HW5 R11944009 何明倩

(a) Dilation

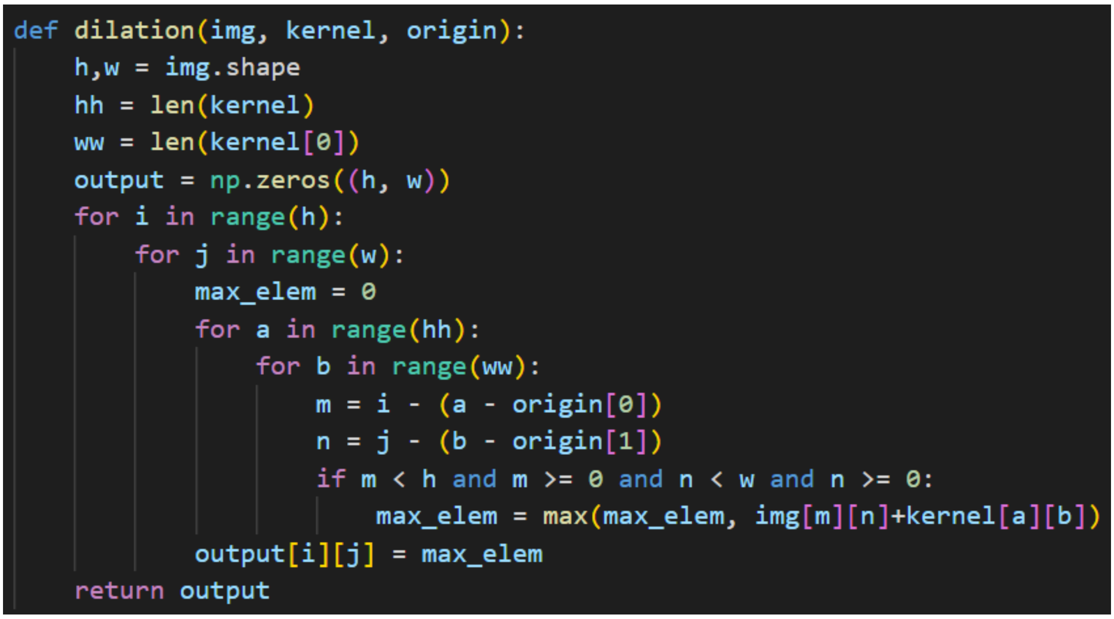
- Description:

  針對 lena 影像用八角形的 kernal 做 diladtion

- Algorithm:

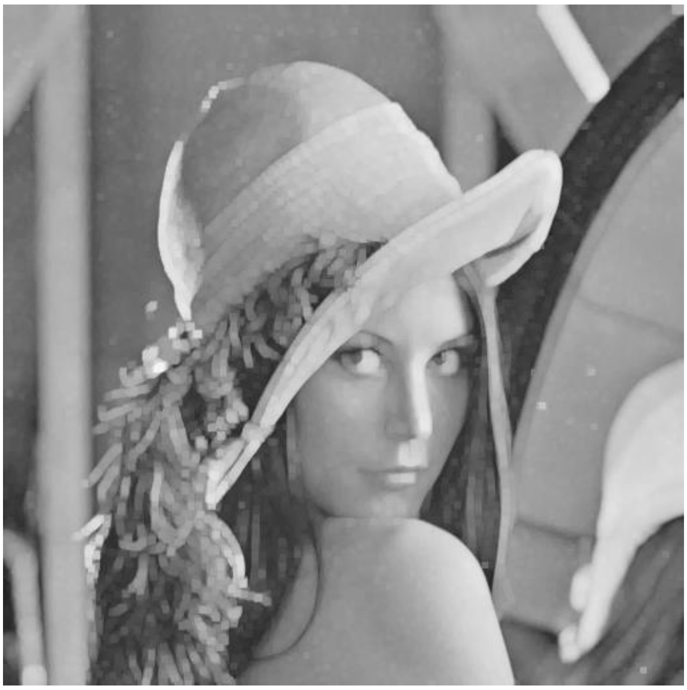
  由左到右由上到下拜訪每個灰階的 lena 影像的 pixel f(i, j)。套用$(f \oplus k) = \max\{f(i-a, j-b) + k(a,b)\} \mid i-a,\ j-b \in F$，$a,\ b \in K$來計算，注意此處是的 kernel 座標 index 是以 origin 為(0, 0)。

