HW10

- **A discription of your homework**

  Programming language used: Python 2.7

  Library used: Numpy, PIL, Scipy.misc, math

- **Your parameters**

  i: row

  j: column

  tem: 用於儲存每個像素的灰階數值 0~255

  mask: masks for calculating gradients

  gra: gradient

  threshold: threshold for each kind of operator

- **Functions**

  laplacian: Laplacian operator

  min_var_laplacian: minimum-variance Laplacian operator

  laplacian_guassian: Laplacian of Gaussian operator

  diff_guassian: Difference of Gaussian operator

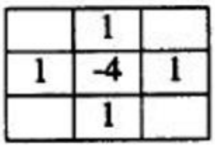
- **The algorithm you used**

  Apply the masks to each pixel of lena: multiply the elements of masks to the gray scales of lena and sum up the values, so we get the gradient.

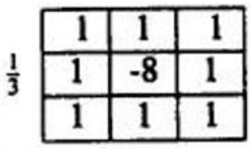
  If gradient > threshold, make that pixel black. Otherwise, make that pixel white.

  1. Laplacian

     mask:



	1	
1	-4	1
	1	



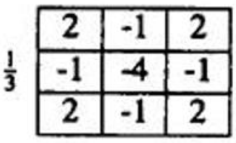
$\frac{1}{3}$

1	1	1
1	-8	1
1	1	1

     threshold=25

  2. minimum-variance Laplacian

     mask:



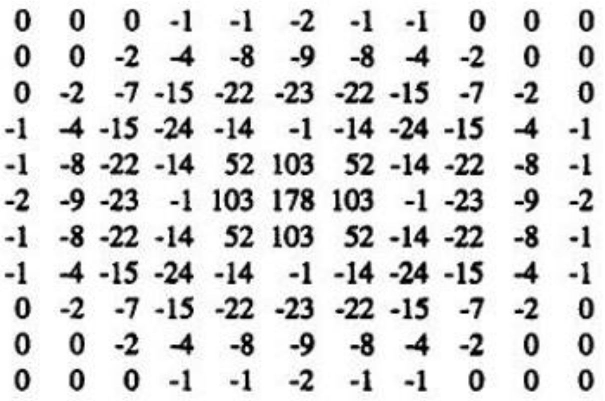
$\frac{1}{3}$

2	-1	2
-1	-4	-1
2	-1	2

     threshold=20

  3. Laplacian of Gaussian

     mask: 11x11



0	0	0	-1	-1	-2	-1	-1	0	0	0
0	0	-2	-4	-8	-9	-8	-4	-2	0	0
0	-2	-7	-15	-22	-23	-22	-15	-7	-2	0
-1	-4	-15	-24	-14	-1	-14	-24	-15	-4	-1
-1	-8	-22	-14	52	103	52	-14	-22	-8	-1
-2	-9	-23	-1	103	178	103	-1	-23	-9	-2
-1	-8	-22	-14	52	103	52	-14	-22	-8	-1
-1	-4	-15	-24	-14	-1	-14	-24	-15	-4	-1
0	-2	-7	-15	-22	-23	-22	-15	-7	-2	0
0	0	-2	-4	-8	-9	-8	-4	-2	0	0
0	0	0	-1	-1	-2	-1	-1	0	0	0

threshold=7000

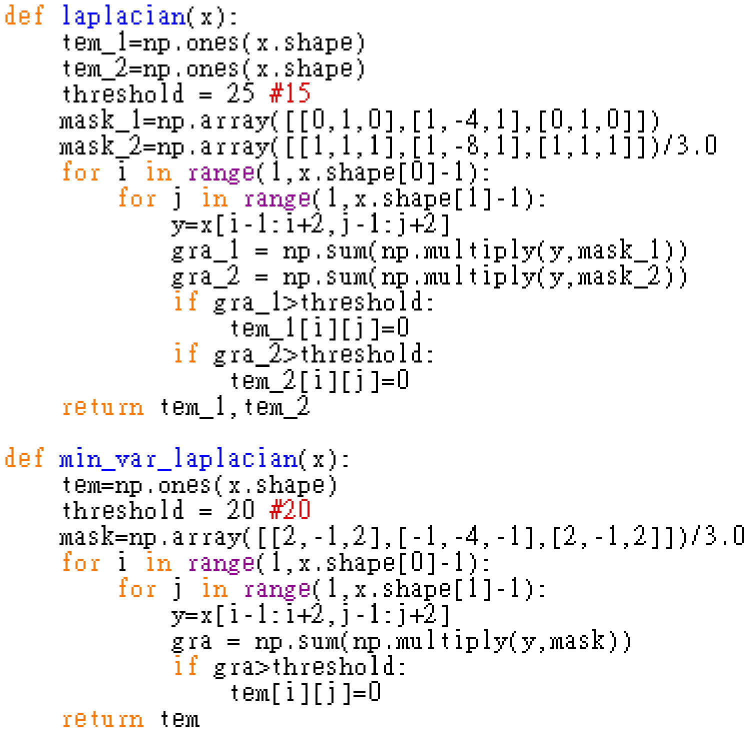
4. Difference of Gaussian

mask: 11x11

$$\text{mask}[i][j] = \frac{1}{2\pi\sigma^2} e^{-\frac{(i-5)^2+(j-5)^2}{2\sigma^2}}$$

