```

- **Size and Length**

```
>> sz
sz =

   3   2

>> size(sz)
ans =

   1   2



>> size(A, 1) % select the size of dimention
ans =  3
>> size(A, 2)
ans =  2

>> v = [1 2 3 4]
v =

   1   2   3   4

>> length(v)
ans =  4
>> length(A)
ans =  3
>> B = [1 2 3; 4 5 6]
B =

   1   2   3
   4   5   6

>> length(B) % length produces the larger dimention size.
ans =  3
```

- **Linux commands**

```
>> pwd    % location
ans = /Users/chayesol
>> cd Desktop    % change the directory
>> pwd
ans = /Users/chayesol/Desktop
>> ls          % list files
Blog                                                Study
Data_Crew                                           git-other
Guideline_of_ML_pipeline.pptx                       git_exer
Hobbies                                             just
```

- **Variable check(who, whos) and remove.**

```
>> who          % show current variables
Variables in the current scope:

A    B    ans   sz   v    w

>> whos       % with more information
Variables in the current scope:

   Attr Name        Size                     Bytes  Class
   ==== ====        ====                     =====  =====
        A           3x2                         48  double
        B           2x3                         48  double
        ans         1x23                        23  char
        sz          1x2                         16  double
        v           1x4                         32  double
        w           1x10000                  80000  double

Total is 10041 elements using 80167 bytes

>> clear A        % remove certain variable
>> who
Variables in the current scope:

B    ans   sz   v    w

>> clear v w
>> who
Variables in the current scope:

B    ans   sz

>> clear      % clear all variables
>> who
>> whos
```

- **Load and save data**

```
>> v = [1 2 3 4]
v =
   1   2   3   4

>> save hello.mat    % you can save it as .txt file. It works identicall
>> clear v
>> who
>> load hello.mat
>> v
v =
   1   2   3   4

>> who
Variables in the current scope:

v
```

- **Selct elements**

```
>> A = [1 2; 3 4; 5 6]
A =

   1   2
   3   4
   5   6

>> A(3, 2)
ans =  6
>> A(2, :)
ans =

   3   4

>> A(2, :)  % ":" means every elements along that row/column
ans =

   3   4

>> A([1 3], :)    % select first and third row and all columns
ans =

   1   2
   5   6

>> A(:, 2) = [10; 11; 12]
A =

    1   10
    3   11
    5   12

>> A = [A, [100; 101; 102]];   % put elements to the right
>> A
A =

     1    10    100
     3    11    101
     5    12    102

>> A(:)    % put all elements of A into a single vector
ans =

     1
     3
     5
    10
    11
    12
   100
   101
   102
```

- **Concatenation**

```
>> A = [1 2; 3 4; 5 6];
>> B = [11 12; 13 14; 15 16]
B =

   11    12
   13    14
   15    16

>> C = [A B]
C =

     1     2    11    12
     3     4    13    14
     5     6    15    16

>> C = [A; B]
C =

     1     2
     3     4
     5     6
    11    12
    13    14
    15    16

>> size(C)
ans =

   6   2

>> [A B]
ans =

     1     2    11    12
     3     4    13    14
     5     6    15    16

>> [A, B]
ans =

     1     2    11    12
     3     4    13    14
     5     6    15    16
```

Computing on Data

- **Element-wise operations**

