Lecture1

Matrix manipulations
- Sub-matrices
- Reproduction
- Reshape
- Determinant, inversion

Flow control
- if, if else, find

Matrices

- A= [1 2 3 4; 5 6 7 8]
- reshape(1:8,4,2)'

MATLAB Mobile

```
>> reshape(1:8,4,2)'

ans =

     1     2     3     4
     5     6     7     8
```

MATLAB Mobile

```
>> A= [1 2 3 4; 5 6 7 8]

A =

     1     2     3     4
     5     6     7     8
```

Rows

- \>\> A(1,:)

ans =

 1 2 3 4

- \>\> A(2,:)

ans =

 5 6 7 8

Columns

- >> A(:,1)

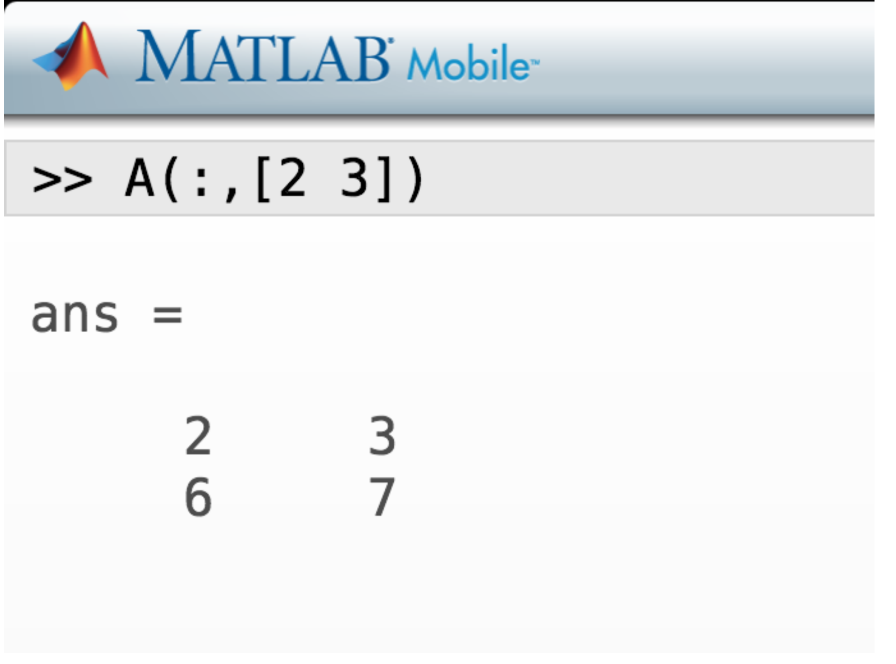
ans =

    1
    5

- >> A(:,[2 3])

ans =

    2   3
    6   7



Sub-matrix

- a=1:1:36
- A=reshape(a,4,9)
- % Extract rows 2:4 and columns 5:8 of A
- A(2:4,5:8)

MATLAB Mobile

```
>> A(2:4,5:8)

ans =

    18    22    26    30
    19    23    27    31
    20    24    28    32
```

MATLAB Mobile

```
>> A

A =

     1     5     9    13    17    21    25    29    33
     2     6    10    14    18    22    26    30    34
     3     7    11    15    19    23    27    31    35
     4     8    12    16    20    24    28    32    36
```

Reshape

```
v=1:12;
reshape(v,3,4)

ans =

     1     4     7    10
     2     5     8    11
     3     6     9    12
```

Reshape

- a=1:1:36
- m=4;n=9
- A=reshape(a,4,9)
- % reshape vector a to matrix A
- % A is composed of m rows and n columns

Gray image

cmw2.bmp

```
I=imread('cmw2.bmp');
imshow(I)
```

```
I=imread('cmw2.bmp')
;
image(I)
```

MATLAB Mobile

```
>> dir

.              .session    Shared
..             Published   cmw2.bmp

>> I=imread('cmw2.bmp');
>> image(I)
```

Sub-matrices

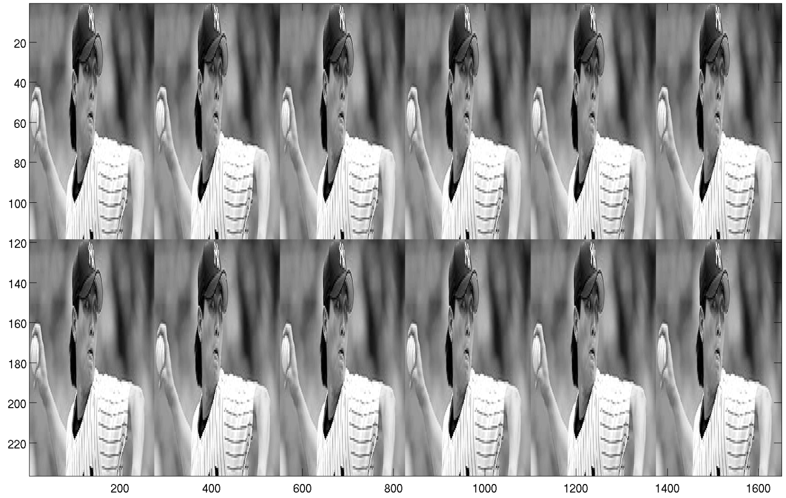
```
I=imread('cmw2.bmp');
image(I);
[m,n]=size(I);
m2=ceil(m/2);
n2=ceil(n/3*2);
Is=I(1:m2,1:n2); figure
imagesc(Is)
colormap(gray)
```

MATLAB Mobile

```
>> I=imread('cmw2.bmp');
image(I);
[m,n]=size(I);
m2=ceil(m/2);
n2=ceil(n/3*2);
Is=I(1:m2,1:n2); figure
imagesc(Is)
colormap(gray)
```

Repeat

```
I2=repmat(Is,2,3);
imagesc(I2);
colormap(gray)
```



Repmat

- A=[1 2;3 4]
- m=2;n=3;
- repmat(A,m,n)
- % repeat A vertically m times
- % repeat the result horizontally n times

MATLAB Mobile

```
>> A=[1 2;3 4]
m=2;n=3;
repmat(A,m,n)

A =

     1     2
     3     4


ans =

     1     2     1     2     1     2
     3     4     3     4     3     4
     1     2     1     2     1     2
     3     4     3     4     3     4
```

Get Rows

- A=reshape(1:16,4,4)
- a=3;b=1;c=2;
- A([a b c],:)
- % get rows specified by [a b c]

```
>> A=reshape(1:16,4,4)
a=3;b=1;c=2;
A([a b c],: )

A =

     1     5     9    13
     2     6    10    14
     3     7    11    15
     4     8    12    16


ans =

     3     7    11    15
     1     5     9    13
     2     6    10    14
```

Get Columns

- A=reshape(1:16,4,4)
- a=3;b=1;c=2;
- A(:,[a b c])
- % get columns specified by [a b c]

```
>> A=reshape(1:16,4,4)
a=3;b=1;c=2;
A(:,[a b c])
```

```
A =

     1     5     9    13
     2     6    10    14
     3     7    11    15
     4     8    12    16


ans =

     9     1     5
    10     2     6
    11     3     7
    12     4     8
```

Row exchange

```
V=reshape(1:12,3,4)
V([3 2],:)=V([2 3],:)

V =

     1     4     7    10
     3     6     9    12
     2     5     8    11
```

Column exchange

```
V=reshape(1:12,3,4)

V(:,[2 3])=V(:,[3 2])

V =

     1     7     4    10
     2     8     5    11
     3     9     6    12
```

Column sum

```
V=reshape(1:12,3,4)

V =

     1     4     7    10
     2     5     8    11
     3     6     9    12

>> sum(V)

ans =

     6    15    24    33
```

Column sum

```
V=reshape(1:12,3,4)

V =

     1     4     7    10
     2     5     8    11
     3     6     9    12

>> sum(V,1)

ans =

     6    15    24    33
```

Row sum

```
V=reshape(1:12,3,4)

V =

     1     4     7    10
     2     5     8    11
     3     6     9    12

>> sum(V,2)

ans =

    22
    26
    30
```

Mean of columns

```
V=reshape(1:12,3,4)

V =

     1     4     7    10
     2     5     8    11
     3     6     9    12

>> mean(V)

ans =

     2     5     8    11
```

Mean of rows

```
V=reshape(1:12,3,4)

V =

     1     4     7    10
     2     5     8    11
     3     6     9    12

>> mean(V,2)
```

Inversion

```
A=reshape(1:4,2,2);
B=inv(A)

B =

   -2.0000    1.5000
    1.0000   -0.5000
```

Linear system

$$
\begin{aligned}
2x + y - z &= 1 \\
-3x - 2y + 5z &= 0 \\
x + y + z &= 5
\end{aligned}
$$

inv

```
A=[2 1 -1;-3 -2 5;1 1 1];
b=[1 0 5]'
```

```
inv(A)*b

ans =

   -1.6000
    5.4000
    1.2000
```

Left devision

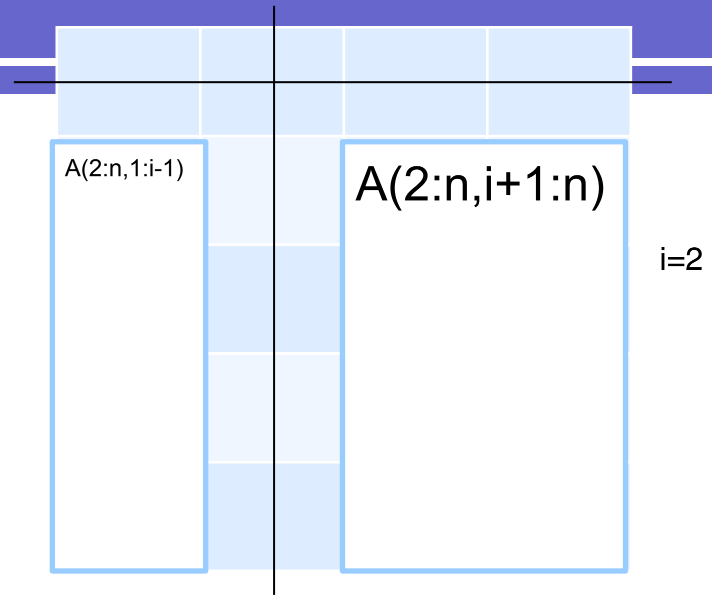
A=[2 1 -1;-3 -2 5;1 1 1];
b=[1 0 5]'

