MATLAB Image Processing Toolbox

Basic Introduction

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- A high-level language for matrix calculations, numerical analysis, and scientific computing
- Programming
  - Can type on command line, or use a program file (“m”-file)
  - Semicolon at end of line is optional (suppresses printing)
  - Control flow (if, for, while, switch,etc) similar to C
  - Differences from C: no variable declarations, no pointers

Why MATLAB?

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- Shorter code, faster computation

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- Focus on ideas, not implementation

$$f(x) = 2{\cdot}\sin(x^3)/3{+}4.56, x \in \{1, 3, 5, \ldots, 9999\}$$

  - C:

```
#include <math.h>
double x, f[500];
for( x=1.; x < 1000; x=x+2)
    f[(x-1)/2]=2*sin(pow(x,3.))/3+4.56;
```

  - MATLAB:

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    f=2*sin((1:2:1000).^3)/3+4.56;
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But: scripting language, interpreted, can be slow

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  - Neighbourhood and block operations
  - Linear filtering and filter design
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  - Neighbourhood and block operations
  - Linear filtering and filter design
  - Transformations
  - Image analysis and enhancement
  - Morphological image operations
  - And many more….

Images in MATLAB

Images in MATLAB

•MATLAB can import/export several image formats:

- –BMP (Microsoft Windows Bitmap)
- –GIF (Graphics Interchange Files)
- –HDF (Hierarchical Data Format)
- –JPEG (Joint Photographic Experts Group)
- –PCX (Paintbrush)
- –PNG (Portable Network Graphics)
- –TIFF (Tagged Image File Format)
- –XWD (X Window Dump)
- –raw-data and other types of image data

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- Data types in MATLAB
  - –Double (64-bit double-precision floating point)
  - –Single (32-bit single-precision floating point)
  - –Int32 (32-bit signed integer)
  - –Int16 (16-bit signed integer)
  - –Int8 (8-bit signed integer)
  - –Uint32 (32-bit unsigned integer)
  - –Uint16 (16-bit unsigned integer)
  - –Uint8 (8-bit unsigned integer)