```
>> A
A =

   1   2
   3   4
   5   6

>> B
B =

   11   12
   13   14
   15   16

>> C = [1 1; 2 2]
C =

   1   1
   2   2

>> A*C
ans =

    5    5
   11   11
   17   17

>> A .* B
ans =

   11   24
   39   56
   75   96

>> A .* B      % '.' is element-wise function
ans =

   11   24
   39   56
   75   96
```

- **Element-wise operations**

```
>> A
A =

   1   2
   3   4
   5   6

>> A .^ 2
ans =

    1    4
    9   16
   25   36

>> 1 ./ A
ans =

   1.00000   0.50000
   0.33333   0.25000
   0.20000   0.16667

>> v = [1; 2; 3]
v =

   1
   2
   3

>> v + ones(length(v),1)
ans =

   2
   3
   4

>> v + 1
ans =

   2
   3
   4
```

- **log, exp, abs**

```
>> log(v)
ans =

   0.00000
   0.69315
   1.09861

>> exp(v)
ans =

    2.7183
    7.3891
   20.0855

>> v = [-1; -2; 3]
v =

  -1
  -2
   3

>> abs(v)
ans =

   1
   2
   3
```

- **Transpose**

```
>> A
A =

   1   2
   3   4
   5   6

>> A'
ans =

   1   3   5
   2   4   6

>> A'     % Transpose
ans =

   1   3   5
   2   4   6

>> (A')'
ans =

   1   2
   3   4
   5   6
```

- **Logical function with matrix**

```
>> a = [1 15 2 0.5]
a =

    1.00000   15.00000    2.00000    0.50000

>> val = max(a)
val =  15
>> [val, ind] = max(a)  % if a is a matrix, use "max(a, [], 2)"
val =  15
ind =  2
>> max(A)      % max row
ans =

   5   6

>> a < 3
ans =

  1  0  1  1

>> a < 3     % element-wise comparison
ans =

  1  0  1  1

>> find(a < 3)
ans =

   1   3   4

>> A = magic(3)     % it produces every sum of direction equals to 10 ma
A =

   8   1   6
   3   5   7
   4   9   2

>> [r, c] = find(A >= 7)    % results in rows and columns sets.
r =

   1
   3
   2

c =

   1
   2
   3    % it means A(1, 1)=8, A(3, 2)=7, A(2, 3)=9
```

- **sum, prod, floor, ceil, and max**

```
>> a
a =

    1.00000   15.00000    2.00000    0.50000

>> sum(a)                 % sum (X, DIM). If DIM is omitted,
                          % it defaults to the first non-singleton
ans =  18.500             % to add up all elements, use "sum(a(:))"

>> prod(a)
ans =  15
>> floor(a)
ans =

    1   15    2    0

>> ceil(a)
ans =

    1   15    2    1

>> rand(3)          % random square matrix
ans =

   0.79868   0.73666   0.56469
   0.14535   0.76850   0.23191
   0.37785   0.20593   0.51562

>> max(rand(3), rand(3))   % get a matrix consists of  maximum elements
ans =

   0.57524   0.99979   0.54784
   0.43340   0.75738   0.83675
   0.91927   0.97823   0.97630

>> A
A =

   8   1   6
   3   5   7
   4   9   2

>> max(A, [], 1)     % column-wise max results
ans =

   8   9   7

>> max(A, [], 2)     % per row max results
ans =

   8
   7
   9
```

- **sum, prod, floor, ceil, and max**

```
>> max(A)
ans =

   8   9   7

>> max(max(A))
ans =  9
>> A(:)
ans =

   8
   3
   4
   1
   5
   9
   6
   7
   2

>> max(A(:))
ans =  9
```

- **Inverse**

```
>> A = magic(3)
A =

   8   1   6
   3   5   7
   4   9   2

>> pinv(A)
ans =

   0.147222  -0.144444   0.063889
  -0.061111   0.022222   0.105556
  -0.019444   0.188889  -0.102778

>> temp = pinv(A)
temp =

   0.147222  -0.144444   0.063889
  -0.061111   0.022222   0.105556
  -0.019444   0.188889  -0.102778
```

- Do some several sums with magic function

```
>> A = magic(9)
A =

   47   58   69   80    1   12   23   34   45
   57   68   79    9   11   22   33   44   46
   67   78    8   10   21   32   43   54   56
   77    7   18   20   31   42   53   55   66
    6   17   19   30   41   52   63   65   76
   16   27   29   40   51   62   64   75    5
   26   28   39   50   61   72   74    4   15
   36   38   49   60   71   73    3   14   25
   37   48   59   70   81    2   13   24   35

