Programming with Matlab

Day 2: More about Loops, Vectors and Matrices

MATLAB, PROS AND CONS:

- **Pros:**

-Graphical Interface.
-Many libraries of predefined functions (TOOLBOXes).
-Easy to plot and represent graphical results.
-Powerful and easy matrix and vector calculus.

- **Cons:**

- Inefficient for exhaustive computation.
- A Java based programming enviroment can be computationally expensive.

More About Loops!

-**While loop**:

Similar to the “for” loop but the number of times the statements in the body are executed can depend on the variable values that are computed in the loop.

Pseudocode

```
while  CONDITION IS TRUE

     DO SOMETHING

end
```

Command Window

```
>> rand
    0.01
```
(generates random number between 0 and 1)

```
>> ceil(1.9)
    2
```
(upper round of the input number)

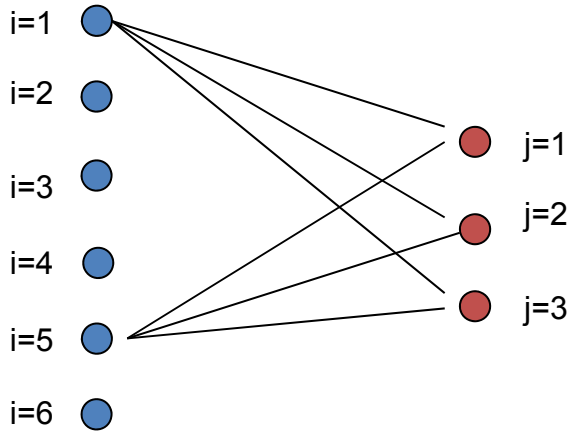
- **Exercise**:

Transform the “pesadito” script into a while loop (with the same output).

More About Loops!

- Nested Loops:

These are loops within loops.



Pseudocode

```
for i=1:6
    for j=1:3

        DO SOMETHING

    end
end
```

- **Exercises**:

1) Write a script that creates a matrix (which will be explained on the next slides!) with the results of multiplying all the numbers from 1 to 5 between them.
2) Extra: Make this script not to compute the same pair twice. (hint: for j = i:N)

Defining Vectors

- Initializing vectors:

Command Window

```
>> vec = [1 8 3 15 7 16];
>>
```

- Vectors as a range of numbers:

Command Window

```
>> vec = [0:4]
vec=
    0  1  2  3   4

>> vec = [1:3:12]
vec=
    1   4   7  10
```

- Accessing vector elements or ranges:

Command Window

```
>>  vec(4)
ans =
   10

>> vec(2:4)
ans =
    4     7    10

>> vec(2:2:4)
ans =
    4    10
```

Manipulating vector elements

- Adding elements

Command Window

```
>> v = [1 8];
>> v = [v 3 4]
v =
    1    8    3    4

>> w = [5 3];
>> q = [4 w]
q =
    4    5    3
```

- Changing single elements

Command Window

```
>> v = [1 4 9 2];
>> v(3) = 1
v =
    1    4    1    2

>> v(2:3)=[9 9]
v =
    1    9    9    2
```

Defining Matrices

- Initializing matrices:

Command Window

```
>> M = [ 2 45 32 ; 65 8 4 ]
 M =
    2   45   32
   65    8    4
```

- Matrices as a range of data:

Command Window

```
>> M = [ 1:8 ; 9:16 ; 17:24 ; 25:32]
M =
   1    2    3    4    5    6    7    8
   9   10   11   12   13   14   15   16
  17   18   19   20   21   22   23   24
  25   26   27   28   29   30   31   32
```

- Accessing matrix elements or ranges:

Command Window

```
>>  M (2,5)
    13

>> M(3,:)
    17  18  19  20  21  22  23  24

>> M(:,3)
     3
    11
    19
    27

>> M(3,1:3)
    17  18  19
```

Some Special Matrices

Command Window

```
>> ones
    1
>> ones(2,3)
    1     1     1
    1     1     1

>>zeros(1,3)
   0     0     0

>>Inf(3,2)
   Inf   Inf
   Inf   Inf
   Inf   Inf

>>NaN(2,1)
   NaN
   NaN
```

2 rows,
3 columns

- Inf: Infinity and NaN: Not-A-Number

Command Window

```
>> 1/0
   Inf

>>Inf/Inf
   NaN

>>NaN+34
   NaN

>>mean([3 4 2 NaN 30])
   NaN

>>mean([3 4 2 Inf 30])
   Inf
```

results too large to represent

undefined numerical results

The same for -,*,/

Operating with vectors and matrices

- Basic operations (element-by-element):

Command Window

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

>> v*5
   5    10    15    20

>> v-3
   -2    -1     0     1

>> v / 6;
>> v * 5.5;
```

Scalar operations are performed element by element.

Command Window

```
>> M = [1 2 ; 3 4 ]
>> N = [2.5 3 ; 2 1]
 M =                          N =
    1    2                       2.5    3.0
    3    4                       2.0    1.0

