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Image Processing in MATLAB

C. M. Chandrashekar

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Image Processing Toolbox

Collection of function to extend numeric computing environment of MATLAB. Supports wide range of image processing operations :

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- Geometric operations

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- Image analysis and enhancement

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Collection of function to extend numeric computing environment of MATLAB. Supports wide range of image processing operations :

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Collection of function to extend numeric computing environment of MATLAB. Supports wide range of image processing operations :

- Geometric operations
- Image analysis and enhancement
- Neighborhood and block operations
- Linear filtering and filter design
- Transforms
- Binary image operations
- Region of interest operations

Images in Matlab

Import /Export several image format

Data types in MATLAB

Images in Matlab

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- JPEG (Joint Photographic Experts Group)

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Data types in MATLAB

- Double (64 -bit double-precision floating point)

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- BMP (windows bitmap)
- TIFF (Tagged Image File Format)
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Data types in MATLAB

- Double (64 -bit double-precision floating point)
- Single (32 -bit single-precision floating point)

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- BMP (windows bitmap)
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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)

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- PNG (Portable Network Graphics)
- BMP (windows bitmap)
- TIFF (Tagged Image File Format)
- XWD (X window Dump)
- RAW and other types of image data

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)

Images in Matlab

Import /Export several image format

- JPEG (Joint Photographic Experts Group)
- PCX (Paintbrush)
- PNG (Portable Network Graphics)
- BMP (windows bitmap)
- TIFF (Tagged Image File Format)
- XWD (X window Dump)
- RAW and other types of image data

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)

Images in Matlab

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- JPEG (Joint Photographic Experts Group)
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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)

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- Int8 (8-bit signed integer)
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- Int32 (32-bit signed integer)
- Int16 (16-bit signed integer)
- Int8 (8-bit signed integer)
- Uint32 (32-bit unsigned integer)
- Uint16 (8-bit unsigned integer)
- Uint8 (8-bit unsigned integer)

Images in Matlab

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Binary images : {0, 1}

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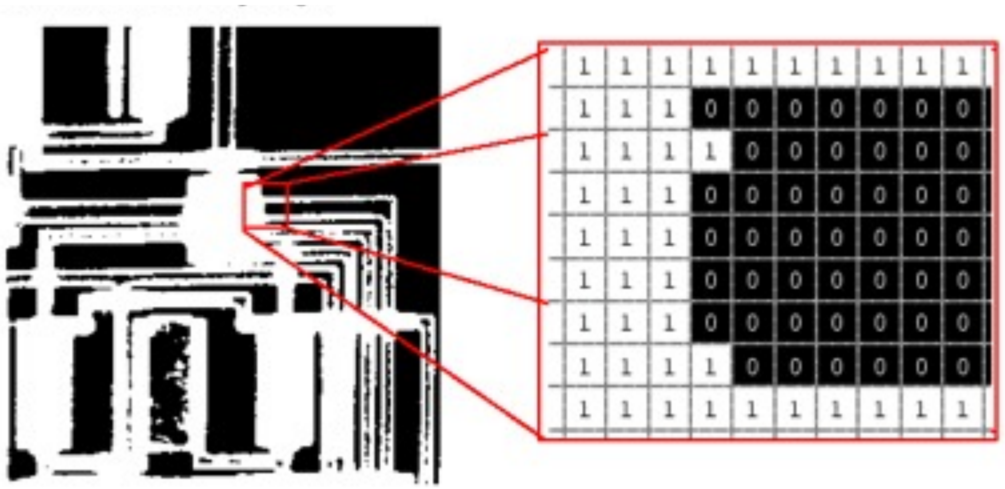
Binary images : {0, 1}

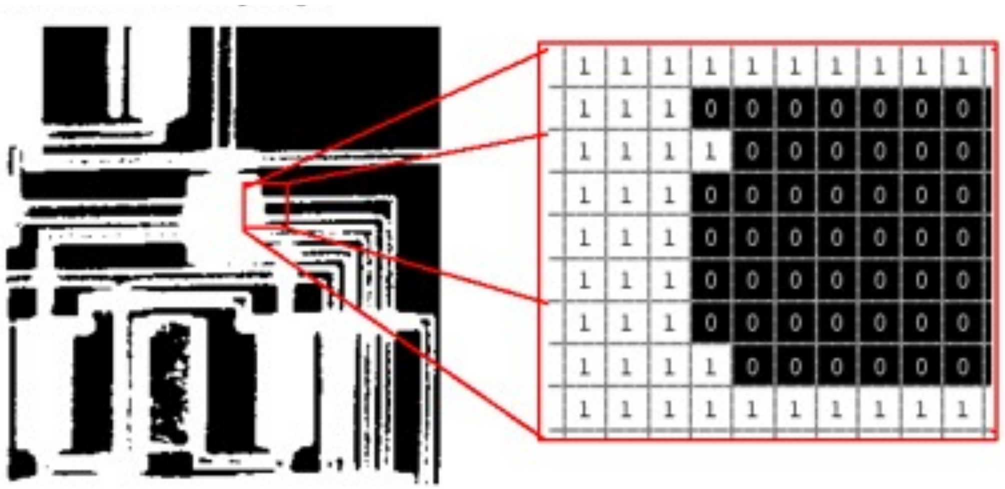


1	1	1	1	1	1	1	1	1	1
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1

Images in Matlab

Binary images : {0, 1}

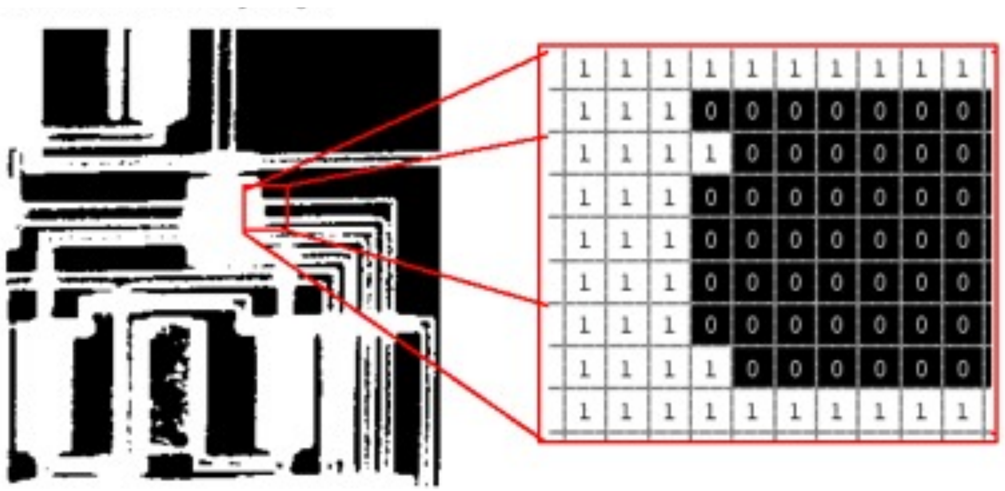
Intensity images : [0, 1] or uint8, double etc.



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

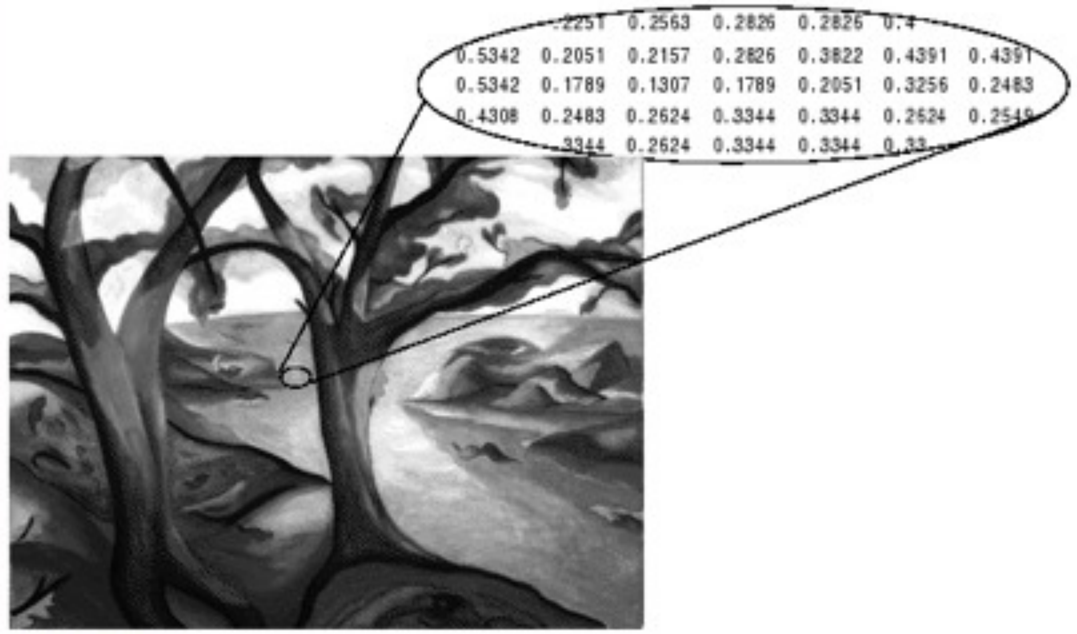
Images in Matlab

Binary images : {0, 1}



```
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
```

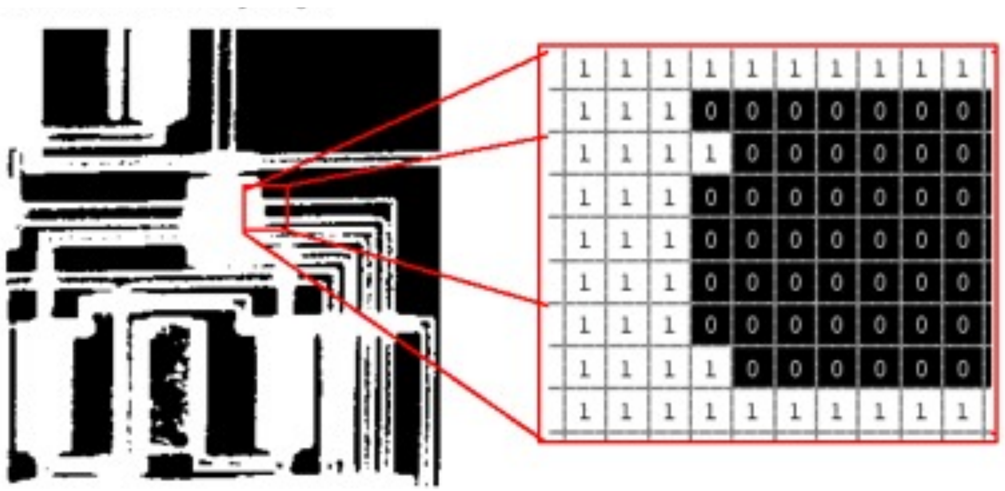
Intensity images : [0, 1] or uint8, double etc.



```
        .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
```

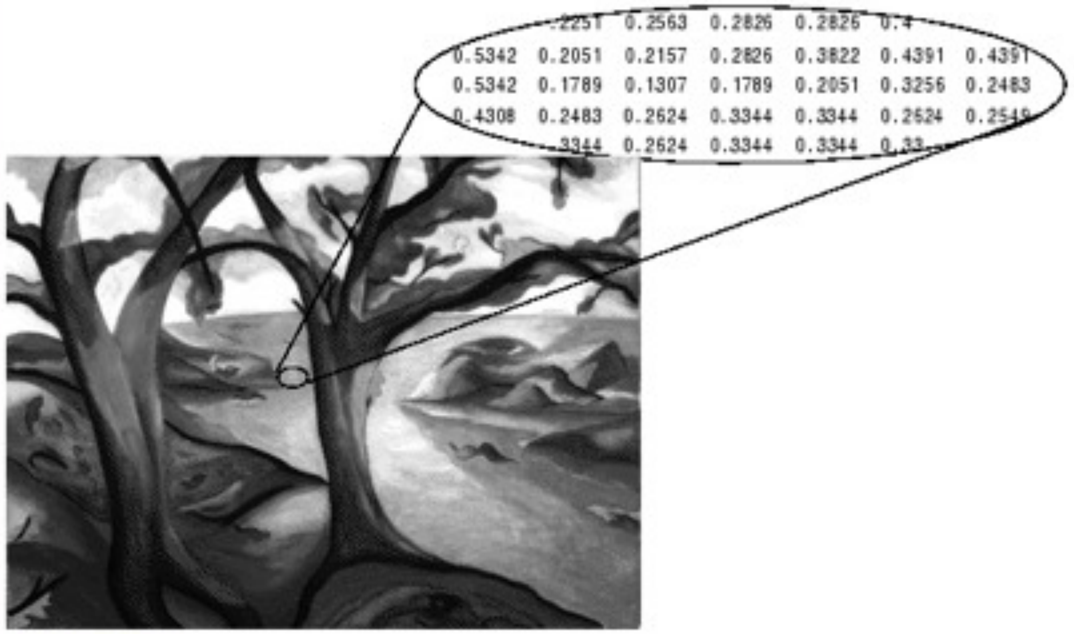
Images in Matlab

Binary images : {0, 1}



```
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
```

Intensity images : [0, 1] or uint8, double etc.

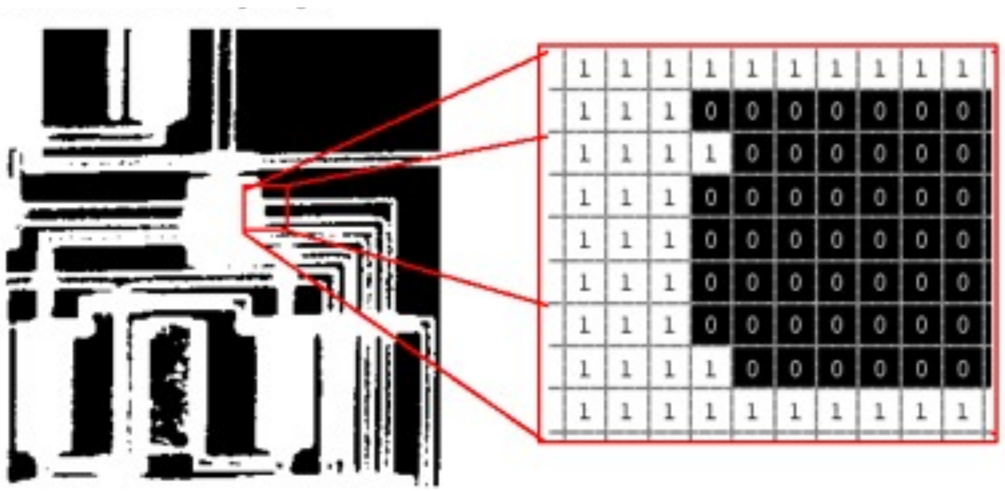


```
        .2251  0.2563  0.2826  0.2826  0.4
0.5342  0.2051  0.2157  0.2826  0.3822  0.4391  0.4391
0.5342  0.1789  0.1307  0.1789  0.2051  0.3256  0.2483
0.4308  0.2483  0.2624  0.3344  0.3344  0.2624  0.2549
        .3344  0.2624  0.3344  0.3344  0.33
```

RGB images

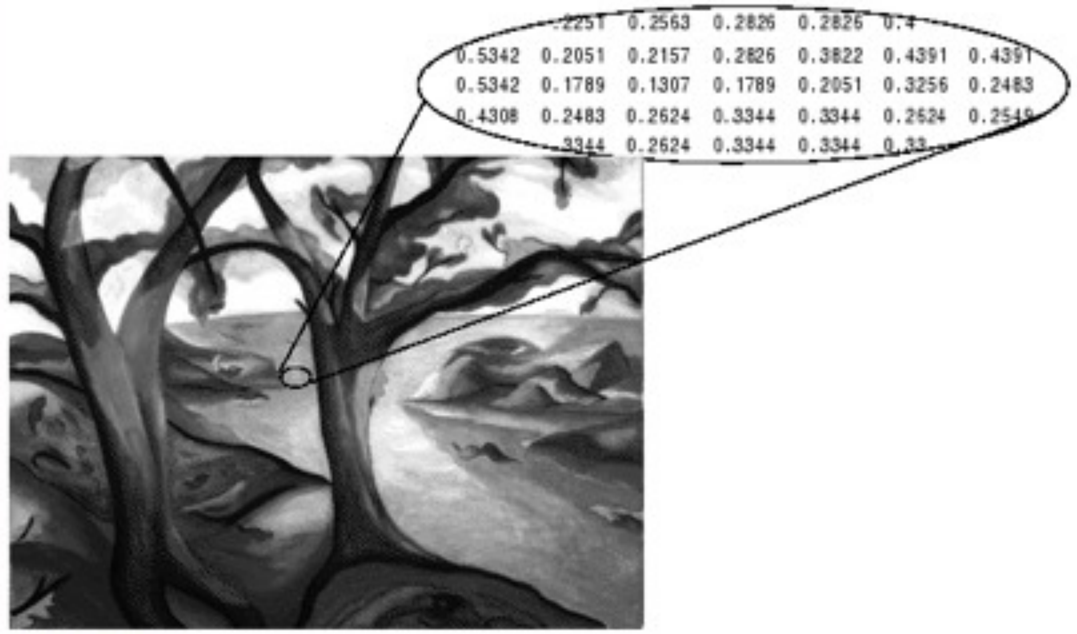
Images in Matlab

Binary images : {0, 1}



```
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
```

Intensity images : [0, 1] or uint8, double etc.

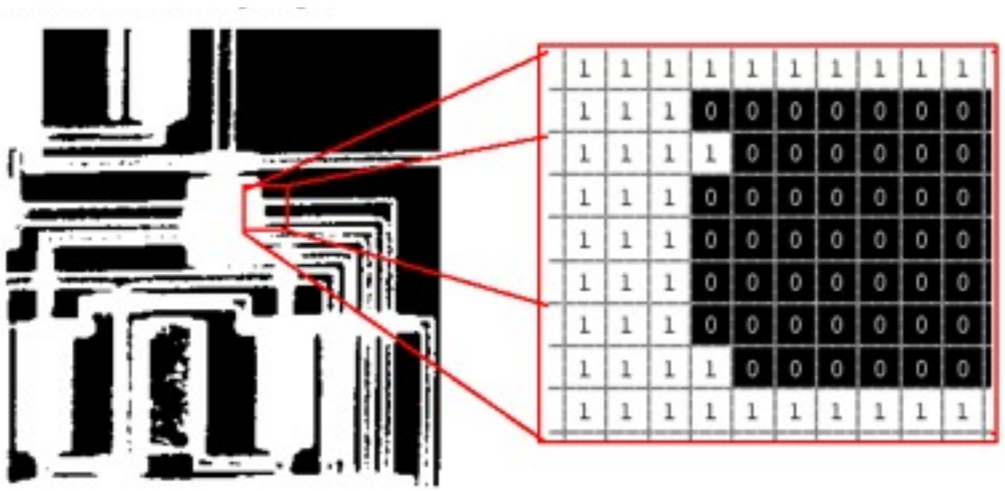


```
        .2251  0.2563  0.2826  0.2826  0.4
0.5342  0.2051  0.2157  0.2826  0.3822  0.4391  0.4391
0.5342  0.1789  0.1307  0.1789  0.2051  0.3256  0.2483
0.4308  0.2483  0.2624  0.3344  0.3344  0.2624  0.2549
        .3344  0.2624  0.3344  0.3344  0.33
```

RGB images $m \times n \times 3$

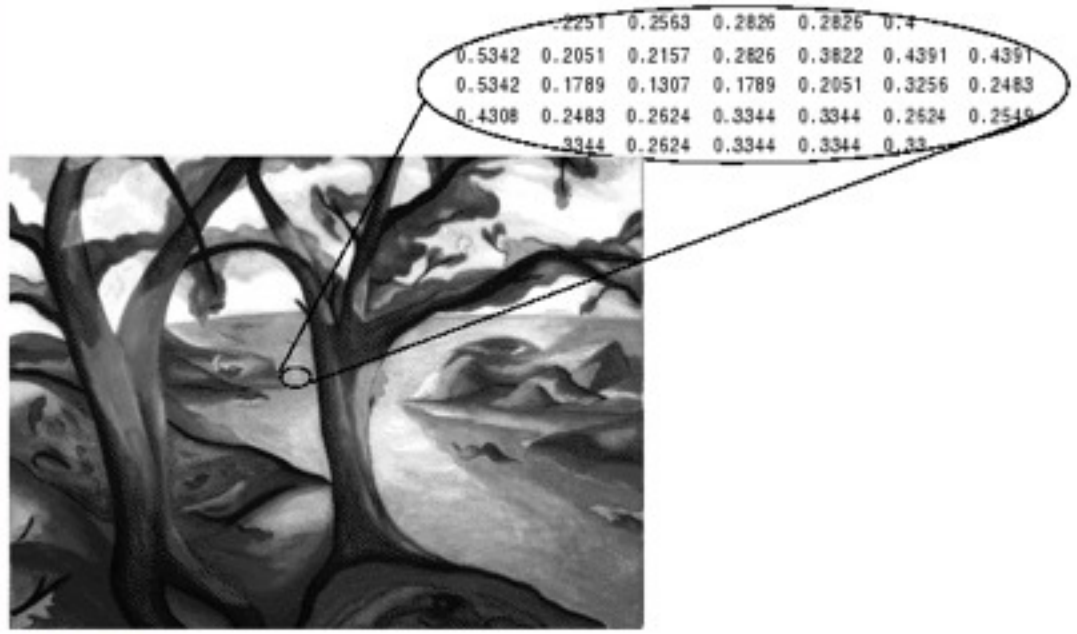
Images in Matlab

Binary images : {0, 1}



```
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
```

Intensity images : [0, 1] or uint8, double etc.



```
        .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
```

RGB images $m \times n \times 3$

```
       .2235   0.1294   Blue    0.4196
  5804  0.2902  0.0627  0.2902  0.2902  0.48
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  0.3
```

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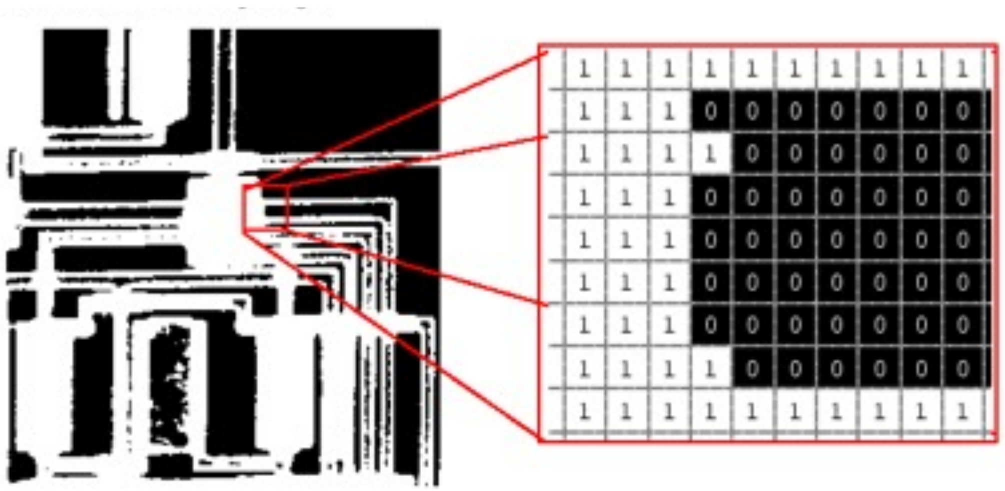
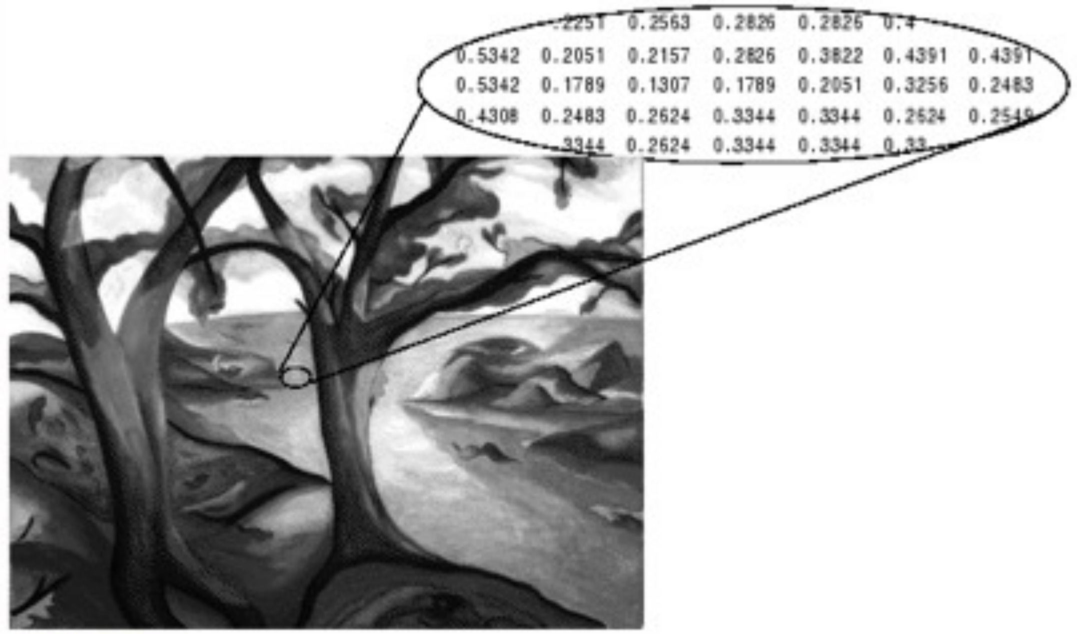


```
1 1 1 1 1 1 1 1 1 1
1 1 1 0 0 0 0 0 0 0
1 1 1 1 0 0 0 0 0 0
1 1 1 0 0 0 0 0 0 0
1 1 1 0 0 0 0 0 0 0
1 1 1 0 0 0 0 0 0 0
1 1 1 0 0 0 0 0 0 0
1 1 1 1 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1 1
```

Intensity images : [0, 1] or uint8, double etc.



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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
```

RGB images $m \times n \times 3$