- Principal code fragment:



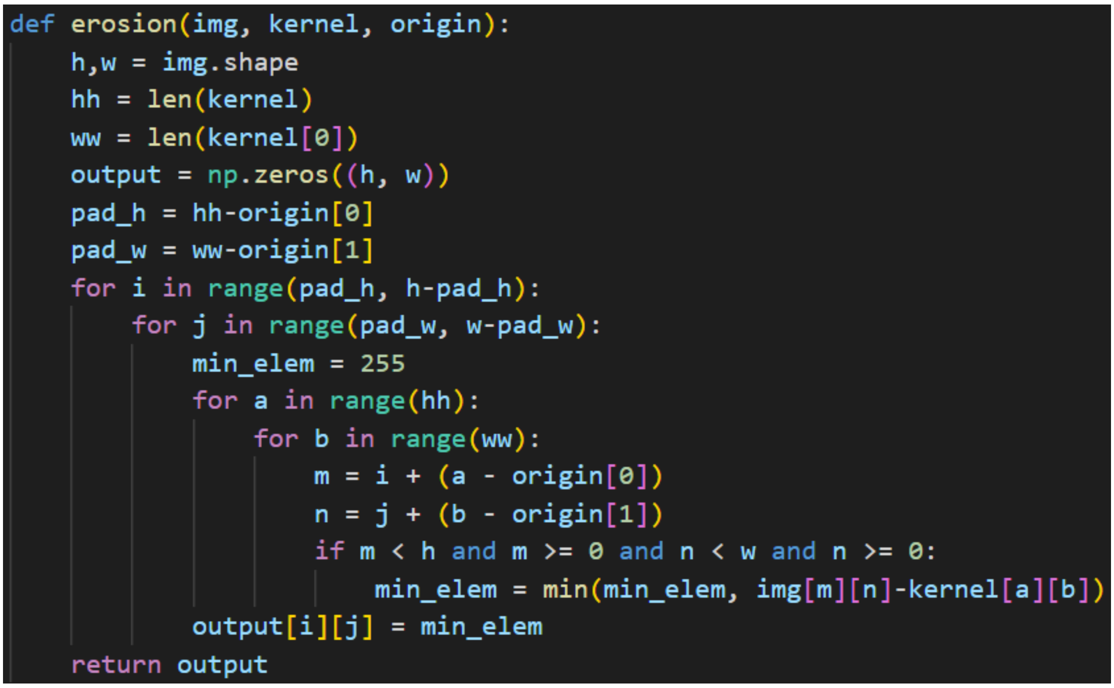
```
def dilation(img, kernel, origin):
    h,w = img.shape
    hh = len(kernel)
    ww = len(kernel[0])
    output = np.zeros((h, w))
    for i in range(h):
        for j in range(w):
            max_elem = 0
            for a in range(hh):
                for b in range(ww):
                    m = i - (a - origin[0])
                    n = j - (b - origin[1])
                    if m < h and m >= 0 and n < w and n >= 0:
                        max_elem = max(max_elem, img[m][n]+kernel[a][b])
            output[i][j] = max_elem
    return output
```

- Result:



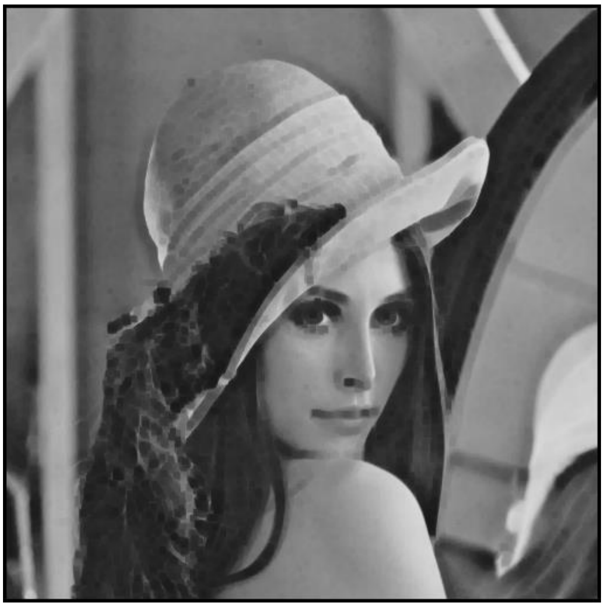
(b) Erosion

- Description:
  針對 lena 影像用八角形的 kernal 做 erosion
- Algorithm:
  由左到右由上到下拜訪每個灰階的 lena 影像的 pixel f(i, j)。套用$(f \ominus k) = \min\{f(i+a, j+b) - k(a,b)\} \mid i+a,\ j+b \in F$，$a,\ b \in K$來計算，注意此處是的 kernel 座標 index 是以 origin 為(0, 0)。另外 erosion 是 kernel 可以放得進去才做，所以影像會變小，各邊會減少 kernel 長度減掉 origin。
- Principal code fragment:



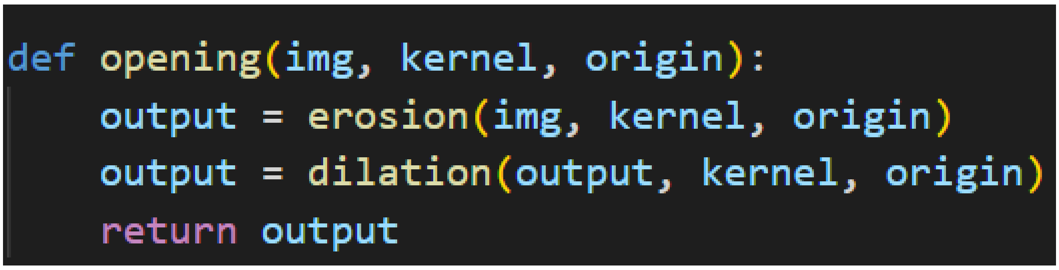
```python
def erosion(img, kernel, origin):
    h,w = img.shape
    hh = len(kernel)
    ww = len(kernel[0])
    output = np.zeros((h, w))
    pad_h = hh-origin[0]
    pad_w = ww-origin[1]
    for i in range(pad_h, h-pad_h):
        for j in range(pad_w, w-pad_w):
            min_elem = 255
            for a in range(hh):
                for b in range(ww):
                    m = i + (a - origin[0])
                    n = j + (b - origin[1])
                    if m < h and m >= 0 and n < w and n >= 0:
                        min_elem = min(min_elem, img[m][n]-kernel[a][b])
            output[i][j] = min_elem
    return output
```

Result:



