AREL ÜNİVERSİTESİ
BİYOMEDİKAL GÖRÜNTÜ İŞLEME

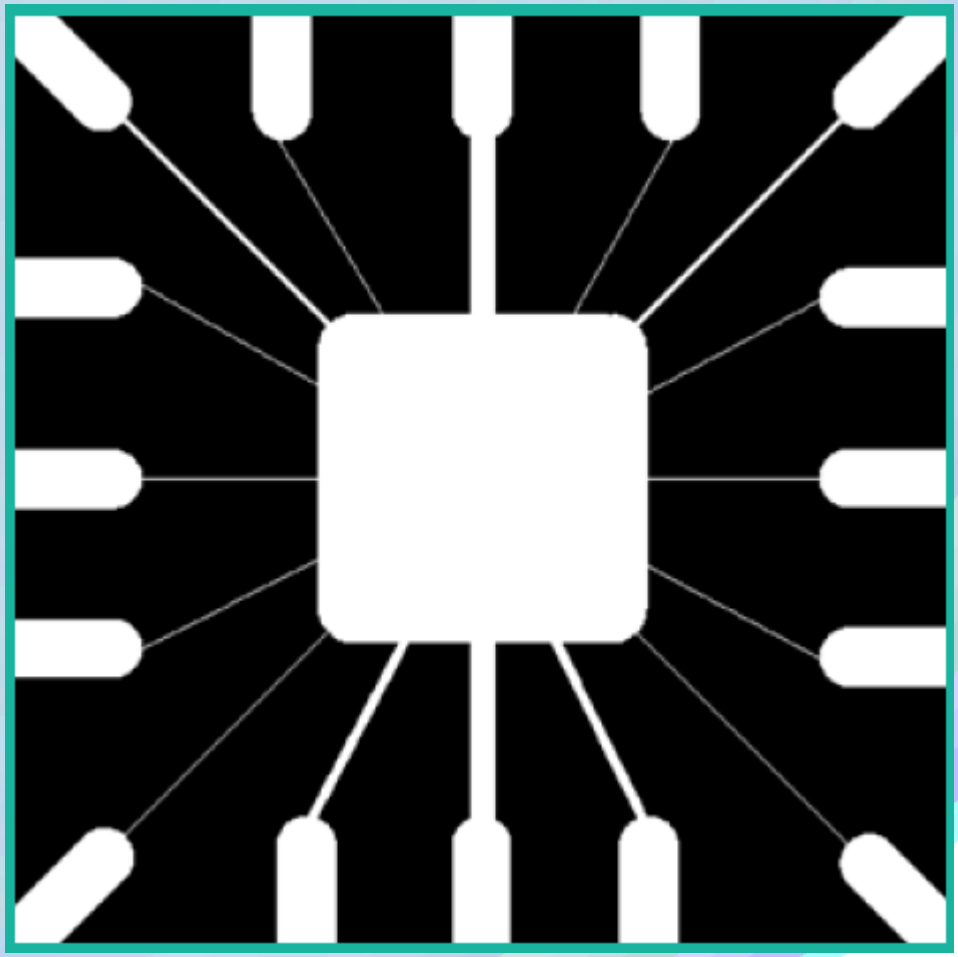
MORFOLOJİK GÖRÜNTÜ İŞLEME

DR. GÖRKEM SERBES

İkili Seviye Görüntü Analizi

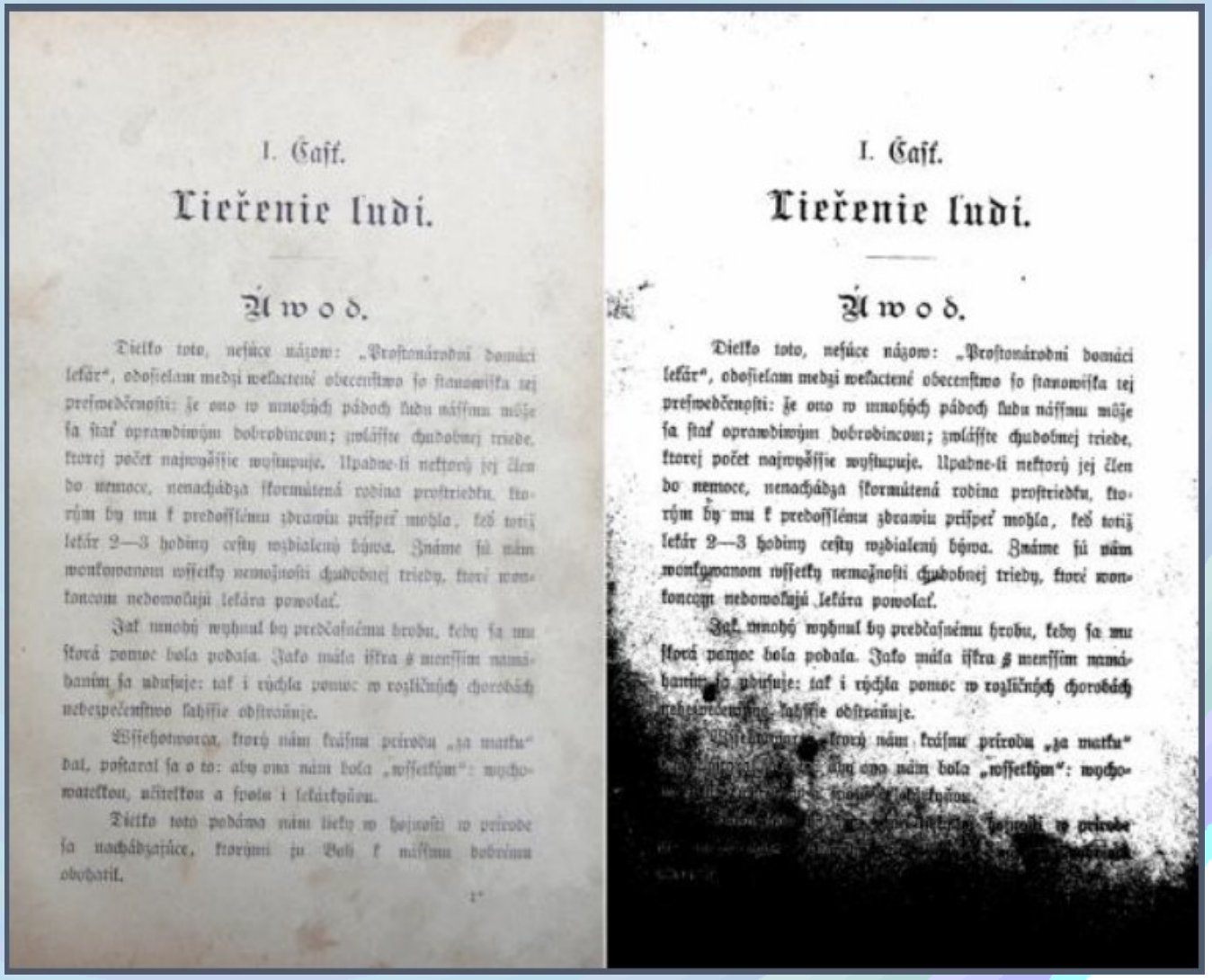
- İkili seviye (binary) görüntüleri işleyen operasyon bütünleri, 1'ler ve 0'lar.
  - 0 arka planı temsil etmekte
  - 1 ön planı temsil etmekte

```
0001001000 1000
0001111000 1000
0001001000 1000
```



İkili Seviye Görüntü Analizi

- Hangi pratik uygulamalarda kullanılabilir?
  - Belge işleme
  - Parça muayene
  - Üretim



I. Časť.

Liečenie ľudi.

Úvod.

Dielko toto, nesúce názov: „Prostonárodní domáci lekár“, odoslelam medzi welactené obecenstwo so stanowiska tej preswedčenosti: že ono w mnohých pádoch ľudu náššmu může sa stať opravdivým dobrodincom; zwláště chudobnej triede, ktorej počet najwyššie wystupuje. Upadne-li nektorý jej člen do nemoce, nenachádza skormútená rodina prostriedku, ktorým by mu k predošlému zdraviu prišpeť mohla, keď totiž lekár 2—3 hodiny cesty wzdialený býwa. Známe sú nám wonkuwanom wšetky nemožnosti chudobnej triedy, ktoré wonkoncom nedowoľujú lekára powolať.

Jak mnohý wyhnul by predčasnému hrobu, keby sa mu skorá pomoc bola podala. Jako mála iskra s menšim namáhaním sa udušuje: tak i rýchla pomoc w rozličných chorobách nebezpečenstwo ľahšie odstraňuje.

Wšehotworca, ktorý nám krásnu prirodu „za matku“ dal, postaral sa o to: aby ona nám bola „wšetkým“: mychowateľkou, učiteľkou a spolu i lekárkyňou.

Dielko toto podáwa nám lieky w hojnosti w prirode sa nachádzajúce, ktorými ju Boh k nášmu dobrému obohatil.

I. Časť.

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Úvod.

