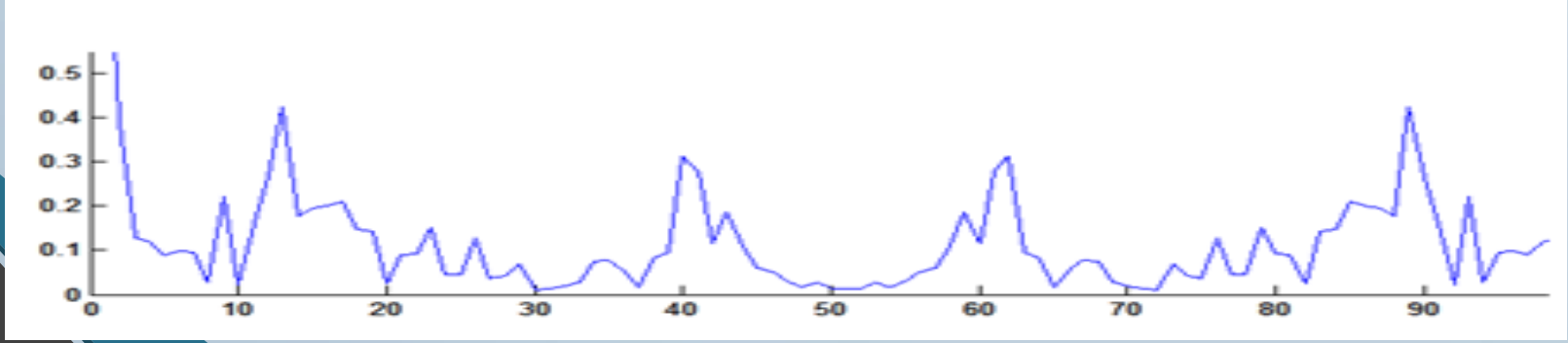
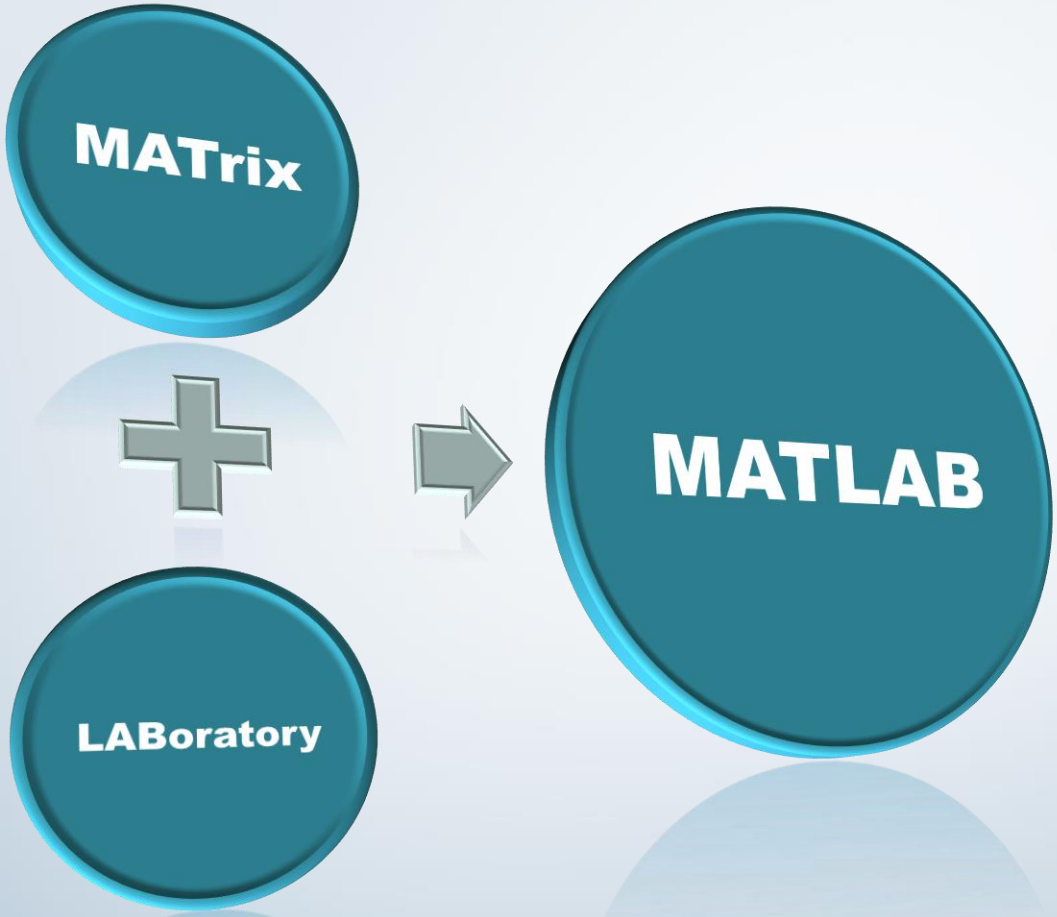
Workshop on Image Processing using MATLAB