```
            .2235   0.1294   Blue     0.4196
      5804  0.2902  0.0627   0.2902   0.2902   0.48
    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
```

Indexed Image

Images in Matlab

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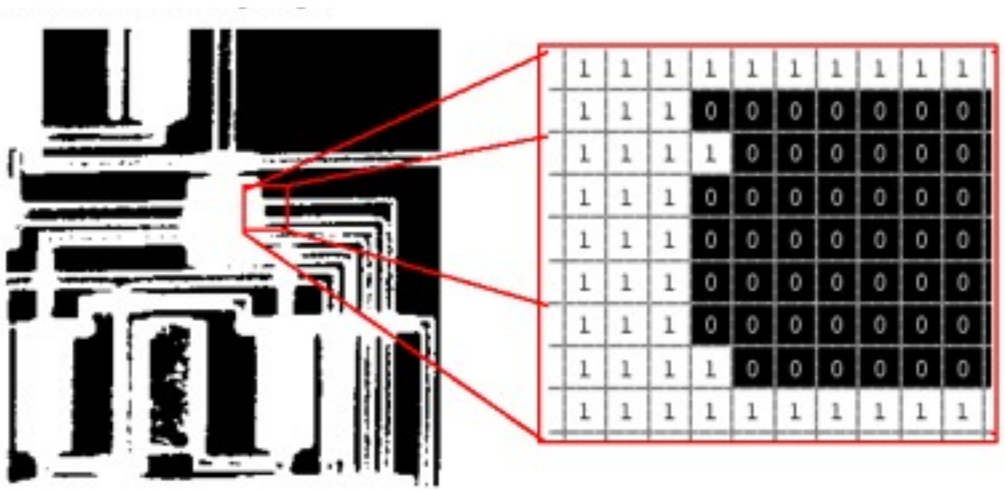
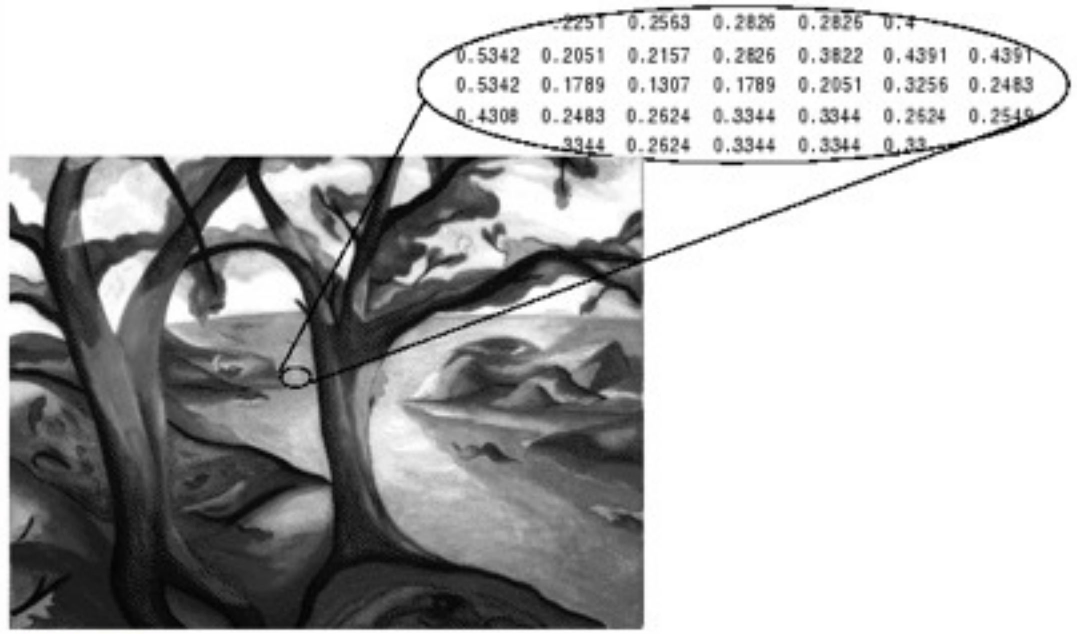
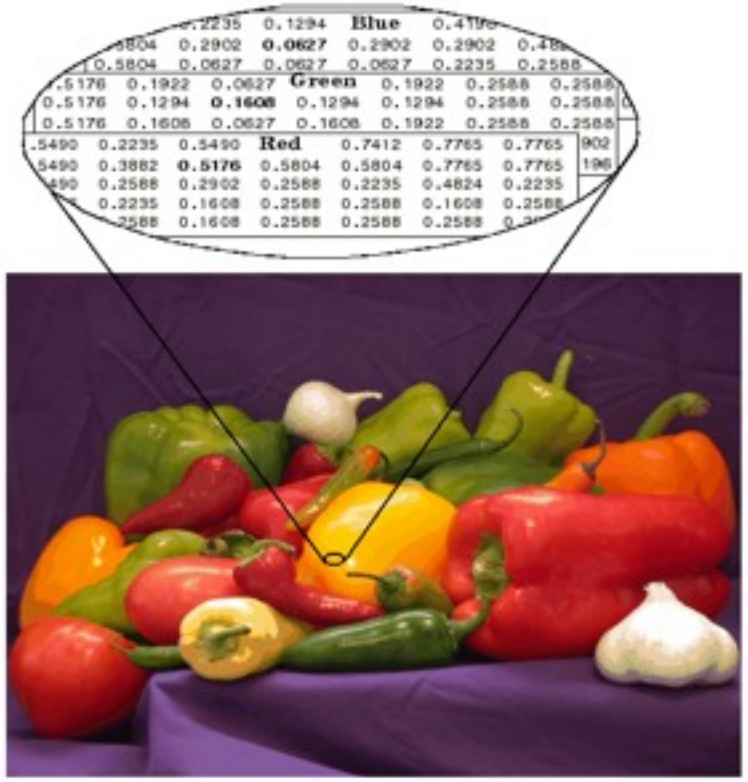


1	1	1	1	1	1	1	1	1	1
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1

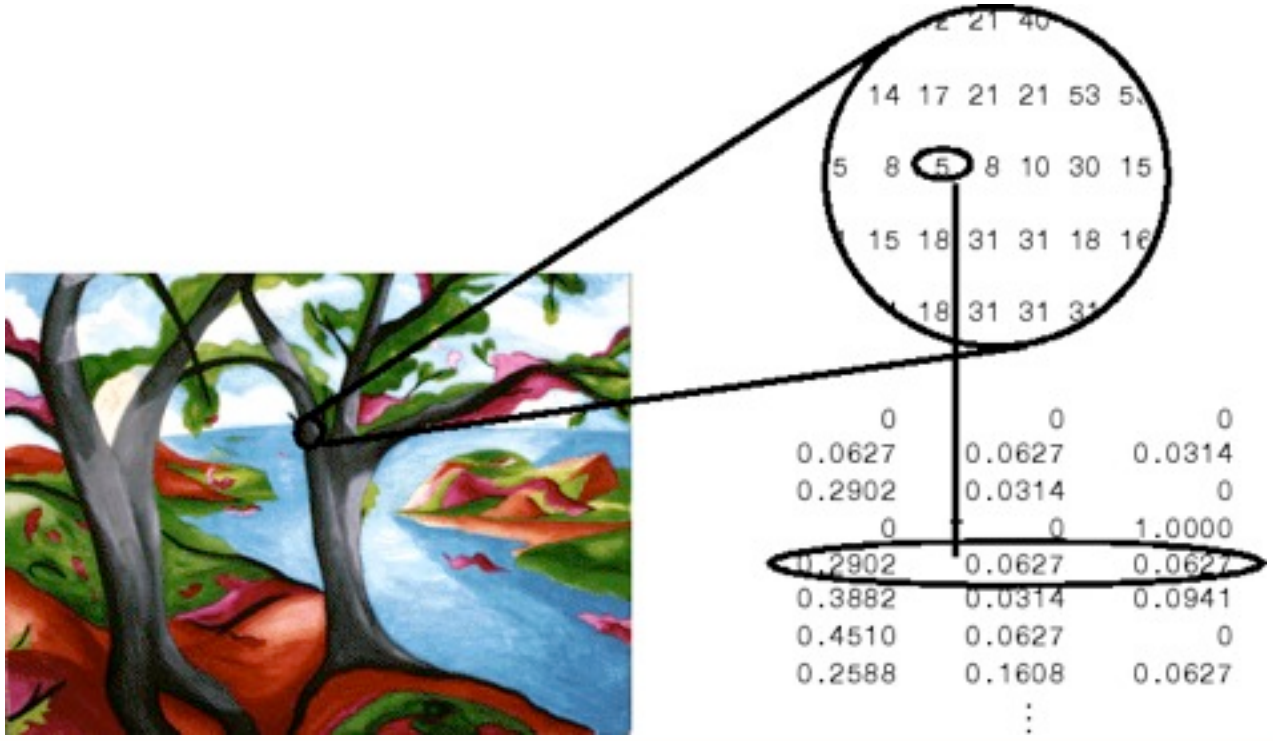
Intensity images : [0, 1] or uint8, double etc.



RGB images $m \times n \times 3$



Indexed Image



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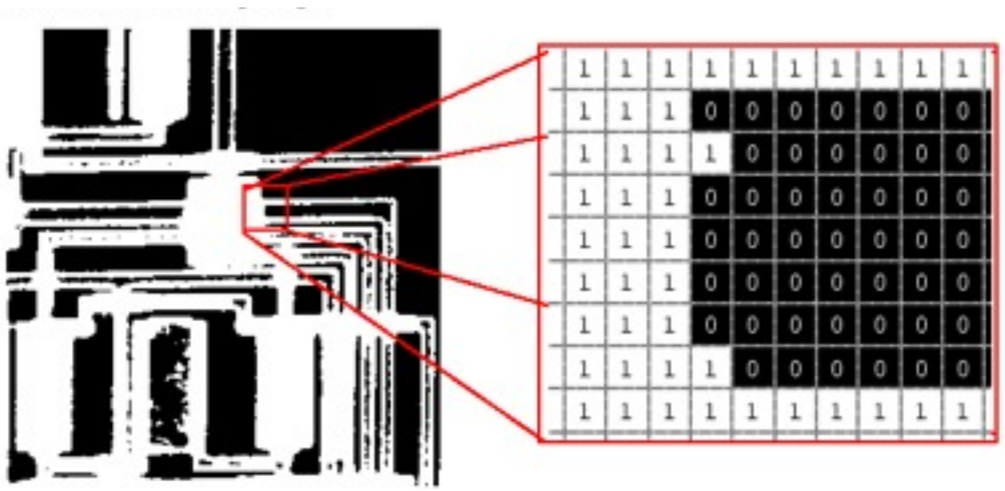
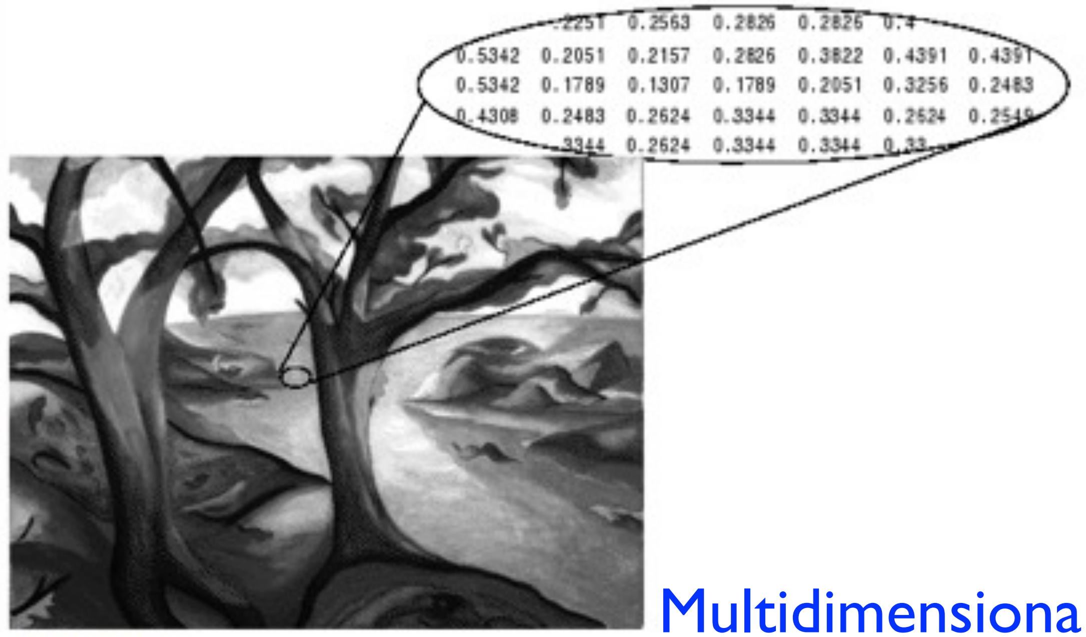


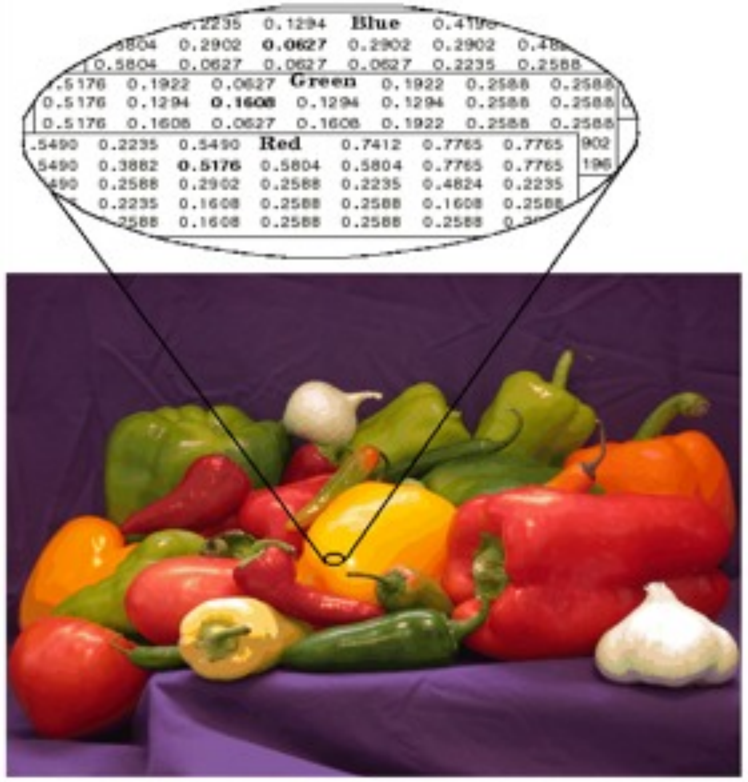
1	1	1	1	1	1	1	1	1	1
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1

Intensity images : [0, 1] or uint8, double etc.

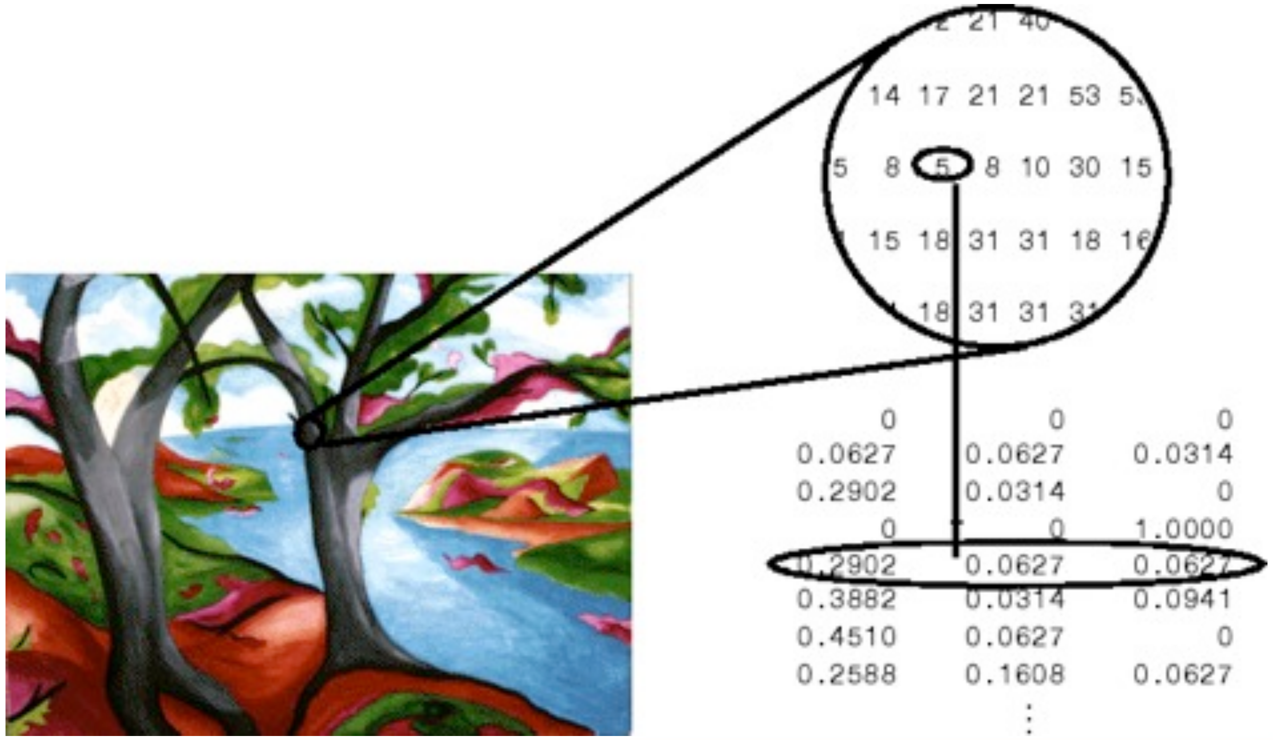


Multidimensional images

RGB images $m \times n \times 3$

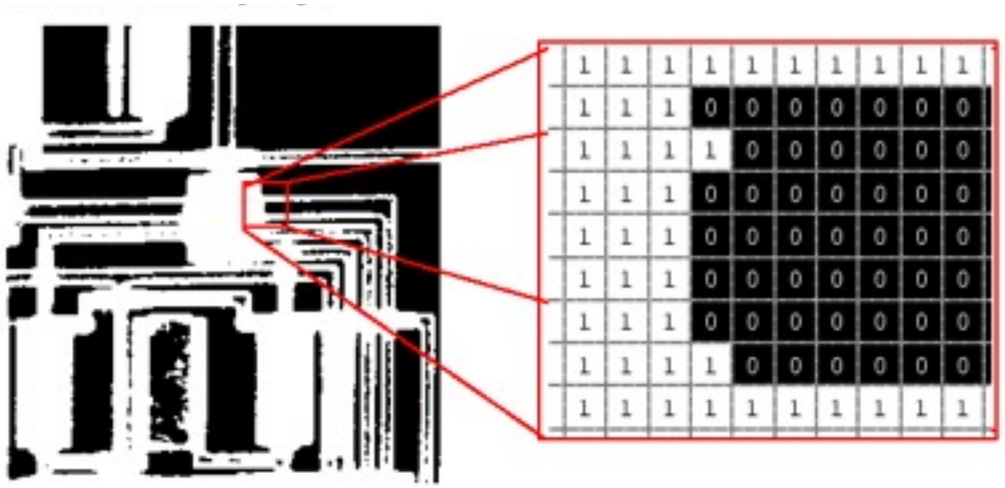


Indexed Image



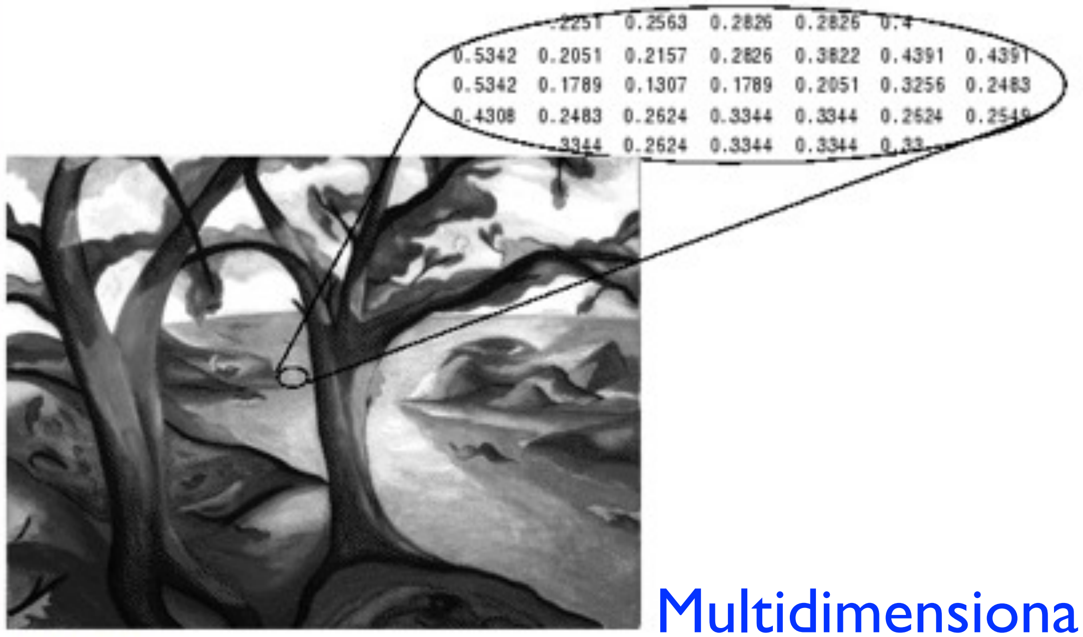
Images in Matlab

Binary images : {0, 1}



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

Intensity images : [0, 1] or uint8, double etc.

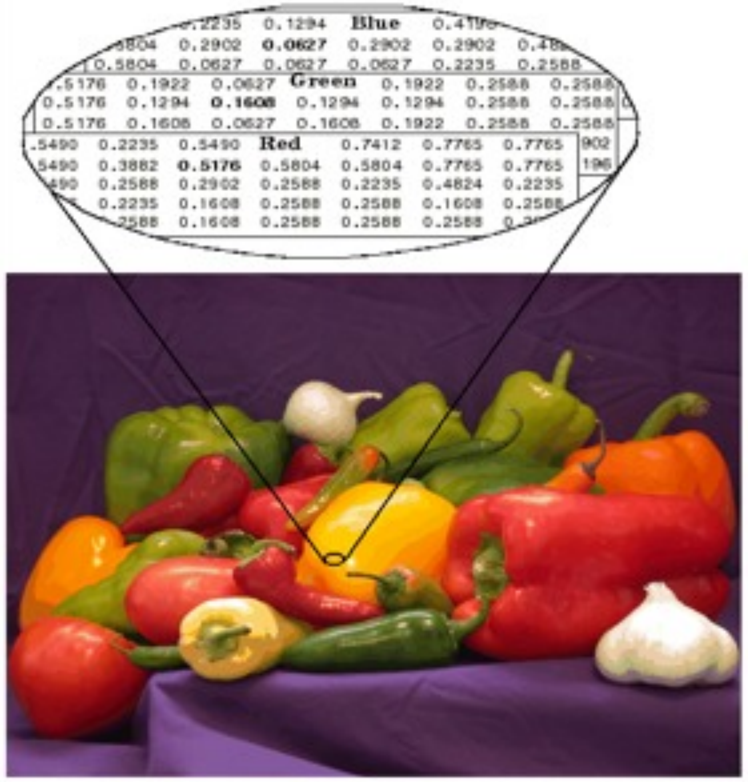


```
 .2251  0.2563  0.2826  0.2826  0.4
0.5342  0.2051  0.2157  0.2826  0.3822  0.4391  0.4391
0.5342  0.1789  0.1307  0.1789  0.2051  0.3256  0.2483
0.4308  0.2483  0.2624  0.3344  0.3344  0.2624  0.2549
 .3344  0.2624  0.3344  0.3344  0.33
```

Multidimensional images

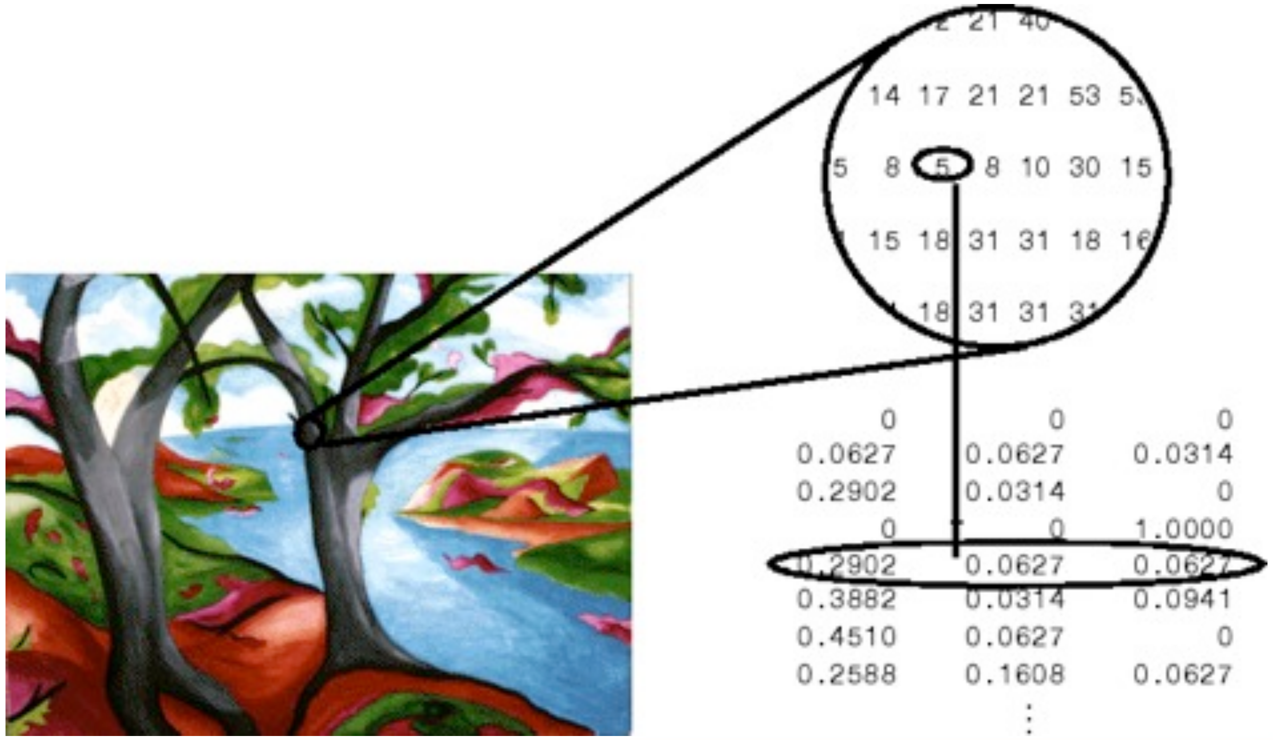
$$m \times n \times p$$

RGB images $m \times n \times 3$



```
 .2235  0.1294  Blue  0.4196
 .5804  0.2902  0.0627  0.2902  0.2902  0.48
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
```

Indexed Image

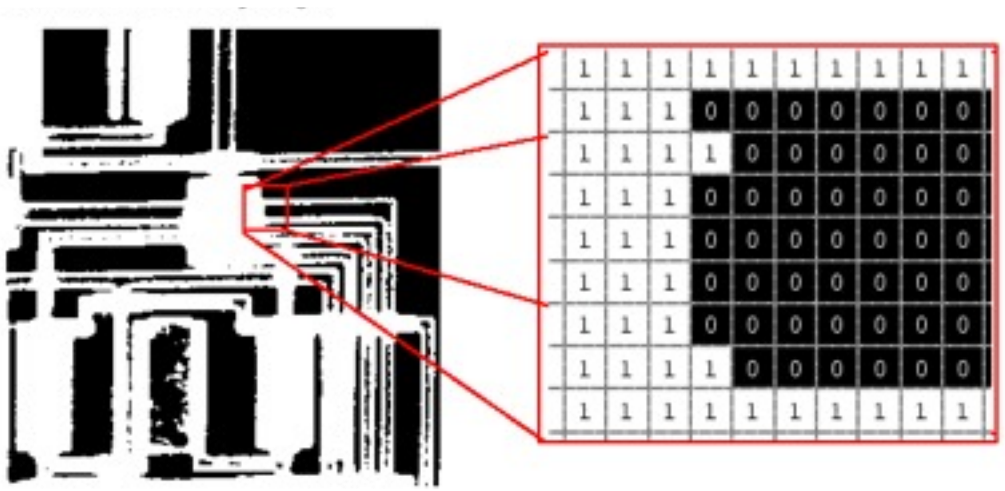


```
  2  21  40
14  17  21  21  53  5
5   8   5   8  10  30  15
   15  18  31  31  18  16
       18  31  31  3
```

```
     0          0          0
0.0627     0.0627     0.0314
0.2902     0.0314          0
     0          0     1.0000
0.2902     0.0627     0.0627
0.3882     0.0314     0.0941
0.4510     0.0627          0
0.2588     0.1608     0.0627
             ⋮
```

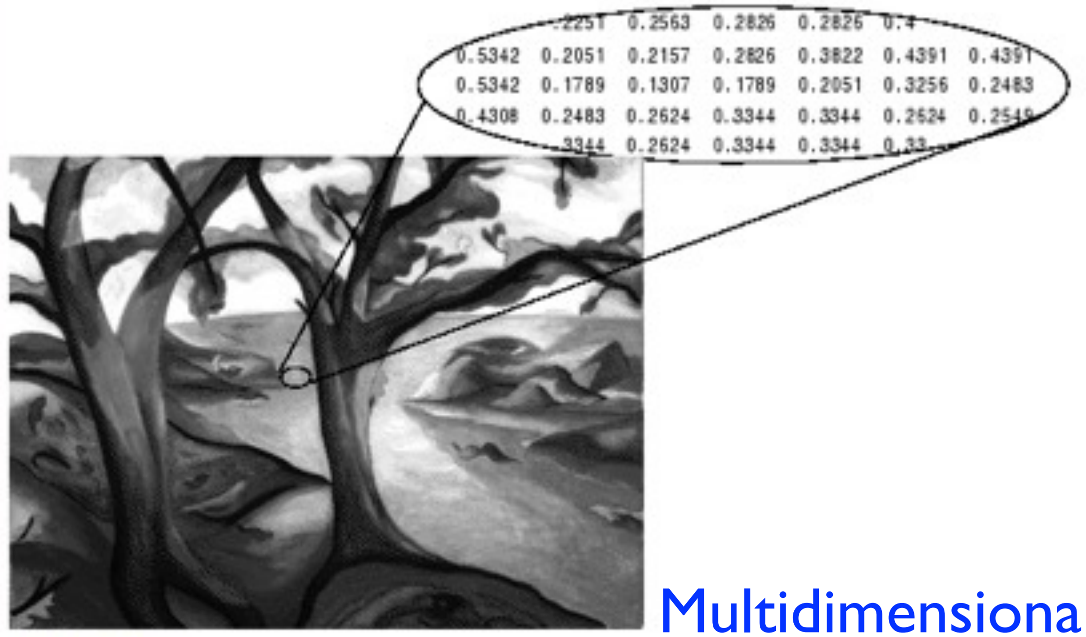
Images in Matlab

Binary images : {0, 1}



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

Intensity images : [0, 1] or uint8, double etc.



```
.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
```

Multidimensional images

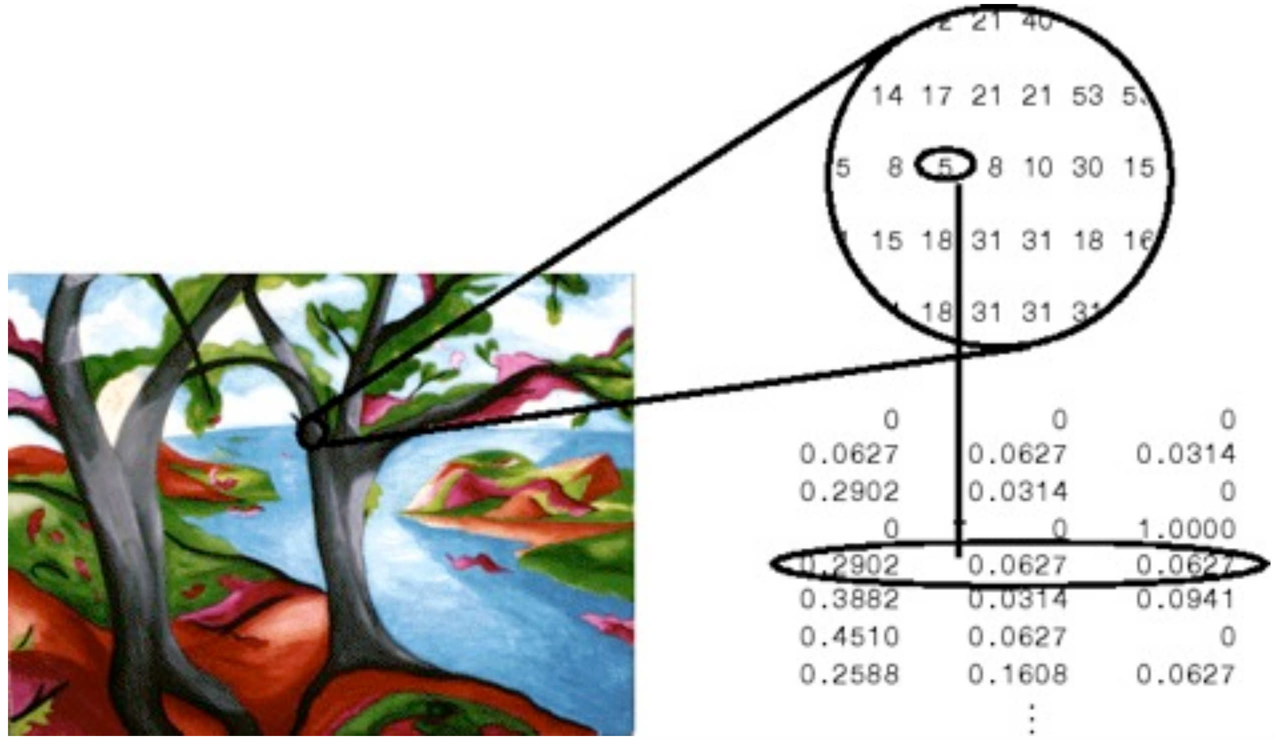
$$m \times n \times p$$

p is the number of layers

RGB images $m \times n \times 3$

```
.2235  0.1294  Blue  0.4196
.5804  0.2902  0.0627  0.2902  0.2902  0.48
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
```

Indexed Image



```
     2  21  40
14  17  21  21  53  5
5   8   5   8  10  30  15
15  18  31  31  18  16
18  31  31  31
```

```
     0          0          0
0.0627     0.0627     0.0314
0.2902     0.0314          0
     0          0     1.0000
0.2902     0.0627     0.0627
0.3882     0.0314     0.0941
0.4510     0.0627          0
0.2588     0.1608     0.0627
              ⋮
```

Image Import and Export

Image Import and Export

- Read and write images in Matlab

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

- Alternatives of `imshow`

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

- Alternatives of `imshow`

```
  imagesc(I)
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

- Alternatives of `imshow`

```
imagesc(I)
imtool(I)
```

Image Import and Export

- Read and write images in Matlab

```
img = imread('filename.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

- Alternatives of `imshow`

```
imagesc(I)
imtool(I)
image(I)
```

Image conversions

Image conversions

dither

Image conversions

dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering
gray2ind

Image conversions

dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind

Create an indexed image from a grayscale intensity image

Image conversions

dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind

Create an indexed image from a grayscale intensity image

grayslice

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind
Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind
Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

im2bw

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind
Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

im2bw
Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind
Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

im2bw
Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

ind2gray

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

gray2ind
Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

im2bw
Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

ind2gray
Create a grayscale intensity image from an indexed image

Image conversions

dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create an indexed image from a grayscale intensity image

grayslice

Create an indexed image from a grayscale intensity image by thresholding

im2bw

Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

ind2gray

Create a grayscale intensity image from an indexed image

ind2rgb

Image conversions

dither
Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create an indexed image from a grayscale intensity image

grayslice
Create an indexed image from a grayscale intensity image by thresholding

im2bw
Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

ind2gray
Create a grayscale intensity image from an indexed image

ind2rgb
Create an RGB image from an indexed image

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dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create a binary image from an intensity image, indexed image, or RGB image, based on a luminance threshold

ind2gray

Create a grayscale intensity image from an indexed image

ind2rgb

Create an RGB image from an indexed image

mat2gray

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ind2gray

Create a grayscale intensity image from an indexed image

ind2rgb

Create an RGB image from an indexed image

mat2gray

Create a grayscale intensity image from data in a matrix, by scaling the data

Image conversions

dither

Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create an indexed image from a grayscale intensity image

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Create an indexed image from a grayscale intensity image by thresholding

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ind2gray

Create a grayscale intensity image from an indexed image

ind2rgb

Create an RGB image from an indexed image

mat2gray

Create a grayscale intensity image from data in a matrix, by scaling the data

rgb2gray

Image conversions

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Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create a grayscale intensity image from an indexed image

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Create a grayscale intensity image from data in a matrix, by scaling the data

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Create a grayscale intensity image from an RGB image

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Create a grayscale intensity image from an RGB image

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Create an RGB image from an indexed image

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Create a grayscale intensity image from data in a matrix, by scaling the data

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Create a grayscale intensity image from an RGB image

rgb2ind
Create an indexed image from an RGB image

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Create a binary image from a grayscale intensity image by dithering; create an indexed image from an RGB image by dithering

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Create an RGB image from an indexed image

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Create a grayscale intensity image from data in a matrix, by scaling the data

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rgb2ind
Create an indexed image from an RGB image

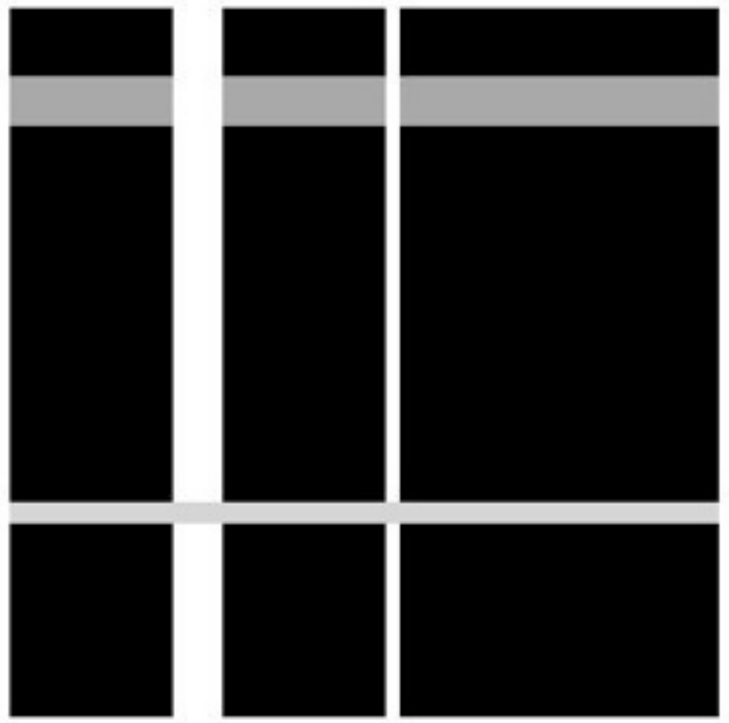
Images and Matrices

Images and Matrices

Building a matrix (or image) ? Intensity Image :

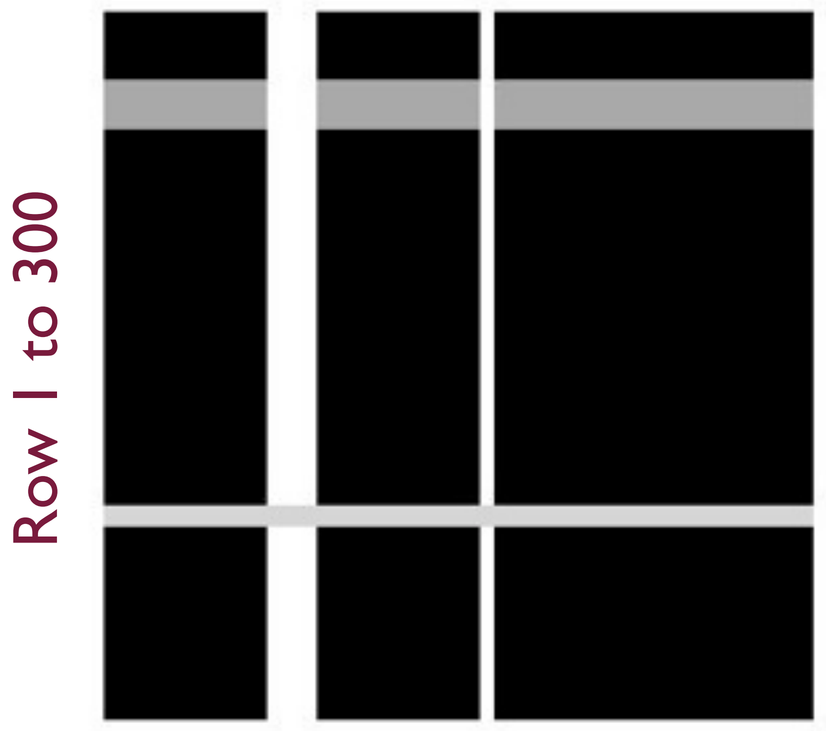
Images and Matrices

Building a matrix (or image) ? Intensity Image :



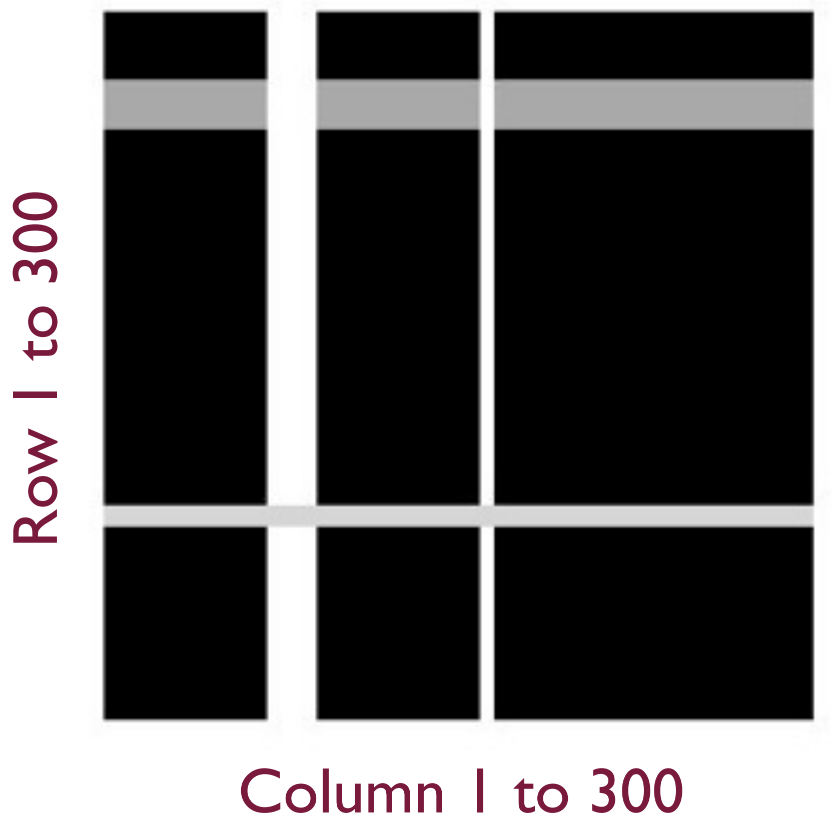
Images and Matrices

Building a matrix (or image) ? Intensity Image :



Images and Matrices

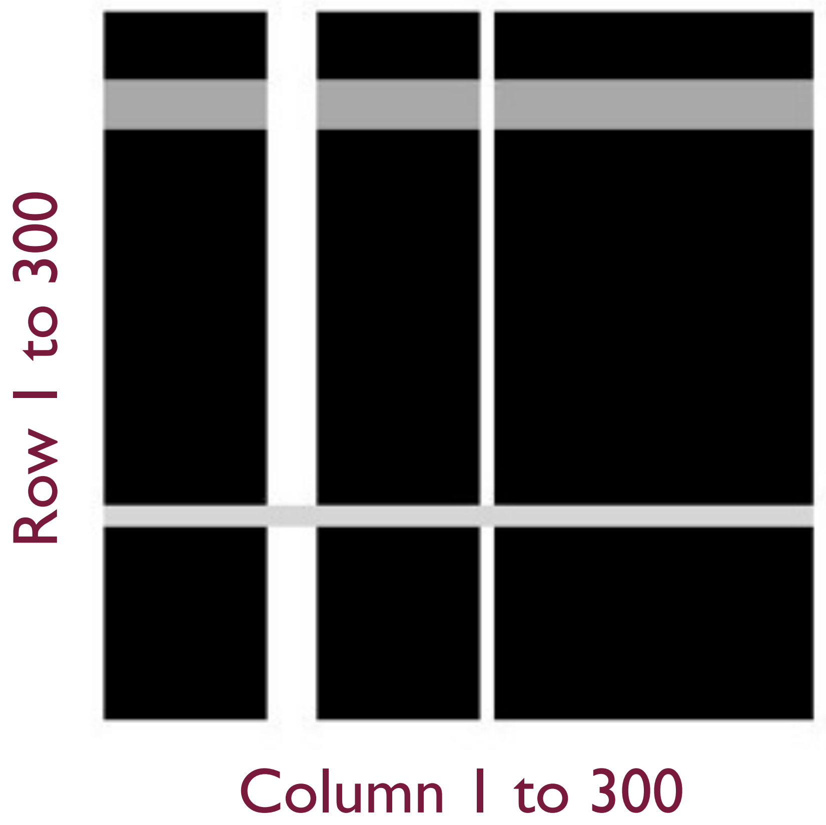
Building a matrix (or image) ? Intensity Image :



Images and Matrices

Building a matrix (or image) ? Intensity Image :

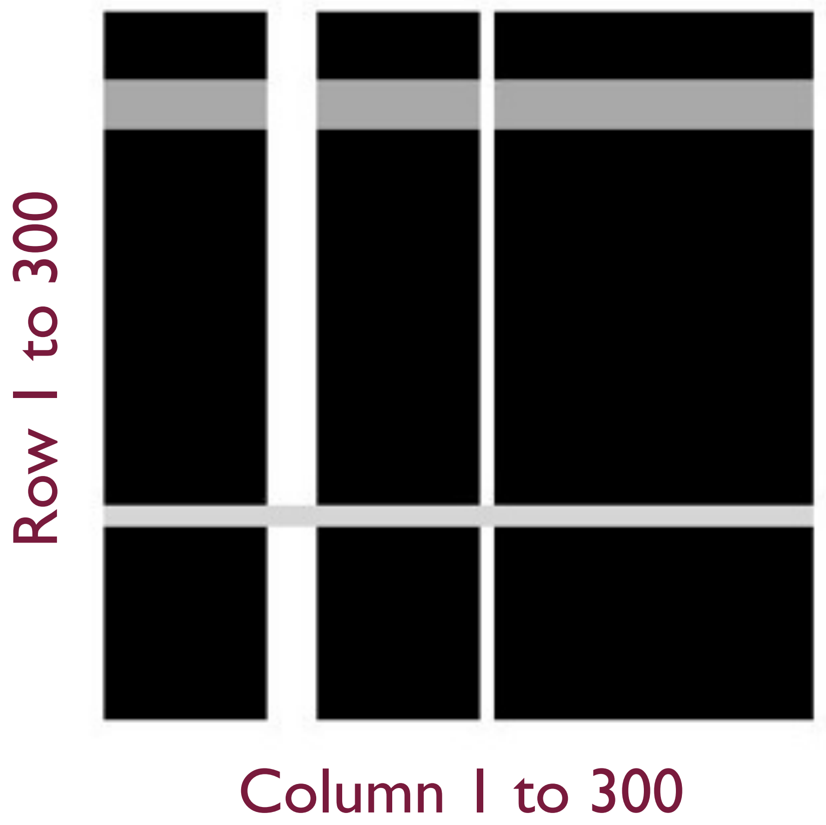
```
row = 300;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