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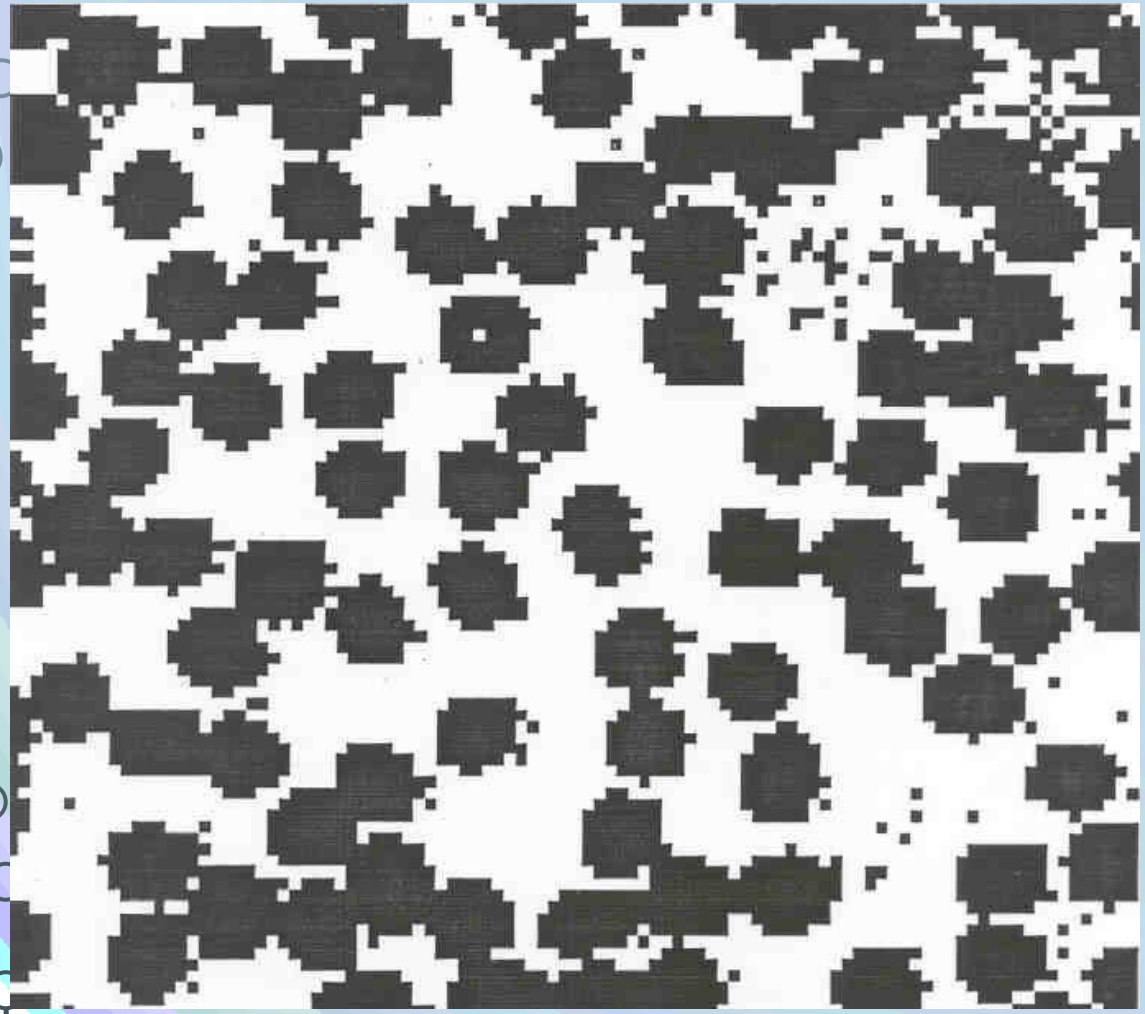
Ne Tür Operasyonlar Yapılıyor?

- Objeleri arka plandan ayrıştırmak.
- Objelerin piksel bütünlüğünü sağlamak.
- Objelerden öznitelik çıkarmak.

Örnek: Kırmızı Kan Hücreleri Görüntüsü



- Kan hücreleri ayrı objelerdir.
- Bir çoğu temas halinde.
- Eşiklemeden dolayı oluşan tuz biber gürültüsü.

Analiz Sonuçları

- 63 ayrı nesne tespit edildi.
- Hücreler ortalama 50 piksel alana sahip.
- Gürültü noktaları var.
- Hücrelerin birleşiminden dolayı oluşan yapılar var.

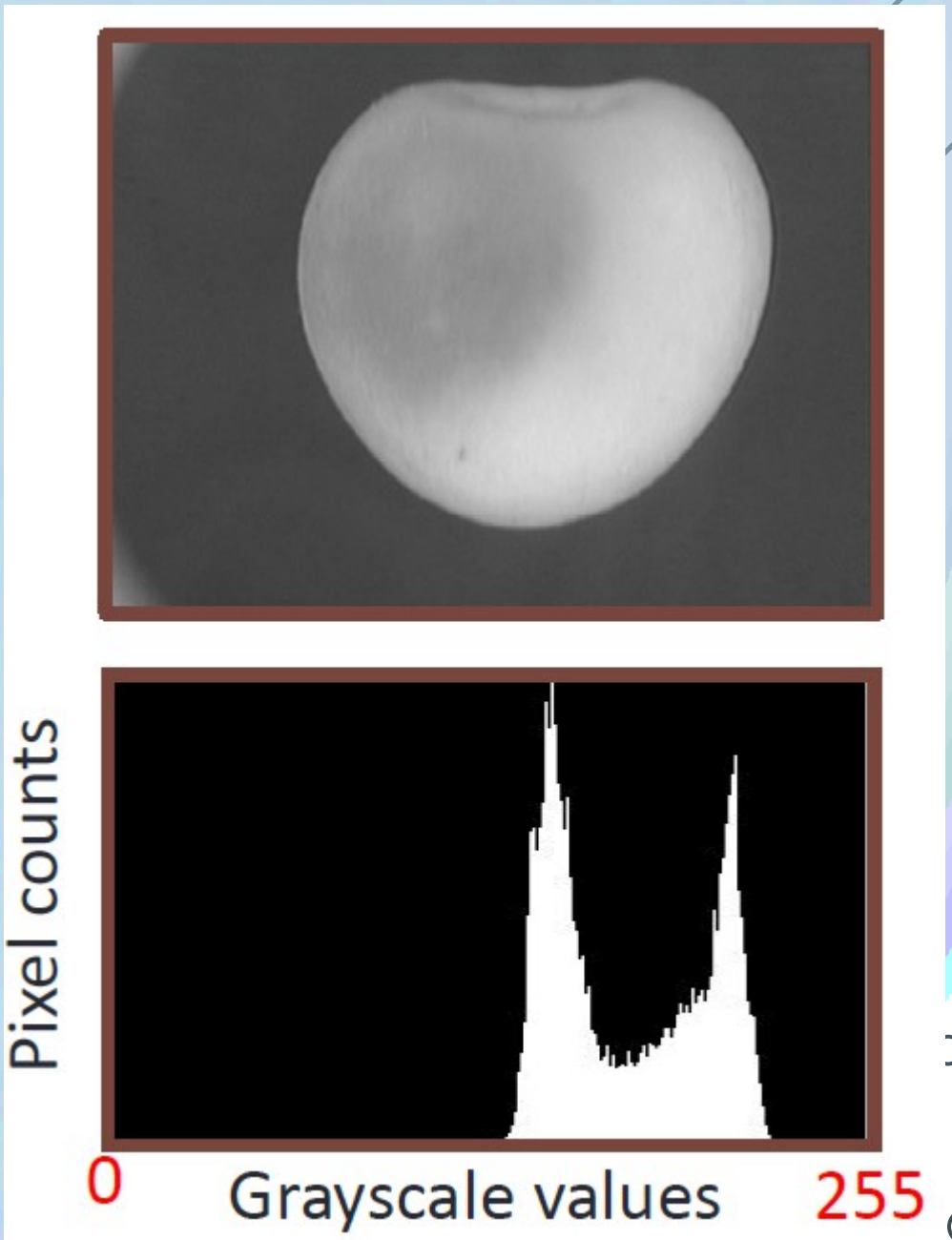
Object	Area	Centroid	Bounding Box	
1	383	(8.8 , 20)	[1 22 1 39]	
2	83	(5.8 , 50)	[1 11 42 55]	
3	11	(1.5 , 57)	[1 2 55 60]	
4	1	(1 , 62)	[1 1 62 62]	
5	1048	(19 , 75)	[1 40 35 100]	gobs
32	45	(43 , 32)	[40 46 28 35]	cell
33	11	(44 , 1e+02)	[41 47 98 100]	
34	52	(45 , 87)	[42 48 83 91]	cell
35	54	(48 , 53)	[44 52 49 57]	cell
60	44	(88 , 78)	[85 90 74 82]	
61	1	(85 , 94)	[85 85 94 94]	
62	8	(90 , 2.5)	[89 90 1 4]	
63	1	(90 , 6)	[90 90 6 6]	

Kullanılan İşlemler

- Gri seviye gürültünün eşiklenmesi.
- Doğru eşik değerlerinin tespit edilmesi.
- Bağlantılı Bileşen Etiketleme (Connected Component Labeling).
- Morfolojik işlemlerin uygulanması.
- İstatiksel analiz ve öznitelik çıkarımı.

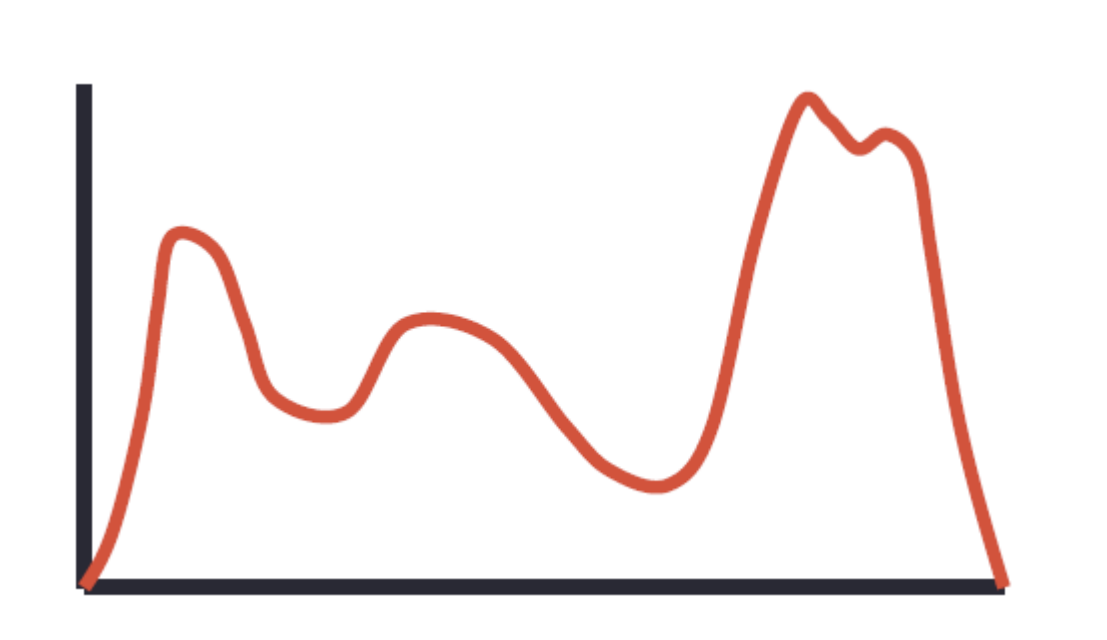
Eşikleme (Thresholding)

- Aka plan siyah.
- Sağlıklı kısım parlak.
- Çürümüş kısım daha koyu.
- Histogramda iki alan ön plana çıkıyor.



