HW1

2.14

Consider the two image subsets, S_1 and S_2 in the following figure. With reference to Section 2.5, and assuming that $V = \{1\}$, determine whether these two subsets are:

(a)* 4-adjacent.

(b) 8-adjacent.

(c) m-adjacent.

		S_1				S_2			
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

不是4邻接的，是8邻接和m邻接的

2.18

Consider the image segment shown in the figure that follows.

(a)* As in Section 2.5, let $V = \{0,1\}$ be the set of intensity values used to define adjacency. Compute the lengths of the shortest 4-, 8-, and m-path between p and q in the following image. If a particular path does not exist between these two points, explain why.

$$\begin{array}{rcccl} & 3 & 1 & 2 & 1\,(q) \\ & 2 & 2 & 0 & 2 \\ & 1 & 2 & 1 & 1 \\ (p) & 1 & 0 & 1 & 2 \end{array}$$

(b) Repeat (a) but using $V = \{1,2\}$.

a

- 不存在4通路

$$\begin{array}{rcccl} & 3 & 1 & 2 & 1\,(q) \\ & 2 & 2 & 0 & 2 \\ & 1 & 2 & 1 & 1 \\ (p) & 1 & 0 & 1 & 2 \end{array}$$

如图从p出发到达0后不存在4邻接的可走路径到达q

- 最短8通路：4，如图所示

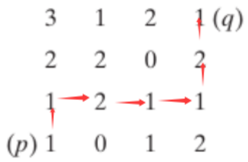
$$\begin{array}{rcccl} & 3 & 1 & 2 & 1\,(q) \\ & 2 & 2 & 0 & 2 \\ & 1 & 2 & 1 & 1 \\ (p) & 1 & 0 & 1 & 2 \end{array}$$

- 最短m通路：5，如图所示

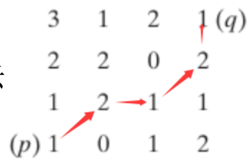
$$\begin{array}{rcccl} & 3 & 1 & 2 & 1\,(q) \\ & 2 & 2 & 0 & 2 \\ & 1 & 2 & 1 & 1 \\ (p) & 1 & 0 & 1 & 2 \end{array}$$

b

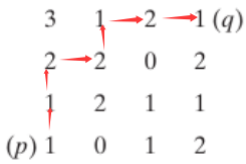
- 最短4通路：6，如图所示



- 最短8通路：4，如图所示



- 最短m通路：6，如图所示



3.10

Two images, $f(x,y)$ and $g(x,y)$ have unnormalized histograms h_f and h_g. Give the conditions (on the values of the pixels in f and g) under which you can determine the histograms of images formed as follows:

(a)* $f(x,y) + g(x,y)$

(b) $f(x,y) - g(x,y)$

(c) $f(x,y) \times g(x,y)$

(d) $f(x,y) \div g(x,y)$

Show how the histograms would be formed in each case. The arithmetic operations are element-wise operations, as defined in Section 2.6.

a,b,c,d都要求至少有一个图像是常数图像时，才能形成运算后的直方图；同时d还要求图像g的任何像素g(x,y)不能为0

一下均假设g为常数c

(a)f直方图灰度整体向右平移c个单位

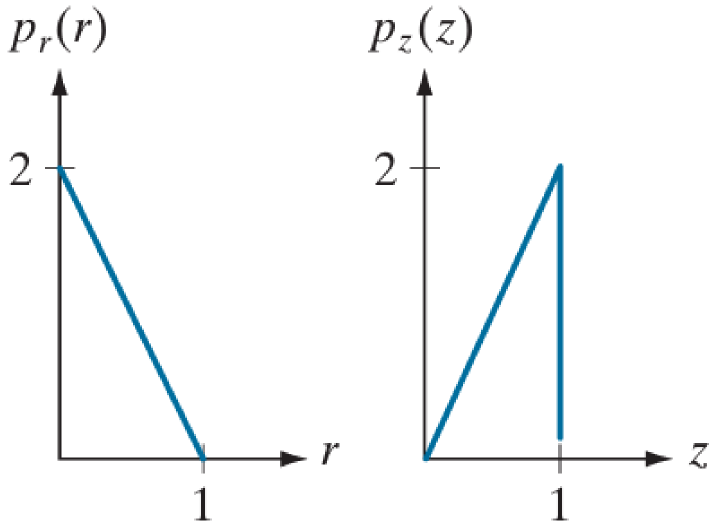
(b)f直方图灰度整体向左平移c个单位

(c)f直方图灰度整体上缩放c

(d)f直方图灰度上整体缩放1/c

3.12

An image with intensities in the range [0,1] has the PDF, $p_r(r)$, shown in the following figure. It is desired to transform the intensity levels of this image so that they will have the specified $p_z(z)$ shown in the figure. Assume continuous quantities, and find the transformation (expressed in terms of r and z) that will accomplish this.



r的pdf：$pdf_r(r) = 2(1-r)$

r的cdf：$cdf_r(r) = 2r - r^2$

z的pdf：$pdf_z(z) = 2z$

z的cdf：$cdf_z(z) = z^2$

直方图变换有式$cdf_r(r) = cdf_z(z)$

得到：$z=\sqrt{2r-r^2}$

3.18

You are given the following kernel and image:

$$w=\begin{bmatrix}1 & 2 & 1\\ 2 & 4 & 2\\ 1 & 2 & 1\end{bmatrix} \qquad f=\begin{bmatrix}0 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\\ 0 & 0 & 0 & 0 & 0\end{bmatrix}$$

(a)* Give a sketch of the area encircled by the large ellipse in Fig. 3.28 when the kernel is centered at point (2,3) (2nd row, 3rd col) of the image shown above. Show specific values of w and f.