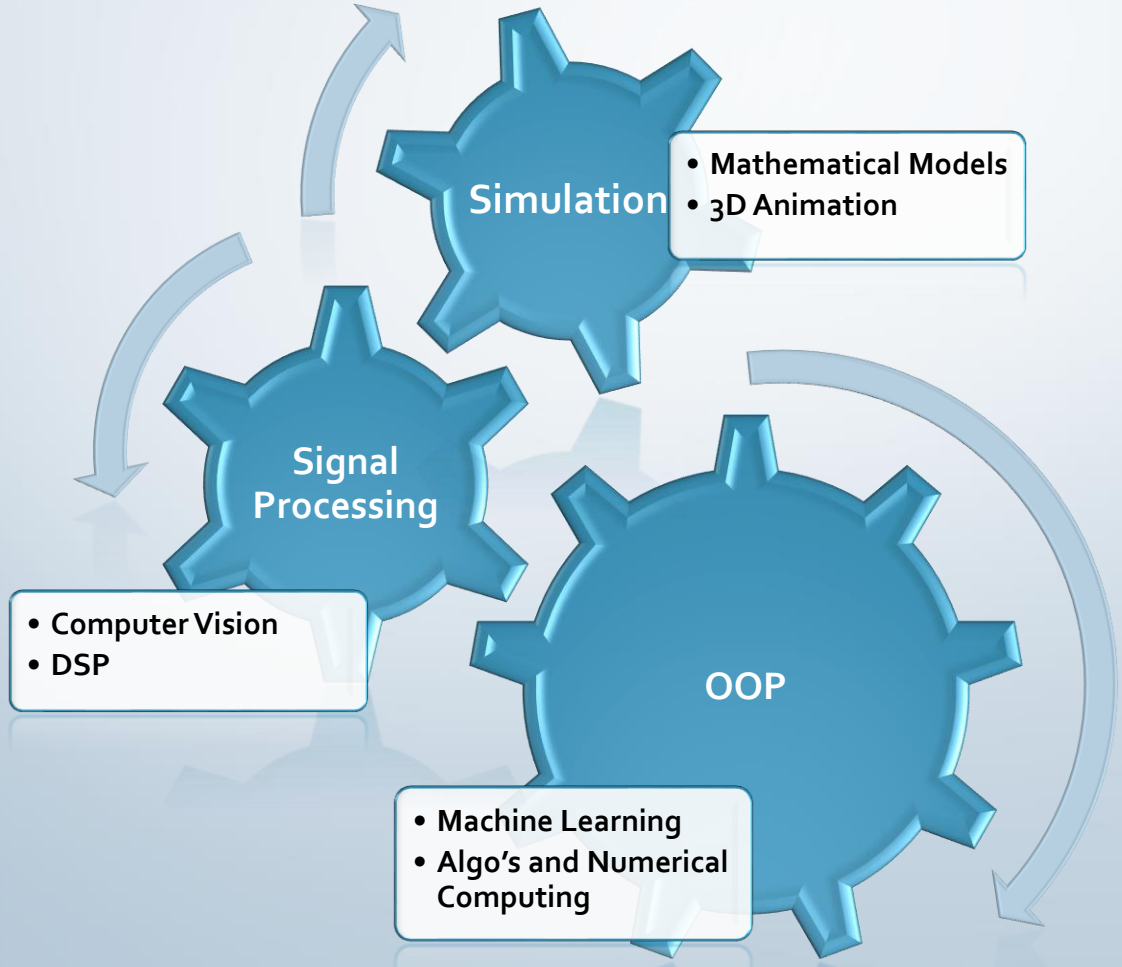




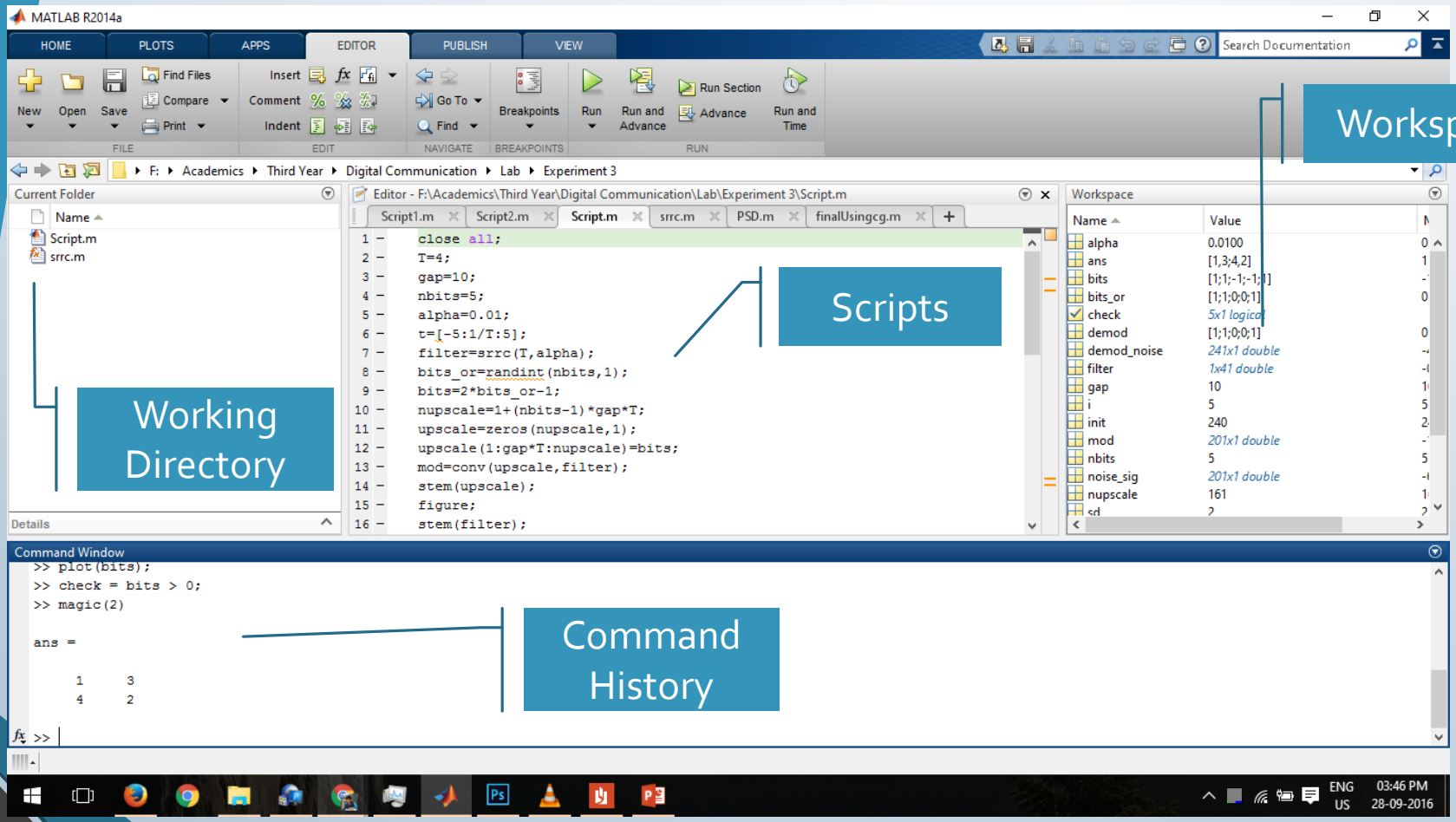
So, Let's have some FUN with Matrices!!

MATLAB

A Fourth Generation Programming Language



Know your MATLAB window



Basics of MATLAB

- Variables
- Creating Arrays
- Indexing Of Arrays
- Operations On Arrays
- Functions
- Control Flow

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Variables

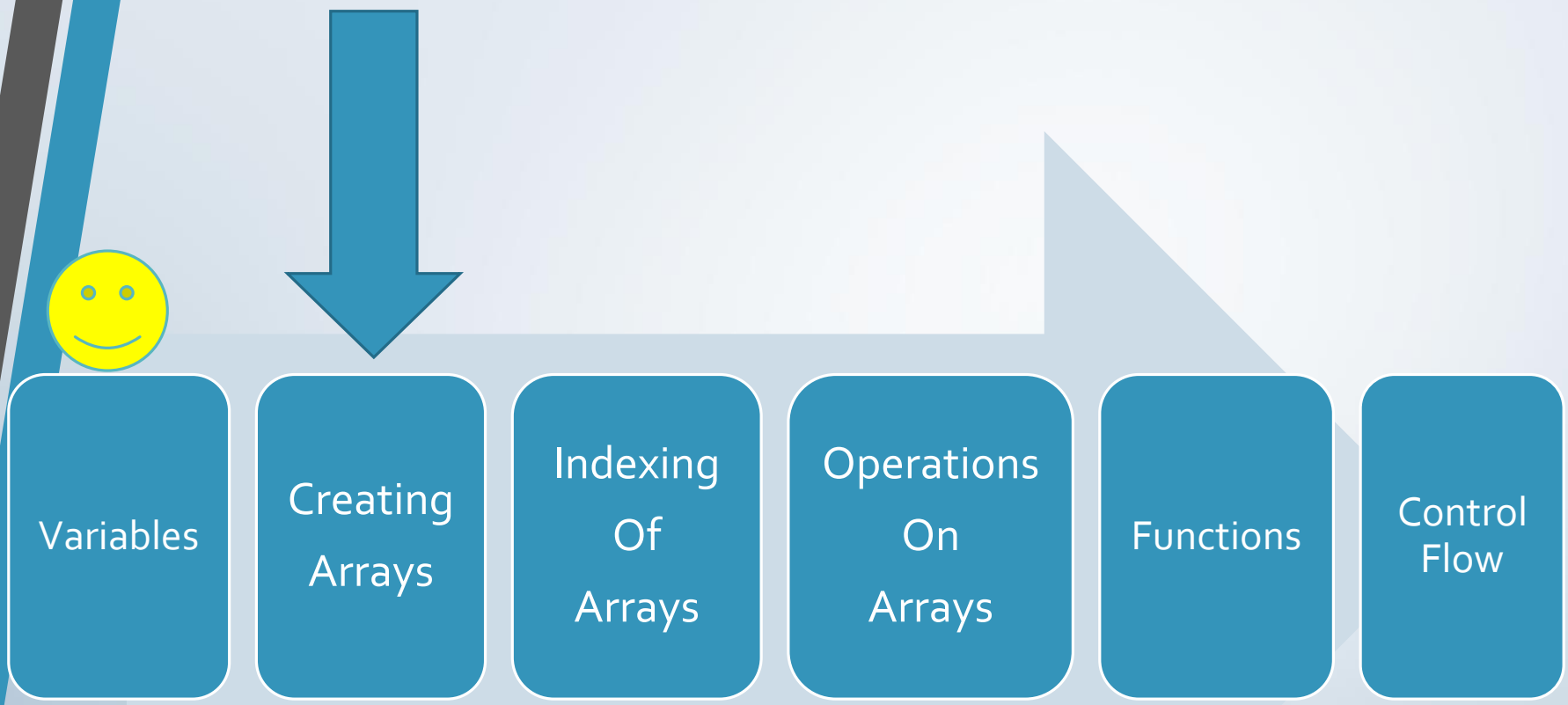
Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
>> a = 2

