



# PENGOLAHAN CITRA & VISI KOMPUTER

## RT1186006

Minggu 9: **Morfologi**

# Outline

- ❖ Morfologi
- ❖ Dilasi
- ❖ Erosi
- ❖ Opening
- ❖ Closing

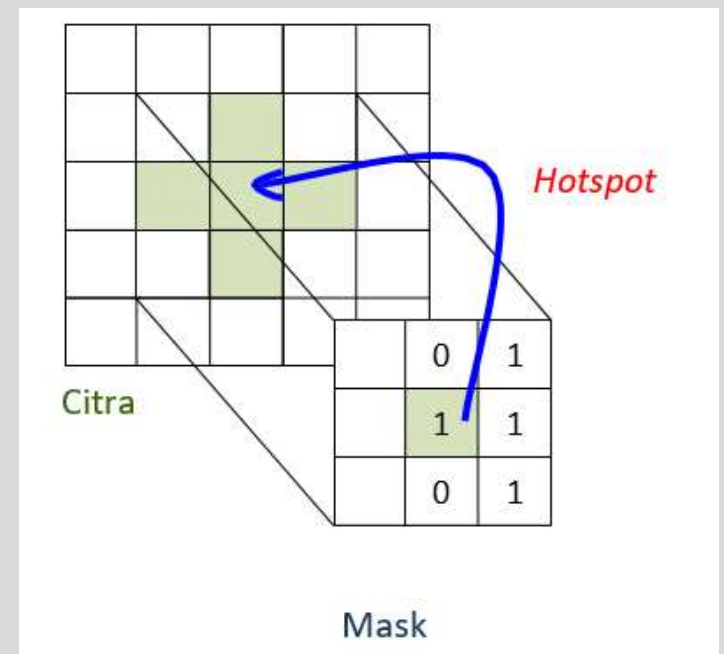
# Operasi Morfologi

- Teknik pengolahan citra yang didasarkan pada bentuk segmen atau region dalam citra
- Biasanya diterapkan pada citra biner, ataupun warna dan citra skala keabuan.
- Berdasarkan nilai biner tersebut dapat dibedakan mana bagian objek dan mana bagian bukan objek atau background.

# Operasi Morfologi

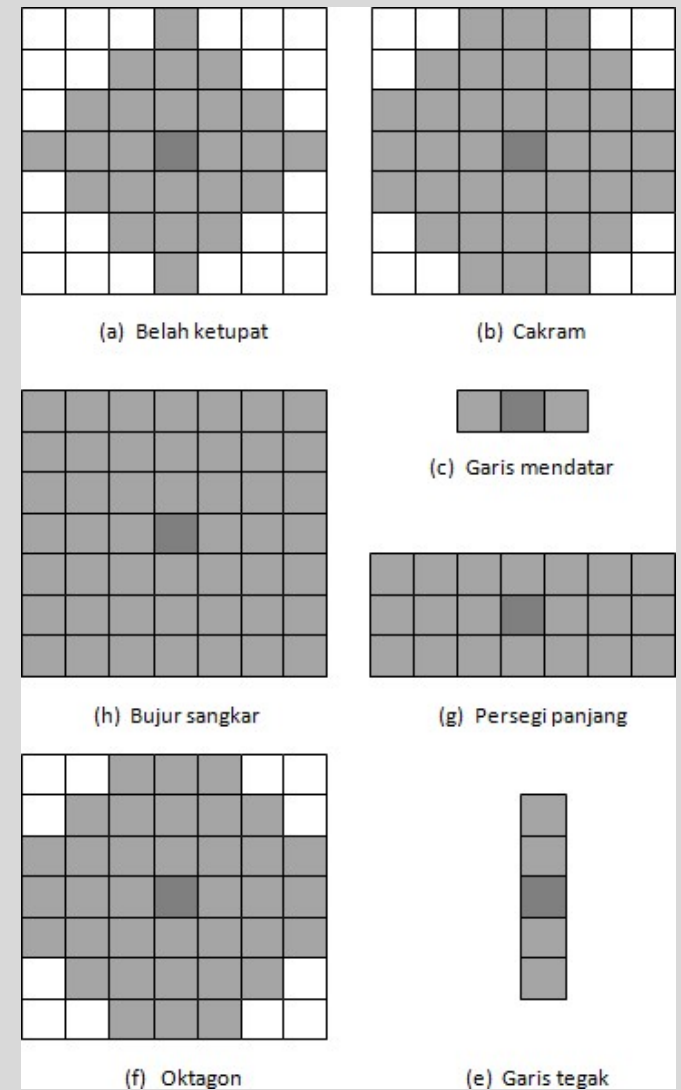
- Beberapa operasi morfologi:
  - Dilasi dan Erosi,
  - Penutupan (*closing*) dan Pembukaan (*opening*).
- Tahapan operasi morfologi dilakukan dengan cara memasing sebuah *Structuring Element* terhadap sebuah citra.
- Implementasi:
  - Memperoleh skeleton (rangka) objek.
  - Menentukan letak objek di dalam citra.
  - Memperoleh bentuk struktur objek.