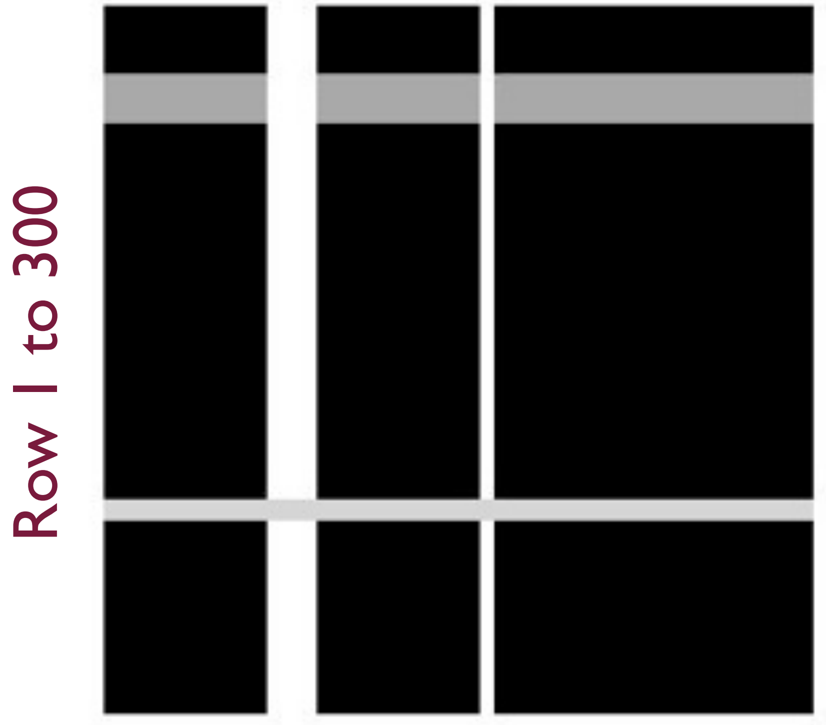
```
row = 300;
col = 300;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

```
row = 300;
col = 300;
img = zeros(row, col);
```

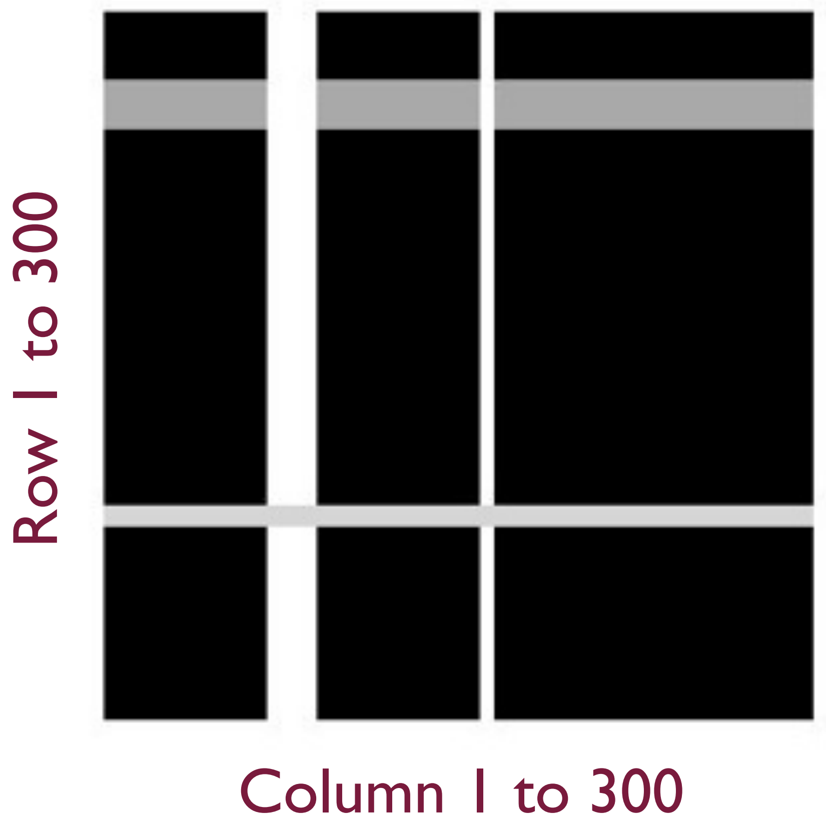


Column 1 to 300

Images and Matrices

Building a matrix (or image) ? Intensity Image :

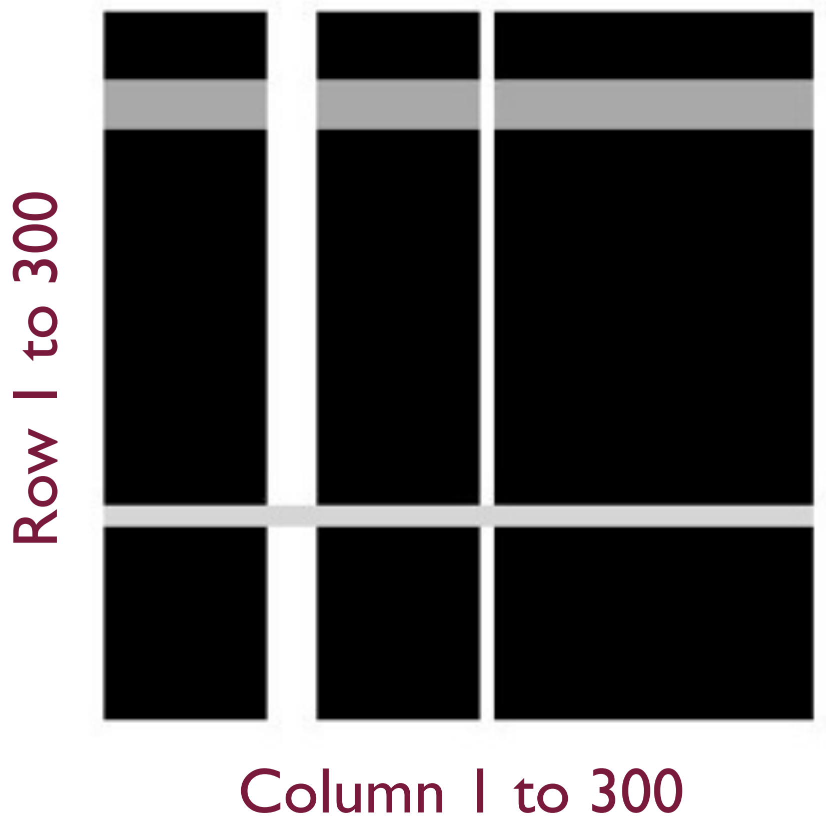
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

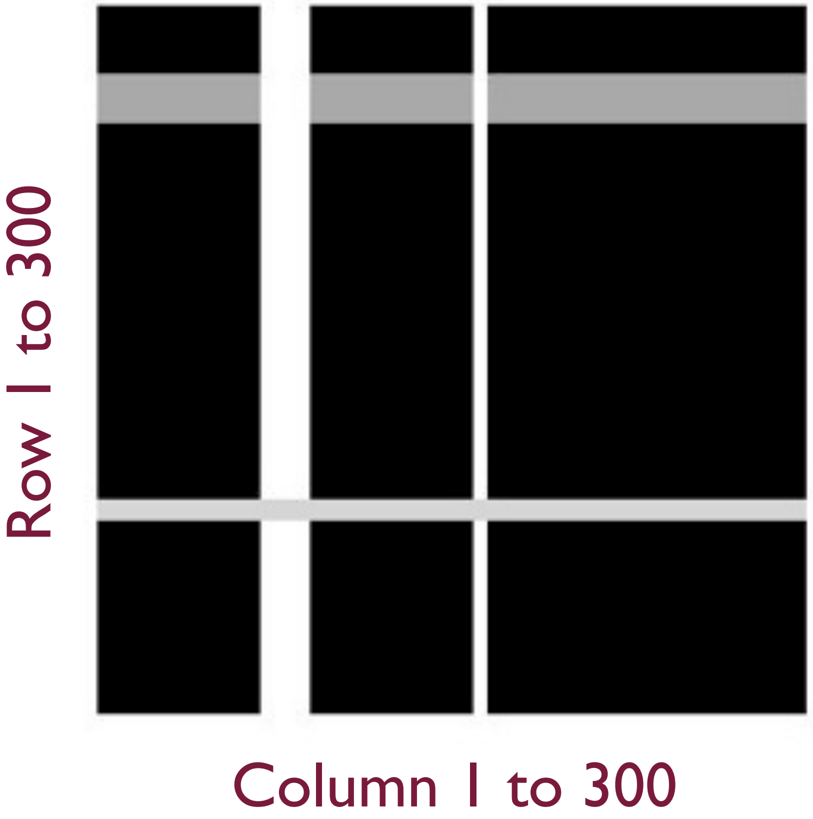
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

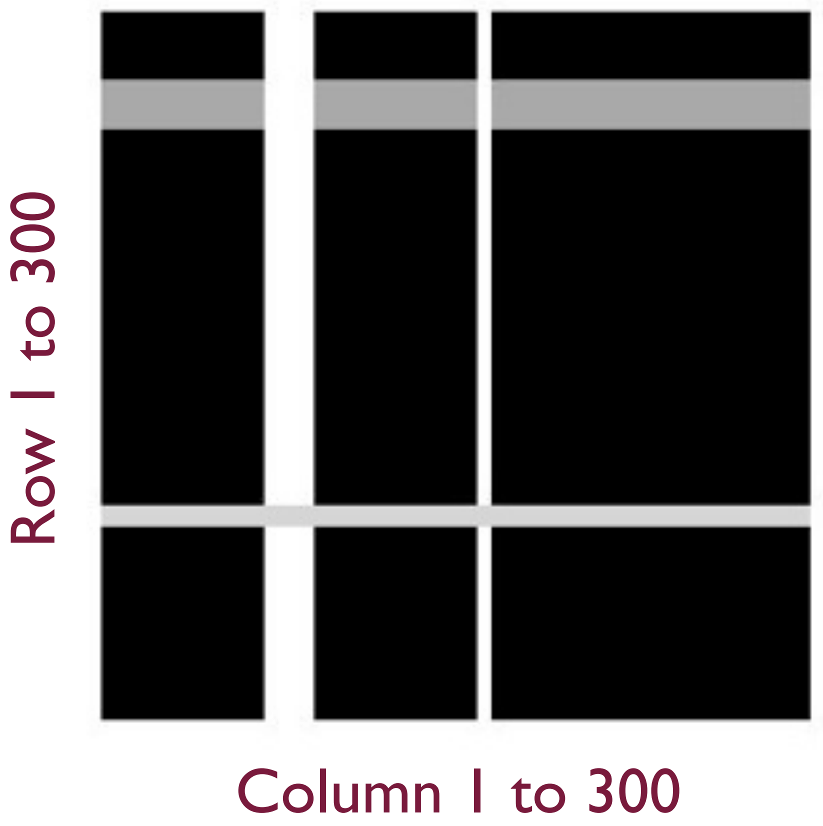
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

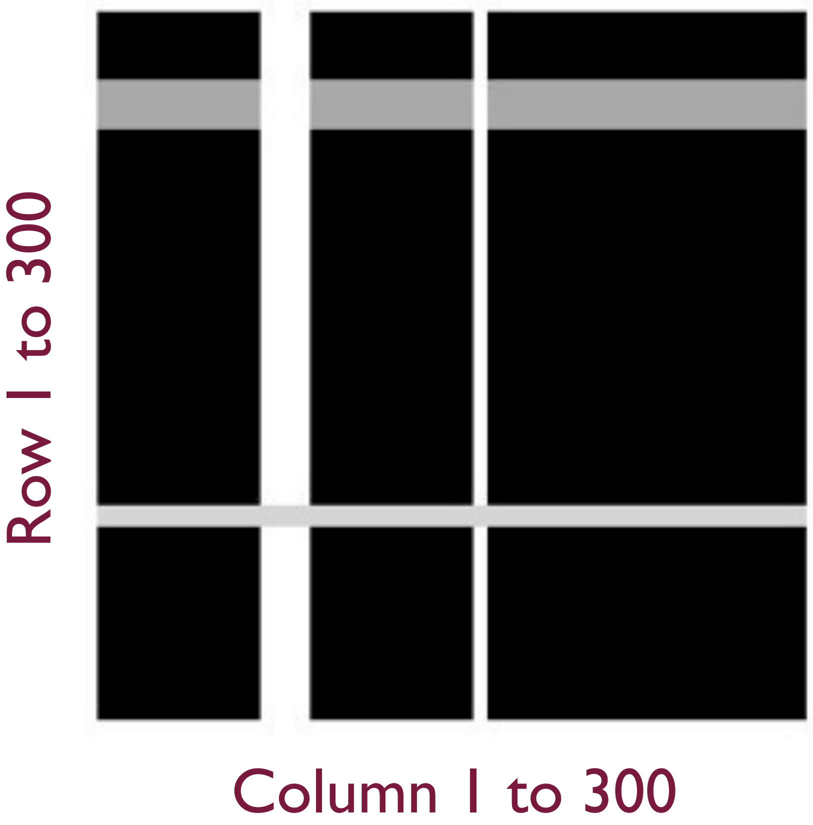
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, 1) = 0.8;
```



Images and Matrices

Building a matrix (or image) ? Intensity Image :

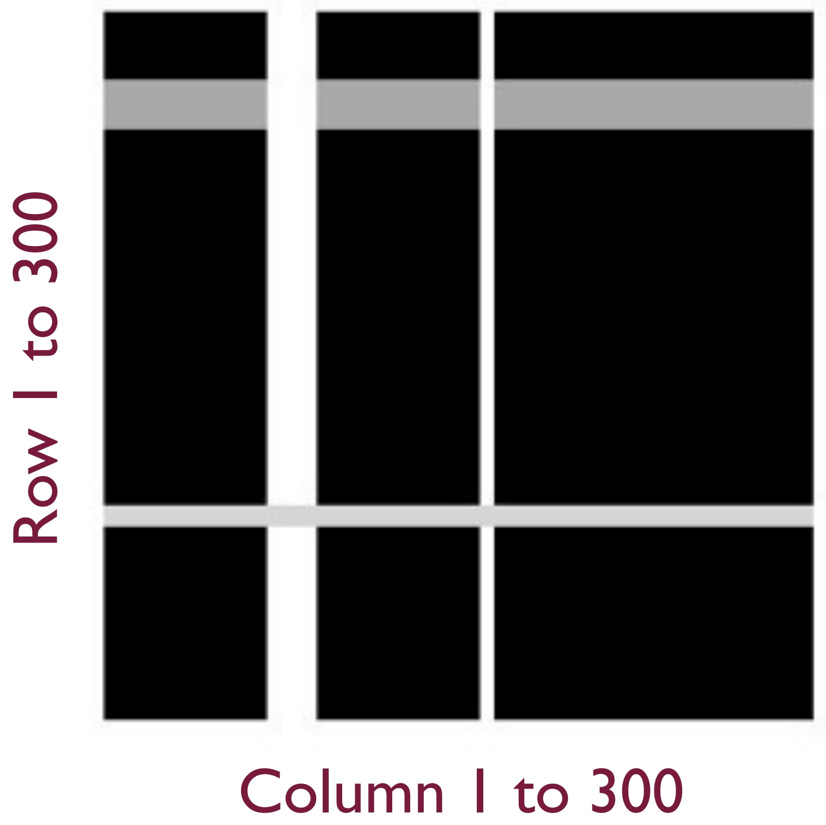
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, 1) = 0.8;
figure;
```



Images and Matrices

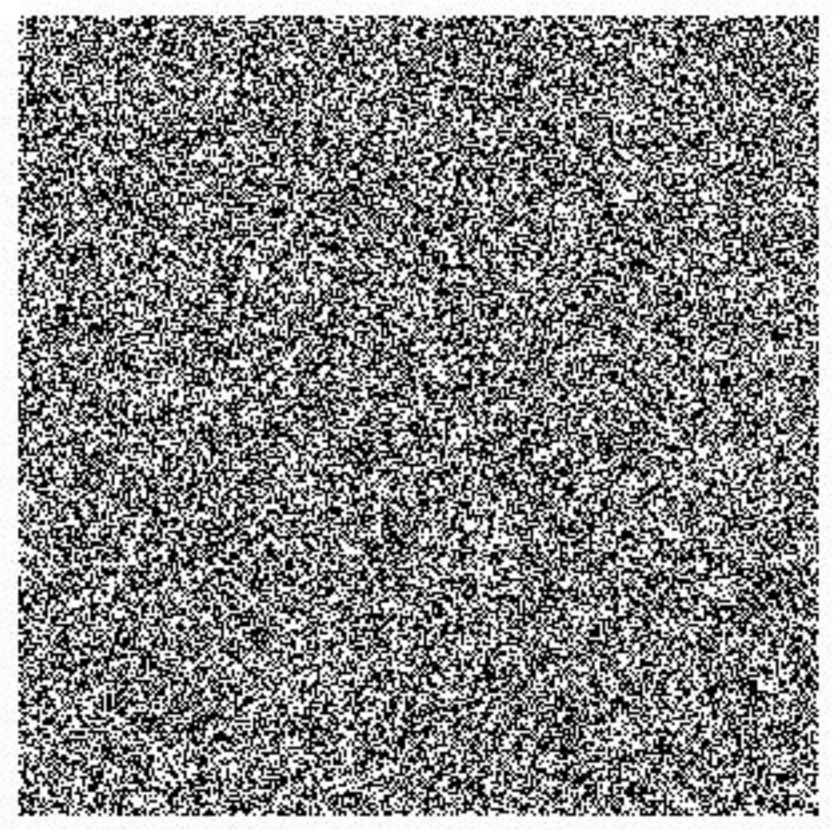
Building a matrix (or image) ? Intensity Image :

```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, 1) = 0.8;
figure;
imshow(img);
```



Images and Matrices

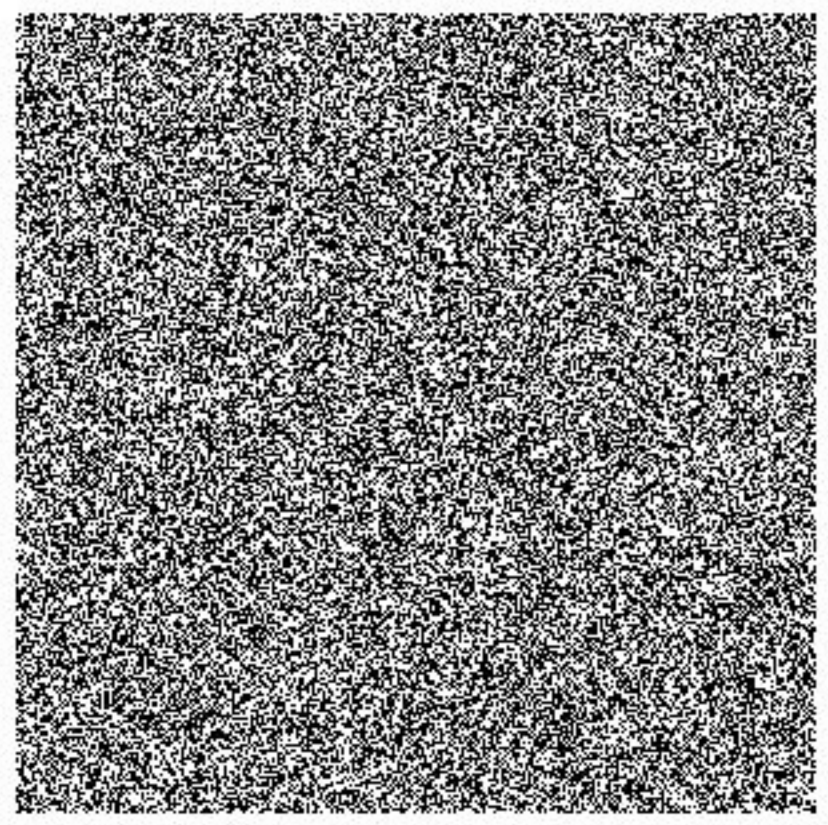
Binary Image :



Images and Matrices

Binary Image :

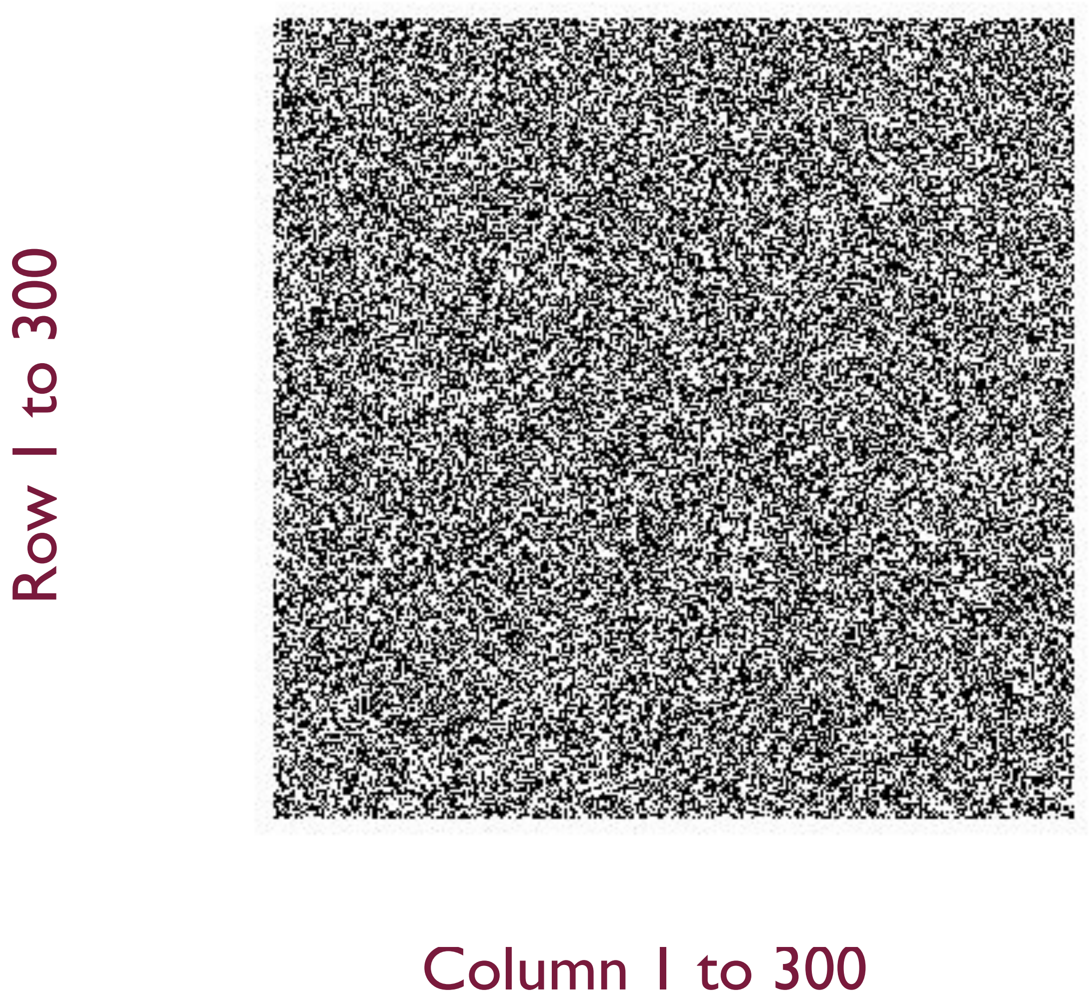
```
row = 300;
```



Images and Matrices

Binary Image :

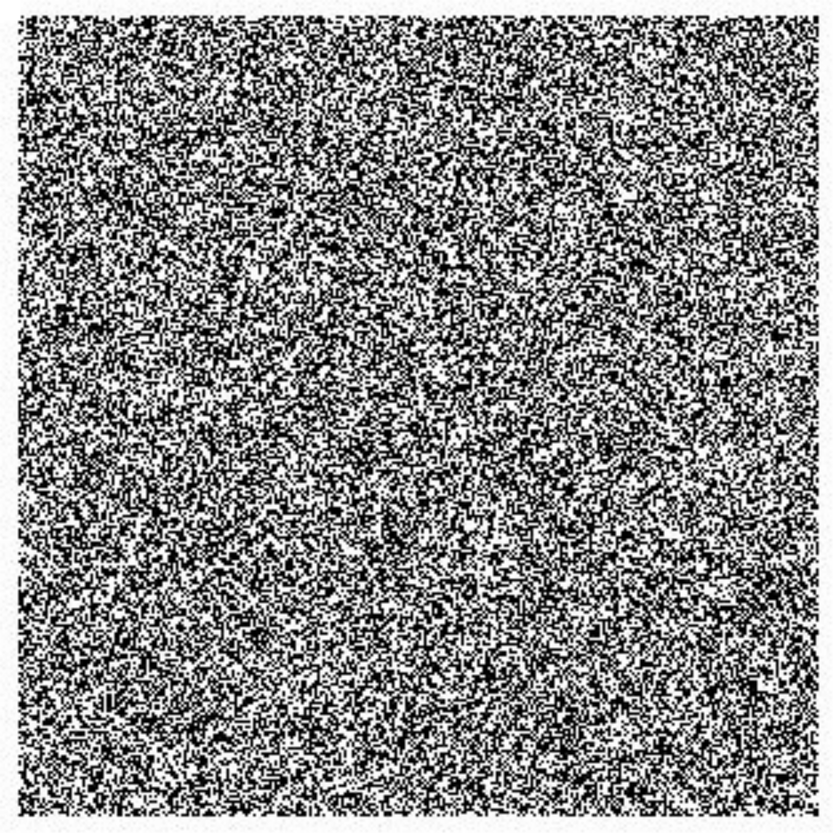
```
row = 300;
col = 300;
```



Images and Matrices

Binary Image :

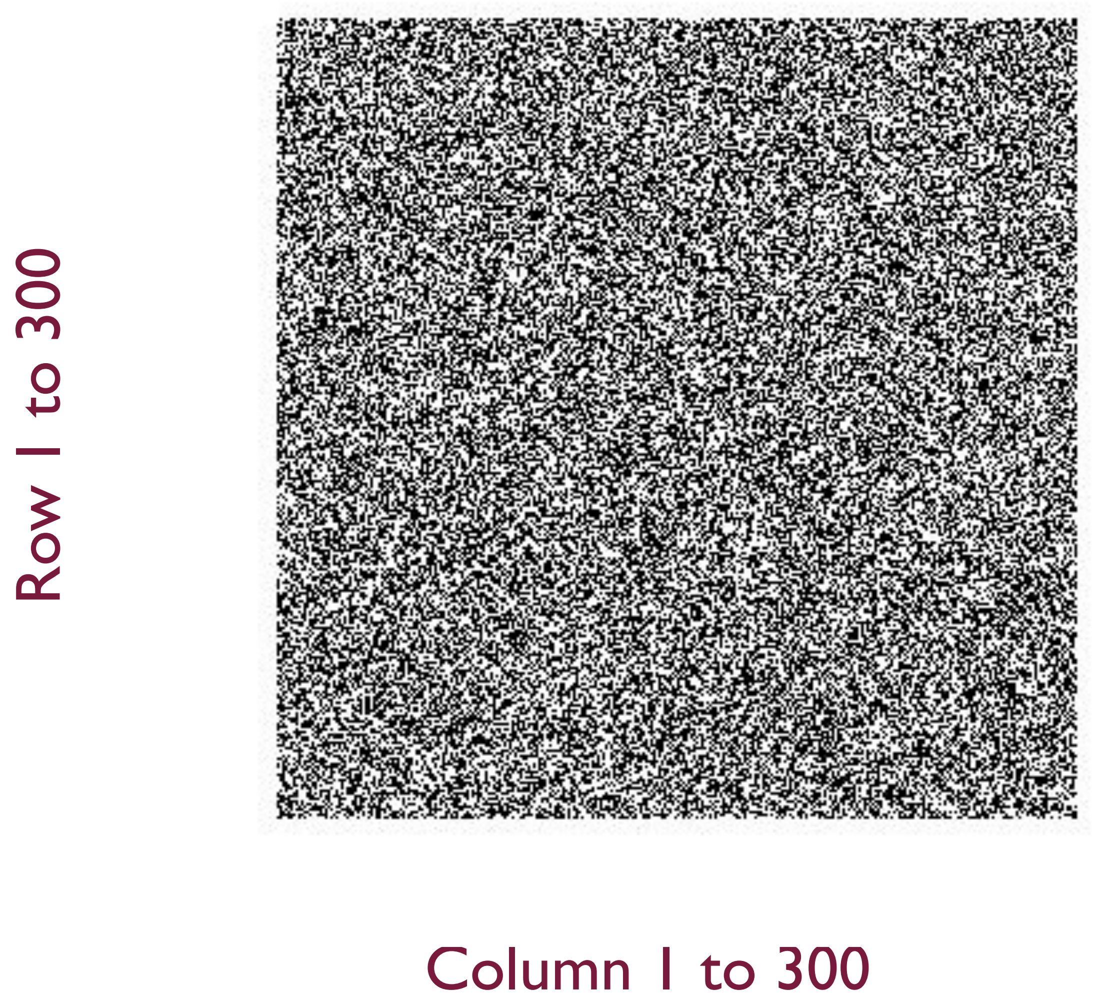
```
row = 300;
col = 300;
img = rand(row, col);
```



Images and Matrices

Binary Image :

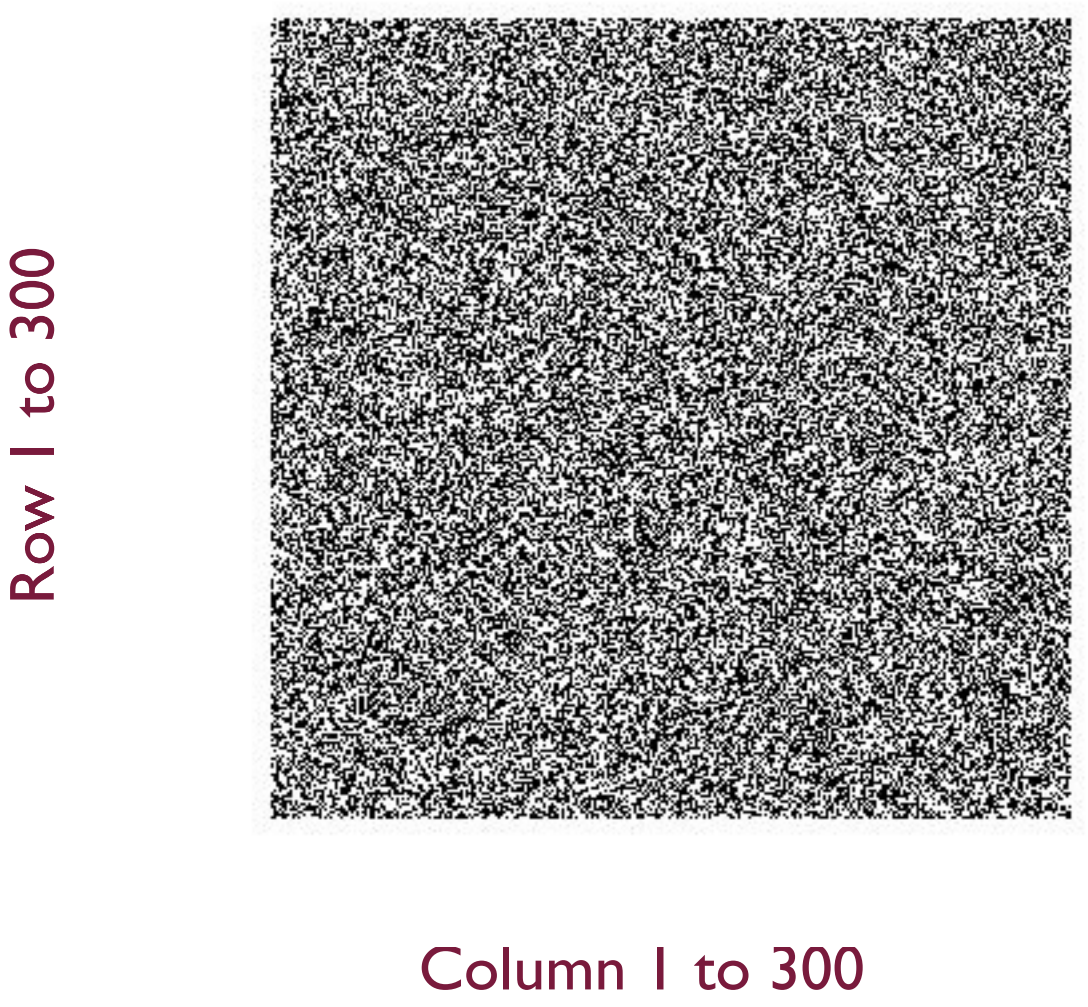
```
row = 300;
col = 300;
img = rand(row, col);
img = round(img);
```



Images and Matrices

Binary Image :

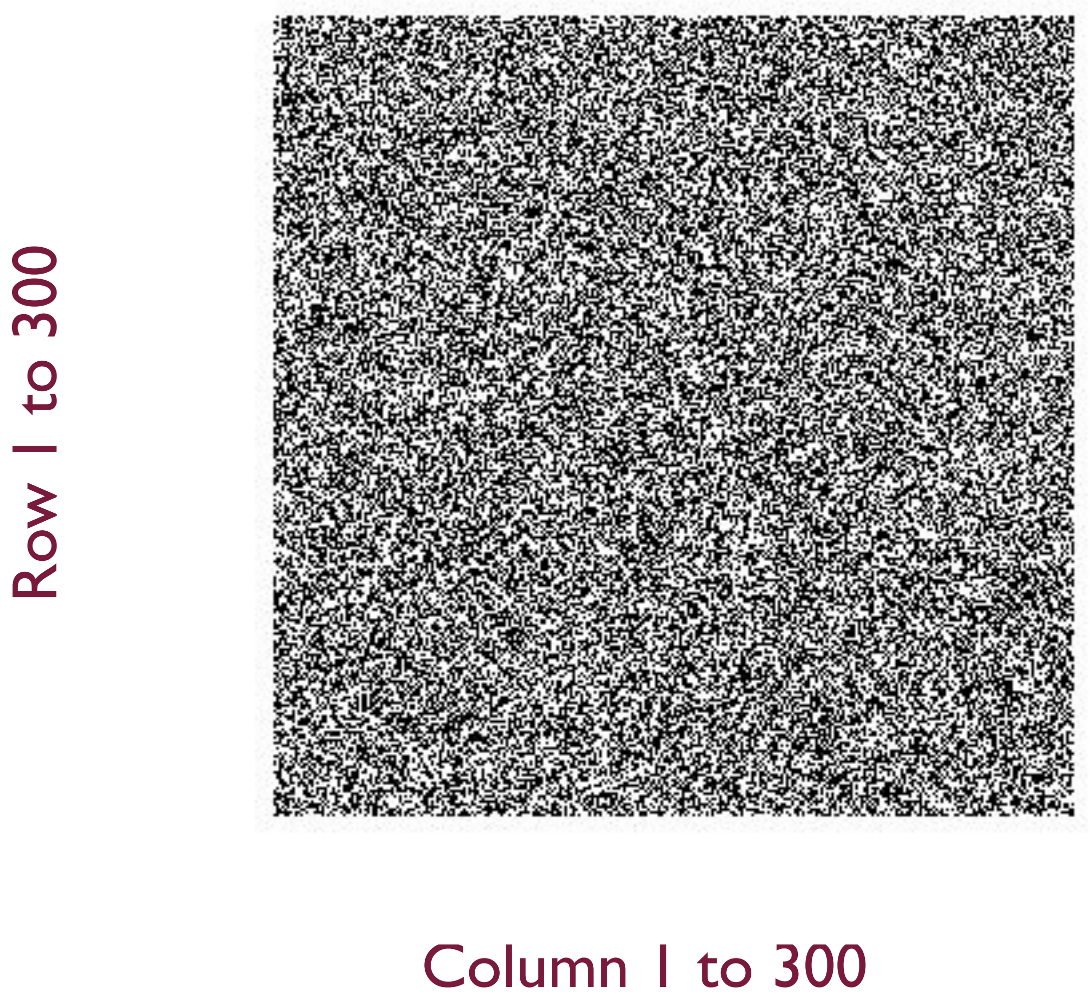
```
row = 300;
col = 300;
img = rand(row, col);
img = round(img);
figure;
```



Images and Matrices

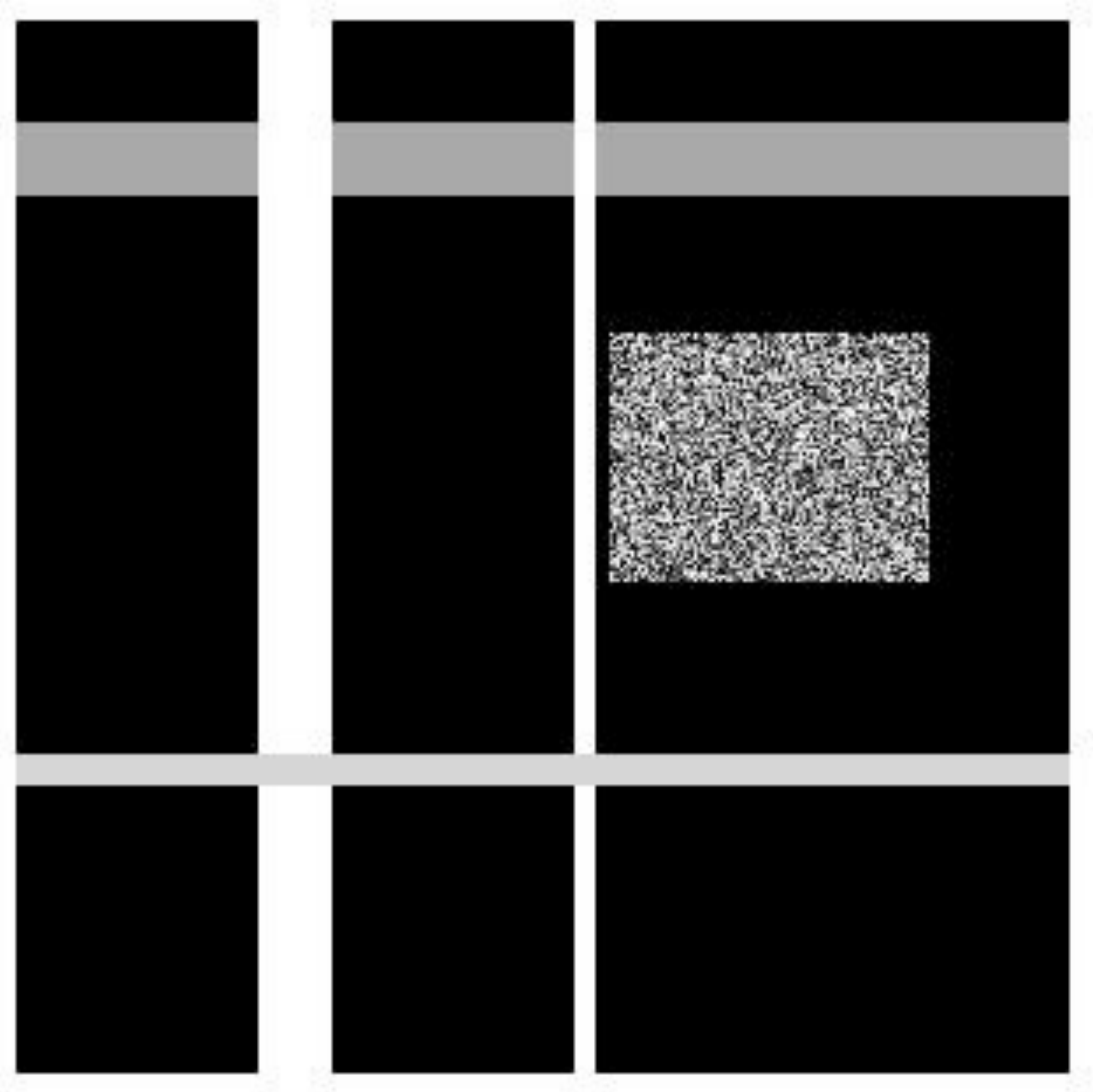
Binary Image :