a =

     2

>> A = 3

A =

     3

>> a

a =

     2

>> 2

ans =

     2
```

Observe that MATLAB is case-sensitive too!

ans is a default MATLAB variable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Creating Arrays

Command Window

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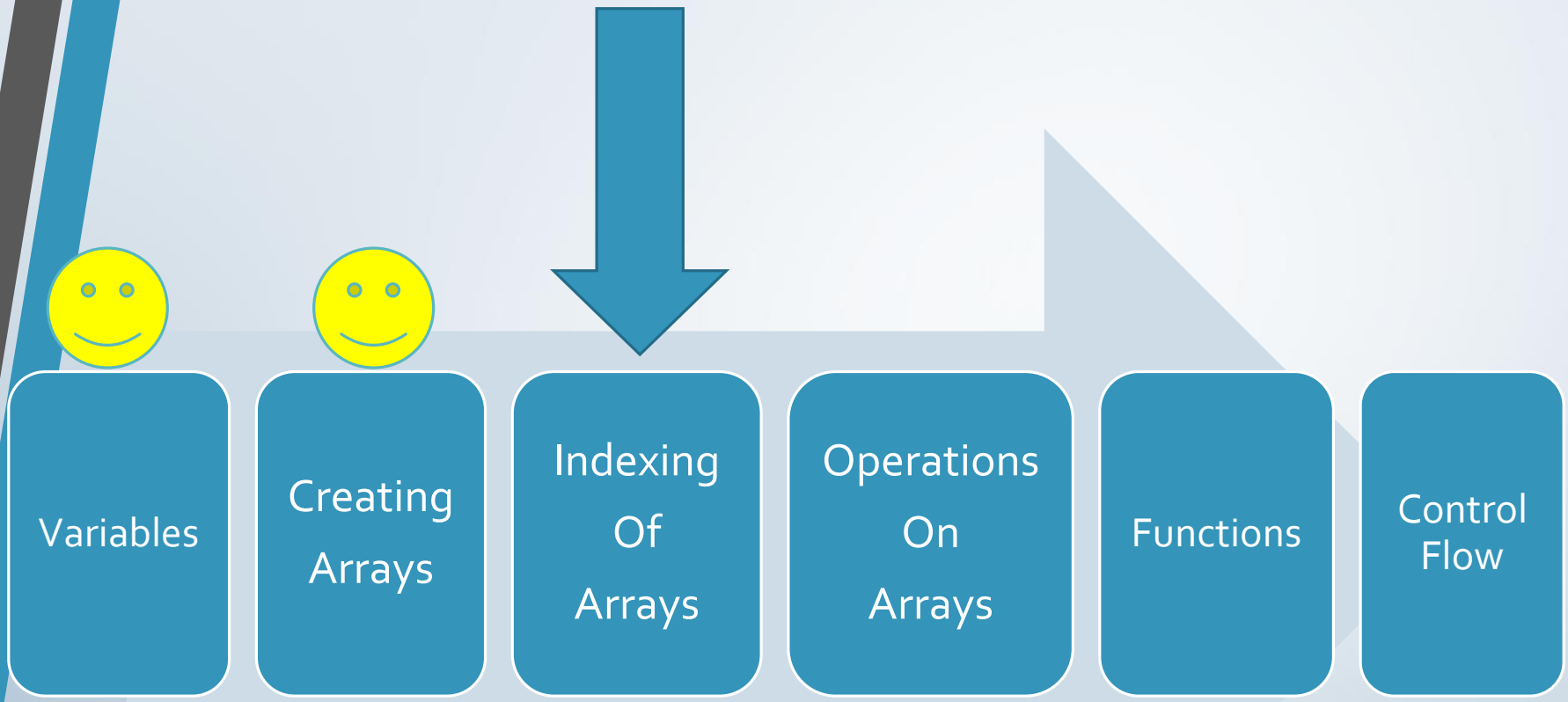
```
>> A = [1,2,3]

A =

     1     2     3

>> B = [1 2 3]

B =

     1     2     3

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

C =

     1     2     3
     4     5     6

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

D =

     1     2     3
```

Commas or spaces! Both will do!

Semi colon is used to suppress output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Indexing of Arrays

Command Window

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```
>> D = [1 2 3; 4 5 6; 7 8 9]

D =

     1     2     3
     4     5     6
     7     8     9

>> D(2,3)

ans =

     6

>> D(1:2, 2)

ans =

     2
     5

>> D(1:2, 2:3)

ans =

     2     3
     5     6
```

Observe that the first element is (1,1) and not (0,0)

The colon operator used for traversal

Indexing of Arrays

Command Window

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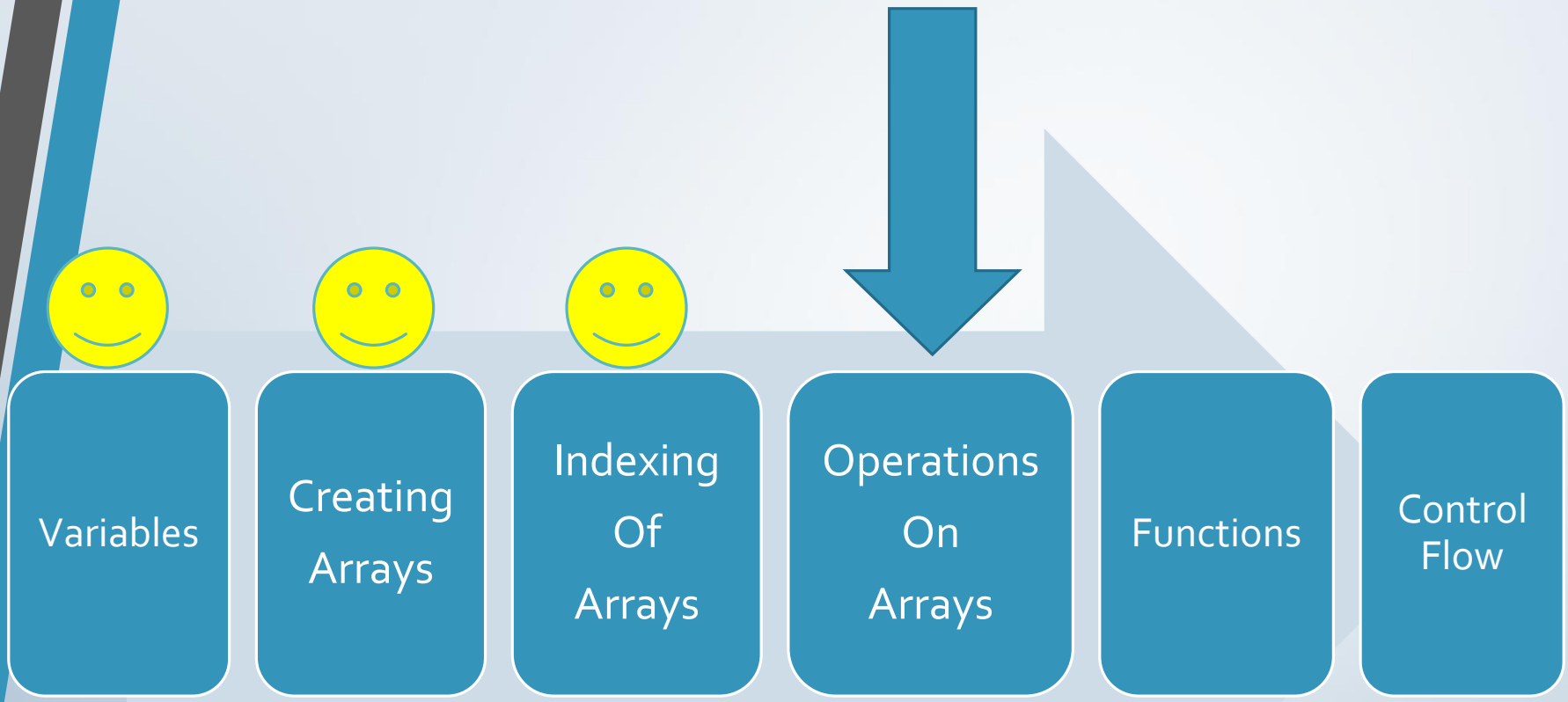
```
>> D

D =

     1     2     3
     4     5     6
     7     8     9

>> D(:, 2)

ans =

     2
     5
     8

>> D(2, :)

ans =

     4     5     6

>> D(:, :)

ans =

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

How to check size of an array??
What if we use different brackets for indexing ????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Operations on Arrays

Command Window

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```
>> D + 2

ans =

     3     4     5
     6     7     8
     9    10    11
```