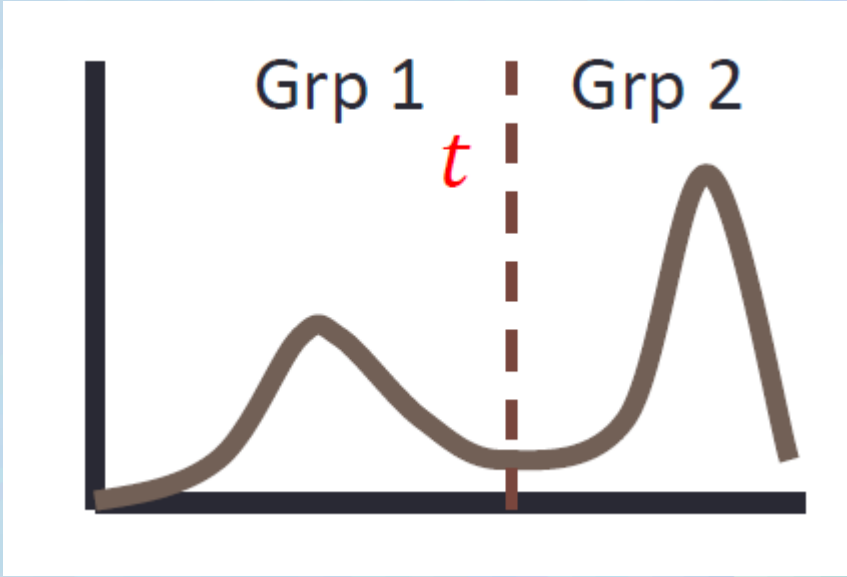
Histogram – Eşik Değeri Bulma

- Histogramı nasıl parçalara böleceğiz?

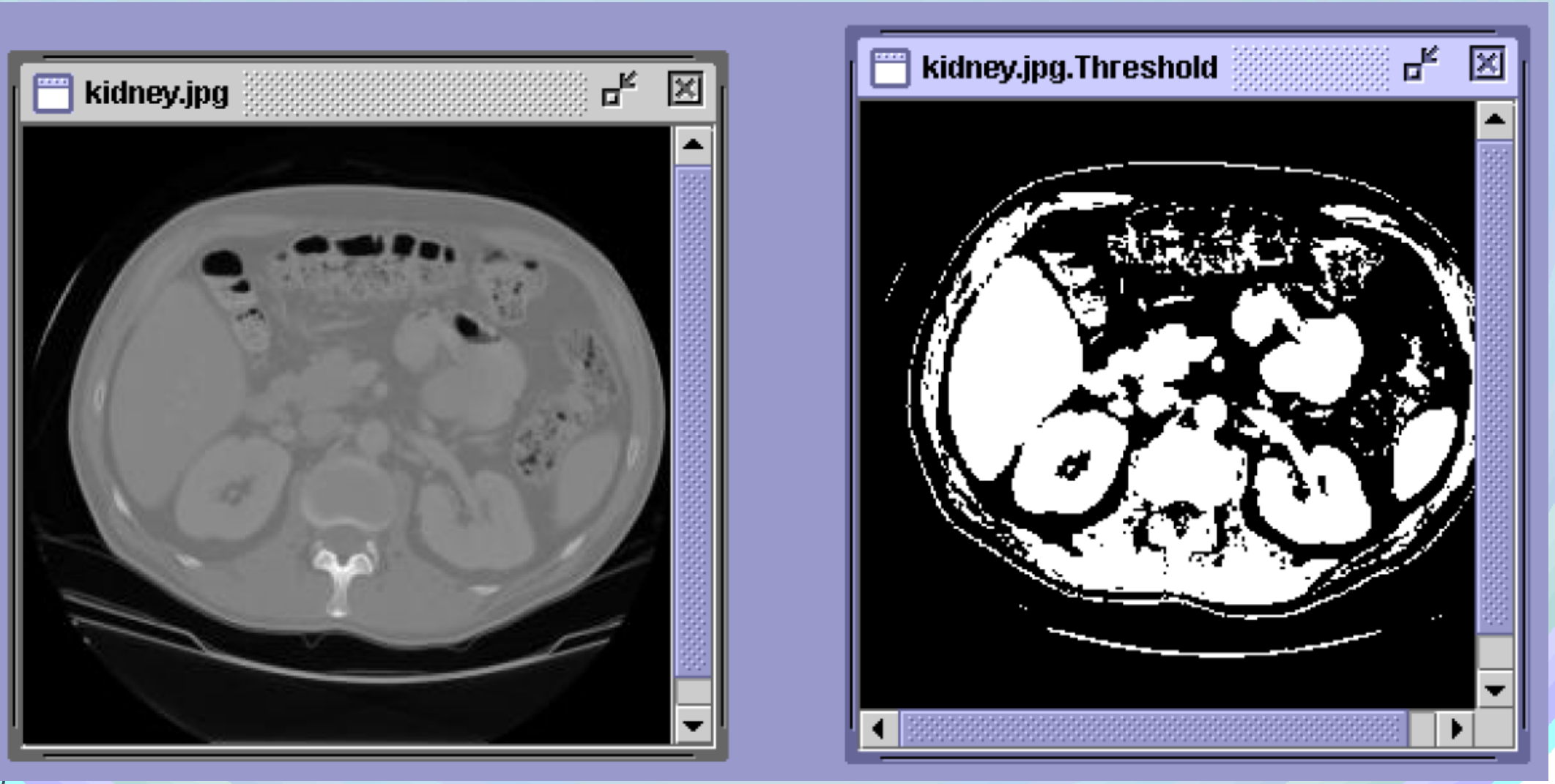


Otomatik Eşik Değeri Bulma : Otsu Metodu

- Kabul: Histogram bimodal.
- Yöntem: Grup içi varyansların ağırlıklı toplamını en aza indiren eşik değerini bulun.

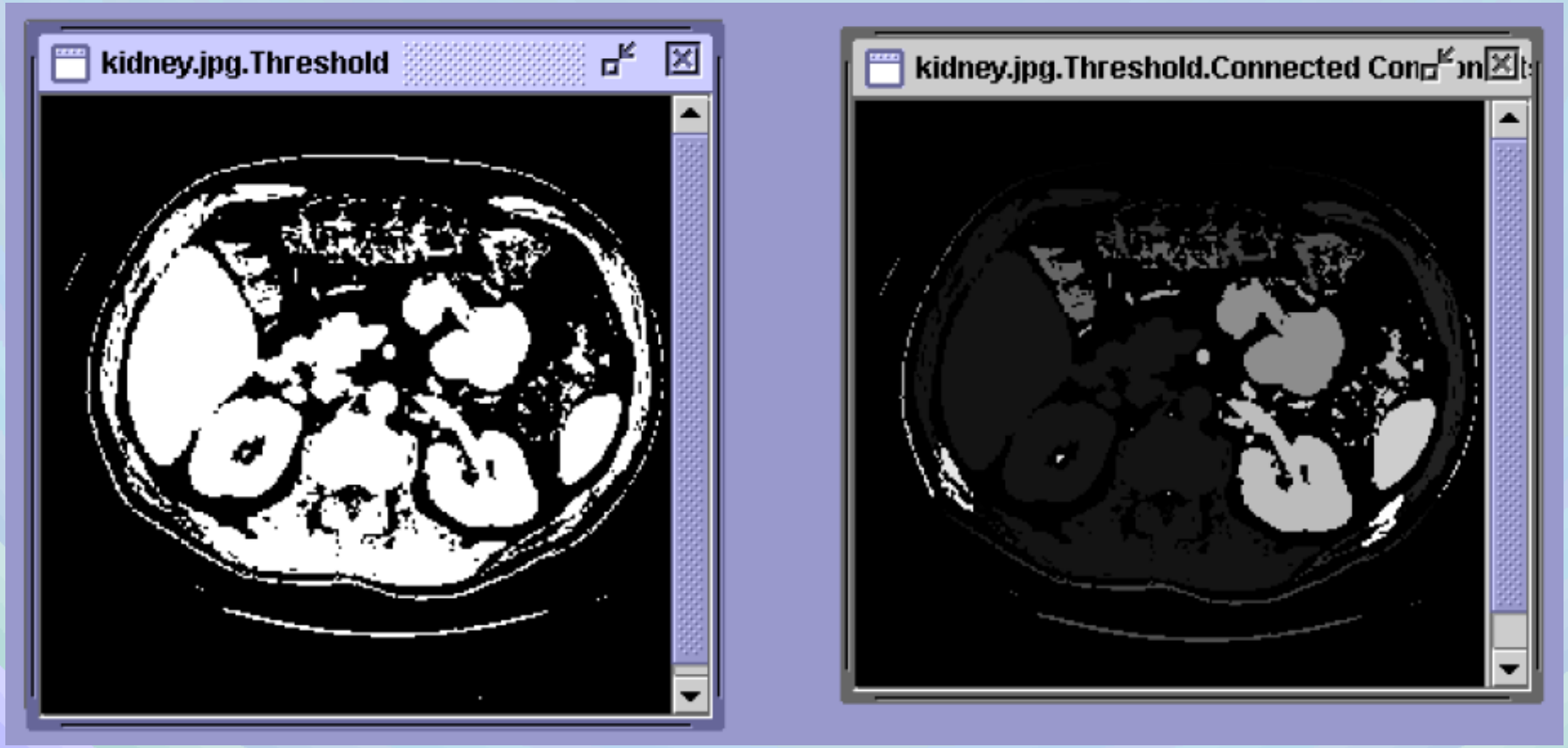


Eşikleme Örneği



Bağlantılı Bileşen Etiketleme (Connected Component Labeling)

- Elinizde ikili (binary) görüntü var ise, birbirine bağlı pikselleri analiz edip onları belirleyebilirsiniz.