```
row = 300;
col = 300;
img = rand(row, col);
img = round(img);
figure;
imshow(img);
```

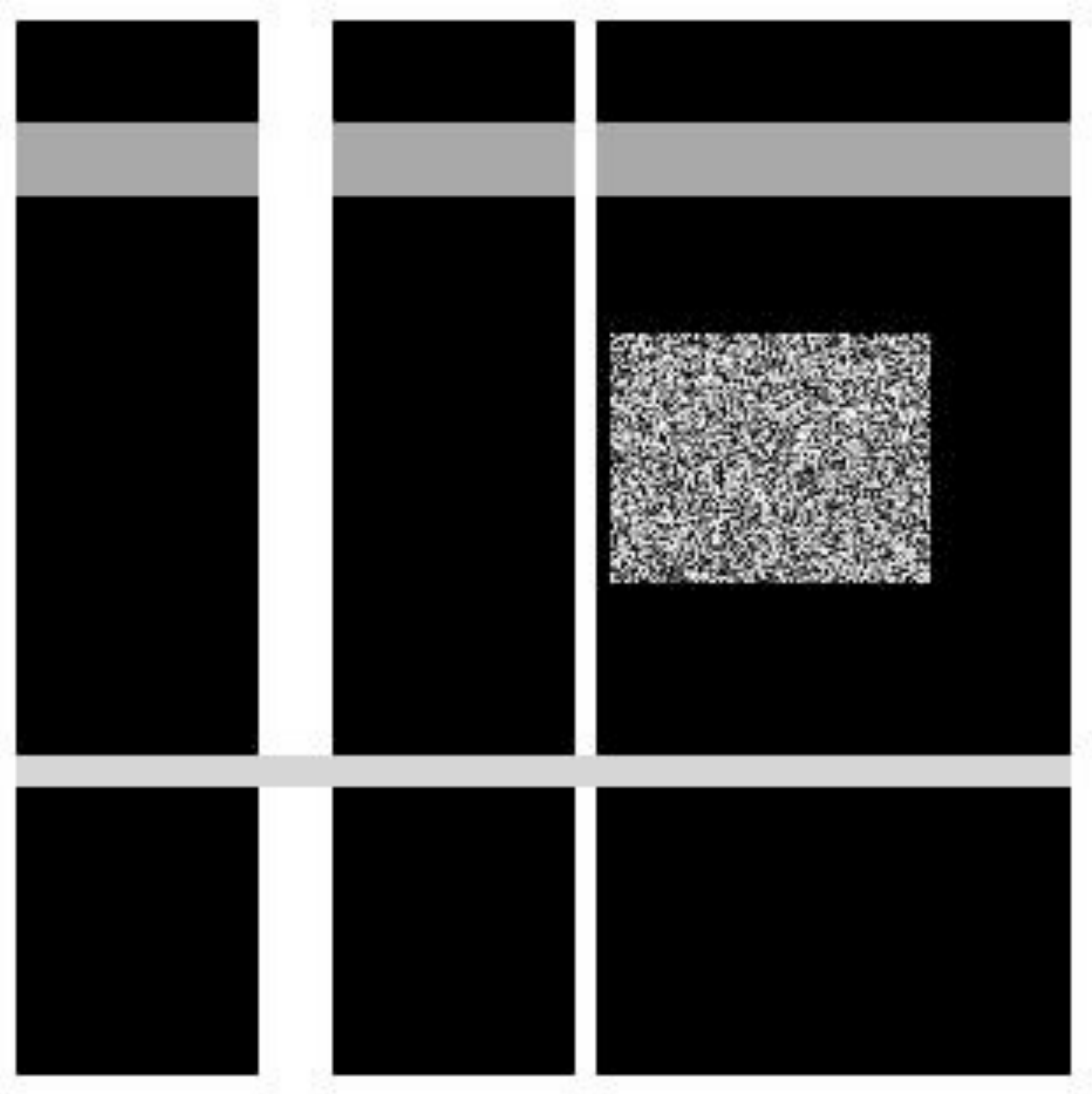


Lets try this out

Lets try this out

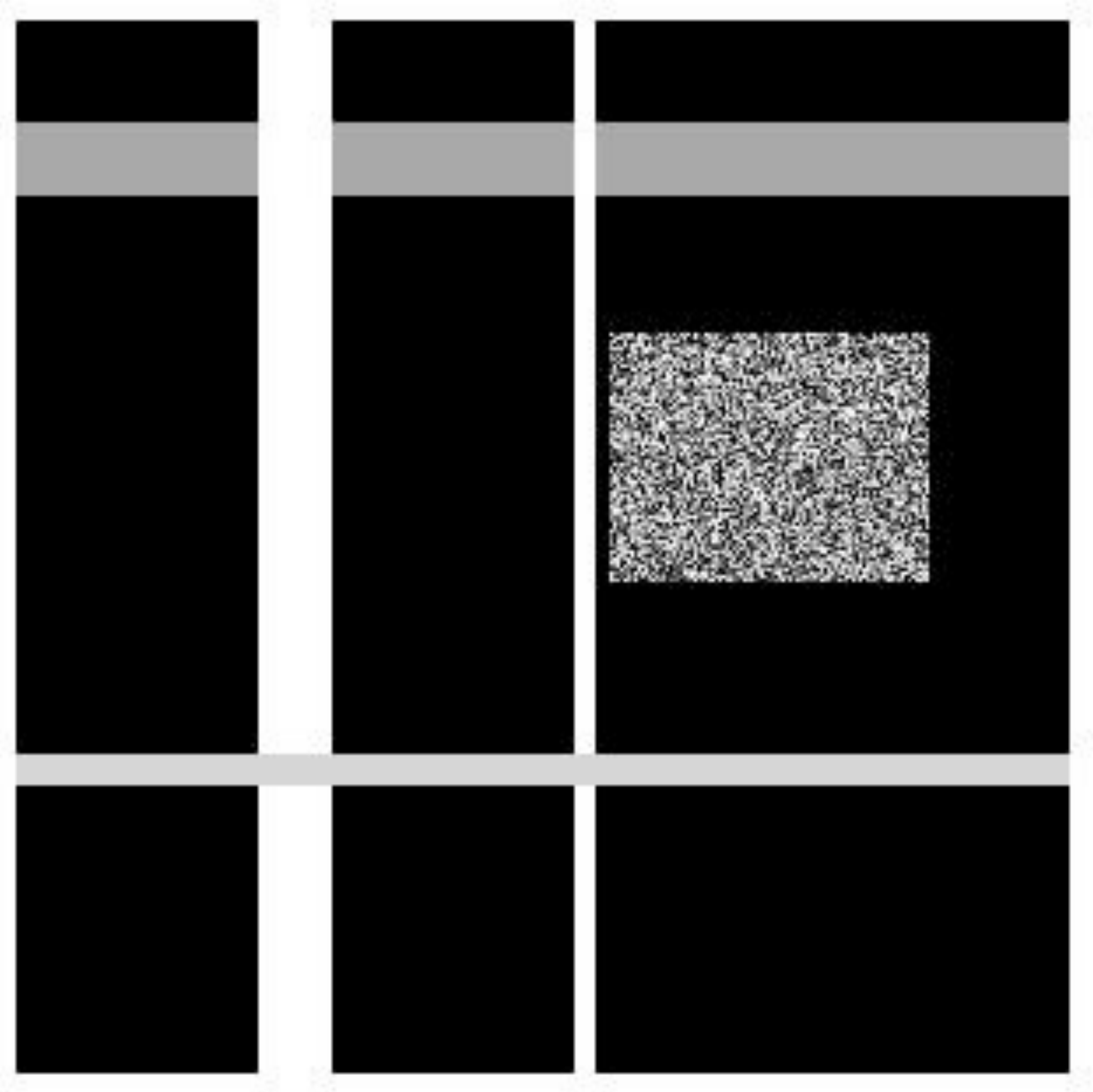


Lets try this out



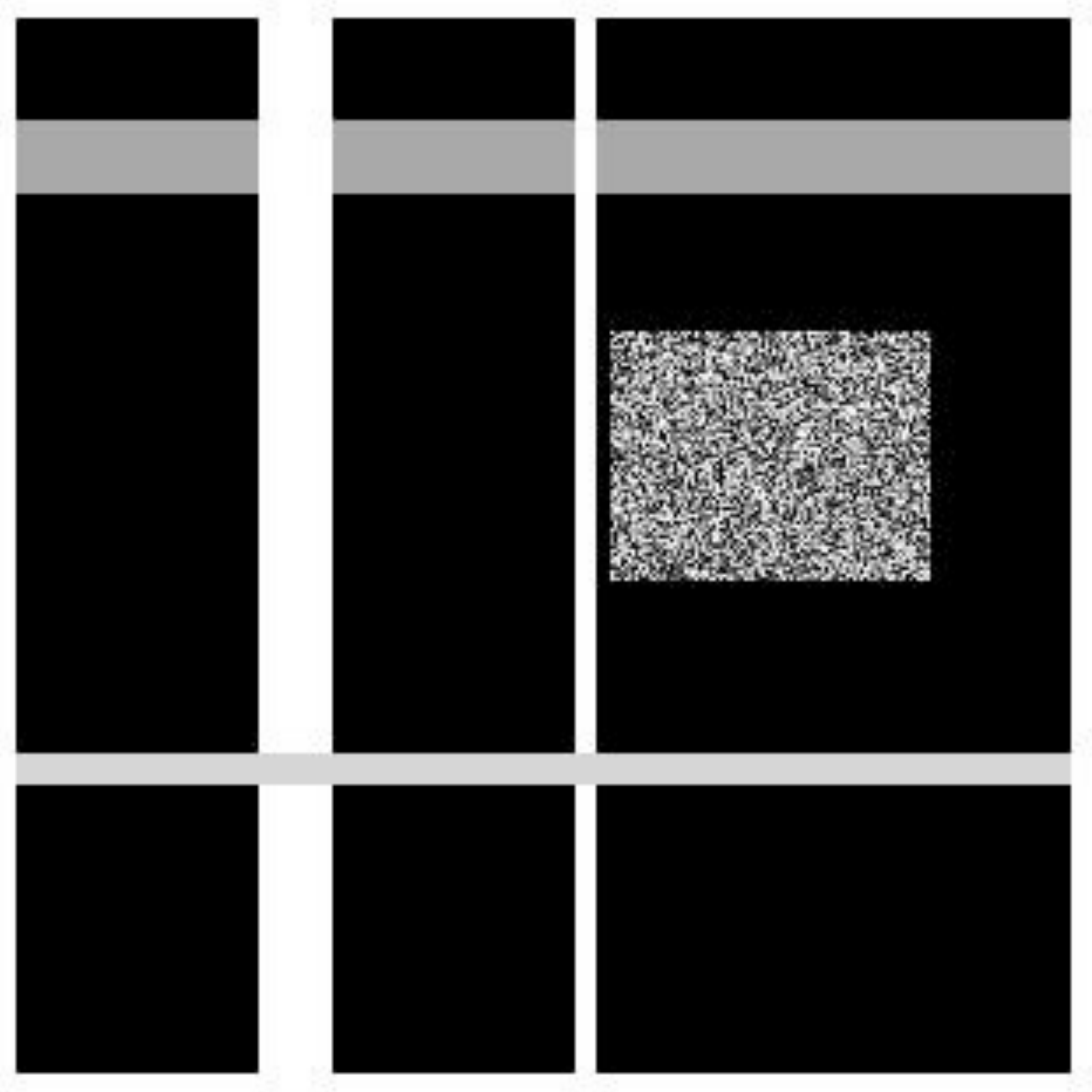
```
row = 300;
```

Lets try this out



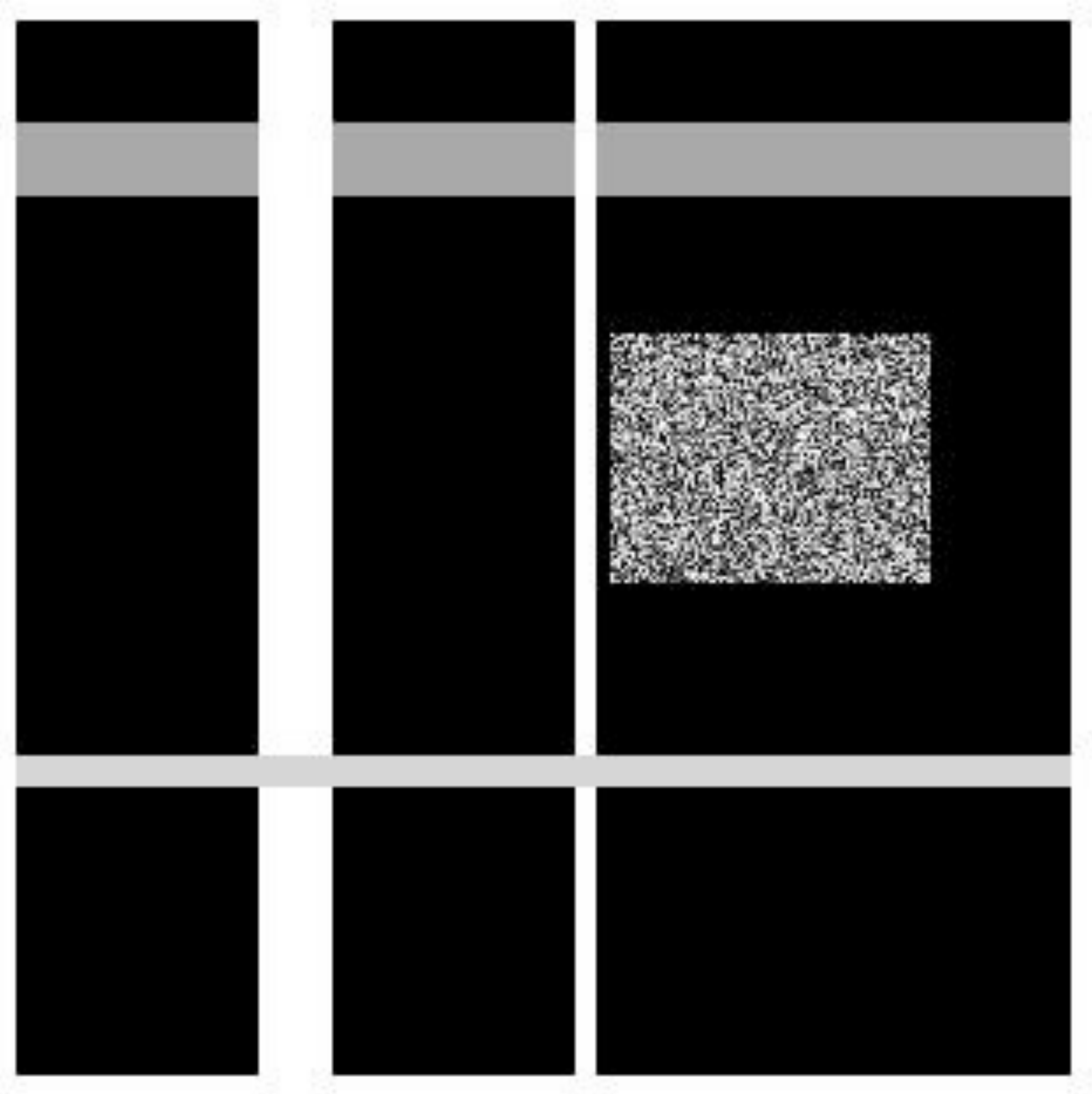
```
row = 300;
col = 300;
```

Lets try this out



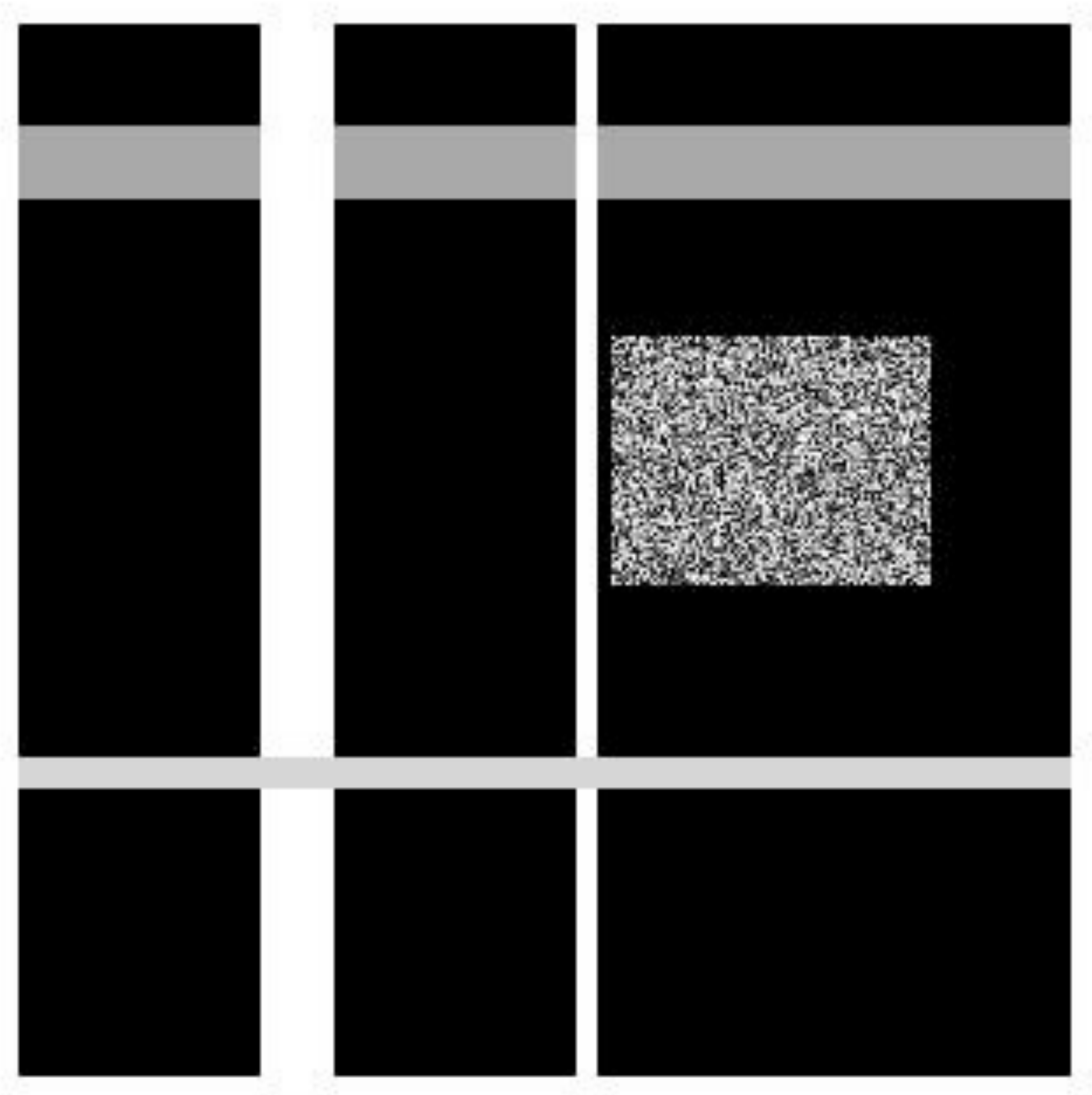
```
row = 300;
col = 300;
img = zeros(row, col);
```

Lets try this out



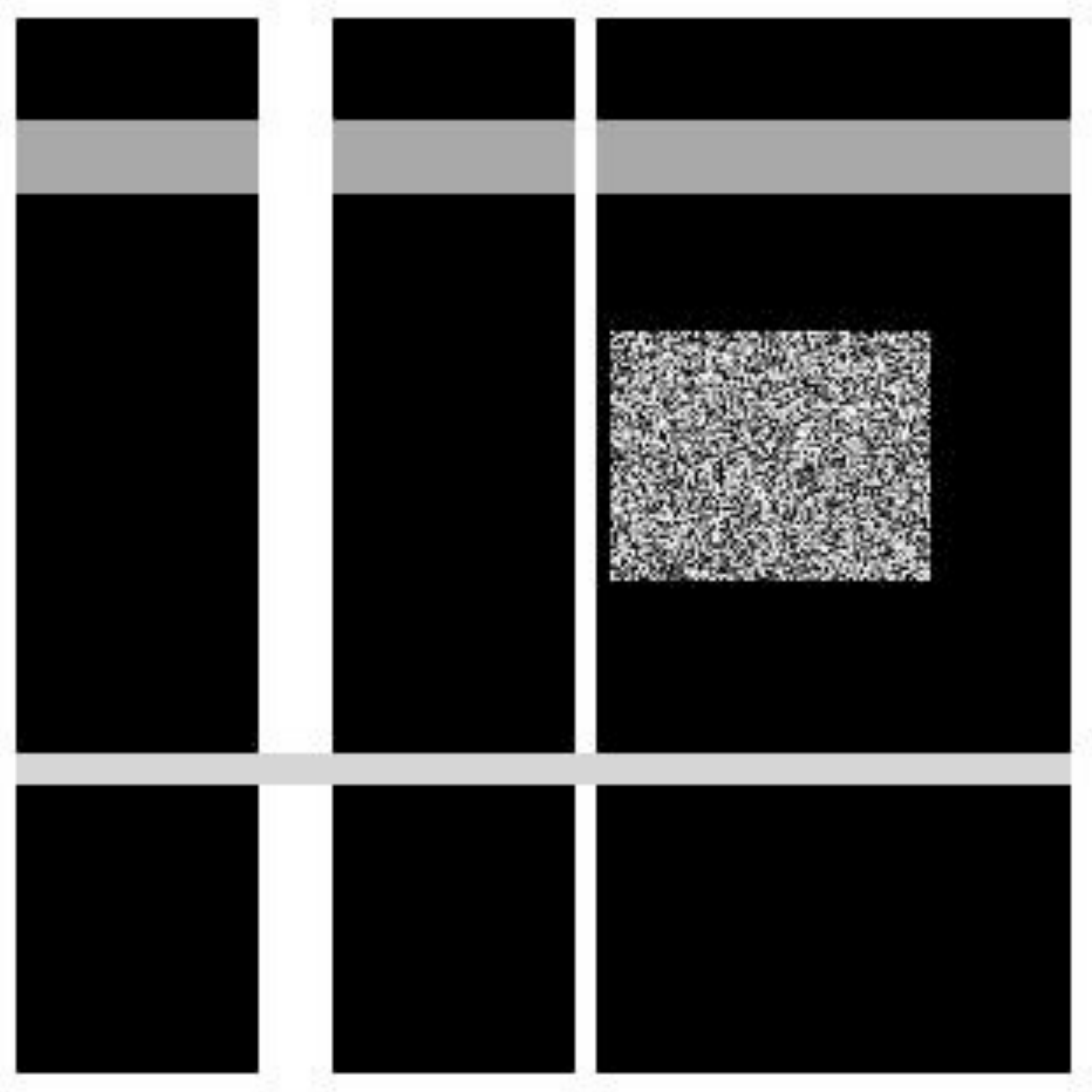
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
```

