江西理工大學 信息工程学院
JIANGXI UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF INFORMATION ENGINEERING

Digital Image Processing
数字图像处理

Lecture 05:

Digital image fundamentals_B

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Digital Image Processing

LECTURE 05:

Digital image fundamentals_B

Sampling/ Quantization

Basic Relationships Between Pixels

采样/量化
像素之间的基本关系
Cǎiyàng/liànghuà
xiàngsù zhī jiān de jīběn guānxì

数字图像基础B

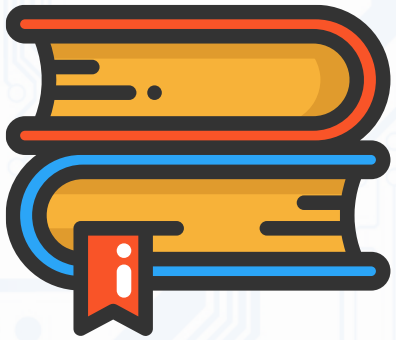
采样和量化

像素之间的基本关系

数字图像基础B

采样和量化

像素之间的基本关系



数字图像处理

讲座05：数字图像fundamentals_B

采样/量化

像素之间的基本关系

采样/量化
像素之间的基本关系
Caiyang/良华
湘智健吉本关系

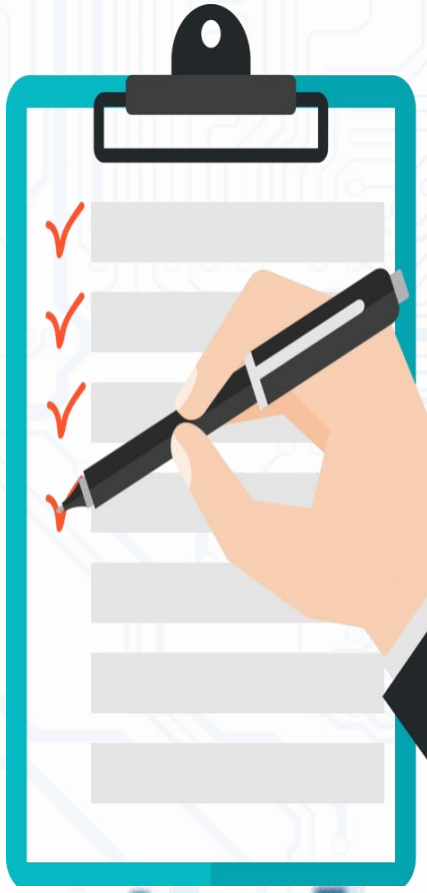
Agenda

- **Sampling/ Quantization**
- **Basic Relationships Between Pixels**
  - Neighborhood
  - Adjacency
  - Connectivity
  - Paths
  - Regions and boundaries
  - Distance

社区
邻接
连接
路径
区域和边界
距离

采样和量化

像素之间的基本关系



- **DPI Vs PPI**

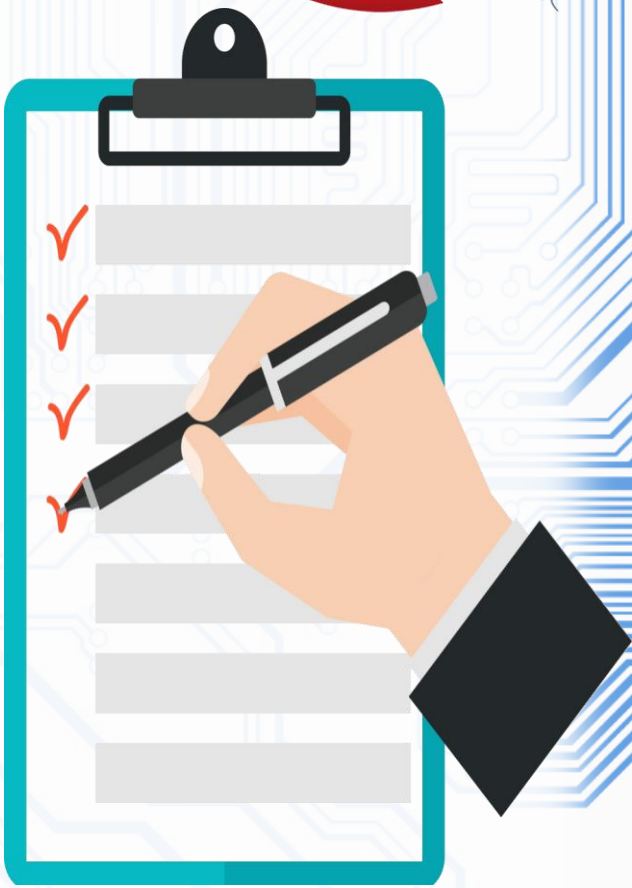
采样/量化
像素之间的
基本关系
邻里邻接连通性路径区域和边界距离DPI 与 PPI

议程

- 采样/量化
- 像素之间的基本关系
  - 社区
  - 邻接
  - 连接性
  - 路径
  - 区域和边界
  - 距离
- DPIVsPPI

采样和量化

像素之间的基本关系



采样/量化
像素之间的
基本关系邻里邻接连通性路径区域和边界距离dpi与PPI

Sampling/ Quantization

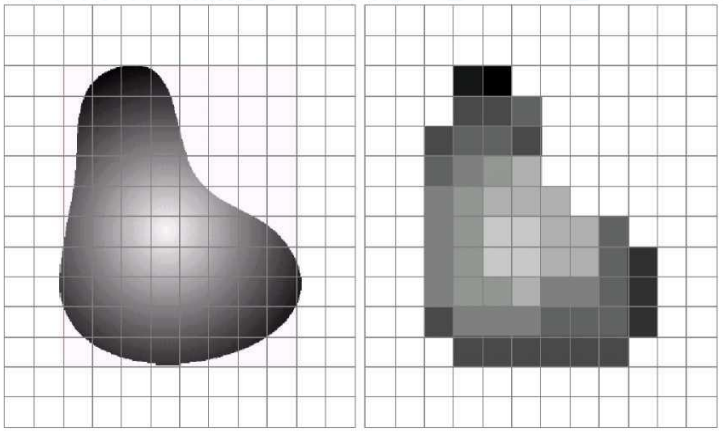
采样/量化 Cǎiyàng/liànghuà

近似 Jìnsì

Sampling and quantization generates **approximation** of a real world scene 采样和量化产生真实世界场景的近似

- Sampling : related to coordinates values (Nyquist frequency) 强度 Qiángdù 采样:与坐标值相关
- Quantization : related to intensity values

量子化:与强度值相关



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

采样/量化

采样/量化Caiyang/lianghua

近似金西

采样和量化生成一个真实世界场景的近似值

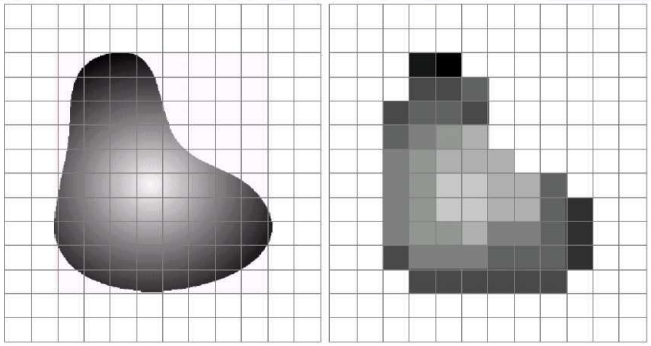
采样和量化产生真实世界场景的近似

- 采样： 与坐标值相关（奈奎斯特频率）相关
- 量化： 与强度值相关

采样:与坐标值相关

强度Qiangdu

量子化:与强度值相关



- 图像取自冈萨雷斯和伍兹，数字图像处理（2002年）

Sampling/ Quantization

为了适合于数字处理，图像函数f(x,y)必须在空间和振幅上进行

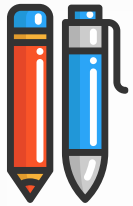
- In order to become suitable for digital processing, an image function f(x,y) must be digitized both spatially and in amplitude.

在空间上 Zài kōngjiān shàng　　振幅 Zhènfú

- Typically, a frame grabber or digitizer is used to sample and quantize the analogue video signal. 通常，一个帧抓取器或数字转换器被用来采样和量化模拟

- Hence in order to create an image which is digital, we need to covert continuous data into digital form. 因此，为了创建数字图像，我们需要将连续的数据转换为数字形

- There are two steps in which it is done: 有两个步骤可以完成:
  - Sampling 抽样
  - Quantization 量化。



采样/量化

为了适合于数字处理，图像函数f(x,y)必须在空间和振幅上进行

- 为了适合于数字处理，图像函数f(x、y)必须在空间和振幅上都进行数字化。

在空间上载建商

振幅Zhenfu

- 通常，帧捕获器或数字化器用于采样和量化模拟视频信号。

通常，一个帧抓取器或数字转换器被用来采样和量化模拟

- 因此，为了创建一个数字的图像，我们需要将连续的数据转换为数字形式。

因此，为了创建数字图像，我们需要将连续的数据转换为数字形

- 有两个步骤：
  - 采样
  - 量化

有两个步骤可以完成:

抽样

量化。

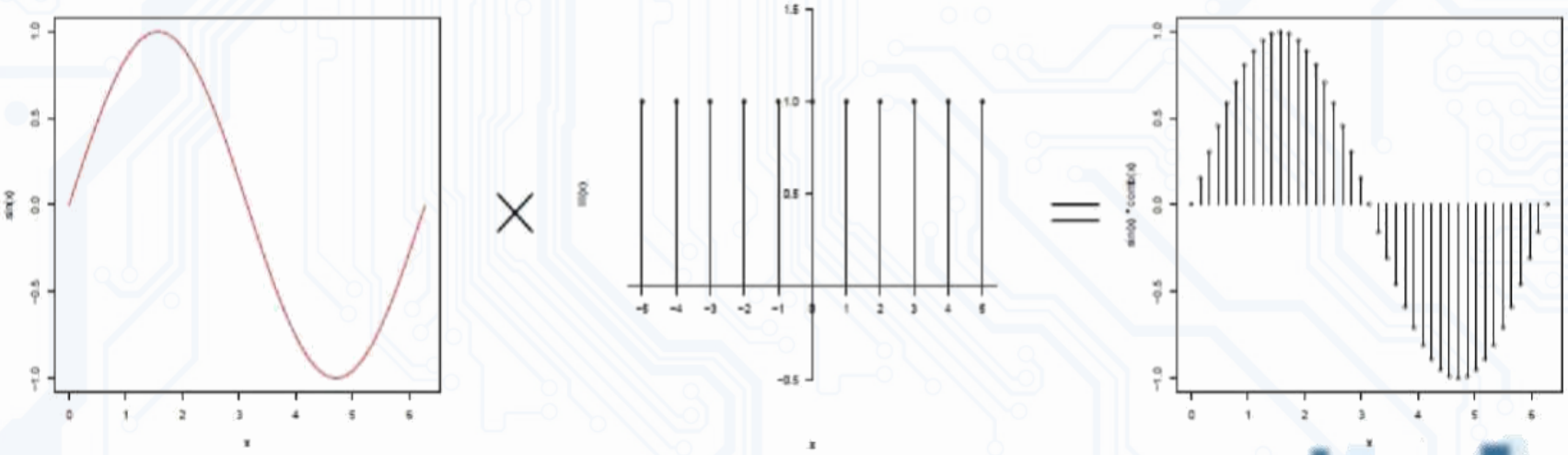
Image (Spatial) Sampling

A digital sensor can only measure a limited number of samples at a discrete set of energy levels Sampling can be thought of as:

采样 Cǎiyàng

Continuous signal x comb function

连续信号x梳功能
Liánxù xìnhào x shū gōngnéng



图像（空间）采样

数字传感器只能在离散的能量水平上测量有限数量的样本采样可以被认为是：

采样Caiyang

连续信号x梳状功能

连续信号x梳功能
连旭新浩x树贡能

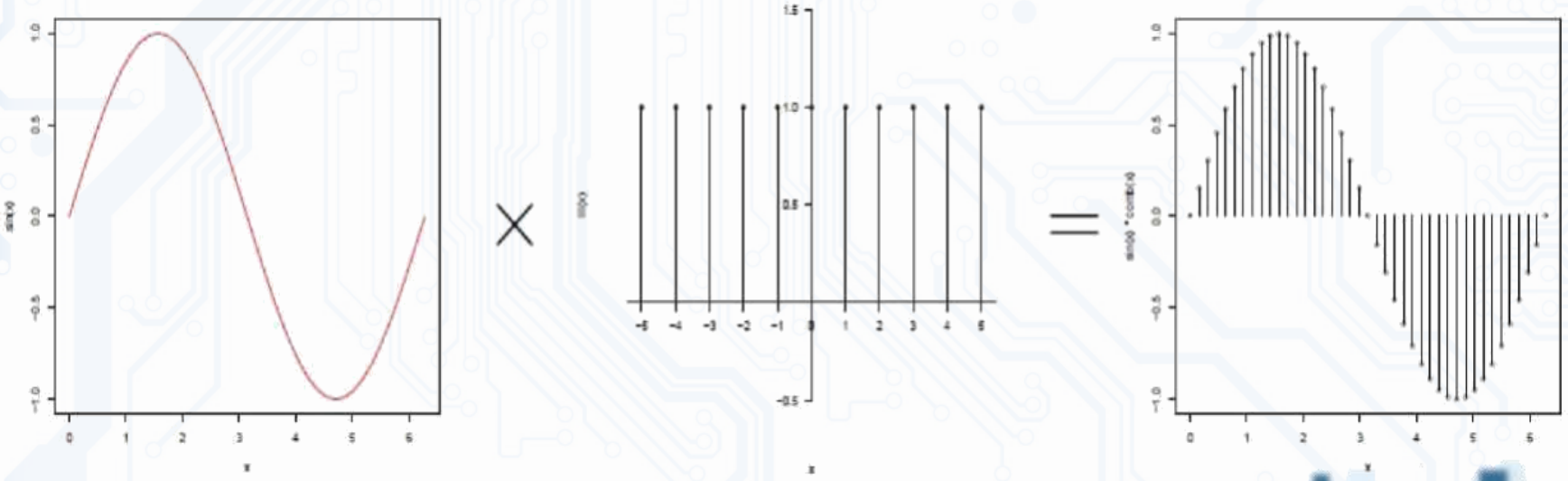
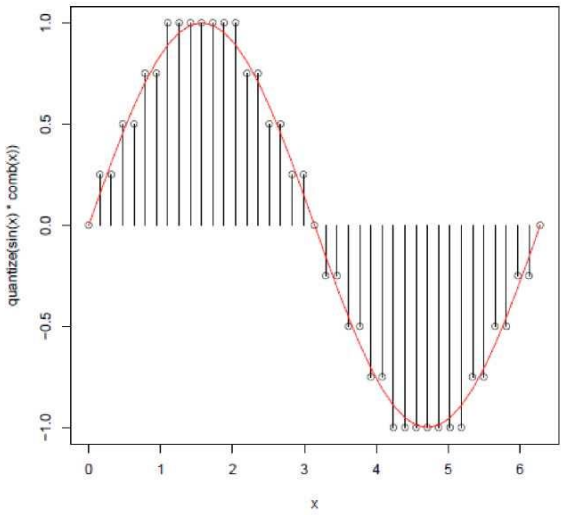


Image Quantization

量化 Lianghuà

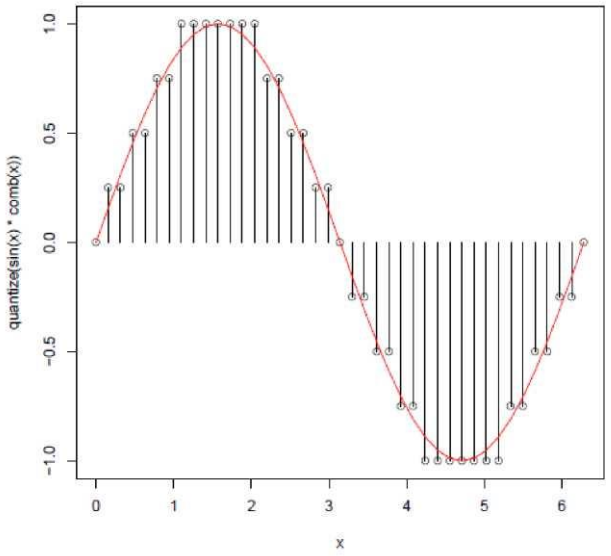
- *Quantization:* process of converting continuous analog signal into its digital representation.
- Limit values image can take
- Discretize image *I(u,v)* values



图像量化

量化
Lianghua

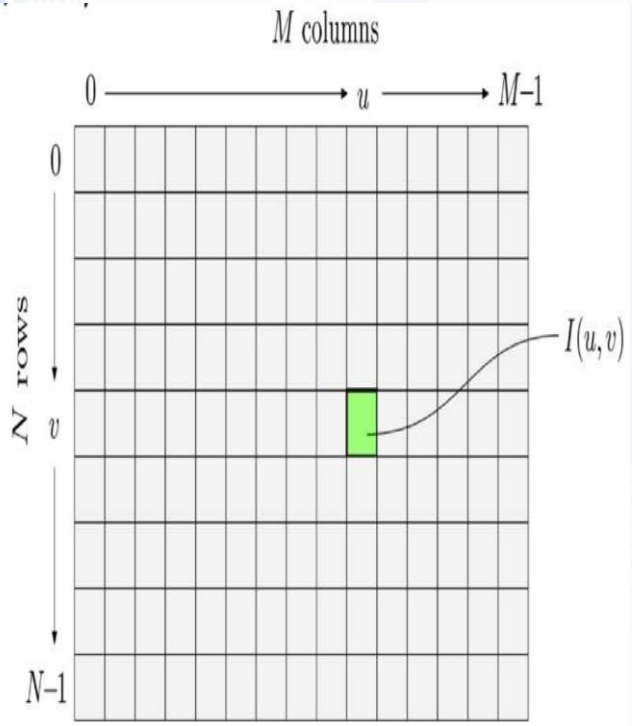
- 量化：将连续模拟信号转换为其数字表示的过程。
- 图像可以获得的极限值
- 离散图像I（u，v）值

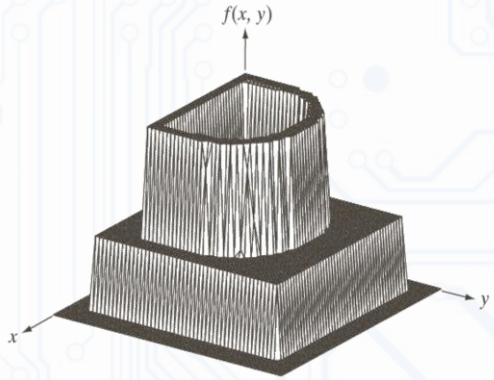


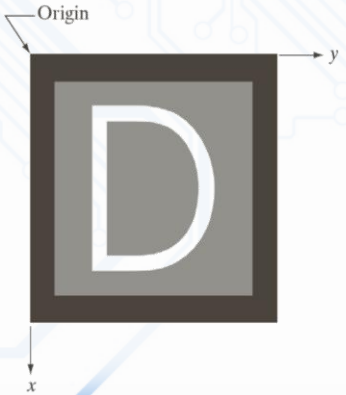
Representing Images

代表图像 Dàibiǎo túxiàng

- Image data structure is 2D array of pixel values
- Pixel values are grey levels in range 0-255 or RGB colors
- Array values can be any data type (bit, byte, int, float,double , etc)







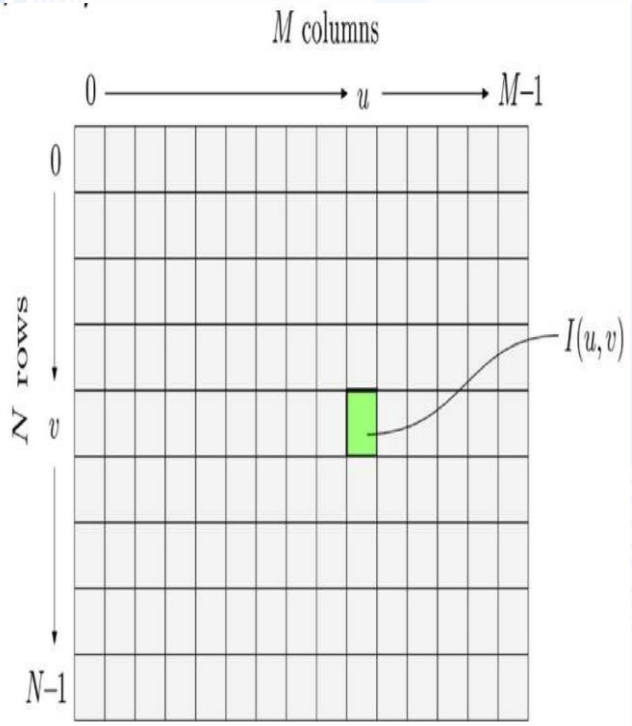
a
b c

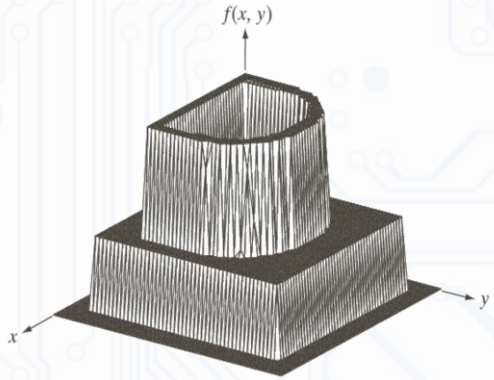
FIGURE 2.18
(a) Image plotted as a surface. (b) Image displayed as a visual intensity array. (c) Image shown as a 2-D numerical array (0, .5, and 1 represent black, gray, and white, respectively).

表示图像

代表图像Daibiao tuxiang

- 图像数据结构是包含像素值的二维数组
- 像素值为范围为0-255或RGB颜色的灰色水平
- 数组值可以是任何数据类型（位、字节、int、浮点、双点等）





a
b c

FIGURE 2.18
(a) Image plotted as a surface.
(b) Image displayed as a visual intensity array.
(c) Image shown as a 2-D numerical array (0, .5, and 1 represent black, gray, and white, respectively).

Sampling/ Quantization

- The **sampling rate** determines the spatial resolution of the digitized image, while the **quantization level** determines the number of grey levels in the digitized image.
- A magnitude of the sampled image is expressed as a digital value in image processing.
- The transition between continuous values of the image function and its digital equivalent is called quantization.
- The number of quantization levels should be high enough for human perception of fine shading details in the image.

量化级别的数量应该足够高，以便人类感知图像中的精细阴影细节。
Liànghuà jíbié de shùliàng yìng gāi zúgòu gāo, yǐbiàn rénlèi gǎnzhī túxiàng zhōng de jīngxì yīnyǐng xìjié.

- The occurrence of false contours is the main problem in image which has been quantized with insufficient brightness levels.

采样/量化

- 采样率决定了数字化图像的空间分辨率，而量化水平决定了数字化图像中的灰度水平的数量。
- 采样图像的大小被表示为图像处理中的数字值。
- 图像函数的连续值与其数字等价值之间的转换称为量化。
- 量化级别的数量应该足够高，以便人类感知图像中的精细阴影细节。
- 假轮廓的出现是图像中因亮度水

量化级别的数量应该足够高，以便人类感知图像中的精细阴影细节。梁华、高、高、、、、、街。

Sampling and quantization

- **To obtain a digital image, f(x,y) must be digitized both in space and amplitude.**

空间坐标数字化——图像采样
Kōngjiān zuòbiāo shùzìhuà——túxiàng cǎiyàng

-digitization of spatial coordinates – **image sampling**
-digitization of amplitude - **grey-level quantization**

幅度数字化 - 灰度量化
Fúdù shu zì huà - huī dù liànghuà

- The **image sampling** is viewed as partitioning an image plane into a grid with coordinates of center of each grid from an integer set ZxZ.

（灰度）量化 (Huī dù) liànghuà

- The **(grey-level) quantization** is viewed as assigning a value from a real number set R as grey level to each grid.

采样和量化

- **要获得数字图像，f（x、y）必须在空间和振幅上同时进行数字化。**

空间坐标数字化——图像采样
刚左彪舒华——图香阳

-空间坐标的数字化。图像采样
-振幅灰度量化的数字化

幅度数字化 灰度量化
子华回都良华

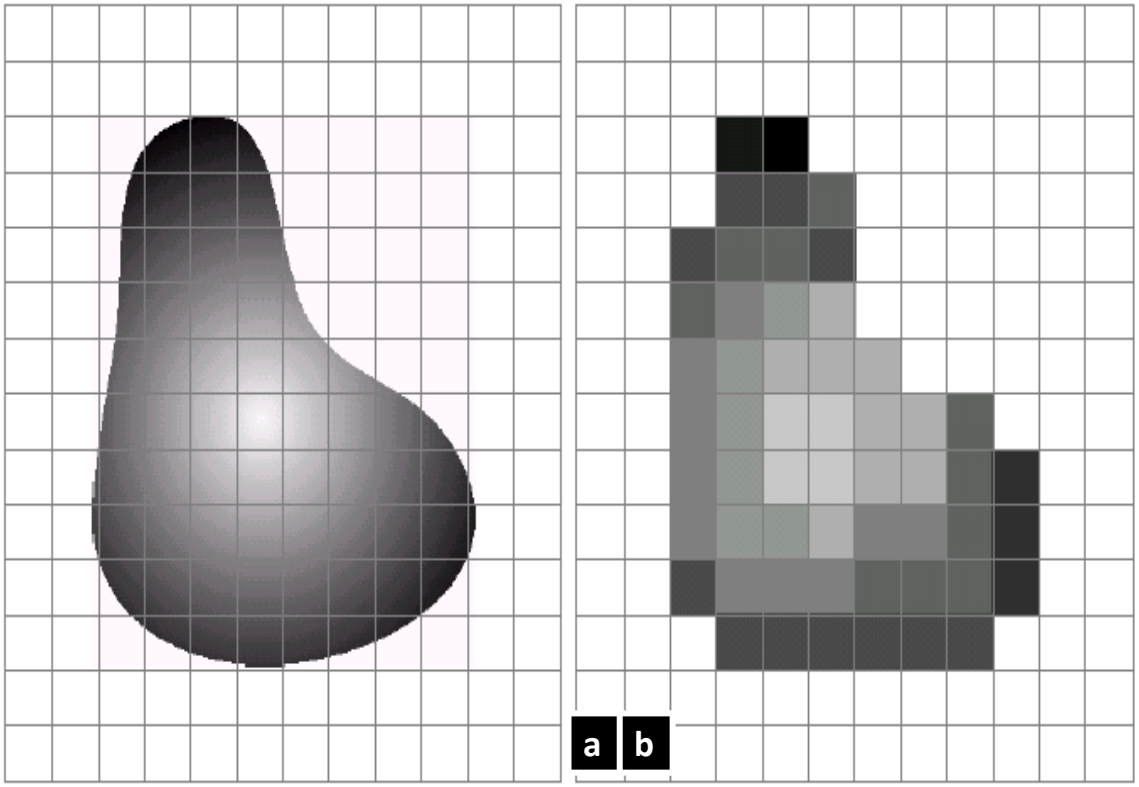
- 图像采样被看作是从一个整数集ZxZ将图像平面分割为具有每个网格中心坐标的网格。

（灰度)量化(回都）良玉华

- （灰度）量化被视为为每个网格分配实数集R的值为灰度。

Image Sampling and Quantization

图像采样和量化 Túxiàng cǎiyàng hé liànghuà

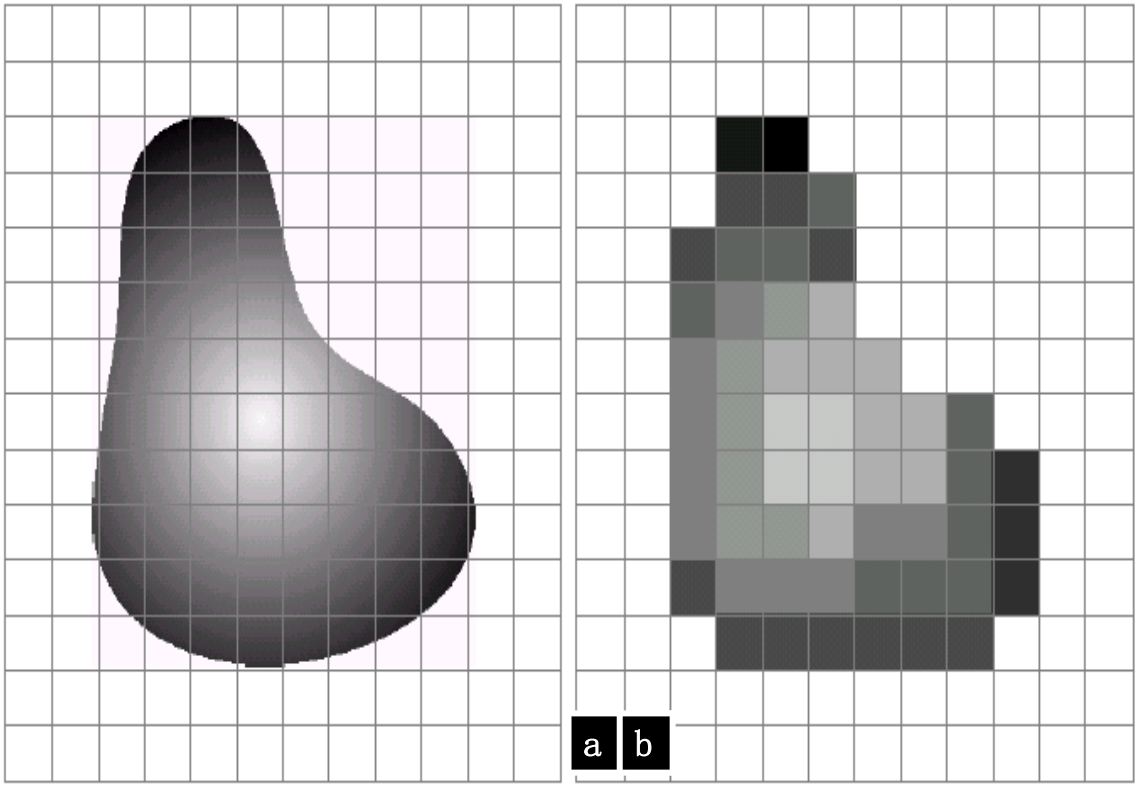


(a) Continuous image projected onto a sensor array.

(b) Result of image sampling and quantization.

图像采样和量化

图像采样和量化图香阳和良华

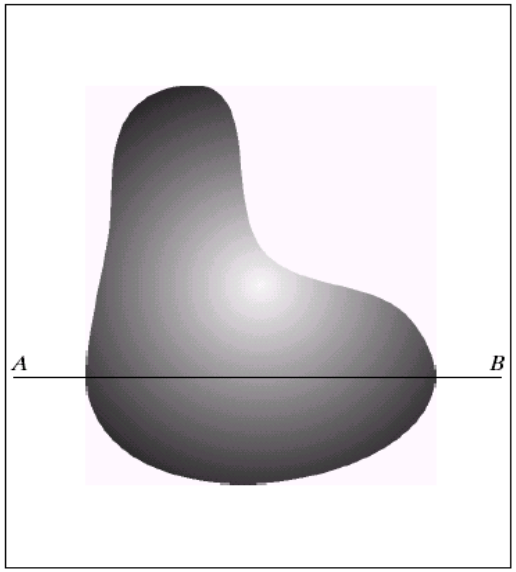


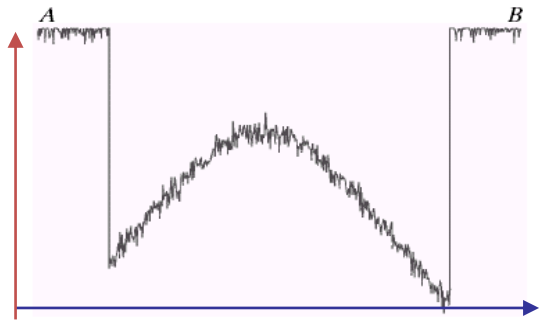
(a) **连续投影到传感器阵列上的图像。**

(b) **图像采样和量化的结果。**

Image Sampling and Quantization

图像采样和量化 Túxiàng cǎiyàng hé liànghuà





a b
c d

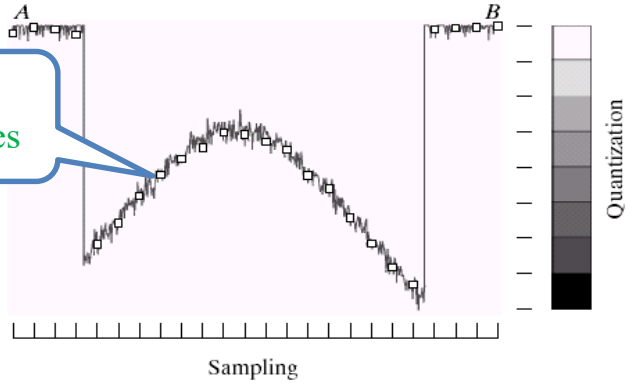
Generating a digital image. (a) Continuous image. (b) A scaling line from A to B in the continuous image, used to illustrate the concepts of sampling and quantization. (c) sampling and quantization. (d) Digital scan line.

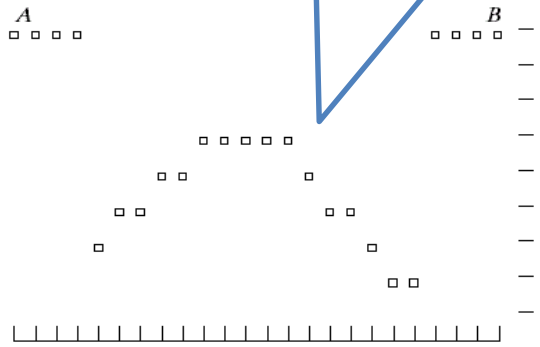
数字化坐标值
Shùzìhuà zuòbiāo zhí

Digitizing the coordinate values

Digitizing the amplitude values

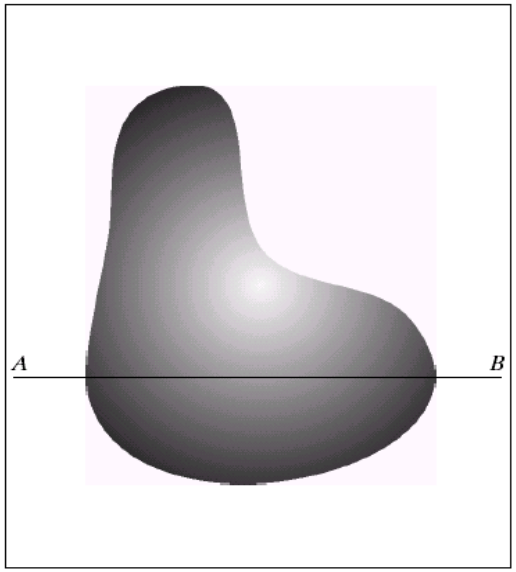
数字化幅度值
Shùzìhuà fúdù zhí

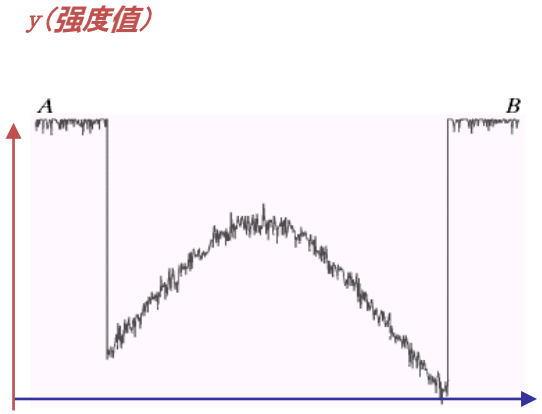




图像采样和量化

图像采样和量化图香阳和良华



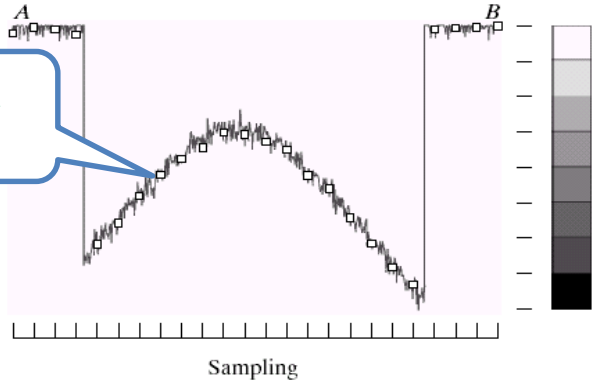


a b
c d

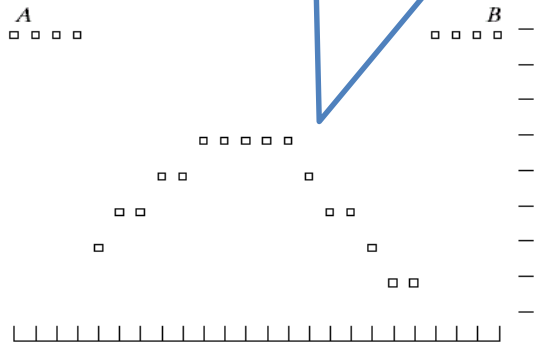
生成一个数字图像。(a)连续的图像。(b)连续图像中从A到B的比例线，用于说明采样和量化的概念。(c)取样和量化。(d)数字扫描线。

数字化坐标值
舒齐华左彪智

数字化坐标值



数字化振幅值

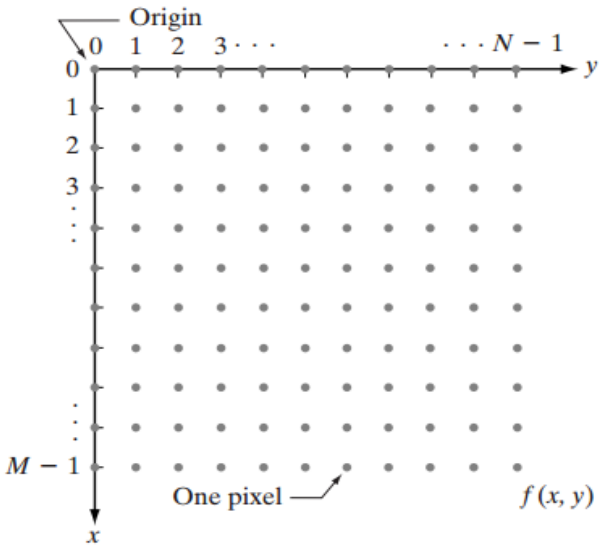


数字化幅度值舒志

Sampling and quantization

采样和量化 Cǎiyàng hé liànghuà

Hence resulting digital image is a MxN matrix in which each matrix element represents a image element or picture element or pixel and its value represents the grey level of that pixel.



$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix}.$$

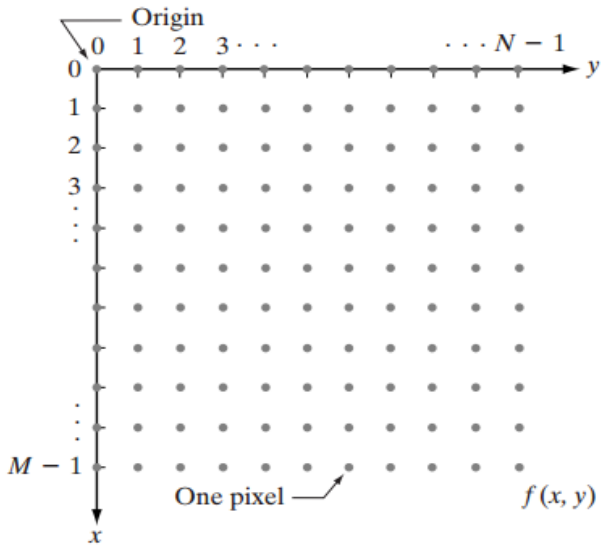
亵渎价值观 Xièdú jiàzhíguān

Desecrate values

采样和量化

采样和量化凯阳和良华

因此，所得到的数字图像是一个MxN矩阵，其中每个矩阵元素表示一个图像元素或图像元素或像素，其值表示该像素的灰度级别。



$$f(x,y)=\begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,N-1) \\ f(1,0) & f(1,1) & \cdots & f(1,N-1) \\ \vdots & \vdots & & \vdots \\ f(M-1,0) & f(M-1,1) & \cdots & f(M-1,N-1) \end{bmatrix}.$$

亵渎价值观Xiedu jiazhiguan

退行性值

Sampling process….

- The sampling process may be viewed as partitioning the xy plane into a grid, with the coordinates of the center of each grid being a pair of elements from the Cartesian product Z^2, which is the set of all ordered pairs of elements (zi, zj), with zi and zj being integers from *Z*.
- Hence, f(x, y) is a digital image if (x, y) are integers from Z^2 and f is a function that assigns a gray-level value (that is, a real number from the set of real numbers,*R*) to each distinct pair of coordinates (x, y).
  - If(x,y) $\subset$Z→ each pair → Gray level (x, y) $\subset$R→ (x, y).

采样过程。

- 采样过程可以看作是将xy平面划分为一个网格，每个网格中心的坐标是来自笛卡尔积Z的一对元素[2]，它是所有有序元素对(zi、zj)的集合，其中zi和zj是来自Z的整数。
- 因此，如果（x、y）是Z的整数，f（x、y）的数字图像[2]f是一个函数，它为每对不同的坐标对（x、y）分配一个灰度值（即实数集合中的实数R）。

  - 如果（x、y)Z→每对→Gray级别（x、y）R→（x、y）。

Sampling and quantization

- This digitization process requires decisions about values for M, N, and for the number, L, of discrete gray levels allowed for each pixel.
  - ***M* and *N* :have to be positive integers**
  - **$L = 2^k$**
- The number, b, of bits required to store a digitized image is: **b=M*N*k**

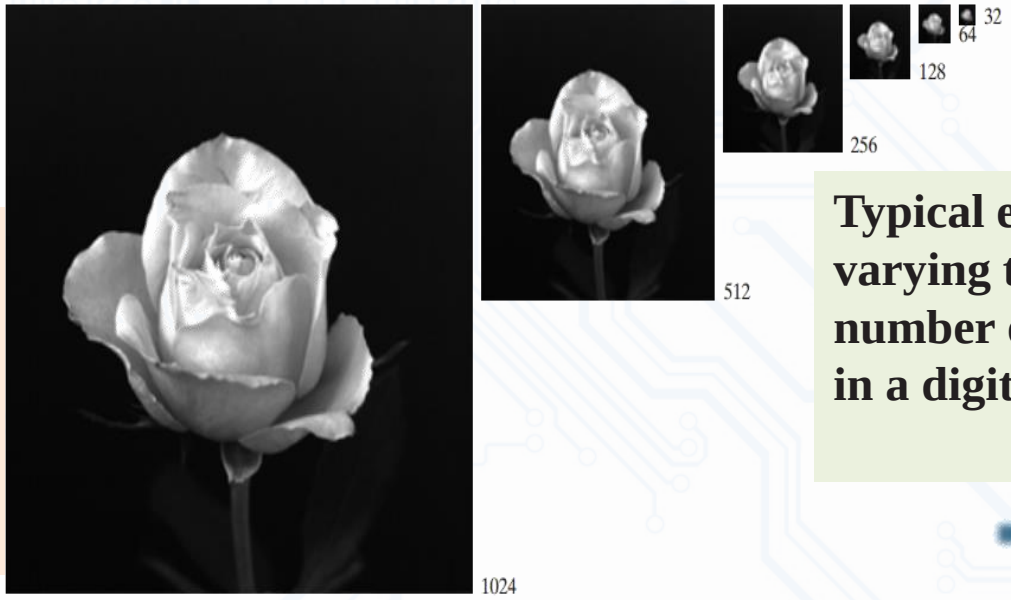


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

Remember that the memory storage and also processing time will be increase by increasing M,N,K

Typical effects of varying the number of samples in a digital image.

采样和量化

- 这个数字化过程需要决定M、N和每个像素允许的离散灰度级数L的值。
  - M和N：必须是正整数
  - $L = 2^k$
- 存储数字化图像所需的比特数b为：b=M*N*k

请记住，内存存储和处理时间也会通过增加M、N、K而增加

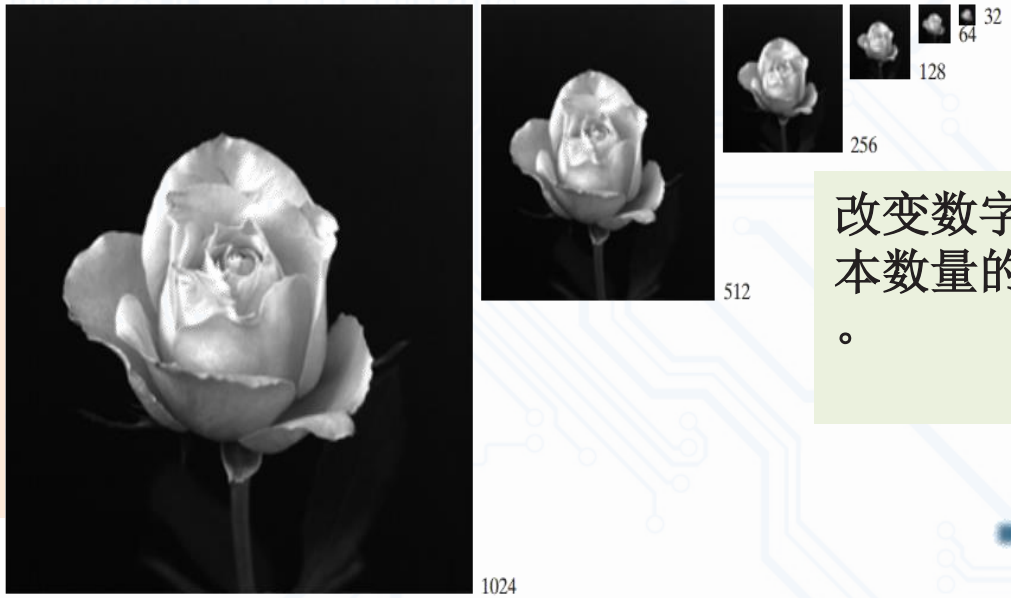


FIGURE 2.19 A 1024 × 1024, 8-bit image subsampled down to size 32 × 32 pixels. The number of allowable gray levels was kept at 256.

改变数字图像中样本数量的典型效果。

Sampling and quantization

采样和量化 Cǎiyàng hé liànghuà

If the quantities M, N and G are chosen to be integer powers of 2 i.e.,

$M=2^p$, $N=2^q$ and $G=2^r$ where p, q and r are any positive integers,

then the size of the resulting digital image is b=MxNxr bits.

Example: What is the (physical) size of an 8-bit (i.e, 256 gray-level)

image of 1024x720 is b=1024x720x8=5898240 bits.

Since 8 bits are 1 byte, b=(5898240/8)=737280 bytes
Since 1024 bytes are 1 kilo byte (kB)=720 kB
(and 1024 kilo bytes are 1 mega bytes (MB))

Using different values of spatial resolution, i.e., coarse as well as fine sampling and gray-level resolution for a given image is known as **non-uniform sampling** and **quantization**.

对给定图像使用不同的空间分辨率值，即粗采样和细采样以及灰度分辨率，称为非均匀采样和量化。
Duì gěi dìng túxiàng shǐyòng bùtóng de kōngjiān fēnbiàn lǜ zhí, jí cū cǎiyàng hé xì cǎiyàng yǐjí huī dù fēnbiàn lǜ, chēng wéi fēi jūnyún cǎiyàng hé liànghuà.

采样和量化

采样和量化凯阳和良华

如果选择量M、N和G为2的整数幂，即，

$M=2^p$，$N=2^q$和$G=2^r$其中p，q和r是任何正整数，

然后得到的数字图像的大小为b=MxNxr位。

示例：8位（即256灰度）的（物理）大小是多少

1024x720的图像是b=1024x720x8=5898240位。

由于8位是1字节，b=（5898240/8）=737280字节，因为1024字节是1千字节(kB)=720kB

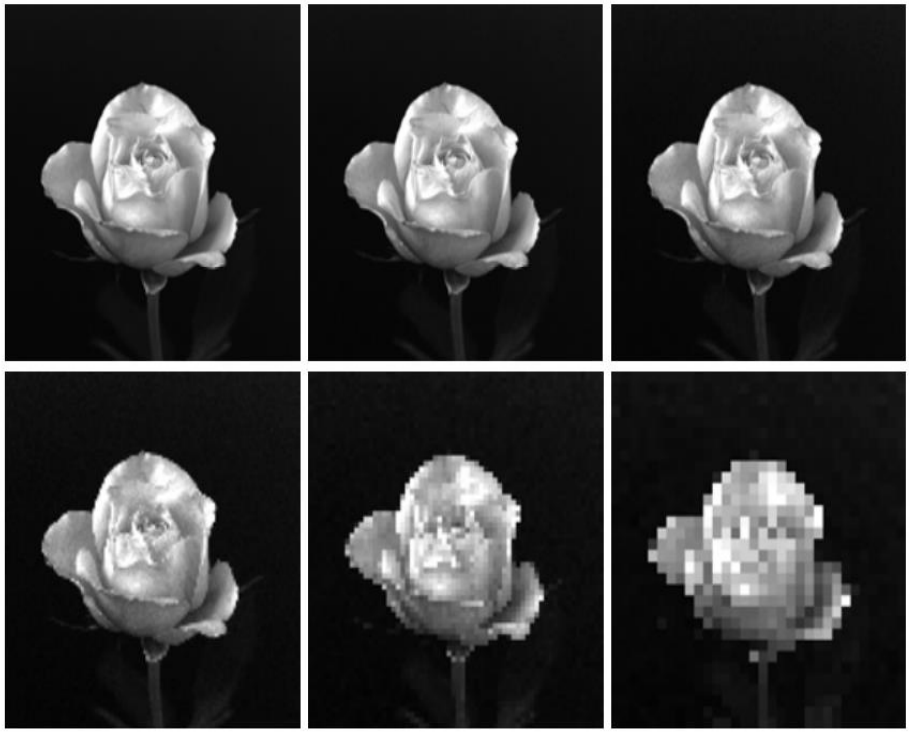
（1024千字节为1兆字节(MB)）

使用不同的空间分辨率值，即对给定图像的粗采样、精细采样和灰度分辨率，被称为非均匀采样和量化。

对给定图像使用不同的空间分辨率值，即粗采样和细采样以及灰度分辨率，称为非均匀采样和量化。
交通、交通、交通、交通、交通、交通。

Sampling and quantization

采样和量化 Cǎiyàng hé liànghuà



a b c
d e f

FIGURE 2.20 (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.

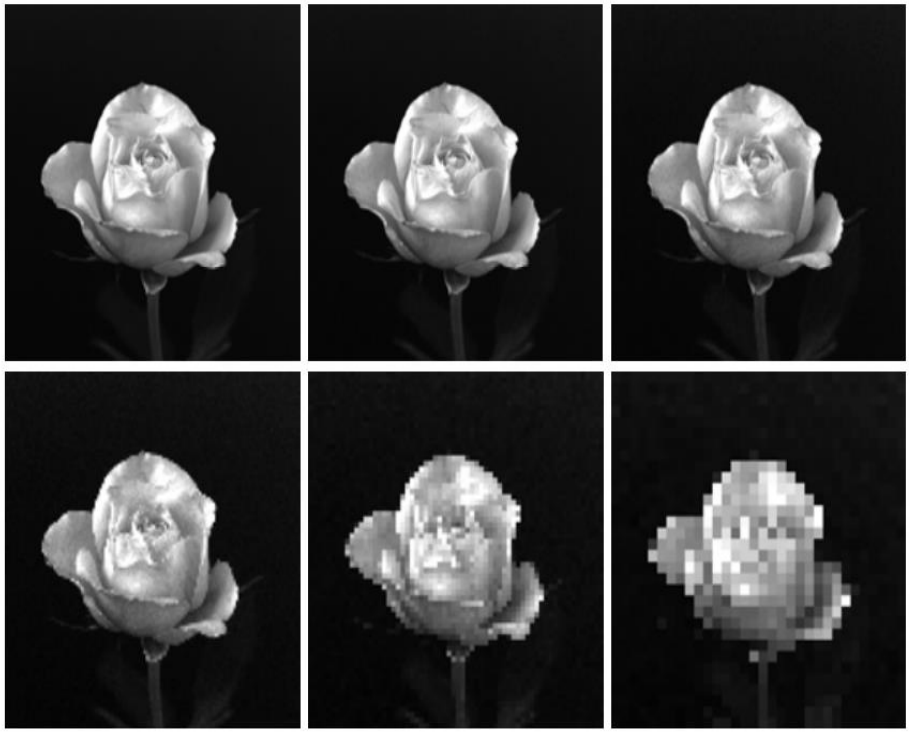
- subsampling the 1024*1024 image.

'The subsampling was accomplished by deleting the appropriate number of rows and columns from the original image.

- For example, the 512*512 image was obtained by deleting every other row and column from the 1024*1024 image.
- The 256*256 image was generated by deleting every other row and column in the 512*512 image, and so on.
- The number of allowed gray levels was kept at 256.

采样和量化

采样和量化凯阳和良华



a b c
d e f

FIGURE 2.20 (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.

- 对1024*1024图像进行子采样。

“子采样是通过从原始图像中删除适当数量的行和列来完成的。”

- 例如，通过从1024*1024图像中删除512*512行和列，获得512*512图像。
- 256*256图像是通过删除512*512图像中的每一行和列来生成的，以此类推。
- 允许的灰色度数保持在256个。

Sampling and quantization

采样和量化 Cǎiyàng hé liànghuà

- An early study by Huang [1965] attempted to quantify experimentally the effects on image quality produced by varying *N* and k simultaneously. The experiment consisted of a set of subjective tests

a b c

FIGURE 2.22 (a) Image with a low level of detail. (b) Image with a medium level of detail. (c) Image with a relatively large amount of detail. (Image (b) courtesy of the Massachusetts Institute of Technology.)

This result suggests that for images with a large amount of detail only a few gray levels may be needed.

这个结果表明，对于具有大量细节的图像，可能只需要几个灰度级。
Zhège jiéguǒ biǎomíng, duìyú jùyǒu dàliàng xìjié de túxiàng, kěnéng zhǐ xūyào jǐ gè huī dù jí.

采样和量化

采样和量化凯阳和良华

- 黄[1965]的一项早期研究试图通过实验来量化同时改变N和k对图像质量的影响。这个实验包括一组主观的测试

a b c

FIGURE 2.22 (a) Image with a low level of detail. (b) Image with a medium level of detail. (c) Image with a relatively large amount of detail. (Image (b) courtesy of the Massachusetts Institute of Technology.)

这一结果表明，对于具有大量细节的图像，可能只需要少量的灰度级别。

这个结果表明，对于具有大量细节的图像，可能只需要几个灰度级。
浙江、界国，都乡，浙江、浙江、浙江。

Sampling and quantization

采样和量化 Cǎiyàng hé liànghuà

- The number of samples or pixels, MxN required to approximate an image is known as **spatial resolution** of the image.
- The low or insufficient spatial resolution results in **pixel replication** causing a **checkerboard effect**.

近似图像所需的样本或像素数 MxN 称为图像的空间分辨率。空间分辨率低或不足会导致像素复制，从而导致棋盘效应。
Jìnsì túxiàng suǒ xū de yàngběn huò xiàngsù shù MxN chēng wèi túxiàng de kōngjiān fēnbiàn lǜ.Kōngjiān fēnbiàn lǜ dī huò bùzú huì dǎozhì xiàngsù fùzhì, cóng'ér dǎozhì qípán xiàoyìng.

Effect of spatial resolution -checkerboard effect

采样和量化

采样和量化凯阳和良华

- 近似图像所需的MxN称为图像的空间分辨率。
- 空间分辨率较低或不足会导致像素复制，从而导致棋盘格效应。

近似图像所需的样本或像素数MxN称为图像的空间分辨率。空间分辨率低或不足会导致像素复制，从而导致棋盘效应。
你的朋友，你的朋友。刚禅、道禅、小英。

空间分辨率-棋盘格效果的效果

Sampling and quantization

- The number of discrete grey levels, G allowed for a pixel in a digital image is known as **grey-level resolution** of the image.

灰度分辨率 Huī dù fēnbiàn lǜ

- The low or insufficient grey-level resolution results in **ridge-like structures** in smooth areas causing **false contouring**.

假轮廓 Jiǎ lúnkuò

采样和量化

- 离散灰度级别的数量，即数字图像中允许一个像素的G被称为图像的灰度分辨率。

灰度分辨率

- 低或不足的灰度分辨率导致光滑区域的脊状结构，导致假轮廓。

假轮廓Jia肺国

Effect of grey-level resolution– false contouring

假轮廓 Jiǎ lúnkuò

Original 8-bit image

Original 4-bit image

Original 2-bit image

1-bit image, binary image

灰度分辨率-假轮廓的影响

假轮廓Jia肺国

原始8位图像

原始4位图像

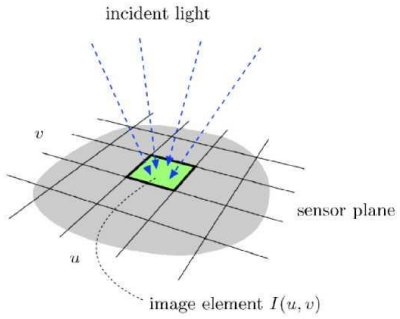
原始2位图像

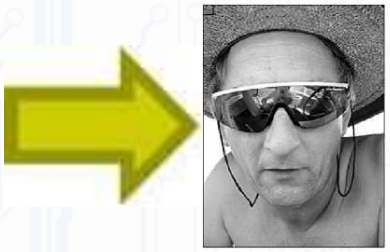
1位图像，二进制图像

空间采样 Kōngjiān cǎiyàng

Spatial Sampling

- Cannot record image values for all (x,y)
- Sample/record image values at discrete (x,y)
- Sensors arranged in grid to sample image





$F(x,y)$

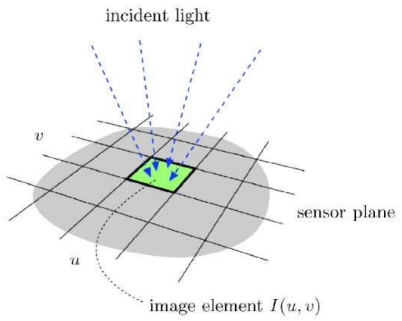
148	123	52	107	123	162	172	123	64	89
147	130	92	95	98	130	171	155	169	163
141	118	121	148	117	107	144	137	136	134
82	106	93	172	149	131	138	114	113	129
57	101	72	54	109	111	104	135	106	125
138	135	114	82	121	110	34	76	101	111 -
138	102	128	159	168	147	116	129	124	117 -
113	89	89	109	106	126	114	150	164	145 * -
120	121	123	87	85	70	119	64	79	127
145	141	143	134	111	124	117	113	64	112

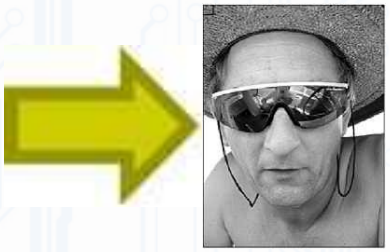
$I(Uy \mathbf{V})$

- After spatial sampling and quantization, an image is a discrete function.
- The image domain Q is now discrete Q C N^2, and so is the image range: $\boldsymbol{I}$: n -> where K E N.

空间采样

- 无法记录所有（x、y）的图像值
- 样本/记录离散（x、y）
- 传感器排列在网格到采样图像





$F(x, y)$

148	123	52	107	123	162	172	123	64	89
147	130	92	95	98	130	171	155	169	163
141	118	121	148	117	107	144	137	136	134
82	106	93	172	149	131	138	114	113	129
57	101	72	54	109	111	104	135	106	125
138	135	114	82	121	110	34	76	101	111
138	102	128	159	168	147	116	129	124	117
113	89	89	109	106	126	114	150	164	145
120	121	123	87	85	70	119	64	79	127
145	141	143	134	111	124	117	113	64	112

$I(Uy\ V)$

- 经过空间采样和量化后，图像是一个离散函数。
- 图像域Q现在是离散的QCN^2，图像范围也是如此：I：n->，其中KEn。

Image as Discrete Function

图像作为离散函数 Túxiàng zuòwéi lísàn hánshù

- After spatial sampling and quantization, an image is a discrete function.
- The image domain Q is now discrete Q C N^2,
- and so is the image range: $\boldsymbol{I}$: n -> where K E N.

图像作为离散函数

图像作为离散函数图祥铃木瑞森汉书

- 经过空间采样和量化后，一个图像为a离散函数。
- 图像域Q现在是离散的QCN^2,
- 图像范围也是如此：I：n->，其中KEn。

Spatial Resolution

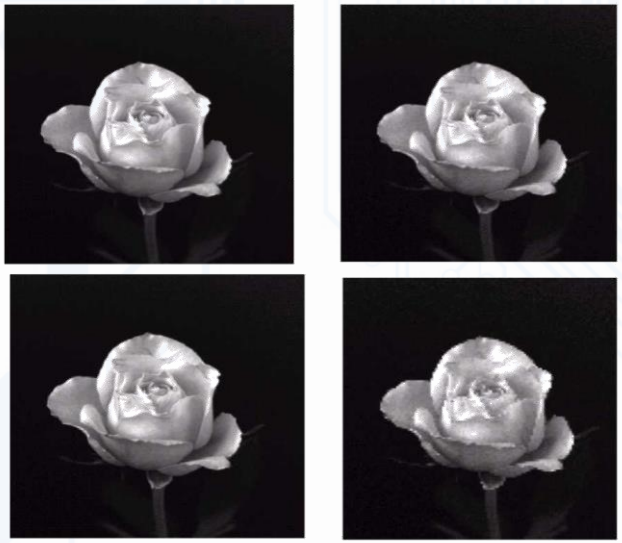
空间分辨率 Kōngjiān fēnbiàn lǜ

The spatial resolution of an image is determined by how fine/coarse sampling was carried out.