- A\b
- % Left devision
- % Ax=b could be solved by left devision

Determinant

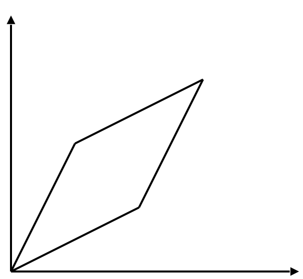
```
A=reshape(1:4,2,2);
>> det(A)

ans =

    -2
```

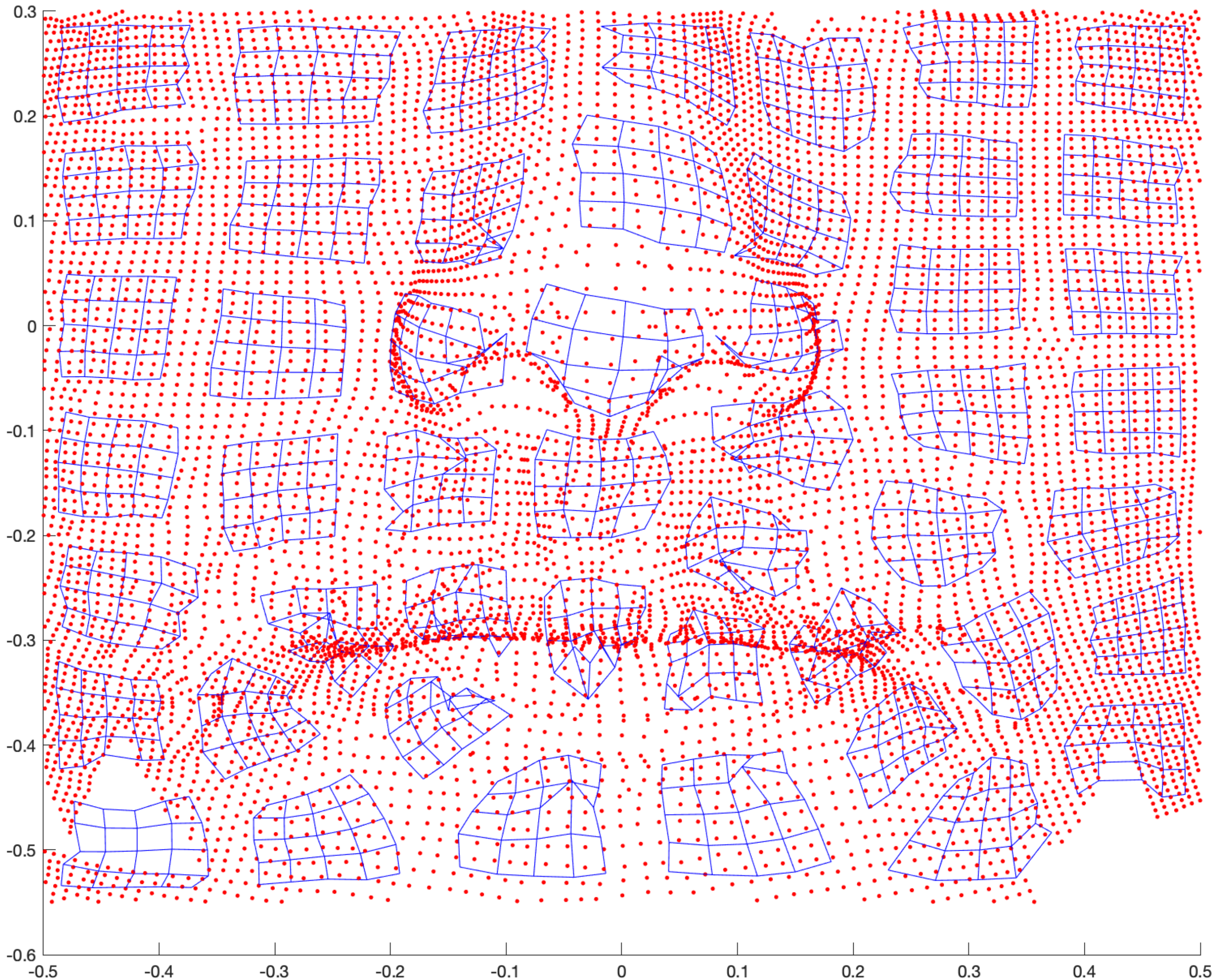
```
function ans=demo_det(A)
ans=0;[m,n]=size(A);
    if m==1
        ans=A; return;
    end
    if m==2

    ans=A(1,1)*A(2,2)-A(1,2)*A(2,1); return;
    end

    for i=1:n
        B=[A(2:n,1:i-1) A(2:n,i+1:n)];
        det_B=demo_det(B);
        s=(-1)^(i+1); ans=ans+s*A(1,i)*det_B;
    end