Matrix + Scalar

```
>> D - 2

ans =

    -1     0     1
     2     3     4
     5     6     7
```

Matrix - Scalar

```
>> D * 2

ans =

     2     4     6
     8    10    12
    14    16    18
```

Matrix * Scalar

```
>> D / 2

ans =

    0.5000    1.0000    1.5000
    2.0000    2.5000    3.0000
    3.5000    4.0000    4.5000
```

Matrix / Scalar

Operations on Arrays

Command Window

```
>> D = [ 5, 10; 15, 20]

D =

     5    10
    15    20

>> E = [10,15;30,45]

E =

    10    15
    30    45

>> D + E

ans =

    15    25
    45    65

>> D - E

ans =

    -5    -5
   -15   -25
```

Matrix + Matrix

Matrix - Matrix

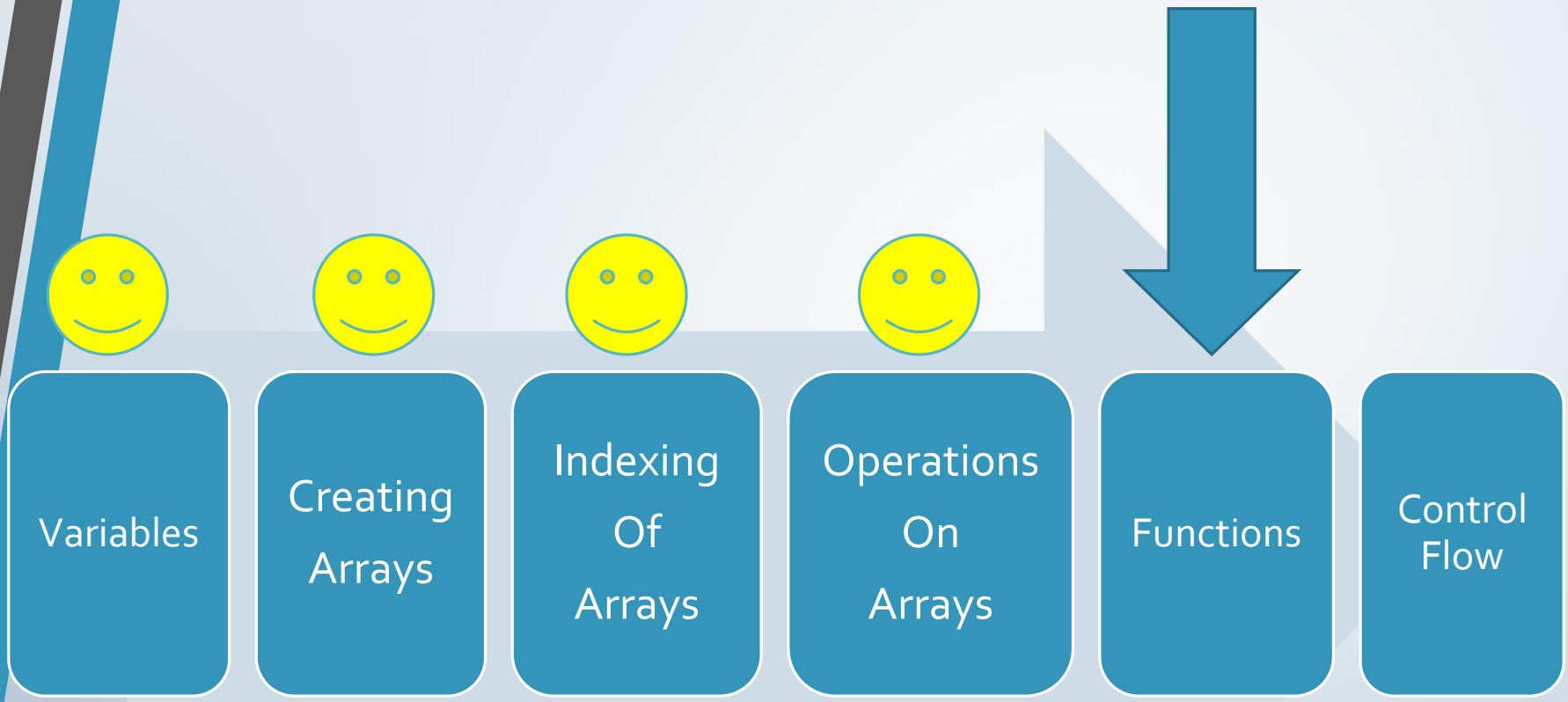
Command Window

```
>> D - E

ans =

    -5    -5
   -15   -25

>> D * E

ans =

       350       525
       750      1125

>> D .* E

ans =

    50   150
   450   900

>> D ./ E

ans =

    0.5000    0.6667
    0.5000    0.4444
```

Product of a Matrix

Dot Product of a Matrix

Dot Division of a Matrix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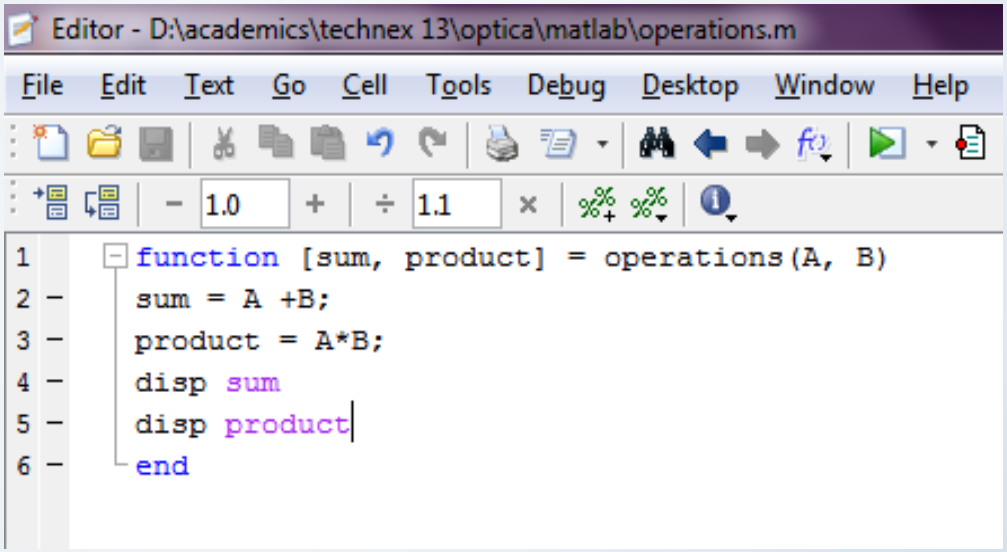
Functions



- **Why functions?**
  - Repeatability
  - Ease of use
- **Function header syntax**:

  function [output variables] = function_name (input variables)

  e.g.

  function[sum, product] = operations(A, B)
- **Remember that the function name and the '.m file' name MUST be the same.**

