Tutorial 5
Morphological Image Processing for Binary Images

COMP 4421: Image Processing

March 8, 2016

Outline

- Dilation and Erosion
- Opening and Closing

Overview

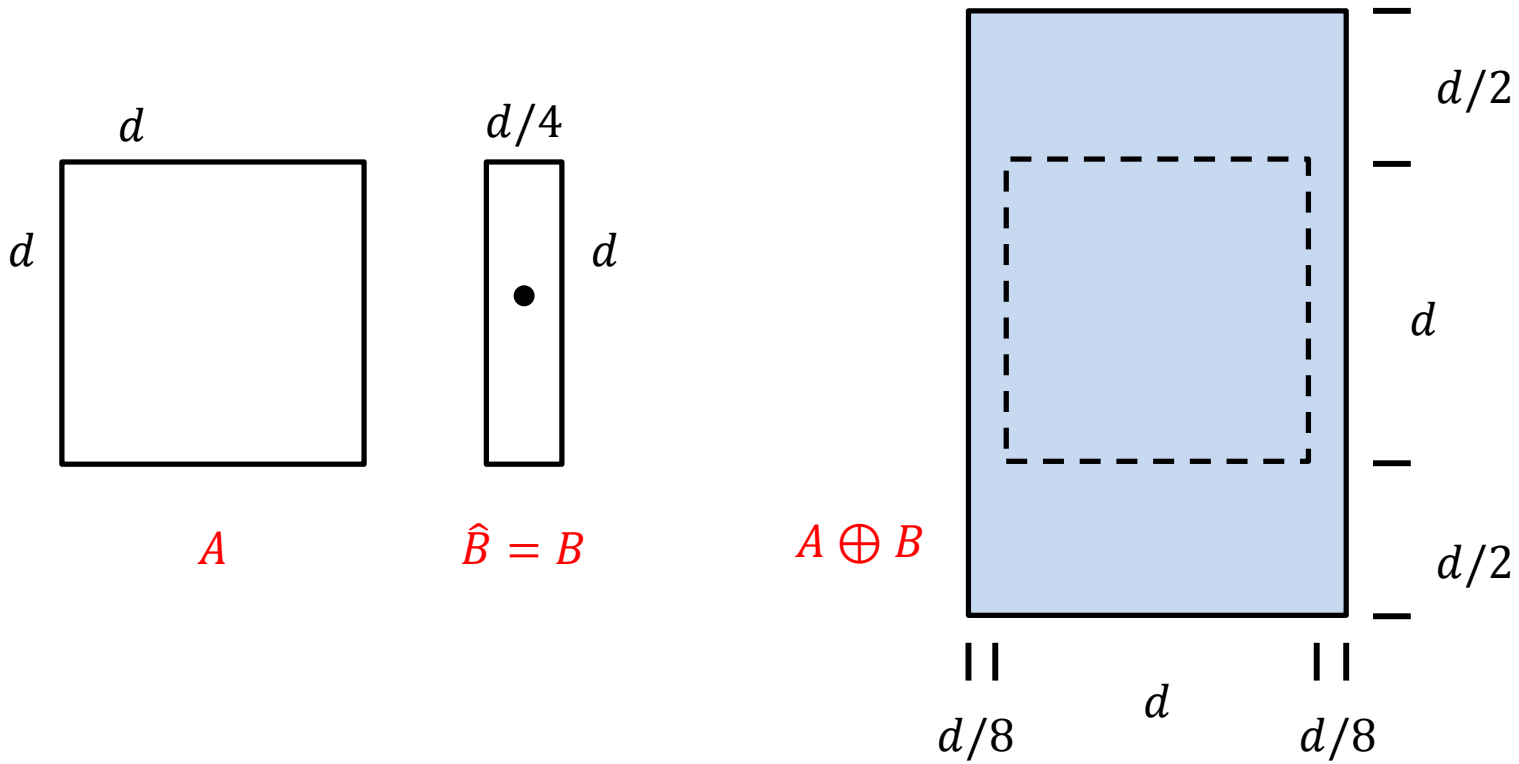
For binary image A, after specifying a structuring element B:

- Dilation: grows or thickens the object
- Erosion: shrinks or thins object
- Opening of A by B:
  is erosion of A by B, followed by dilation of the result by B
- Closing of A by B:
  is dilation followed by erosion (opposite to opening)

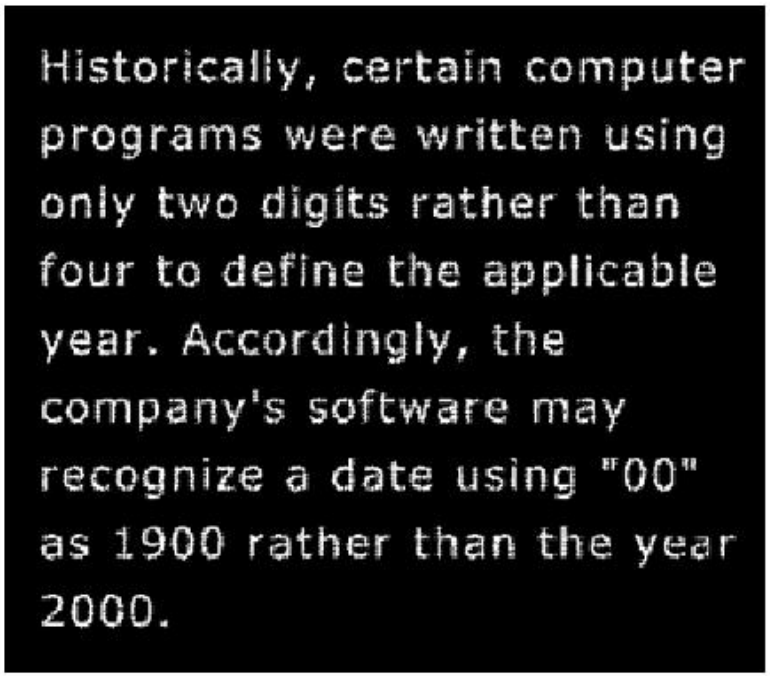
Dilation

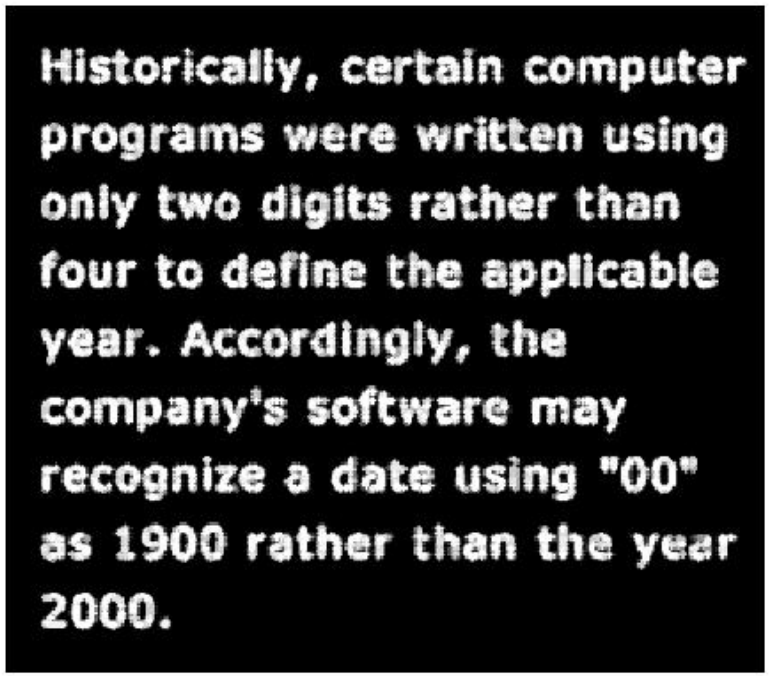
The dilation of A by B is defined as

$$A \oplus B = \{z | (\hat{B})_z \cap A \neq \phi\}$$



Dilation


Historically, certain computer programs were written using only two digits rather than four to define the applicable year. Accordingly, the company's software may recognize a date using "00" as 1900 rather than the year 2000.


Historically, certain computer programs were written using only two digits rather than four to define the applicable year. Accordingly, the company's software may recognize a date using "00" as 1900 rather than the year 2000.

Dilation

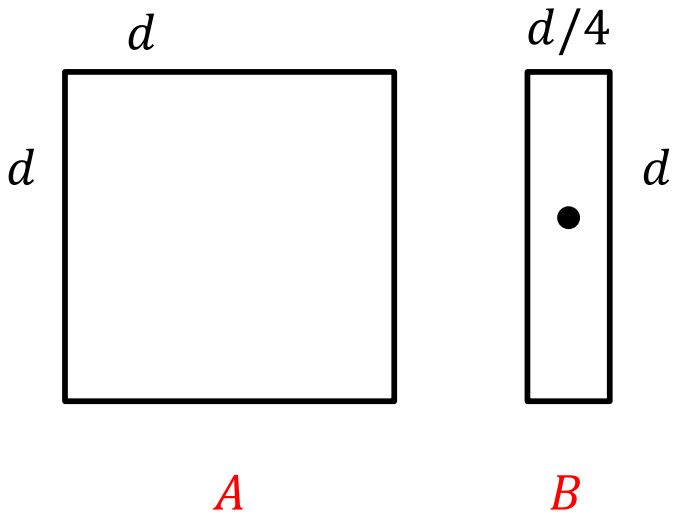
Matlab Code

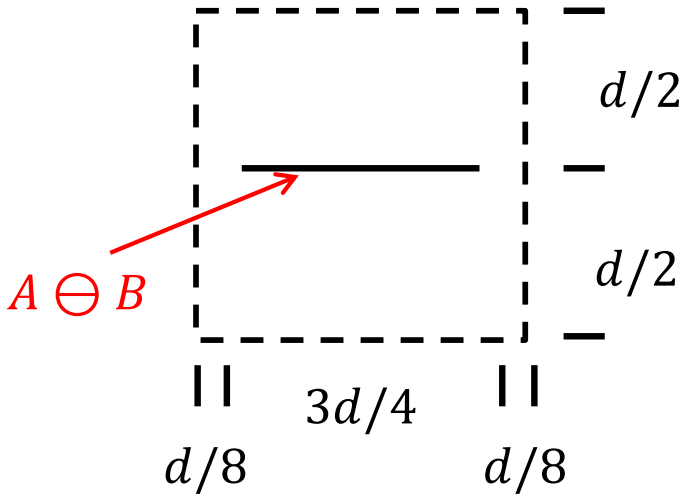
```
A = imread('broken-text.bmp');
B = [0 1 0; 1 1 1; 0 1 0];
A2 = imdilate(A,B);
figure,subplot(1,2,1),imshow(A);
subplot(1,2,2),imshow(A2);
```

Erosion

The erosion of A by B is defined as

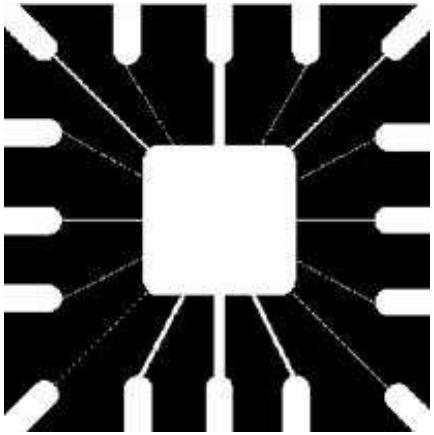
$$A \ominus B = \{z | (B)_z \subseteq A\}$$



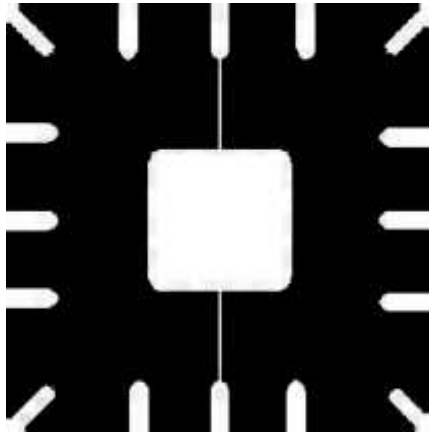


Erosion

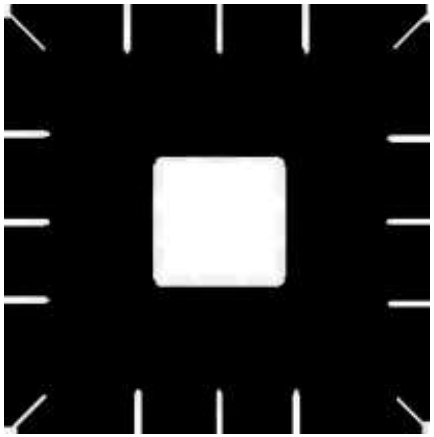
Original Image



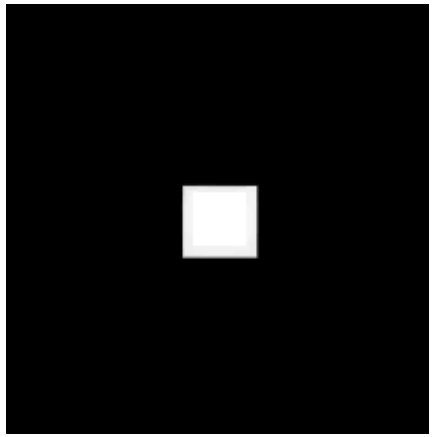
Erosion 1



Erosion 2



Erosion 3



Dilation

Matlab Code

```
A = imread('mask.jpg');
figure,subplot(2,2,1);imshow(A);title('Original Image');
se = strel('disk',3);
A2 = imerode(A, se);
subplot(2,2,2);imshow(A2);title('Erosion 1');
se = strel('disk',6);
A3 = imerode(A, se);
subplot(2,2,3);imshow(A3);title('Erosion 2');
se = strel('disk',20);
A4 = imerode(A, se);
subplot(2,2,4);imshow(A4);title('Erosion 3');
```

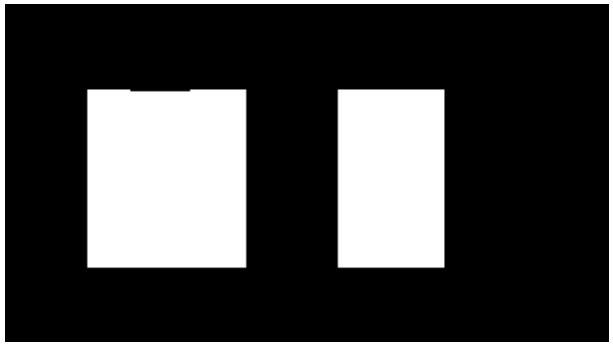
Opening and Closing

Original Image

Opening Image

Closing Image

Closing of the former Opening Image



Dilation

Matlab Code

```
f = imread('shapes.bmp');
figure;subplot(2,2,1),imshow(f);title('Original Image');
se = strel('square', 15);
fo = imopen(f, se);
subplot(2,2,2),imshow(fo);title('Opening Image');
fc = imclose(f, se);
subplot(2,2,3),imshow(fc);title('Closing Image');
foc = imclose(fo,se);
subplot(2,2,4),imshow(foc);title('Closing of the former Opening
Image');
```

Opening and Closing

Original Image

Opening Image

opening followed by closing

Dilation

Matlab Code

```
f = imread('noisy-fingerprint.bmp');
figure,subplot(1,3,1),imshow(f);title('Original Image');
se = strel('square', 3);
fo = imopen(f,se);
subplot(1,3,2),imshow(fo);title('Opening Image');
foc = imclose(fo,se);
subplot(1,3,3),imshow(foc);title('opening followed by closing');
```

Thank you!