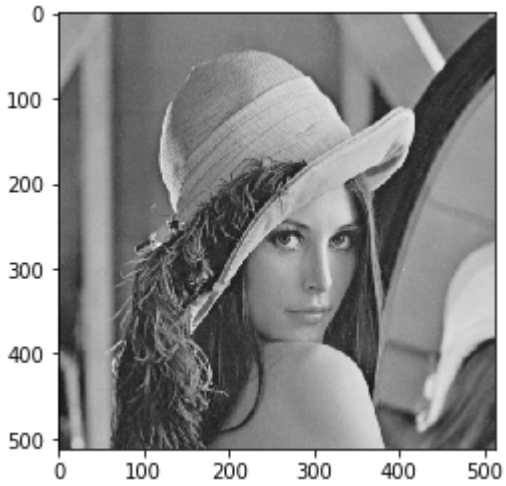
In [1]:
```
import sys
from tqdm import tqdm_notebook
import numpy as np
import cv2
import math
import cv2
import matplotlib.pyplot as plt
import numpy as np
import sys
img = cv2.imread('lena.bmp', 0)
%matplotlib inline
```

原圖

In [2]:
```
def binarize(image):
    return (img>127)*255
plt.imshow(img,cmap='gray', norm = None, vmin = 0, vmax = 0xff)
plt.show()
```



(a) Dilation

In [3]:
```
octogonKernel = [[-2, -1], [-2, 0], [-2, 1],
                 [-1, -2], [-1, -1], [-1, 0], [-1, 1], [-1, 2],
                 [0, -2], [0, -1], [0, 0], [0, 1], [0, 2],
                 [1, -2], [1, -1], [1, 0], [1, 1], [1, 2],
                 [2, -1], [2, 0], [2, 1]]

def dilation(img, kernel):
    img_dil = np.zeros(img.shape, np.int)
    for i in range(img.shape[0]):
        for j in range(img.shape[1]):
            if img[i][j] > 0:
                for element in kernel:
                    x, y = element
                    if img.shape[0]>(i + x) >= 0 and  img.shape[1]>(j +
                        img_dil[i + x][j + y] = 255
    return img_dil


plt.figure(figsize=(10,10))
plt.imshow(dilation(binarize (img),octogonKernel),cmap='gray')
plt.show()
```

(b) Erosion

In [4]:
```
def erosion(img, kernel):
    img_ero = np.zeros(img.shape, np.int)
    for i in range(img.shape[0]):
        for j in range(img.shape[1]):
            exist = True
            for element in kernel:
                x, y = element
                if img.shape[0]>(i + x) >=0 and img.shape[1]>(j + y) >=(
                    if (img[i + x][j + y]==0):
                        exist = False
                        break
                else:
                    exist = False
            if exist:
                img_ero[i][j] = 255
    return img_ero
plt.figure(figsize=(10,10))
plt.imshow(erosion(binarize (img),octogonKernel),cmap='gray')
plt.show()
```

(c) opening

In [5]:
```
def opening(img, kernel):
    return dilation(erosion(img, kernel), kernel)
plt.figure(figsize=(10,10))
plt.imshow(opening(binarize (img),octogonKernel),cmap='gray')
plt.show()
```

(d) closing

In [6]:
```
def closing(img, kernel):
    return erosion(dilation(img, kernel), kernel)
plt.figure(figsize=(10,10))
plt.imshow(closing(binarize (img),octogonKernel),cmap='gray')
plt.show()
```

(e) Hit-and-miss transform

In [7]:
```
jKernel = [[0, -1], [0, 0], [1, 0]]
kKernel = [[-1, 0], [-1, 1], [0, 1]]
def hitAndMiss( image, jKernel, kKernel ):
    return (( erosion(image, jKernel) +erosion( -image+255, kKernel ) )=
plt.figure(figsize=(10,10))
z=hitAndMiss(binarize (img), jKernel, kKernel)
plt.imshow(z,cmap='gray')
plt.show()
```