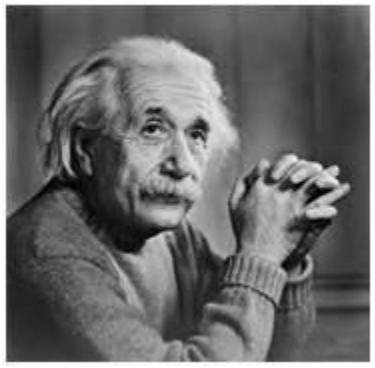
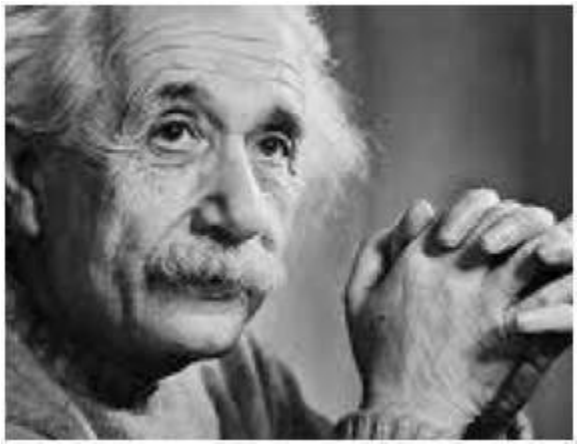
## Concept of Zooming

**Zooming** is one of the essential concepts of image processing. It simply means to enlarge an image so that the details of that image become more transparent and visible.

Zooming simply means enlarging a picture in a sense that the details in the image became more visible and clear.

Digital zoom is basically image processing within a camera. During a digital zoom, the center of the image is magnified and the edges of the picture got crop out.

<table>
<tr>
<td>  </td>
<td>  </td>
</tr>
</table>

## Zooming methods

There are three most common zooming methods in image processing:

1. Pixel replication
2. Pixel interpolation

## Pixel replication

**Pixel replication** is also known as **nearest neighbor interpolation** because using it we can only replicate the neighboring pixels. Let's see how this method work.

### *Methodology*

In the pixel replication method, new pixels are produced through the existing pixels or already given pixels of the input image. Every pixel of the input picture is

replicated *n* times row-wise and *n* times column-wise, and the input image gets zoomed.

**Note**: We apply this method first row wise, and then column wise.

***Example***

Let's try to understand this method using a 2 by 2 matrix, through an image having dimensions of two rows and two columns. Let's suppose we have the following matrix, and we zoom it twice using the pixel replication method:

| | |
|---|---|
| 1 | 2 |
| 3 | 4 |

To apply pixel replication, we follow two steps:

1. Row-wise zooming
2. Column-wise zooming

***Row-wise zooming***

With **row-wise zooming**, each pixel is replicated twice in the rows. This is a very simple process. We copy the pixels of the rows to their adjacent new cell. The new image is as follows:

| | | | |
|---|---|---|---|
| 1 | 1 | 2 | 2 |
| 3 | 3 | 4 | 4 |

***Column-wise zooming***

With **column-wise zooming**, we replicate each pixel column-wise as we did with the rows. We copy the column pixels to their adjacent new column. The new image is as follows:

| | | | |
|---|---|---|---|
| 1 | 1 | 2 | 2 |
| 1 | 1 | 2 | 2 |
| 3 | 3 | 4 | 4 |
| 3 | 2 | 4 | 4 |

**Advantage**

- This method is easy to implement as the pixels are copied into adjacent rows and columns.

## Disadvantage

- The image produced by this method is always too blurry because of the increased zooming factor. As the zooming factor increases, the image gets more blurred.

# Pixel Interpolation

## Methodology

We pick two adjacent elements from a row in the zero-order hold method. We then add these elements. After the addition, we divide the result by two. Then the resulting number is placed between the adjacent elements we picked earlier.

**Note**: We apply this method row-wise first and then column-wise.

## Example

We'll try to understand this method using a 2 * 2 matrix (or an image whose dimensions are two rows and two columns). Suppose we have the following matrix. Let's zoom it twice using the zero-order hold method:

| | |
|---|---|
| 1 | 2 |
| 3 | 4 |

To apply the zero-order hold, we follow these two steps:

1. Row-wise zooming
2. Column-wise zooming

### *Cloumn-wise zooming*

We'll take the two numbers in the first row, add them, and divide them by 22: (2+1)/2=3/2=1.5(2+1)/2=3/2=1.5.

| | | | |
|---|---|---|---|
| 1 | 0 | 2 | 0 |
| 3 | 0 | 4 | 0 |

| | | | |
|---|---|---|---|
| 1 | 1.5 | 2 | 1 |
| 3 | 3.5 | 4 | 2 |

***Row-wise zooming***

We take the first two adjacent column pixel values in the table above. We add these and divide the result by 2, giving us (1+3)/2=4/2=2(1+3)/2=4/2=2. We place this value in a new row between the original values of the first column. We then apply the same method to all the columns. The new image would look as follows:

| | | | |
|---|---|---|---|
| 1 | 1.5 | 2 | 1 |
| 0 | 0 | 0 | 0 |
| 3 | 3.5 | 4 | 2 |
| 0 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| 1 | 1.5 | 2 | 1 |
| 2 | 2.5 | 3 | 1.5 |
| 3 | 3.5 | 4 | 2 |
| 1.5 | 2 | 2 | 1 |

**Advantages**

- This method does not produce a blurry image, unlike the other methods.
- We can always double the image resolution without any special effort.
- It is easy to implement with zero computation overhead.

**Disadvantages**

- This method can only run on the power of two.
- Because of the power two, it doesn't allow us to zoom images by custom resolution.

# Dilation and Erosion in Image Processing

Erosion and Dilation are **morphological image processing** operations. In morphism, we find the shape and size or structure of an object. Both operations are defined for binary images, but we can also use them on a grayscale image. These are widely used in the following way:

- Removing Noise
- Identify intensity bumps or holes in the picture.
- Isolation of individual elements and joining disparate elements in image.

## Dilation

Dilation is a technique where we expand the image. It adds the number of pixels to the boundaries of objects in an image. The structuring element controls it. The structuring element is a matrix of 1's and 0's.

### Structuring Element

The size and shape of the structuring element define how many numbers of the pixel should be added or removed from the objects in an image.

## Erosion

Erosion is much similar to dilation. The difference is that the pixel value calculated minimum rather than the maximum in dilation. The image is replaced under the anchor point with that calculated minimum pixel. Unlikely dilation, the regions of darker shades increase. While it decreases in white shade or brighter side.