```

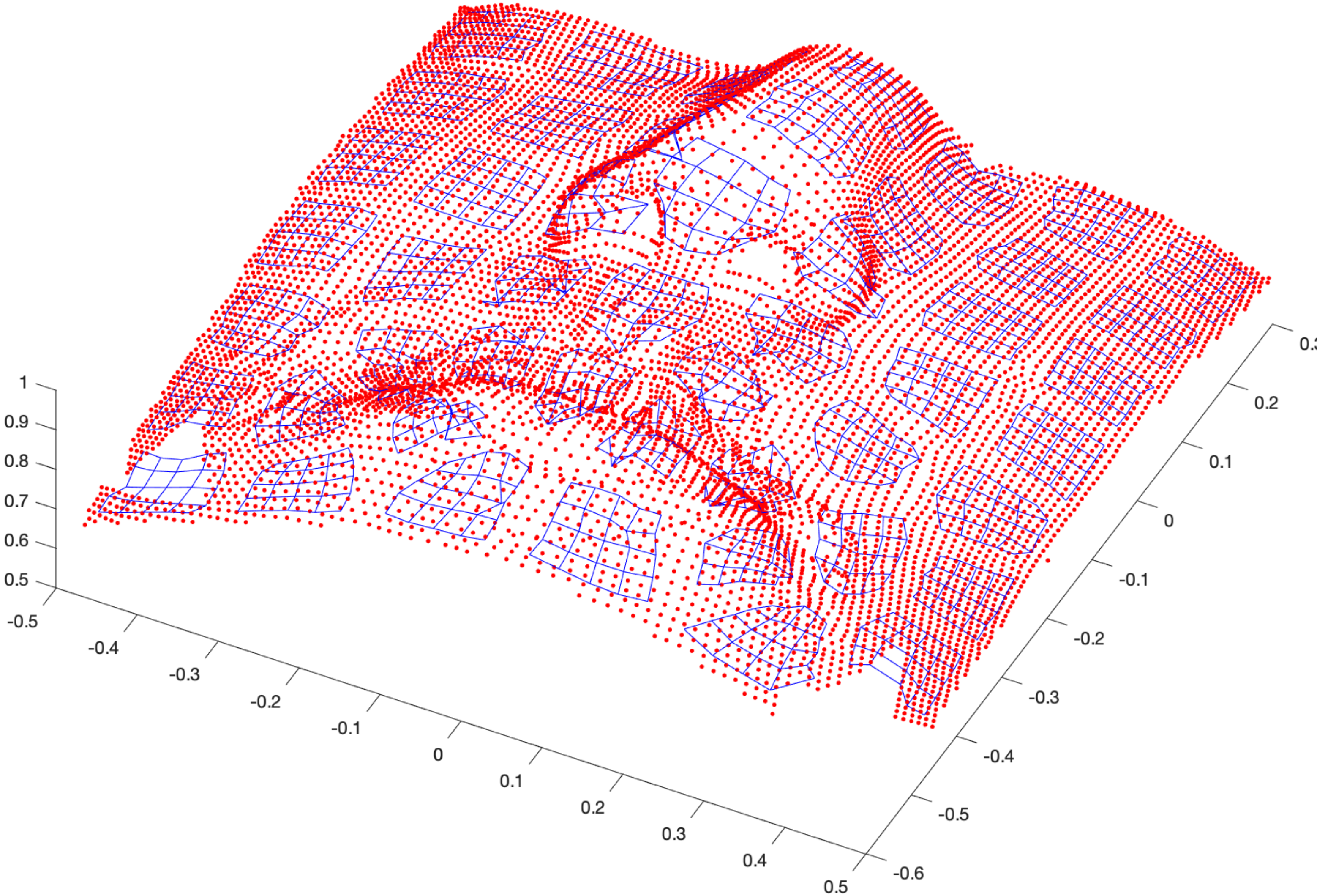


Area of a parallelogram

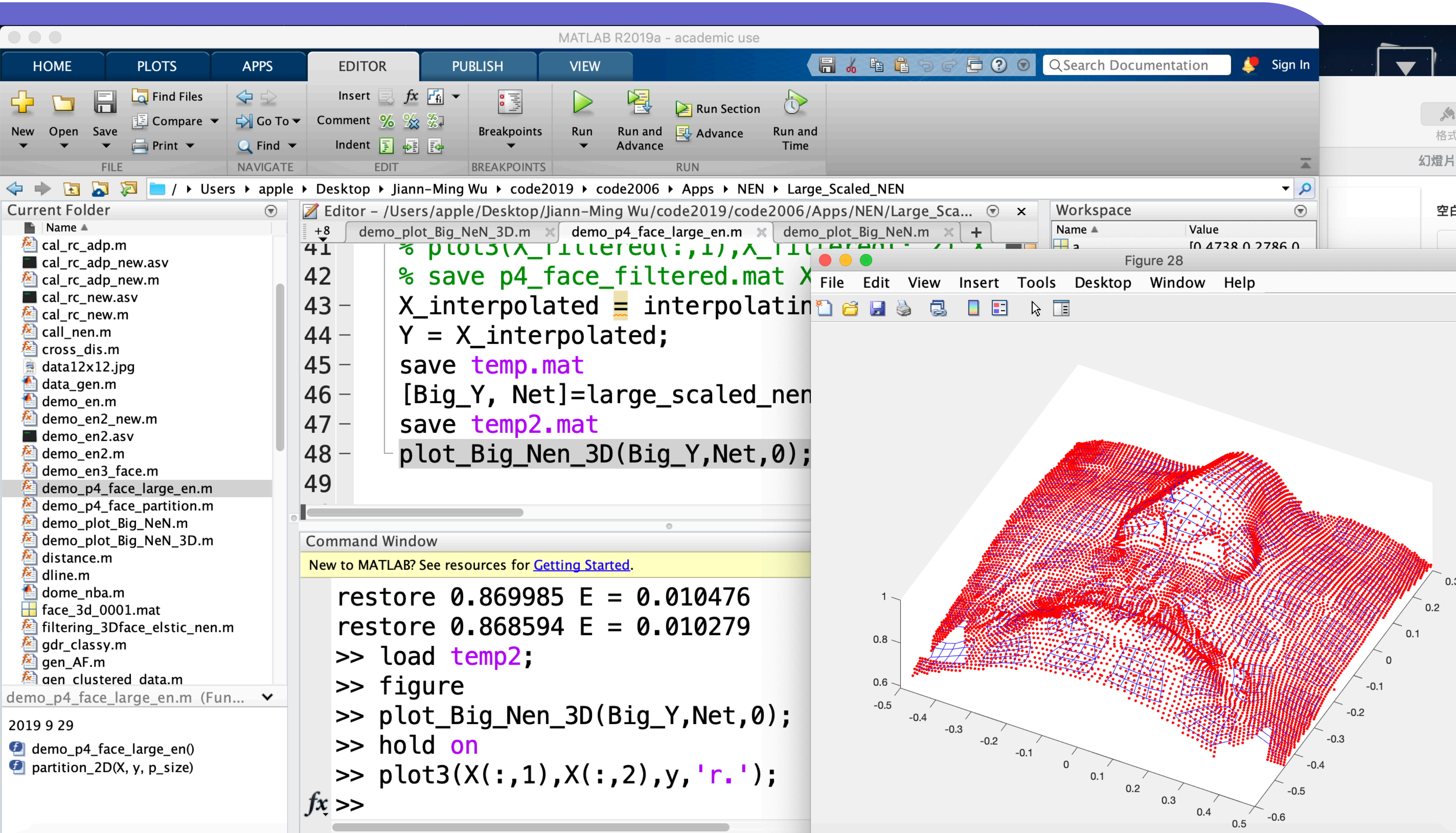
- v1,v2 denotes two vectors in a plane
- Calculate the area of the parallelogram determined by v1 and v2




0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5

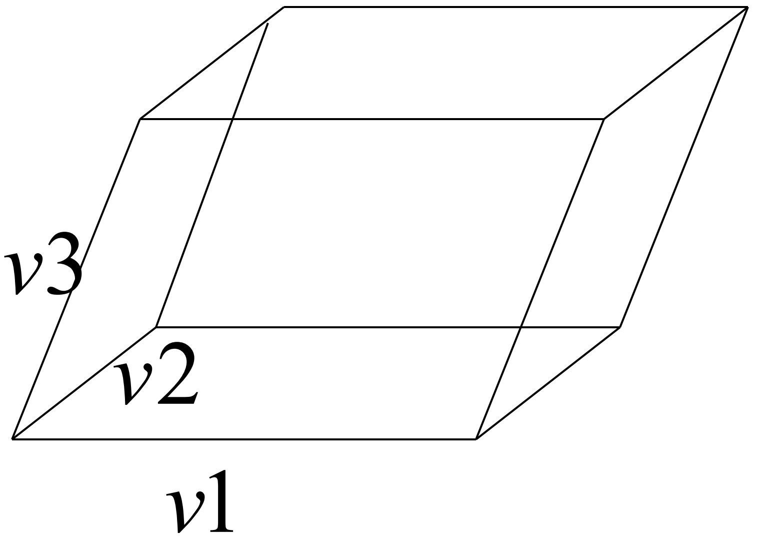


1
0.9
0.8
0.7
0.6
0.5
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6


MATLAB R2019a - academic use
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Sign In
New
Open
Save
Find Files
Compare
Print
Go To
Find
Insert
Comment
Indent
Breakpoints
Run
Run and Advance
Run Section
Advance
Run and Time
FILE
NAVIGATE
EDIT
BREAKPOINTS
RUN
/ Users apple Desktop Jiann-Ming Wu code2019 code2006 Apps NEN Large_Scaled_NEN
Current Folder
Name
cal_rc_adp.m
cal_rc_adp_new.asv
cal_rc_adp_new.m
cal_rc_new.asv
cal_rc_new.m
call_nen.m
cross_dis.m
data12x12.jpg
data_gen.m
demo_en.m
demo_en2_new.m
demo_en2.asv
demo_en2.m
demo_en3_face.m
demo_p4_face_large_en.m
demo_p4_face_partition.m
demo_plot_Big_NeN.m
demo_plot_Big_NeN_3D.m
distance.m
dline.m
dome_nba.m
face_3d_0001.mat
filtering_3Dface_elstic_nen.m
gdr_classy.m
gen_AF.m
demo_p4_face_large_en.m (Fun...
2019 9 29
demo_p4_face_large_en()
partition_2D(X, y, p_size)
Editor – /Users/apple/Desktop/Jiann-Ming Wu/code2019/code2006/Apps/NEN/Large_Sca...
demo_plot_Big_NeN_3D.m
demo_p4_face_large_en.m
demo_plot_Big_NeN.m
% save p4_face_filtered.mat X
X_interpolated = interpolatin
Y = X_interpolated;
save temp.mat
[Big_Y, Net]=large_scaled_nen
save temp2.mat
plot_Big_Nen_3D(Big_Y,Net,0);
Workspace
Name
Value
Command Window
New to MATLAB? See resources for Getting Started.
restore 0.869985 E = 0.010476
restore 0.868594 E = 0.010279
>> load temp2;
>> figure
>> plot_Big_Nen_3D(Big_Y,Net,0);
>> hold on
>> plot3(X(:,1),X(:,2),y,'r.');
>>
Figure 28
File
Edit
View
Insert
Tools
Desktop
Window
Help

Volume of a parallelepiped

A=[v1;v2;v3]
det(A)



```
reshape(randperm(9),3,3)

ans =

     5     9     6
     2     1     8
     7     3     4
```

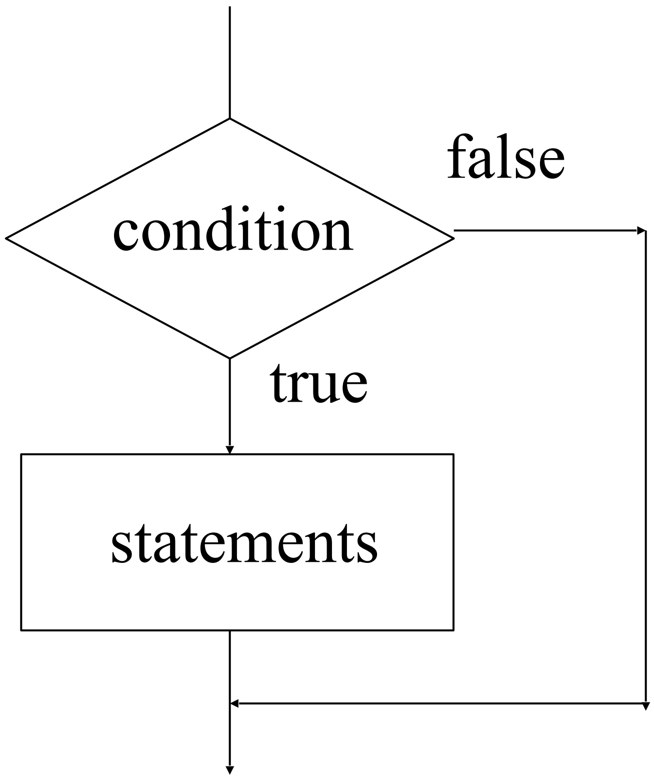
Append Horizontally

```
>> A=reshape(randperm(9),3,3);
>> B=reshape(randperm(9),3,3);
>> C=[A B]

C =

     6     2     9     5     4     9
     3     4     5     6     3     7
     8     7     1     8     1     2
```