>> M+N
   3.5    5.0
   5.0    5.0

>> M.*N
   2.5    6.0
   6.0    4.0
```

```
>> M./N;
>> M.^2;
```

The dot indicates an element-by-element operation

Basic functions

- For vectors:

Command Window

```
>>v=[4 8 3 2]
v =
    4    8    3    2

>> length(v)
    4

>> max(v)        >> min(v)
    8                2

>> sum(v)
    17

>> mean(v)      >> std(v)
    4.25             2.63
```

- For matrices:

Command Window

```
>> M=[3 6 1 4; 8 0 2 4]
M =
    3    6    1    4
    8    0    2    4

>>size(M)
    2    4
>>length(M)
    4
```

length of largest dimension

```
>> max(M)
    8    6    2    4

>> sum(M)
    11    6    3    8

>> mean(M)
    5.5   3.0    1.5    4.0
```

operating along columns

2D Graphical Display

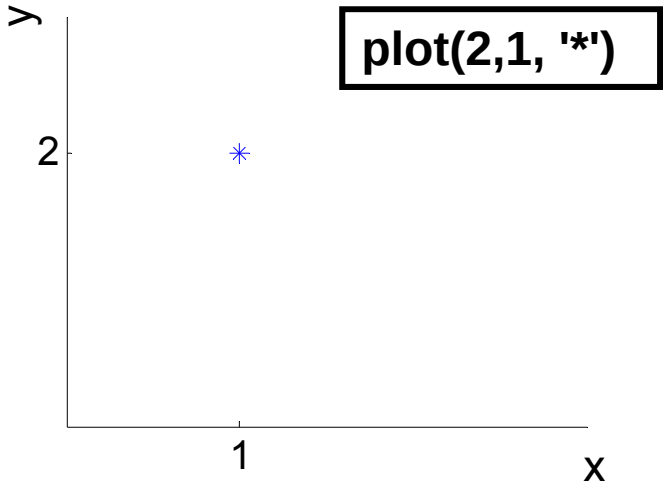
-“Plot” function:

plot(X coord´s, Y coord´s,’properties’)

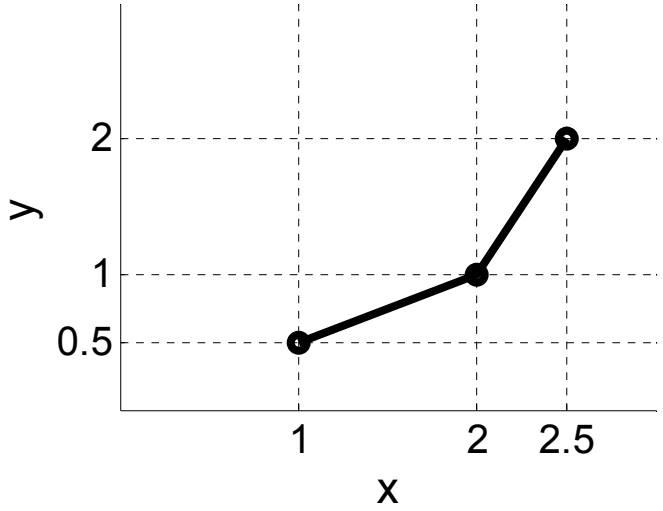
Values for X´s coordinates

Values for Y´s coordinates

Graphic properties (eg. ‘-.r’)



plot(2,1, '*')



plot([1 2 5/2] , [1/2 1 2] ,‘.-k')

2D Graphical Display

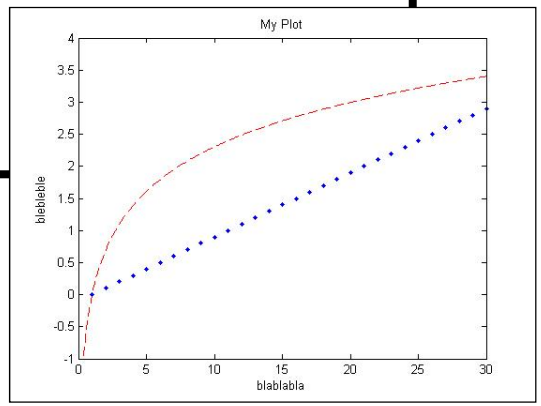
- Example:

Command Window

```
>> x = [0:0.1:100];
>> y = log(x);
>> plot(x,y,'--r');← Style and color

>> xlabel('blablabla');
>> ylabel('blebleble');
>> title('My Plot');