threshold=26

- **Principal code fragment**

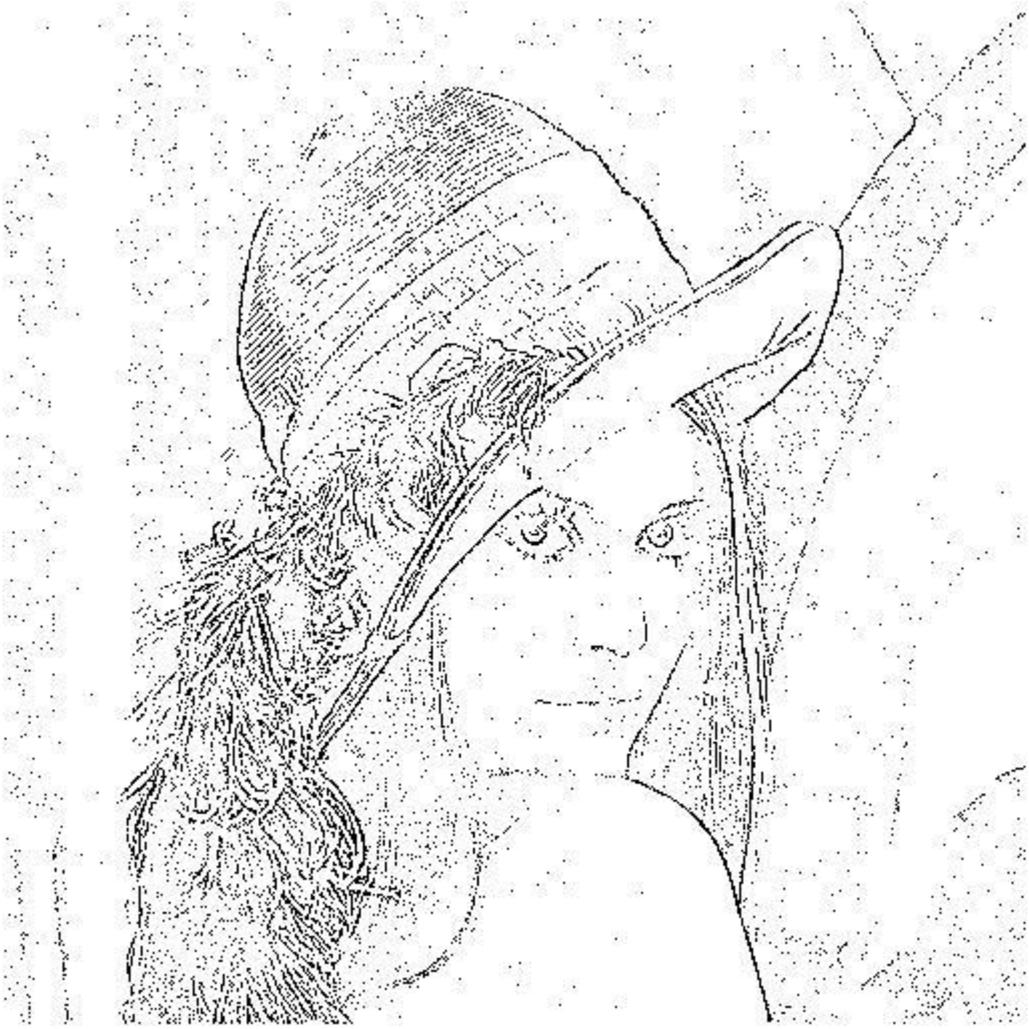


```
def laplacian(x):
    tem_1=np.ones(x.shape)
    tem_2=np.ones(x.shape)
    threshold = 25 #15
    mask_1=np.array([[0,1,0],[1,-4,1],[0,1,0]])
    mask_2=np.array([[1,1,1],[1,-8,1],[1,1,1]])/3.0
    for i in range(1,x.shape[0]-1):
        for j in range(1,x.shape[1]-1):
            y=x[i-1:i+2,j-1:j+2]
            gra_1 = np.sum(np.multiply(y,mask_1))
            gra_2 = np.sum(np.multiply(y,mask_2))
            if gra_1>threshold:
                tem_1[i][j]=0
            if gra_2>threshold:
                tem_2[i][j]=0
    return tem_1,tem_2

def min_var_laplacian(x):
    tem=np.ones(x.shape)
    threshold = 20 #20
    mask=np.array([[2,-1,2],[-1,-4,-1],[2,-1,2]])/3.0
    for i in range(1,x.shape[0]-1):
        for j in range(1,x.shape[1]-1):
            y=x[i-1:i+2,j-1:j+2]
            gra = np.sum(np.multiply(y,mask))
            if gra>threshold:
                tem[i][j]=0
    return tem
```

