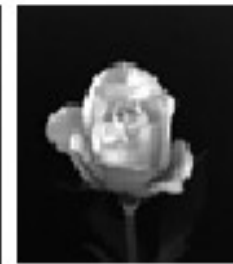
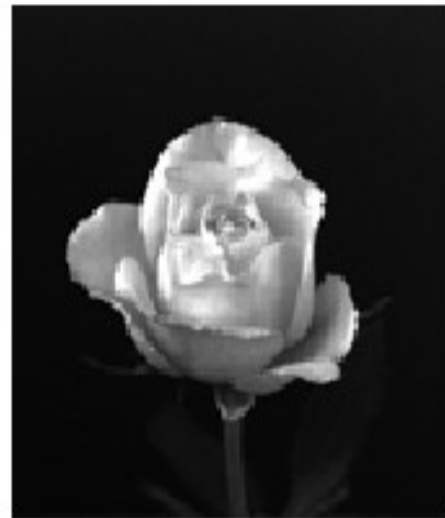


Digital Image Processing Using MATLAB

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Resolution

- **Spatial Resolution:** Spatial resolution is the smallest detectable detail in an image.



A 1024*1024, 8-bit image subsampled down to size 32*32 pixels. The number of allowable gray levels was kept at 256

Image Shrinking

25	25	75	75	255	255
25	25	75	75	255	255
0	0	255	255	0	0
0	0	255	255	0	0
255	255	75	75	75	75
255	255	75	75	75	75



25	25	75	75	255	255
0	0	255	255	0	0
255	255	75	75	75	75



25	75	255
0	255	0
255	75	75

Image Shrinking (2)

```
A = imread('E:\Sunset_GrayScale_s2', 'jpg');  
imshow (A);  
[m, n] = size(A);  
j=1;  
For i=1:2:m  
    A1(j, :) =A (i , :);  
    j=j+1;  
end  
figure, imshow(A1);  
imwrite (A1, 'E:\Sunset_GrayScale_s1.jpg');  
  
j=1;  
For i=1:2:n  
    A2(:, j) =A1(:, i);  
    j=j+1;  
end  
figure, imshow(A2);  
imwrite(A2,'E:\Sunset_GrayScale_s.jpg');
```

Image Shrinking (3)



Image Shrinking (4)