Functions

Command Window

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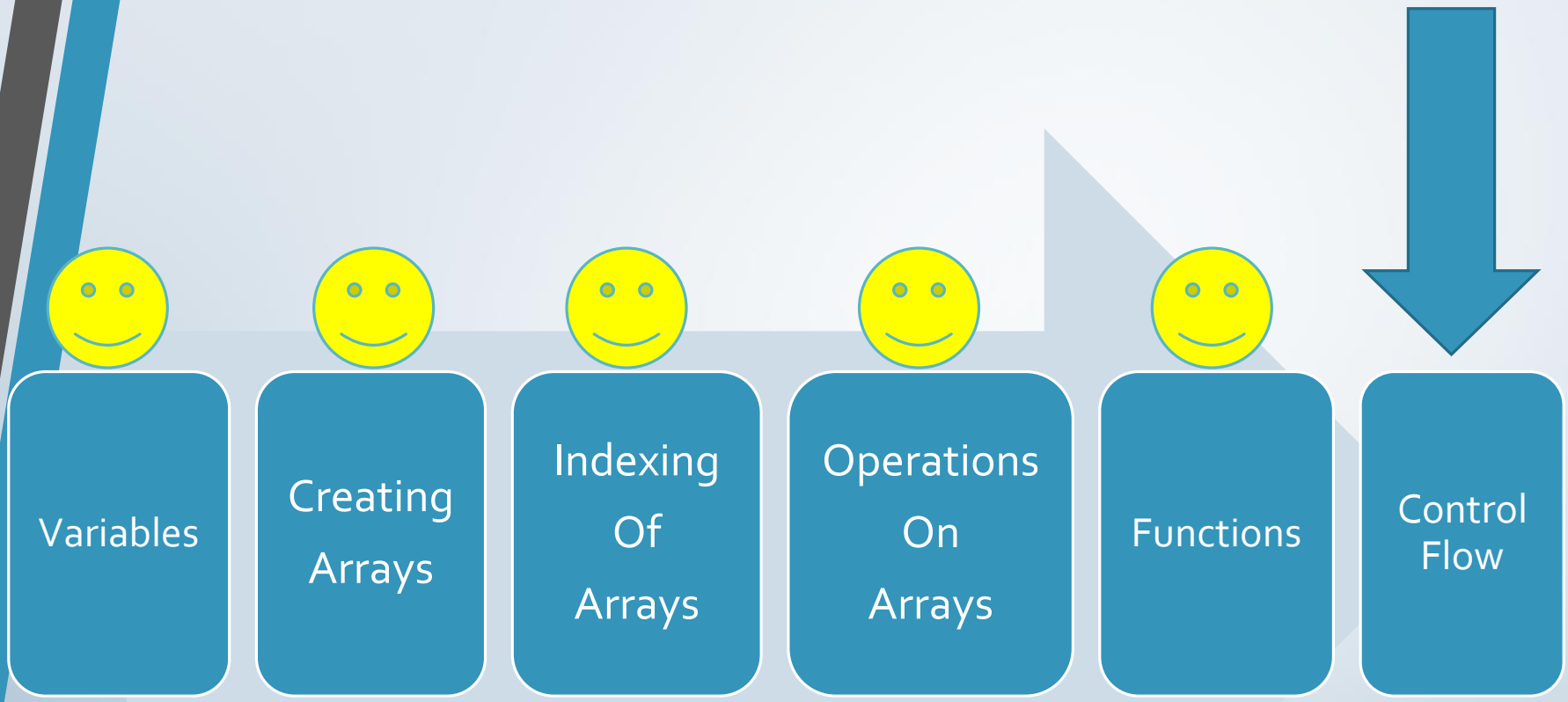
```
>> C = D + 2

C =

     3     4     5
     6     7     8
     9    10    11

>> [s, p] = operations(C, D)

s =

     4     6     8
    10    12    14
    16    18    20


p =

    54    66    78
    90   111   132
   126   156   186

>> [s, p] = operations(C, D);
>>
```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Control Flow Statements

Editor - D:\academics\technex 13\optica\matlab\control_flow.m

```
function [] = control_flow()
i = 0; j = 0;

disp('while loop');
while i < 5
    disp (i)
    i = i+1;
end

disp('for loop');
for j = 0:3:9
    disp (j)
end

disp('if else if statement');
if j == 9
    disp ('Completely Closed Interval')
elseif j == 8
    disp ('Semi Closed Interval')
else
    disp ('j is neither 8 nor 9')
end

end
```

Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Sta

```
while loop
     0

     1

     2

     3

     4

for loop
     0

     3

     6

     9

if else if statement
Completely Closed Interval
>>
```

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A Few Commands

Command Window

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```
>> who

Your variables are:

A    B    C    D    a    ans  b    c    im   im1  p    s

>> whos
  Name         Size                    Bytes  Class     Attributes

  A            1x3                        24  double
  B            1x3                        24  double
  C            3x3                        72  double
  D            3x3                        72  double
  a            1x1                         8  double
  ans          3x3                        72  double
  b           13x13                     1352  double
  c            1x5                        40  double
  im         287x250x3                215250  uint8
  im1         75x100x3                 22500  uint8
  p            3x3                        72  double
  s            3x3                        72  double

