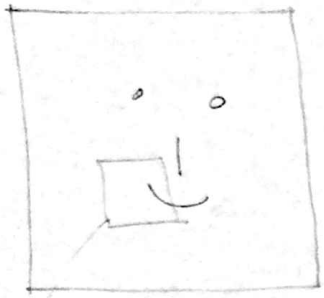
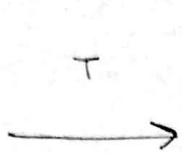
Geometric Transformations

Example 1: How to reduce the size of an image?

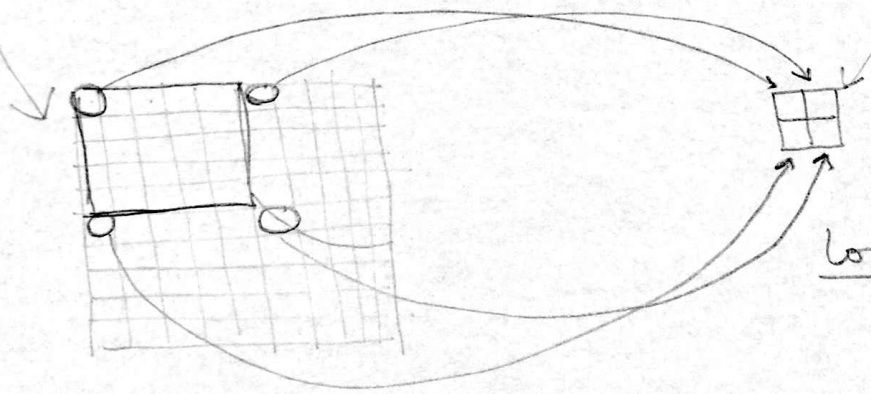
I : 500 × 500





$$J = T\{I\}$$

```
for i = 1 : 100
    for j = 1 : 100
        J(i,j) = I(5*i, 5*j);      ⊛
    end
end
```



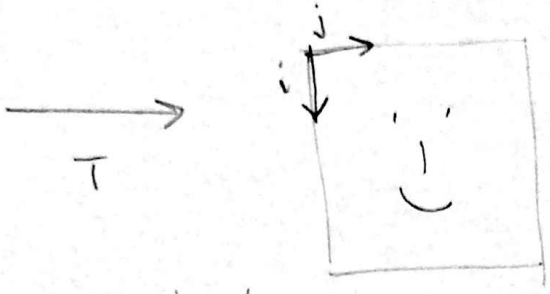
Lost information

Better result: each pixel of J is the average of 5×5 subwindow of I.

⊛ `J(i,j) = mean2(I(5*i-4:5*i, 5*i-4:5*i));`

Example 2: How to increase the size?

I: 64 × 64



$J = T\{I\}$

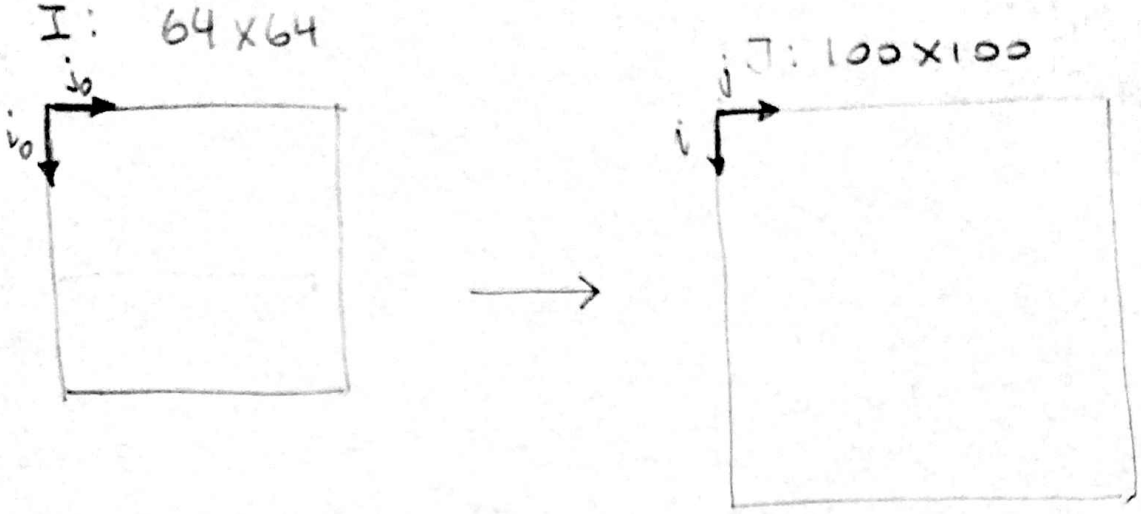
```
for i = 1:200
    for j = 1:200
        J(i,j) = I(round(i/2), round(j/2))
    end
end
```