>> sum(A, 1)
ans =

   369   369   369   369   369   369   369   369   369

>> sum(A, 2)
ans =

   369
   369
   369
   369
   369
   369
   369
   369
   369
```

- **Do some several sums with magic function**

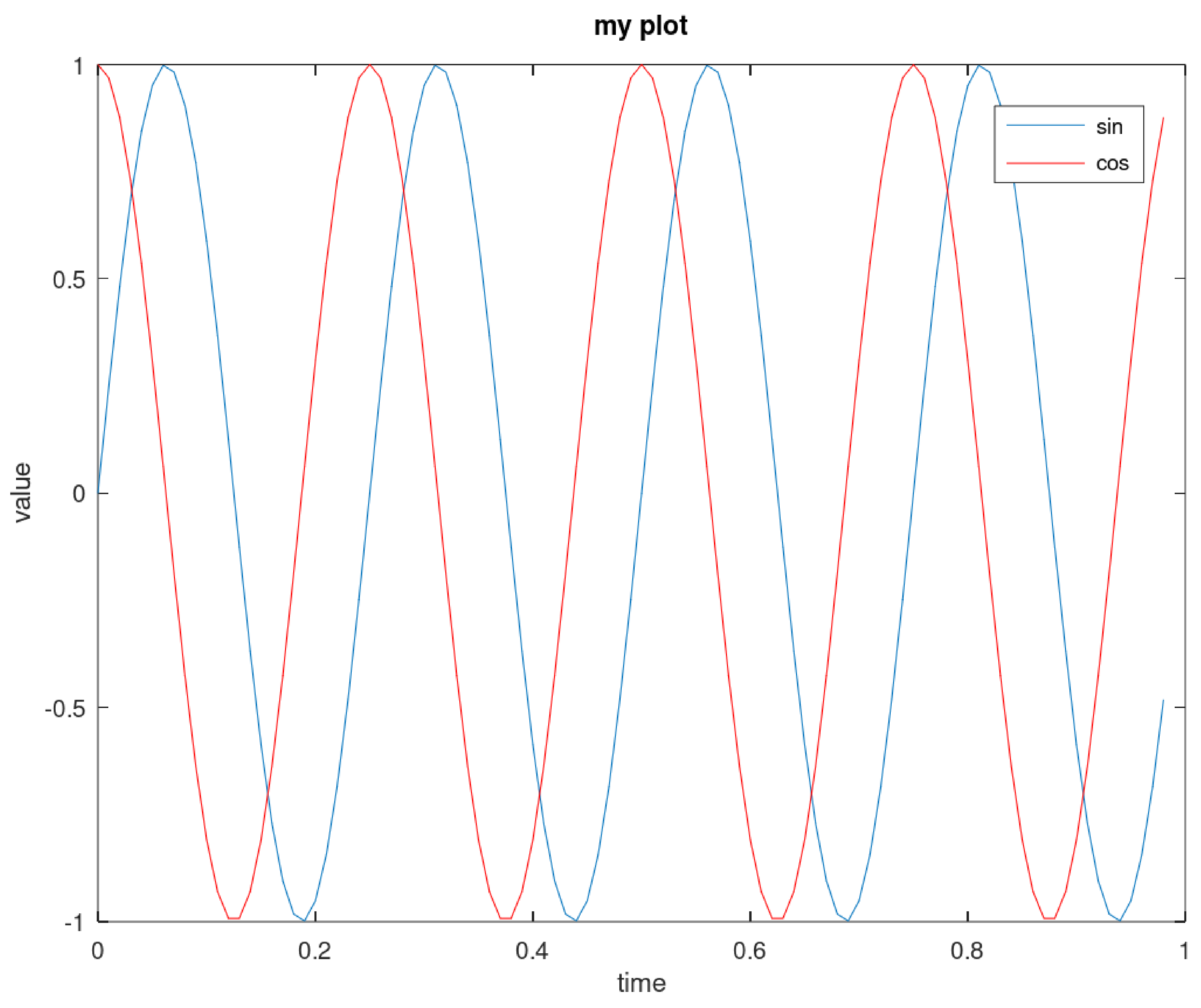
```
>> eye(9)
ans =

Diagonal Matrix

   1   0   0   0   0   0   0   0   0
   0   1   0   0   0   0   0   0   0
   0   0   1   0   0   0   0   0   0
   0   0   0   1   0   0   0   0   0
   0   0   0   0   1   0   0   0   0
   0   0   0   0   0   1   0   0   0
   0   0   0   0   0   0   1   0   0
   0   0   0   0   0   0   0   1   0
   0   0   0   0   0   0   0   0   1

>> A.* eye(9)
ans =

   47    0    0    0    0    0    0    0    0
    0   68    0    0    0    0    0    0    0
    0    0    8    0    0    0    0    0    0
    0    0    0   20    0    0    0    0    0
    0    0    0    0   41    0    0    0    0
    0    0    0    0    0   62    0    0    0
    0    0    0    0    0    0   74    0    0
    0    0    0    0    0    0    0   14    0
    0    0    0    0    0    0    0    0   35

>> sum(sum(A .*eye(9)))
ans =  369
>> sum(sum(A .*flipud(eye(9))))
ans =  369
```

Plotting Data

- **Plot**