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- Binary images: {0,1}

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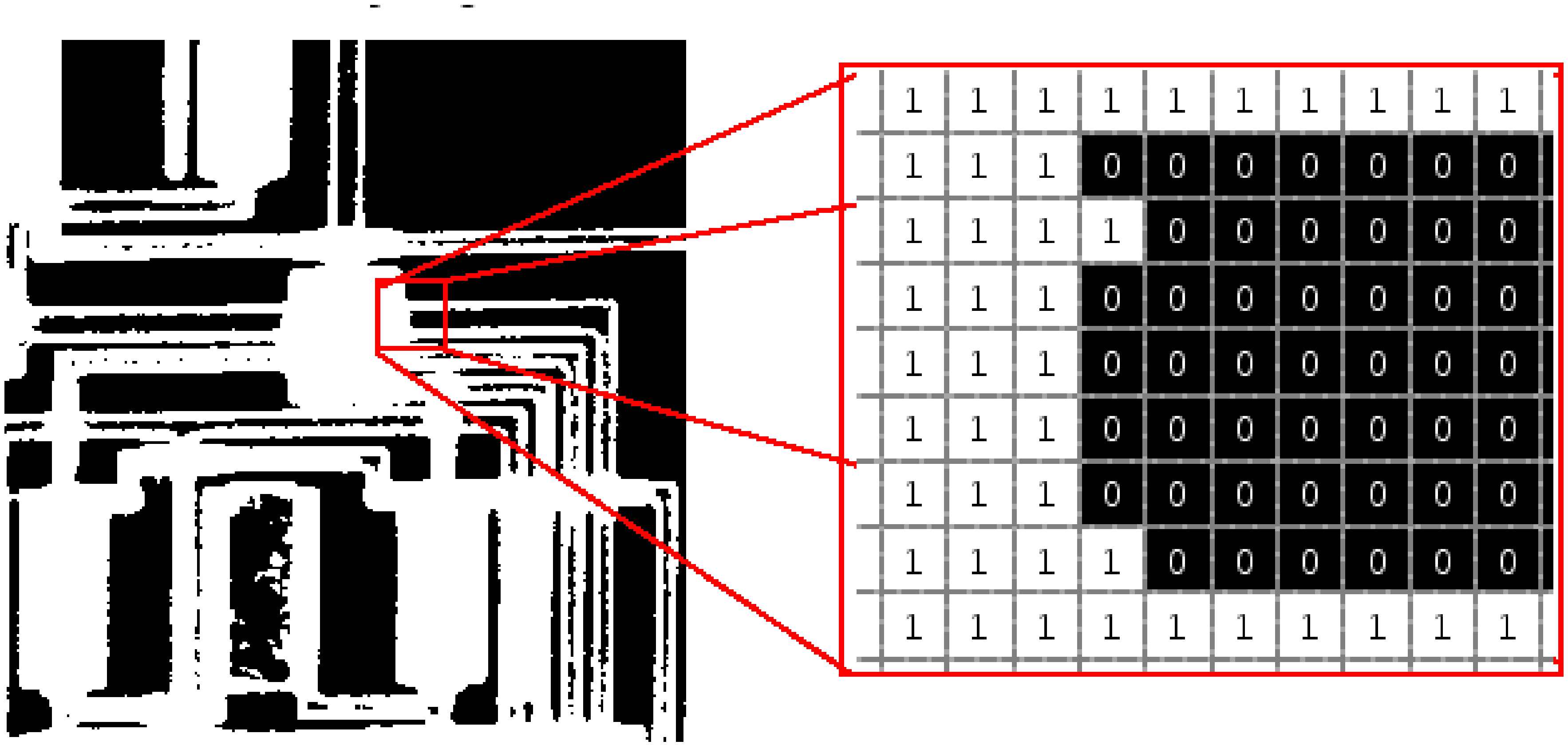