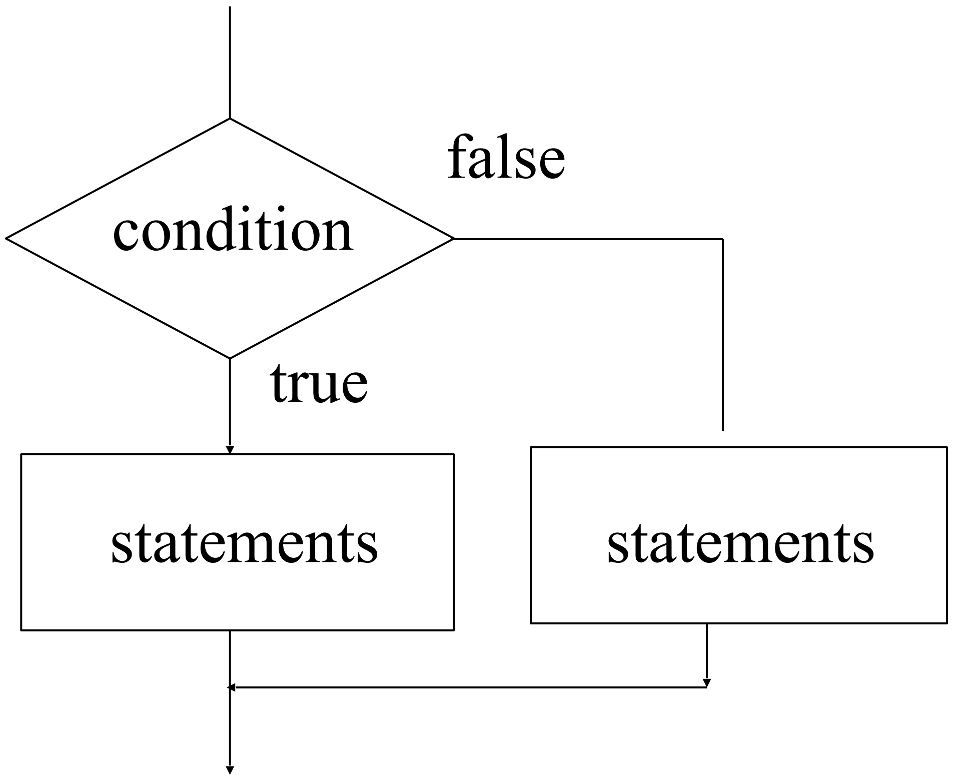
Append Vertically

```
>> C=[A;B]

A =

     6     2     9
     3     4     5
     8     7     1
     5     4     9
     6     3     7
     8     1     2
```

if



if else

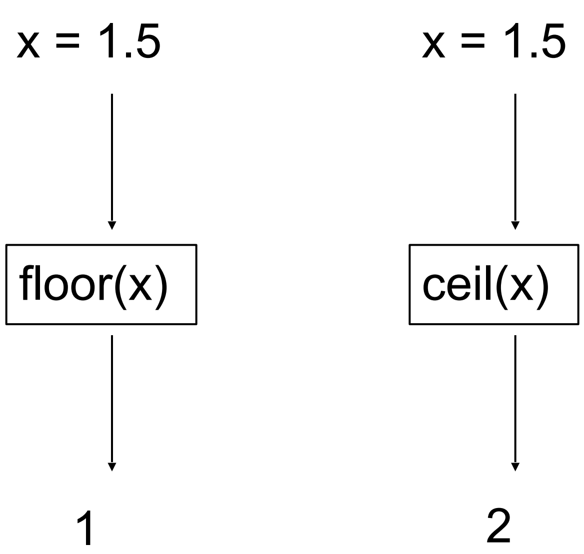


FOR Looping

- Series sum of ceils and floors
- Symbolic differentiation
- Counting ATCG
- Markov Chain

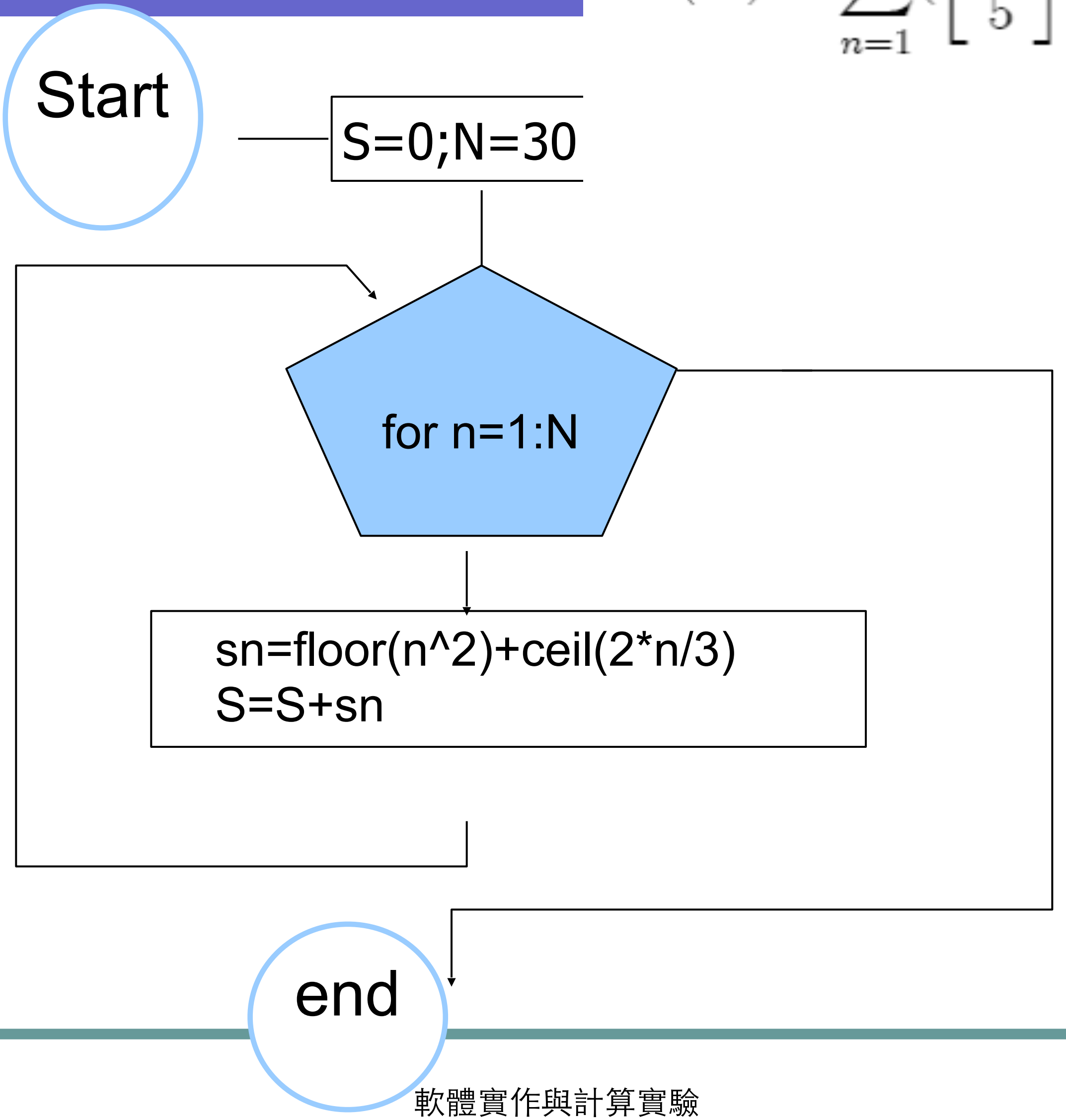
Summation

$$S(N) = \sum_{n=1}^{N} \left(\left\lfloor \frac{n^2}{5} \right\rfloor + \left\lceil \frac{2*n}{3} \right\rceil \right)$$

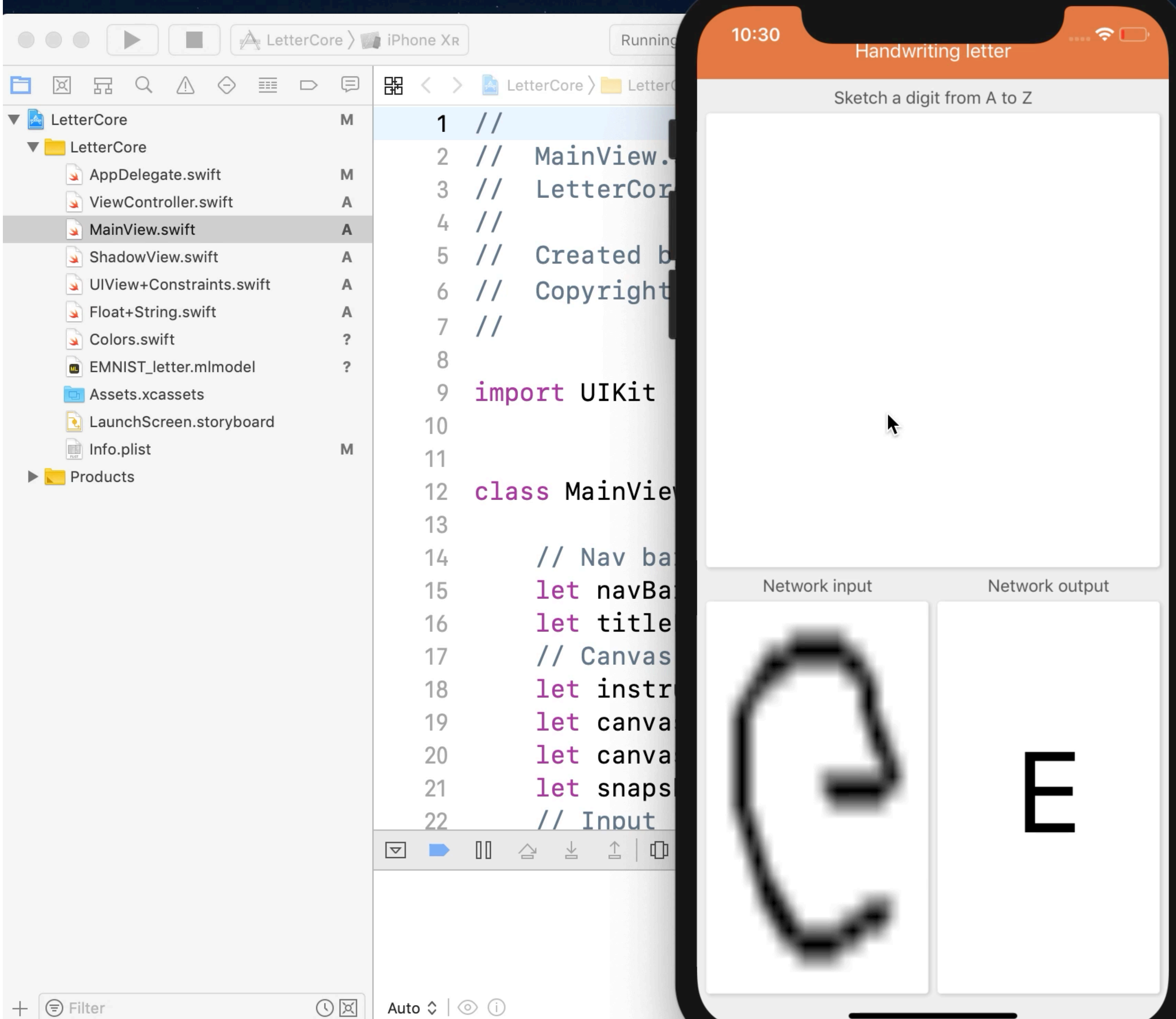


Flow chart

$$S(N) = \sum_{n=1}^{N} \left(\left\lfloor \frac{n^2}{5} \right\rfloor + \left\lceil \frac{2*n}{3} \right\rceil \right)$$



```
S = 0; N = 20;
for n = 1: N
    sn = floor(n^2)+ceil(2*n/3);
    S = S + sn;
end
display(S)
```