Lets try this out



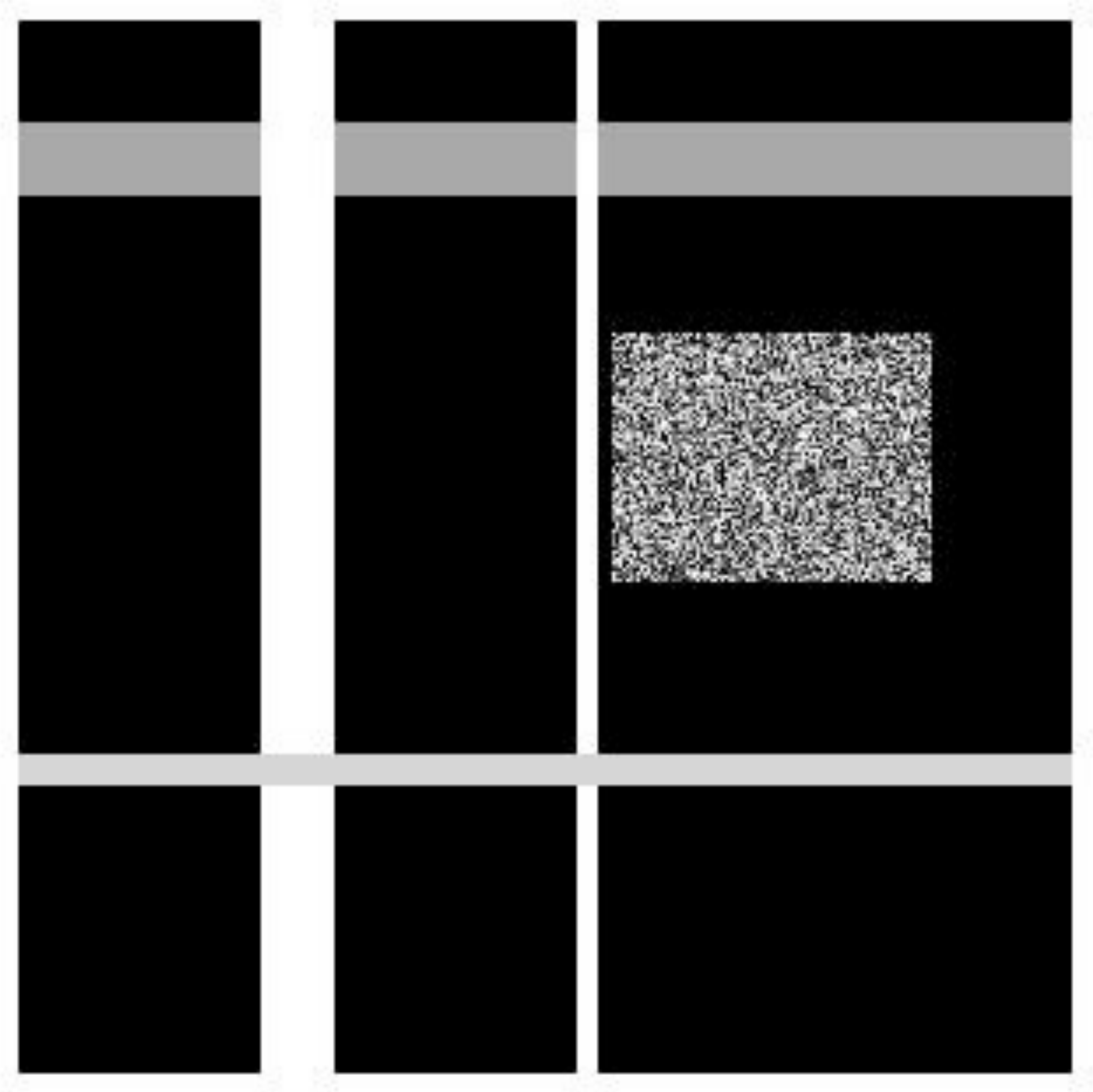
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
```

Lets try this out



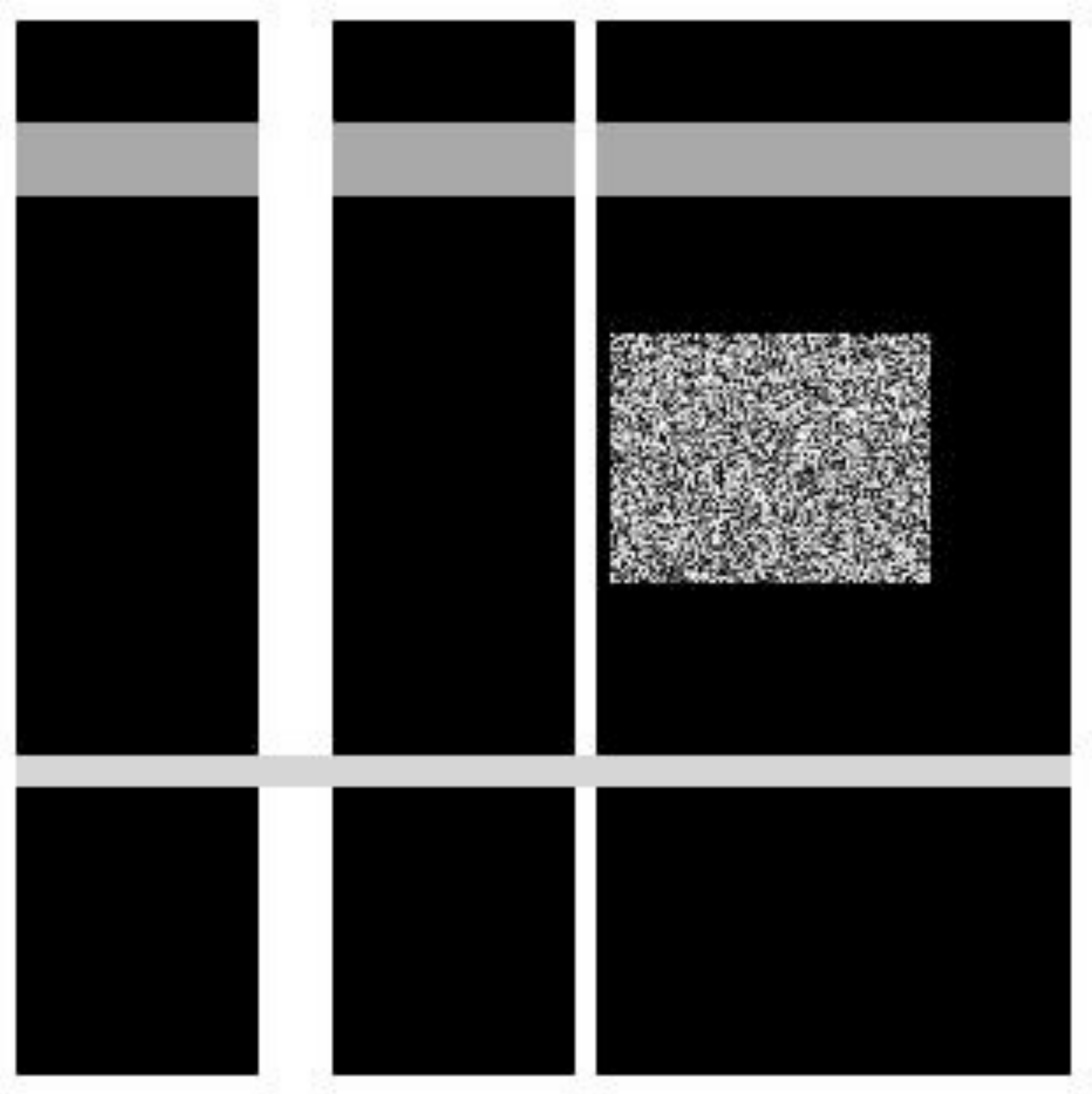
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
```

Lets try this out



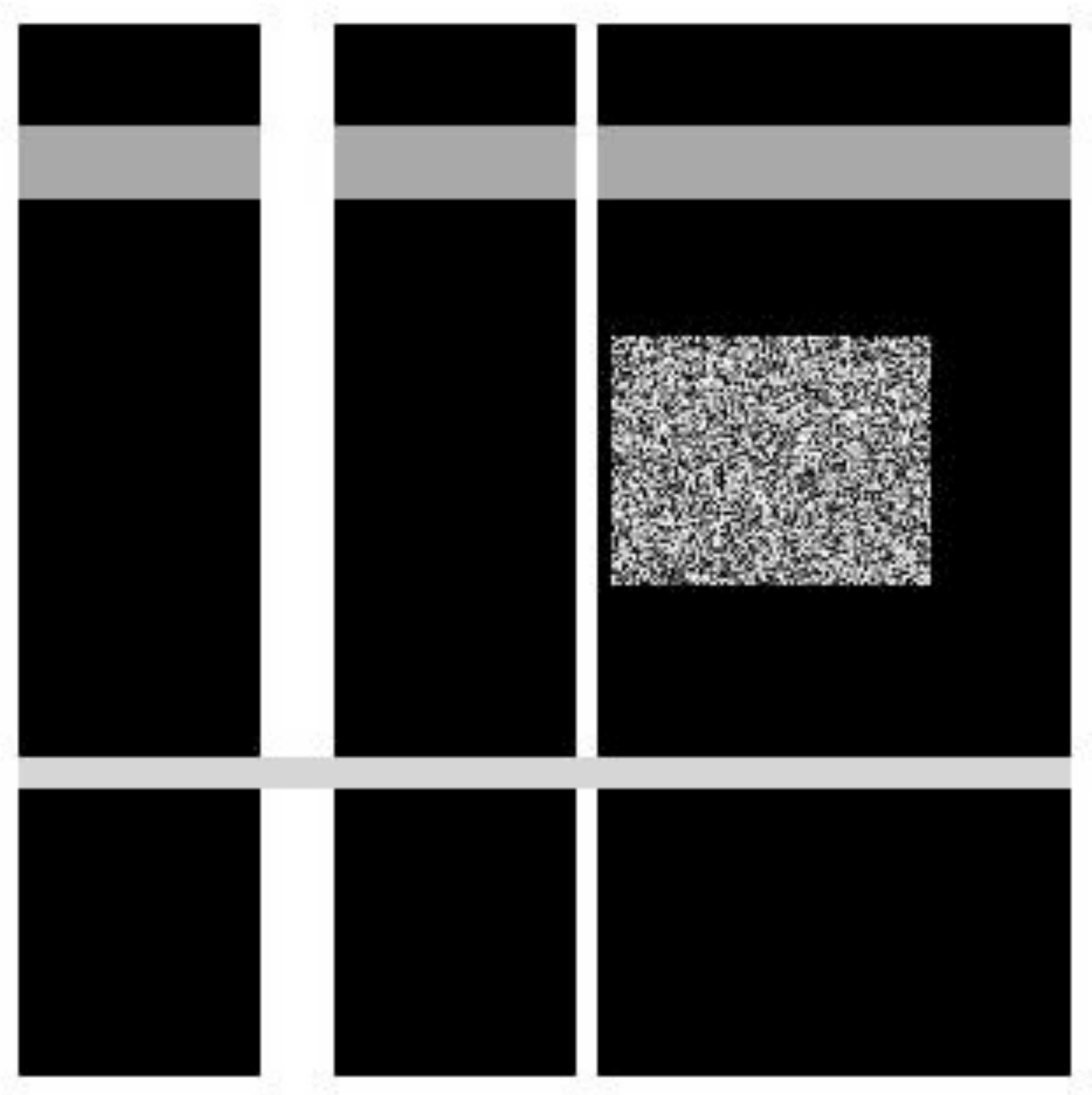
```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;
```

Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;
```

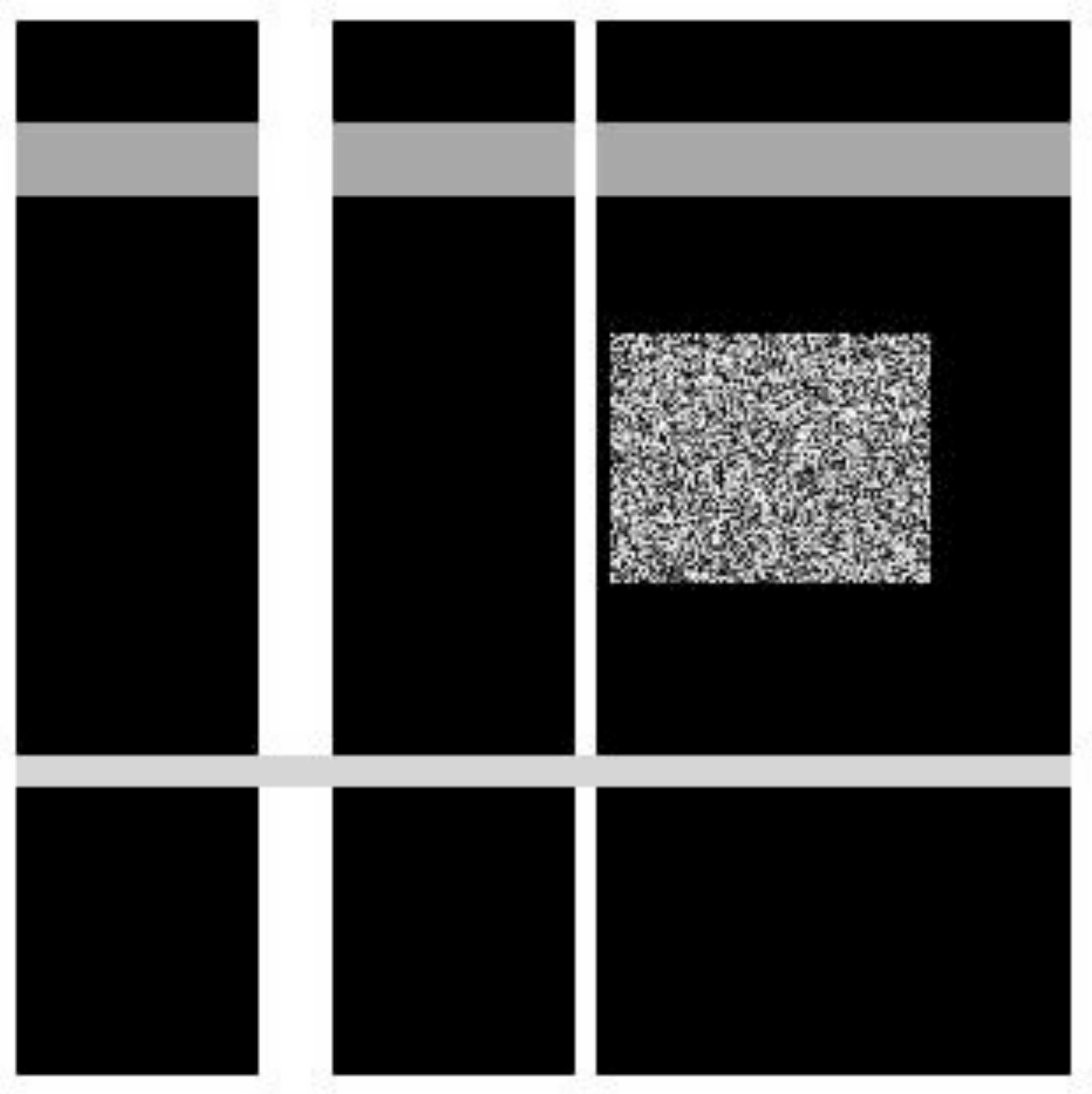
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
```

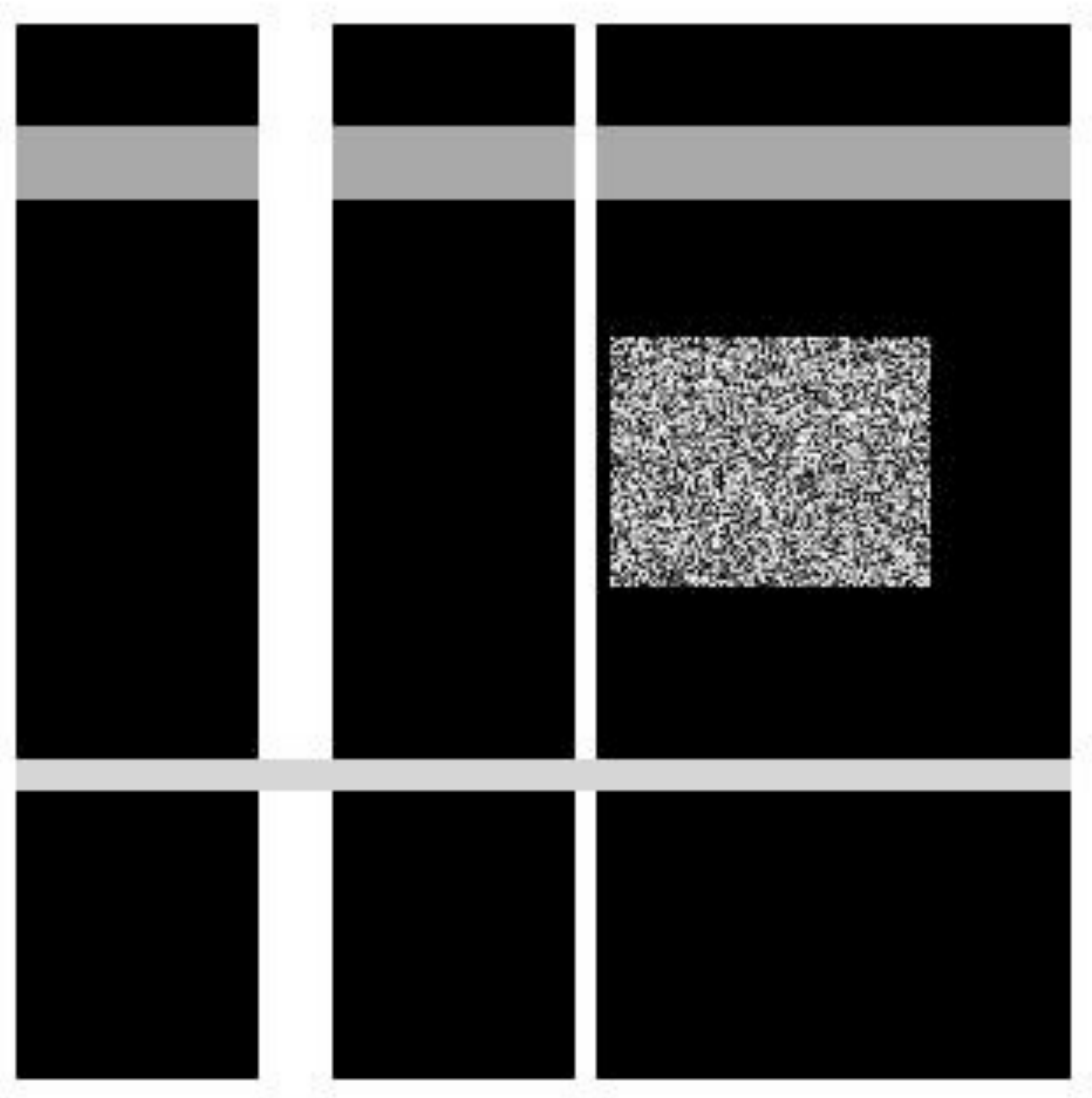
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
```

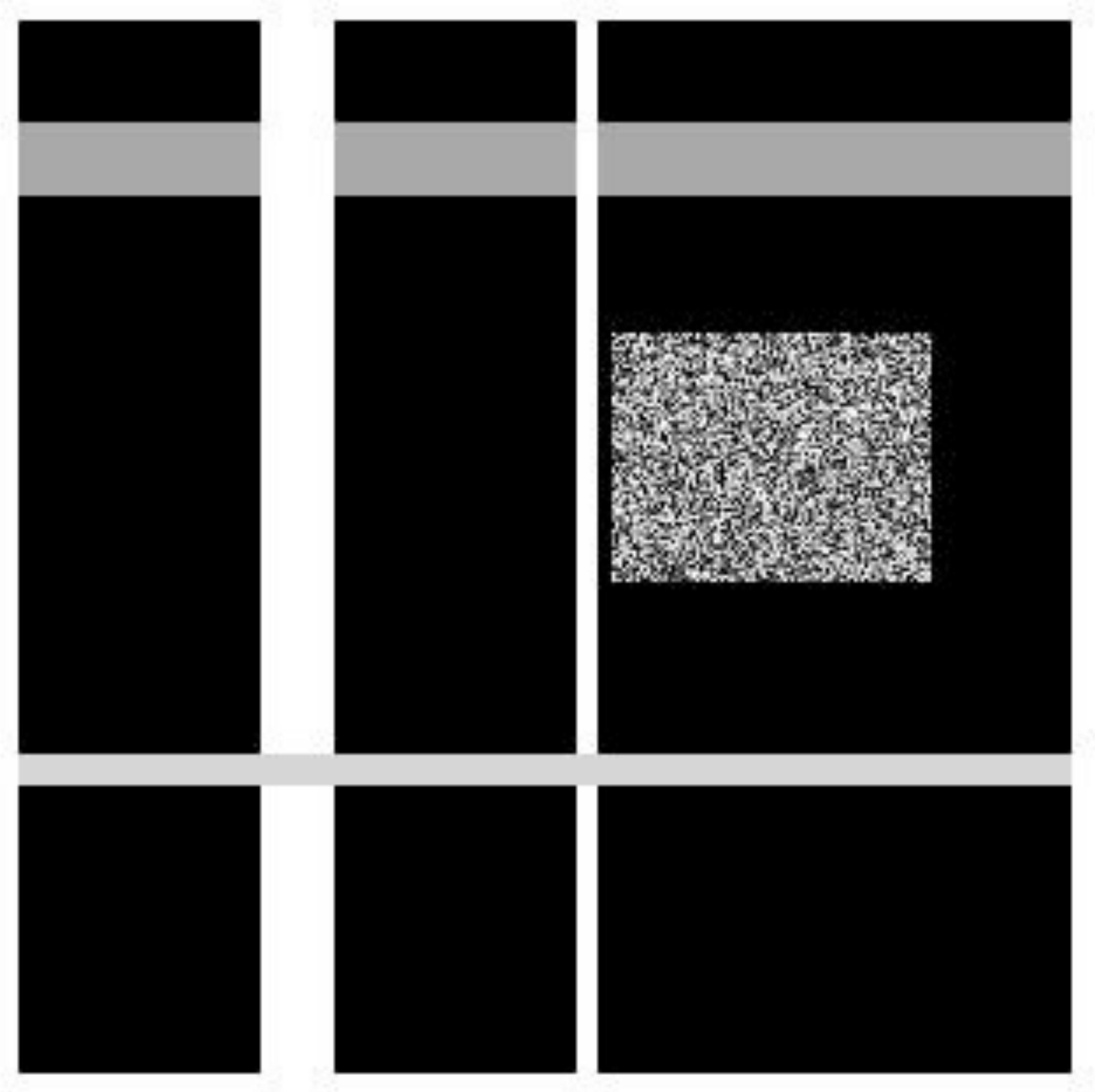
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
        img(i, j) = rand;
```

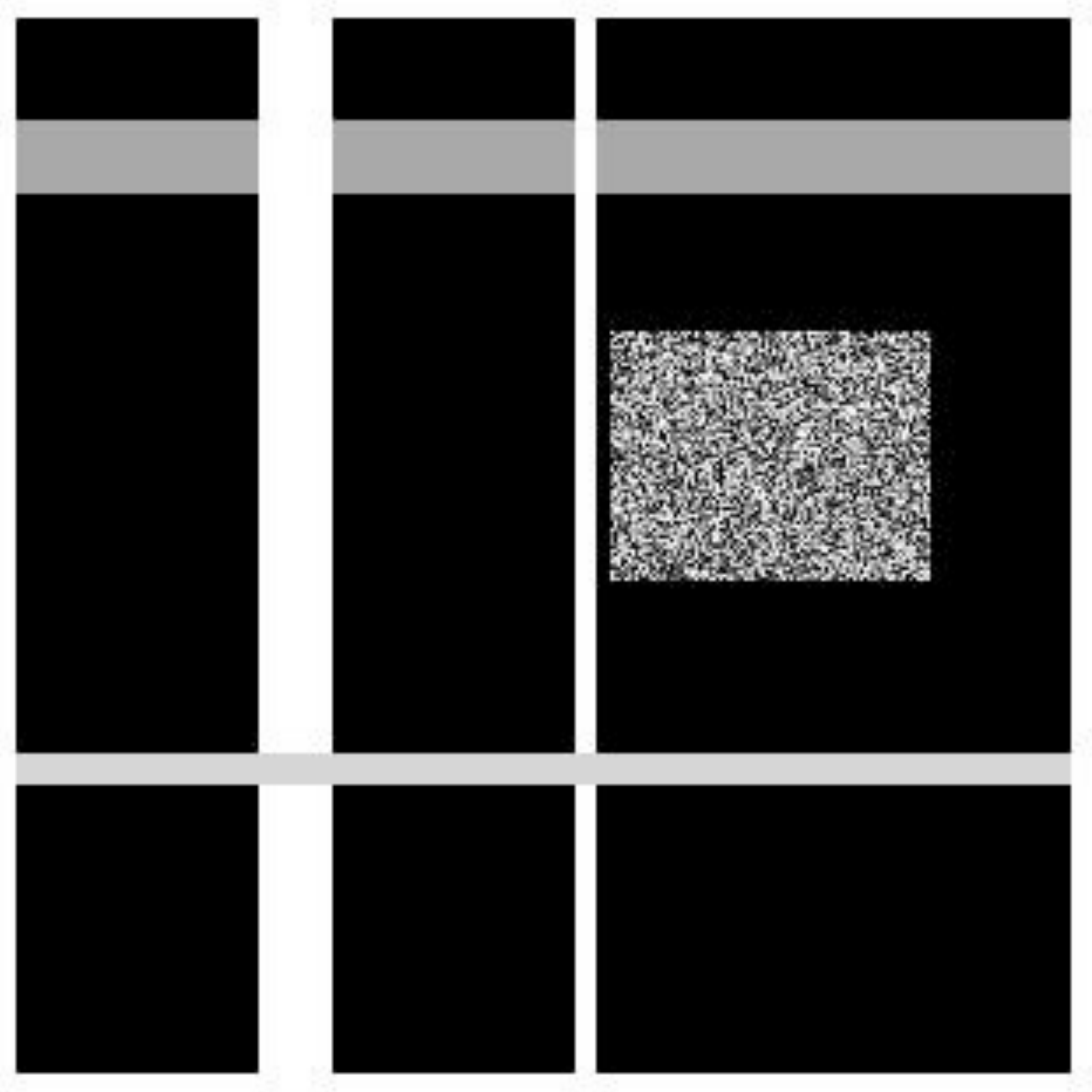
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
        img(i, j) = rand;
    end
```

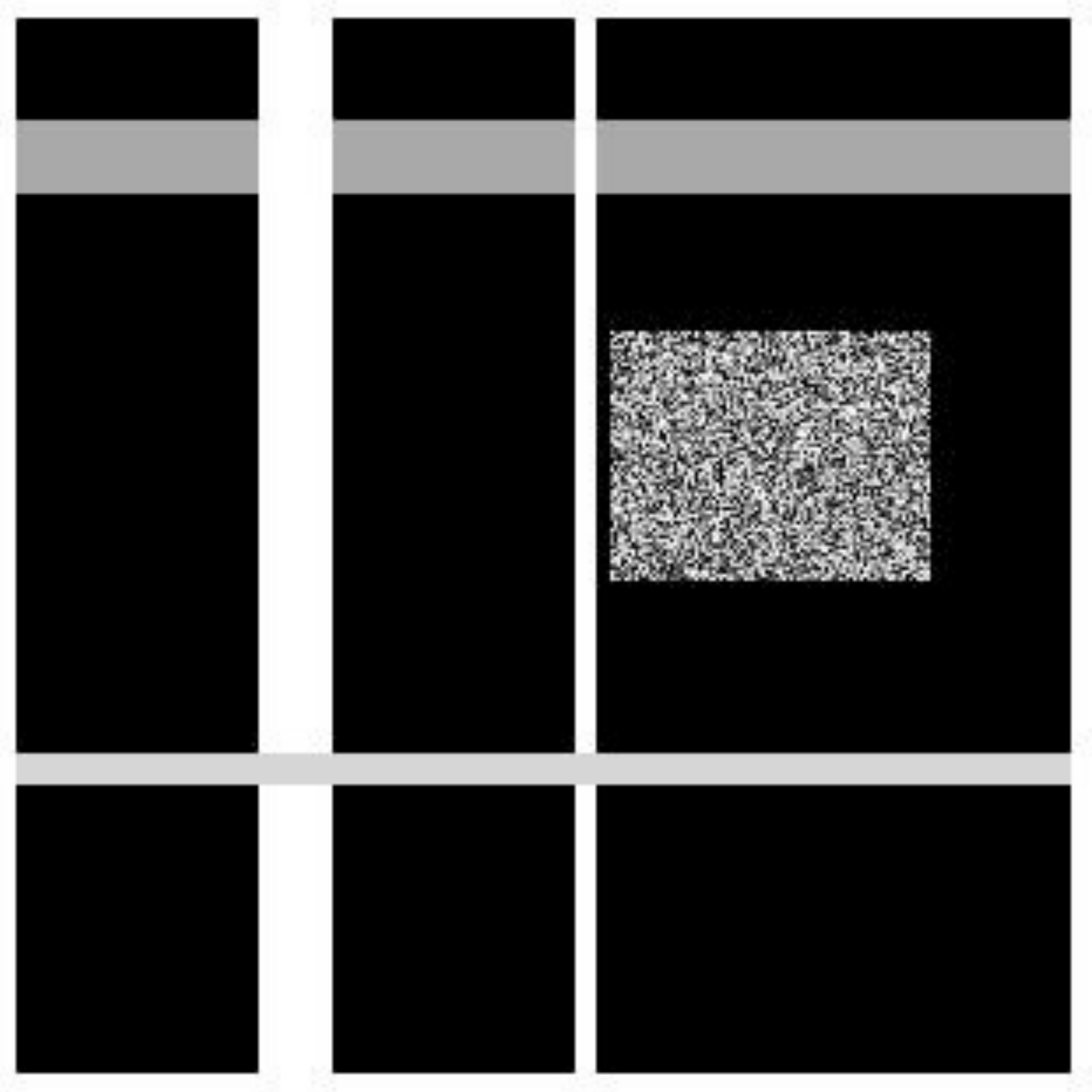
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
        img(i, j) = rand;
    end
end
```

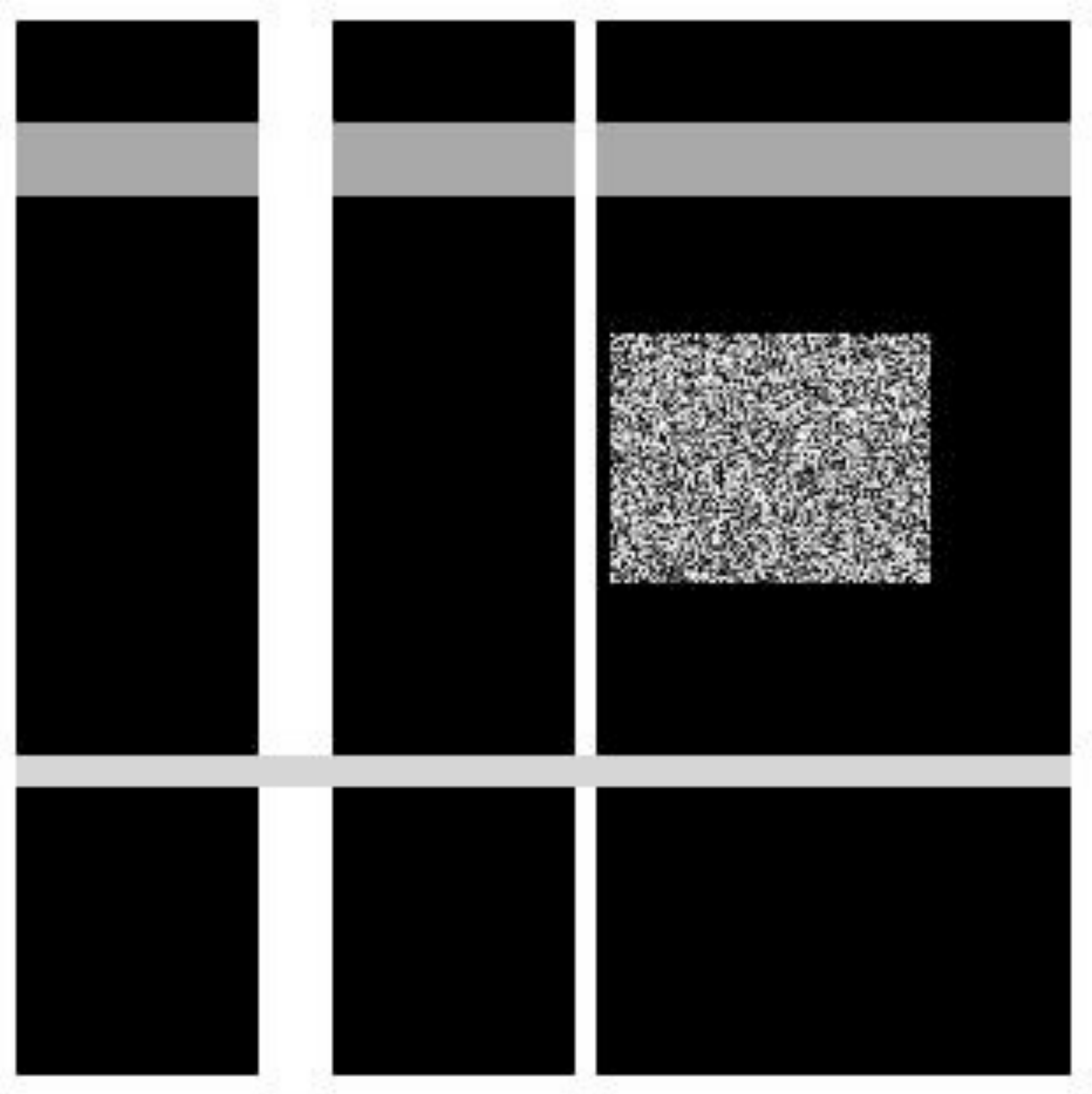
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
        img(i, j) = rand;
    end
end
figure;
```

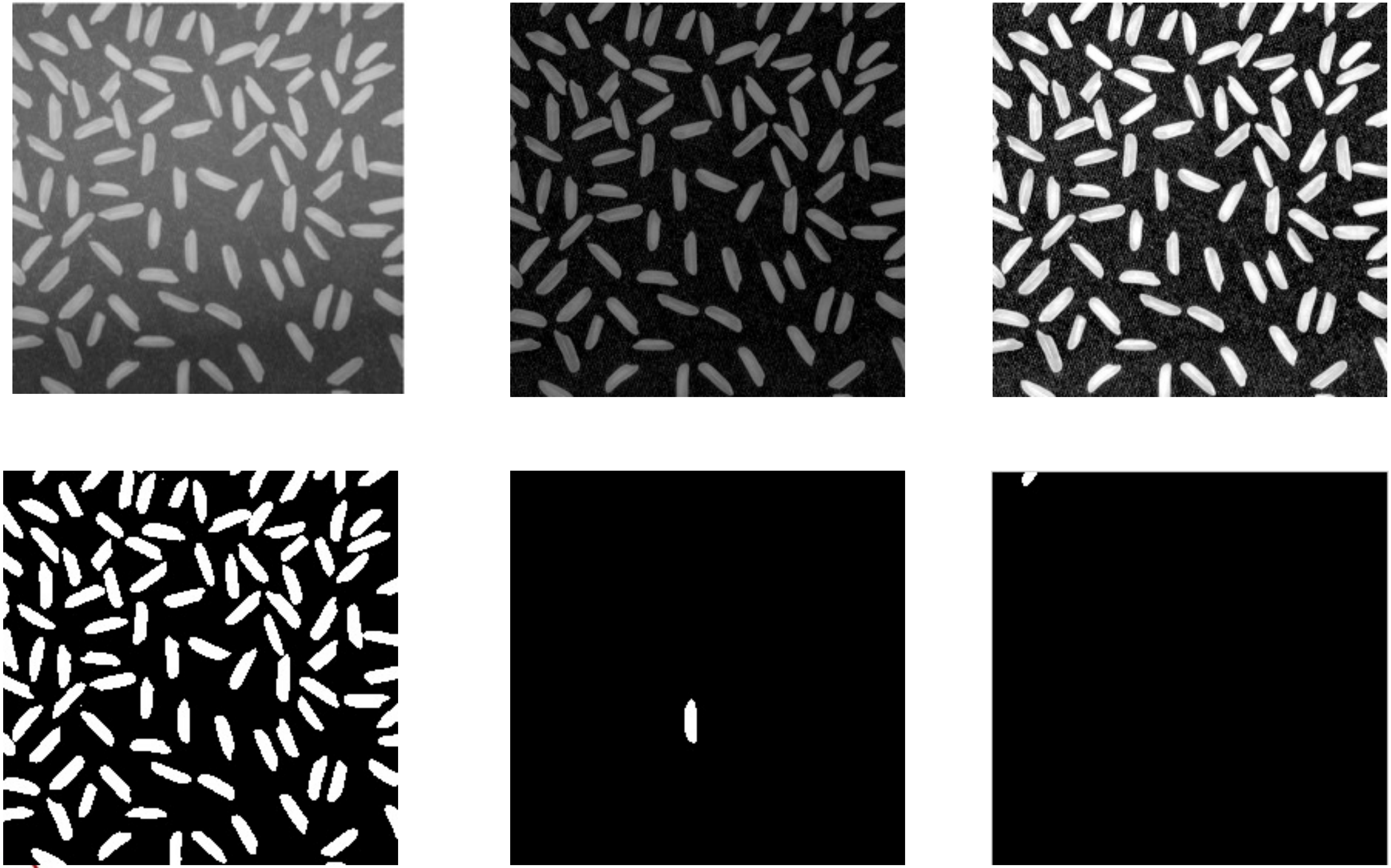
Lets try this out



```
row = 300;
col = 300;
img = zeros(row, col);
img(30:50, :) = 0.6;
img(:, 70:90) = 1;
img(:, 160:165) = 1;
img(210:218, :) = 0.8;

for i = 90:160
    for j = 170:260
        img(i, j) = rand;
    end
end
figure;
imshow(img);
```

Image Processing

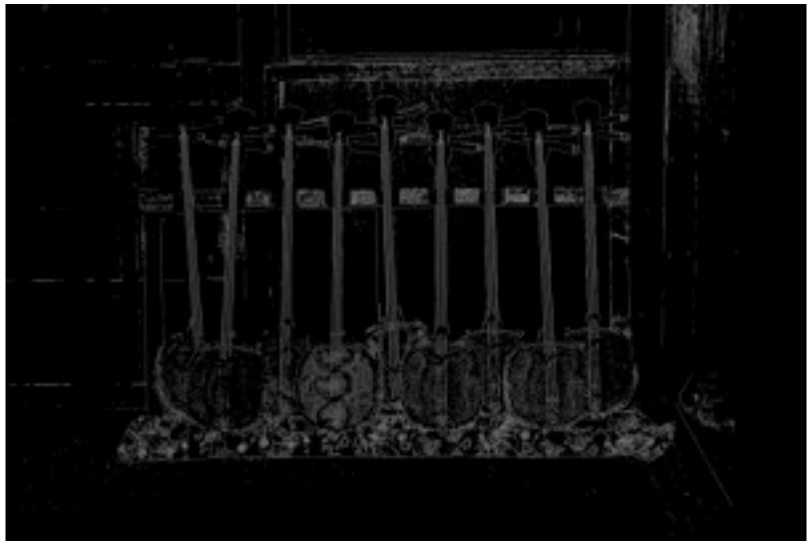


Outline of an Image

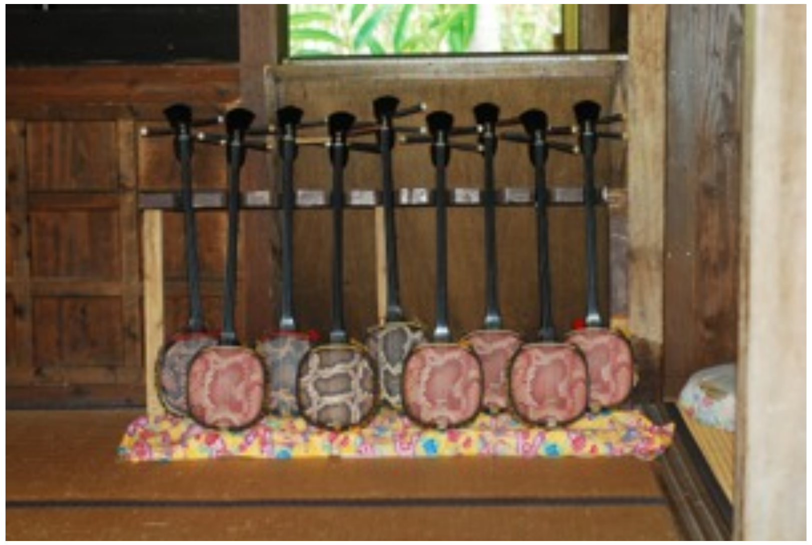
Outline of an Image

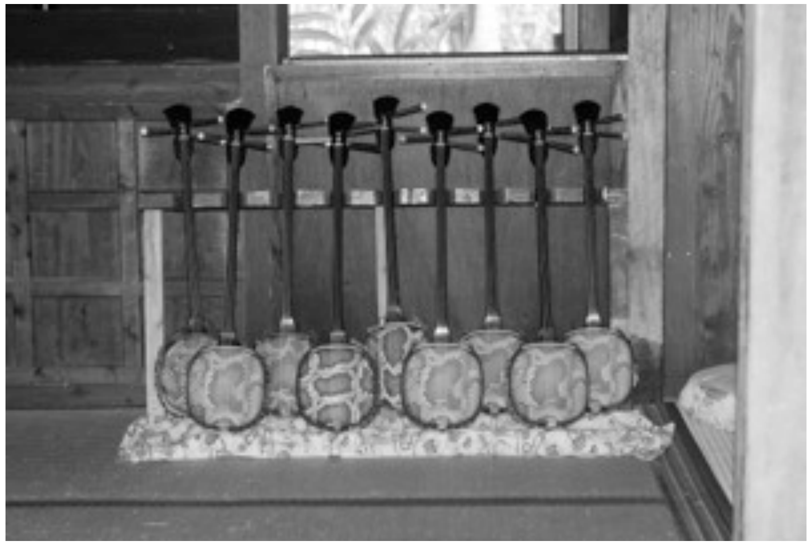
Outline of an Image

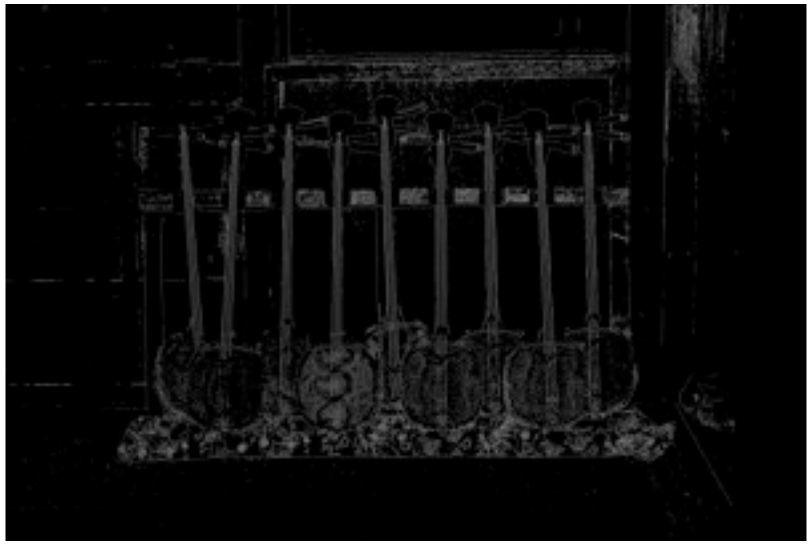
Outline of an Image

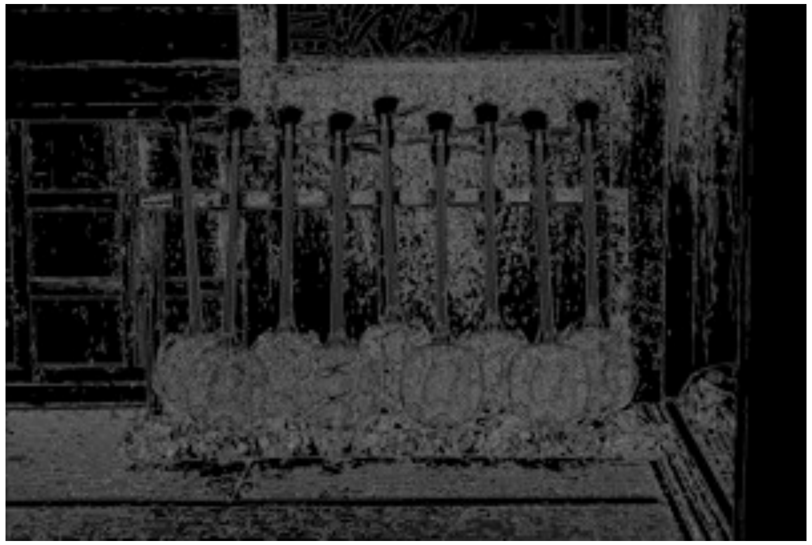


Outline of an Image



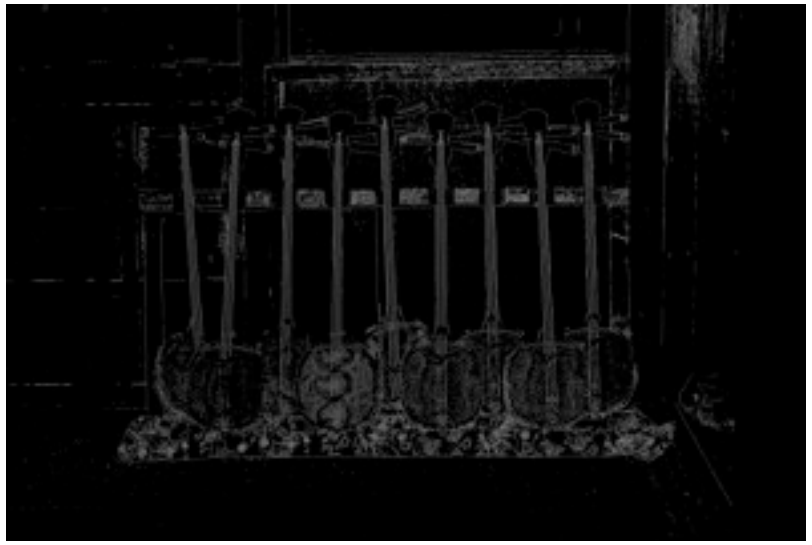


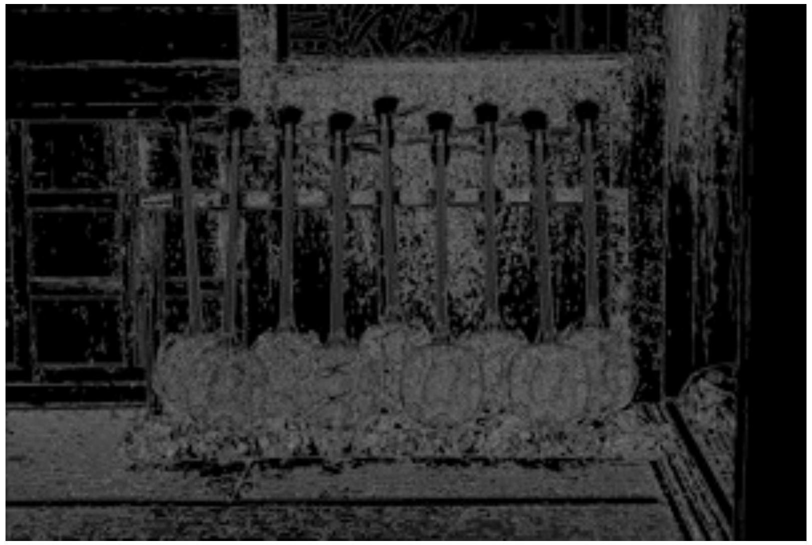




Outline of an Image

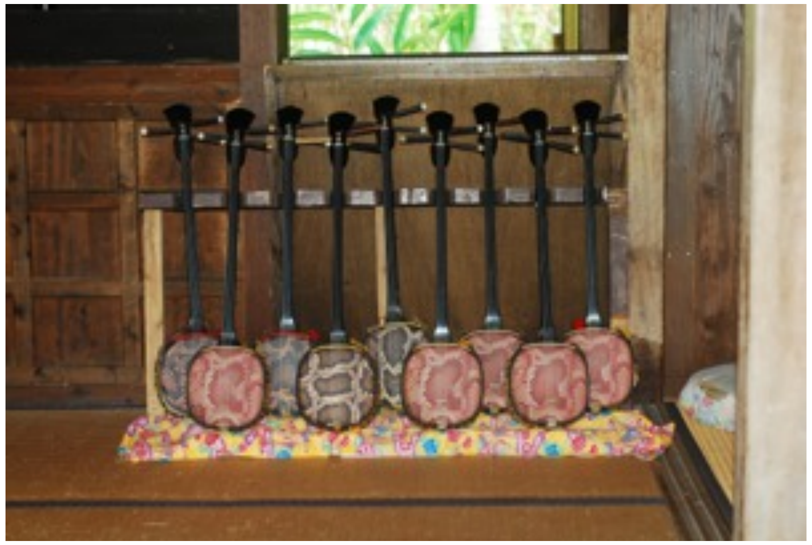
```
A = 'music.jpg';
```

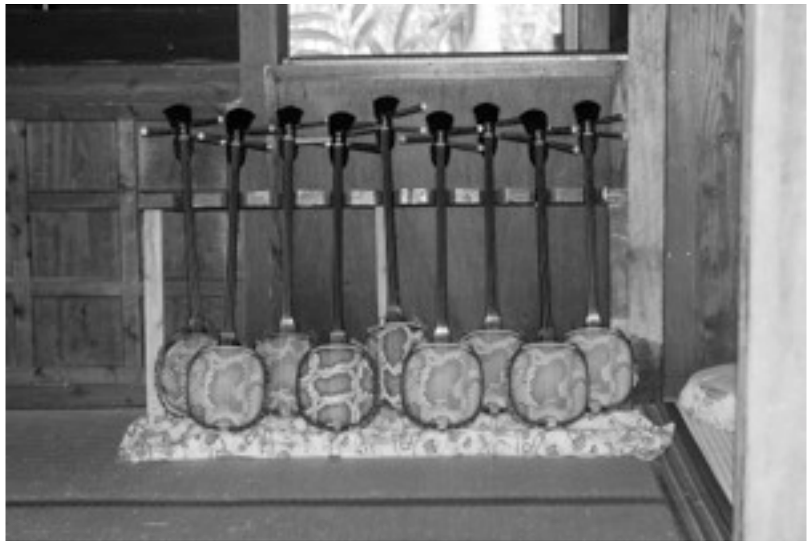


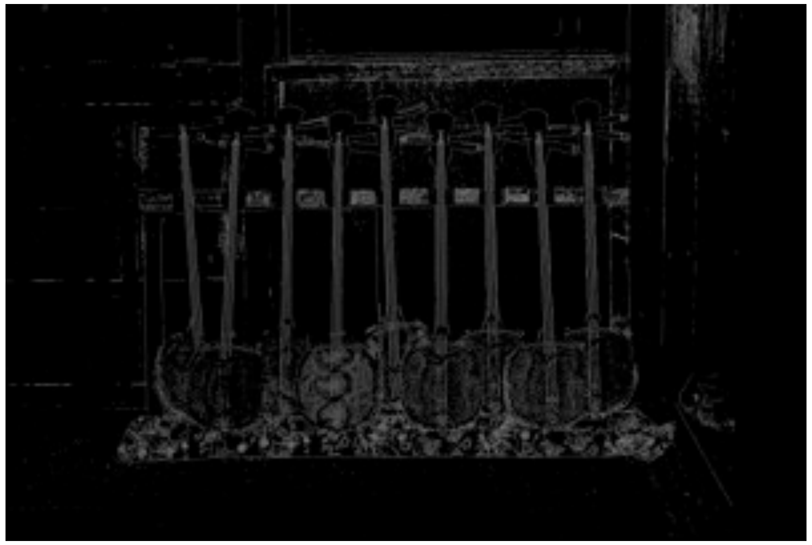


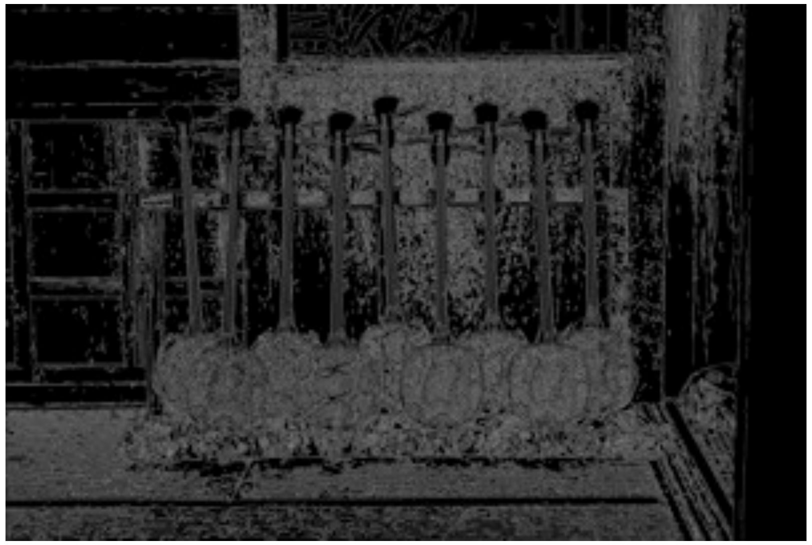
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
```



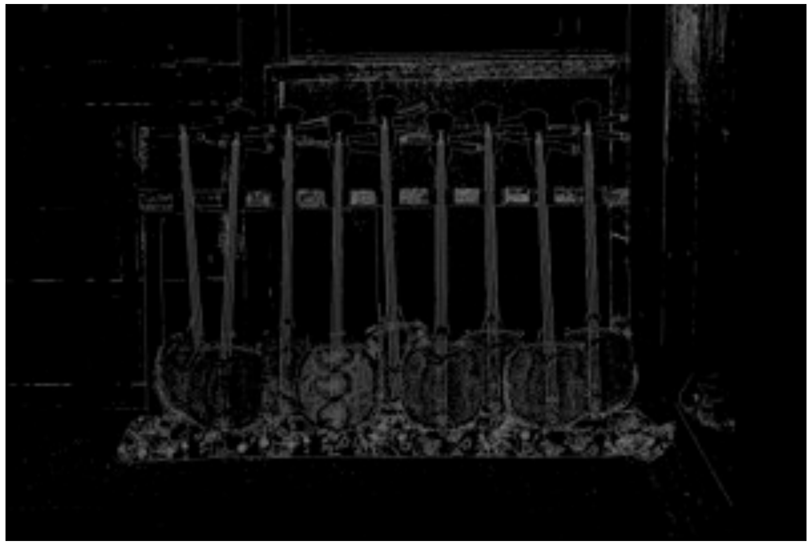


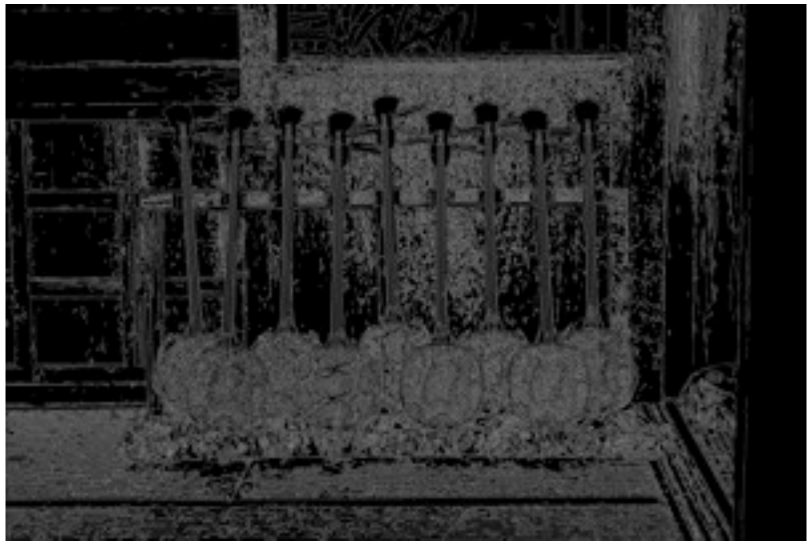




Outline of an Image

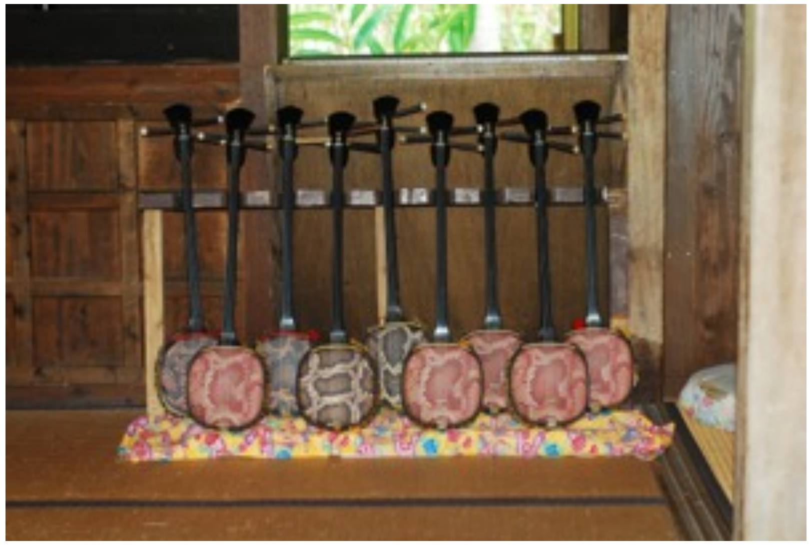
```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
```

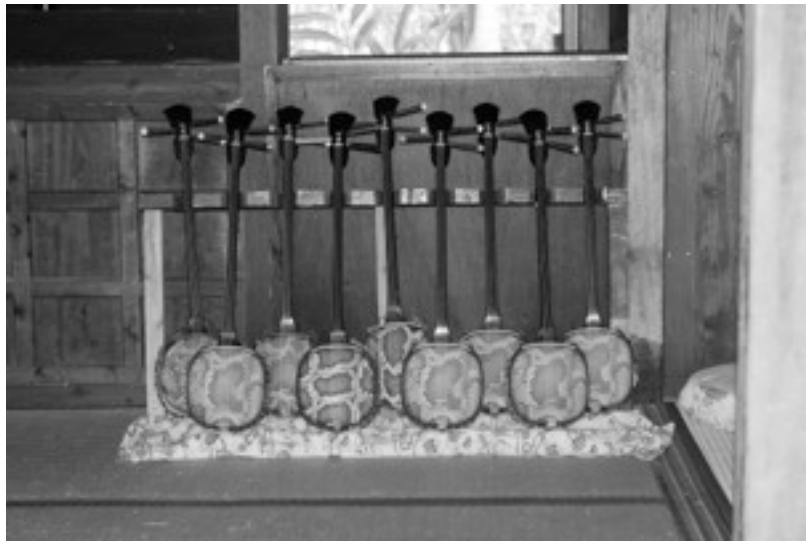


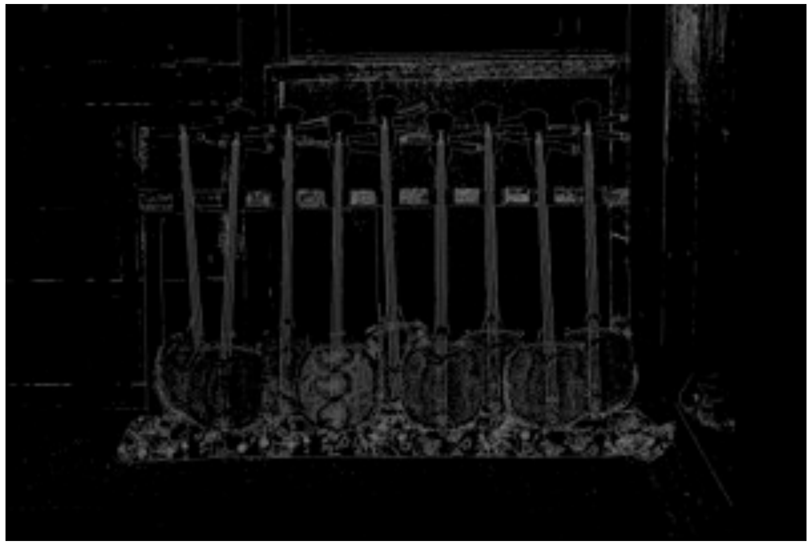


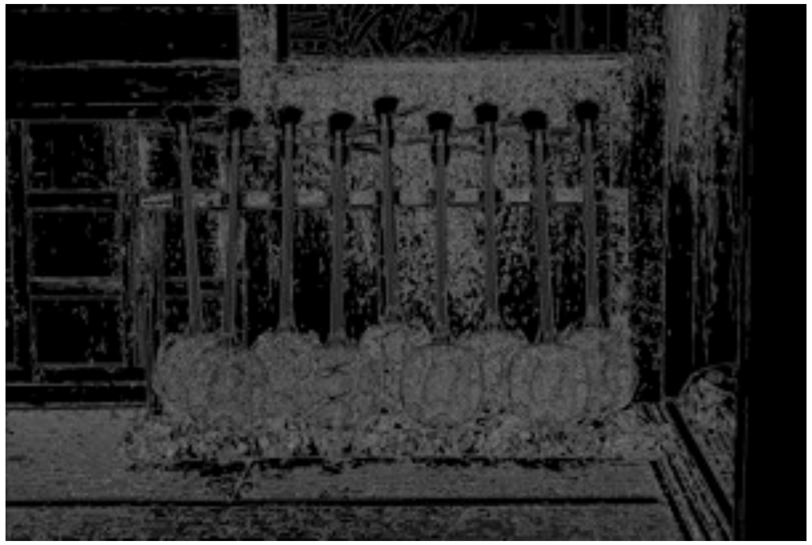
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
```



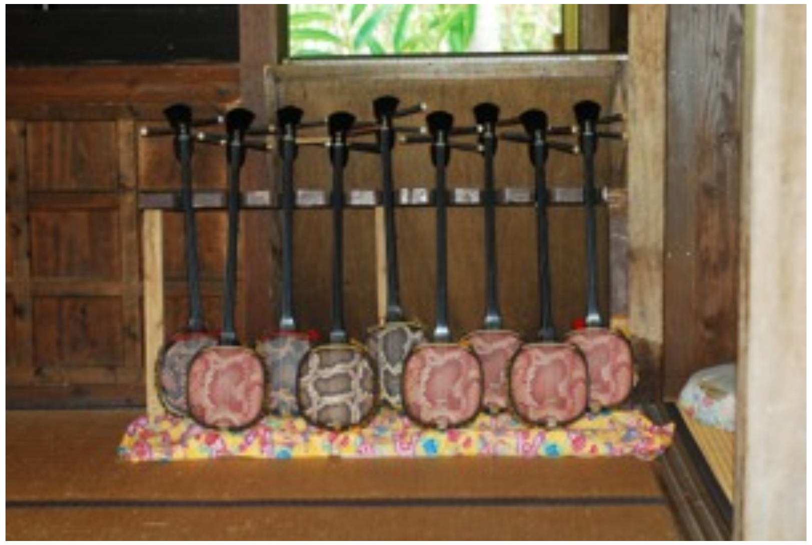


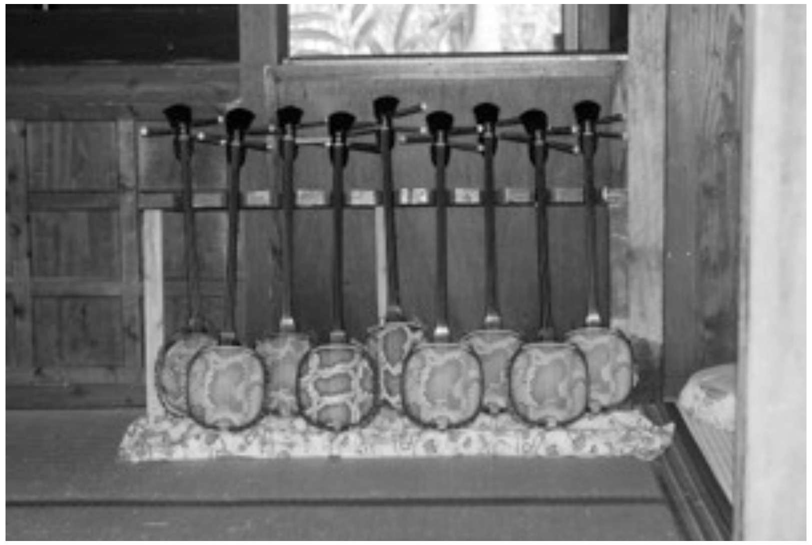


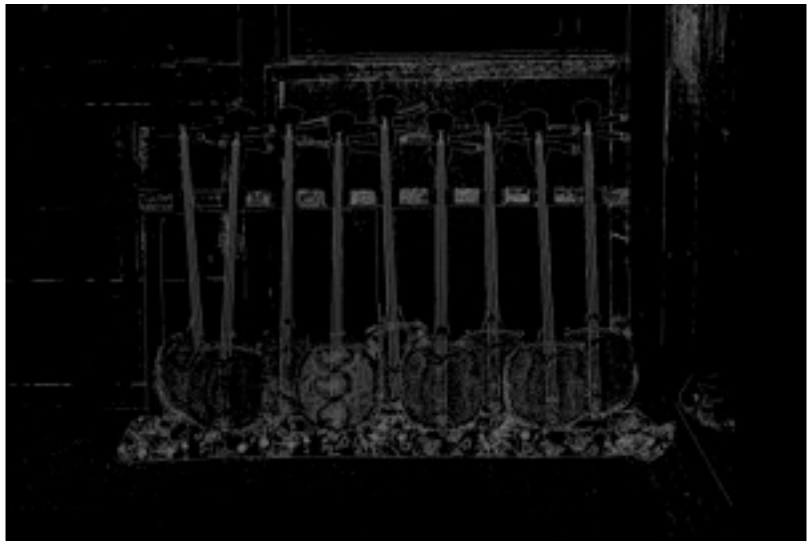


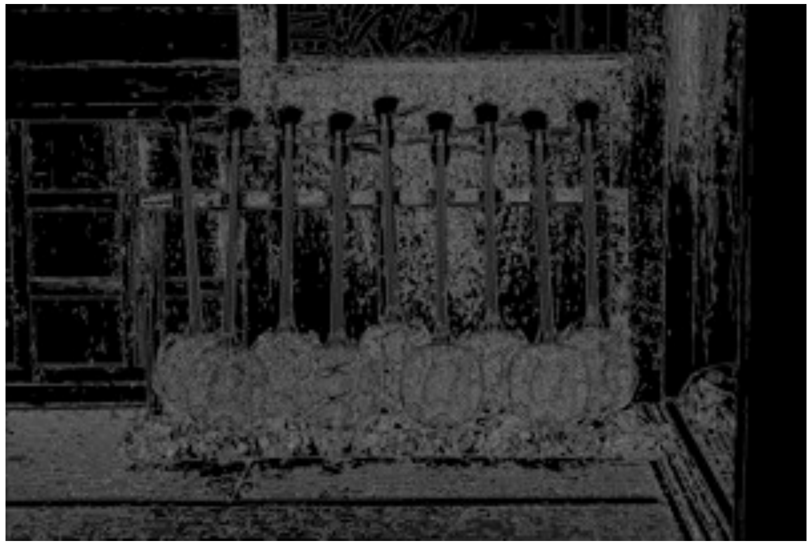
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
```



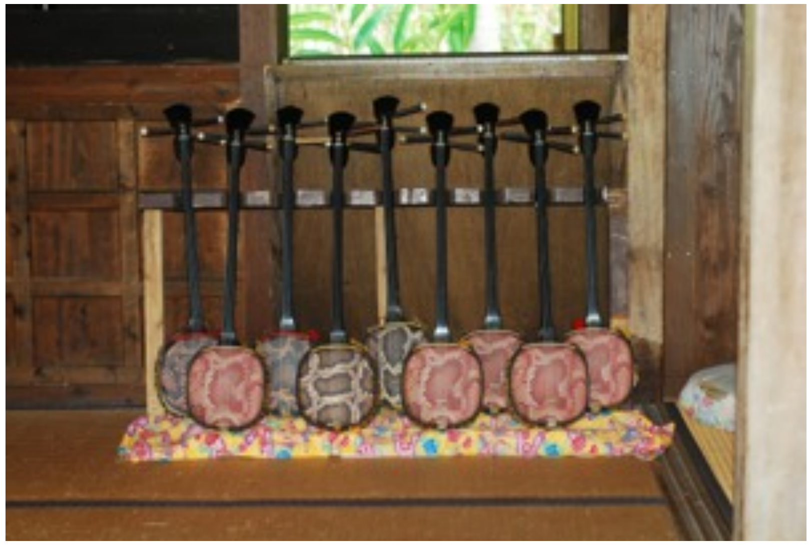


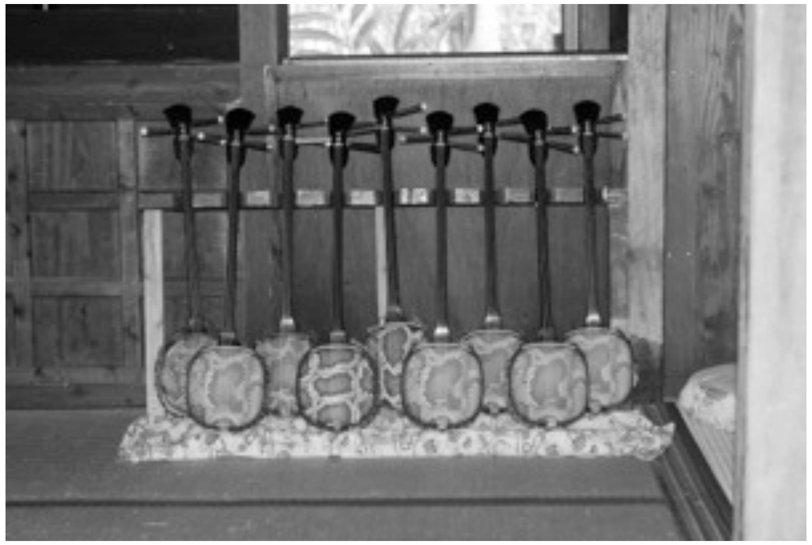


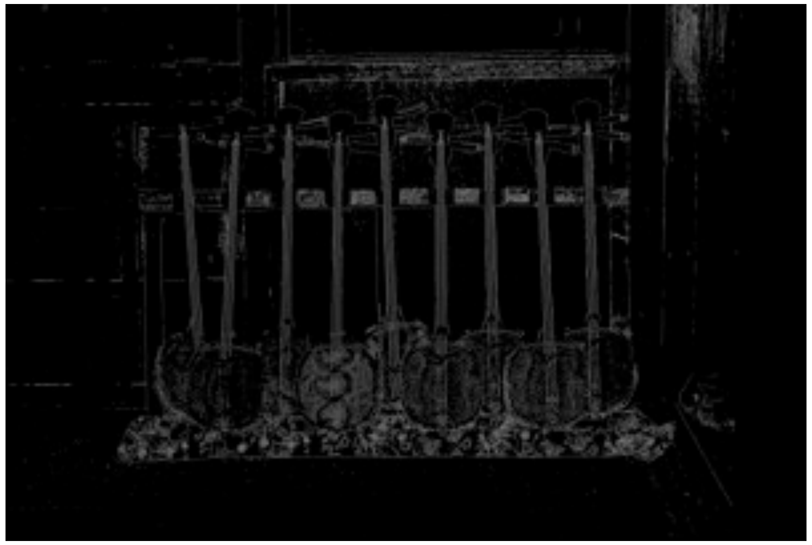


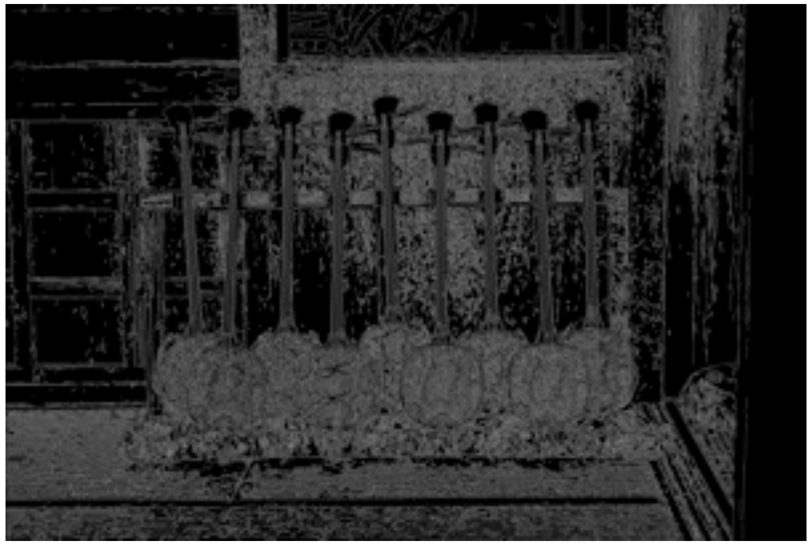
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
```



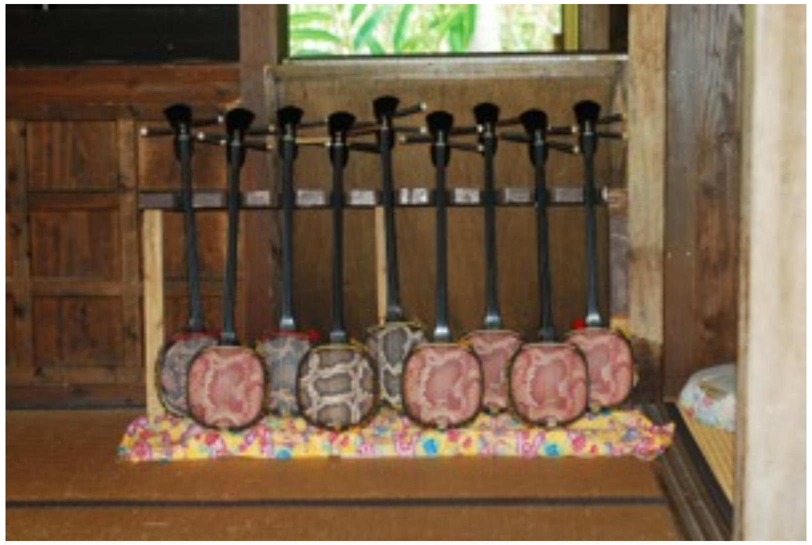


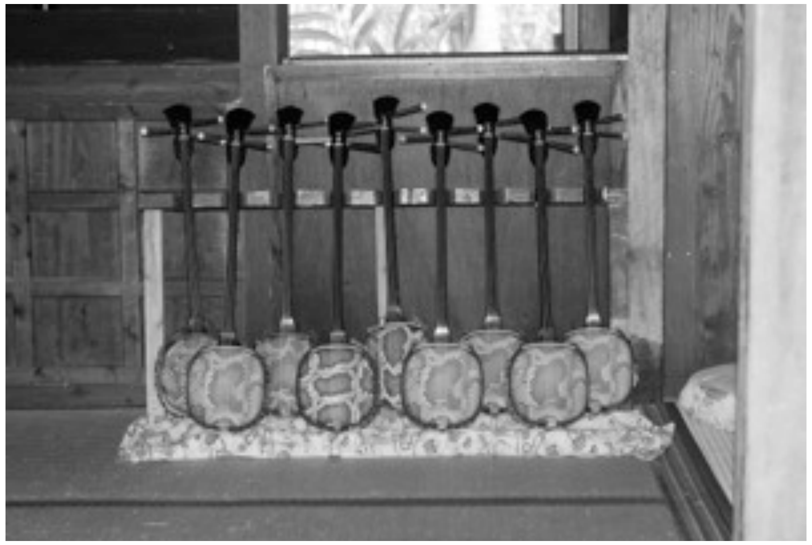


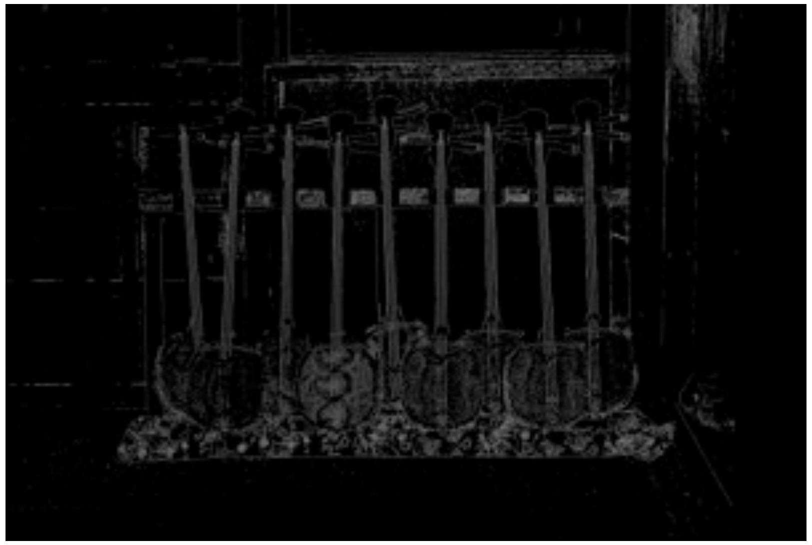


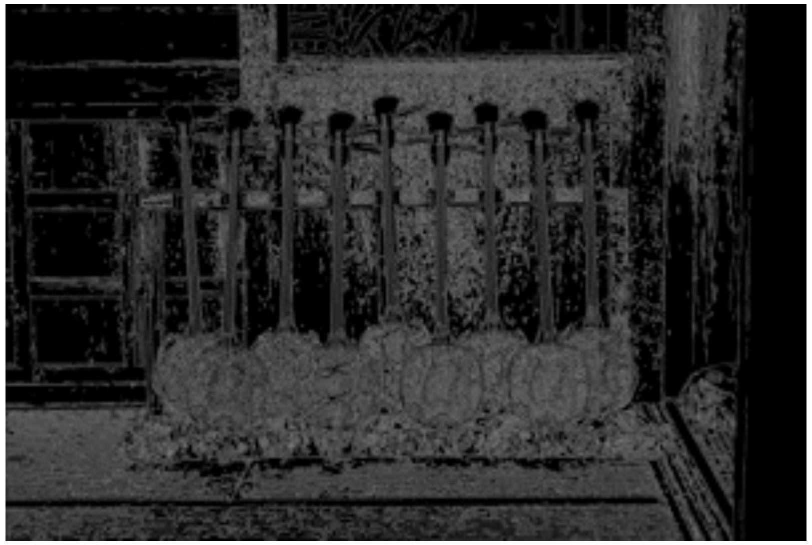
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
figure(2), imshow(D);
```



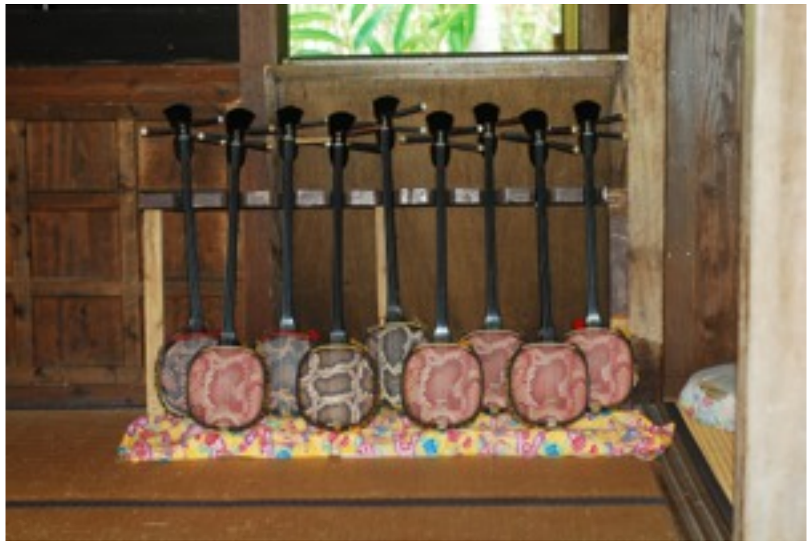


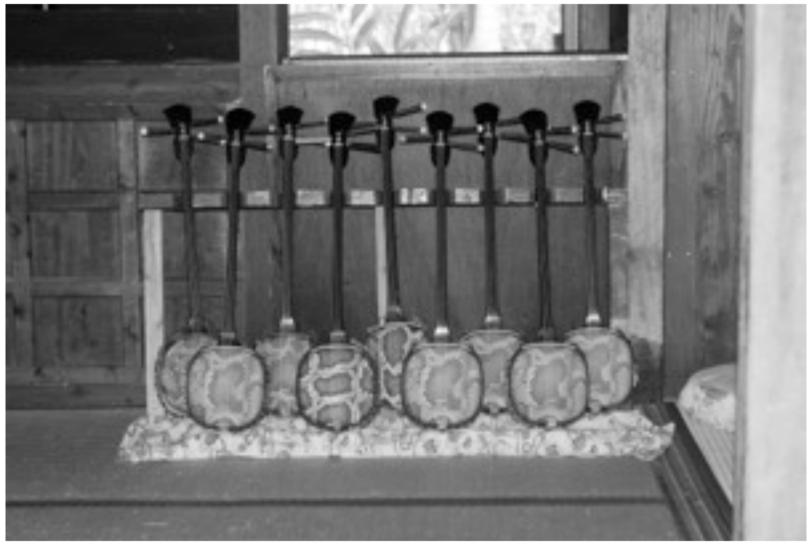


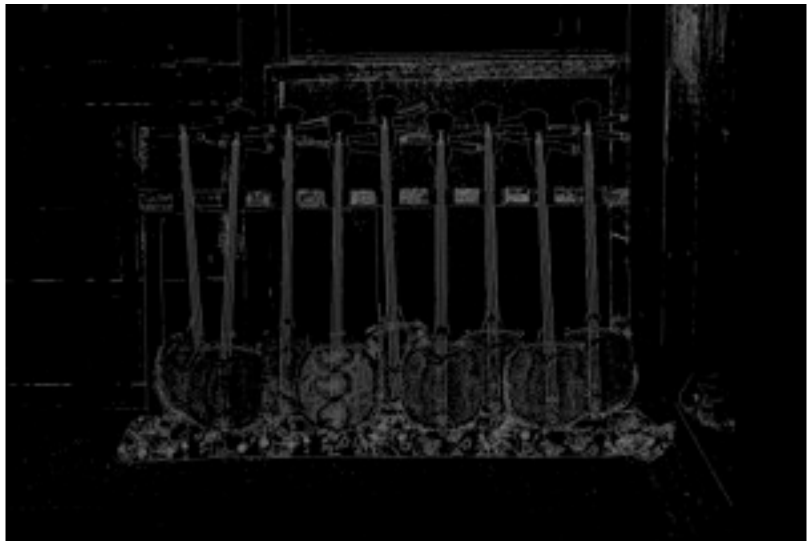


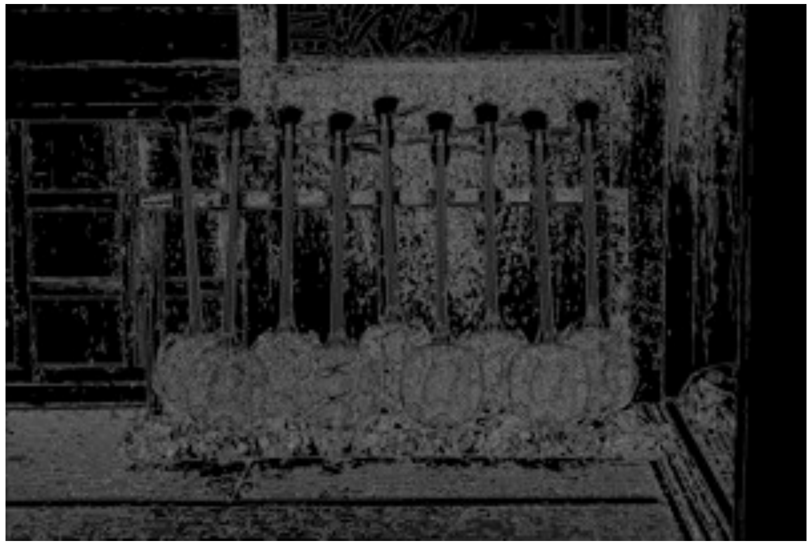
Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
figure(2), imshow(D);
figure(3), imshow(E);
```



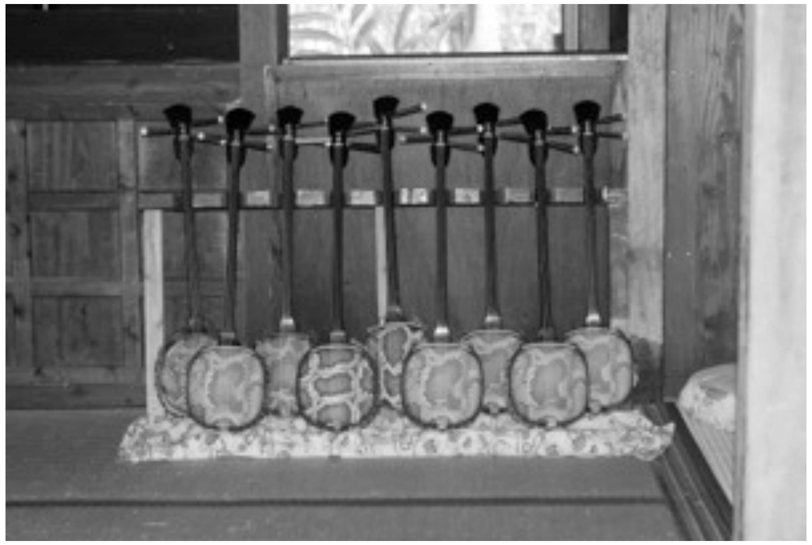


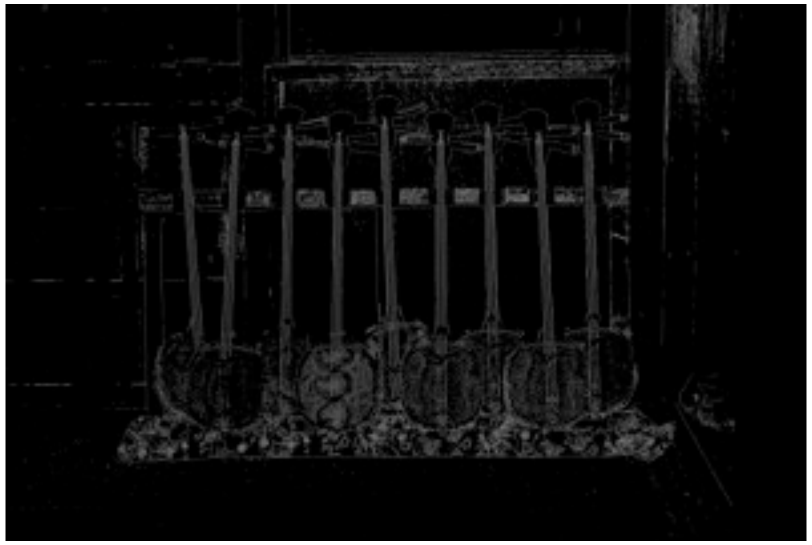


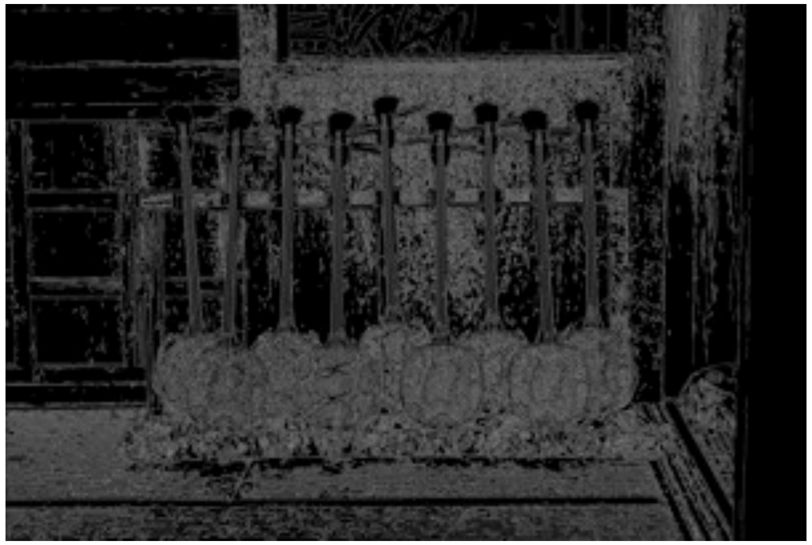


Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
figure(2), imshow(D);
figure(3), imshow(E);
imwrite(C, 'wbphoto.jpg', 'jpg')
```

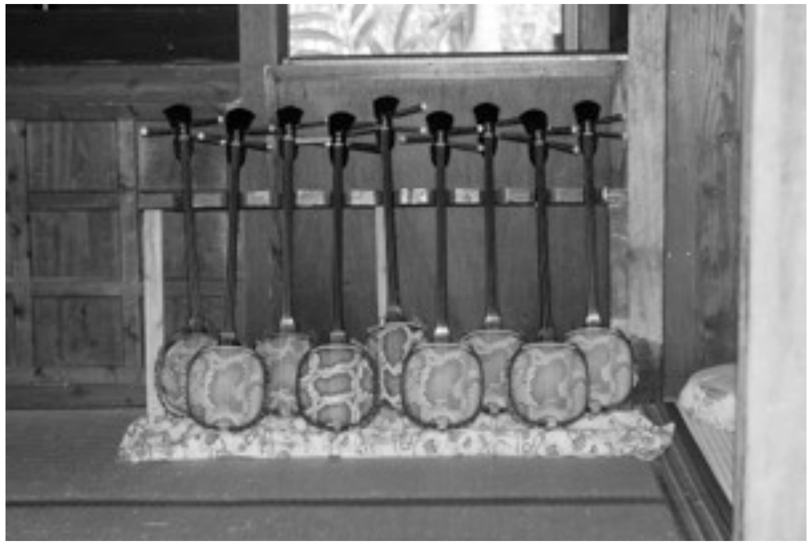


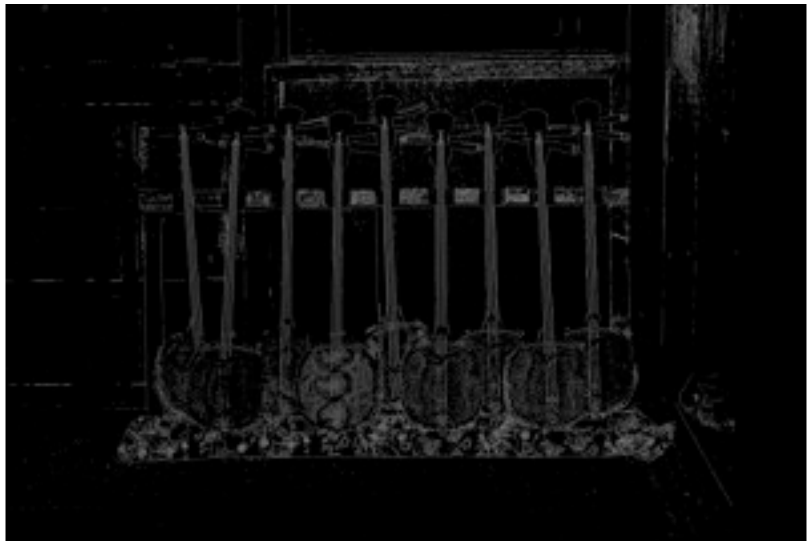


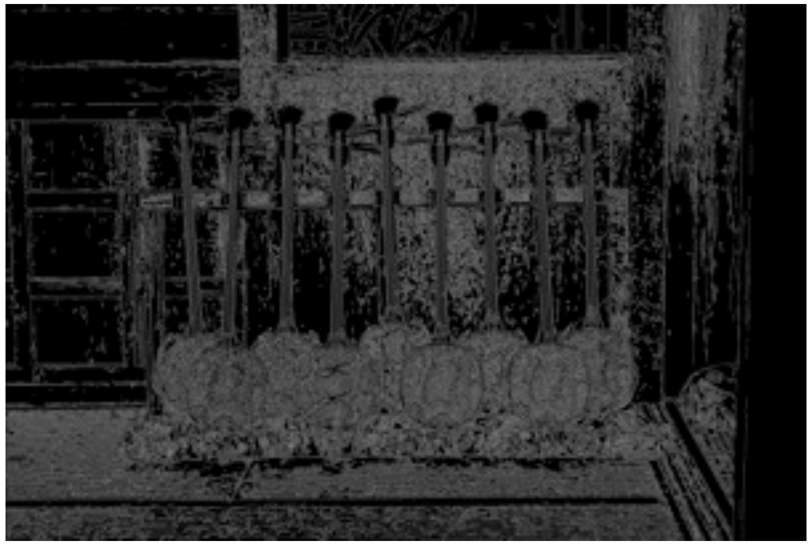


Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
figure(2), imshow(D);
figure(3), imshow(E);
imwrite(C, 'wbphoto.jpg', 'jpg')
imwrite(D, 'prewittoutline.jpg', 'jpg')
```

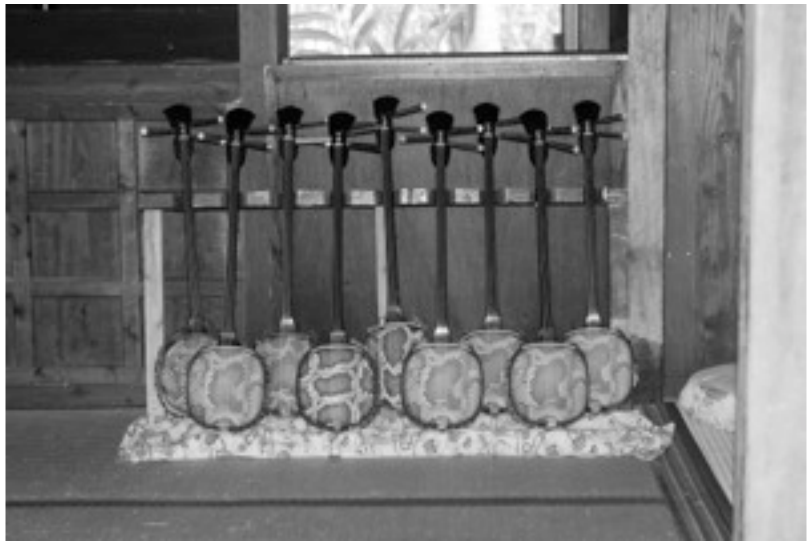


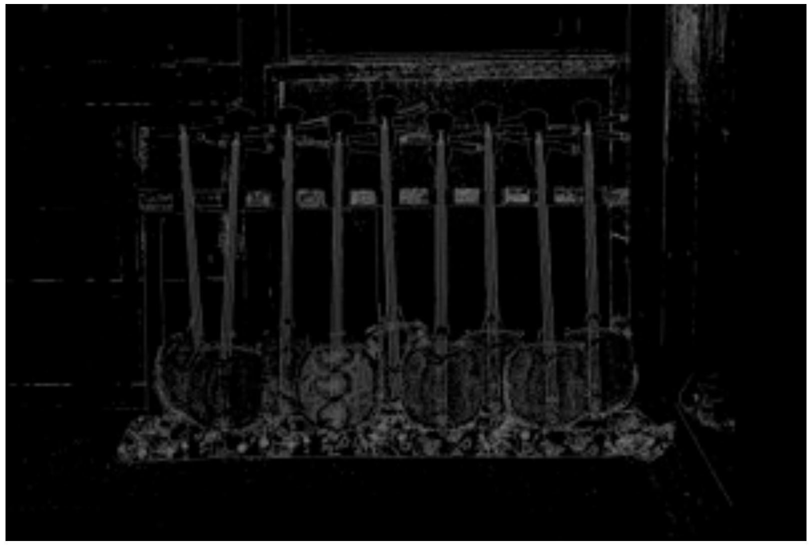


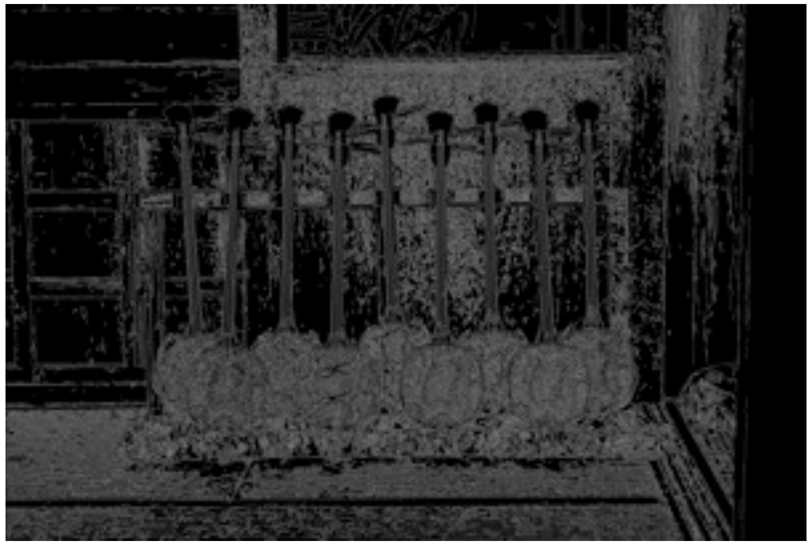


Outline of an Image

```
A = 'music.jpg';
B = imread(A, 'jpeg');
C =rgb2gray(B);
D = edge(C,'prewitt');
E = edge(C,'canny');
figure(1), imshow(C);
figure(2), imshow(D);
figure(3), imshow(E);
imwrite(C, 'wbphoto.jpg', 'jpg')
imwrite(D, 'prewittoutline.jpg', 'jpg')
imwrite(E, 'cannyoutline.jpg', 'jpg')
```





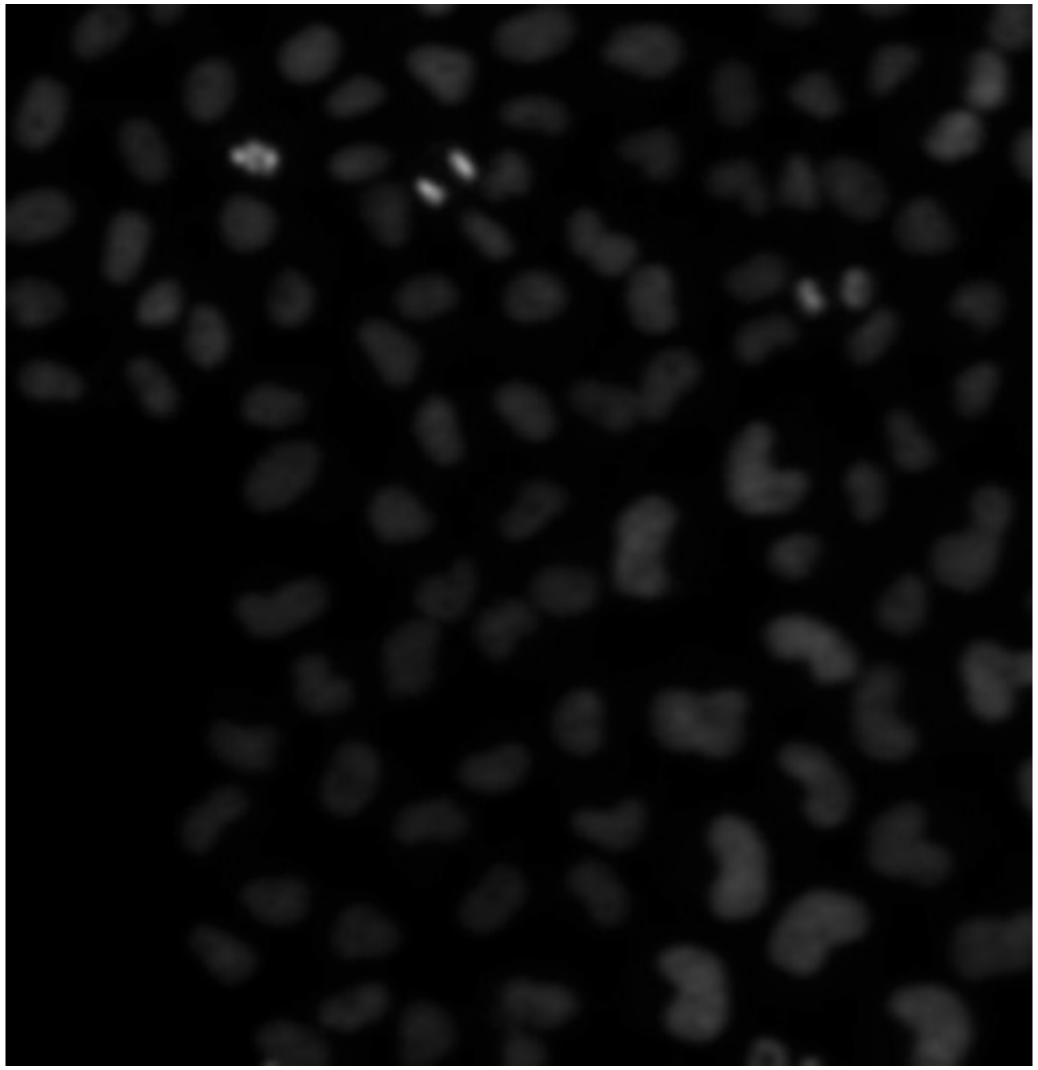


Cell counting

input : cell.bmp

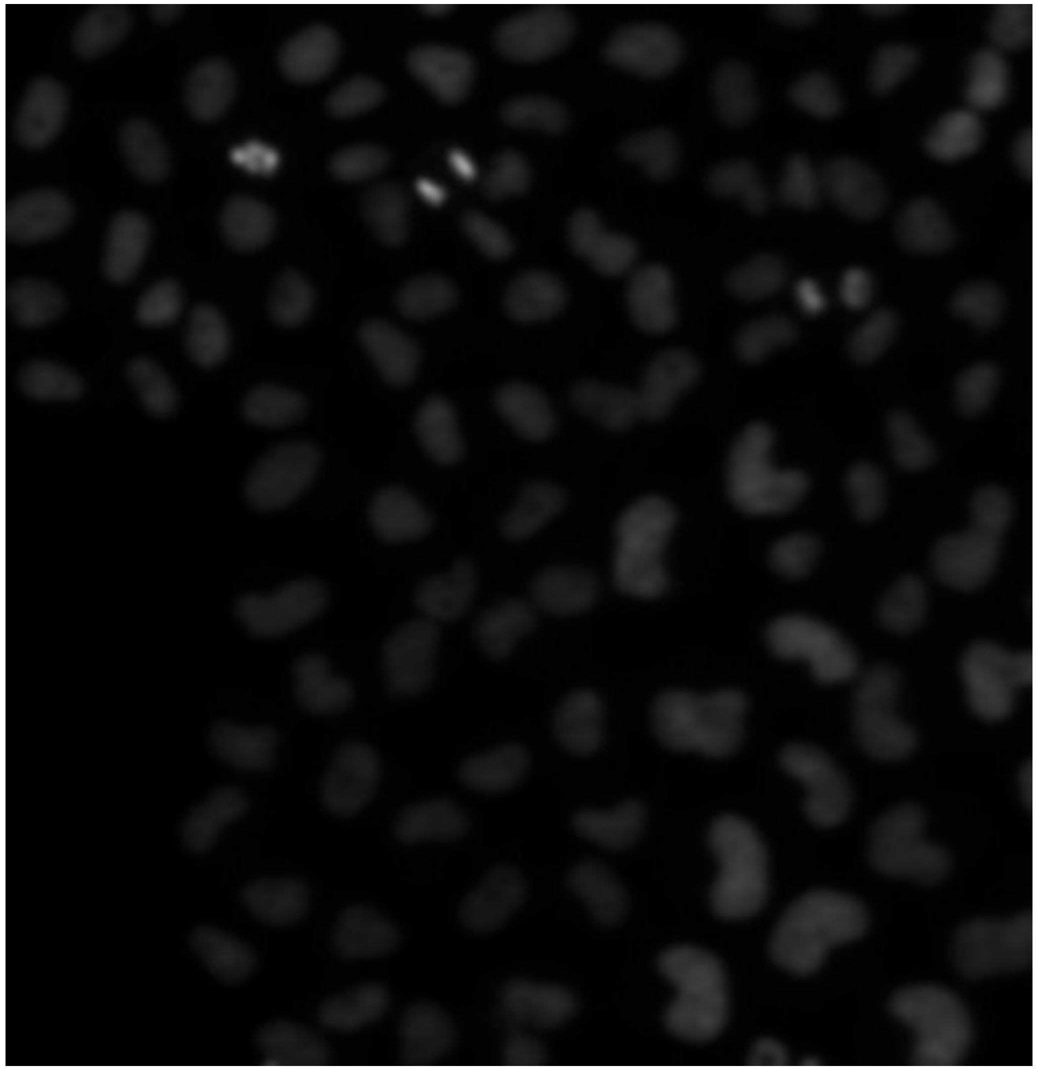
Cell counting

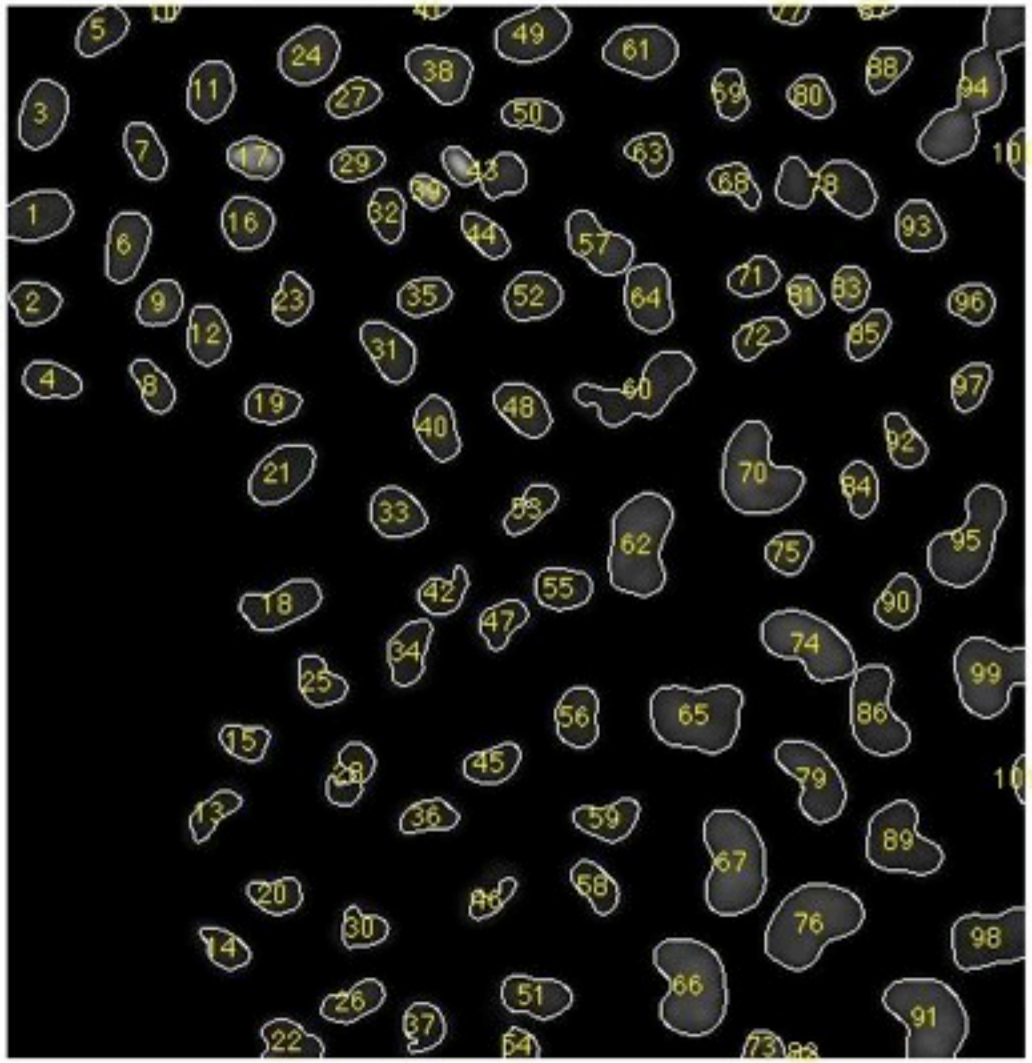
input : cell.bmp



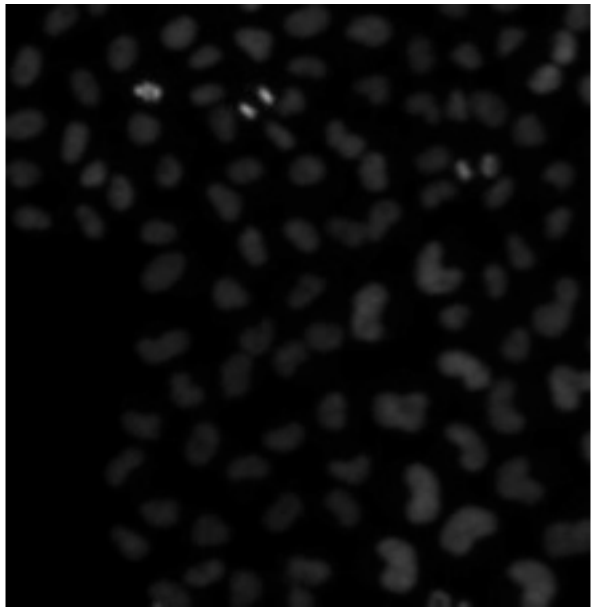
Cell counting

input : cell.bmp



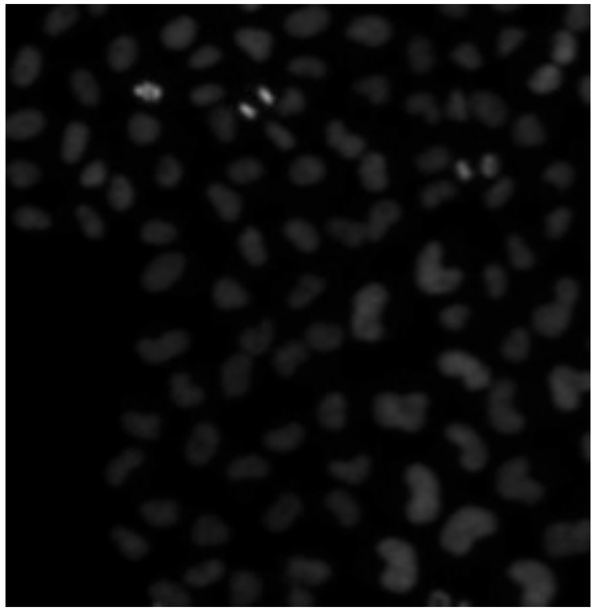


Cell counting ...

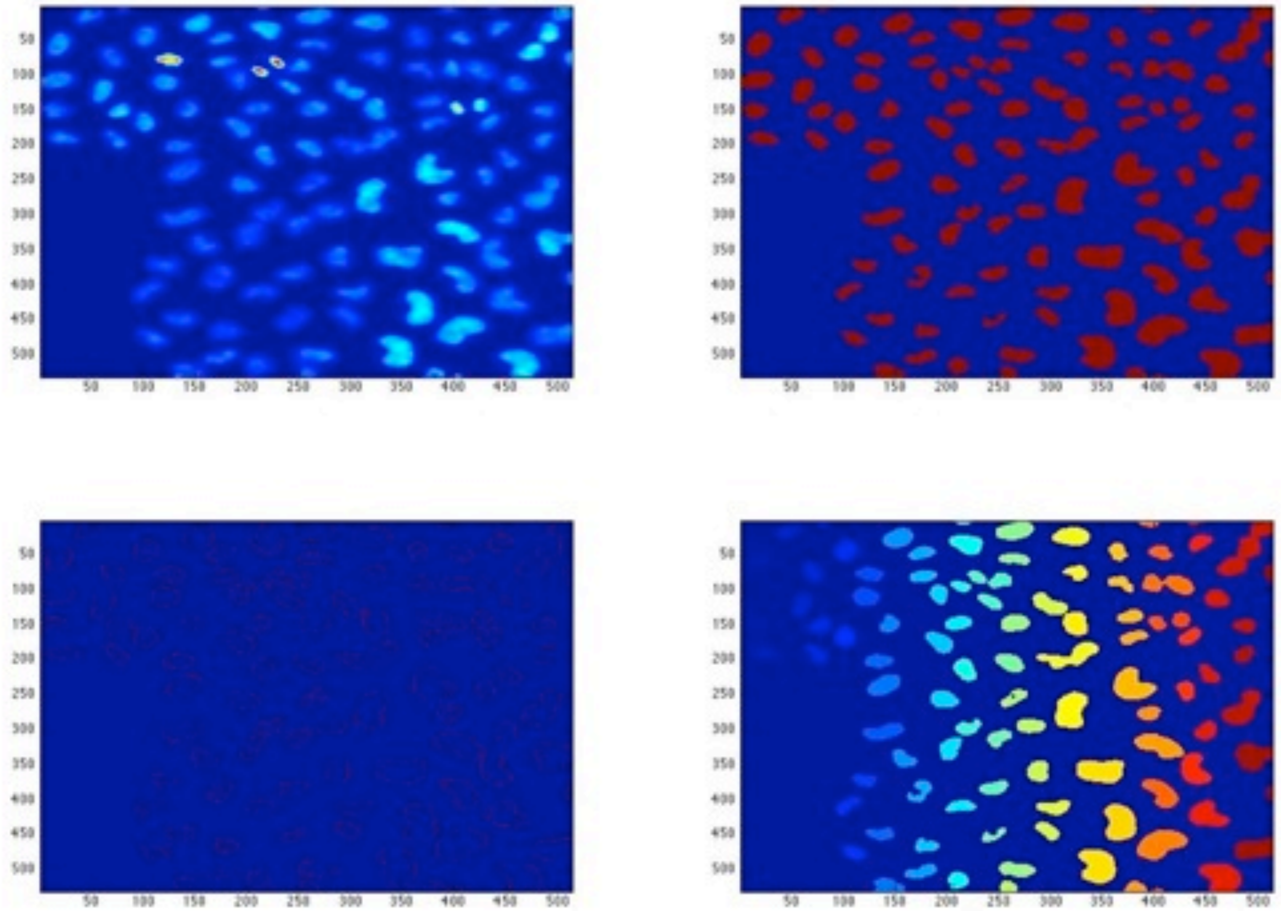


input : cells.bmp

Cell counting ...

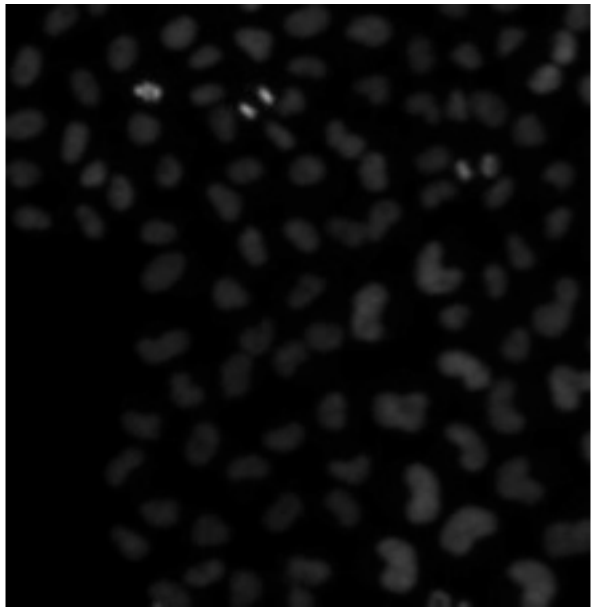


input : cells.bmp

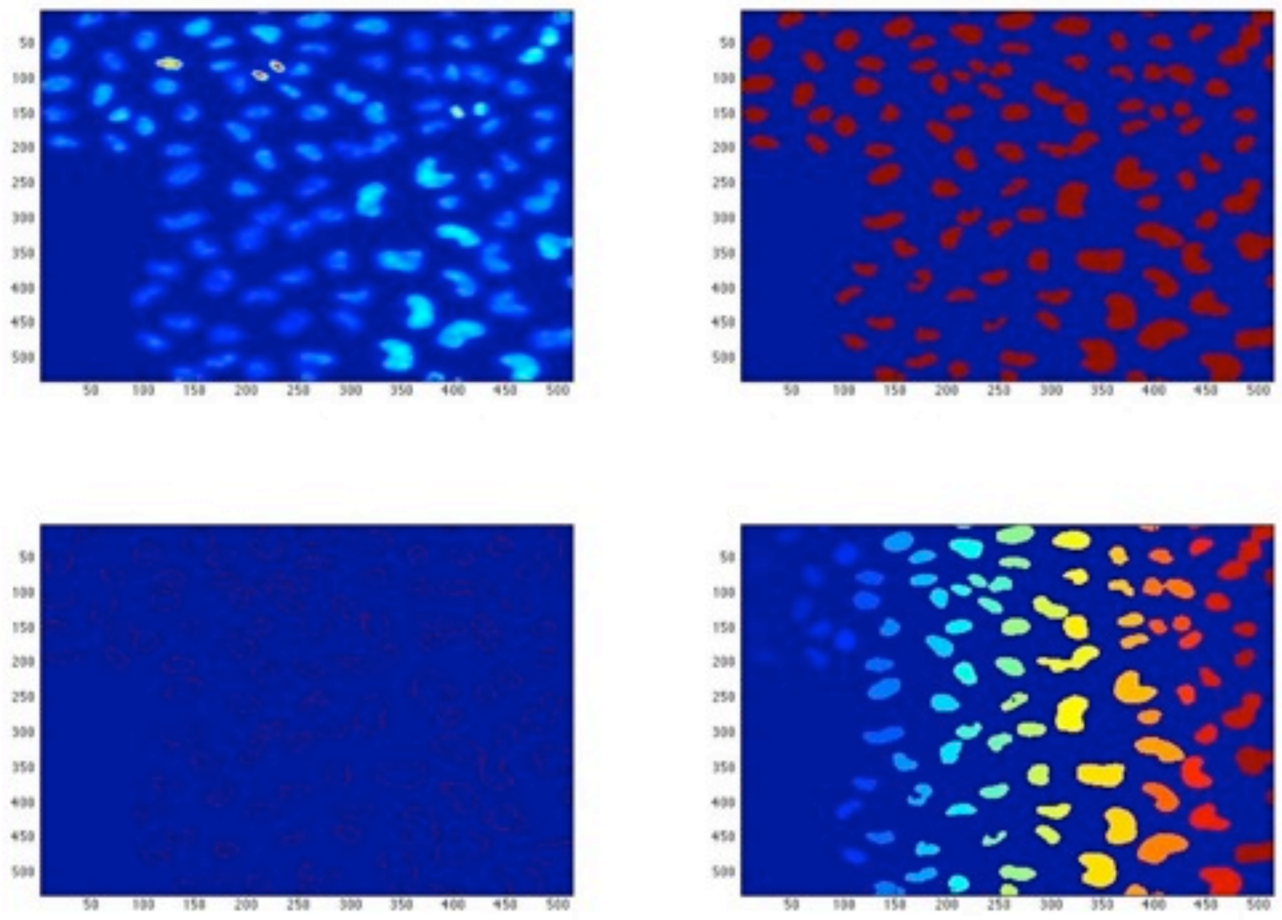


Cell counting ...