1	1	1	1	1	1	1	1	1	1
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1

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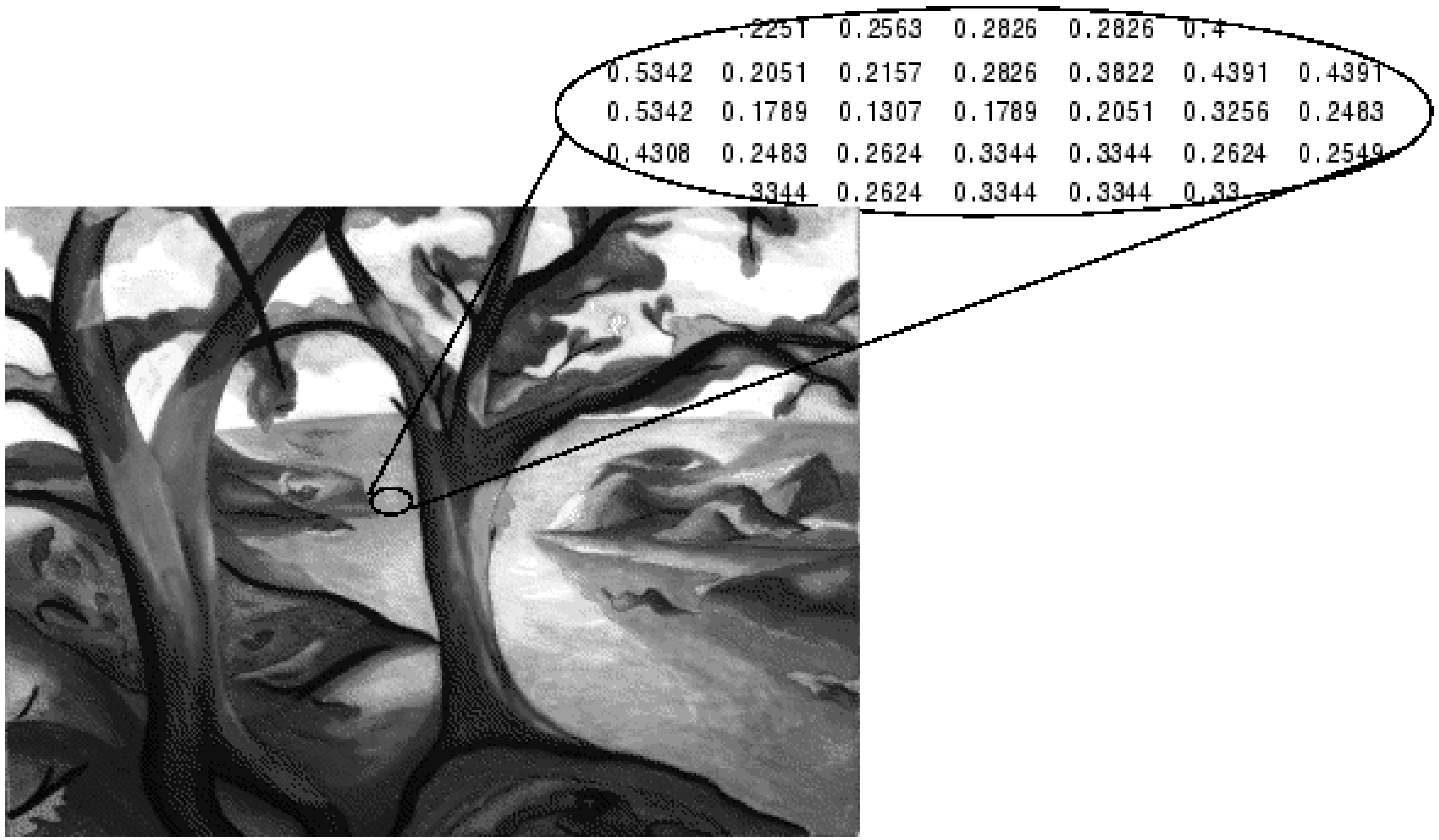

```
      .2251  0.2563  0.2826  0.2826  0.4
0.5342  0.2051  0.2157  0.2826  0.3822  0.4391  0.4391
0.5342  0.1789  0.1307  0.1789  0.2051  0.3256  0.2483
0.4308  0.2483  0.2624  0.3344  0.3344  0.2624  0.2549
       3344  0.2624  0.3344  0.3344  0.33
```