Bağlantılı Bileşen Etiketleme (Connected Component Labeling)

Original Binary Image

0	0	0	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	1
0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	1	1	1
0	0	0	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1
0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1

Bağlantılı Bileşen Etiketleme (Connected Component Labeling)

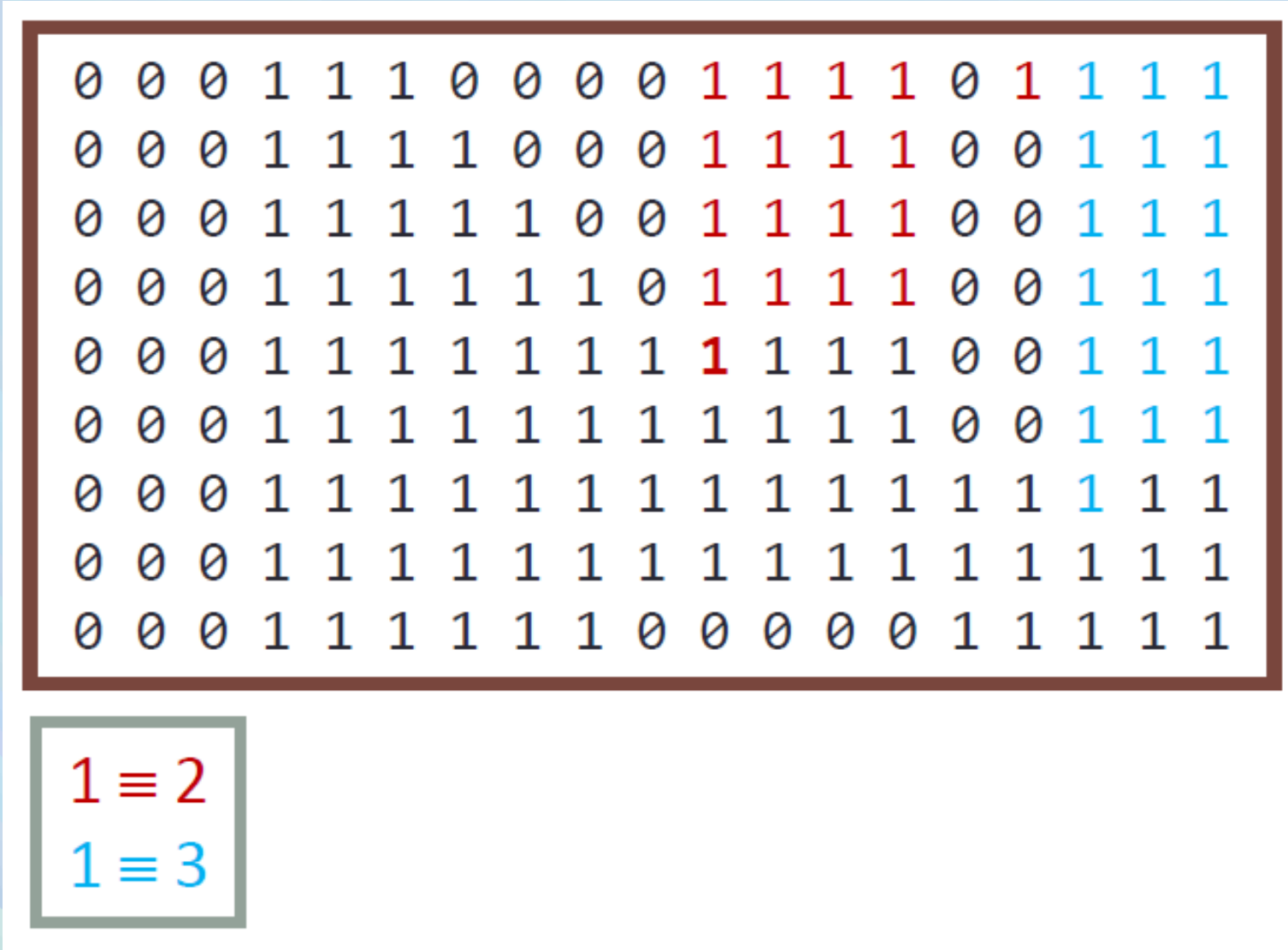
Bağlantılı Bileşen Etiketleme (Connected Component Labeling)

0	0	0	1	1	1	0	0	0	0	2	2	2	2	0	3	3	3	3
0	0	0	1	1	1	1	0	0	0	2	2	2	2	0	0	3	3	3
0	0	0	1	1	1	1	1	0	0	2	2	2	2	0	0	3	3	3
0	0	0	1	1	1	1	1	1	0	2	2	2	2	0	0	3	3	3
0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	3	3	3	
0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	3	3	3	
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1

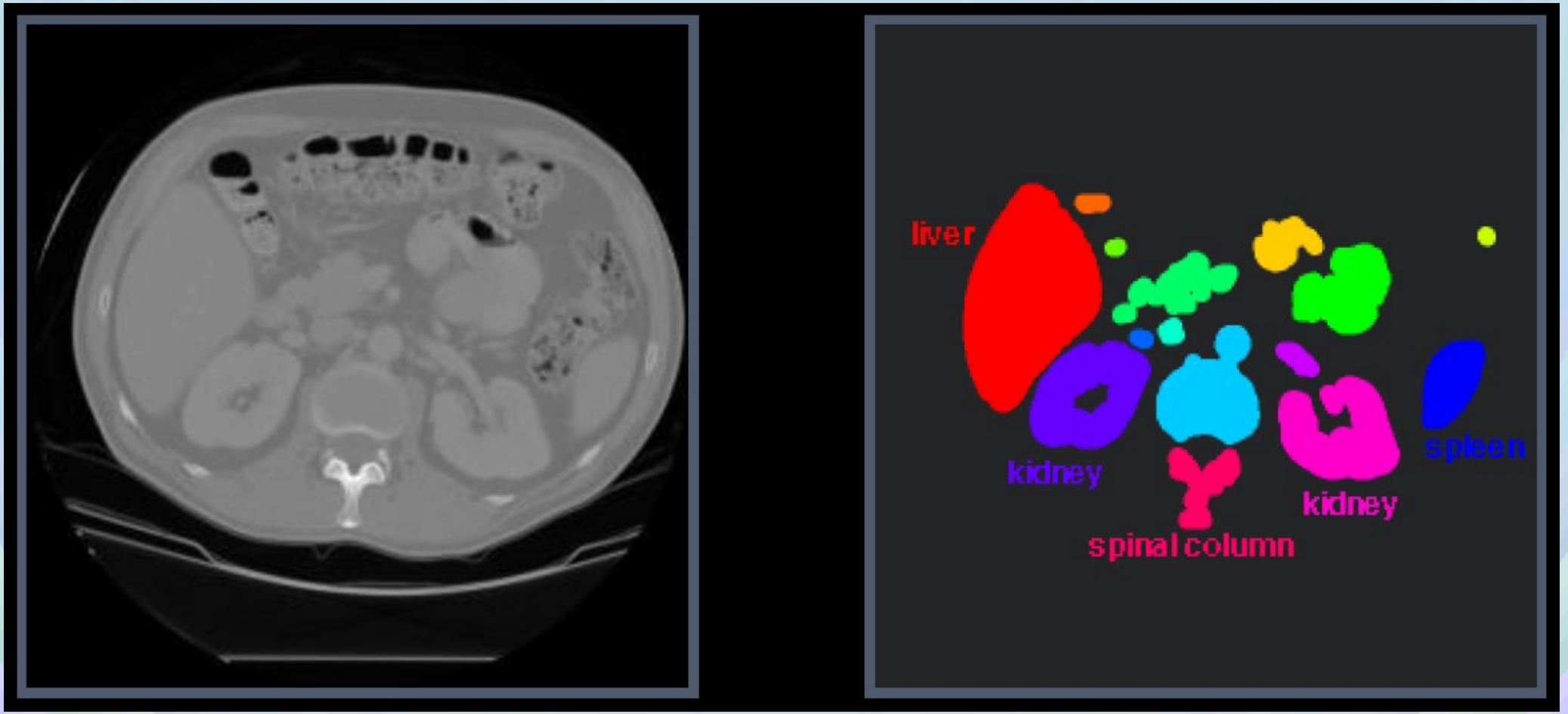
$1 \equiv 2$

$1 \equiv 3$

Bağlantılı Bileşen Etiketleme (Connected Component Labeling)



Ayrılan Objeleri Etiketleme



Morfolojik İşlemler

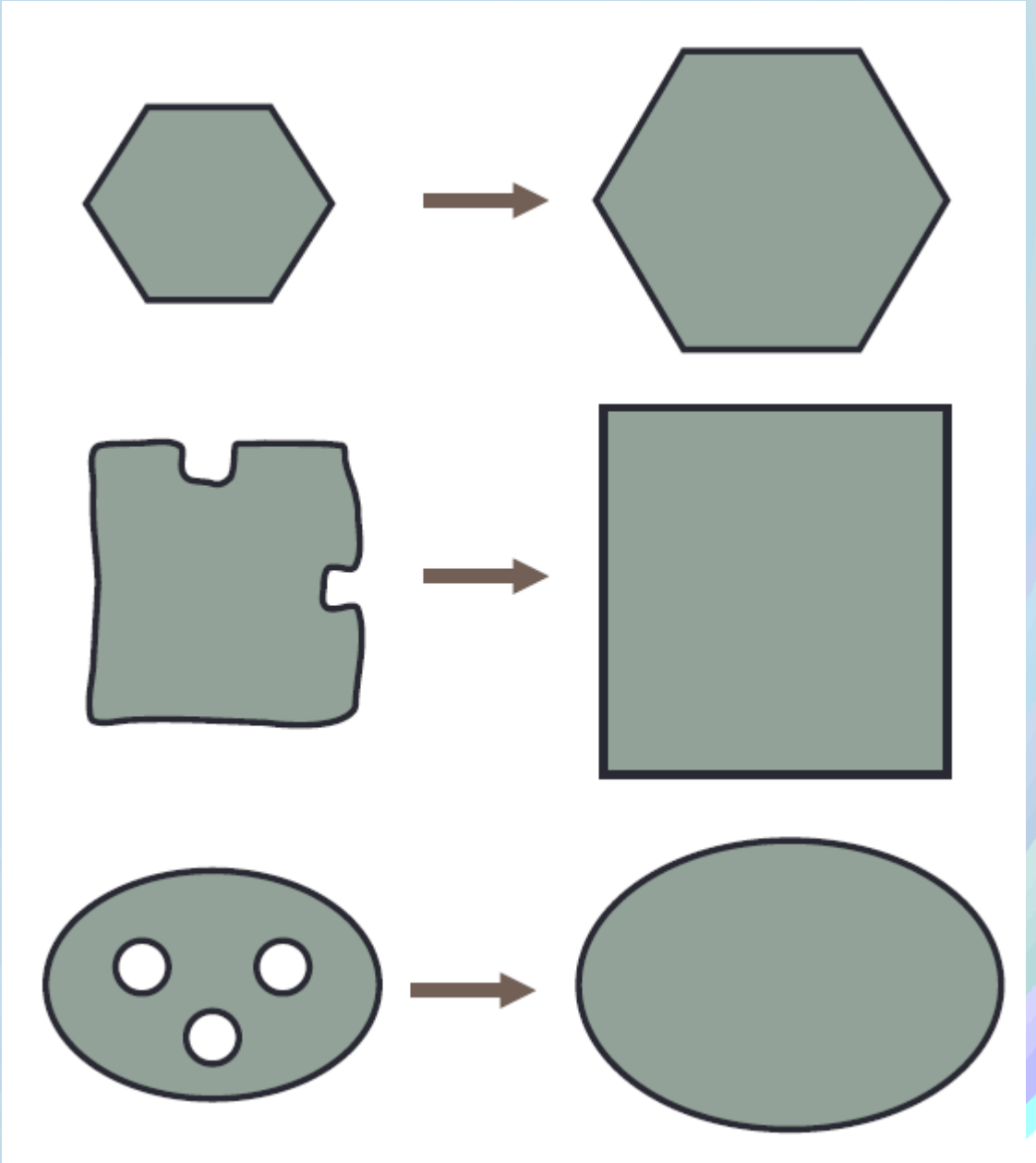
- Temel iki işlem:
  - Dilation (Genişleme)
  - Erosion (Aşınma)