```
nucleiImage = imread('cells.bmp');
threshImage = nucleiImage >20;
edgeImage = edge(threshImage, 'sobel');
labeledImage = bwlabel(threshImage);
figure(1);
subplot(2, 2, 1);imagesc(nucleiImage);
subplot(2, 2, 2);imagesc(threshImage);
subplot(2, 2, 3);imagesc(edgeImage);
subplot(2, 2, 4);imagesc(labeledImage);
```

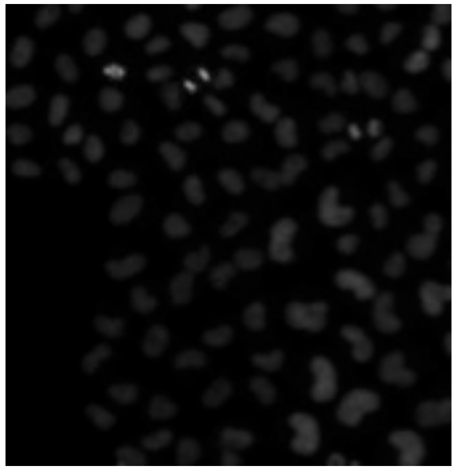


input : cells.bmp

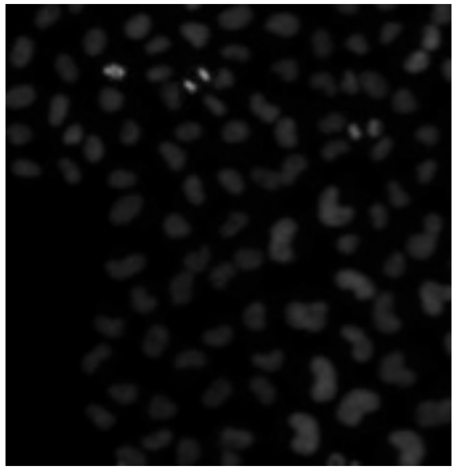


Cell counting ...

Cell counting ...

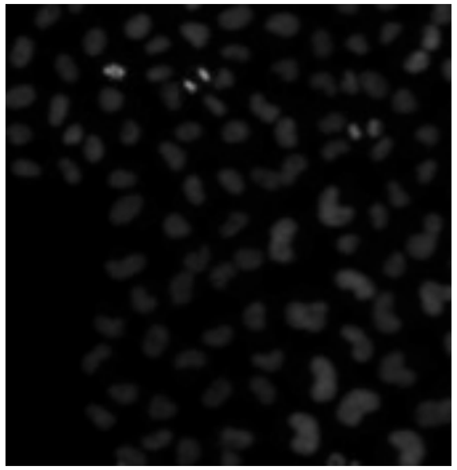


Cell counting ...

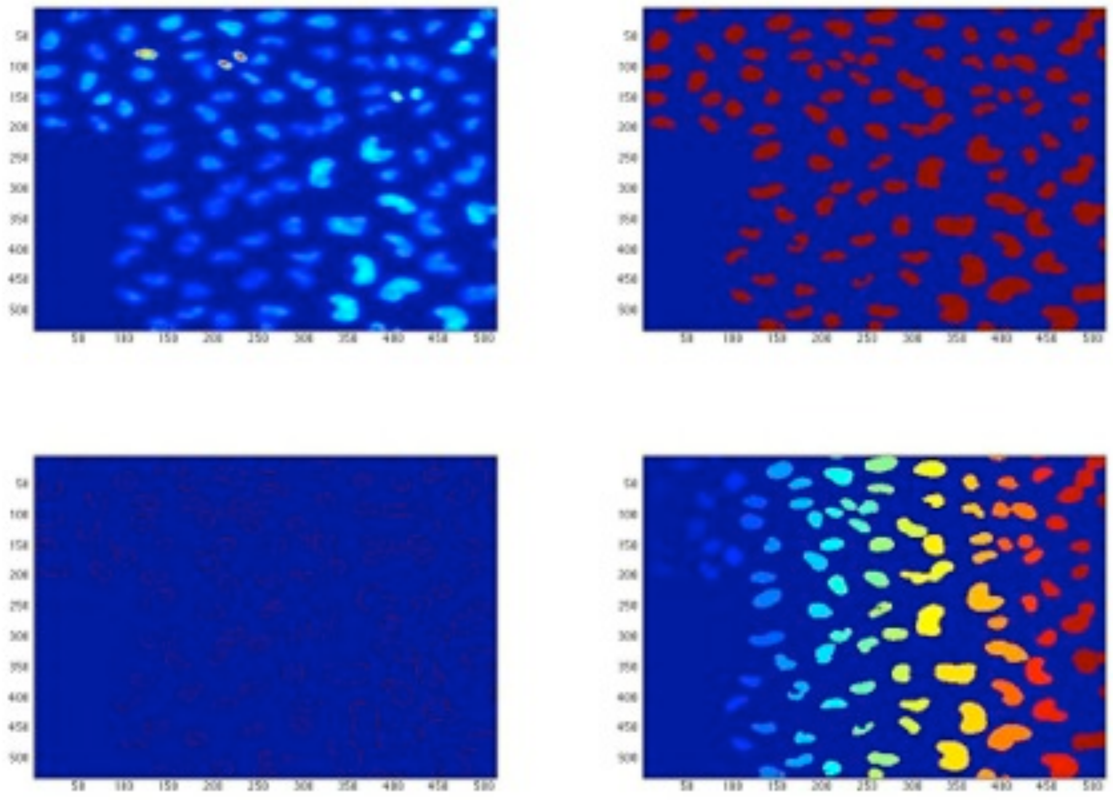


input : cells.bmp

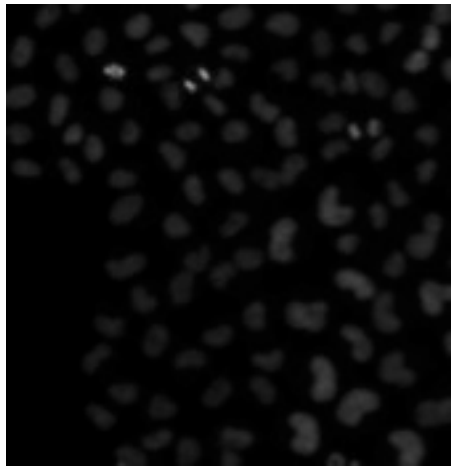
Cell counting ...



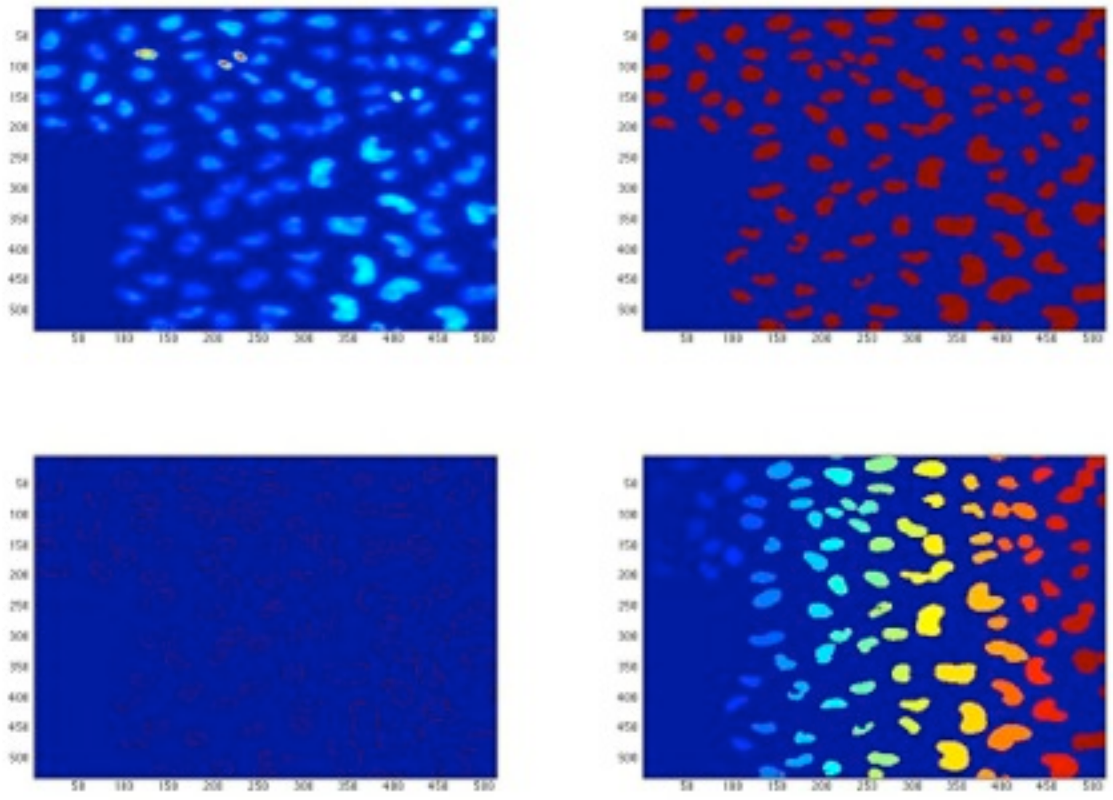
input : cells.bmp



Cell counting ...



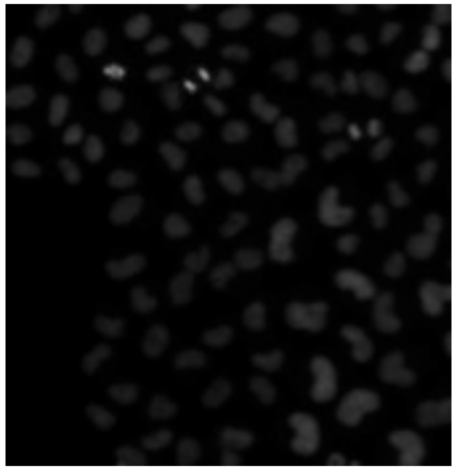
input : cells.bmp



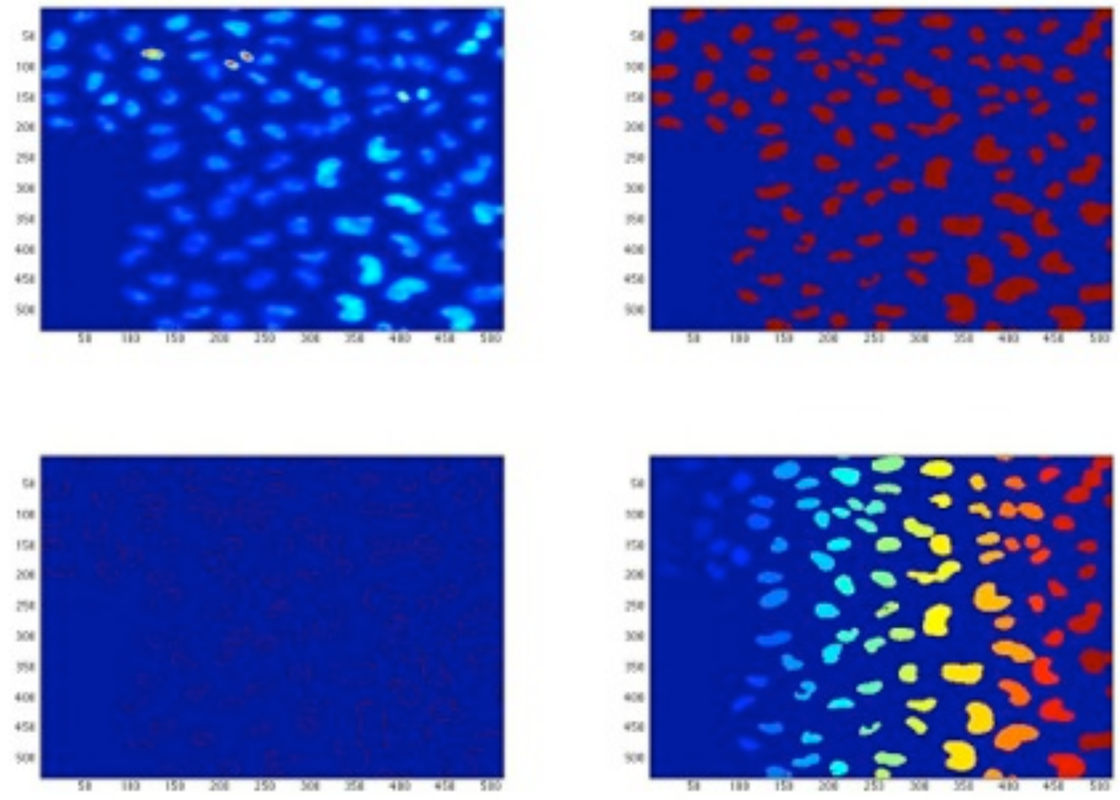
```
stats = regionprops(labeledImage,'Centroid', 'Area');
edges = find(edgeImage ~= 0);
nucleiImage(edges) = 255;

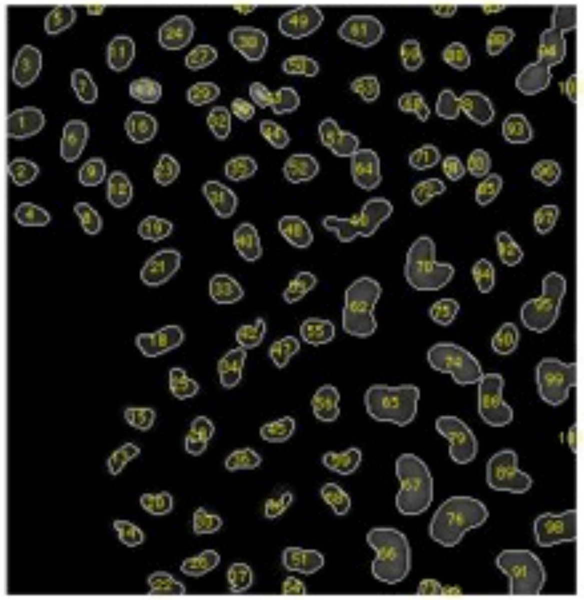
figure(2);
imshow(nucleiImage);
for i =1:length(stats)
text(stats(i).Centroid(1), stats(i).Centroid(2),...
num2str(i), 'Color',[1, 1, 0], 'FontSize', 14,...
'HorizontalAlignment', 'center');
end;
```

Cell counting ...



input : cells.bmp

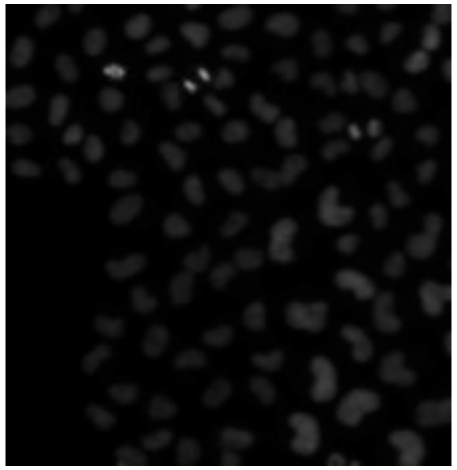




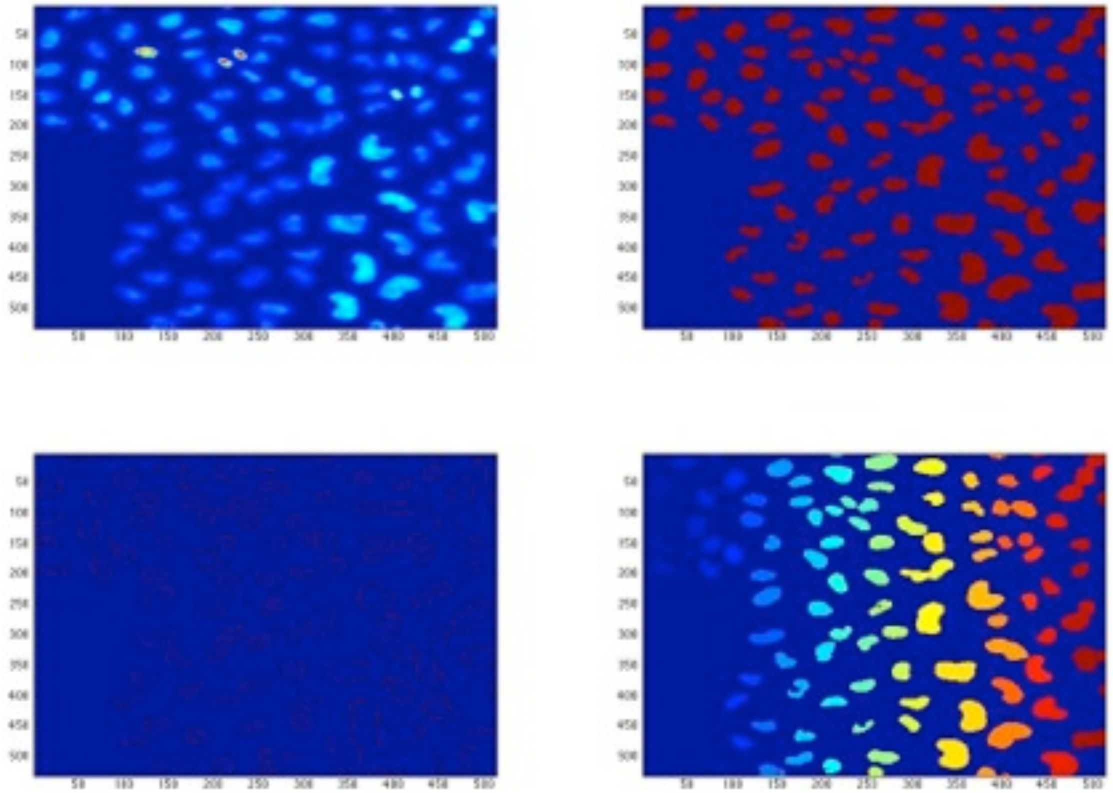
```
stats = regionprops(labeledImage,'Centroid', 'Area');
edges = find(edgeImage ~= 0);
nucleiImage(edges) = 255;

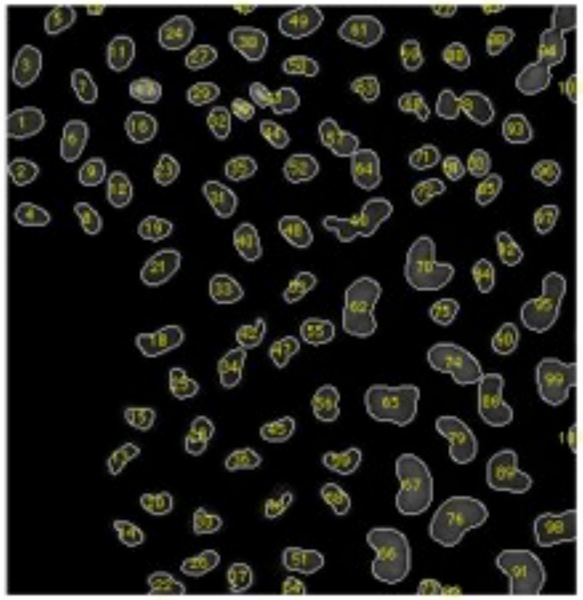
figure(2);
imshow(nucleiImage);
for i =1:length(stats)
text(stats(i).Centroid(1), stats(i).Centroid(2),...
num2str(i), 'Color',[1, 1, 0], 'FontSize', 14,...
'HorizontalAlignment', 'center');
end;
```

Cell counting ...



input : cells.bmp



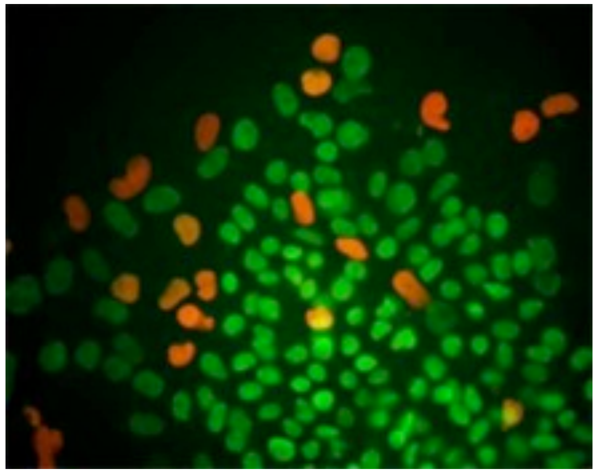


output

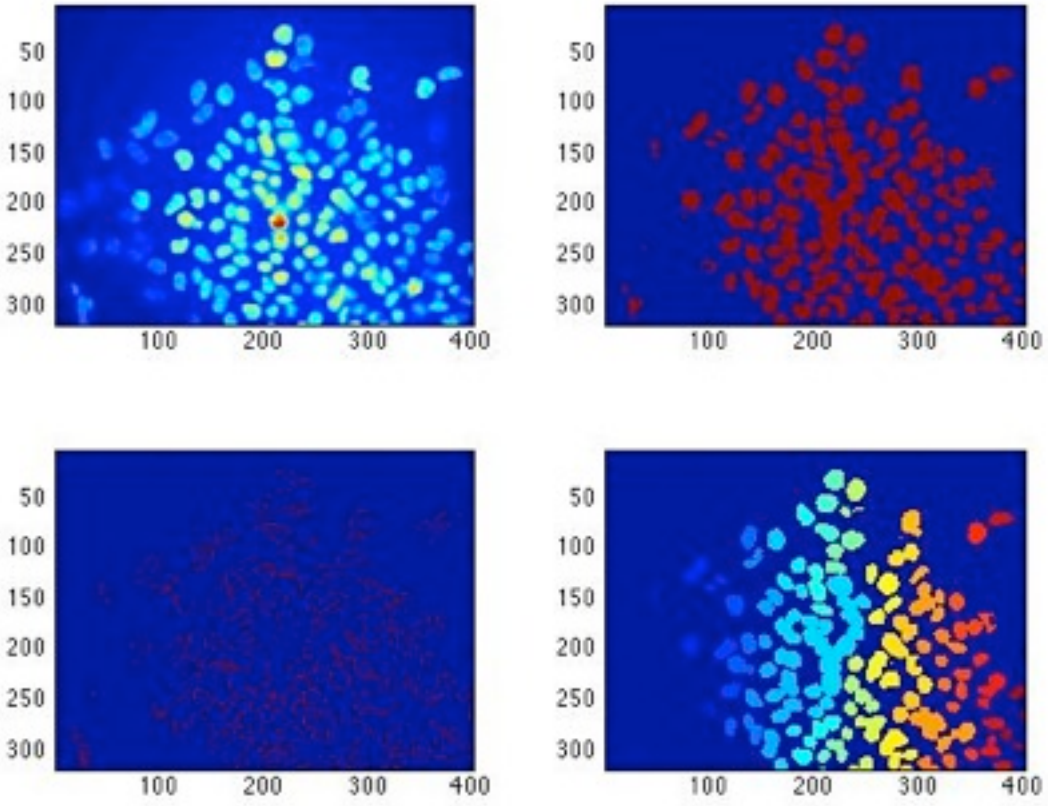
```
stats = regionprops(labeledImage,'Centroid', 'Area');
edges = find(edgeImage ~= 0);
nucleiImage(edges) = 255;

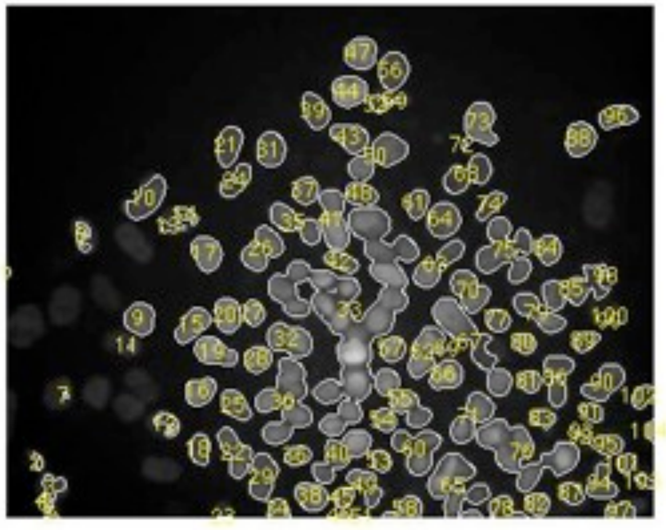
figure(2);
imshow(nucleiImage);
for i =1:length(stats)
text(stats(i).Centroid(1), stats(i).Centroid(2),...
num2str(i), 'Color',[1, 1, 0], 'FontSize', 14,...
'HorizontalAlignment', 'center');
end;
```

Cell counting ...



input : cells2.jpg





output

```
nucleiImage0 = imread('cells2.jpg');
nucleiImage = rgb2gray(nucleiImage0);
```