Spatial resolution: smallest discernable image detail

- Vision specialists talk about image resolution
- Graphic designers talk about *dots per inch* (DPI)

Spatial Resolution: Stretche



V Images taken from Gonzalez & Woods, Digital Image Processing (2002)

空间分辨率

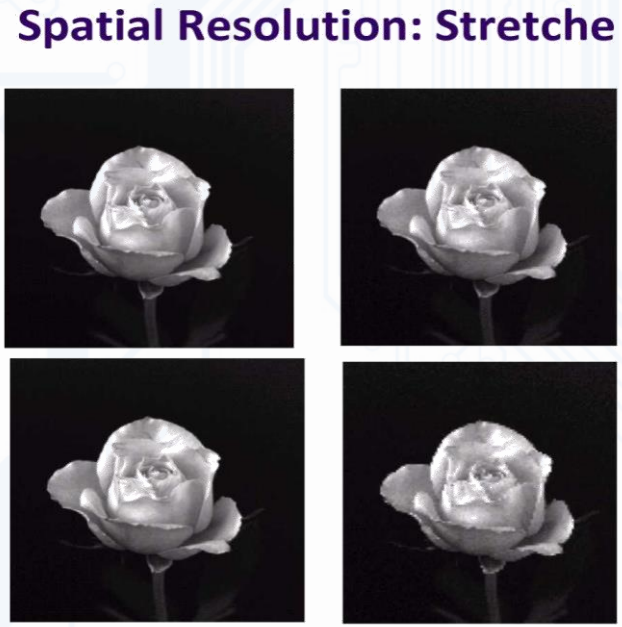
空间分辨率刚福建卢

图像的空间分辨率取决于精细/粗采样的执行方式。

空间分辨率：最小的可识别图像细节

视觉专家谈论图像的分辨率

平面设计师谈论每英寸的点(DPI)



V图像取自冈萨雷斯和伍兹，数字图像处理（2002年）

Intensity Level Resolution

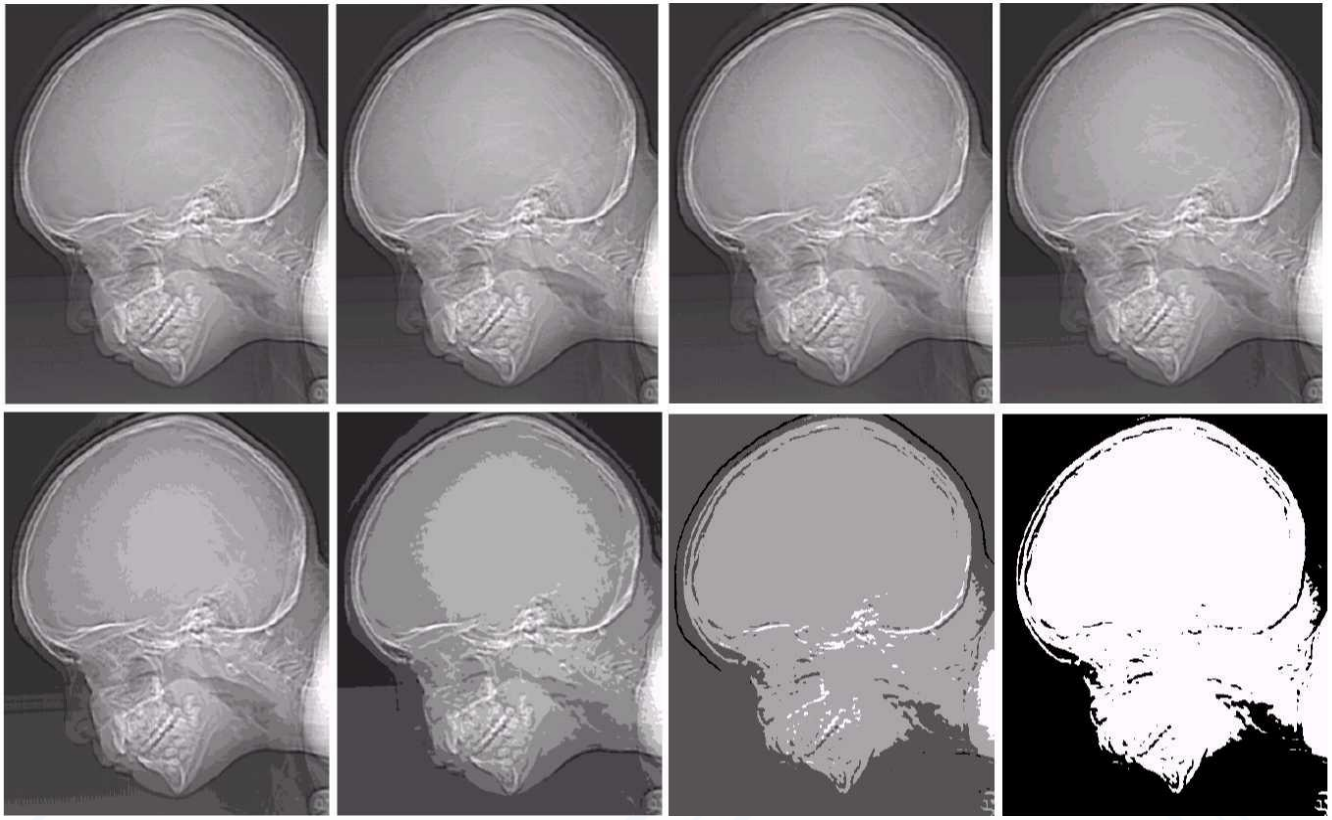
强度水平分辨率 Qiángdù shuǐpíng fēnbiàn lǜ

256 grey levels (8 bits per pixel)

128 grey levels (7 bits per pixel)

64 grey levels (6 bits per pixel)

32 grey levels (5 bits per pixel)



16 grey levels (4 bpp)

8 grey levels (3 bpp)

4 grey levels (2 bpp)

2 grey levels (1 bpp)

强度级分辨率

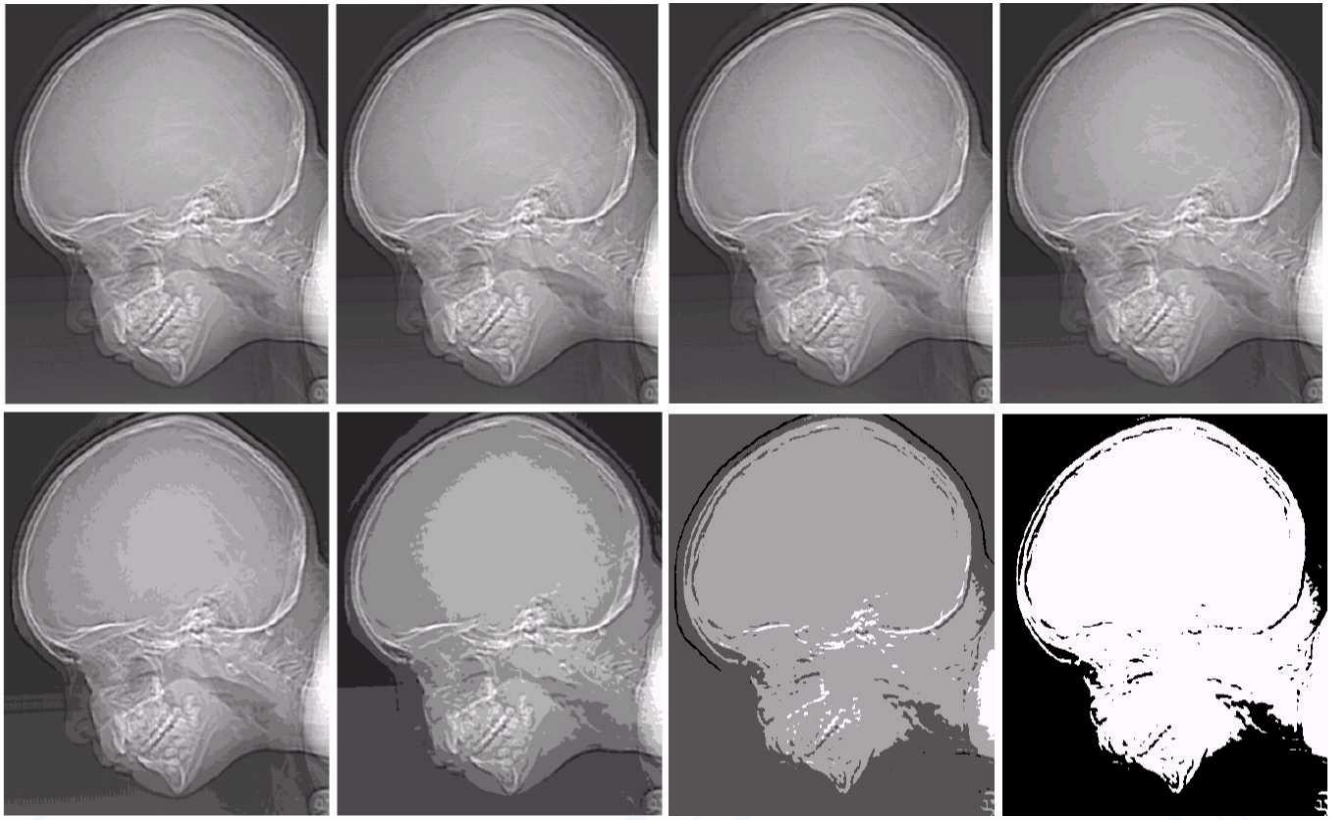
强度水平分辨率强都水露

256灰色水平
（每像素8位）

128灰色水平
（每像素7位）

64灰色水平
（每像素6位）

32灰色水平
（每像素5位）



16个灰色水平（4页）

8个灰色水平（3bpp）

4个灰色水平（2bpp）

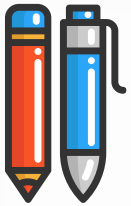
2个灰色层（1bpp）

Basic Relationships Between Pixels

像素之间的基本关系 Xiàngsù zhī jiān de jīběn guānxì

- Neighborhood
- Adjacency
- Connectivity
- Paths
- Regions and boundaries

1.邻里
2.邻接
3.连通性
4.路径
5.区域和边界



像素之间的基本关系

像素之间的基本关系香苏智健健关系

- 社区
- 邻接
- 连接性
- 路径
- 区域和边界

1. 邻里
2. 邻接
3. 连通性
4. 路径
5. 区域和边界

Neighbors of a Pixel

邻里

像素 Xiàngsù

- A pixel *p* at coordinates (*x*,*y*) has four *horizontal* and *vertical* neighbors whose coordinates are given by:

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

	(x, y-1)	
(x-1, y)	*P (x,y)*	(x+1, y)
	(x, y+1)	

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

像素的邻居

邻里 像素Xiangsu

- 坐标（x、y）处的像素p有四个水平和垂直相邻点，其坐标由：

(x+1, y)，(x-1，y)，(x，y+1)，(x, y-1)

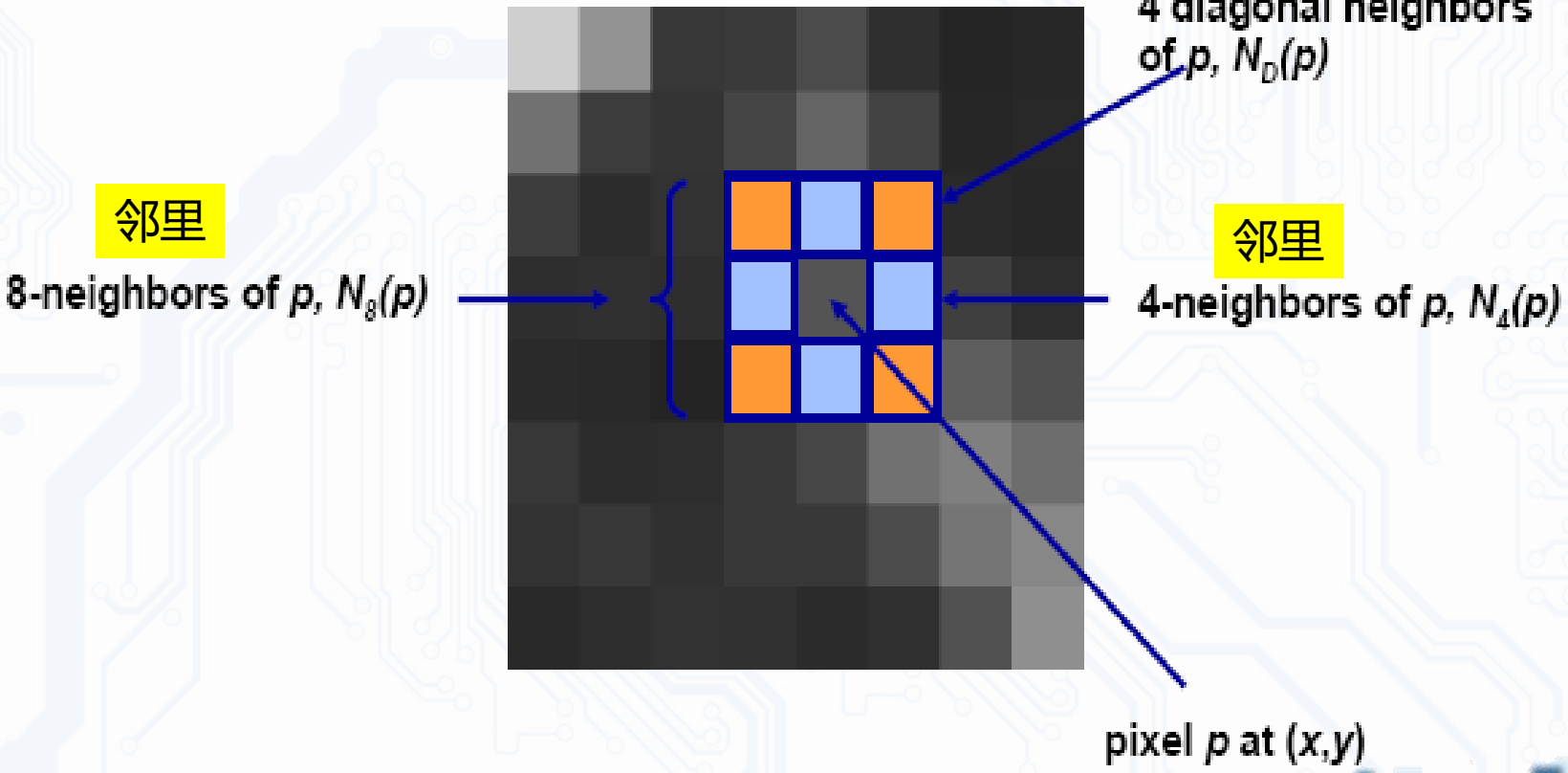
	(x，y-1)	
(x-1，y)	*P (x, y)*	(x+1, y)
	(x，y+1)	

- 这组像素，称为4个邻居或p，用N表示$_4$(p).
- 每个像素距离（x、y）有一个单位距离，如果（x、y）位于图像的边界上，则p的一些邻居位于数字图像的外部。

Neighbors of a pixel

邻里

像素 Xiàngsù



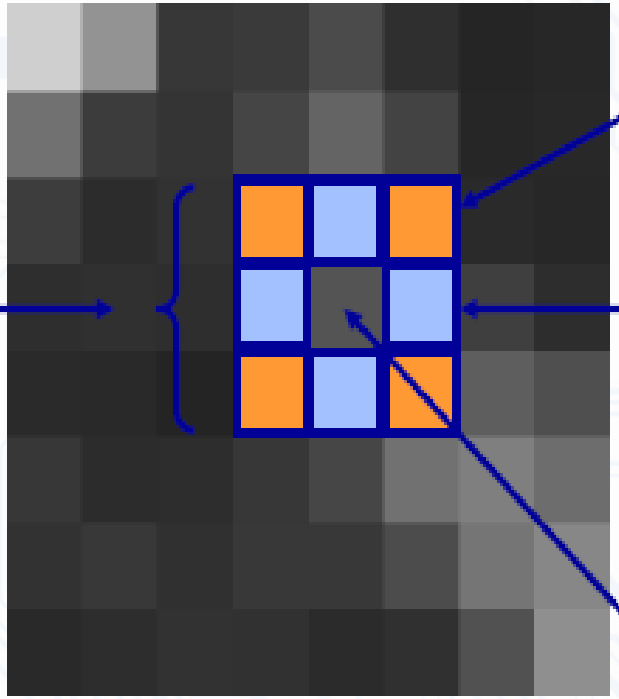
像素的邻居

邻里

像素Xiangsu

邻里

4 diagonal neighbors of p, $N_D(p)$



邻里

8-neighbors of p, $N_8(p)$

邻里

4-neighbors of p, $N_4(p)$

pixel p at (x,y)

Neighbors of a Pixel
像素的邻居

- $N_4(p)$: 4 Neighbors of Pixel
  4像素的邻居
- $N_D(p)$: 4 Diagonal Neighbors of Pixel
  像素对角邻域
- $N_8(p)$: 8 Neighbors of Pixels
  8像素的邻居

Fig. : 8: Central Pixel 'p'

Neighbors of a Pixel

邻里

像素 Xiàngsù

对角线 Duì jiǎo xiàn

- The four *diagonal* neighbors of *p* have coordinates: p的四个对角线邻居有坐标:
  (x+1, y+1), (x+1, y-1), (x-1, y+1), (x-1, y-1)

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

and are denoted by $N_D(p)$. ， 用ND(p)表示。

These points, together with the 4-neighbors, are called the 8-neighbors of p, denoted by $N_8(p)$.

这些点连同4个邻点称为p的8个邻点，用N表示(p)。

(x-1, y+1)	(x, y-1)	(x+1, y-1)
(x-1, y)	**P (x,y)**	(x+1, y)
(x-1, y-1)	(x, y+1)	(x+1, y+1)

As before, some of the points in $N_D(p)$ and $N_8(p)$ fall outside the image if (x,y) is on the border of the image.

和之前一样，如果(x,y)在图像的边界上，N(p)和Ns (p)中的一些点落在图

Neighbors of a Pixel

邻里

像素 Xiàngsù

对角线 Duì jiǎo xiàn

$N_4(p)$: A pixel p at coordinate (x,y) has two horizontal and two 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-neighbours of p and it denoted by $N_4(p)$:
- Each pixel is a unit distance from (x,y)

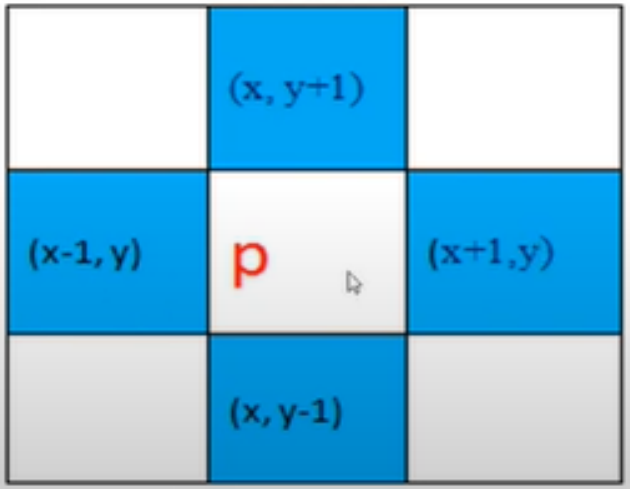


Fig. 9: $N_4(p)$

像素的邻居

邻里

像素Xiangsu

对角线Dui角县

- p的四个对角线邻居有以下坐标：

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

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

，并用N表示$_D$(p).

这些点和4个邻居一起，被称为p的8个邻居，用N表示$_8$(p).

(x-1, y+1)	(x, y-1)	(x+1, y-1)
(x-1, y)	*P (x, y)*	(x+1, y)
(x-1, y-1)	(x, y+1)	(x+1, y+1)

和前一样，在N_D(p)和N_8(p)如果（x、y）位于图像的边框上，则落在图像之外。

Neighbors of a Pixel

$N_D(p)$: 像素p的四个对角邻居都有坐标

The four diagonal neighbors of pixel p have coordinates **(x+1, y+1), (x-1, y-1) , (x-1,y+1), and (x+1, y-1)** are denoted by neighbors ($N_D(p)$) of a Pixel p.

由像素p的邻居(No(p))表示。

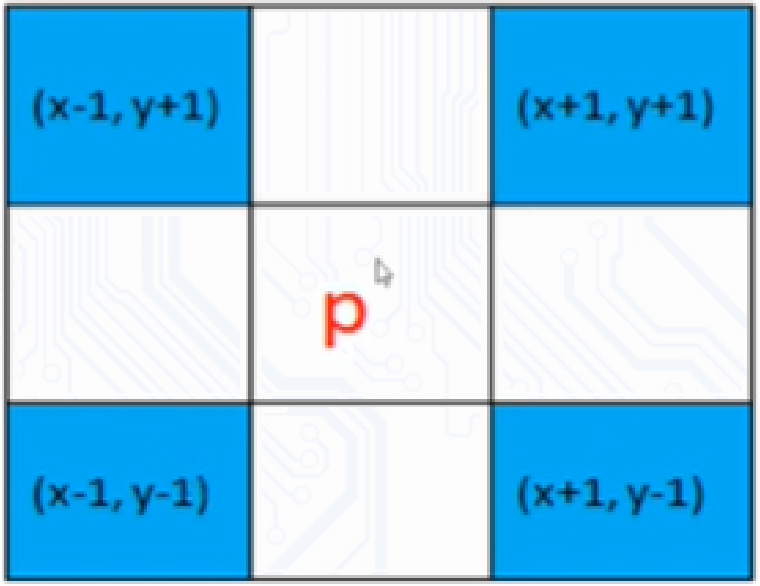


Fig. 10:$N_D(p)$

Neighbors of a Pixel

结合

$N_8(p)$: Combining Diagonal pixels ($N_D(p)$) together with the 4-neighbor (N4(p))are called the 8-neighbors of p.

$N_8(p)$=(All pixels of $N_4(p)$) U (All pixels of $N_D(p)$)

Nq(p):将对角线pisels()与Aneihor (ipare

称为p的s邻居

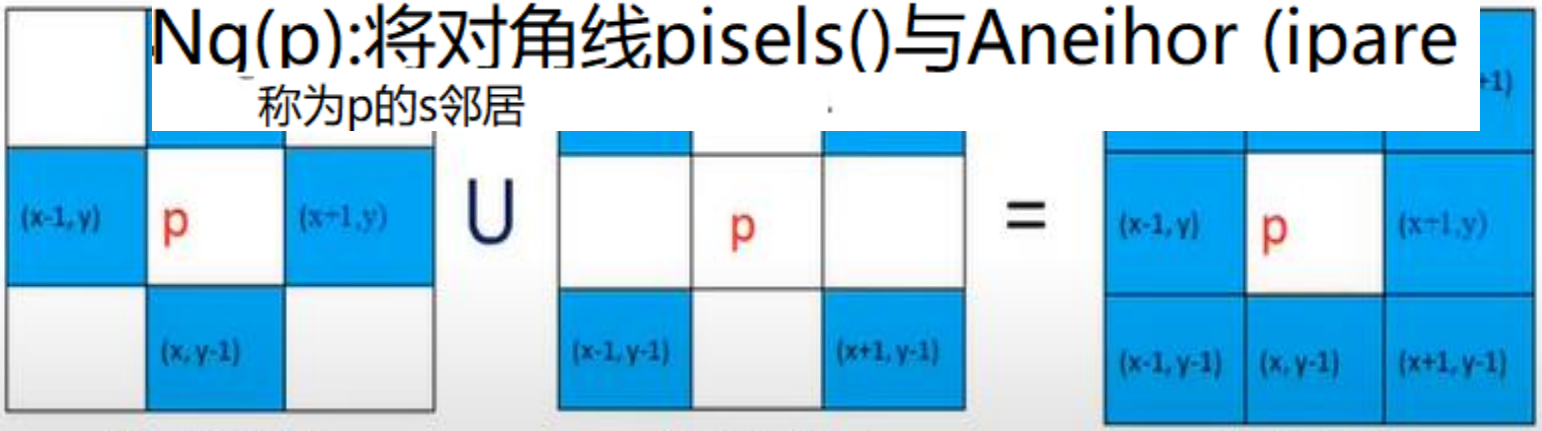


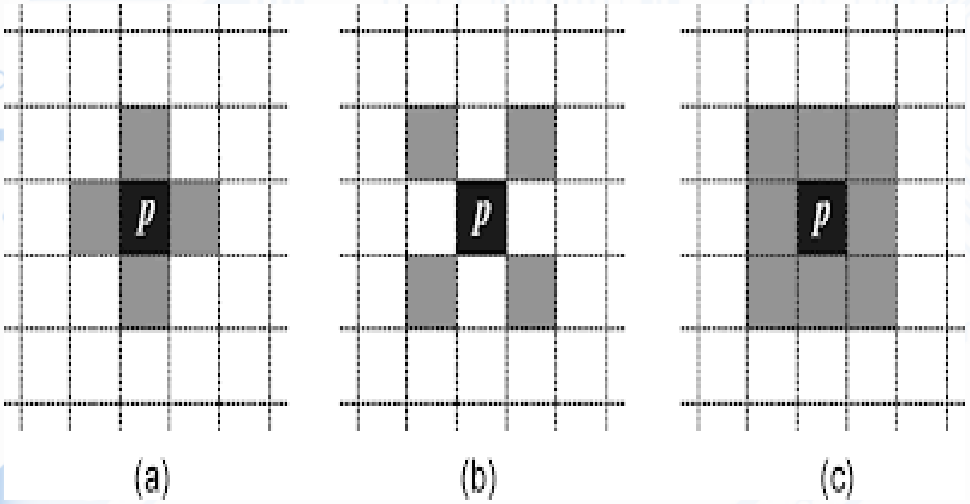
Fig. 11: $N_4(p)$ Fig. 12 : $N_D(p)$ Fig. 13 : $N_8(p)$

Summery Neighbors of a pixel …

邻里

Neighbors of a pixel p at coordinates (x,y)

- **4-neighbors of p**, denoted by $\mathbf{N_4(p)}$: (x-1, y), (x+1, y), (x,y-1), and (x, y+1).
- **4 diagonal neighbors of p**, denoted by $\mathbf{N_D(p)}$: (x-1, y-1), (x+1, y+1), (x+1,y-1), and (x-1, y+1).
- **8 neighbors of p**, denoted $\mathbf{N_8(p)}$ N8(p) = N4(p) U ND(p)



neighborhood of pixel p (from an image topology perspective):

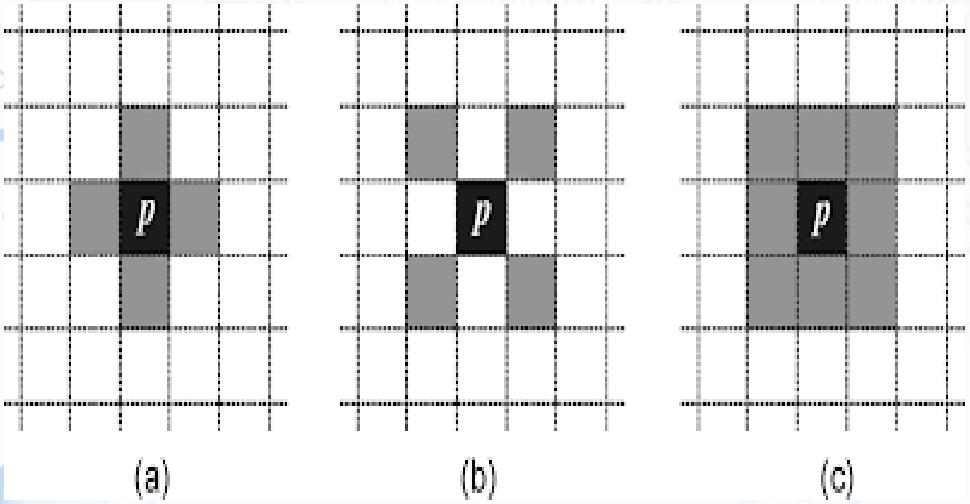
(a) 4-neighborhood;
(b) diagonal neighborhood;
(c) 8-neighborhood.

一个像素的夏天的邻居。

邻里

在坐标处的像素p的邻居（x、y）

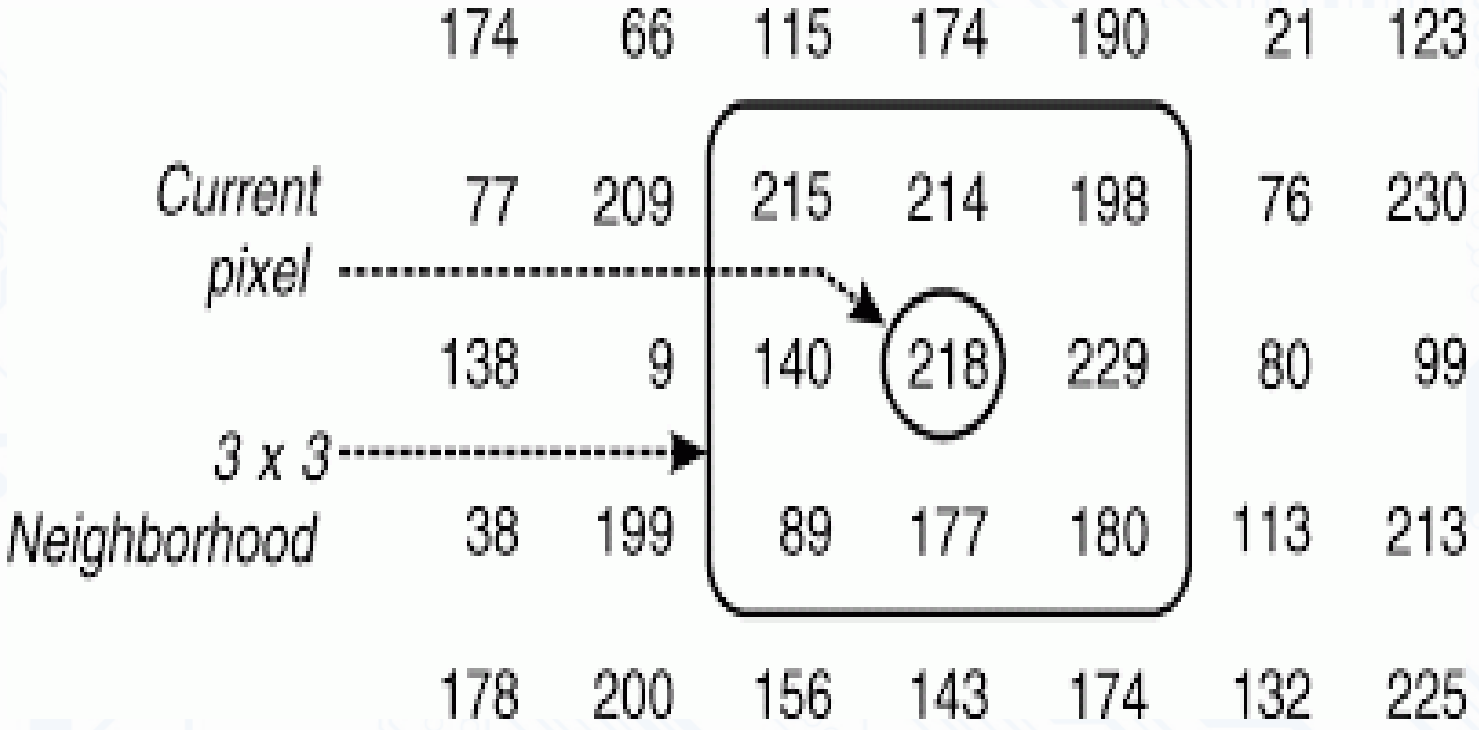
- p的4个邻居，用N表示$_4$(p)：（x-1、y）、（x+1、y）、（x、y-1）和（x、y+1）。
- p的4个对角线邻居，用N表示$_D$(p)：（x-1、y-1）、（x+1、y+1）、（x+1、y-1）和（x-1、y+1）。
- p的8个邻居，记为N_8(p)N8(p)=N4(p)U ND(p)



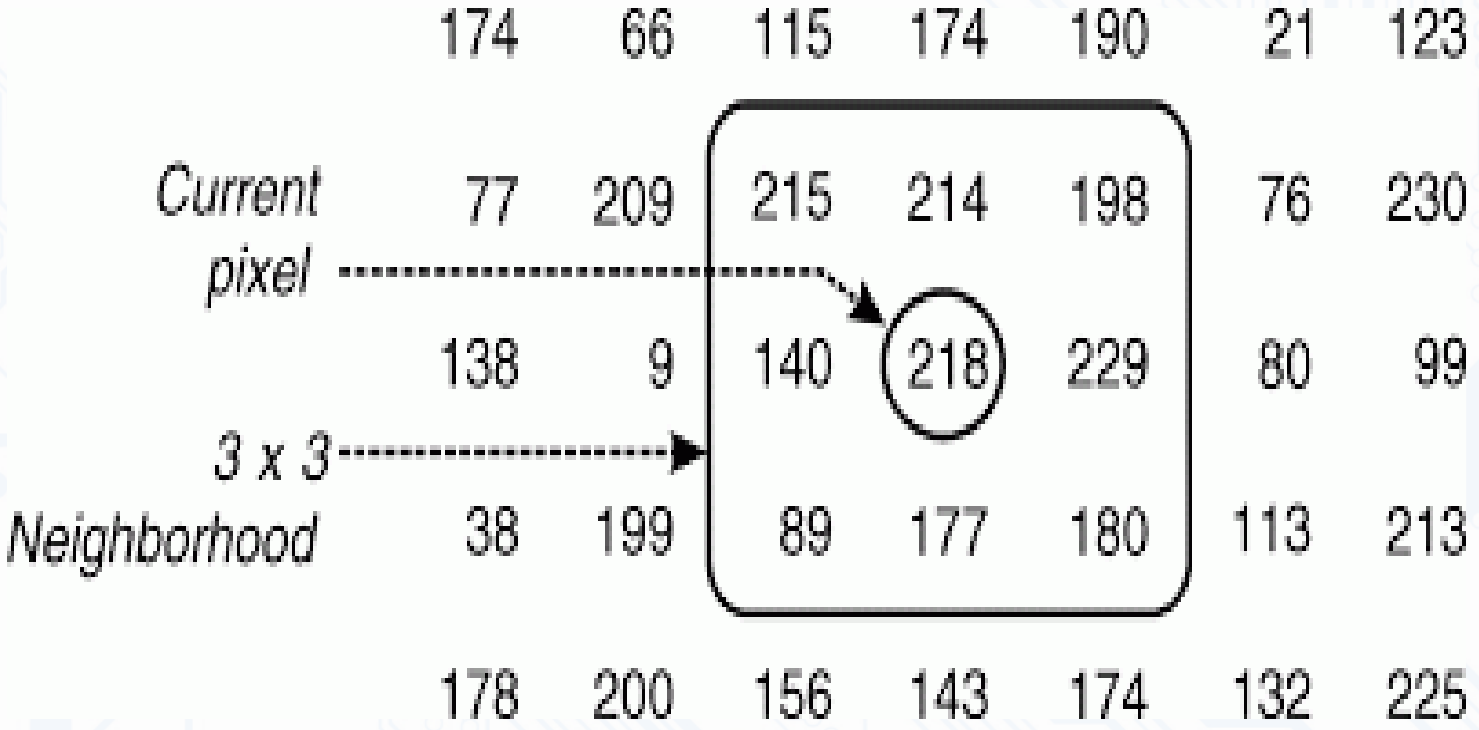
像素p的邻域（从图像拓扑的角度来看）：

(a)4个社区；
(b)对角线社区；
(c)8个社区。

Basic Relationships Between Pixels



像素之间的基本关系


174 66 115 174 190 21 123
Current pixel
77 209 215 214 198 76 230
138 9 140 218 229 80 99
3 x 3 Neighborhood
38 199 89 177 180 113 213
178 200 156 143 174 132 225

Why we need to study Connectivity

- Connectivity between pixels is a fundamental concept that simplifies the definition of numerous digital image concepts, such as regions and boundaries.

为什么我们需要研究联系性

- 像素之间的连接是一个基本概念，它简化了许多数字图像概念的定义，如区域和边界。

Basic Relationships Between Pixels

Adjacency: 邻接 Línjiē

- Two pixel are said to be Adjacent if
  - Both of them are neighbours
  - Have similar properties(eg. Defined range of gray-level values, V)
  - Let V be the set of intensity values

➢ **4-adjacency**:

Two pixels p and q with values from V are 4-adjacent if q is in the set $N_4(p)$.

➢ **8-adjacency:**

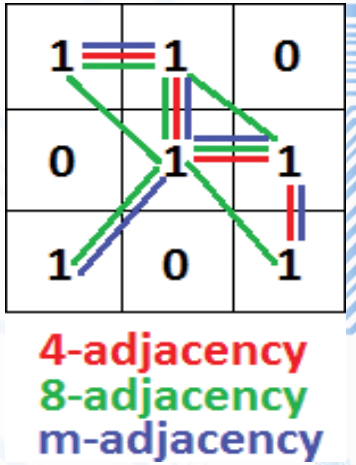
Two pixels p and q with values from V are 8-adjacent if q is in the set $N_8(p)$.

➢ **m-adjacency:**

Two pixels p and q with values from V are m-adjacent if

(i) q is in the set $N_4(p)$, or

(ii) q is in the set $N_D(p)$ and the set $N_4(p) \cap N_4(q)$ has no pixels whose values are from V.



像素之间的基本关系

邻接林杰

如果两个像素是相邻的，则称之为相邻的

- 他们俩都是邻居
- 具有相似的性质(如。定义的灰度值范围，V)

-设V为强度值的集合

- **4邻接：**

  如果q在集合N中，值来自V的两个像素p和q为4-相邻$_4$(p).

- **8邻接：**

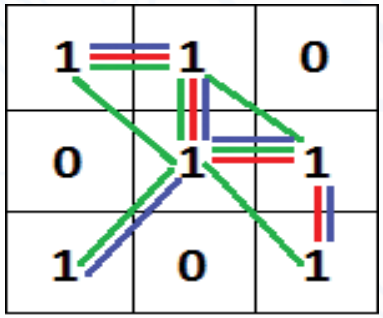
  如果q在集合N中，值来自V的两个像素p和q为8-相邻$_8$(p).

- **m-邻接：**

  两个像素的p和q与m相邻

  (i)q在集合N中$_4$(p)，或

  (ii)q在设定值N中$_D$(p)和设置$N_4(p) \cap N_4(p)$没有一个值来自V的像素。



Example

- For the bellow image check whether the Two pixels p and q are 4 adjacent if v=(1,2)

对于下面的图像，如果v=(1,2)，检查两个像素
p和q是否相邻4

0	1	1(q)
0	2(p)	0
0	0	1

First the values should be in V➔ OK
P=2 and q=1

Second $N_4(p)$.
Q is not then p and q are not

首先，值应该在V OK P=2和q-1

第二个N (p) .
Q不是，那么p和Q不是

8-adjacency:

邻接。

- **8-adjacency:**

Two pixels p and q are **8-adjacency** 两个像素p和q是8邻接的

if 1)Their values lies from V 2) q is in the set $N_8(p)$.

1)它们的值来自v2) q在No(p)集合中。

- For the bellow image check whether the Two pixels p and q are 8-adjacent if v=(1,2)

对于下面的图像，检查两个像素p和q。

如果v=(1,2)

0	1	1(q)
0	2(p)	0
0	0	1

First the values should be in V➔ OK

P=2 and q=1

Second N8(p).

Q is in the set

首先，值应该是V→OK P-2和q=1

第二个N8

Q在集合中

Yes we have **8-adjacency**

是的，我们有8个邻接体

m-adjacency:

➢ **m-adjacency:**

Two pixels p and q are **m-adjacency**

if 1)Their values lies from V 2) one of following condtion

q is in the set $N_4(p)$. OR q is in the set $N_D(p)$. And the set $N_4(p) \cap N_4(q)$ has no pixels whose values are from V.

- For the bellow image check whether the Two pixels p and q are 8-adjacent if v=(1,2)

First the values should be in V➔ OK

P=2 and q=1

Second $N_4(p)$ =NO(**Q is not element of N4(p)**

$N_4(p) \cap N_4(p)$ (common pixel should not be V).

Q is in the set

$N_4(p)$ is 0 0 1 0 $N_4(q)$ is 1 0 The value 1 is in v

0	1	1(q)
0	2(p)	0
0	0	1

NO we don't have **m-adjacency**

m-adjacency

- m-adjacenc

两个像素p和q是m邻接的

如果1)它们的值来自V 2)下列条件之一

q在集合N(p)中。或者说q在集合Nb(p)中。集合N(p) N(q)没有来自V的像

- 对于下面的图像，如果v=(1,2)，检查两个像素p和q是否相

首先值应该在V中

p 2和q1

第二N(p) =NO(Q不是N4(p)的元素)

N(p) O N(p)(普通像素不应为V)。

q在集合中

N4(p) = 00 10 N(q) = 10 1在v中

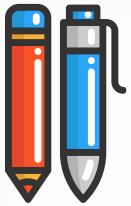
0	1	1(
()	2)	0
0	(p	1

不，我们没有m邻接

Adjacency and Connectivity

邻接和连通性 Línjiē hé liántōng xìng

- Let V: a set of intensity values used to define adjacency and connectivity.
- In a binary image, $V = \{1\}$, if we are referring to adjacency of pixels with value 1.
- In a gray-scale image, the idea is the same, but V typically contains more elements, for example, $V = \{180, 181, 182, \ldots, 200\}$
- If the possible intensity values 0 – 255, V set can be any subset of these 256 values.



邻接和连通性

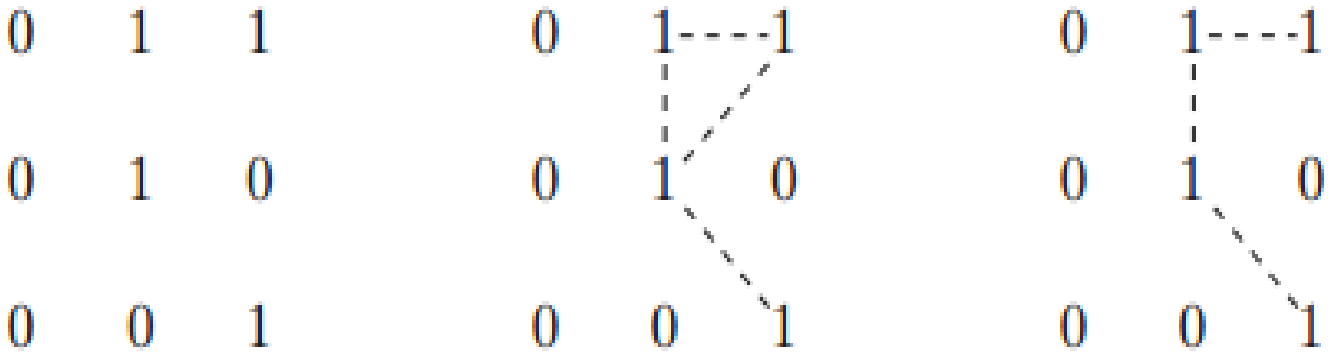
邻接和连通性临洁同兴

- 设V：用于定义邻接性和连通性的一组强度值。
- 在二进制图像中，V={1}，如果我们指的是值为1的像素的邻接。
- 在灰度图像中，这个想法是相同的，但V通常包含更多的元素，例如，V={180、181、182、...，200}
- 如果可能的强度值0-255，V集可以是这256个值的任何子集。

Adjacency 邻接

邻接 Línjiē

邻接林杰



(a) Arrangement of pixels;

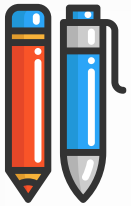
(a) 像素的布置；

(b) pixels that are 8-adjacent (shown dashed) to the center pixel;

(b) 与中心像素相邻8个的像素（如虚线所示）；

(c) m-adjacency.

(c) m邻接。



Notice

边缘 Biānyuán

- The concept of an *edge* is found frequently in discussions dealing with regions and boundaries. There is a key difference between these concepts, however.The boundary of a finite region forms a closed path and is thus a “global” concept.

通知

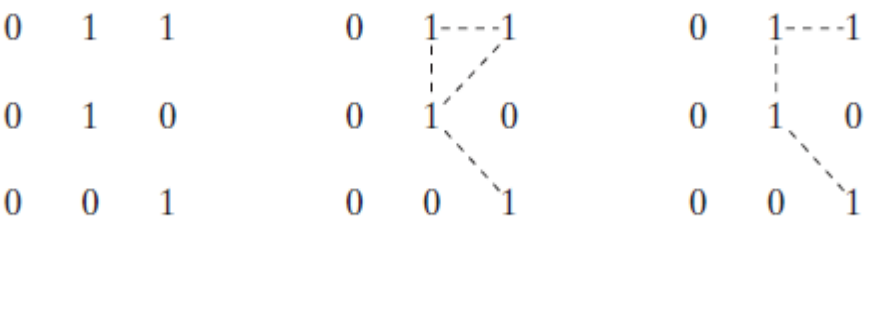
边缘Bianyuan

- 边缘的概念经常在讨论区域和边界时被发现。然而，这些概念之间有一个关键的区别。一个有限区域的边界形成了一条封闭的路径，并且是
因此是一个“全球”概念。

数字路径

数字化路径Shuzihua lujing

- 返回到前面的示例：



a b c

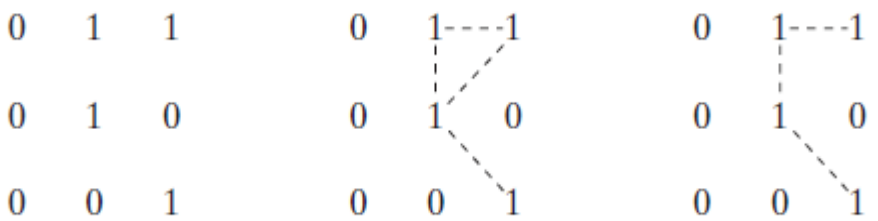
FIGURE 2.26 (a) Arrangement of pixels; (b) pixels that are 8-adjacent (shown dashed) to the center pixel; (c) *m*-adjacency.