# Operasi Morfologi



# Structuring Element

- Image yang akan dimorphology, akan dilakukan operasi refleksi dan translasi oleh struktur yang dinamakan dengan Structure Element (SE).
- Saat bekerja dengan image, SE harus dalam bentuk rectangular arrays, dengan cara menambahkan element background terkecil
- Cross, Rectangle, Line, dan Circle SE adalah SE yang paling sering dipakai



# Operasi Dilasi

- Salah satu wujud dari operasi morfologi memiliki tujuan untuk memperbesar ukuran segmen objek dengan menambah lapisan di sekeliling objek
- **Cara:**
  - Mengubah semua titik latar yang bertetangga dengan titik batas menjadi titik objek, atau lebih mudahnya set setiap titik yang tetangganya adalah titik objek menjadi titik objek.
  - Mengubah semua titik di sekeliling titik batas menjadi titik objek, atau lebih mudahnya set semua titik tetangga sebuah titik objek menjadi titik objek.

# Operasi Dilasi

- Operasi dilasi juga digunakan untuk mendapatkan gambar yang lebih lebar dirumuskan sebagai berikut : (Gonzales & Woods, 2002):

- $A \oplus B = \{z | (\hat{B})_z \cap A \neq \emptyset\}$
- $A \oplus B = \{z | [(\hat{B})_z \cap A] \subseteq A\}$

Dilasi ini sangat berguna ketika diterapkan dalam obyek-obyek yang terputus dikarenakan hasil pengambilan citra yang terganggu oleh noise, kerusakan obyek fisik yang dijadikan citra digital, atau disebabkan resolusi yang jelek, misalnya teks pada kertas yang sudah agak rusak sehingga bentuk hurufnya terputus



# Operasi Dilasi

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.



Citra asli

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Hasil dilasi dengan strel:

|   |   |   |
|---|---|---|
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |

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.



Hasil dilasi dengan strel:

|   |   |   |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

# Operasi Dilasi

- $A = \{ (2,2), (2,3), (2,4), (3,2), (3,3), (3,4), (4,3) \}$
- $B = \{ (-1, 0), (0,0), (1,0) \}$
- A Dilasi B =  $\{ (2,2) + (-1, 0), (2,2) + (0, 0) + (2,2) + (1, 0),$   
 $(2,3) + (-1, 0), (2,3) + (0, 0) + (2,3) + (1, 0),$   
 $(2,4) + (-1, 0), (2,4) + (0, 0) + (2,4) + (1, 0),$   
 $(3,2) + (-1, 0), (3,2) + (0, 0) + (3,2) + (1, 0),$   
 $(3,3) + (-1, 0), (3,3) + (0, 0) + (3,3) + (1, 0),$   
 $(3,4) + (-1, 0), (3,4) + (0, 0) + (3,4) + (1, 0),$   
 $(4,3) + (-1, 0), (4,3) + (0, 0) + (4,3) + (1, 0) \}$

$= \{ (1,2), (2,2), (3,2), (1,3), (2,3), (3,3), (1,4), (2,4), (3,3), (2,2), (3,2), (4,2), (2,3), (3,3), (4,3), (2,4),$   
 $(3,4), (4,4), (3,3), (4,3), (5,3) \}$

$= \{ (1,2), (1,3), (1,4), (2,2), (2,3), (2,4), (3,2), (3,3), (3,4), (4,2), (4,3), (4,4), (5,3) \}$

|   | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 1 | 1 | 0 |
| 3 | 0 | 1 | 1 | 1 | 0 |
| 4 | 0 | 0 | 1 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 |

Citra Asli

|    | -1 | 0 | 1 |
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| -1 |    |   |   |
| 0  |    |   |   |
| 1  |    |   |   |

Strel

|   | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | 0 |
| 2 | 0 | 1 | 1 | 1 | 0 |
| 3 | 0 | 1 | 1 | 1 | 0 |
| 4 | 0 | 1 | 1 | 1 | 0 |
| 5 | 0 | 0 | 1 | 0 | 0 |

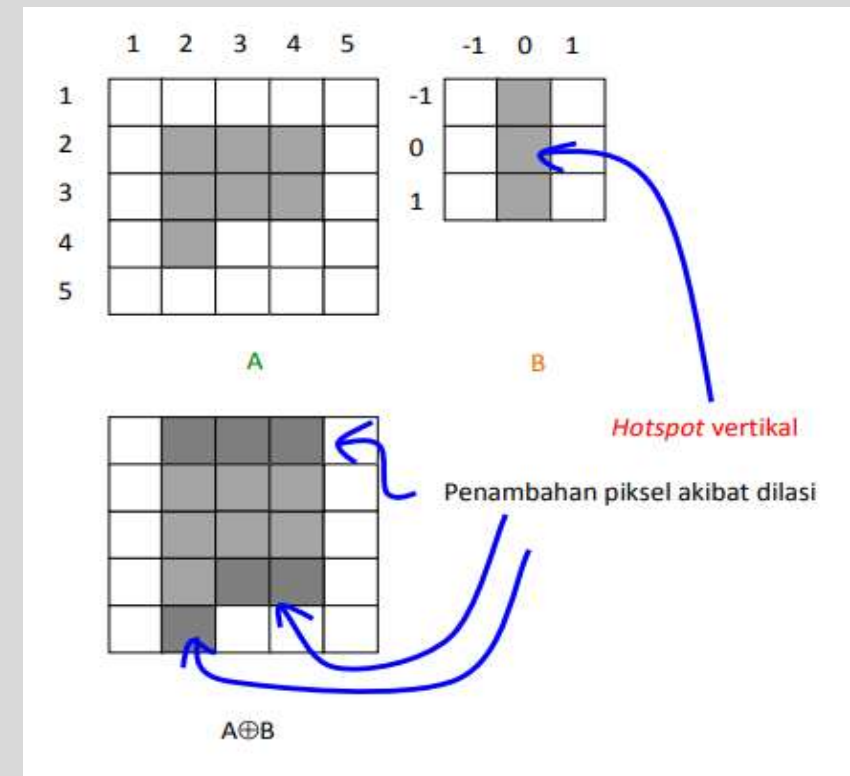
Citra Hasil Dilasi

# Operasi Dilasi

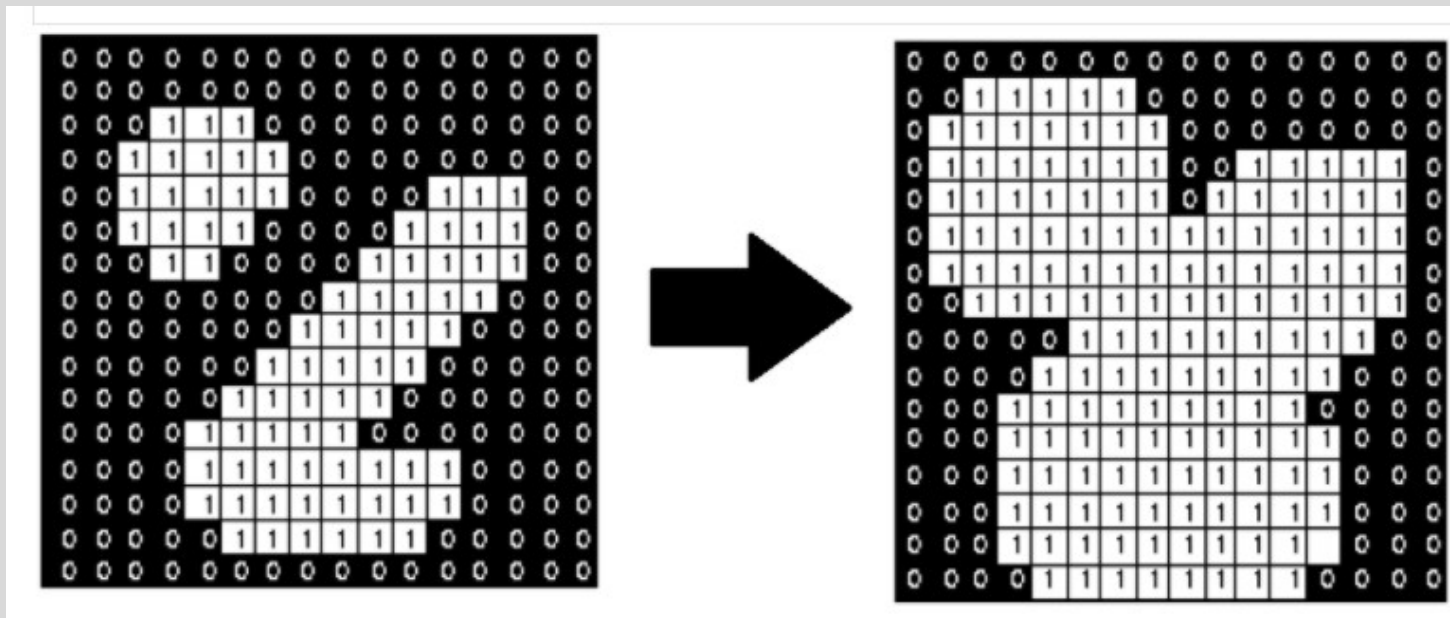
- $A = \{ (2,2), (2,3), (2,4), (3,2), (3,3), (3,4), (4,3) \}$
- $B = \{ (-1, 0), (0,0), (1,0) \}$

A (+) B = pada tabel berikut

| Posisi Poros<br>(y,x) ∈ A | Strel                | A (+) B             |
|---------------------------|----------------------|---------------------|
| (2,2)                     | (-1,0), (0,0), (1,0) | (1,2), (2,2), (3,2) |
| (2,3)                     | (-1,0), (0,0), (1,0) | (1,3), (2,3), (3,3) |
| (2,4)                     | (-1,0), (0,0), (1,0) | (1,4), (2,4), (3,4) |
| (3,2)                     | (-1,0), (0,0), (1,0) | (2,2), (3,2), (4,2) |
| (3,3)                     | (-1,0), (0,0), (1,0) | (2,3), (3,3), (4,3) |
| (3,4)                     | (-1,0), (0,0), (1,0) | (2,4), (3,4), (4,4) |
| (4,3)                     | (-1,0), (0,0), (1,0) | (3,3), (4,3), (5,3) |



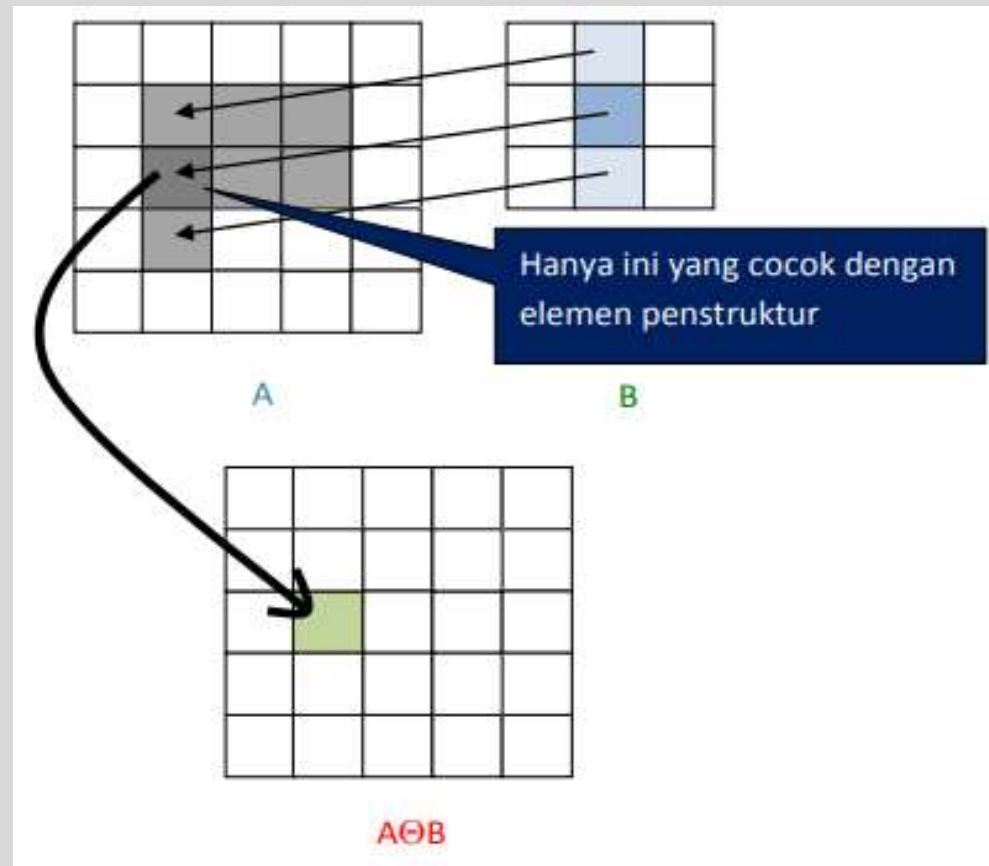
# Contoh Efek Operasi Dilasi



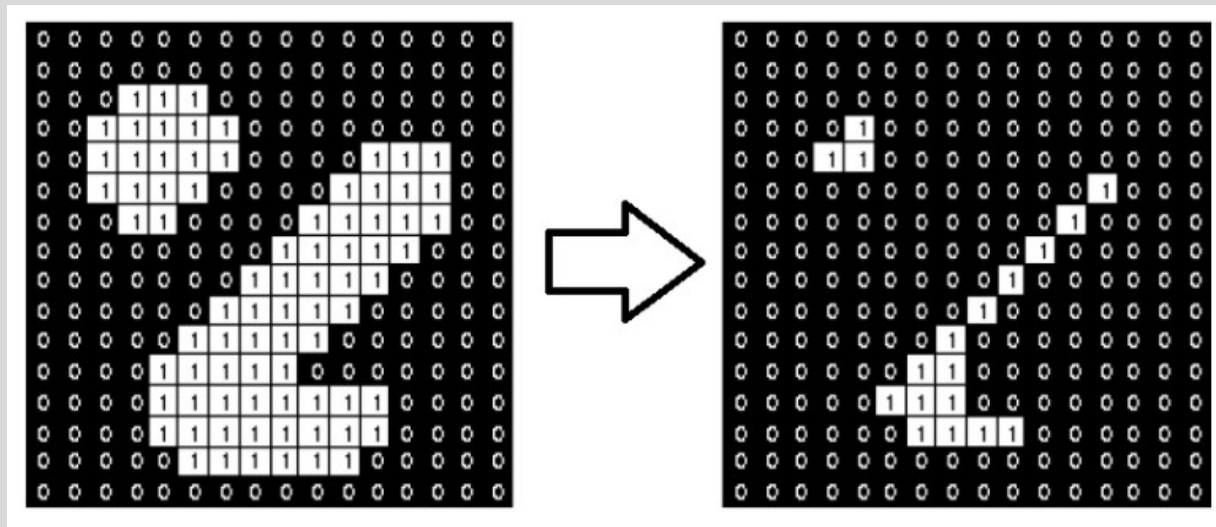
# Operasi Erosi

- Salah satu wujud operasi morfologi yang berkebalikan dengan dilasi
- Operasi ini membuat objek pada suatu citra menjadi lebih kecil atau tipis
- **Cara:**
  - Mengubah semua titik batas menjadi titik latar
  - Membuat semua titik di sekeliling titik latar menjadi titik latar

# Operasi Erosi



# Operasi Erosi



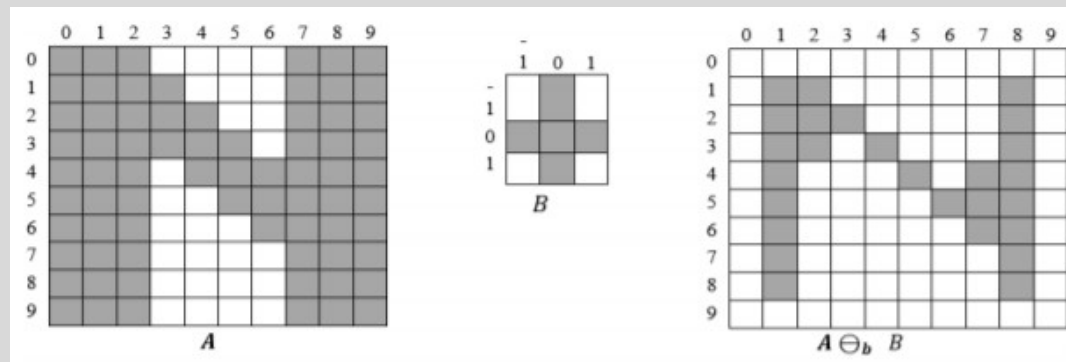
(Sumber : <https://devtrik.com/opencv/operasi-morfologi-pada-pengolahan-citra/>)

# Operasi Erosi

$A = \{(0,0), (0,1), (0,2), (0,7), (0,8), (0,9), (1,0), (1,1), (1,2), (1,3), (1,7), (1,8), (1,9), (2,0), (2,1), (2,2), (2,4), (2,7), (2,8), (2,9), (3,0), (3,1), (3,2), (3,3), (3,4), (3,5), (3,7), (3,8), (3,9), (4,0), (4,1), (4,2), (4,4), (4,5), (4,6), (4,7), (4,8), (4,9), (5,0), (5,1), (5,2), (5,5), (5,6), (5,7), (5,8), (5,9), (6,0), (6,1), (6,2), (6,6), (6,7), (6,8), (6,9), (7,0), (7,1), (7,2), (7,7), (7,8), (7,9), (8,0), (8,1), (8,2), (8,7), (8,8), (8,9), (9,0), (9,1), (9,2), (9,7), (9,8), (9,9)\}$

$B = \{(-1,0), (0,-1), (0,0), (0,1), (1,0)\}$

$A \ominus B = \{(1,1), (1,2), (1,8), (2,1), (2,2), (2,3), (2,8), (3,1), (3,2), (3,4), (3,8), (4,1), (4,5), (4,7), (4,8), (4,9), (5,0), (5,1), (5,6), (5,7), (5,8), (6,1), (6,7), (6,8), (7,1), (7,8), (8,1), (8,8)\}$





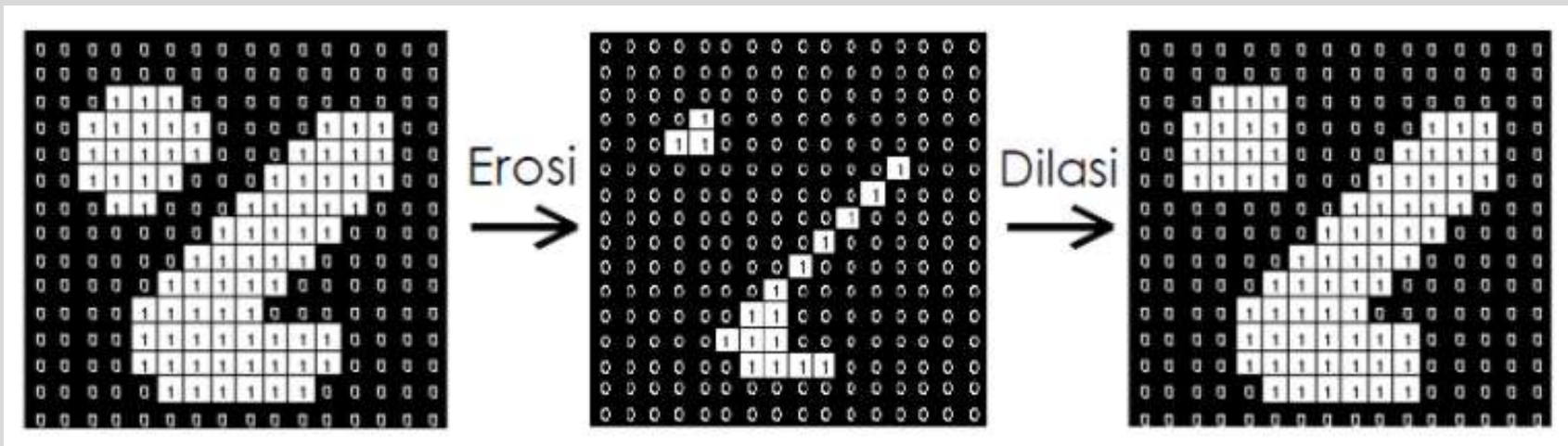
# Operasi Opening

- Kombinasi antara operasi erosi dan dilasi yang dilakukan secara berurutan, tetapi citra asli dierosi terlebih dahulu baru kemudian hasilnya didilasi, menggunakan SE yang sama.
- Tujuan: memutus bagian-bagian dari objek yang hanya terhubung dengan 1 atau 2 buah titik saja, atau menghilangkan objek-objek kecil tanpa mengubah area objek secara signifikan.

# Operasi Opening

- Opening bersifat *idempotent* yaitu jika operasi opening diulang-ulang, tidak berdampak berkelanjutan.
- Operasi opening menggunakan persamaan sebagai berikut:

$$A \circ B = (A \ominus B) \oplus B$$



# Opening

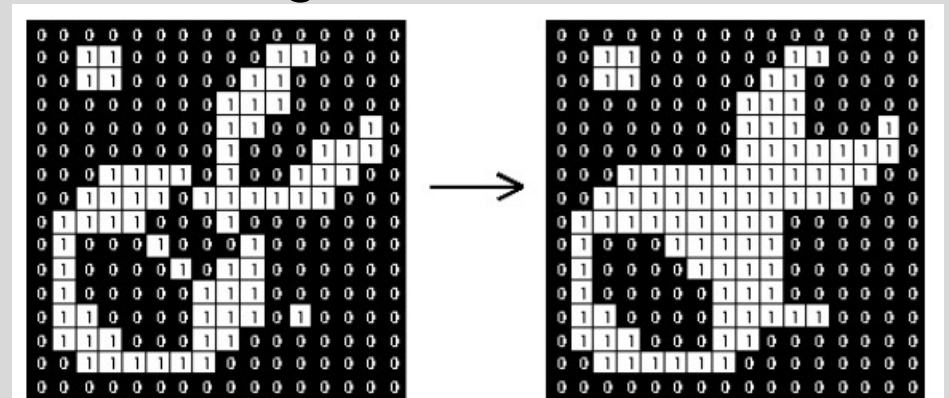
- SE Circle 11



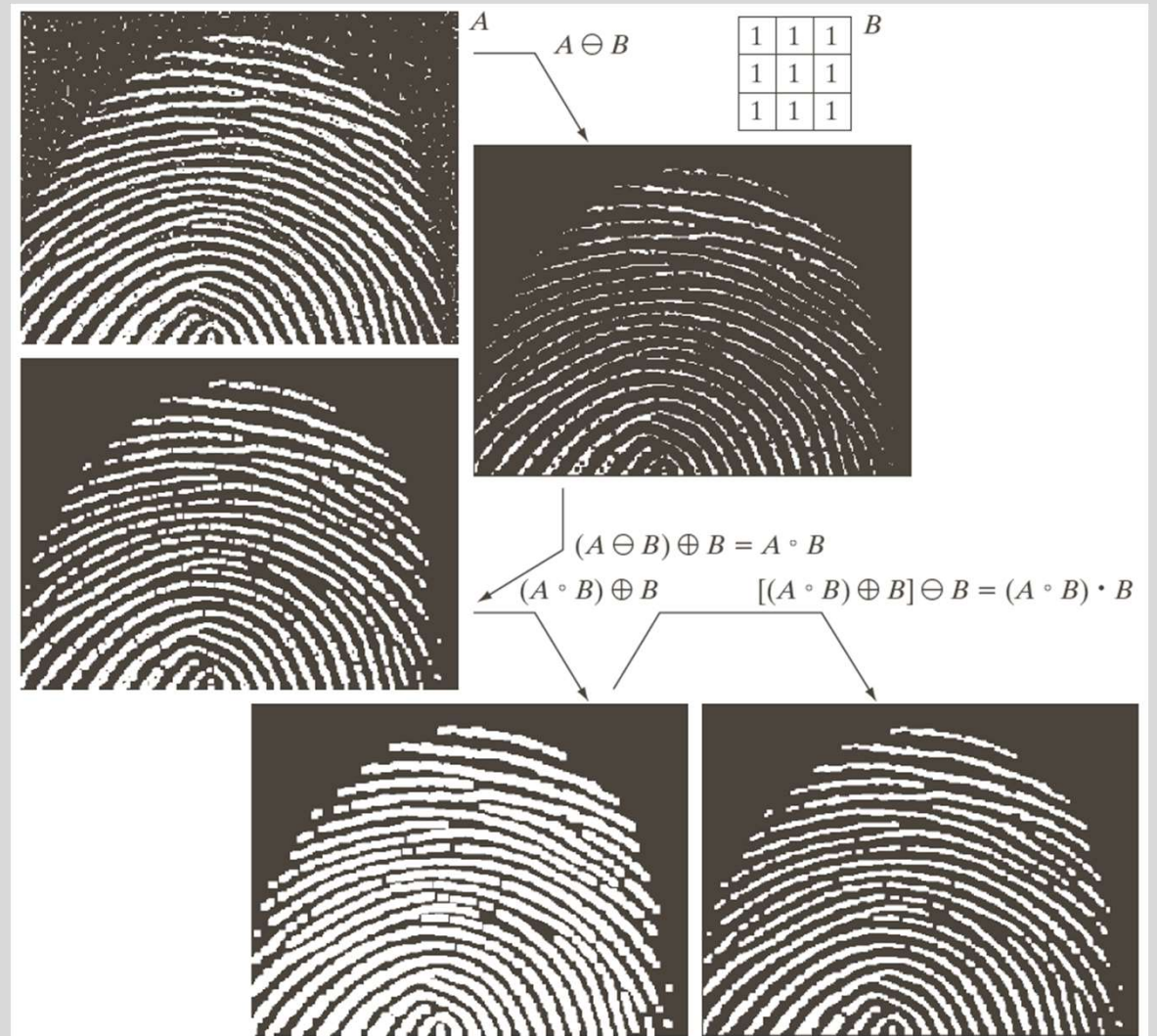
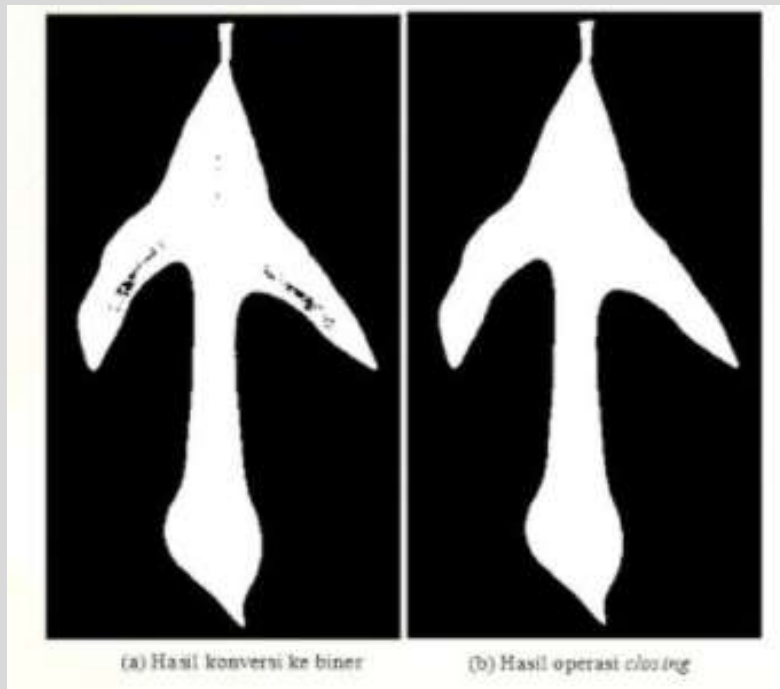
# Operasi Closing

- Kombinasi antara operasi dilasi dan erosi yang dilakukan secara berurutan.
- Tujuan: menutup atau menghilangkan lubang-lubang kecil yang ada dalam segmen objek, serta menggabungkan objek yang berdekatan tanpa mengubah objek secara signifikan.
- Operasi *closing* menggunakan persamaan sebagai berikut:

$$A \bullet B = (A \oplus B) \ominus B$$



# Operasi Closing



# TOP HAT

- Top Hat/White Hat Top Hat Transform, juga dikenal sebagai White Hat Transform, diperoleh dengan menghapus atau mengurangi Opening gambar dari gambar aslinya. Operator ini memberi fitur cerah pada gambar yang lebih kecil dari Structuring Element.

- $T_{hat}(f) = f - y(f)$



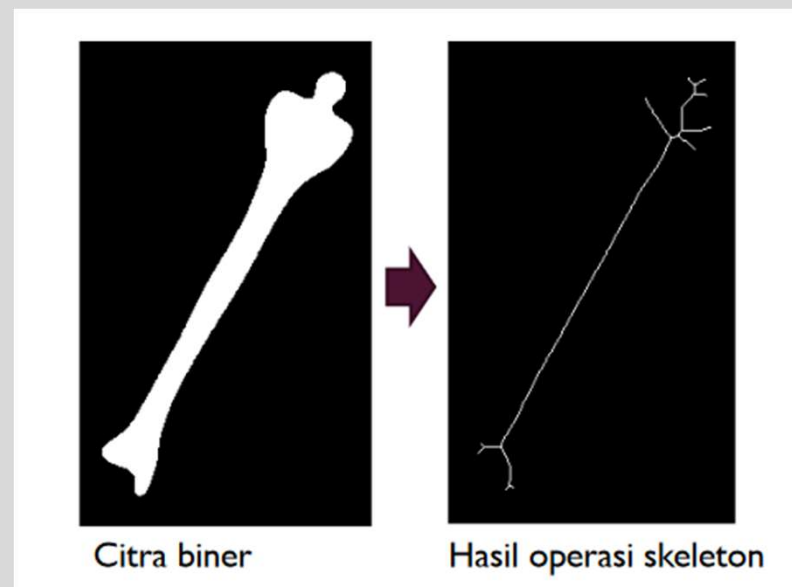
# Black Hat

- Black Hat/Bottom Hat Transformasi Black Hat, juga dikenal sebagai Transformasi Bottom Hat, diperoleh dengan menghapus atau mengurangi Closing gambar dari gambar aslinya. Operator ini memberi fitur gelap pada gambar yang lebih kecil dari Elemen Penataan.
- $B_{hat}(f) = B(f) - f$



# Skeleton

Skeleton memberikan representasi simpel dari suatu objek dengan jumlah piksel yang kecil dan tetap mempertahankan karakteristik ukuran, posisi dan topologi dari bentuk aslinya.





# Thinning

- Penipisan himpunan  $A$  oleh strel  $B$ , yang dinyatakan dengan  $A \oslash B$ , dapat didefinisikan dalam transformasi hit-or-miss dengan bentuk:
  - $A \oslash B = A \cap (A \circledast B)^c$
  - $A \oslash B = A - (A \circledast B)$
- Prosesnya adalah:
  - Menipiskan  $A$  oleh satu lewatan dengan  $B_1$ ,
  - kemudian menipiskan hasilnya dengan satu lewatan  $B_2$ ,
  - dan seterusnya, sampai  $A$  ditipiskan dengan satu lewatan  $B_n$ .
  - Semua proses ini diulang sampai tidak ada perubahan yang terjadi.
- Setiap penipisan dilewatkan dengan menggunakan persamaan  $A \oslash B = A \cap (A \circledast B)^c$

|   |   |   |   |   |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |

A B1 B2 B3 B4 B5 B6 B7 B8

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| 1 | 1 | 1 | 1 | 1 |
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| 0 | 0 | 0 | 0 | 0 |
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| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 |