```
>> t = [0: 0.01: 0.98];
>> plot(t, y1);
>> hold on;                 % to duplicate two graphs
>> plot(t, y2, 'r');
>> xlabel('time')                  % x label
>> ylabel('value')                 % y label
>> title('my plot')                % title
>> legend('sin','cos')  % legend
>> cd Desktop; print -dpng 'myPlot.png'          % save result as a file
>> close                    % close figure
```

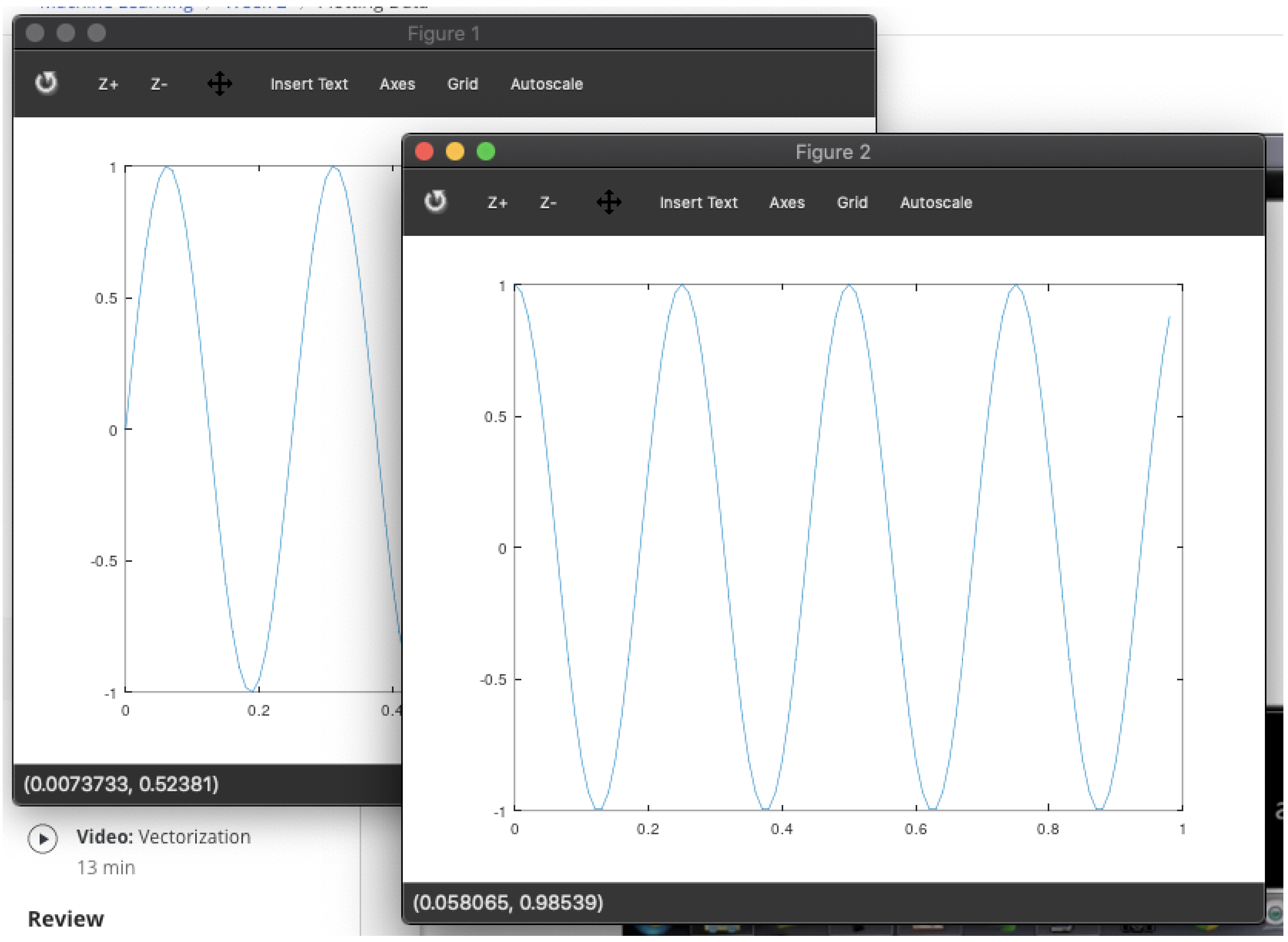
  - Result



- **Pop up two figures.**