在图(b)中，右上角和右下角像素之间的路径是8条路径。并且在图(c)中相同的2个像素之间的路径为m个路径

A Digital Path

数字化路径 Shùzìhuà lùjìng

- Return to the previous example:



a b c

FIGURE 2.26 (a) Arrangement of pixels; (b) pixels that are 8-adjacent (shown dashed) to the center pixel; (c) *m*-adjacency.

In figure (b) the paths between the top right and bottom right pixels are 8-paths. And the path between the same 2 pixels in figure (c) is m-path

像素之间的基本关系

- 路径 小路小鲁

（数字）路径（或曲线）
（蜀）路经（火县）

像素p带坐标（x的（数字）路径（或曲线）$_0$，y_0）到像素Q，以及带有坐标的像素Q（x_n，y_n）是一个具有坐标的不同像素的序列

- 坐标（x0、y0）、（x1、y1）、...，（xn、yn），其中（x0、y0）=（x、y）和（xn、yn）=（s、t），
  - S：图像中像素的一个子集。
  - N是路径的长度

像素（≤）和（≤1、≤1）与1≤相邻。

- 如果（x_0, y_0）=（x_n，y_n），该路径是封闭的路径。

关闭Guanbi

Basic Relationships Between Pixels

- **Path** 小路 Xiǎolù

（数字）路径（或曲线）
(Shùzì) lùjìng (huò qūxiàn)

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

- coordinates (x0,y0), (x1,y1), …, (xn,yn), where (x0,y0)= (x,y) and (xn,yn)=(s,t),
  - *S*: a subset of pixels in an image.
  - n is the length of the path

and pixels (xi,yi) and (xi-1,yi-1) are adjacent for $1 \leq i \leq n$.

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

关闭 Guānbì

数字路径连接

- 我们可以根据指定的邻接类型指定4、8或m个路径。
- 设S表示图像中像素的一个子集，
- 如果两个像素p和q之间存在完全由S中的像素组成的路径，则在S中连接。

连接的Linjiede

- 对于S中的任何像素p，S中连接到它的像素集称为S的连接分量。

- 如果S只有一个连接的组件，则它称为连接集。

连通集Liantong ji

A Digital Path connectivity

- We can specify 4-, 8- or m-paths depending on the type of adjacency specified.
- Let *S* represent a subset of pixels in an image,
- Two pixels *p* and *q* are said to be connected in *S* if there exists a path between them consisting entirely of pixels in *S*.

连接的 Liánjiē de

- For any pixel *p* in *S*, the set of pixels that are connected to it in *S* is called a connected component of *S*.

- If S has only one connected component, it is called a connected set.

连通集 Liántōng jí

边界（或边界）

边界（或边界）

- ✓ 区域R的边界是区域中有一个或多个不属于R的邻居的像素集。
- ✓ 如果R碰巧是一个整个图像，那么它的边界被定义为图像的第一行和最后行和列中的像素集。

地面和背景

- ✓ 一幅图像包含K个不相交区域，Rk、k=1、2、...，K。设Ru表示所有K个区域的并集，设(Ru)c表示它的补体。
  - ✓ R中的所有点$_u$**被称为前景；**
  - ✓ (R中的所有点$_u$)^c**称为背景。**

Boundary (or border)

Boundary (or border)

- ✓ The ***boundary*** of the region R is the set of pixels in the region that have one or more neighbors that are not in R.
- ✓ If R happens to be an entire image, then its boundary is defined as the set of pixels in the first and last rows and columns of the image.

Foreground and background

- ✓ An image contains K disjoint regions, Rk, k = 1, 2, …, K. Let Ru denote the union of all the K regions, and let (Ru)c denote its complement.
  - ✓ All the points in R_u is called **foreground**;
  - ✓ All the points in $(R_u)^c$ is called **background**.

区域和边界

区域和边界奎街

- **区域**

R：图像中像素的一个子集。

如果R是连接集，R是图像的区域。

- **边界**

区域R的边界是区域中有一个或多个不在R中的邻居的区域中的像素集。

Region and Boundary

区域和边界 Qūyù hé biānjiè

- **Region**

  R: a subset of pixels in an image.

  R is a region of the image if R is a connected set.

- **Boundary**

  The boundary of a region R is the set of pixels in the region that have one or more neighbors that are not in R.

区域和边界

区域和边界奎街

如果R碰巧是一个整个图像，那么它的边界被定义为图像中第一行和最后行和列中的像素集。

这种额外的定义是必需的，因为一个图像没有其边界之外的邻居

通常，当我们提到一个区域时，我们指的是一个图像的子集，并且区域边界中恰好与图像边界重合的任何像素都被隐式地作为区域边界的一部分包含在内。

Region and Boundary

区域和边界 Qūyù hé biānjiè

If *R* happens to be an entire image, then its boundary is defined as the set of pixels in the first and last rows and columns in the image.

This extra definition is required because an image has no neighbors beyond its borders

Normally, when we refer to a region, we are referring to subset of an image, and any pixels in the boundary of the region that happen to coincide with the border of the image are included implicitly as part of the region boundary.

成像几何

- 图像几何校正（通常称为图像缩变）是对图像数据进行数字操作的过程，使图像的投影精确地匹配特定的投影表面或形状。
- 图像几何校正通过对数字领域中的图像应用预补偿的逆失真，平衡由离轴投影仪或屏幕管理或不对称屏幕表面形成的变形。

Imaging Geometry

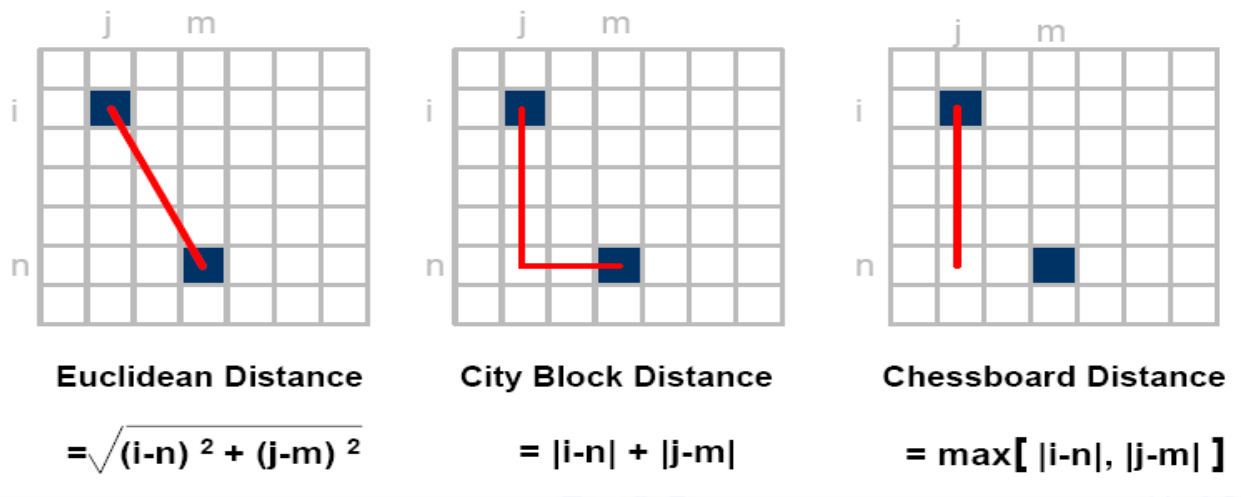
- **Image Geometry Correction** (frequently referred to as Image Warping) is the procedure of digitally manipulating image data such that the image's projection accurately matches a specific projection surface or shape.
- Image geometry correction balances the deformation formed by off-axis projector or screen management or asymmetrical screen surface, by apply a pre-compensating inverse distortion to that image in the digital domain.

距离测量

Dm距离：

定义为两个点之间最短的m路径。

- 在这种情况下，两个像素之间的距离将取决于路径上的像素的值，以及它们的相邻像素的值。

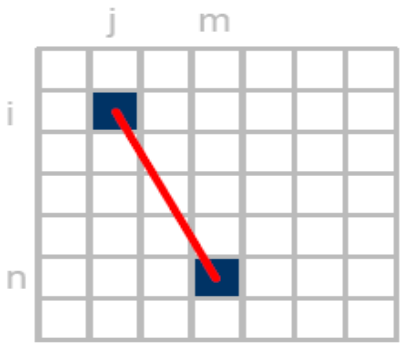


Distance Measures

Dm distance:

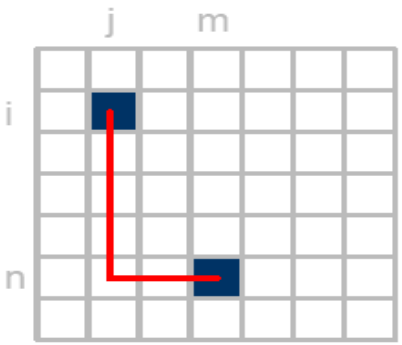
is defined as the shortest m-path between the points.

- In this case, the distance between two pixels will depend on the values of the pixels along the path, as well as the values of their neighbors.



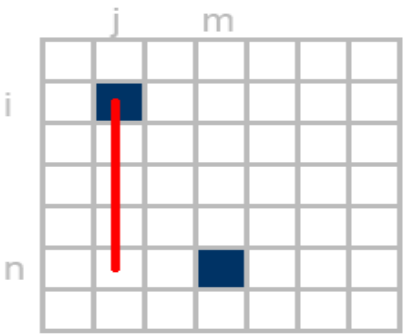
Euclidean Distance

$= \sqrt{(i-n)^2 + (j-m)^2}$



City Block Distance

$= |i-n| + |j-m|$



Chessboard Distance

$= \max[\,|i-n|, |j-m|\,]$

Distance Measures 距离测量

For pixels p, q and z, with coordinates (x,y), (s,t) and (v,w), respectively, D is a distance function if:

(a) $D(p,q) \geq 0$ ($D(p,q) = 0$ if f $p = q$),

(b) $D(p,q) = D(q, p)$, and

(c) $D(p,z) \leq D(p,q) + D(q,z)$.

对于像素p、x和z，分别坐标为 (x,y), (s,t) , 和(v,w)，D为距离函数：

(a)D(p，q)≥0(D(p，q)=0ifp=q)，

(b)D（p、q）=D（q、p）和

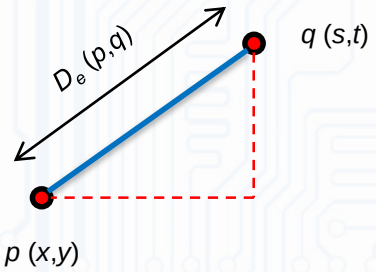
(c) D (p, z) ≤ D (p, q) + D (q, z).

Distance Measures

The following are the different Distance measures:

a. Euclidean Distance : 欧几里得距离

$D_e(p, q) = [(x-s)^2 + (y-t)^2]^{1/2}$

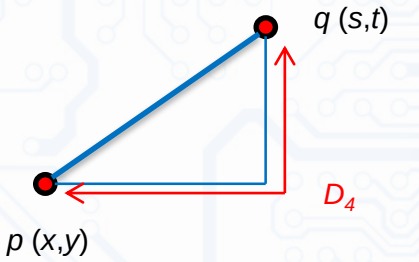


城市街区距离

b. City Block Distance:

$D_4(p, q) = |x-s| + |y-t|$

		2		
	2	1	2	
2	1	0	1	2
	2	1	2	
		2		

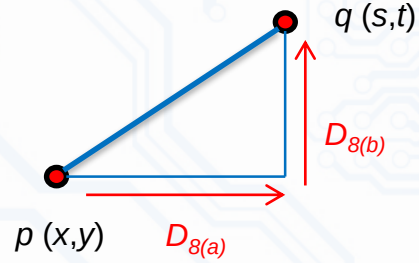


棋盘距离

c. Chess Board Distance:

$D_8(p, q) = \max(|x-s|, |y-t|)$

2	2	2	2	2
2	1	1	1	2
2	1	0	1	2
2	1	1	1	2
2	2	2	2	2



$D_8 = \max(D_{8(a)}, D_{8(b)})$

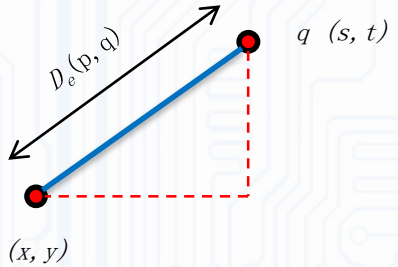
距离测量

以下是不同的距离测量值：

a. 欧几里得距离：

欧几里得距离

$D_e(p, q) = [(x-s)^2 + (y-t)^2]^{1/2}$

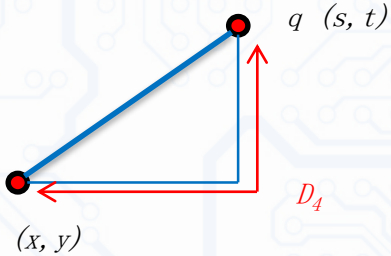


b. 城市街区距离：

城市街区距离

$D_4(p, q) = |x-s| + |y-t|$

		2		
	2	1	2	
2	1	0	1	2
	2	1	2	
		2		

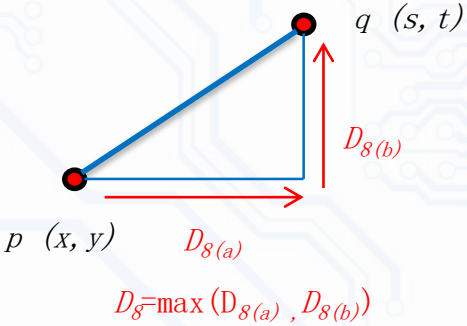


c. 国际象棋板距离：

棋盘距离

$D_8(p, q) = \max(|x-s|, |y-t|)$

2	2	2	2	2
2	1	1	1	2
2	1	0	1	2
2	1	1	1	2
2	2	2	2	2

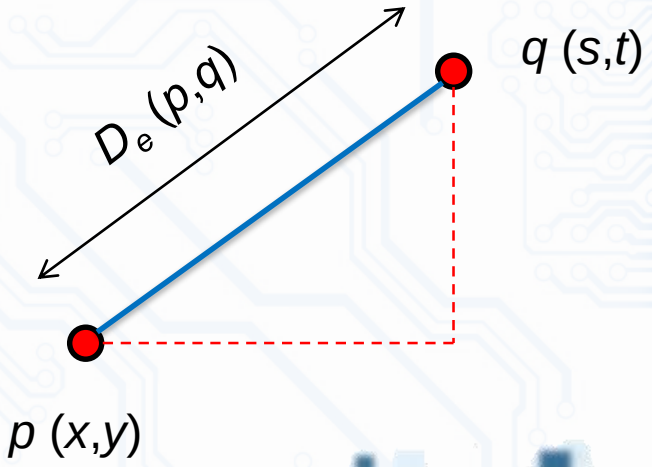


Distance Measures
Euclidean Distance

The *Euclidean Distance* between p and q is defined as:

$$D_e(p,q) = [(x - s)^2 + (y - t)^2]^{1/2}$$

Pixels having a distance less than or equal to some value r from (x,y) are the points contained in a disk of radius r centered at (x,y)

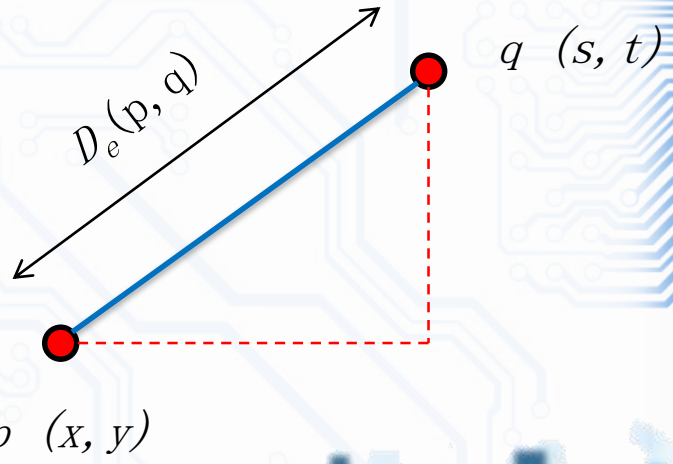


距离测量
欧氏距离

p和q之间的欧氏距离定义为：

$$D_e(p,q) = [(x - s)^2 + (y - t)^2]^{1/2}$$

距离小于或等于的像素
(xy)的某个值r是点
包含在半径为（x、y）为中心的圆盘中

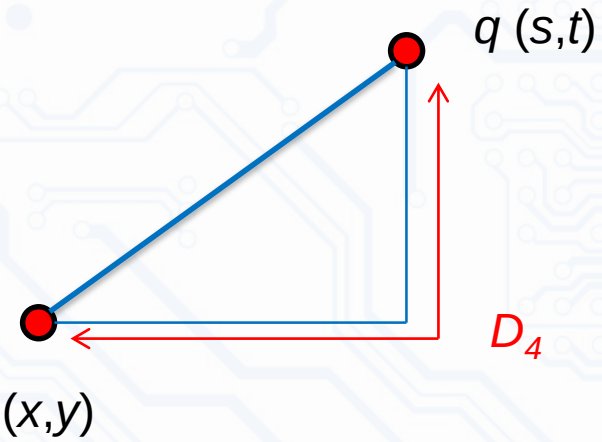


Distance Measures
City Block Distance:

The D_4 *distance* (also called *city-block distance*) between p and q is defined as:

$$D_4(p,q) = |x - s| + |y - t|$$

Pixels having a D4 distance from (x,y), less than or equal to some value r form a Diamond centered at (x,y)

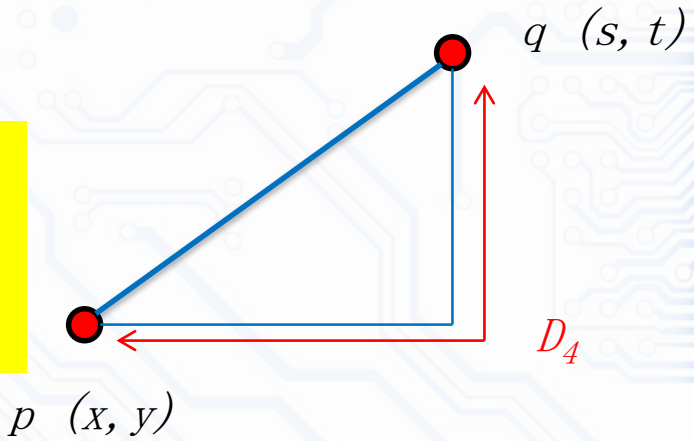


距离测量
城市街区距离：

D_4p和q之间的距离（也称为城市街区距离）定义为：

$$D_4(p,q) = |x - s| + |y - t|$$

距离（x、y）小于或等于某个值r的像素形成以（x、y）为中心的金刚石



Distance Measures

欧几里得距离

Example:

The pixels with distance $D_4 \leq 2$ from (x,y) form the following contours of constant distance.

The pixels with $D_4 = 1$ are the 4-neighbors of (x,y)

		2		
	2	1	2	
2	1	0	1	2
	2	1	2	
		2		

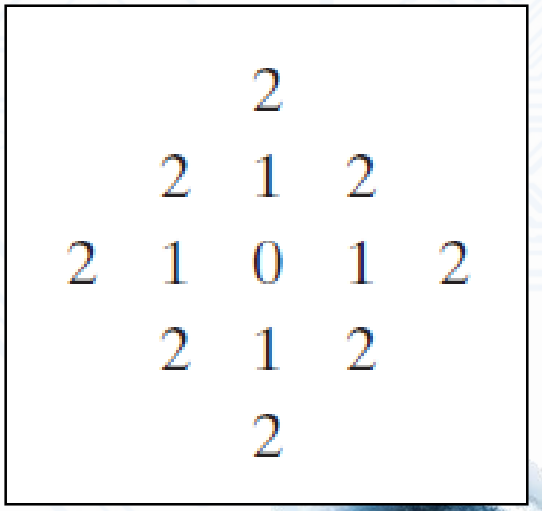
距离测量

欧几里得距离

示例：

距离为D的像素$_4$来自(x，y)的≤2形成了以下恒定距离的轮廓。

带D的像素$_4$=1是（x、y）的4个邻居



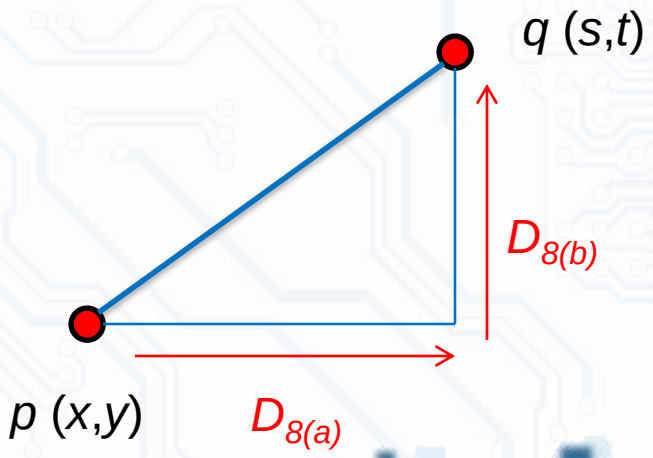
Distance Measures

Chess Board Distance 城市街区距离

- The D_8 *distance* (also called *chessboard distance*) between p and q is defined as:

$$D_8(p,q) = \max(|x-s|, |y-t|)$$

Pixels having a D_8 distance from (x,y), less than or equal to some value r form a square Centered at (x,y)



$$D_8 = \max(D_{8(a)}, D_{8(b)})$$

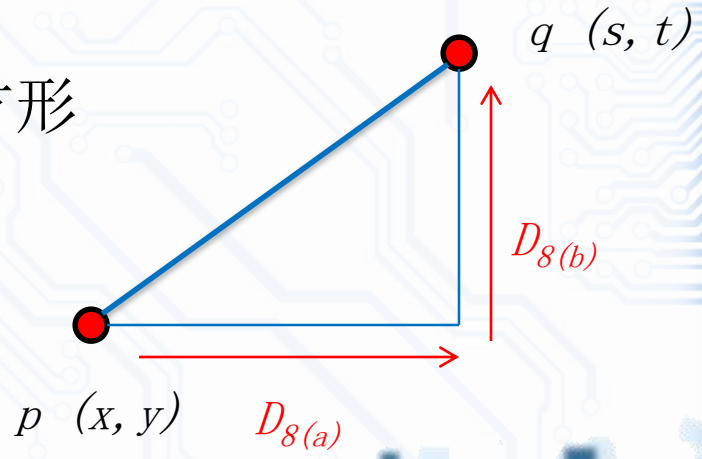
距离测量
国际象棋板距离

城市街区距离

- D_8p和q之间的距离（也称为棋盘距离）定义为：

$D_8(p, q)=\max(|x-s|, |y-t|)$

带有D的像素$_8$距离
（x、y），小于或等于一些
值r形成一个以（x、y）为中心的正方形



$D_8=\max(D_{8(a)}, D_{8(b)})$

Distance Measures 城市街区距离

Example:

D_8 distance ≤ 2 from (x,y) form the following contours of constant distance.

2	2	2	2	2
2	1	1	1	2
2	1	0	1	2
2	1	1	1	2
2	2	2	2	2

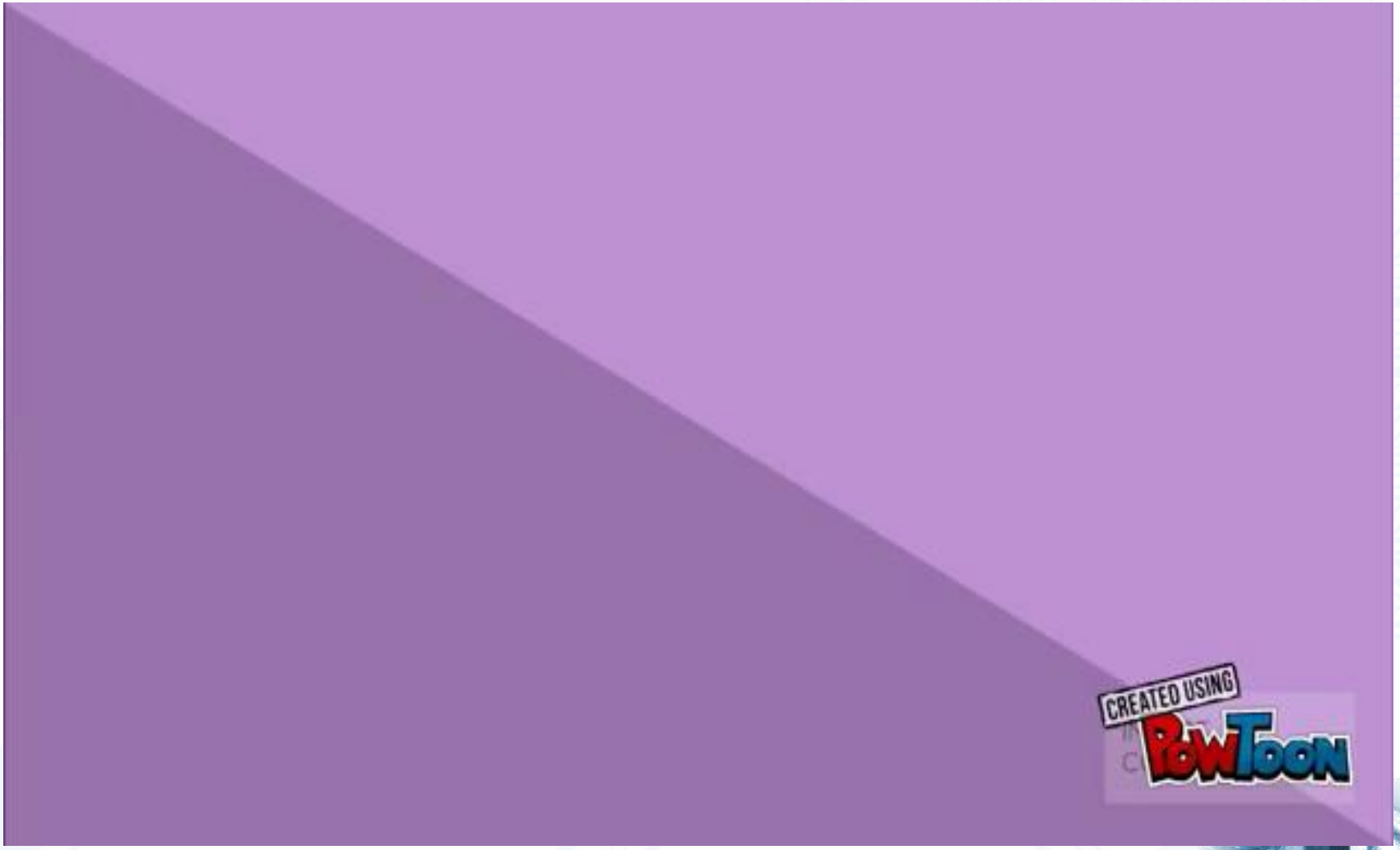
距离测量

城市街区距离

示例：

D_8距离≤2与(x、y)的距离形成以下恒定距离的轮廓。

2	2	2	2	2
2	1	1	1	2
2	1	0	1	2
2	1	1	1	2
2	2	2	2	2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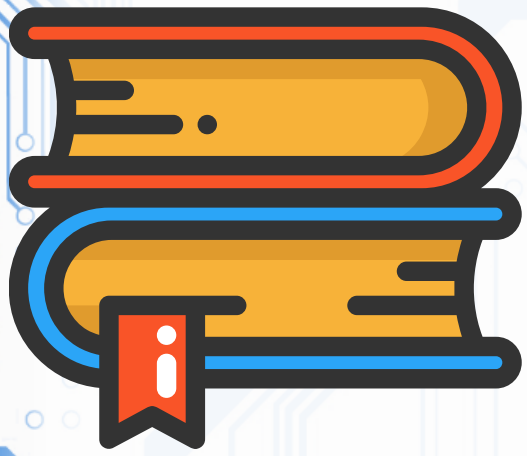
江西理工大學信息工程学院
JIANGXI UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF INFORMATION ENGINEERING



Digital Image Processing

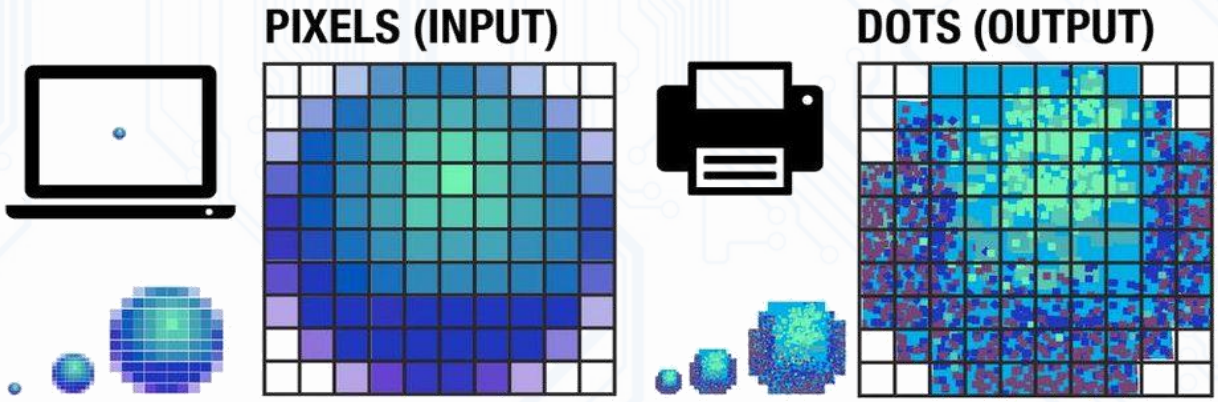
Lecture6: PPI vs DPI

第六节：PPIvsDPI

PPI vs DPI

PPI与DPI

- PPI and DPI are two important terms that anyone who works with images should know. Both define the resolution, or clarity, of an image but each refers to separate media—that is, **digital versus print**. 数字与印刷
- PPI and DPI are often used interchangeably when they shouldn't be.
- As an application Understanding how they are different and how to apply each in your projects will empower you to produce a quality print, to optimize digital images for web and ultimately to save yourself valuable time.

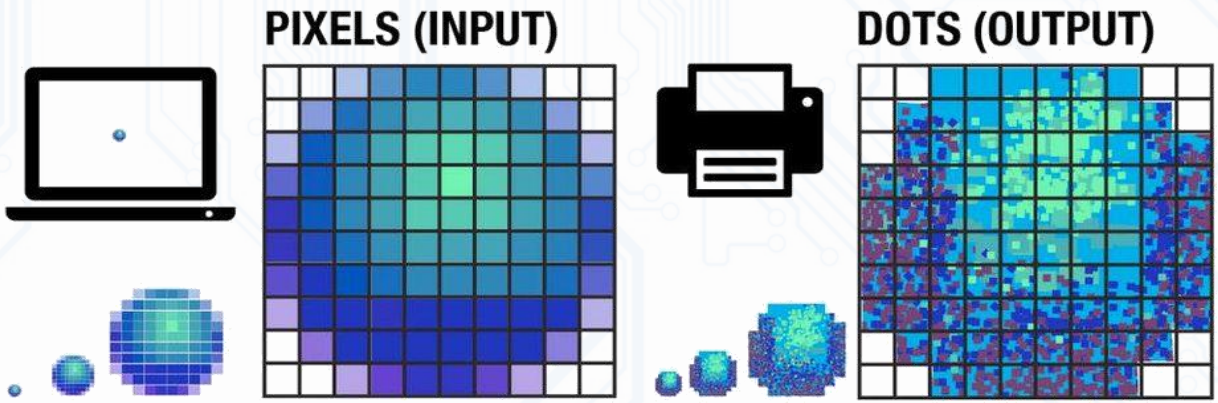


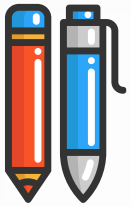
PPI与DPI

- PPI和DPI是任何使用图像的人都应该知道的两个重要术语。两者都定义了图像的分辨率或清晰度，但每个图像都指的是单独的媒体——即数字和打印。

数字与印刷

- PPI和DPI通常在不应该同时使用的情况下互换使用。
- 作为一个应用程序，了解它们是如何不同的，以及如何在您的项目中应用它们，将使您能够产生高质量的打印，优化网络的数字图像，并最终节省自己宝贵的时间。





What PPI means

PPI是什么意思

- **PPI, or pixels per inch**, refers both to the fixed number of pixels that a screen can display and the density of pixels within a digital image.
- **Pixel count** on the other hand refers to the number of pixels across the length and width of a digital image—that is, the image dimensions in pixels.
- **Pixels**, or “picture elements”, are the smallest building blocks of a digital image Zoom in to any image on your and you will see it break up into colored squares—these are pixels.

PPI是什么意思

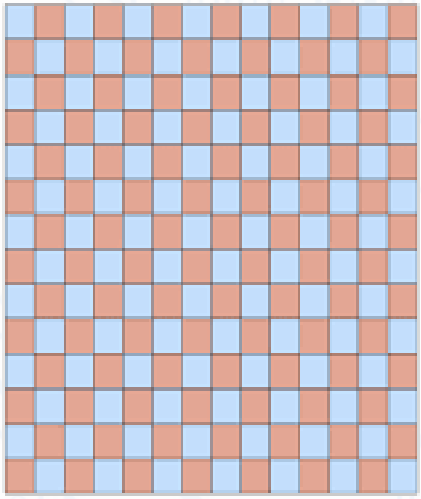
ppi是什么意思

- PPI，或每英寸的像素，是指屏幕可以显示的固定像素数量和数字图像中的像素密度。
- 另一方面，像素计数是指在数字图像的长度和宽度上的像素数，即以像素为单位的图像尺寸。
- 像素，或“图片元素”，是数字图像的最小构建块，放大到你身上的任何图像，你会看到它分解成彩色方块——这些都是像素。

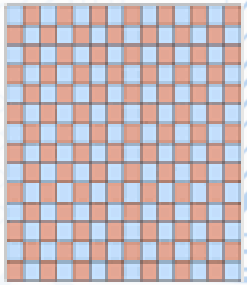
What DPI means

DPI 是什么意思

DPI, or dots per inch, refers to the resolution value of a physical printer. Printers reproduce an image by spitting out tiny dots, and the number of dots per inch affects the amount of detail and overall quality of the print.



72 dpi

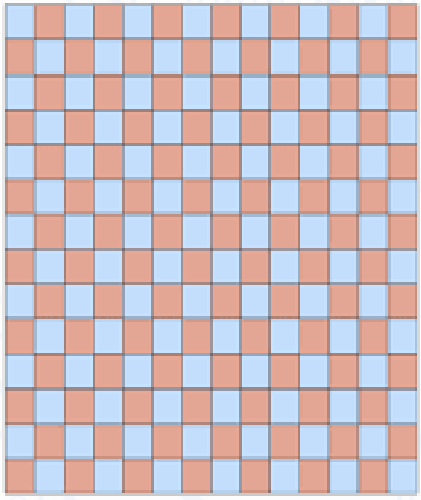


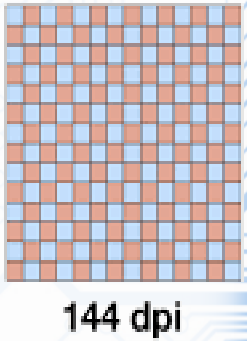
144 dpi

DPI是什么意思

DPI是什么意思

DPI，或每英寸的点，是指物理打印机的分辨率值。打印机通过吐出小点来复制图像，每英寸的点的数量会影响细节和打印的数量和整体质量。





PPI vs DPI

PPI（每英寸像素数）

- **PPI(Pixels Per Inch):**That's how many points of light live on an inch of screen. This is the number of pixels per inch in your image. This will affect the print size of your photo and will affect the quality of the output.While PPI can help you determine the quality of an image, it really has little else to do with actual printing.

DPI（每英寸点数）

- **DPI (Dots Per Inch):**That's how many droplets of liquid squeeze into an inch of your printed paper.DPI is a measure of how many tiny, tiny droplets of ink a printer is laying down in its dither pattern to form one inch of a print. DPI only refers to the printer. Every pixel output is made up of different coloured inks (usually 4-6 colours, although many printers use more now). Because of the small number of colours, the printer needs to be able to mix these inks to make up all the colours of the image. So each pixel of the image is created by a series of tiny dots (you could think of them as sub-pixels).

PPI与DPI

ppi（每英寸像素数）

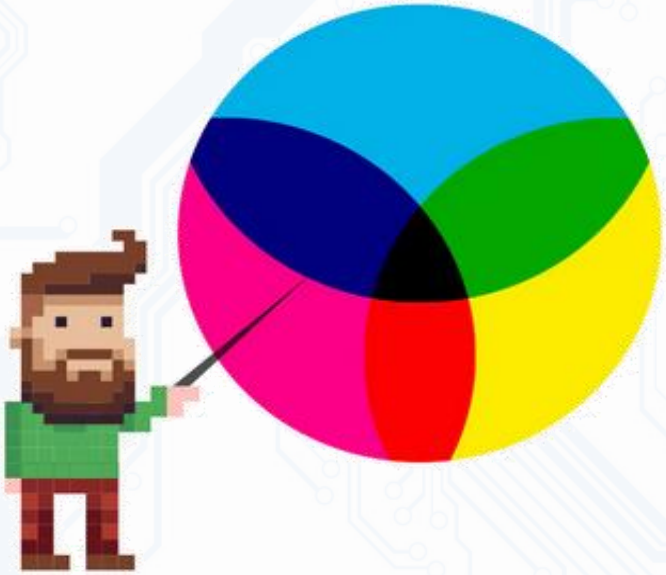
- PPI（每英寸像素）：这就是一英寸屏幕上存在的多少光点。这是您的图像中每英寸的像素数。这将影响您的照片的打印大小，并将影响输出的质量。虽然PPI可以帮助你确定图像的质量，但它与实际打印几乎没有其他关系。

- dpi（每英寸点数）就是多少液滴挤压到打印纸的数量。DPI是指打印机以不同的形式形成多少小滴墨水，形成一英寸的打印。DPI仅指打印机。每个像素输出都由不同颜色的墨水组成（通常是4-6种颜色，尽管现在许多打印机使用更多）。由于颜色的数量较少，打印机需要能够混合这些油墨来构成图像的所有颜色。所以图像的每个像素都是由一系列小点创建的（你可以把它们是子像素）。

PPI vs DPI

PPI 与 DPI

Printer dots mix CMYK inks



Dots

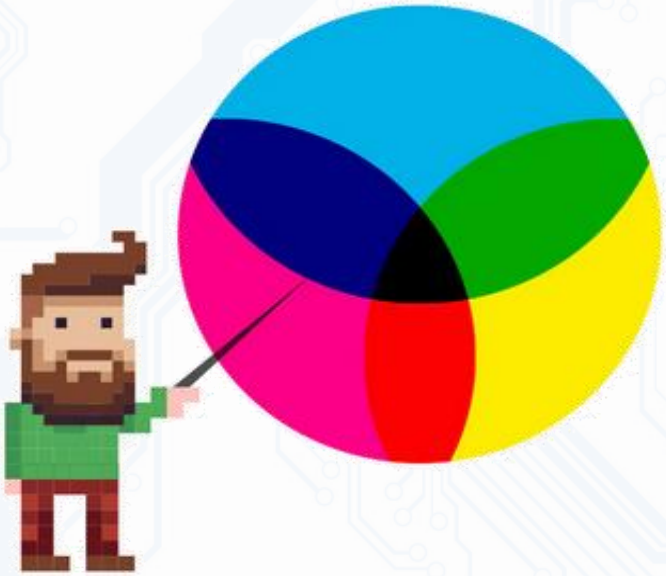
DPI describes the amount of detail in an image based on the concentration of printer dots

DPI

PPI与DPI

PPI与dpi

打印机圆点混合CMYK油墨



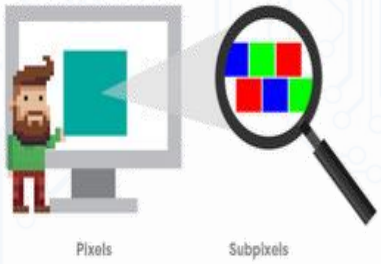
DPI根据打印机点的浓度来描述图像中的详细数量

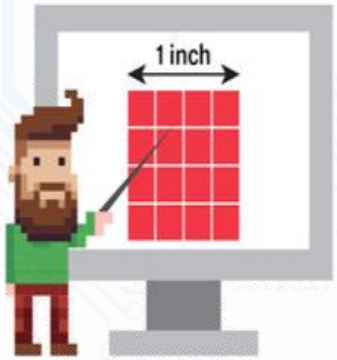
What is the difference between PPI and DPI?

PPI 和 DPI 有什么区别?

- PPI describes the resolution in pixels of a digital image whereas DPI describes the amount of ink dots on a printed image.

- Though PPI largely refers to screen display, it also affects the print size of your design and thus the quality of the output. DPI, on the other hand, has nothing to do with anything digital and primarily concerns print.





Pixel count

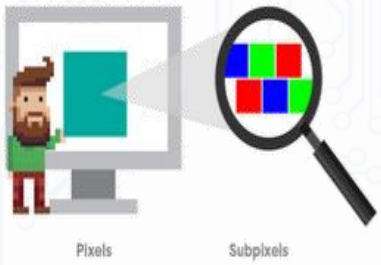
PPI

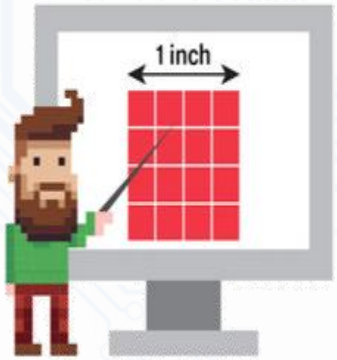
PPI和DPI有什么区别？

PPI和dpi有什么区别？

- PPI描述数字图像的像素分辨率，而DPI描述打印图像上的墨点的数量。

- 虽然PPI主要指的是屏幕显示，但它也会影响您设计的打印大小，从而影响输出的质量。另一方面，DPI与任何数字产品都无关，主要与印刷产品有关。





Pixel count


PPI

PPI……..

- Within pixels are sub-pixels, red, green and blue light elements that the human eye cannot see because additive color processing blends them into a single hue which appears on the pixel level.

PPI 使用 RGB（红、绿、蓝）颜色模型

- This is why **PPI utilizes the RGB (red, green and blue) color model**, also known as the additive color model.
- This does not exist in print—only in the electronic display of images, like television screens, computer monitors and digital photography.

ppi.....

- 在像素内是亚像素，红色、绿色和蓝色的光元素，人眼看不到，因为附加的颜色处理将它们混合成一个出现在像素水平上的单一色调。

- **这就是为什么PPI使用rgb（红、绿、蓝）颜色模型模型，也被称为加性颜色模型。**
- 这并不存在于印刷品中——只存在于图像的电子显示中，如电视屏幕、计算机显示器和数码摄影。

When do you use PPI?

- Use PPI whenever you are working with digital images.
- PPI is most useful in preparing files for printing (though DPI will be used by the physical printer—see more in the DPI section below).
- An image with a higher PPI tends to be higher quality because it has a greater pixel density, but exporting at **300 PPI is generally considered industry standard quality.**

Lower PPI

A lower PPI resolution results in less detail and a pixelated image

Higher PPI

A higher PPI resolution results in more detail and a sharper image

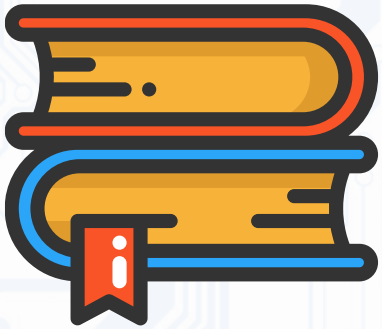
你什么时候使用PPI？

- 每当您使用数字图像时，请使用PPI。
- PPI在准备打印文件时最有用(尽管DPI将被物理打印机使用——请参阅下面DPI的更多部分)。
- PPI较高的图像往往质量较高，因为它的像素密度更大，但以300PPI输出通常被认为是行业标准质量。

较低的PPI分辨率会导致更少的细节和像素化的图像

更高的PPI分辨率会导致更详细和更清晰的图像

江西理工大學 信息工程学院
JIANGXI UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF INFORMATION ENGINEERING



Digital Image Processing

LECTURE 06B: Digital image fundamentals _C

Example

数字图像基本原理_C

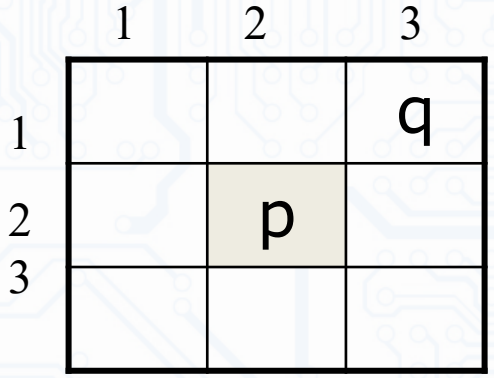
样例

Example

Q1. Compute the distance between the two pixels using the three distances :

q:(1,1)

P: (2,2)



Euclidian distance : $((1-2)^2+(1-2)^2)^{1/2}$ = sqrt(2).

D4(City Block distance): |1-2| +|1-2| =2

D8(chessboard distance) : max(|1-2|,|1-2|)= 1

(because it is one of the 8-neighbors)

Examples: Adjacency and Path

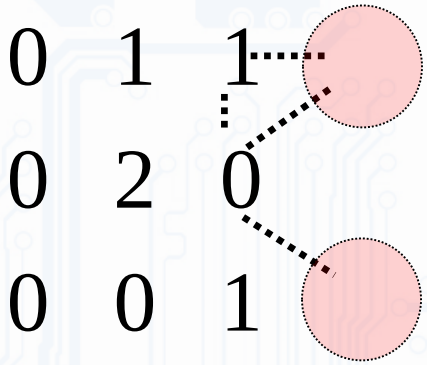
示例：邻接和路径

V = {1, 2}

$0_{1,1}$ $1_{1,2}$ $1_{1,3}$

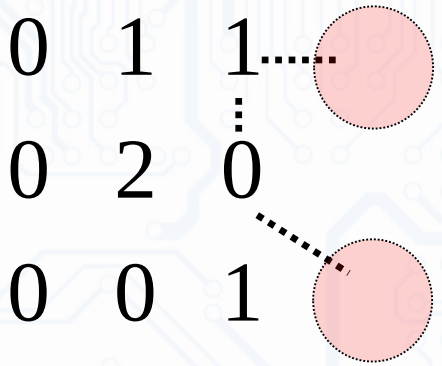
$0_{2,1}$ $2_{2,2}$ $0_{2,3}$

$0_{3,1}$ $0_{3,2}$ $1_{3,3}$



8-adjacent

8相邻



m-adjacent

相邻m

The 8-path from (1,3) to (3,3):
(i) (1,3), (1,2), (2,2), (3,3)
(ii) (1,3), (2,2), (3,3)

The m-path from (1,3) to (3,3):
(1,3), (1,2), (2,2), (3,3)

Basic Relationships Between Pixels

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

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

Where $\forall i, 0 \le i \le n, (x_i, y_i) \in S$

像素之间的基本关系

连接在S

设S表示图像中像素的一个子集。带有坐标的两个像素p_0，y_0）和q与坐标（x_n，y_n），如果存在一条路径，则称为在S中被连接

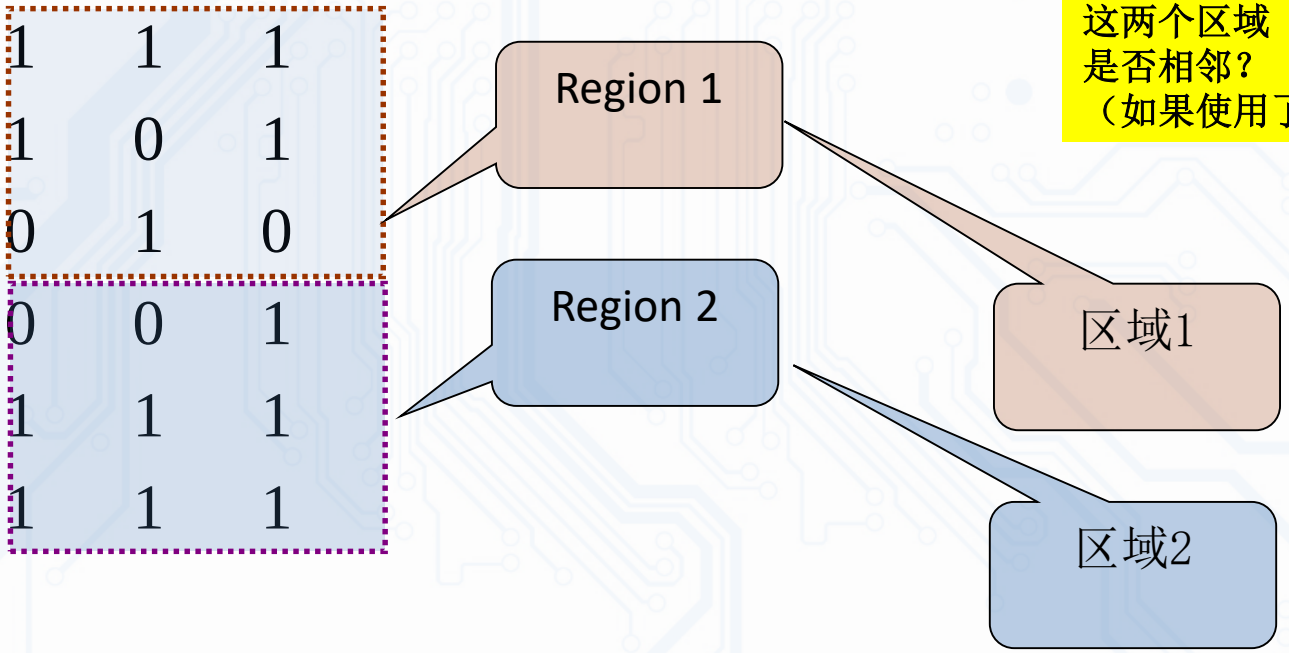
(x_0, y_0)，(x_1, y_1)，…，(x_n, y_n)

在哪里 $\forall i, 0 \le i \le n, (x_i, y_i) \in S$

Question 1
问题1

- **In the following arrangement of pixels, are the two regions (of 1s) adjacent? (if 8-adjacency is used)**

在以下像素排列中，
这两个区域（每隔1秒）
是否相邻？
（如果使用了8个邻接字）



Question 2
问题2

In the following arrangement of pixels, are the two parts (of 1s) adjacent? (if 4-adjacency is used)

在以下像素排列中，两个部分（1s）是否相邻？（如果使用了4个邻接字）

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

Part 1

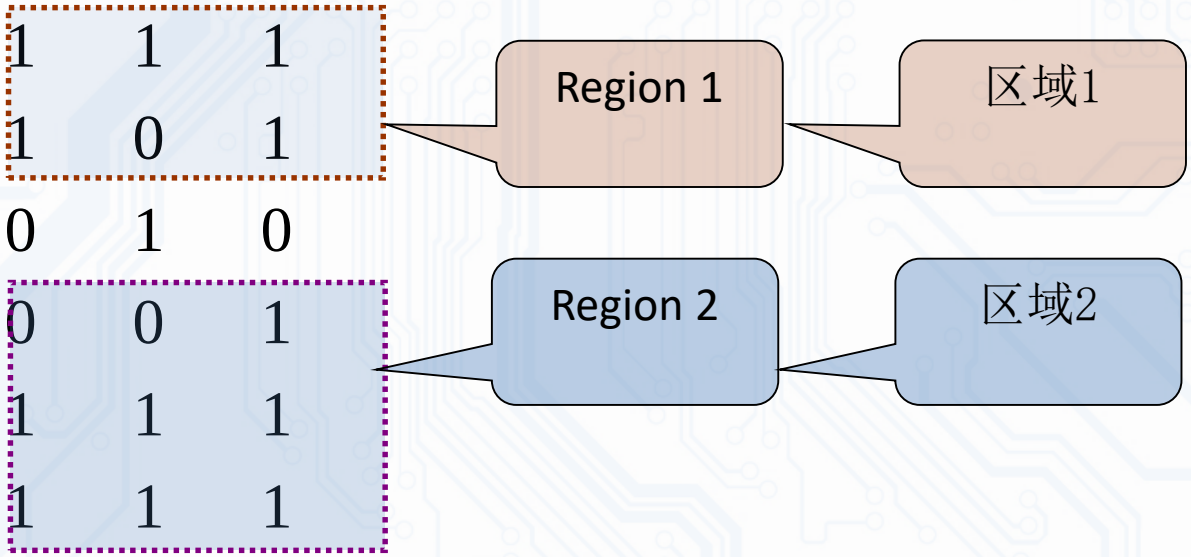
第1部分

Part 2

第二部分

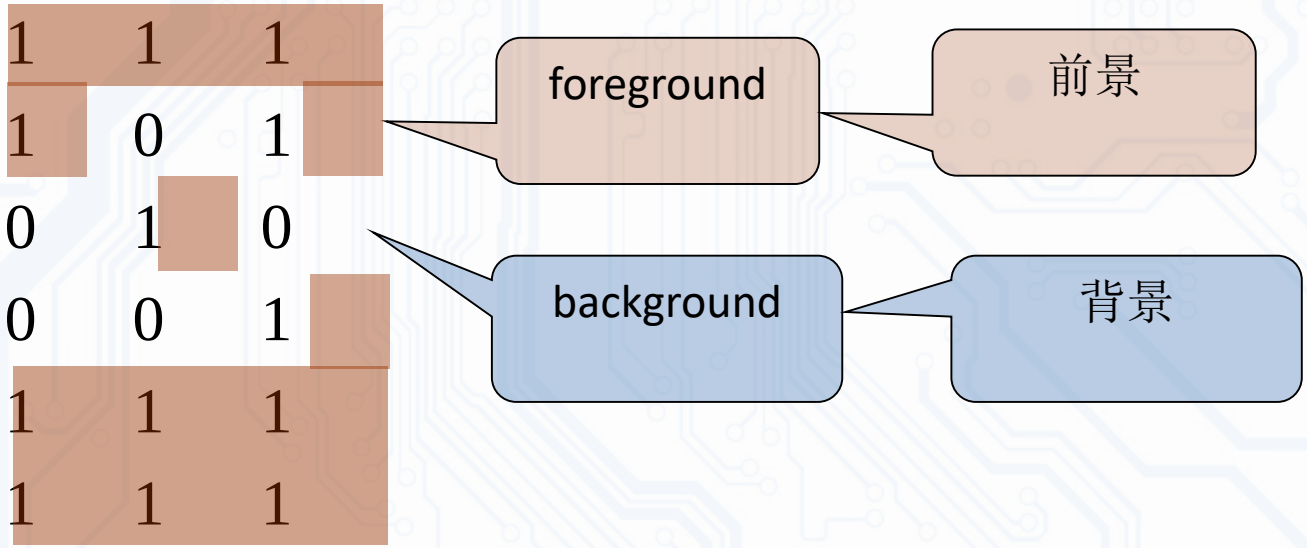
- **In the following arrangement of pixels, the two regions (of 1s) are disjoint (if 4-adjacency is used)**

在以下像素排列中，这两个区域（单位为1s）是不相交的（如果使用4-邻接）



- **In the following arrangement of pixels, the two regions (of 1s) are disjoint (if 4-adjacency is used)**

在以下像素排列中，这两个区域（单位为1s）是不相交的（如果使用4-邻接）



Question 3 问题3

In the following arrangement of pixels, the circled point is part of the boundary of the 1-valued pixels if 8-adjacency is used, true or false?

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

在下面的像素排列中，如果使用8邻接，圈出的点是1值像素的边界的一部分，是真还是假？

Solve and send

解决并发送
Jiějué bìng fāsòng

Question 4　问题4

- **In the following arrangement of pixels, the circled point is part of the boundary of the 1-valued pixels if 4-adjacency is used, true or false?**

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

在下面的像素排列中，如果使用4邻接，圈出的点是1值像素边界的一部分，是真还是假？

Solve and send

Question 5　　问题5

- **In the following arrangement of pixels, what's the value of the chessboard distance between the circled two points?**

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

在下面的像素排列中，圈出的两点之间的棋盘距离的值是多少？

Solve and send

解决并发送
Jiějué bìng fāsòng

Question 6 问题6

- **In the following arrangement of pixels, what's the value of the city-block distance between the circled two points?**

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

在下面的像素排列中，圈出的两点之间的城市街区距离的值是多少？

Solve and send

解决并发送
Jiějué bìng fāsòng

Question 7

- **In the following arrangement of pixels, what's the value of the length of the m-path between the circled two points?**

在下面的像素排列中，圈出的两点之间的m个路径长度的值是多少？

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

Solve and send

解决并发送
Jiějué bìng fāsòng

Example :Distance Measures

示例：距离测量

Review and solve

- Example:

Consider the following arrangement of pixels and assume that p, p_2, and p_4 have value 1 and that p_1 and p_3 can have can have a value of 0 or 1

Suppose that we consider

the adjacency of pixels

values 1 (i.e. $V = \{1\}$)

回顾与解决
Huígù yǔ jiějué

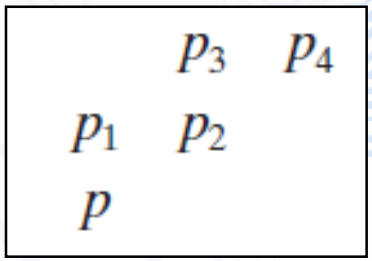
- 示例：

考虑下面的像素排列，并假设p，p_2，和p_4有值1和那个p_1和p_3可以有的值可以是0或1吗

假设我们考虑

像素的邻接性

值1（即V={1}）



Example :Distance Measures

示例：距离测量

Review and solve

- Cont. Example:

Now, to compute the D_m between points p and p_4

Here we have 4 cases:

Case1: If p_1 =0 and p_3 = 0

The length of the shortest m-path (the D_m *distance) is 2* (p, p_2, p_4)

回顾与解决

Huígù yǔ jiějué

- 控制。示例：

现在，要计算D_m在p点和p点之间4

这里我们有4个案例：

案例1：如果p_1=0和p_3= 0

最短的m路径的长度

（D_m距离）为2（p、p_2、p_4）

	0	1
0	1	
1		

Example :Distance Measures
示例：距离测量

- Cont. Example:

Review and solve

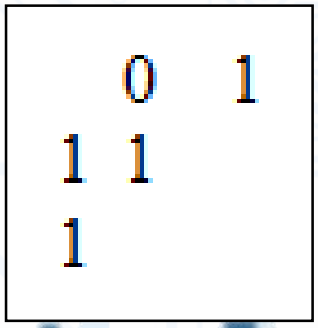
Case2: If p_1 =1 and p_3 = 0

now, p_1 *and p will no longer be adjacent (see m-adjacency definition)*

then, the length of the shortest path will be 3 (p, p_1, p_2, p_4)

回顾与解决
Huígù yǔ jiějué

- 控制。示例：
- 案例2：如果p1=1和p3= 0
- 现在，p1和p将不再相邻（请参见m-邻接定义）
- 然后，最短路径的长度将为3(p，p1，p2，p4)



Example :Distance Measures
示例：距离测量

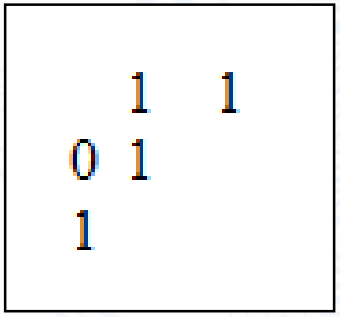
- Cont. Example:

Review and solve

Case3: If p_1 =0 and p_3 = 1

The same applies here, and the shortest –m-path will be 3 (p, p_2, p_3, p_4)

回顾与解决
Huígù yǔ jiějué



- 控制。示例：
- 案例3：如果p1=0和p3= 1
- 同样也适用于这里，最短的m路径是3，p2，p3，p4）

Example :Distance Measures
示例：距离测量

- Cont. Example:

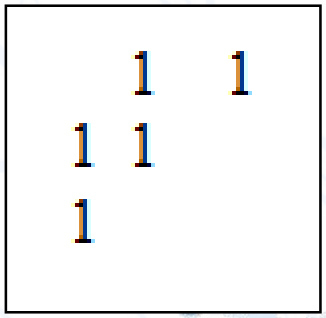
Review and solve

Case4: If p_1 =1 and p_3 = 1

The length of the shortest m-path will be 4 (p, p_1 , p_2, p_3, p_4)

回顾与解决
Huígù yǔ jiějué

- 控制。示例：
- 案例4：如果p1=1和p3= 1
- 最短的m路径的长度将为41， p2， p3， p4)



Student Task_3: DIP

- 请帮我翻译部分的朋友鼓掌
- Qǐng bāng wǒ fānyì bùfèn de péngyǒu gǔzhǎng

Solve the Question shared in mooc

解决mooc分享的问题

Send for Next lecture

发送下一个讲座

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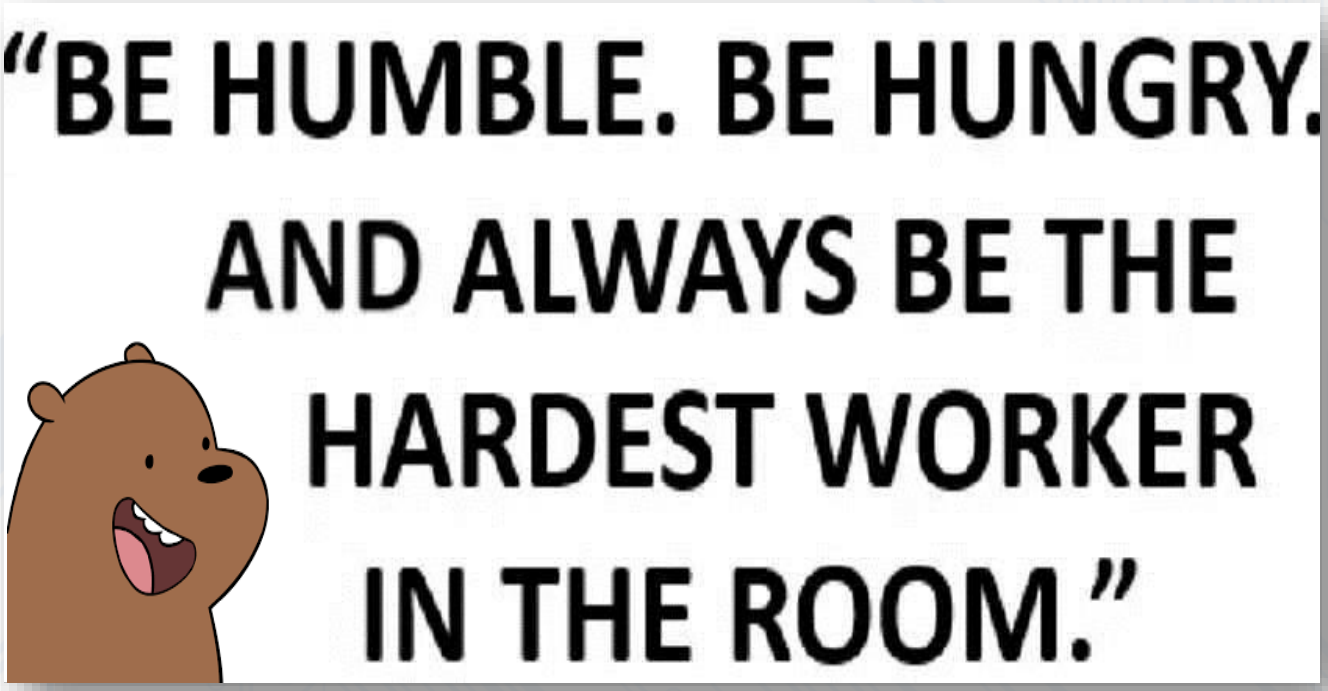
Digital Image Processing

THANK YOU



保持谦虚,保持饥饿,并且永远做房间里面最努力的那个人,了分过越来越师老