>> clear
>> who
>> whos
>>
```

The command '*clc*' clears the screen of the command window

The command '*help*' helps. A LOT.

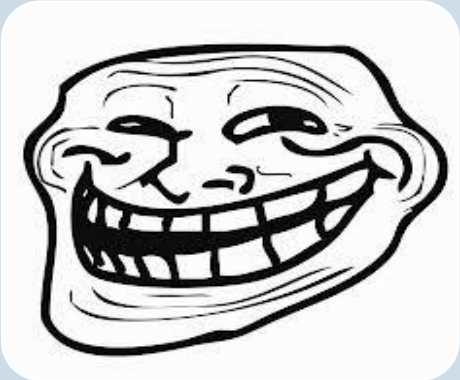
A Few Functions

- Trigonometric: sin(), sind(), cos(), cosd(), etc
- Inverse trigonometric: asin(), asind(), acos(), acosd(), etc
- min(), max()
- size()
- sort()
- zeros()
- ones()
- eye()

Finally, Enough of Basics!

Let's have some Images!! :D

Images



Black and White

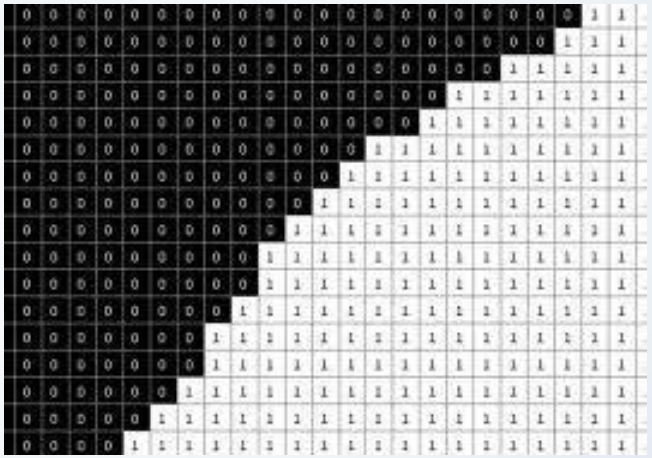
(Binary)

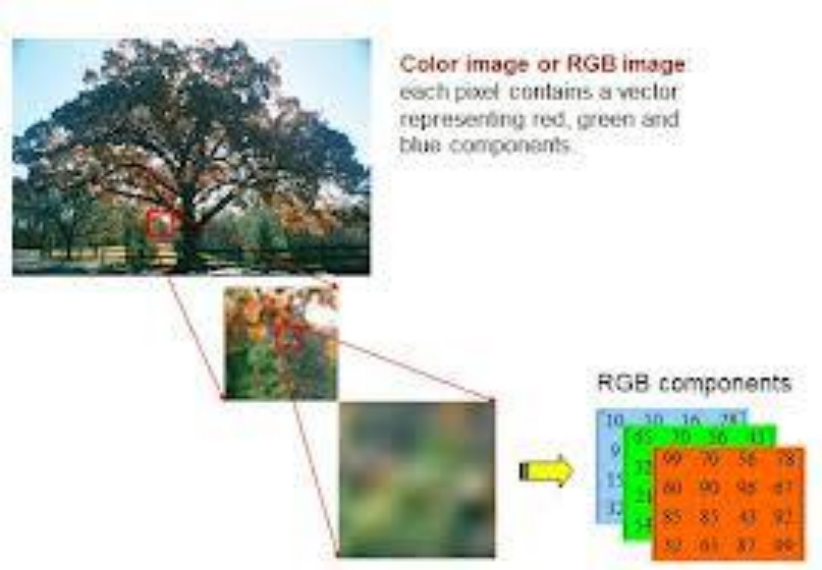
Gray scale

Colour

Images in MATLAB

- Each image is seen as a matrix of size equal to the *number of pixel rows* x *number of pixel columns*
- Each pixel has a value of intensity
- Each element of the matrix contains the value of this intensity at the corresponding to the pixel it represents





Images in MATLAB (Contd.)

Binary

- All the elements of the matrix are either zero or one
- Zero represents black and 1 represents white

Gray scale

- All the elements of the matrix lie between 0 and 255
- Zero represents Black, 255 represents White and the intermediate values represent shades of Gray.

RGB

- Each color has a specific RGB value!
- RGB Images are seen as 3D matrices with the 1st plane corresponding to R, 2nd to G and 3rd to B

Working with Images

Basics

- imread()
- imshow()
- imtool()

Pre-Processing

- imcrop()
- imresize()

Analysis

- Basic Analysis using Data Cursor
- Conversion to Binary i.e. im2bw()
- L-Matrix i.e bwlabel()
- B-Matrix i,e, bwboundaries()
- regionprops()

Processing

- Morphological Operations
- Contrast Enhancement
- Histogram Equalization
- Image Smoothing
- Blurring

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Processing

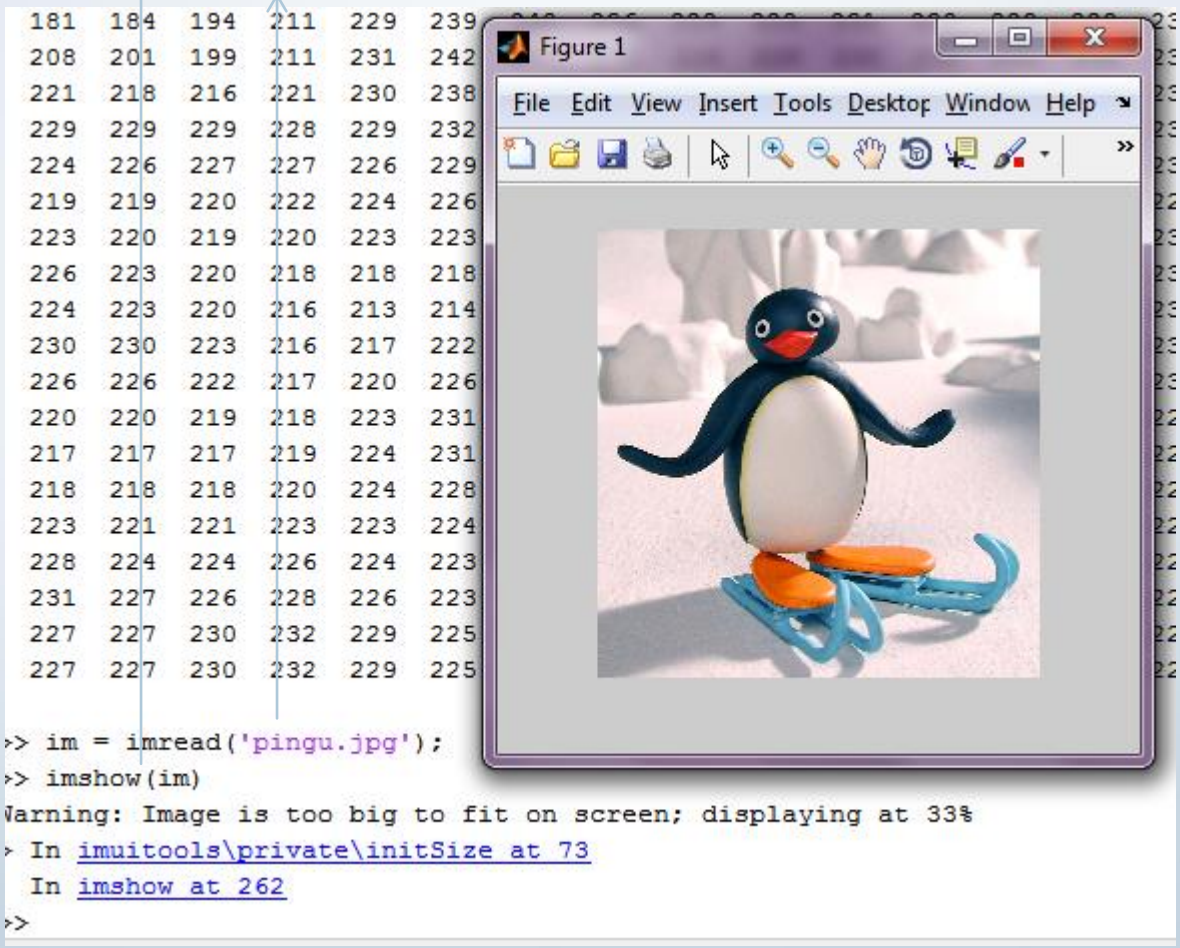
- Noise Removal / Noise Reduction
- Contrast Enhancement
- Histogram Equalization
- Image Smoothing
- Blurring

Basics

- imread(): Reads the image as a matrix
- imshow(): Shows the image as an 'image'
- imtool(): Same as imshow but with different tools

The input argument: A Matrix

The input argument: File name along with extension



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Pre-Processing

- imcrop():
  - imcrop(im) : Interactive crop tool
  - imcrop(im, [x1,y1,x2,y2])

- imresize():
  - imresize(im, 0.5)
  - imresize(im, [200, 200])
  - imresize(im, [200, NaN])or imresize(im, [NaN, 200])
  - imresize(im, 0.5, ‘nearest’) or imresize(im, 0.5, ‘bilinear’) or imresize(im, 05, ‘bicubic’)

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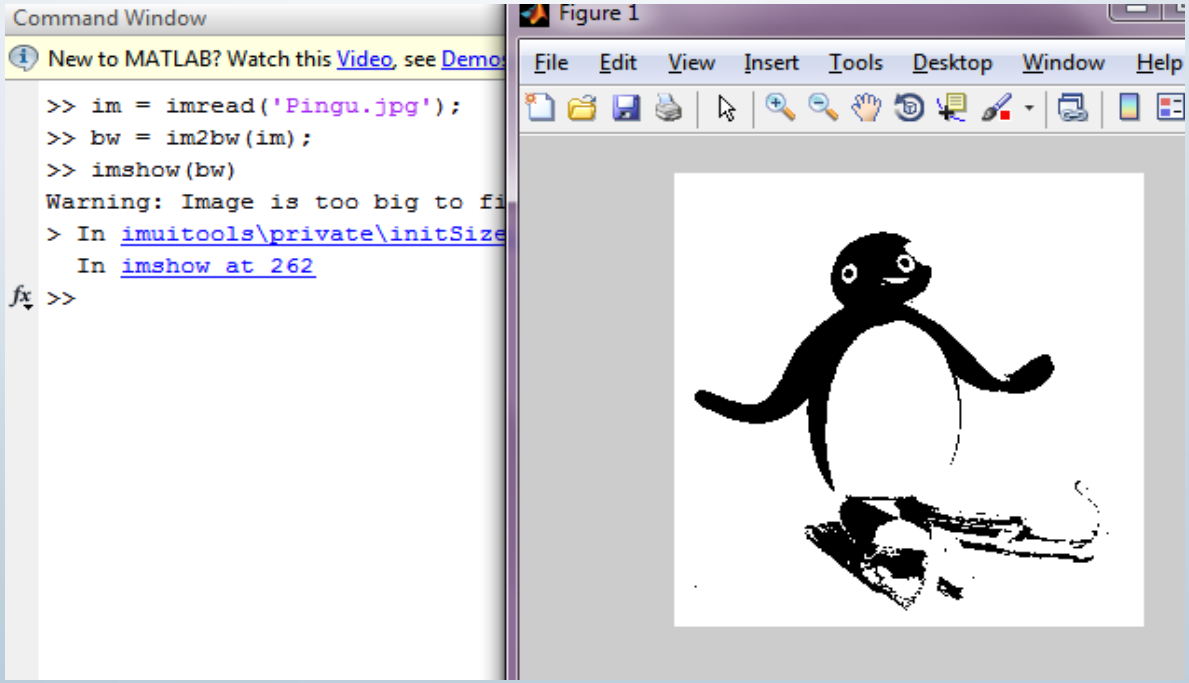
Conversion to Binary (stay tuned for more)

- Why converting?
  - Less information in binary => Computational Ease
  - Can focus on only the area of interest
  - Most of the analysis can be done on Binary only

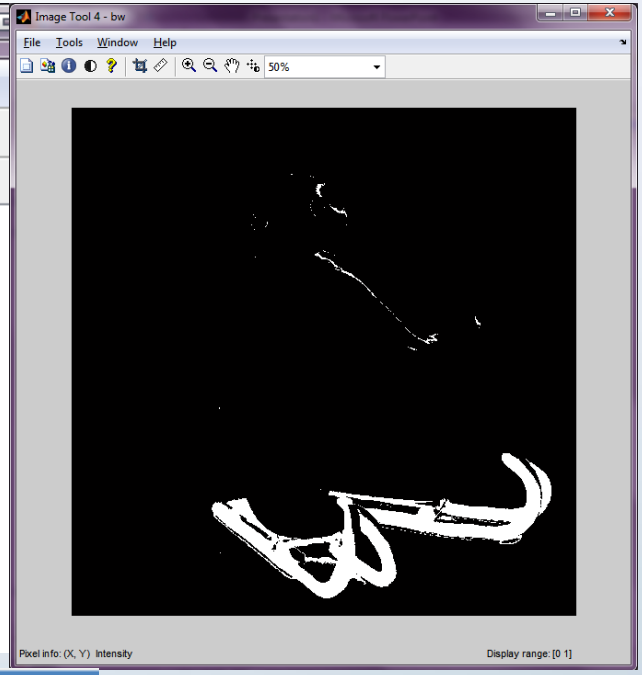
- im2bw(): This function converts a RGB image to a binary image



How to set the threshold ourselves??

Editor - C:\Users\abhiman\Desktop\convert.m