```
>> figure(1); plot(t, y1);
>> figure(2); plot(t, y2);
```

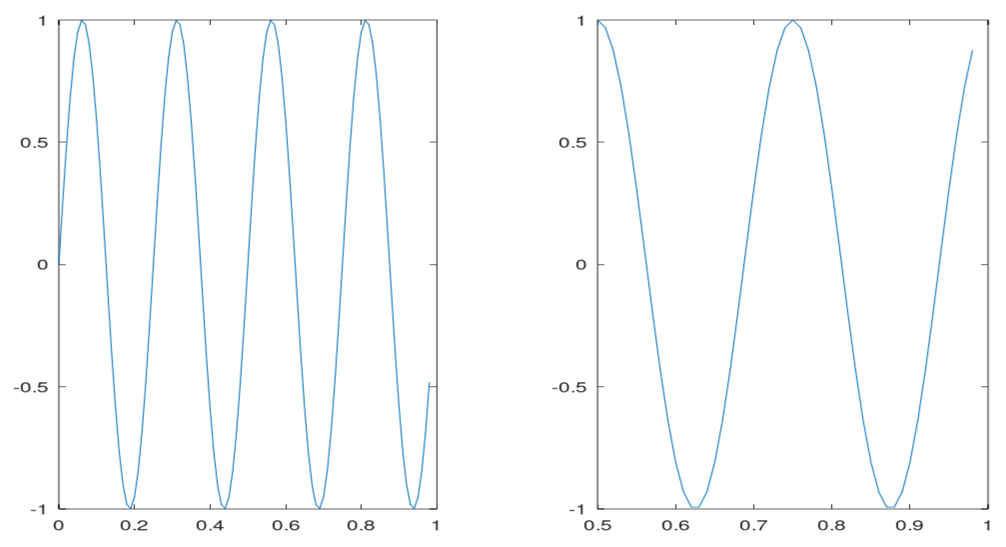
  - Result



- **Subplot**

```
>> subplot(1,2,1); % Divides plot a 1x2 grid, access first element
>> plot(t, y1);
>> subplot(1,2,2);
>> plot(t,y2);
>> axis([0.5 1 -1 1])       % change the axis of plot
```

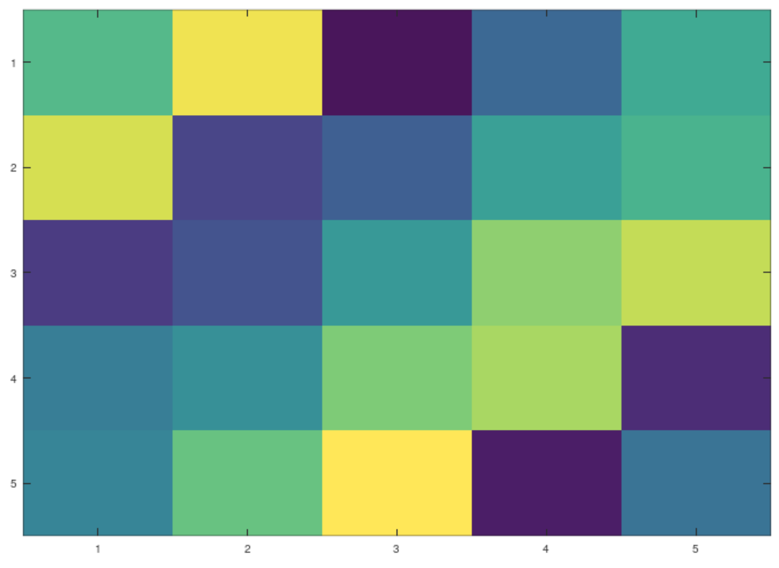
  - Result

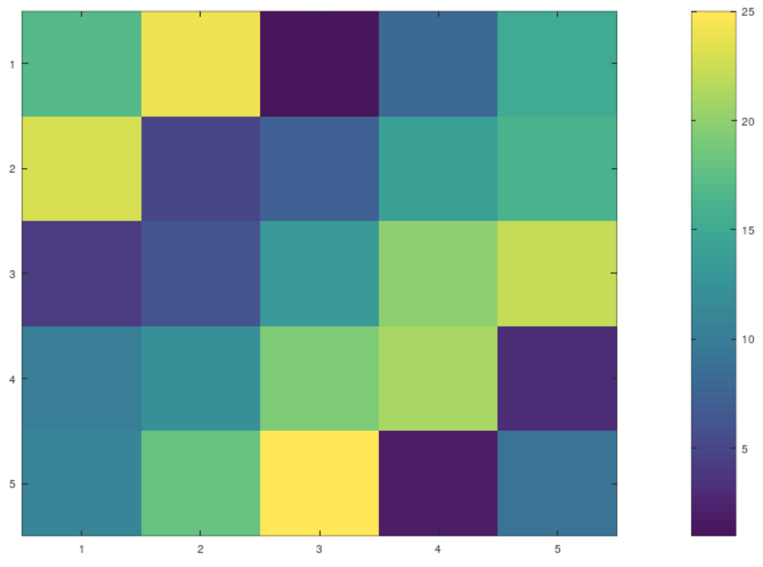


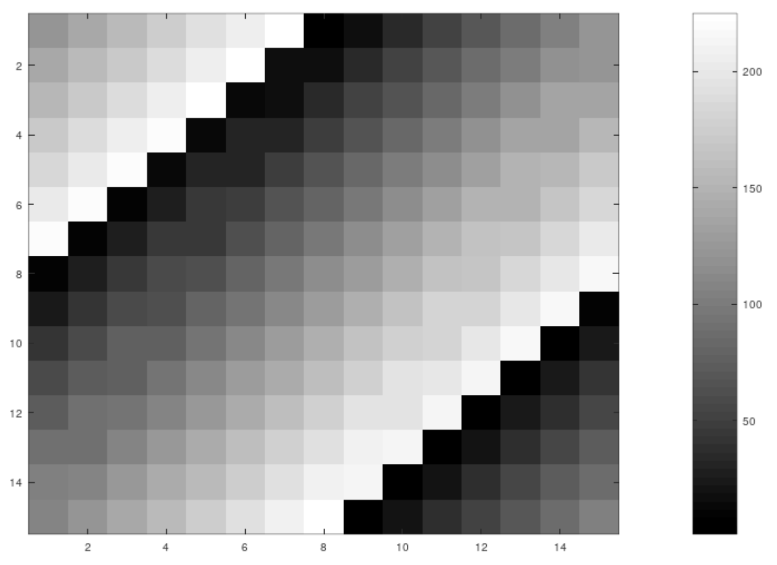
- **Colormap**