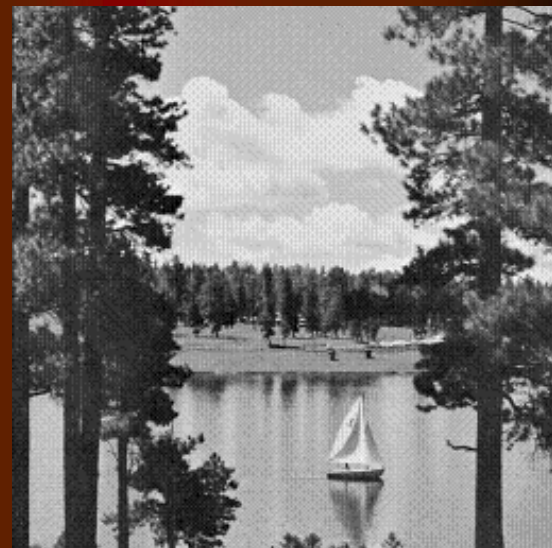
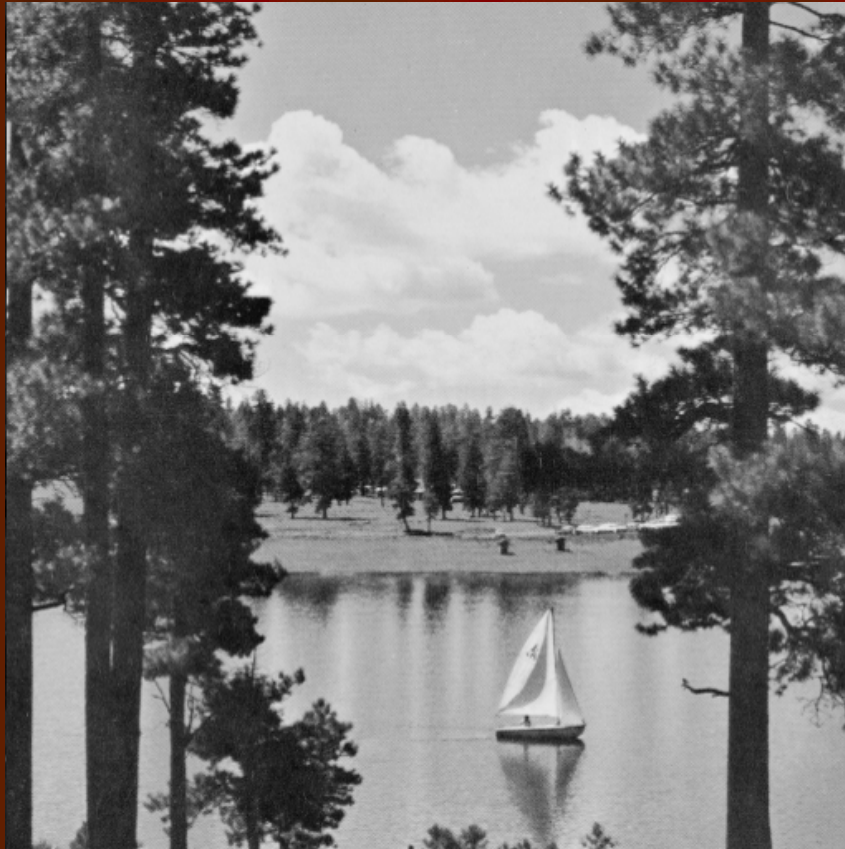
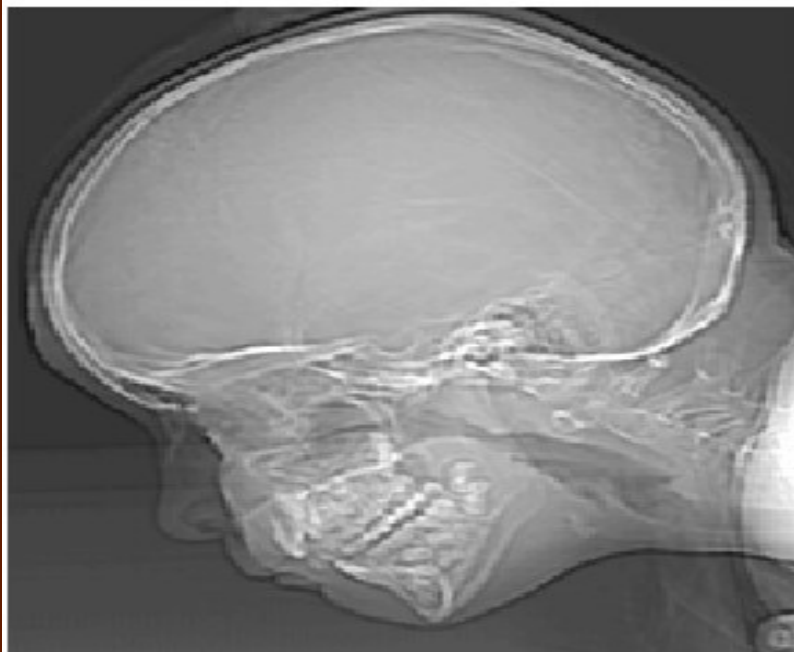


Image Shrinking (5)

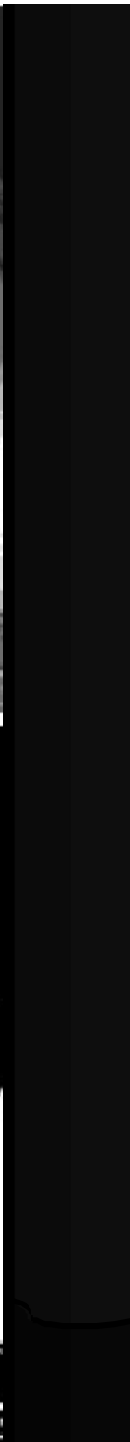
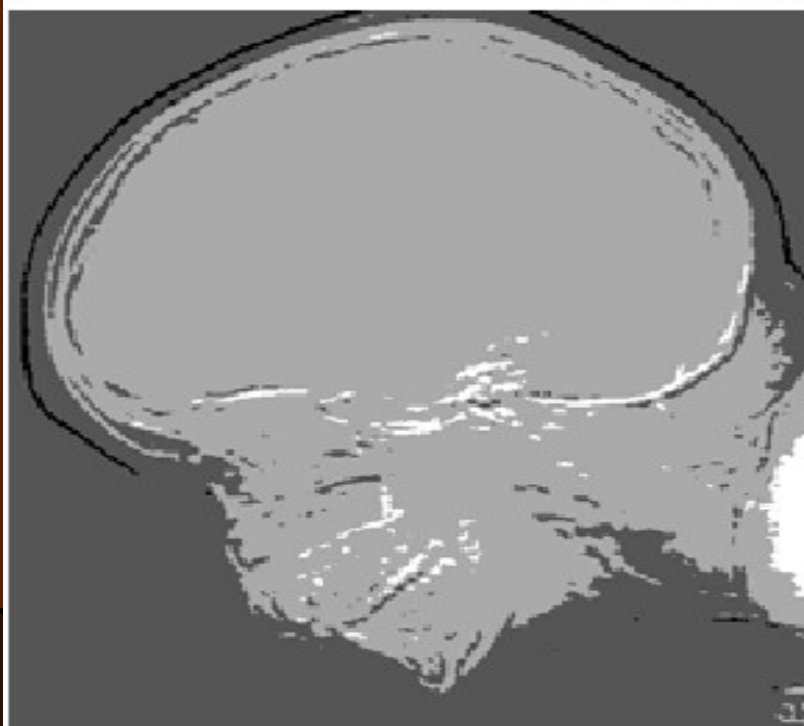
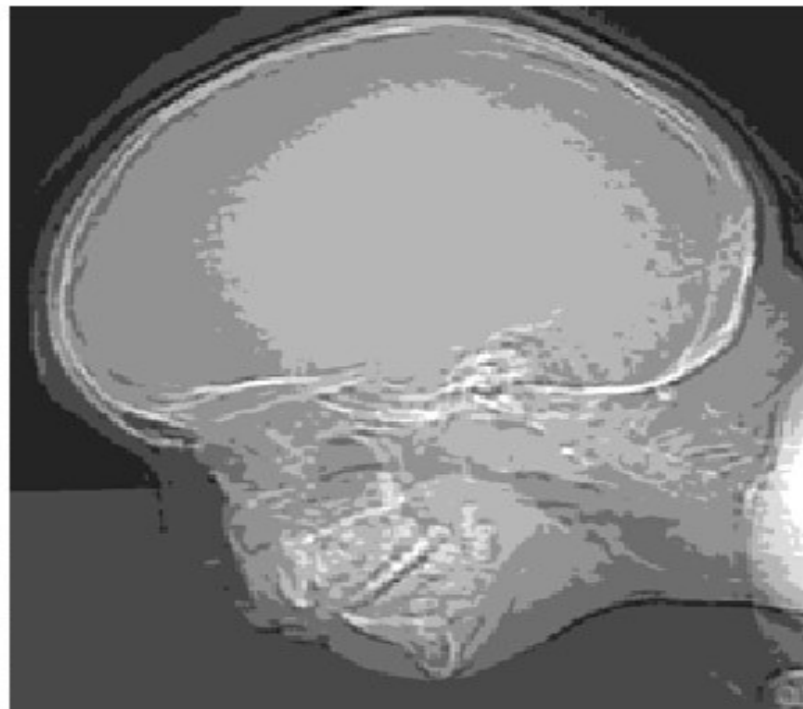
```
A = imread('E:\Sunset_GrayScale_s2', 'jpg');  
imshow (A);  
B= A(1:2:end, 1:2:end);  
figure, imshow(B);
```


Resolution

- **Grey level Resolution:** *Gray-level resolution* similarly refers to the smallest detectable change in gray level.



(a) 452*374, 256-level image (b)–(d) Image displayed in 128, 64, and 32 gray levels, while keeping the spatial resolution constant.



Decreasing Gray Levels(1)

255	255	255
200	100	150
0	50	180

127	127	127
100	50	75
0	25	90

63	63	63
50	25	37
0	12	45

31	31	31
25	12	18
0	6	22

1	1	1
1	0	1
0	0	1

3	3	3
3	1	2
0	0	2

7	7	7
6	3	4
0	1	5

15	15	15
12	6	9
0	3	11

Decreasing Gray Levels(2)



Decreasing Gray Levels(3)

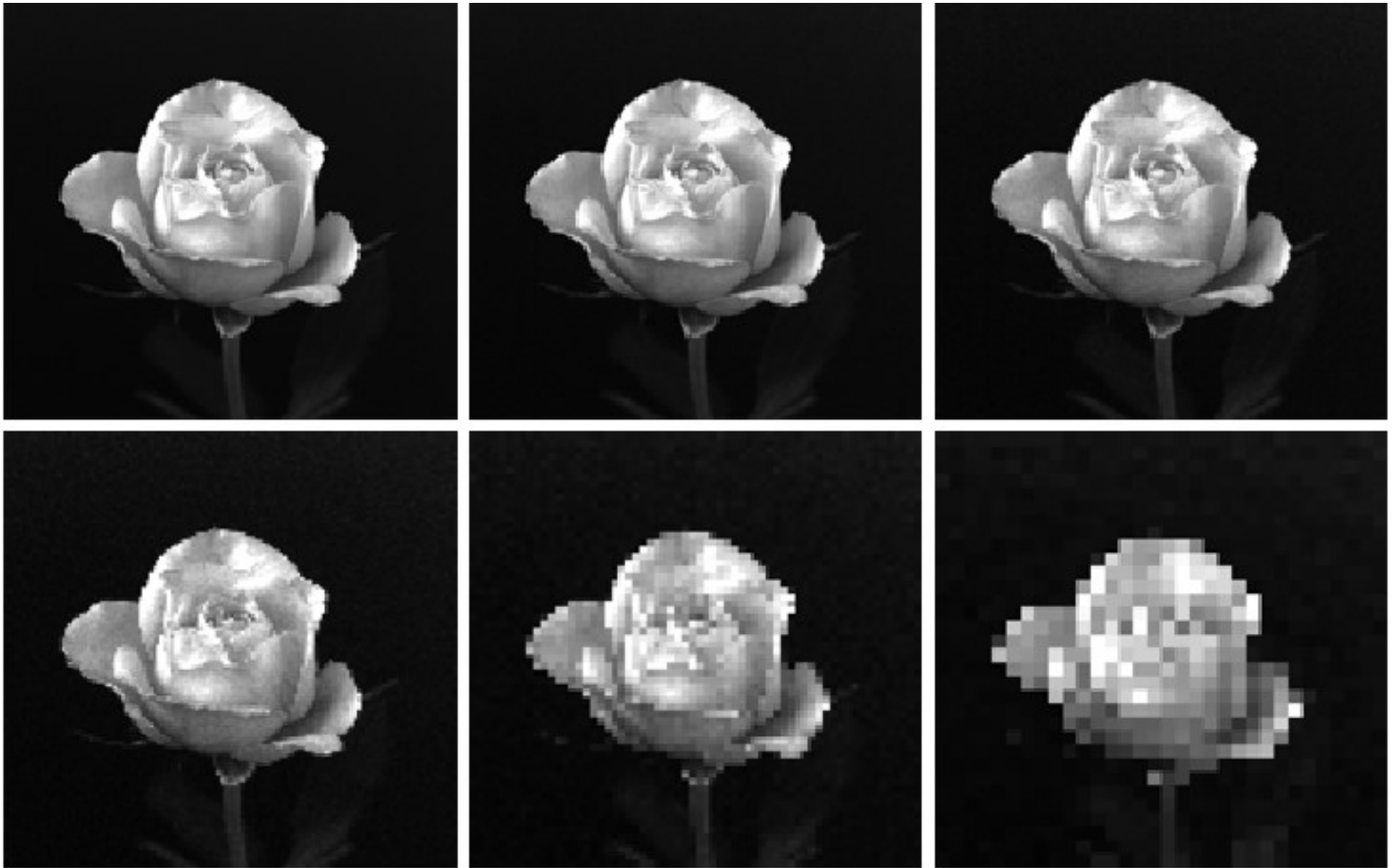


Decreasing Gray Levels(4)

```
clear;
clc;
A= imread('E:\Sunset_Grayscale.jpg');
imshow(A);
[m,n] =size(A);
k=1;
A1=A;
while k<=7
    x=['E:\Sunset_GrayLevel',int2str(k),'.jpg'];
    A1=double(A);
    A1= floor(A1 /(2^k))
    k=k+1;
    A1=mat2gray(A1);
    imshow(A1);
    eval (['print ', '-djpeg ',x])
end
```

Image Zooming (1)

- Zooming requires two steps:
- Creation of new pixel locations and assignment of gray levels to those location.
- There are various methods to achieve Image Zooming
 - ✓ Pixel Replication
 - ✓ Nearest Neighbour Interpolation
 - ✓ Bi-Linear Interpolation



(a) 1024*1024, 8-bit image. (b) 512*512 image resampled into 1024*1024 pixels by row and column duplication. (c) through (f) 256*256, 128*128, 64*64, and 32*32 images resampled into 1024*1024 pixels.