A A ⊗ B1 A1 = A - (A ⊗ B1) A1 ⊗ B2 A2 = A1 - (A1 ⊗ B2)

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| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 |
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |

A2 ⊗ B3 A3 = A2 - (A2 ⊗ B3) A3 ⊗ B4 A4 = A3 - (A3 ⊗ B4) A4 ⊗ B5 A5 = A4 - (A4 ⊗ B5)

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 1 | 1 | 1 | 1 | 0 |
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| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |

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| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
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| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 |

A5 ⊗ B6 A6 = A5 - (A5 ⊗ B6) A6 ⊗ B7 A7 = A6 - (A6 ⊗ B7) A7 ⊗ B8 A8 = A7 - (A7 ⊗ B8)

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
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| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 1 | 1 | 0 | 0 |
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| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

thinning kedua

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
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|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 |
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|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
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|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
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| 0 | 0 | 0 | 0 | 0 |
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|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

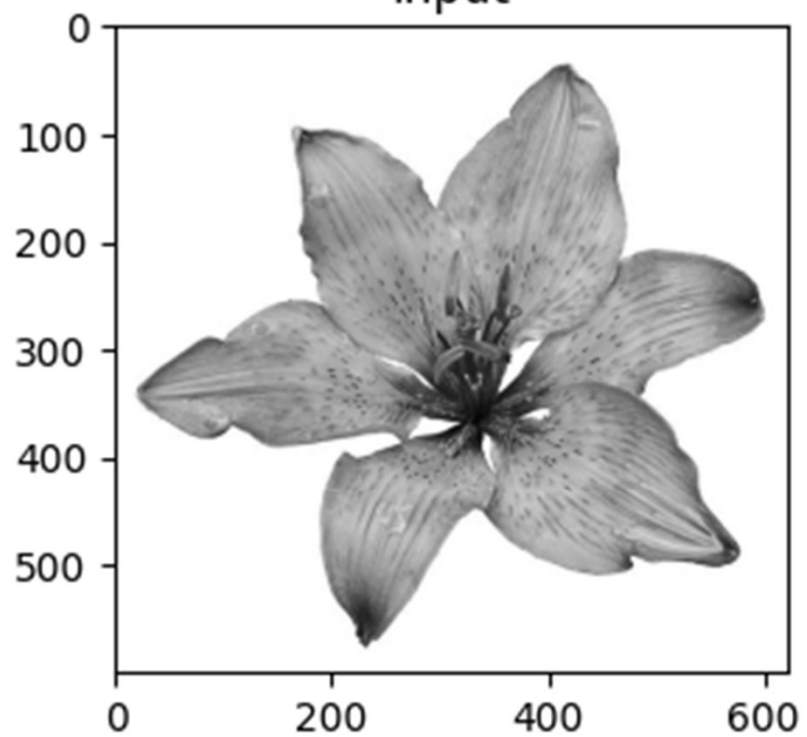
|   |   |   |   |   |
|---|---|---|---|---|
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| 0 | 0 | 0 | 0 | 0 |
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| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

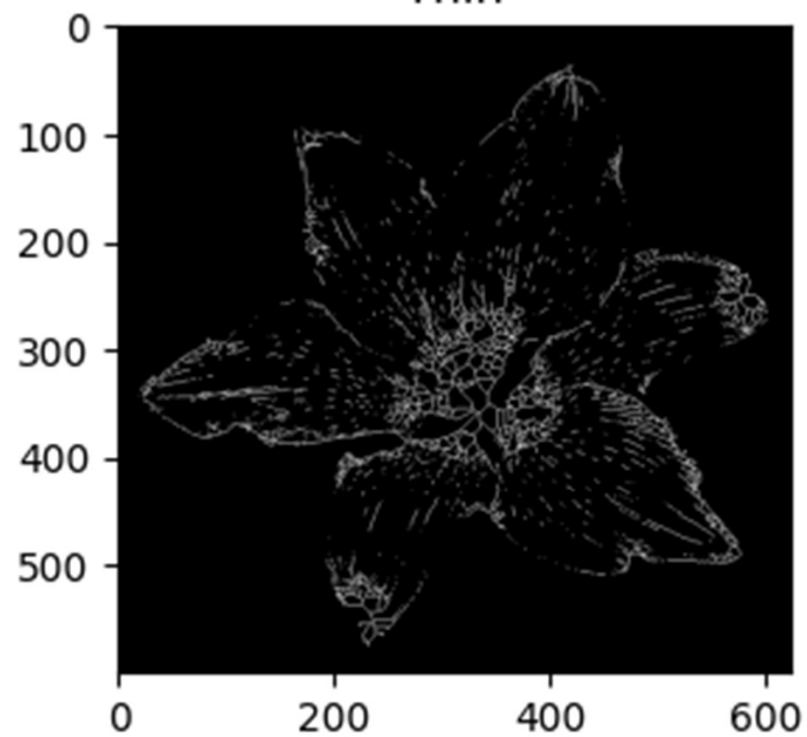
|   |   |   |   |   |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

hasil akhir setelah 2 kali thinning

Input



Thin



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**TERIMA KASIH!**



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