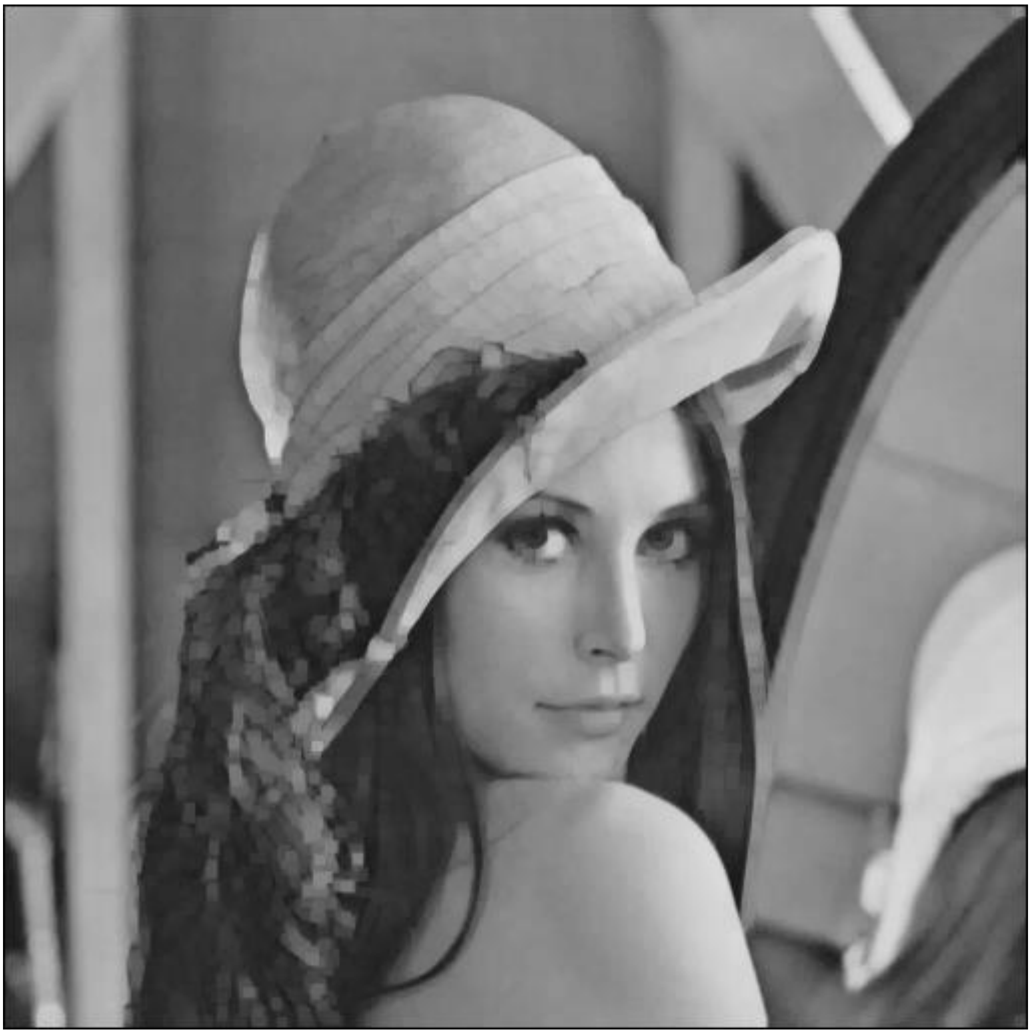
(c) Opening

- Description:
  針對 lena 影像用八角形的 kernal 做 opening
- Algorithm:
  利用上述所做的 dilation 和 erosion function。先做 erosion 再做 dilation。
- Principal code fragment:



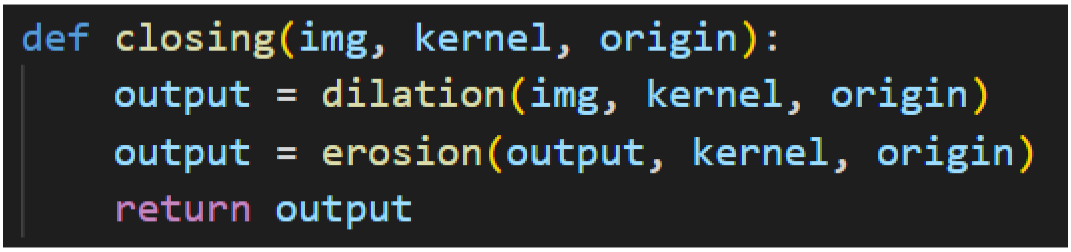
```python
def opening(img, kernel, origin):
    output = erosion(img, kernel, origin)
    output = dilation(output, kernel, origin)
    return output
```

- Result:



(d) Closing

- Description:
  針對 lena 影像用八角形的 kernal 做 closing
- Algorithm:
  利用上述所做的 dilation 和 erosion function。先做 dilation 再 erosion。
- Principal code fragment:



```python
def closing(img, kernel, origin):
    output = dilation(img, kernel, origin)
    output = erosion(output, kernel, origin)
    return output
```

- Result: