



CHANGED 4 MINUTES AGO



Computer Vision HW5, Gray Scale Morphology Report

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Prerequisites and env as the following

```
Ubuntu WSL for windows with jupyter notebook
Python3.6.7
OpenCV for image IO
Matplotlib for displaying image
```

a, dilation

By definition from [wikipedia](#), use the probing kernel to search for the supremum of neighbour pixels.

$$(f \oplus b)(x) = \sup_{y \in E} [f(y) + b(x - y)]$$

```
def dilation(a, b):
    ra, ca = a.shape # original image
    res = np.zeros(a.shape, dtype = 'int32')

    for ai in range(ra):
        for aj in range(ca):

            max_value = 0
            for b_each in b:
                bi, bj = b_each
                if ai + bi >= 0 and ai + bi < ra\
                and aj + bj >= 0 and aj + bj < ca:
                    # extend the value
                    max_value = max(max_value, a[ai + bi, aj + bj])

            res[ai, aj] = max_value

    return res
```



Time complexity, kernel size K : $O(MNK)$

b, erosion

By definition from [wikipedia](#), use the probing kernel to search for the infimum of neighbour pixels.

$$(f \ominus b)(x) = \inf_{y \in B} [f(x + y) - b(y)],$$

```
def erosion(a, b):
    ra, ca = a.shape # original image
    res = np.zeros(a.shape, dtype = 'int32')

    for ai in range(ra):
        for aj in range(ca):

            min_value = 0x100
            for b_each in b:
                bi, bj = b_each
                if ai + bi >= 0 and ai + bi < ra \
                and aj + bj >= 0 and aj + bj < ca:
                    # extend the value
                    min_value = min(min_value, a[ai + bi, aj + bj])

            res[ai, aj] = min_value
```

```
return res
```



Time complexity, kernel size K : $O(MNK)$

c, opening

```
def opening(a, b):  
    return dilation(erosion(a, b), b)
```



Time complexity, kernel size K : $O(MNK)$

d, closing

```
def closing(a, b):  
    return erosion(dilation(a, b), b)
```



Time complexity, kernel size K : $O(MNK)$