```
>> clf;                    % clear figure
>> imagesc(A)
>> imagesc(A), colorbar;
>> imagesc(magic(15)), colorbar, colormap gray;
```

- Results







Control Statements: for, while, if statement

- **for, while, if statesments**

```
>> v = zeros(10, 1)
v =

   0
   0
   0
   0
   0
   0
   0
   0
   0
   0

>> for i=1:10,          % for
>      v(i) = 2^i;
>   end;
>> v
v =

      2
      4
      8
     16
     32
     64
    128
    256
    512
   1024

>> i = 1;
>> while i <= 5,        % while
>      v(i) = 100;
>      i = i+1;
>   end;
>> v
v =

    100
    100
    100
    100
    100
     64
    128
    256
    512
   1024
```

- **for, while, if statesments**

```
>> i=1;
>> while true,
>      v(i) = 999;
>      i = i+1;
>      if i == 6,          % if
>         break;
>      end;
>   end;
>> v
v =

    999
    999
    999
    999
    999
     64
    128
    256
    512
   1024

>> v(1)=2;
>> if v(1)==1,                          % if else
>      disp('The value is one');
>   elseif v(1) == 2,
>      disp('The value is two');
>   else
>      disp('The value is not one or two.');
>   end;
The value is two
```

- **function as a module**

  if you have a `squareAndCubeThisNumber.m` file like following at your Desktop,

```
% This is squareAndCubeThisNumber.m file contents.
% input: x, outputs: y1, y2
function [y1, y2] = squareAndCubeThisNumber(x)