- Ve bu temel işlemlerin birleşiminden oluşan işlemler.
  - Açma ve Kapama
  - İnceltme ve kalınlaştırma

Dilation (Genişleme)

- Biri ikili görüntüdeki bağlanmış 1’li kümeleri genişletir.

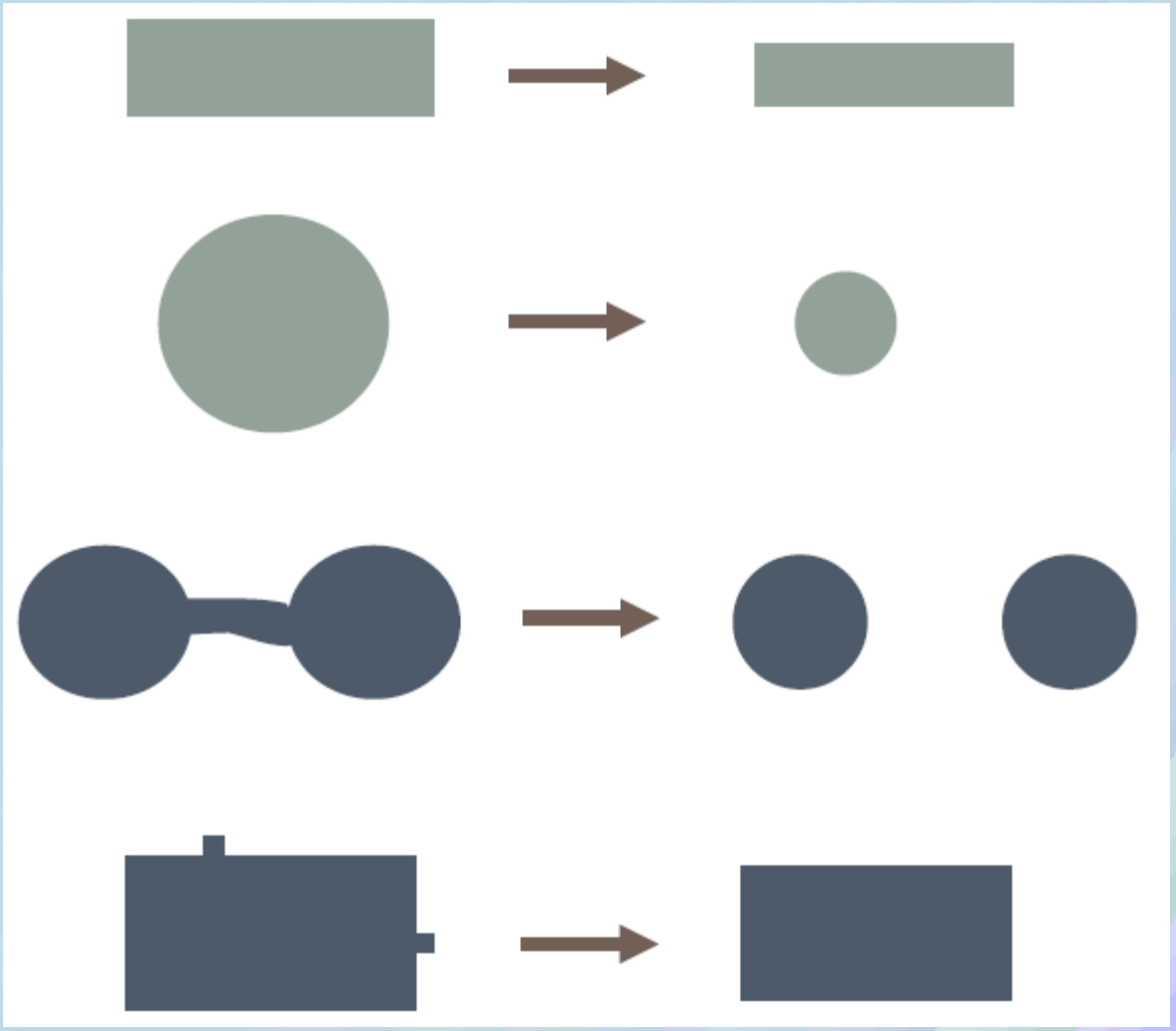
- Ne için kullanılır:
  - İmgeleri genişletmek
  - Boşlukları doldurmak.



Erosion (Aşınma)

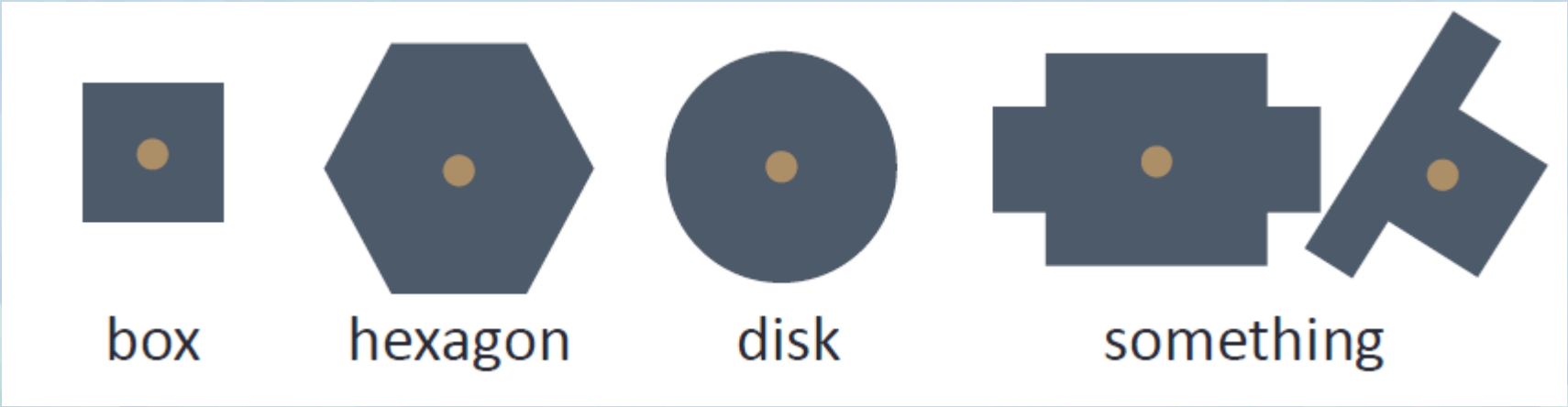
- Biri ikili görüntüdeki bağlanmış 1’li kümeleri küçültür.

- Ne için kullanılır:
  - İmgeleri küçültmek
  - Köprüleri, dalları ve çıkıntıları kaldırmak.

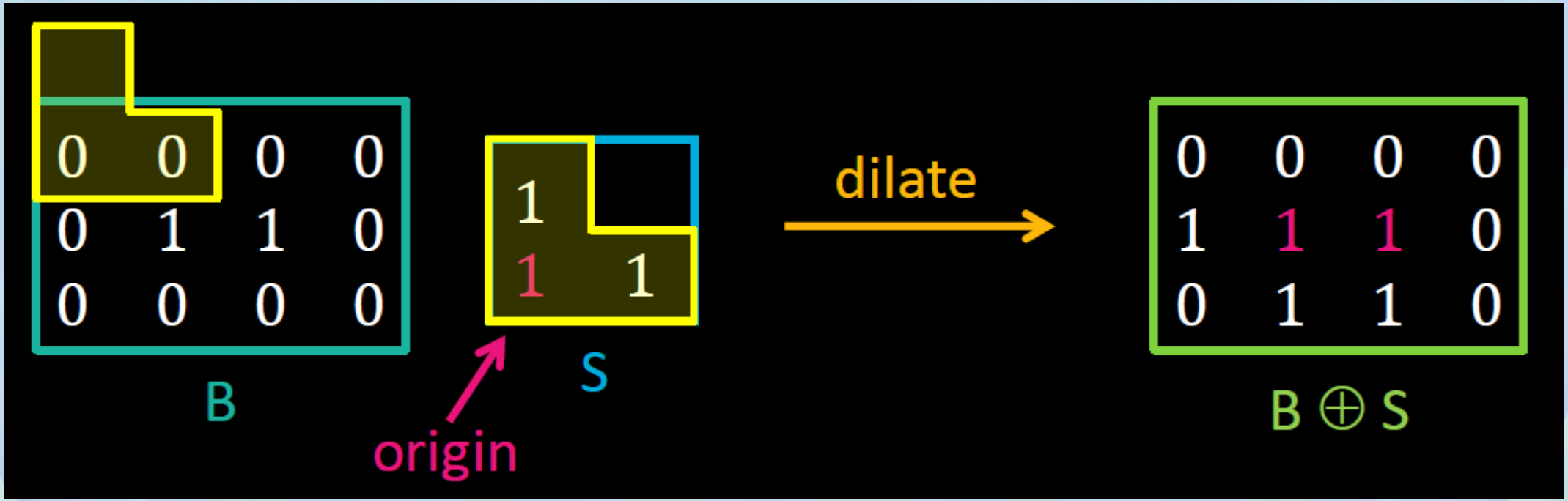


Yapı Elemanı (Structure Element)