From 64^2 = 4096 pixels we have now 128^2 = 16,384

4x

Inferred information

Example 3: Any scale factor



$$i = \frac{100}{64} i_0 \qquad j = \frac{100}{64} j_0$$

$$\downarrow$$

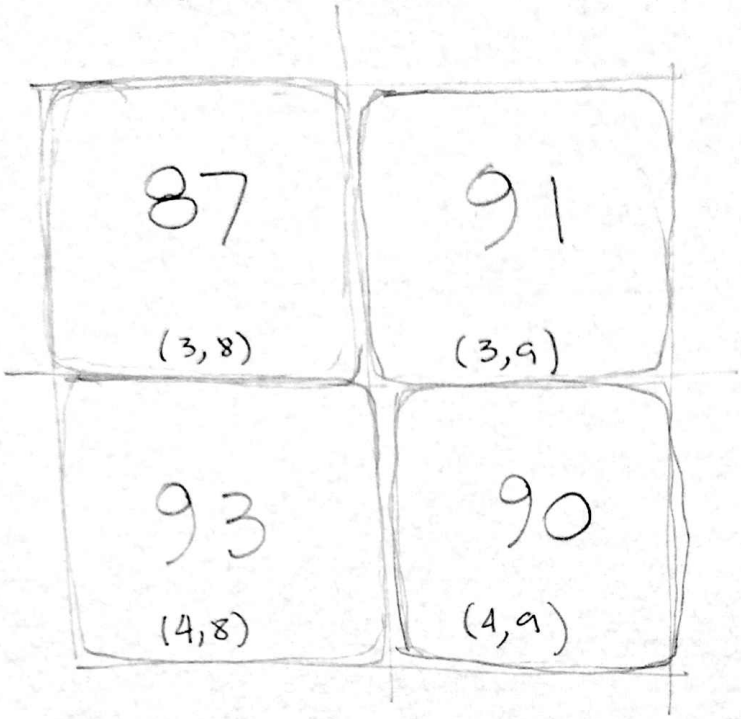
$$i_0 = \frac{64}{100} i \qquad j_0 = \frac{64}{100} j$$

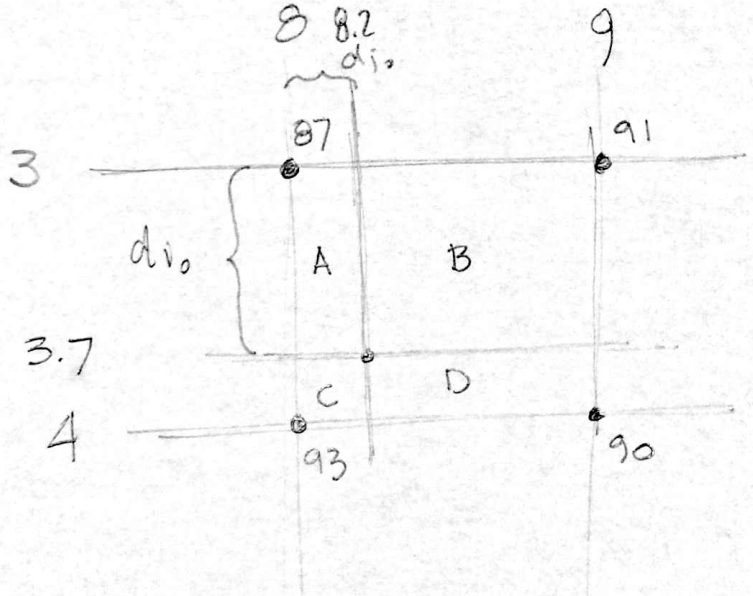
SOLUTION I (nearest-neighbor)

```
for i = 1:100
    i0 = round((64/100) i);
        for j = 1:100
        j0 = round((64/100) j);
        J(i,j) = I(i0,j0)
    end
end
```

SOLUTION II (bilinear interpolation)

What is the gray-value of $I(3.7, 8.2)$?





Total Area = A+B+C+D = 1

$A = 0.2 \times 0.7$

$B = 0.8 \times 0.7$

$C = 0.2 \times 0.3$

$D = 0.8 \times 0.3$

$$I(3.7, 8.2) \simeq 87 \times w_1 + 91 \times w_2 + 93 \times w_3 + 90 \times w_4$$

$$\sum_{k=1}^{4} w_k = 1$$

$$\simeq 87D + 91C + 93B + 90A$$

$$91.02$$

SOLUTION II

```
for i = 1:100
    i_o = (64/100) i
    ni_o = fix(i_o)
    di_o = i_o - ni_o
    for j = 1:100
        j_o = (64/100) j
        nj_o = fix(j_o)
        dj_o = j_o - nj_o
        A = di_o * dj_o
        B = di_o * (1 - dj_o)
        C = (1 - di_o) * dj_o
        D = (1 - di_o) * (1 - dj_o)
    J(i,j) = A * I(ni_o+1, nj_o+1) +
             B * I(ni_o+1, nj_o) +
             C * I(ni_o, nj_o+1)
             D * I(ni_o, nj_o);
    end
end.
```