```
function[bw] = convert(im)
[m,n,h] = size(im);
bw = zeros(m,n);
for i = 1:m
    for j = 1:n
        if im(i,j,1) < 120 && im(i,j,2) < 190 && im(i,j,3) > 120
            bw(i,j) = 1;
        end
    end
end
end
```



Command Window

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```
>> pingu = imread('Pingu.jpg');
>> skates = convert(pingu);
>> imtool(skates)
>>
```

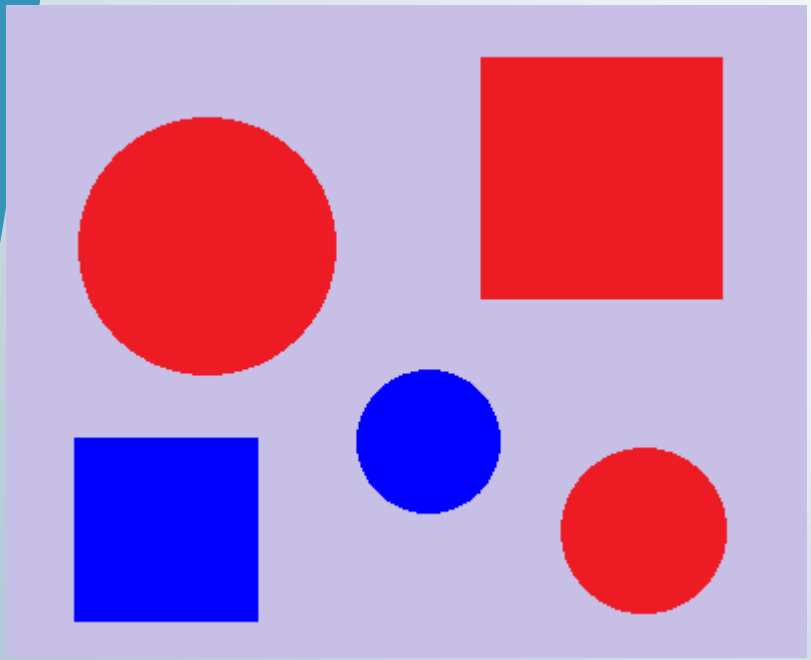
bwlabel() and L-matrix

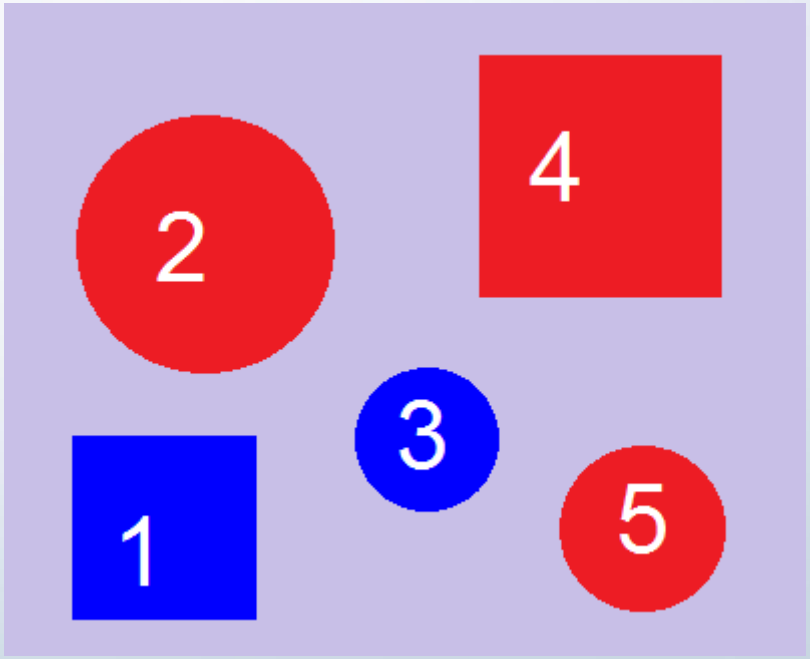
- bwlabel(binary_image) will return a L-matrix which basically the Label matrix
- L-Matrix is a 2 D matrix of the same size as that of the image.
- The various objects present in an image are given filled with the pixels of the same value, the object number.
- Object number is decided by traversing from left to right and then top to bottom as tie-breaker.
- Each object in the binary image is numbered 1,2,3,…. and all the pixels of L corresponding to the objects in binary image have value respectively 1, 2, 3,….
- The background pixels are 0 by default.

