a. upside-down lena.bmp

利用 getpixel()函式來得到 pixels

up 是讀取圖片上半部由左上到右下

down 是讀取圖片下半部由左下到右上

之後利用 putpixel()函式將 pixels 位置交換

```
def upside_down(img):
    result = Image.new(img.mode, img.size)
    for y in range(height//2): # 0-255
        for x in range(width): # 0-511
            up = img.getpixel((x, y))
            down = img.getpixel((x, height - 1 - y)) # 512 - 1 - y :511,510,509.....,256

            result.putpixel((x, height - 1 - y), up)
            result.putpixel((x, y), down)

    result.show()
    return result
```

結果

b. right-side-left lena.bmp

同第一題，利用迴圈和兩個函式將 pixesl 左右交換

```
def right_side_left(img):
    result = Image.new(img.mode, img.size)
    for y in range(height): # 0-511
        for x in range(width//2): # 0-255
            left = img.getpixel((x, y))
            right = img.getpixel((width - 1 - x, y))

            result.putpixel((width - 1 - x, y), left)
            result.putpixel((x, y), right)

    result.show()
    return result
```

結果

c. diagonally flip lena.bmp

同上，讀取像素後依照對角線翻轉放置

```
def diagonally_mirrored(img):
    result = Image.new(img.mode, img.size)
    for y in range(height):
        for x in range(width - y):
            a = img.getpixel((x, y))
            b = img.getpixel((width - 1 - x, height - 1 - y))

            result.putpixel((width - 1 - x, height - 1 - y), a)
            result.putpixel((x, y), b)

    result.show()
    return result
```

結果

d. rotate lena.bmp 45 degrees clockwise

直接使用 Pillow 內建函式 rotate()

```
def rotate(img):
    result = img.rotate(45)
    result.show()
    return result
```

結果

e. shrink lena.bmp in half

直接使用 Pillow 內建函式 resize()

將照片尺寸由 512 縮小到 256

```
def shrink(img):
    x, y = int(width/2) ,int(height/2)
    result = img.resize((x,y))
    result.show()
    return result
```

結果

f. binarize lena.bmp at 128 to get a binary image

先將照片利用 ndarray 讀取

設閥值為 128，判斷像素是否大於這閥值，回傳布林值

布林值 True 為 1，Fales 為 0，乘以 255 會以黑(0)白(255)顯示

```
def binarize(img):
    im = np.array(img.convert('L'))
    th = 128
    im_bin_128 = (im > th) * 255
    # print(i
    result = Image.fromarray(np.uint8(im_bin_128))
    result.show()
    return result
```

Image: Image

結果