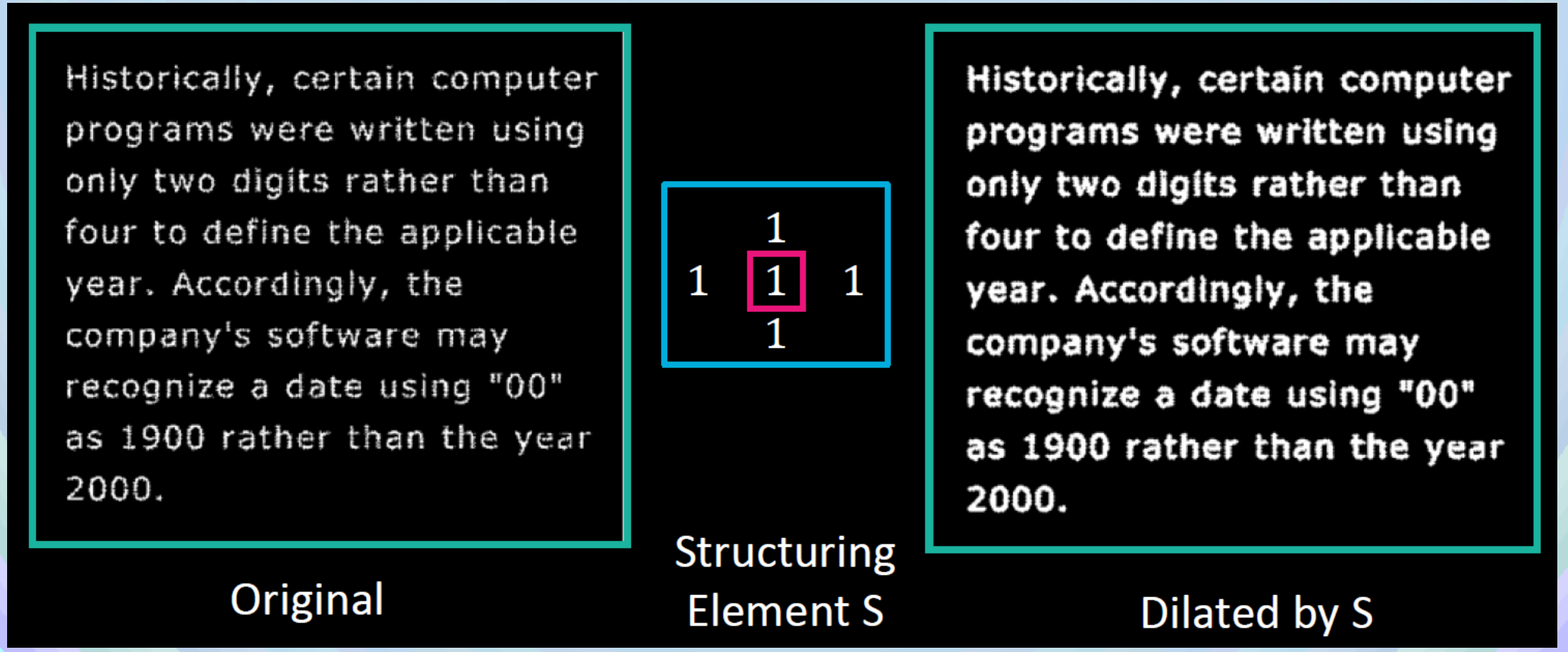
- Sayısal olarak oluşturulabilen her şekil ve ebatta olabilir.
- Morfolojik işlemlerde kullanılan maskelerdir.
- Orjin ile birlikte belirtilir.



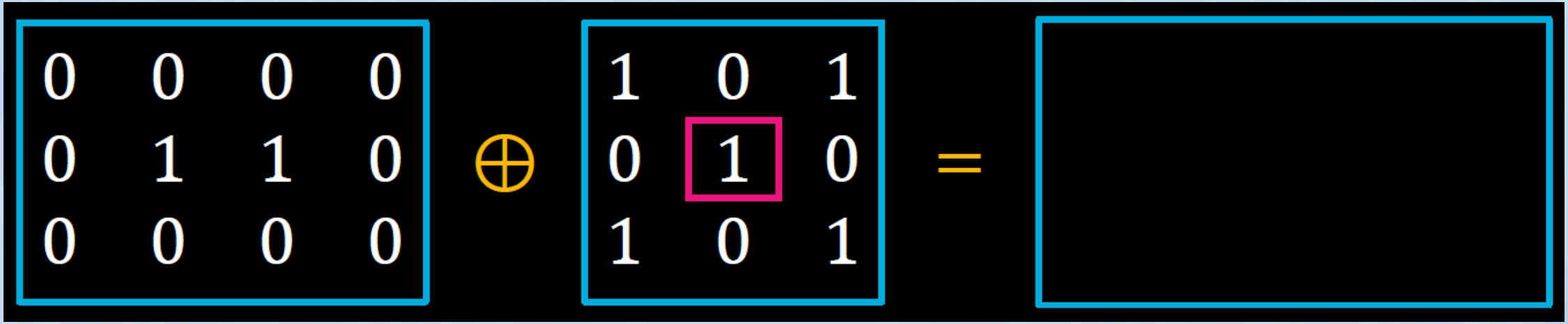
Dilation (Genişleme)



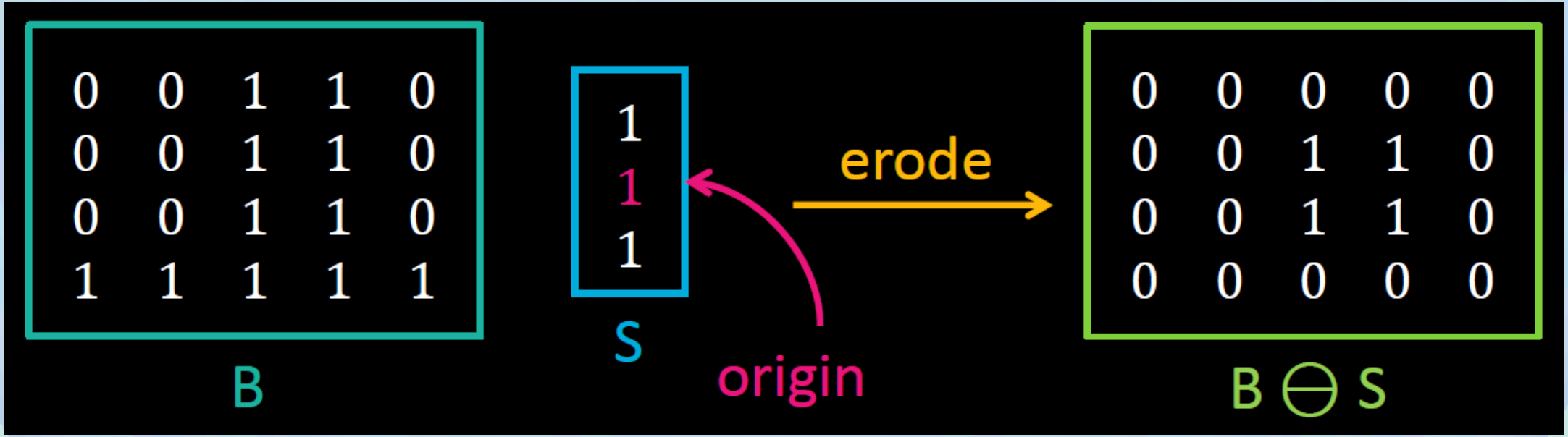
Örnek


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.
1
1 1 1
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.
Original
Structuring Element S
Dilated by S

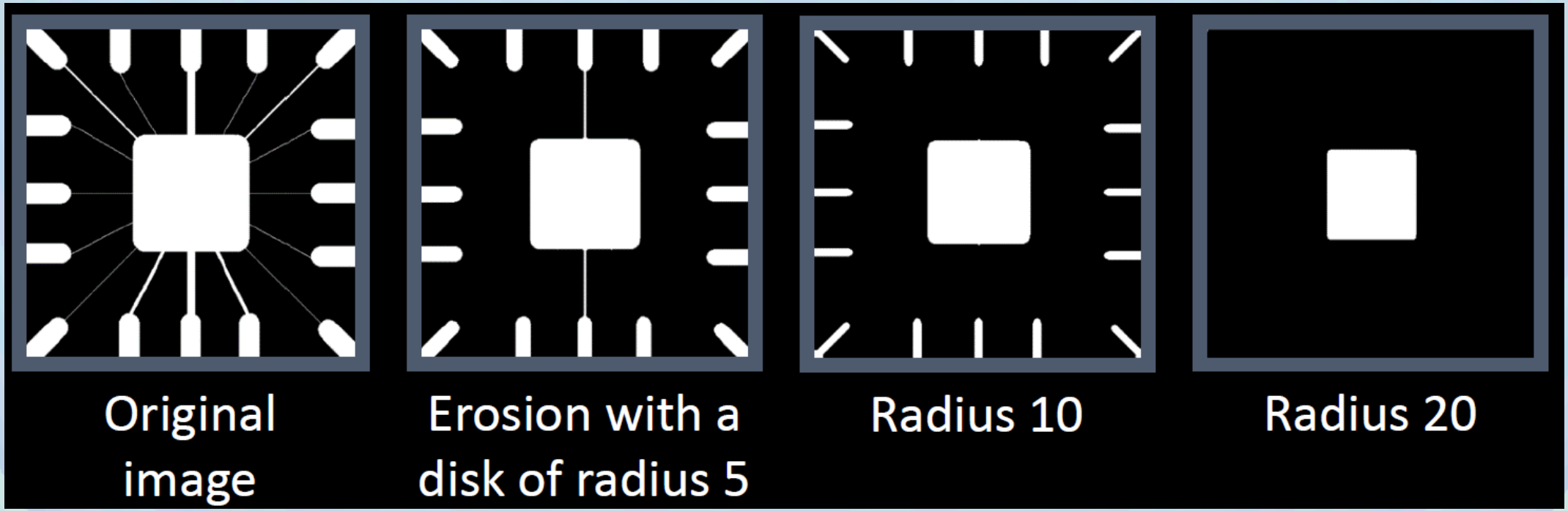
Soru:



Erosion (Aşınma)

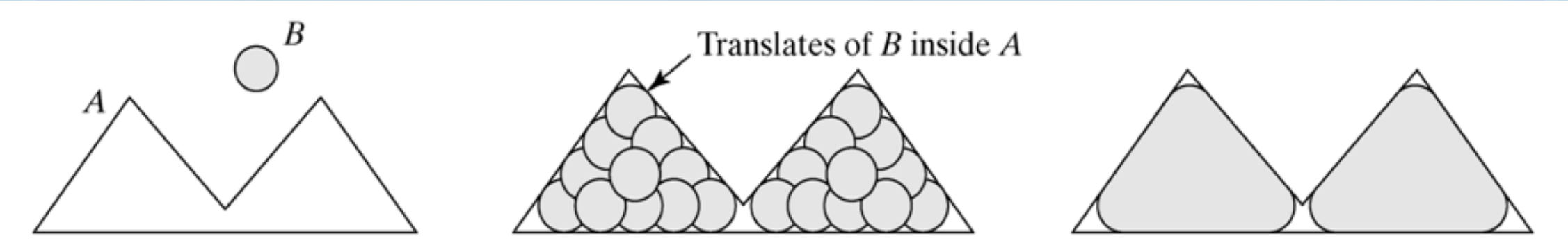


Aşınmada Yapı Elemanının Boyutunun Etkisi

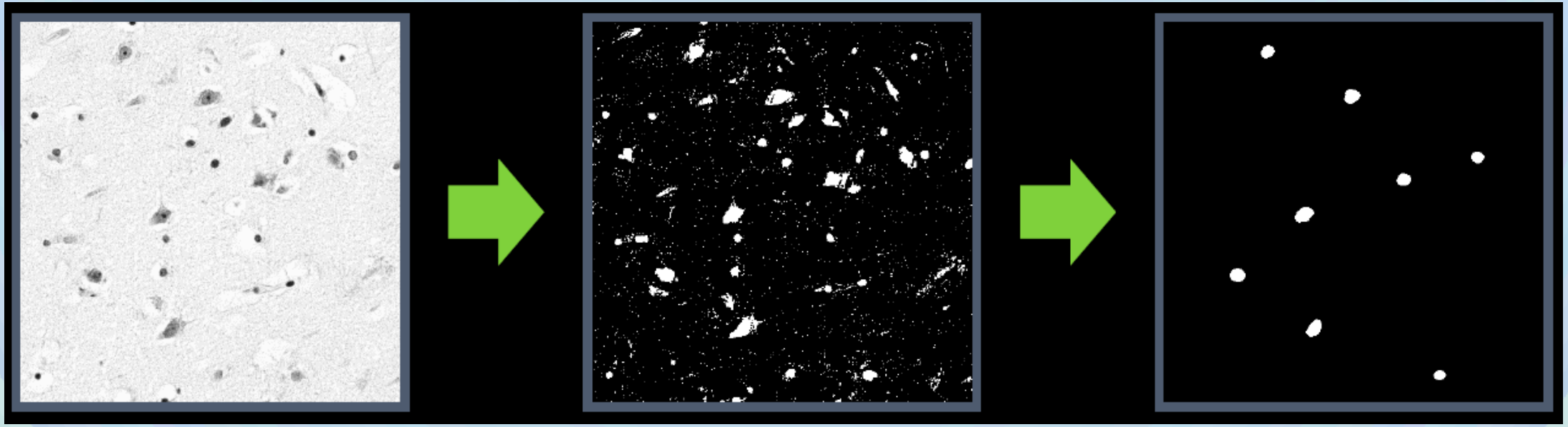


Opening (Açma)

- Önce aşındırma ve sonrasında genişleme operatörü uygulanmakta .

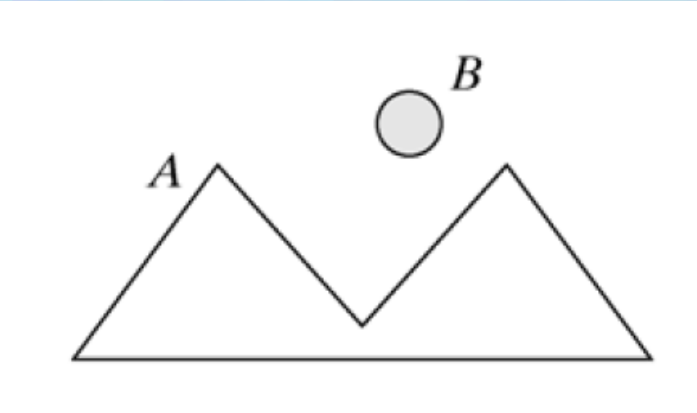


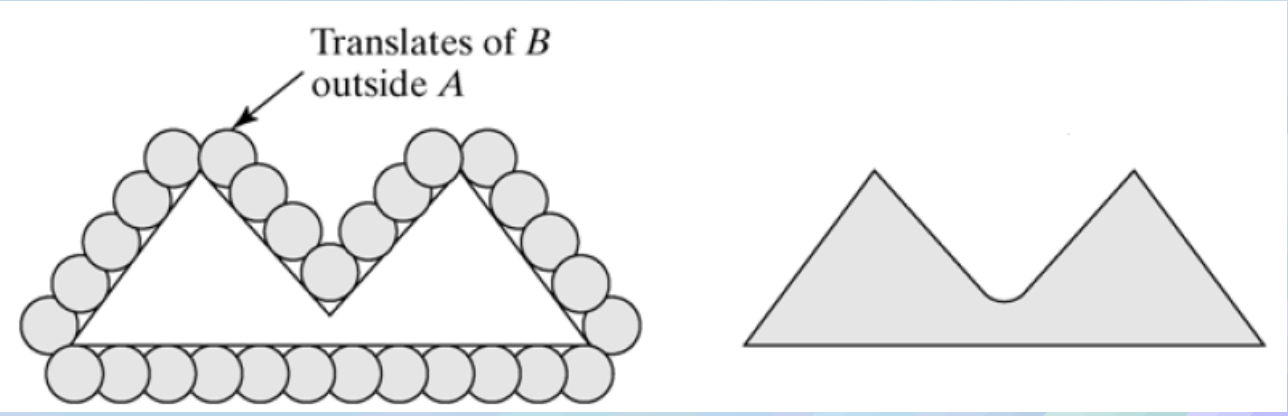
Opening Örnek



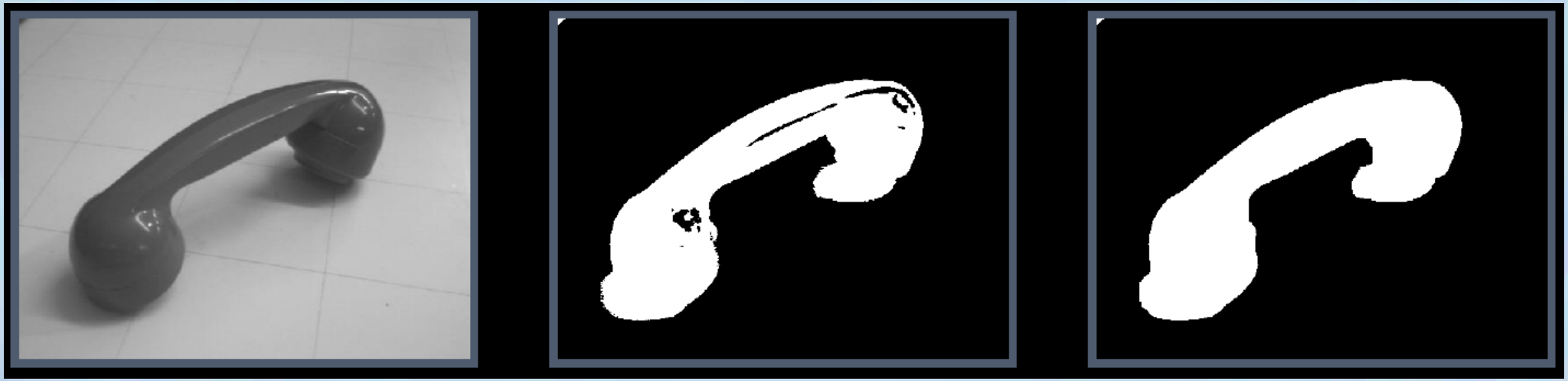
Closing (Kapama)

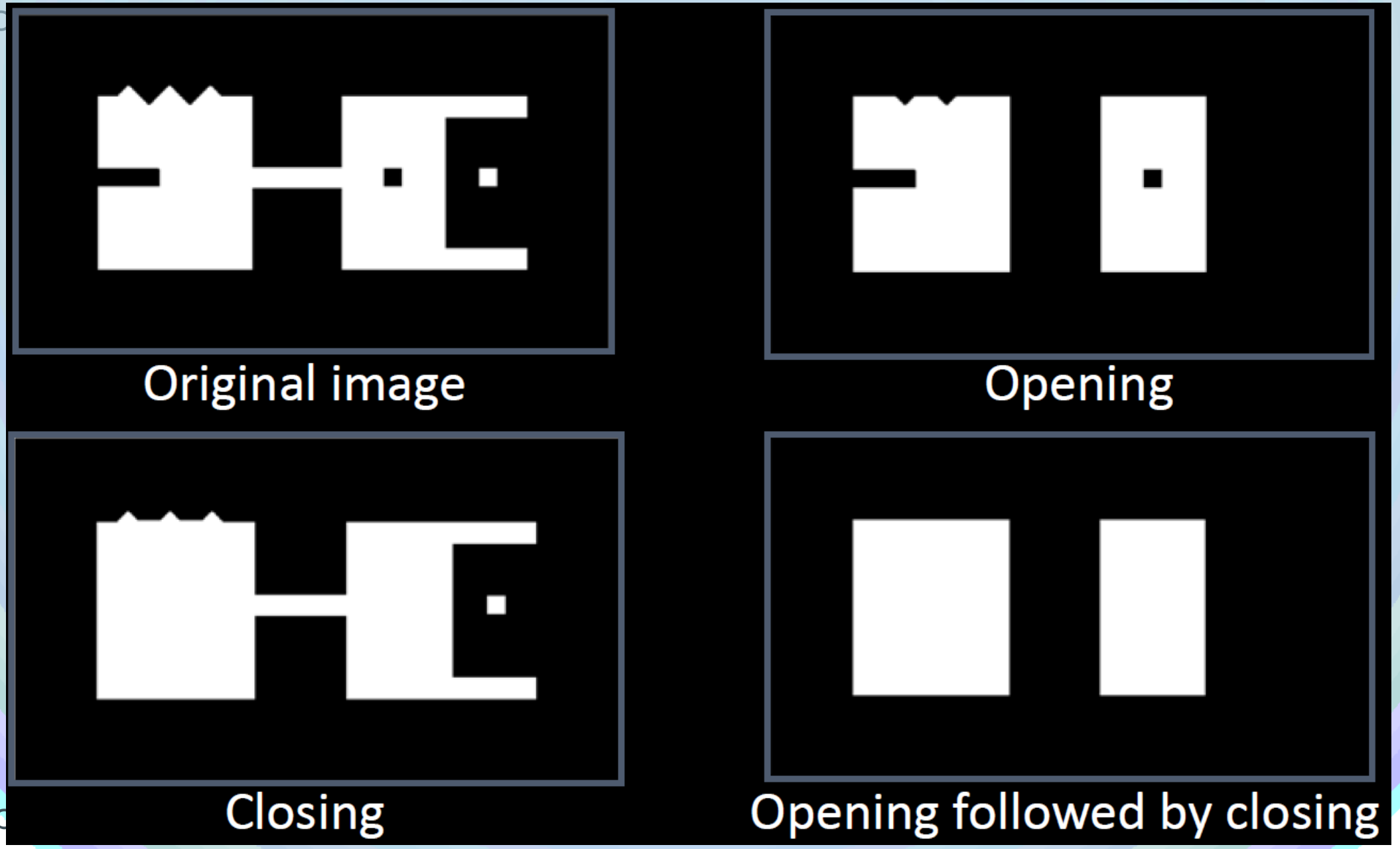
- Önce genişleme ve sonrasında aşındırma operatörü uygulanmakta .