- L = bwlabel(bw);

  imtool(bw);

L-matrix labels

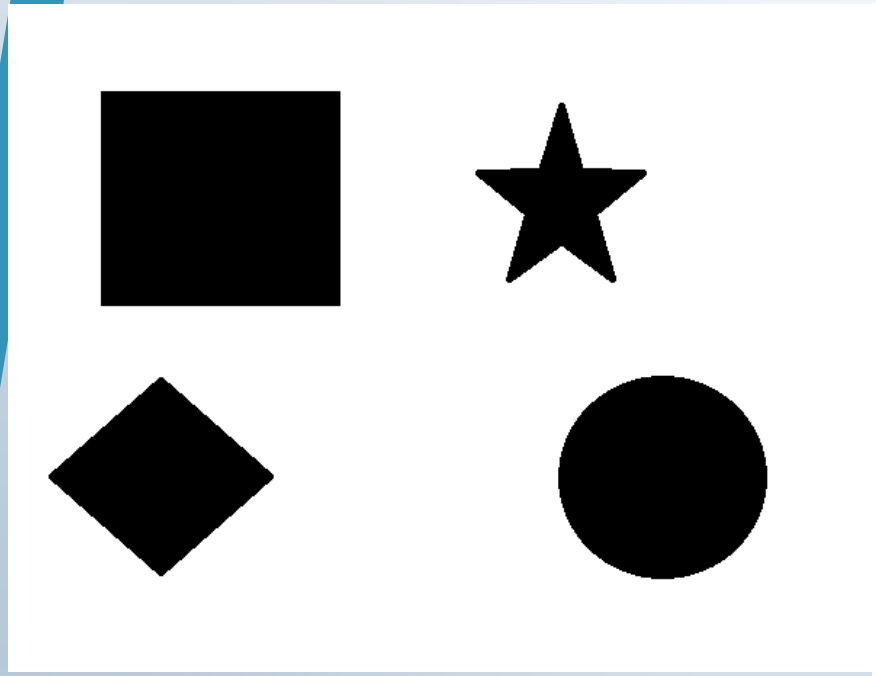


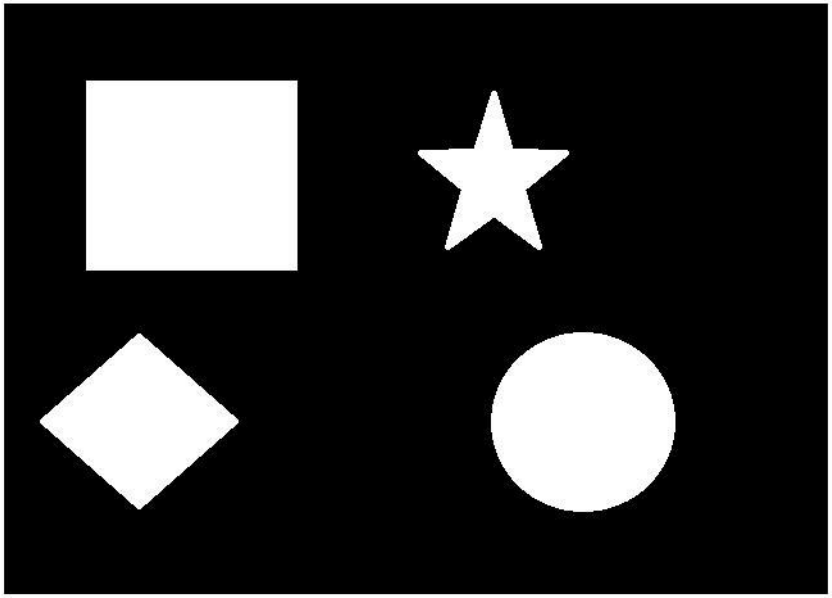


Algorithm :BwLabel

- Bwlabel works on the concept of connected regions.
- It starts from the left top most pixel and travels column wise(left to right and top to bottom).
- It keeps a record of all the pixels it has visited and never visits the ones which it has already visited.
- Black(pixel value 0) is considered background and white (pixel value 1) is considered as an object.
- If at all it finds a white pixel,it continues it search in the eight directions from the pixel marking every pixel visited as read.
- Bwlabel(BW,4) searches only in four directions.

Difference and no of objects,area





Do They have the same no of objects?
Background is always black (pixel value
max(L(:));
Sum(sum(L==1));

regionprops()

- It is used to measure properties of image regions like centroid, perimeter, area, etc.
- Syntax:

```
STATS=regionprops(L, properties);
```

- `STATS` is a structure array of length equal to the number of labelled objects in L.
- `properties` are a comma-separated list of various properties to be measured.

syntax

- Stats=regionprops(L, ‘area’, ‘perimeter’);
- 1st object properties
- Stats(1)
- Area
- Stats(1).Area

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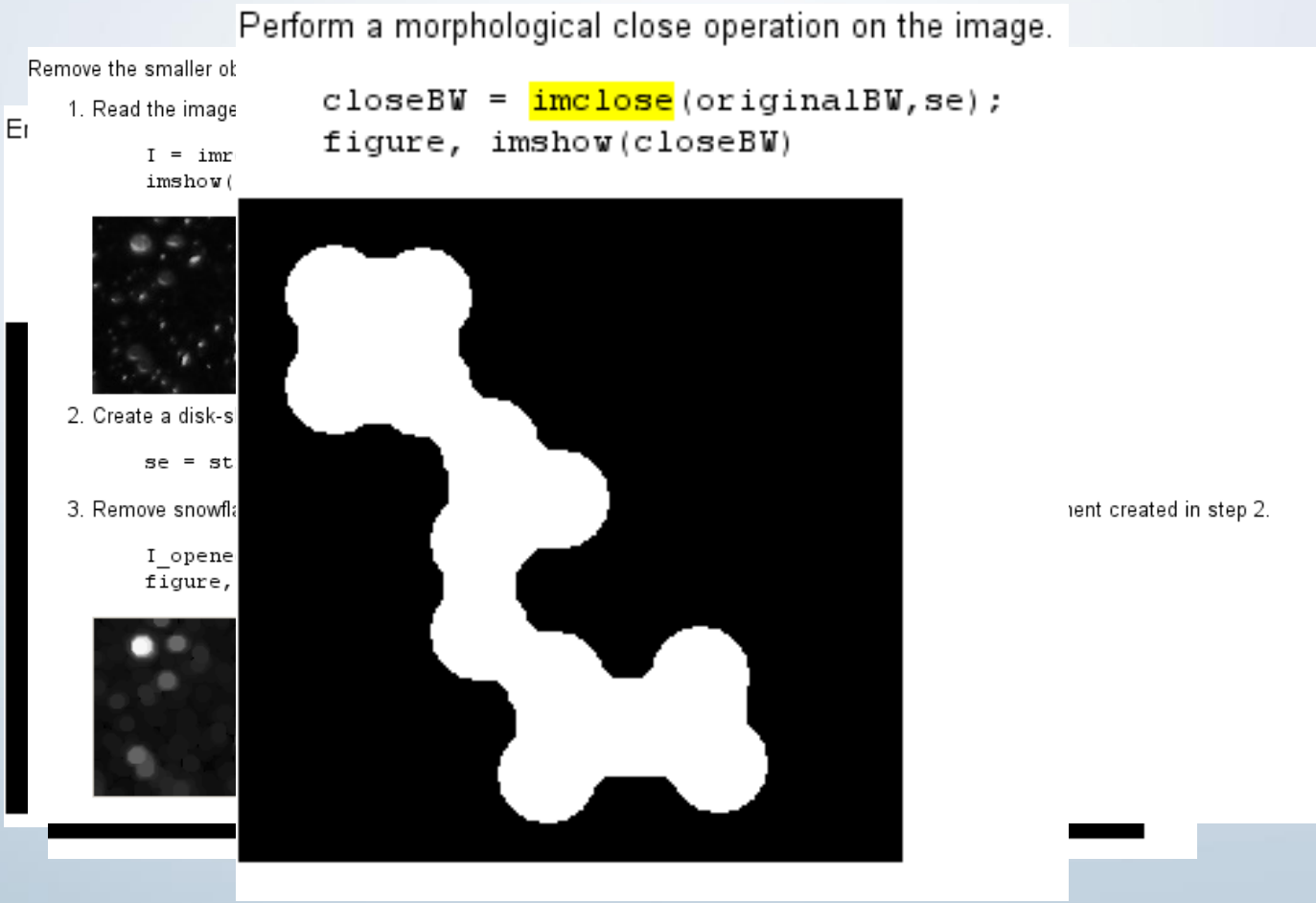
Morphological Operations

- imerode()
- imdilate()
- imopen()
- imclose()
- imfill()
- bwmorph()
- bwperim()



Contacts

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