LetterCore
iPhone XR
Running
LetterCore
AppDelegate.swift
ViewController.swift
MainView.swift
ShadowView.swift
UIView+Constraints.swift
Float+String.swift
Colors.swift
EMNIST_letter.mlmodel
Assets.xcassets
LaunchScreen.storyboard
Info.plist
Products
Filter
//
// MainView.
// LetterCor
//
// Created b
// Copyright
//
import UIKit
class MainVie
// Nav ba
let navBa
let title
// Canvas
let instr
let canva
let canva
let snaps
// Input
Auto
10:30
Handwriting letter
Sketch a digit from A to Z
Network input
Network output
E

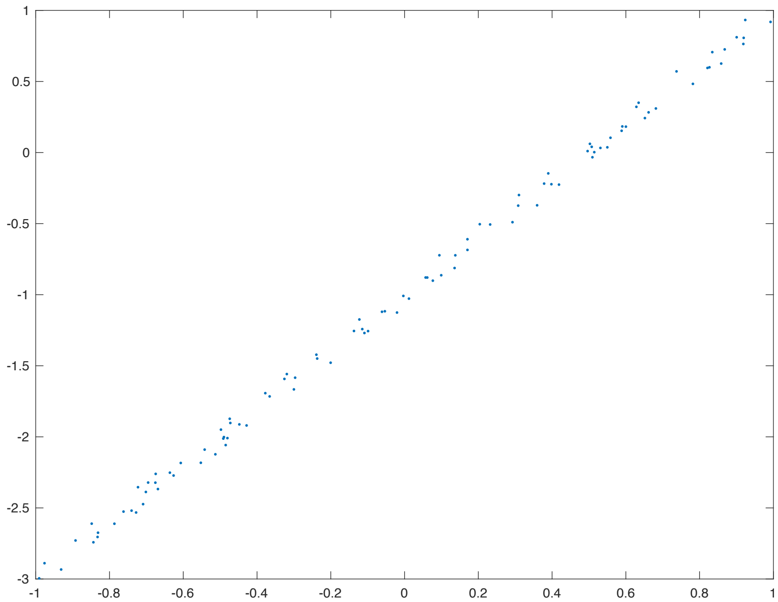
Coding Exercise

```
a = 2; b = -1; n = 100
x = 2*rand(n,1)-1; y = a * x + b + rand(n,1)*0.2-0.1;
```

Use only one statement to estimate a and b

$$\begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \sum_{i=1}^{n} x_i^2 & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} x_i & n \end{pmatrix}^{-1} \begin{pmatrix} \sum_{i=1}^{n} x_i\, y_i \\ \sum_{i=1}^{n} y_i \end{pmatrix}$$

```
>> a = 2; b = -1; n = 100;
>> x = 2*rand(n,1)-1;y = a * x + b+ rand(n,1)*0.2-0.1;
>> plot(x,y,'.')
```



Series

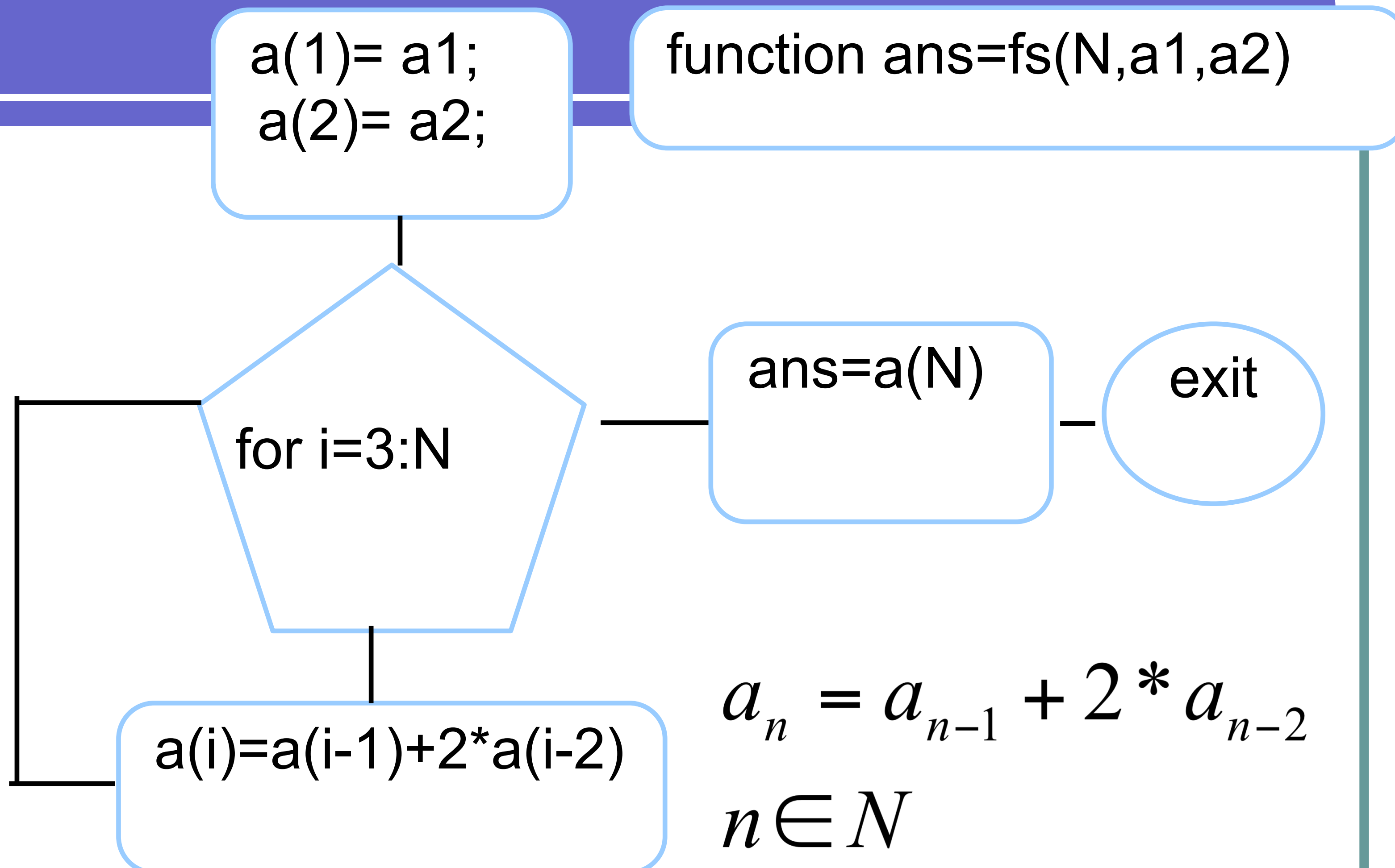
$$a_n = a_{n-1} + 2 * a_{n-2}$$

$$n \in N$$

Problem

- INPUT: a_1, a_2 and n
- OUTPUT: a_n

- Draw a flow chart to determine a_n by a for-loop
- Write a matlab function to calculate a_n for given a_1 , a_2 and n



$$a_n = a_{n-1} + 2 * a_{n-2}$$

$$n \in N$$

Symbolic Differentiation

```
>> x=sym('x');
>> diff(tanh(x))

ans =

1-tanh(x)^2
```

Symbolic differentiation

```
>> x=sym('x');
>> diff(x.^3+2*x)

ans =

3*x^2+2
```

Symbolic Differentiation

demo_diff.m

- Input a string, fstr
- Plot the function specified by fstr
- Plot the derivative of the given function

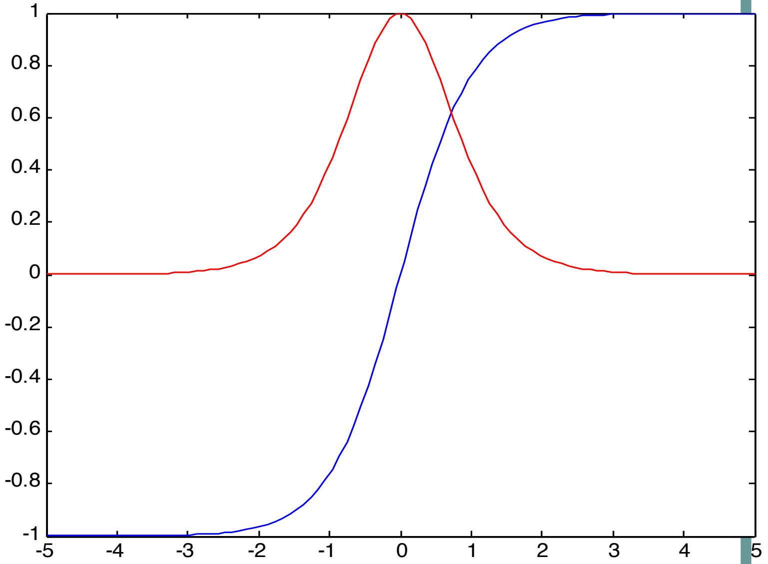
- MATLAB Web Server Demos

Example

function of x:tanh(x)

fx1 =

Inline function:
fx1(x) = 1-tanh(x).^2



Histogram

- Sample space, {1,2,3,4,5,6}
- Count occurrences of possible outcomes in a series