>> axis([xmin xmax ymin ymax])
>> hold on
>> plot(x,'.b')
>> hold off
```



- Exercise :

5) Make a script which represents graphically the following functions:

   i. sin(x)
   ii. sin(2x)
   iii. sin(3x)
   iv. sin(4x)

   $0 < x < 4\,\pi$ (interval size 0.1)

Vectors and loops should be used!!
Try with "hold on"

Exercise of the day!

Protein sequence alignment

Aim: Given a protein sequence, we want to display an alignment against itself, in order to identify graphically similar regions inside the sequence.

Sequence = [‘AAAEYDSLEYDSLGYENEAAAEYDSLEYDSLGYENE’]

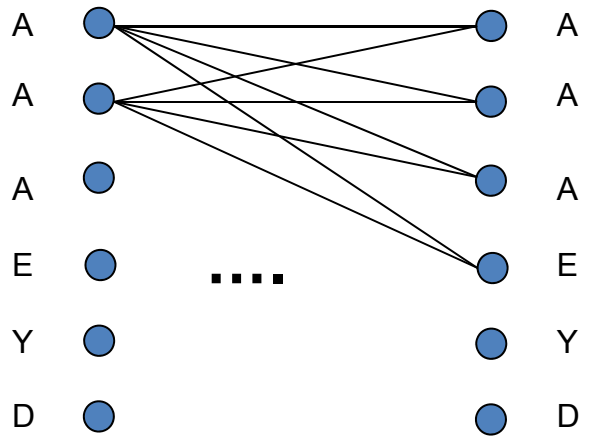
• Hint 1: We want to compare all against all residues

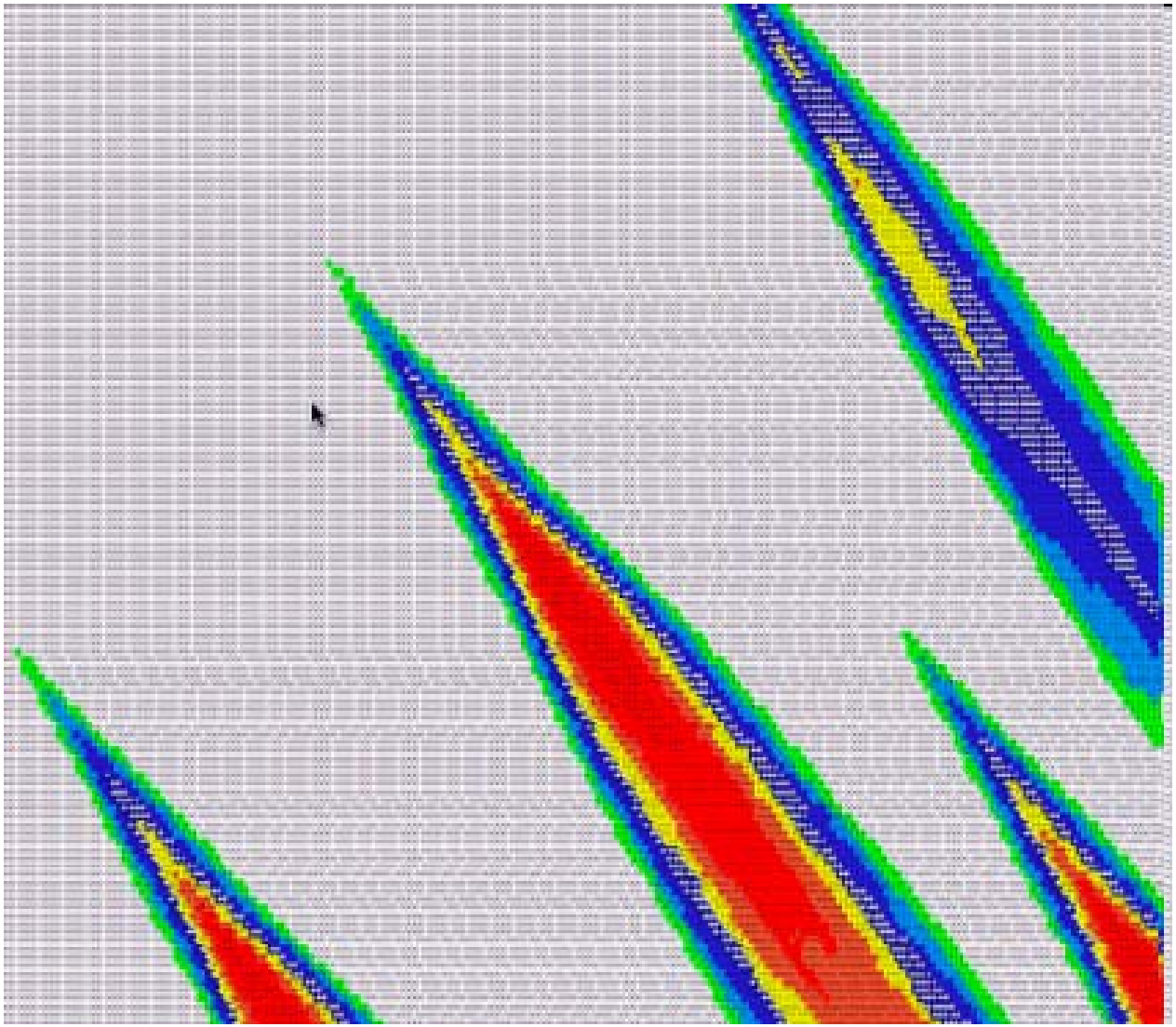
• Hint 2: Question to answer:

$$i == j \Rightarrow 1$$
$$i \mathrel{!}= j \Rightarrow 0$$

• Hint 3: Binary matrix needed…

• Hint 4: Try to display the result graphically with “imagesc(Matrix)” !





Don’t give up, coding can be fun!