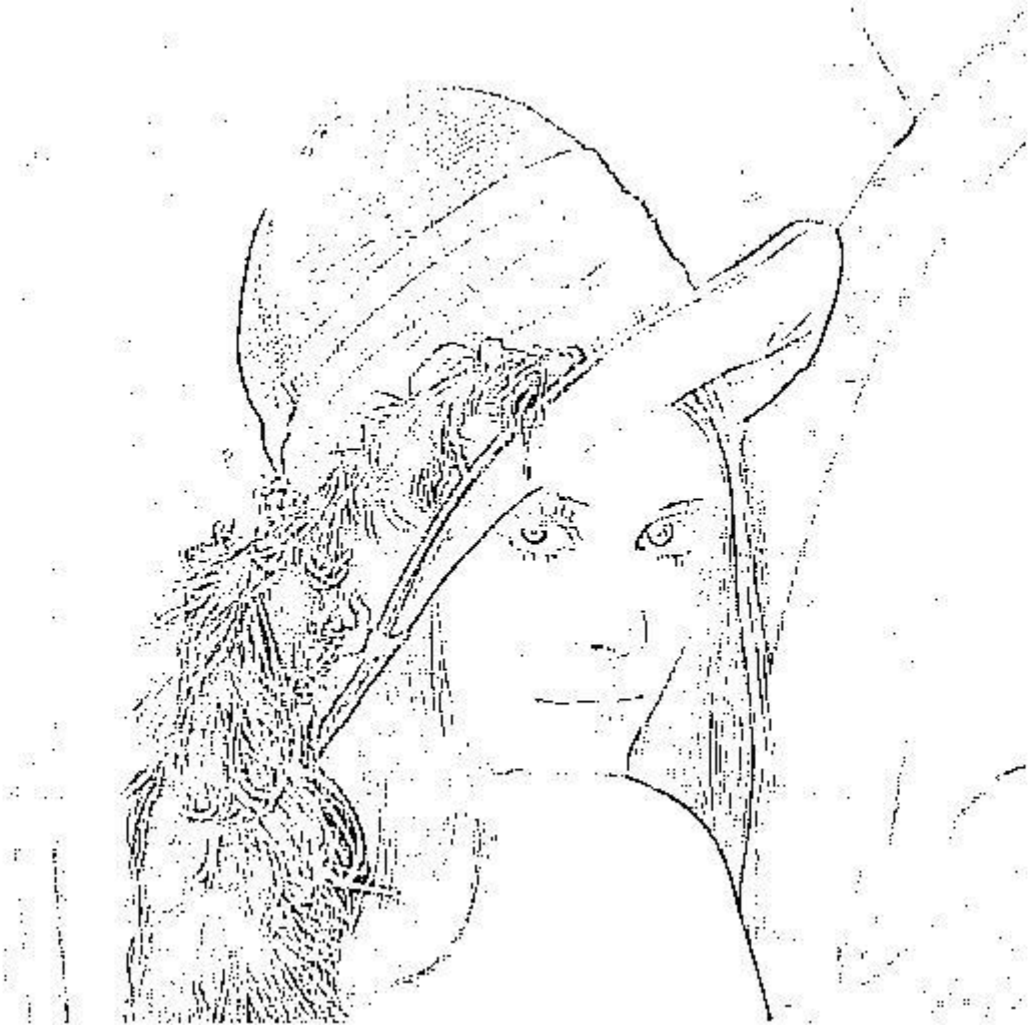
```
def laplacian_guassian(x):
    tem=np.ones(x.shape)
    threshold = 7000 #3000
    mask=[[0,0,0,-1,-1,-2,-1,-1,0,0,0],
          [0,0,-2,-4,-8,-9,-8,-4,-2,0,0],
          [0,-2,-7,-15,-22,-23,-22,-15,-7,-2,0],
          [-1,-4,-15,-24,-14,-1,-14,-24,-15,-4,-1],
          [-1,-8,-22,-14,52,103,52,-14,-22,-8,-1],
          [-2,-9,-23,-1,103,178,103,-1,-23,-9,-2],
          [-1,-8,-22,-14,52,103,52,-14,-22,-8,-1],
          [-1,-4,-15,-24,-14,-1,-14,-24,-15,-4,-1],
          [0,-2,-7,-15,-22,-23,-22,-15,-7,-2,0],
          [0,0,-2,-4,-8,-9,-8,-4,-2,0,0],
          [0,0,0,-1,-1,-2,-1,-1,0,0,0]]
    for i in range(5,x.shape[0]-5):
        for j in range(5,x.shape[1]-5):
            y=x[i-5:i+6,j-5:j+6]
            gra = np.sum(np.multiply(y,mask))
            if gra>threshold:
                tem[i][j]=0
    return tem

def diff_guassian(x):
    tem=np.ones(x.shape)
    threshold = 26 #1
    mask = np.zeros([11,11])
    sigma_1=1.0
    sigma_2=3.0
    for i in range(11):
        for j in range(11):
            value_1=math.exp(-((i-5)**2+(j-5)**2)/(2*sigma_1**2))/(2*math.pi*sigma_1**2)
            value_2=math.exp(-((i-5)**2+(j-5)**2)/(2*sigma_2**2))/(2*math.pi*sigma_2**2)
            value=value_1-value_2
            mask[i][j]=value
    for i in range(5,x.shape[0]-5):
        for j in range(5,x.shape[1]-5):
            y=x[i-5:i+6,j-5:j+6]
            gra = np.sum(np.multiply(y,mask))
            if gra>threshold:
                tem[i][j]=0
    return tem
```

- **Resulting images**

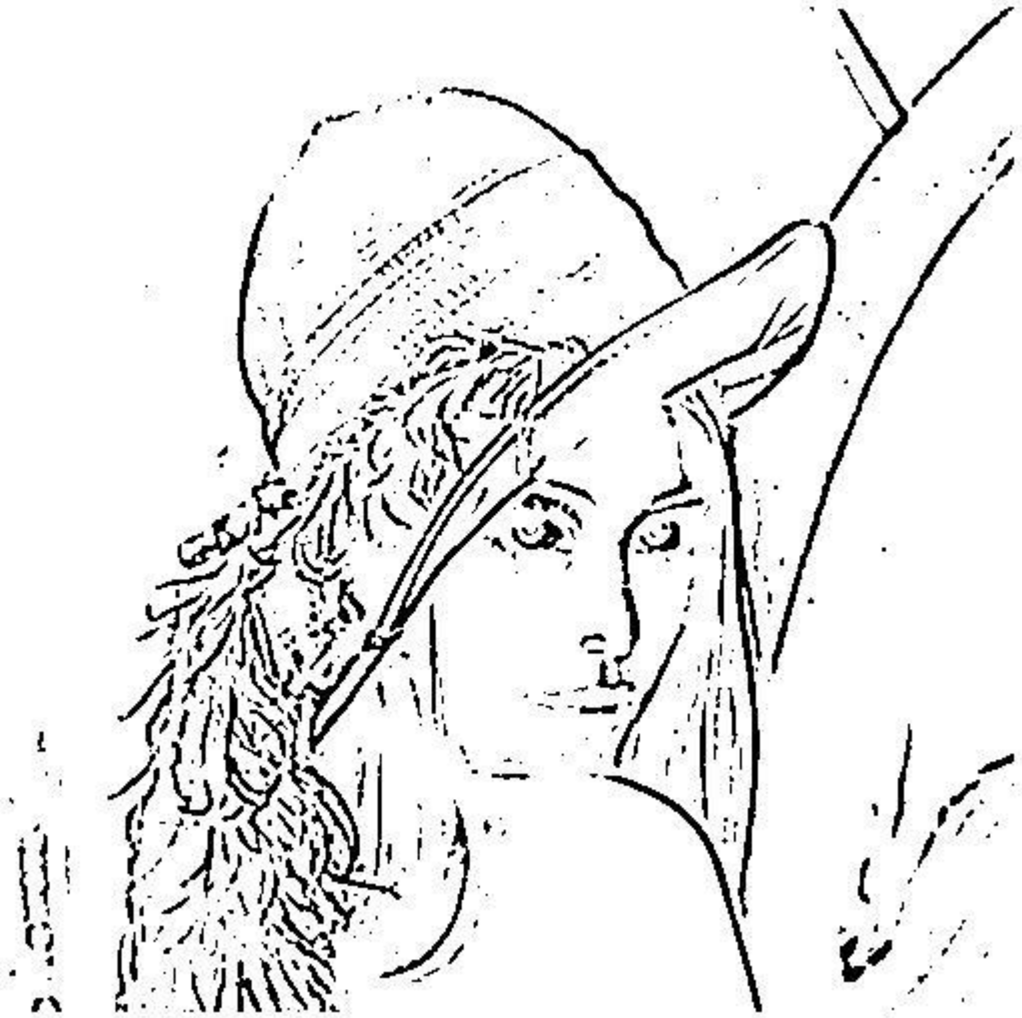
1. Laplacian



2. minimum-variance Laplacian



3. Laplacian of Gaussian



4. Difference of Gaussian