Image Zooming (2) (Pixel Replication)

25	75	255
0	255	0
255	75	75



25	25	75	75	255	255
0	0	255	255	0	0
255	255	75	75	75	75



25	25	75	75	255	255
25	25	75	75	255	255
0	0	255	255	0	0
0	0	255	255	0	0
255	255	75	75	75	75
255	255	75	75	75	75

Image Zooming (3)

```
A = imread('E:\Sunset_GrayScale_s', 'jpg');  
imshow (A);  
[m, n] = size(A);  
J=1;  
For i=1:1:n  
    A1(:, j) =A(:, i);  
    A1(:, j+1) =A(:, i);  
    J=j+2;  
end  
figure, imshow(A1);  
imwrite (A1, 'E:\Sunset_GrayScale_s1.jpg');
```

```
J=1;  
For i=1:1:m  
    A2(j, :) =A1(i, :);  
  
    A2(j+1, :) =A1(i, :);  
  
    J=j+2;  
end  
figure, imshow(A2);  
  
imwrite(A2, 'E:\Sunset_GrayScale_s2.jpg');
```

Image Zooming (4)



Image Zooming (5)

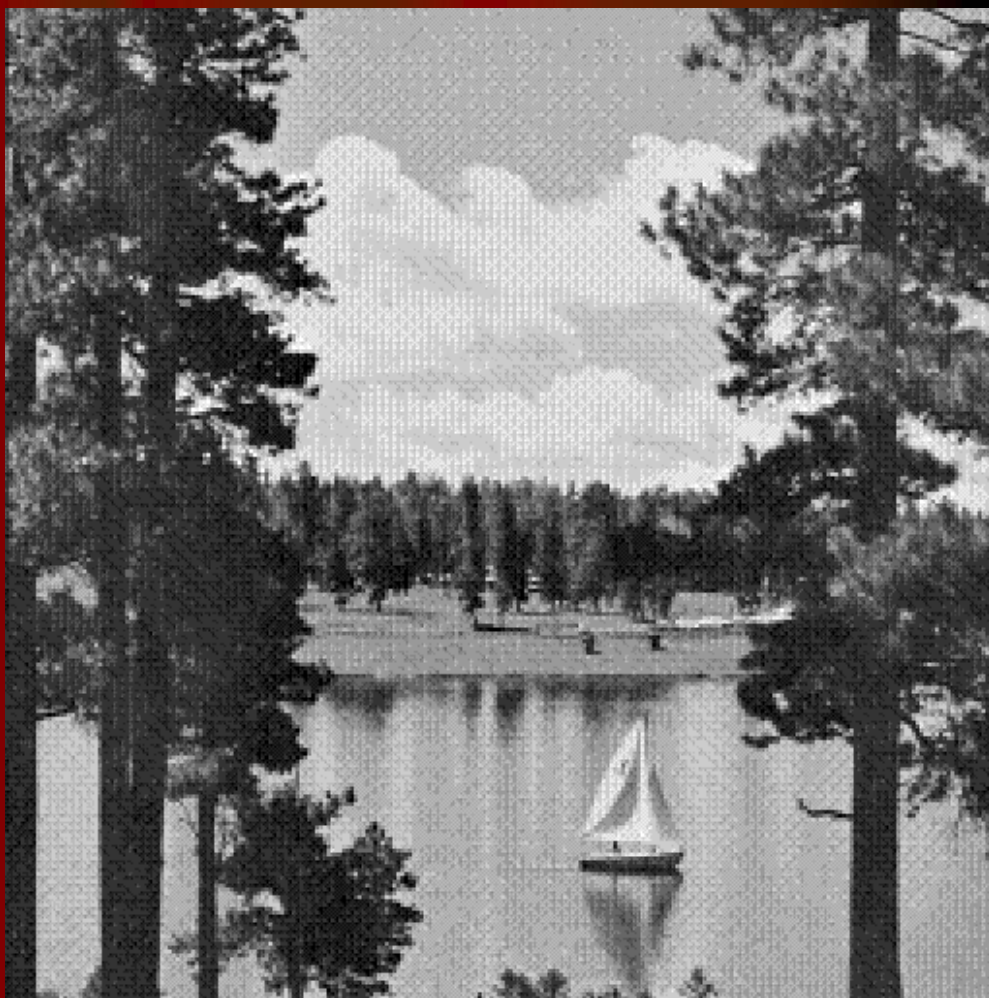
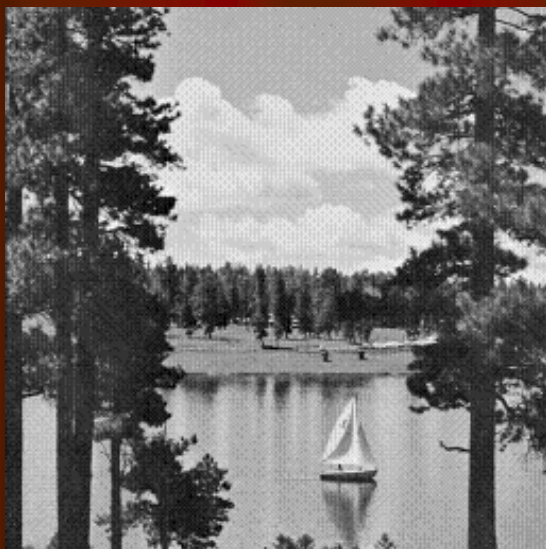
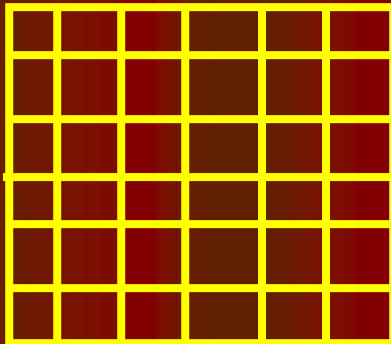