A series

```
n=10;
s=ceil(rand(1,10)*6);
```

Histogram

s =

6 2 4 3 6 5 3 1 5 3

↓

```
count=hist(s,[1 2 3 4 5 6])
```

↓

count =

1 1 3 1 2 2

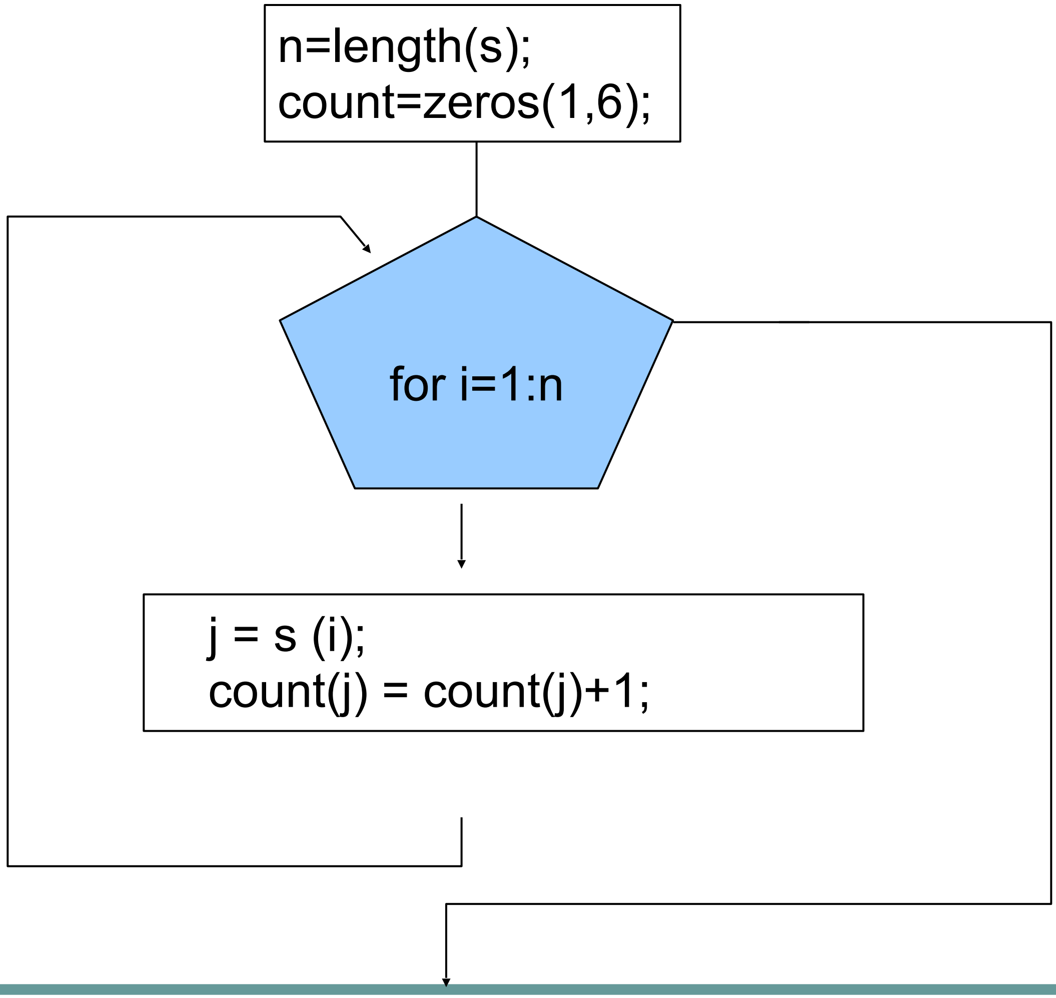
```
hist(s,[1 2 3 4 5 6])
```

Histogram

- INPUT: a series
- INPUT: [1 2 3 4 5 6]
- OUTPUT: occurrences of possible outcomes

Flow chart I :

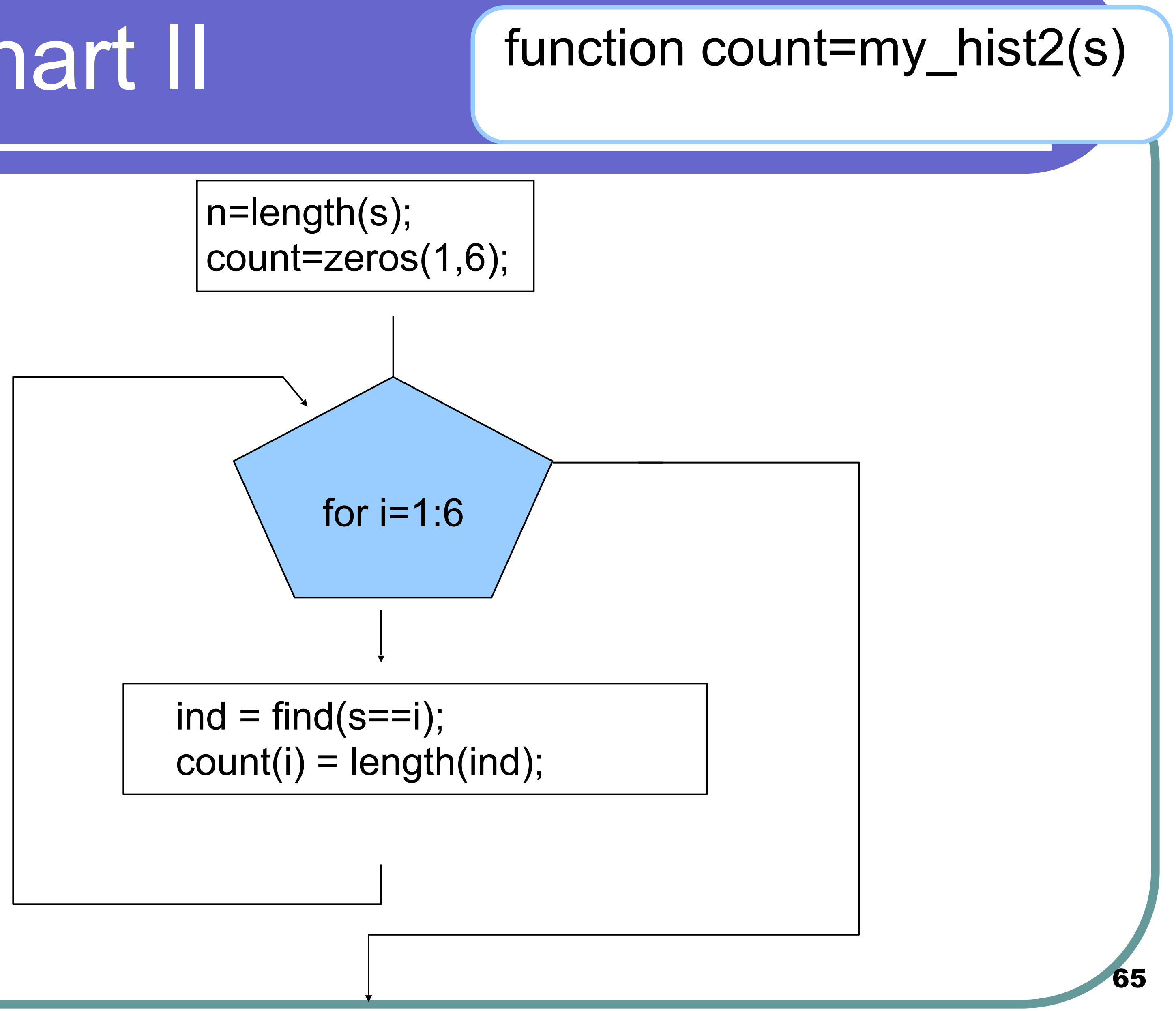
function count=my_hist(s)



```
j=s(i);
count(j) = count(j) +1;
```

- j stores the ith elemet
- increase one for counting j

Flow chart II



function count=my_hist2(s)

```
n=length(s);
count=zeros(1,6);
for i=1:6
    ind = find(s==i);
    count(i) = length(ind);
end
```

DNA sequence

ATCG sequence

load mitochondria
mitochondria(1:200)

mitochondria(1:200)

gatcacaggtctatcaccctattaaccactcacggga
gctctccatgcatttggtattttcgtctgggggtgtgca
cgcgatagcattgcgagacgctggagccggagcac
cctatgtcgcagtatctgtctttgattcctgcctcattctatt
atttatcgcacctacgttcaatattacaggcgaacata
cctacta

ss='gatcacaggtctatcaccctattaaccact cacgggagctctccatgcatttggtattttcgt ctgggggtgtgcacgcgatagcattgcga gacgctggagccggagcaccctatgtcgc agtatctgtctttgattcctgcctcattctattattt atcgcacctacgttcaatattacaggcgaac atacctacta'

ATCG

- Calculate probabilities of a,t,c,g in a given ATCG sequence.

