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Image Interpolation

Interpolation is a basic tool used extensively in tasks such as zooming, shrinking (image resizing), rotating, and geometric corrections. Fundamentally, interpolation is the process of using known data to estimate values at unknown locations. When we are finished assigning intensities to all the points in the overlay grid, we expand it to the original specified size to obtain the zoomed image.

Interpolation (sometimes called ***resampling***) — an imaging method to increase (or decrease) the number of pixels in a digital image. See figure (1).

Some digital cameras use interpolation to produce a larger image than the sensor captured or to create digital zoom.

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Types of interpolation:

1. nearest neighbor interpolation(See fig.1)

Nearest Neighbor Interpolation

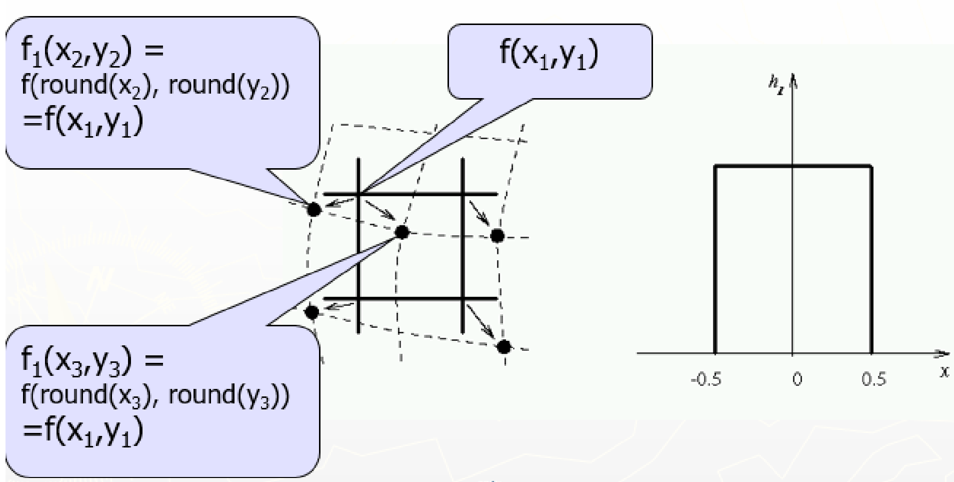
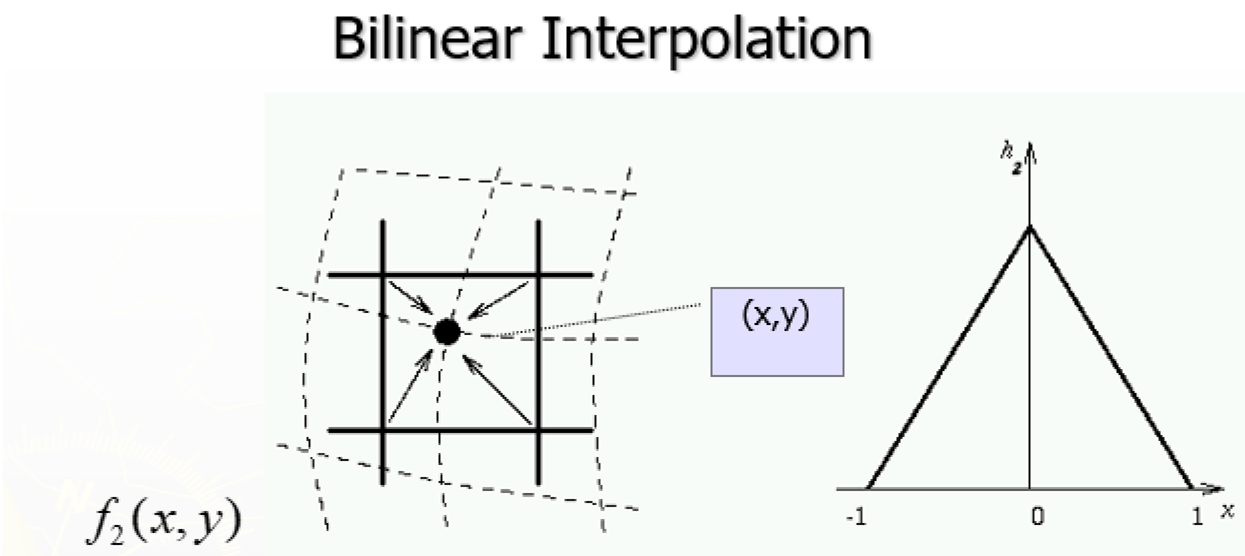


Figure 1. :Image nearest neighbor interpolation

2-Bilinear Interpolation (See fig.2)



3-Bicubic Interpolation:

The sixteen coefficients are determined by using the sixteen nearest neighbors for intensity value assigned to point (x,y).

Figure 3: Examples of image interpolation.

Some Basic Relationships between Pixels :

we consider several important relationships between pixels in a digital image. When referring to a particular pixel, such as p and q.

1- Neighbors of a Pixel:

A pixel p at coordinates has four horizontal and vertical neighbors whose coordinates are given by

$(x + 1, y), (x - 1, y), (x, y + 1), (x, y - 1)$

This set of pixels, called the **4-neighbors** of p, is denoted by $\mathbf{N_4(p)}$. Each pixel is a unit distance from (x,y) , and some of the neighbor locations of p lie outside the digital image if (x,y) is on the border of the image.

The **four diagonal neighbors** of p have coordinates:

$(x + 1, y + 1), (x + 1, y - 1), (x - 1, y + 1), (x - 1, y - 1)$

and are **denoted by $N_D(p)$**. These points, together with the 4 neighbors, are called the 8-neighbors of p, denoted by $N_8(p)$ As before, some of the neighbor locations in $N_D(p)$ and $N_8(p)$ **(the pixels $N4(p) \cup N_D(p)$)** are called **8-neighbors** of p denoted **N8(p**) fall outside the image if (x,y) is on the border of the image. See figure 4.

	*	
*	P	*
	*	

$N_4(p)$

*		*
	p	
*		*

$N_D(p)$

*	*	*
*	P	*
*	*	*

$N_8(p)$

Figure 4: Set of pixels for pixel p with difference neighbors.

2-Adjacency

Let V be the set of intensity values used to define adjacency. In a binary image, if we are referring to adjacency of pixels with value 1. In a grayscale image, the idea is the same, but set V typically contains more elements. For example, in the adjacency of pixels with a range of possible intensity values 0 to 255, set V could be any subset of these 256 values. We consider three types of adjacency:

(a) 4-adjacency: Two pixels' p and q with values from V are 4-adjacent if q is in the set.

(b) 8-adjacency: Two pixels' p and q with values from V are 8-adjacent if q is in the set.

(**c) m-adjacency (mixed adjacency**): Two pixels' p and q with values from V are m-adjacent if:

(i) q is in $N_4(p)$ or

(ii) q is in $N_D(p)$ and the set has no pixels whose values are from V.

3-Path

A (digital) path (or curve) from pixel p with coordinates (x_0, y_0) to pixel q with coordinates (x_n, y_n) is a sequence of distinct pixels with coordinates

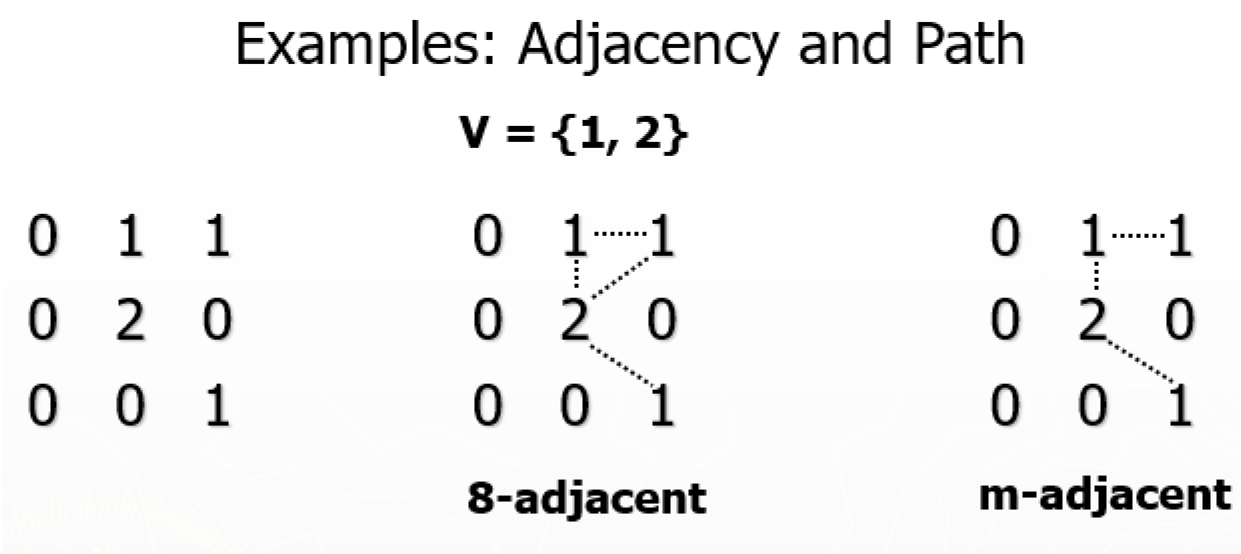
$$(x_0, y_0), (x_1, y_1), \ldots, (x_n, y_n)$$

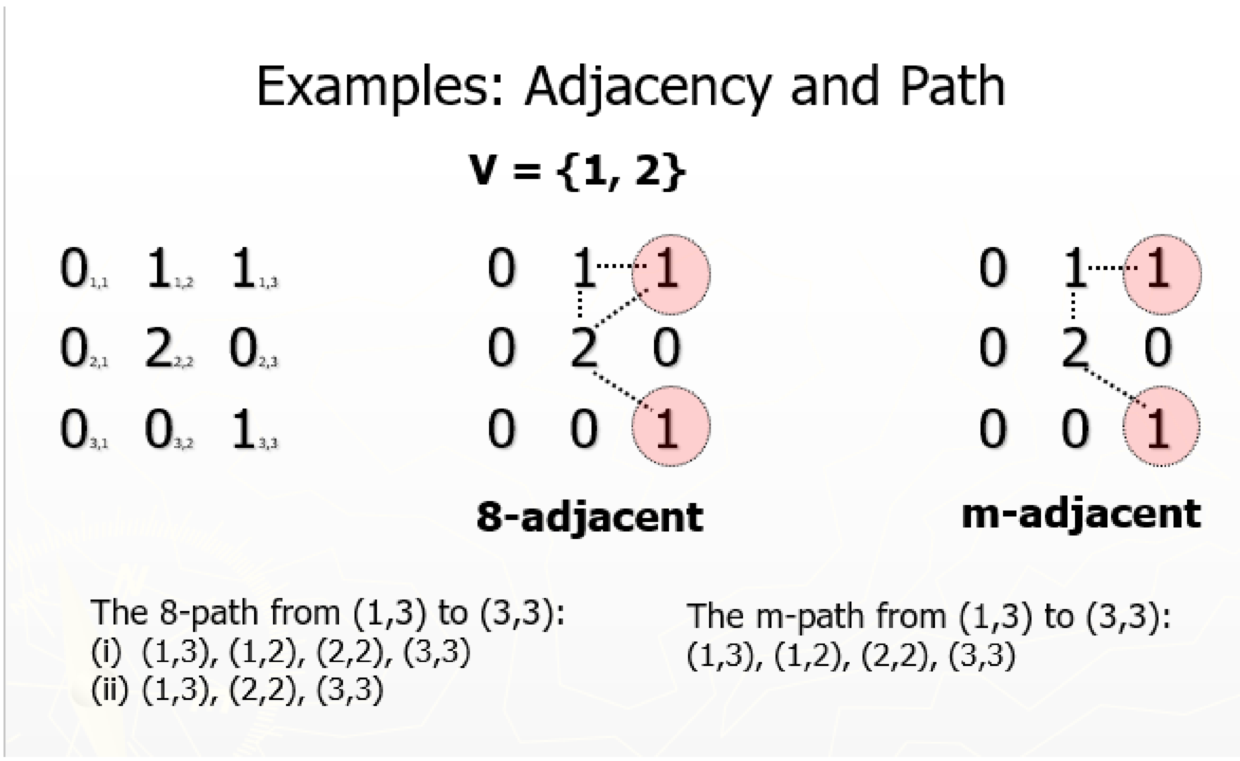
Where (x_i, y_i) and (x_{i-1}, y_{i-1}) are adjacent for $1 \leq i \leq n$.

Here n is the length of the path.

If $(x_0, y_0) = (x_n, y_n)$, the path is closed path.

We can define 4-, 8-, and m-paths based on the type of adjacency used.





4-Connected in S

Let S represent a subset of pixels in an image. Two pixels p with coordinates (x_0, y_0) and q with coordinates (x_n, y_n) are said to be connected in S if there exists a path

$(x_0, y_0), (x_1, y_1), \ldots, (x_n, y_n)$

- For every pixel *p* in S, the set of pixels in S that are connected to *p* is called a ***connected component*** of S.
- If S has only one connected component, then S is called ***Connected Set***.
- We call R a ***region*** of the image if R is a connected set.
- Two regions, R_i and R_j are said to be ***adjacent*** if their union forms a connected set.
- Regions that are not to be adjacent are said to be ***disjoint***.

Examples :

$$
\begin{array}{c}
\left.\begin{matrix}1&1&1\\1&0&1\\0&1&0\end{matrix}\right\} R_i \\
\left.\begin{matrix}0&0&1\\1&1&1\\1&1&1\end{matrix}\right\} R_j
\end{array}
\qquad
\begin{matrix}0&0&0&0&0\\0&1&1&0&0\\0&1&1&0&0\\0&1&1&1&0\\0&1&1&1&0\\0&0&0&0&0\end{matrix}
\qquad\qquad
\begin{matrix}0&0&0\\0&1&0\\0&1&0\\0&1&0\\0&1&0\\0&0&0\end{matrix}
$$

(1) Two regions (of 1s) that are adjacent if 8-adjecency is used.

(2) The circled point is part of the boundary of the 1-valued pixels only if 8-adjacency between the region and background is used.

(3) The inner boundary of the 1-valued region does not form a closed path, but its outer boundary does.