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- RGB images : m × n × 3

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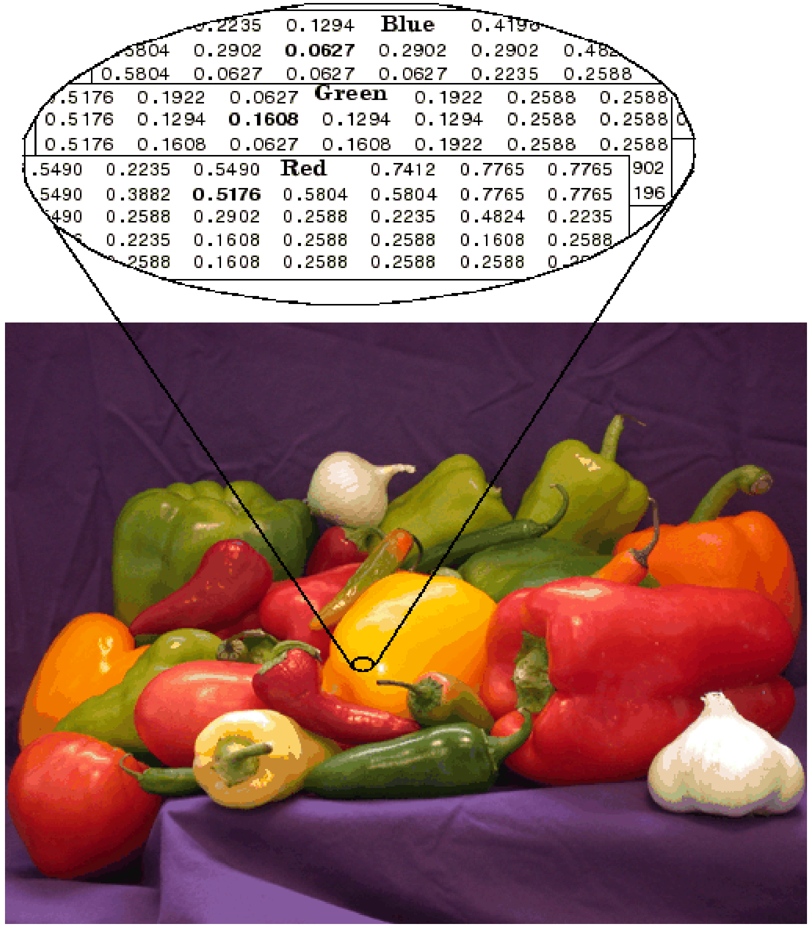
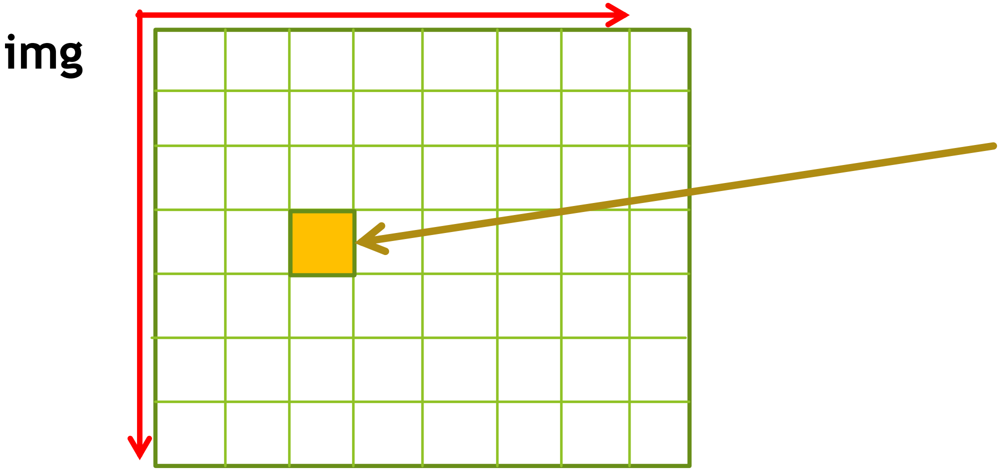


```
 .2235   0.1294   Blue     0.4196
.5804   0.2902   0.0627   0.2902   0.2902   0.482
0.5804   0.0627   0.0627   0.0627   0.2235   0.2588
.5176   0.1922   0.0627   Green    0.1922   0.2588   0.2588
0.5176   0.1294   0.1608   0.1294   0.1294   0.2588   0.2588
0.5176   0.1608   0.0627   0.1608   0.1922   0.2588   0.2588
.5490   0.2235   0.5490   Red      0.7412   0.7765   0.7765   902
.5490   0.3882   0.5176   0.5804   0.5804   0.7765   0.7765   196
490     0.2588   0.2902   0.2588   0.2235   0.4824   0.2235
        0.2235   0.1608   0.2588   0.2588   0.1608   0.2588
.2588   0.1608   0.2588   0.2588   0.2588   0.2
```

MATLAB Image Coordinates

- MATLAB stores images as matrices
- In MATLAB, image pixels are referenced using **(row, col)** values
- Origin of the coordinate system **(1,1)** is the top left corner of the image



Thus, **img(4,3)** refers to the pixel at the 4th row and 3rd column.

Image Matrix

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  - Each pixel has values in the range [0,255]

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- For some function you may need to convert image to double format
  - Double format has pixel values in the range [0,1]
  - To convert any image format to double, use MATLAB function “im2double()”

```
e.g.: A = imread(‘filename.extension’);
        A_double = im2double(A);
```