(b)* Compute the convolution $w \star f$ using the *minimum* zero padding needed. Show the details of your computations when the kernel is centered on point (2,3) of f; and then show the final full convolution result.

(c) Repeat (b), but for correlation, $w \,☆\, f$.

a

$$f=\begin{bmatrix}0&0&0&0&0\\0&0&1&0&0\\0&0&1&0&0\\0&0&1&0&0\\0&0&0&0&0\end{bmatrix}$$

$$w=\begin{bmatrix}1&2&1\\2&4&2\\1&2&1\end{bmatrix}$$

$$f_{2,3}=\begin{bmatrix}0&0&0\\0&1&0\\0&1&0\end{bmatrix}$$

b

$$f_{pad}=\begin{bmatrix}0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&1&0&0&0\\0&0&0&1&0&0&0\\0&0&0&1&0&0&0\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\end{bmatrix}$$

padding后，f中的point(2,3)对应f_{pad}的point(3,4)

$$f_{pad3,4}=\begin{bmatrix}0&0&0\\0&1&0\\0&1&0\end{bmatrix}$$

$$w_{flip}=\begin{bmatrix}1&2&1\\2&4&2\\1&2&1\end{bmatrix}$$

点积得到，$1\times4+1\times2=6$

完整卷积结果：$(w\bigstar f)(x,y)=\begin{bmatrix}0&0&0&0&0&0&0\\0&0&1&2&1&0&0\\0&0&3&6&3&0&0\\0&0&4&8&4&0&0\\0&0&3&6&3&0&0\\0&0&1&2&1&0&0\\0&0&0&0&0&0&0\end{bmatrix}$

c

$$f_{pad} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

padding后，f中的point(2,3)对应f_{pad}的point(3,4)

$$f_{pad3,4} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix}$$

$$w = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

点积得到，$1 \times 4 + 1 \times 2 = 6$

由于核对称，卷积和相关结果一样，完整相关结果：$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 0 & 3 & 6 & 3 & 0 & 0 \\ 0 & 0 & 4 & 8 & 4 & 0 & 0 \\ 0 & 0 & 3 & 6 & 3 & 0 & 0 \\ 0 & 0 & 1 & 2 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

3.39

Show that the Laplacian defined in Eq. (3-50) is isotropic (invariant to rotation). Assume continuous quantities. From Table 2.3, coordinate rotation by an angle θ is given by

$$x' = x\cos\theta - y\sin\theta \quad \text{and} \quad y' = x\sin\theta + y\cos\theta$$

where (x, y) and (x', y') are the unrotated and rotated coordinates, respectively.

即证明坐标旋转后拉普拉斯算子形式不变

$$\frac{\partial f}{\partial x} = \frac{\partial f}{\partial x'}\frac{\partial x'}{\partial x} + \frac{\partial f}{\partial y'}\frac{\partial y'}{\partial x} = \frac{\partial f}{\partial x'}\cos\theta + \frac{\partial f}{\partial y'}\sin\theta$$

$$\frac{\partial f}{\partial y} = \frac{\partial f}{\partial x'}\frac{\partial x'}{\partial y} + \frac{\partial f}{\partial y'}\frac{\partial y'}{\partial y} = \frac{\partial f}{\partial y'}\cos\theta - \frac{\partial f}{\partial x'}\sin\theta$$

$$\frac{\partial^2 f}{\partial x^2} = \frac{\partial^2 f}{\partial x'^2}\cos^2\theta + 2\frac{\partial^2 f}{\partial x'\partial y'}\sin\theta\cos\theta + \frac{\partial^2 f}{\partial y'^2}\sin^2\theta$$

$$\frac{\partial^2 f}{\partial y^2} = \frac{\partial^2 f}{\partial x'^2}\sin^2\theta - 2\frac{\partial^2 f}{\partial x'\partial y'}\sin\theta\cos\theta + \frac{\partial^2 f}{\partial y'^2}\cos^2\theta$$

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = \frac{\partial^2 f}{\partial x'^2}(\cos^2\theta + \sin^2\theta) + \frac{\partial^2 f}{\partial y'^2}(\sin^2\theta + \cos^2\theta) = \frac{\partial^2 f}{\partial x'^2} + \frac{\partial^2 f}{\partial y'^2}$$

其他题目

其他题目

1. Use the ‘moon.tif’ image to achieve results in Figure 3.46. Post your Matlab codes.

```
I = imread('moon.tif');
I = im2double(I);
laplacian_kernel_a = [0 1 0; 1 -4 1; 0 1 0];
laplacian_kernel_b = [1 1 1; 1 -8 1; 1 1 1];
% 图 3.46(a)
subplot(2,2,1);
imshow(I);
title('(a)');
% 图 3.46(b)
laplacian_a = imfilter(I, laplacian_kernel_a, 'replicate');
subplot(2,2,2);
imshow(laplacian_a);
title('(b)');
% 图 3.46(c)
c = -1;
I_sharpened_c = I + c * laplacian_a;
I_sharpened_c = mat2gray(I_sharpened_c);
subplot(2,2,3);
imshow(I_sharpened_c);
title('(c)');
% 图 3.46(d)
laplacian_b = imfilter(I, laplacian_kernel_b, 'replicate');
I_sharpened_d = I + c * laplacian_b;
I_sharpened_d = mat2gray(I_sharpened_d);
subplot(2,2,4);
imshow(I_sharpened_d);
```

```
title('(d)');
```