$$\Pr(x='a')=?$$

$$\Pr(x='t')=?$$

$$\Pr(x='c')=?$$

$$\Pr(x='g')=?$$

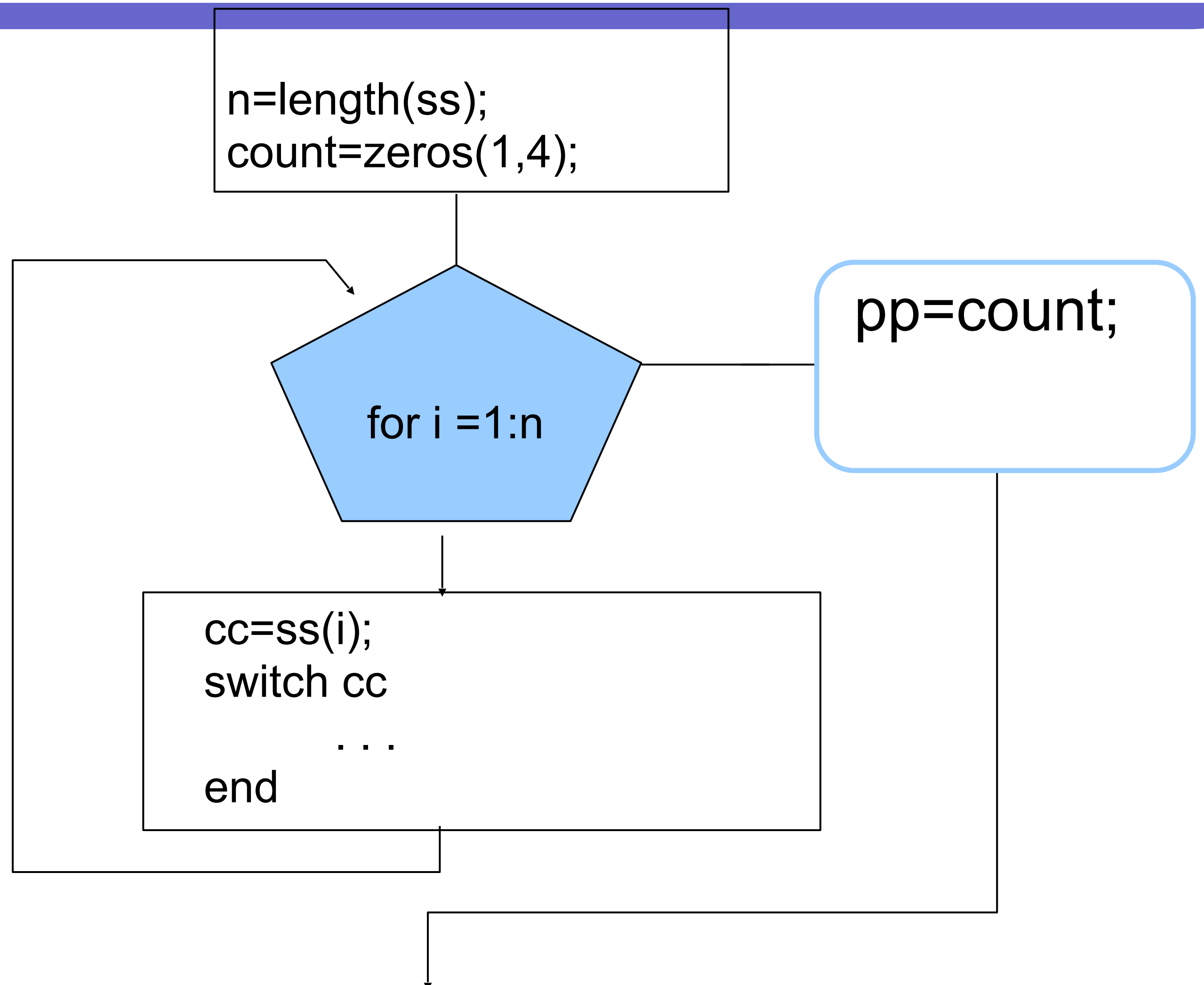
ATCG

- Count numbers of a,t,c,g in a given ATCG sequence.

Input : ss
Output : numbers of 'a', 't', 'c' and 'g'

Flow chart

function pp=p_atcg(ss)



Switch

```
cc=ss(i);
  switch cc
     case 'a'
        count(1)=count(1)+1;
     case 't'
        count(2)=count(2)+1;
     case 'c'
        count(3)=count(3)+1;
     case 'g'
        count(4)=count(4)+1;
  end
```

function pp=p_atcg(ss)

```
n=length(ss);
count=zeros(1,4);
for i =1:n
    cc=ss(i);
    switch cc
        case 'a'
            count(1)=count(1)+1;
        case 't'
            count(2)=count(2)+1;
        case 'c'
            count(3)=count(3)+1;
        case 'g'
            count(4)=count(4)+1;
    end
end
```

- INPUT: ss and s
- Count occurrences of s within ss

ss =

gtttcctact

s = 'g'

```
ind=find(ss==s);
length(ind)
```

ans =

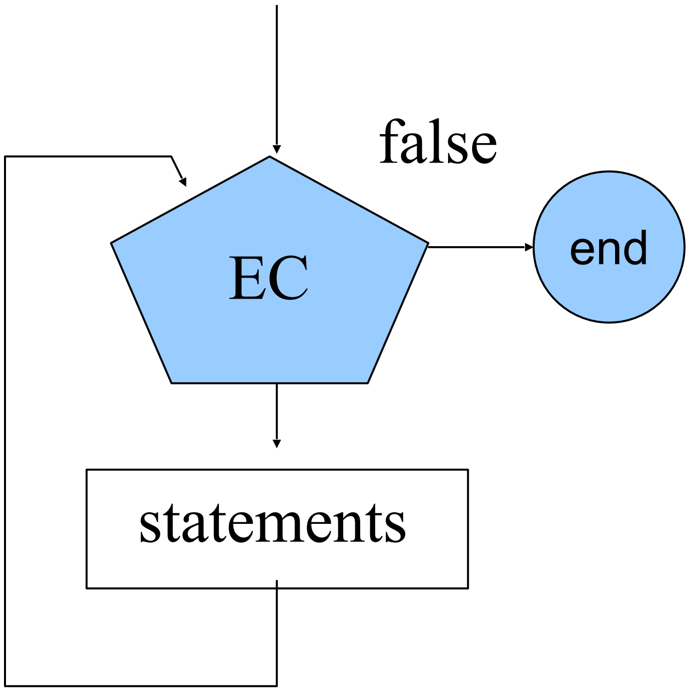
1

While-Loop programming

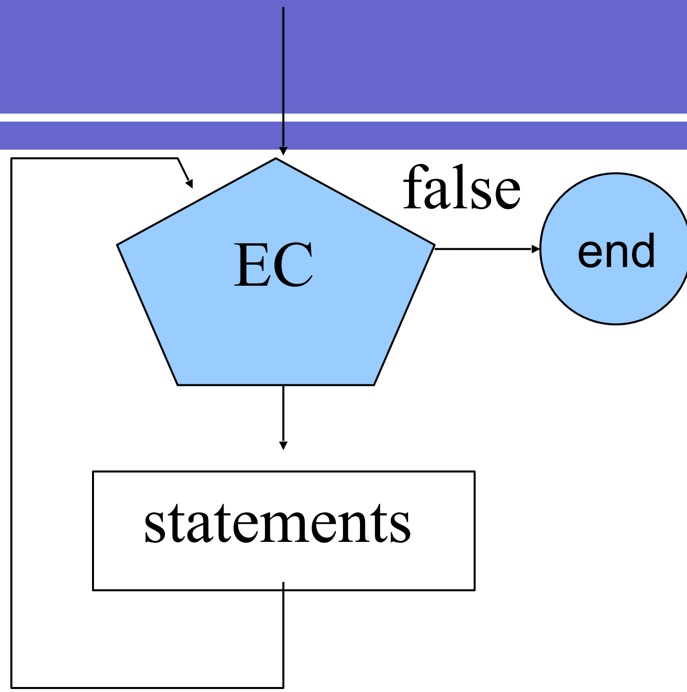
- While-loop flow chart
- Decimal to binary representations

While loop

```
while entry_condition
        statements;
end
```



Flow chart



- Execute body statements repeatedly until the entry condition fails
- The entry condition should eventually become false by iteratively executing body statements

Decimal to binary representations

- Input : positive decimal numbers
- Output : binary representations of the input

Mod

```
>> r=mod(10,3)

ans =

     1
>> q=(10-r)/3

ans =

     3
```

Quotient

```
>> r=mod(100,7)

ans =

    2


>> q=(100-r)/7

ans =

   14
```

Decimal to binary representation

- Let M be a positive decimal number
- Let b be an array of length n

$$b = [b_n, \ldots, b_2, b_1]$$

$$\text{where } b_n > 0$$

- b denotes the binary representation of M if

$$M = b_n 2^{n-1} + b_{n-1} 2^{n-2} + \ldots + b_1 2^0$$

$$C = 'b_n b_{n-1} \ldots b_1'$$

Example

- M > 0
- M=1, b_1=1
- M=5, C=‘101’