Image Zooming (6)

(Nearest Neighbour Interpolation)

25	75	255
0	255	0
255	75	75

1,1	1,2	1,3
2,1	2,2	2,3
3,1	3,2	3,3



1,1	1.4,1	1.8,1	2.2,1	2.6,1	3.0,1
1,1.4	1.4,1.4	1.8,1.4	2.2,1.4	2.6,1.4	3.0,1.4
1,1.8	1.4,1.8	1.8,1.8	2.2,1.8	2.6,1.8	3.0,1.8
1,2.2	1.4,2.2	1.8,2.2	2.2,2.2	2.6,2.2	3.0,2.2
1,2.6	1.4,2.6	1.8,2.6	2.2,2.6	2.6,2.6	3.0,2.6
1,3.0	1.4,3.0	1.8,3.0	2.2,3.0	2.6,3.0	3.0,3.0

Image Zooming (7)

(Nearest Neighbour Interpolation)

25	75	255
0	255	0
255	75	75

1,1	1.4,1	1.8,1	2.2,1	2.6,1	3.0,1
1,1.4	1.4,1.4	1.8,1.4	2.2,1.4	2.6,1.4	3.0,1.4
1,1.8	1.4,1.8	1.8,1.8	2.2,1.8	2.6,1.8	3.0,1.8
1,2.2	1.4,2.2	1.8,2.2	2.2,2.2	2.6,2.2	3.0,2.2
1,2.6	1.4,2.6	1.8,2.6	2.2,2.6	2.6,2.6	3.0,2.6
1,3.0	1.4,3.0	1.8,3.0	2.2,3.0	2.6,3.0	3.0,3.0

25	25	75	75	255	255
25	25	75	75	255	255
0	0	255	255	0	0
0	0	255	255	0	0
255	255	75	75	75	75
255	255	75	75	75	75

Image Zooming (8)

```
a=imread('c:\house2.bmp');  
a=double(a);  
x=linspace(1,64,64);  
y=linspace(1,64,64);  
xi=linspace(1,64,128);  
yi=linspace(1,64,128);  
[xx, yy]=meshgrid(xi,yi);  
zz=interp2(x,y,a,xx,yy,'nearest');  
imshow(mat2gray(zz));
```