y1 = x^2;
y2 = x^3;
```

  and you register the Desktop path to the octave environmnet with following command,

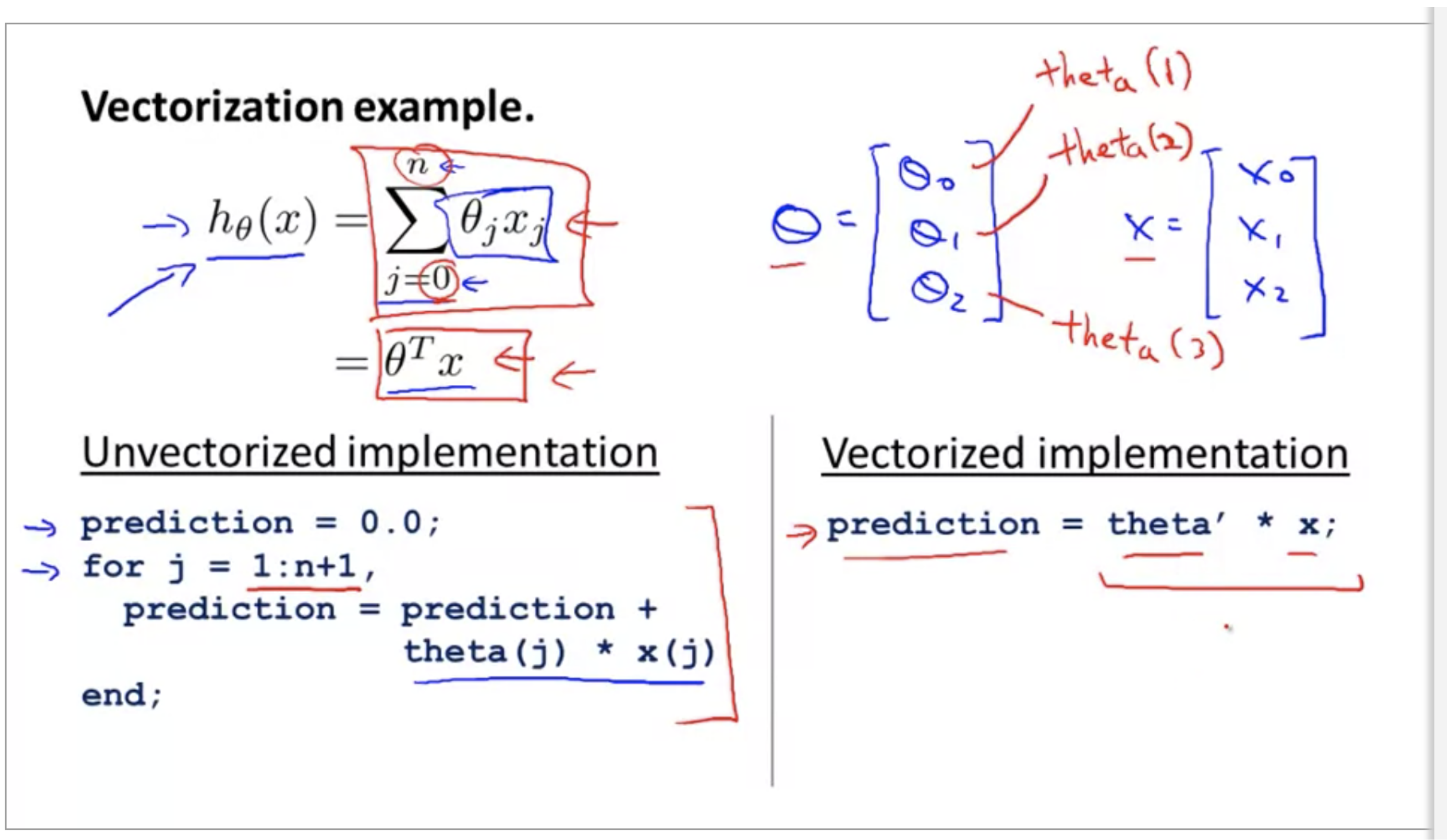
```
>> addpath('/Users/chayesol/Desktop')
```

  theh, you can see the results like following,

```
>> [a, b] = squareAndCubeThisNumber(5)
a =  25
b =  125
```

Vectorization

- Rather than writing code yourself to multiply matrices, if you let Octave do it by typing a times b, that would use a very efficient routine to multiply the two matrices.
- If you use appropriate vectorization implementations you get much simpler code and much more efficient code.
- Vectorization example.



Vectorization example.

$$h_\theta(x) = \sum_{j=0}^{n} \theta_j x_j$$
$$= \theta^T x$$

$$\theta = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \theta_2 \end{bmatrix} \quad x = \begin{bmatrix} x_0 \\ x_1 \\ x_2 \end{bmatrix}$$

theta(1)
theta(2)
theta(3)

Unvectorized implementation

```
prediction = 0.0;
for j = 1:n+1,
  prediction = prediction +
               theta(j) * x(j)
end;
```

Vectorized implementation

```
prediction = theta' * x;
```