$$b = [b_3, b_2, b_1]$$

$$\mathrm{M} = b_3 2^2 + b_2 2^1 + b_1 2^0$$

1 0 1

Example

- M=25, C: '11001' $b = [b_5, b_4, b_3, b_2, b_1]$

$$M = b_5 2^4 + b_4 2^3 + b_3 2^2 + b_2 2^1 + b_1 2^0$$

b_5	b_4	b_3	b_2	b_1
1	1	0	0	1

- The problem is to find b for given M

Example

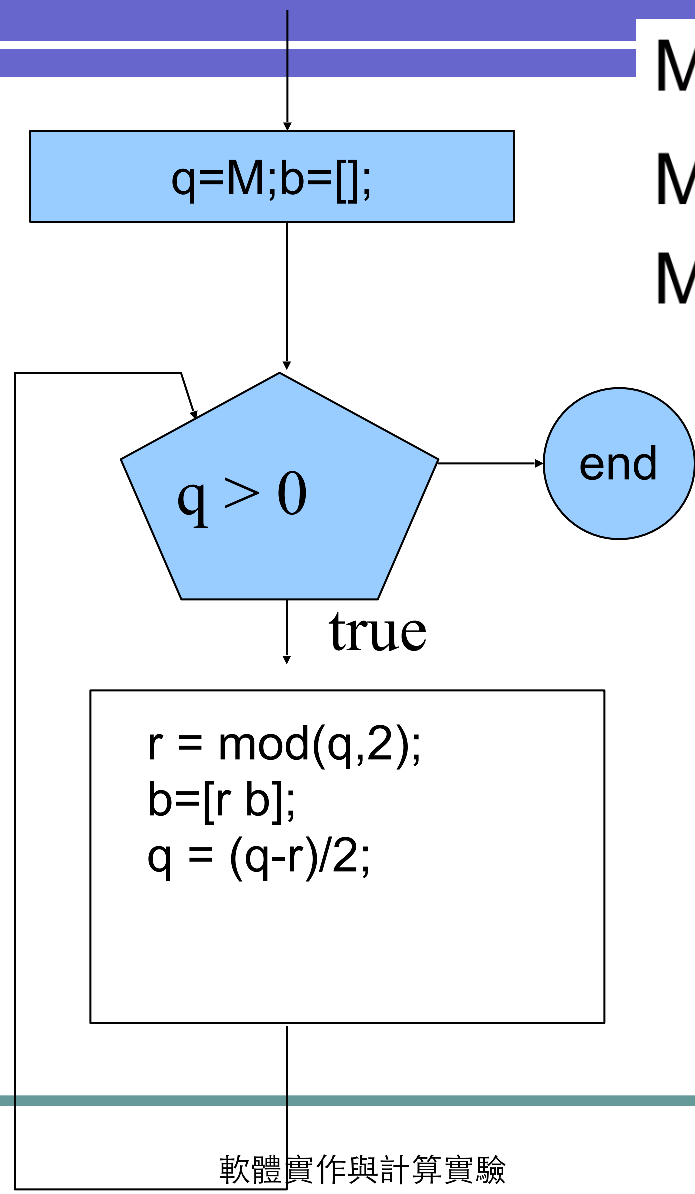
- M > 0 $\quad \mathrm{M} = b_n 2^{n-1} + b_{n-1} 2^{n-2} + \ldots + b_1 2^0$
- M=1, b_1=1
- M=5, b=[1 0 1]
- M=25, b=[1 1 0 0 1]
- The problem is to find b for given M

Determine b

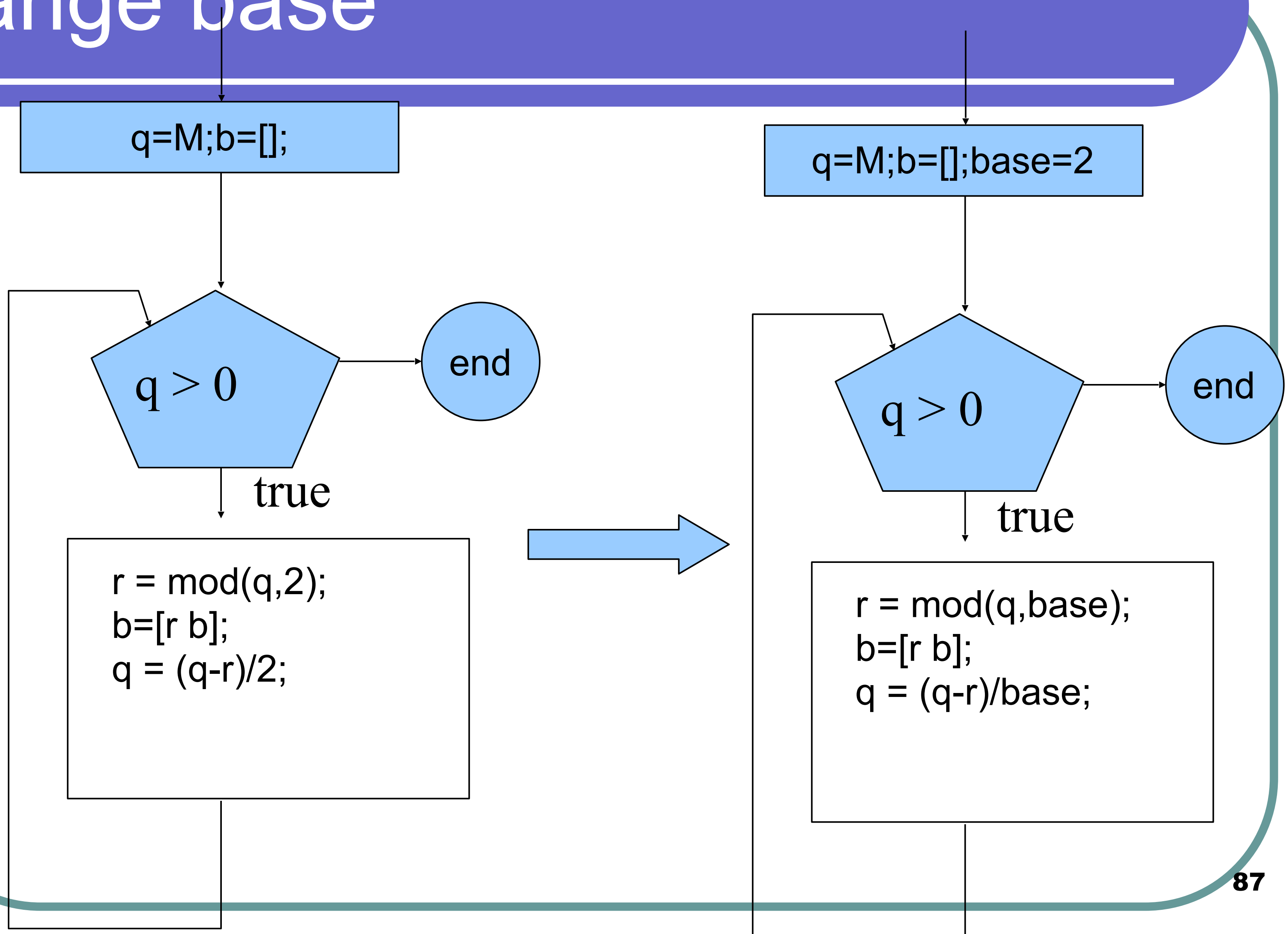
M=1, b_1=1

M=5, b=[1 0 1]

M=25, b=[1 1 0 0 1]

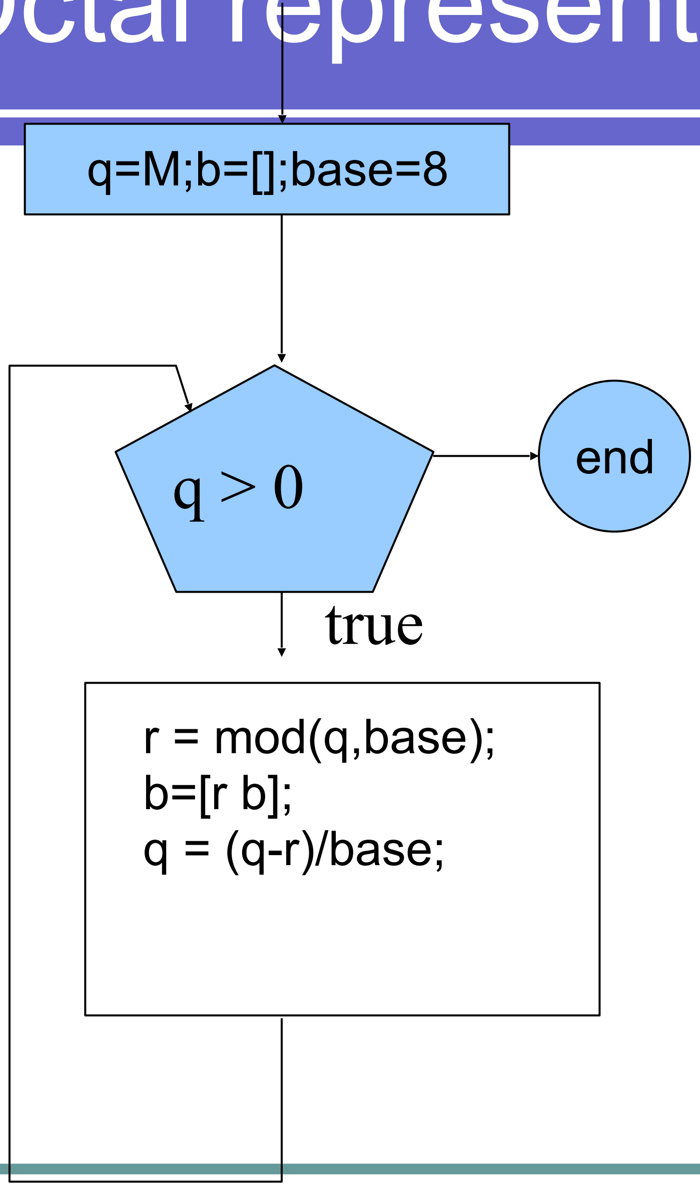


Change base



q=M;b=[];
q > 0
end
true
r = mod(q,2);
b=[r b];
q = (q-r)/2;
q=M;b=[];base=2
q > 0
end
true
r = mod(q,base);
b=[r b];
q = (q-r)/base;

Decimal to Octal representation



```
>> dec2oct(7)

ans =

     7

>> dec2oct(8)

ans =

     1     0
```

```
>> dec2oct(18)

ans =

     2     2

>> dec2oct(64)

ans =

     1     0     0
```