Closing Example – Segmentation Simple segmentation:




Original image
Opening
Closing
Opening followed by closing

Gerçek Örnek – Parmak izi

Temel Morfolojik Uygulamalar

- Boundary extraction
- Region filling
- Extraction of connected components
- Convex Hull
- Thinning
- Skeletons
- Pruning

Sınır Çıkarma

Let $A \oplus B$ denote the dilation of A by B and let $A \ominus B$ denote the erosion of A by B.

The boundary of A can be computed as:

$$A - (A \ominus B)$$

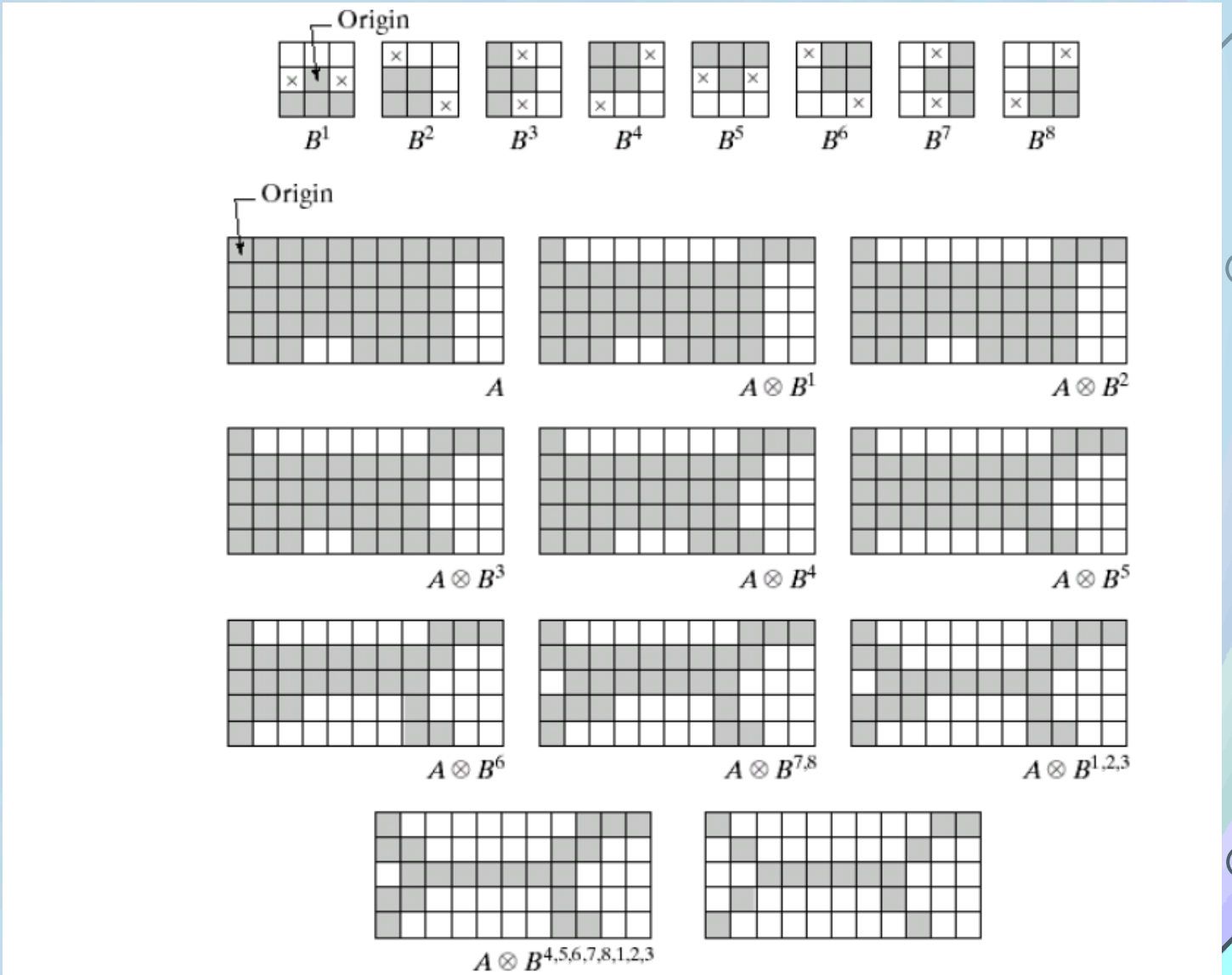
where B is a 3x3 square structuring element.

That is, we subtract from A an erosion of it to obtain its boundary.

Sınır Çıkarma Örneği

İnceltme

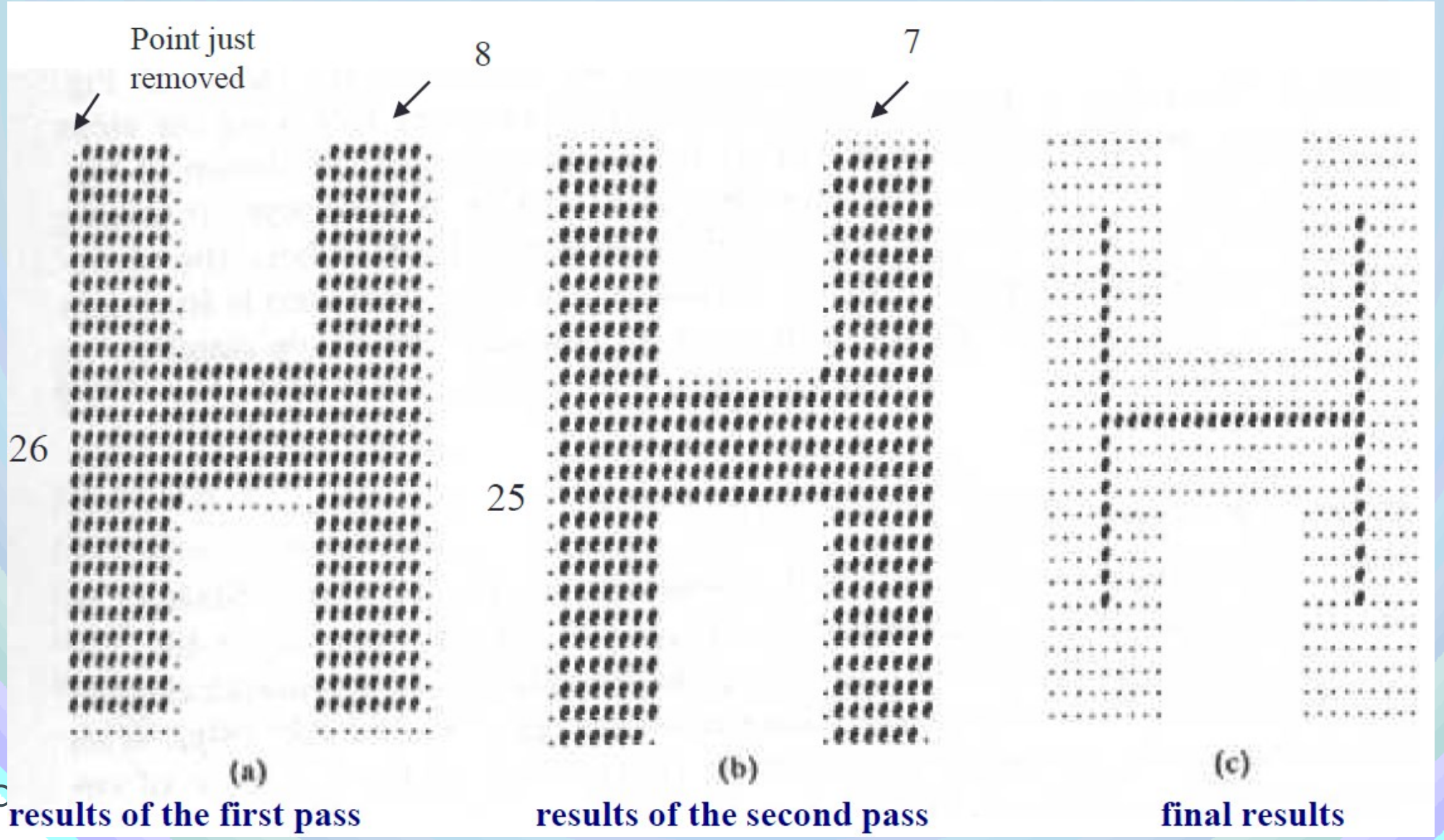
$$A \otimes B$$
$$= A - (A \circledast B)$$
$$= A \cap (A \circledast B)^c$$



a
b c d
e f g
h i j
k l

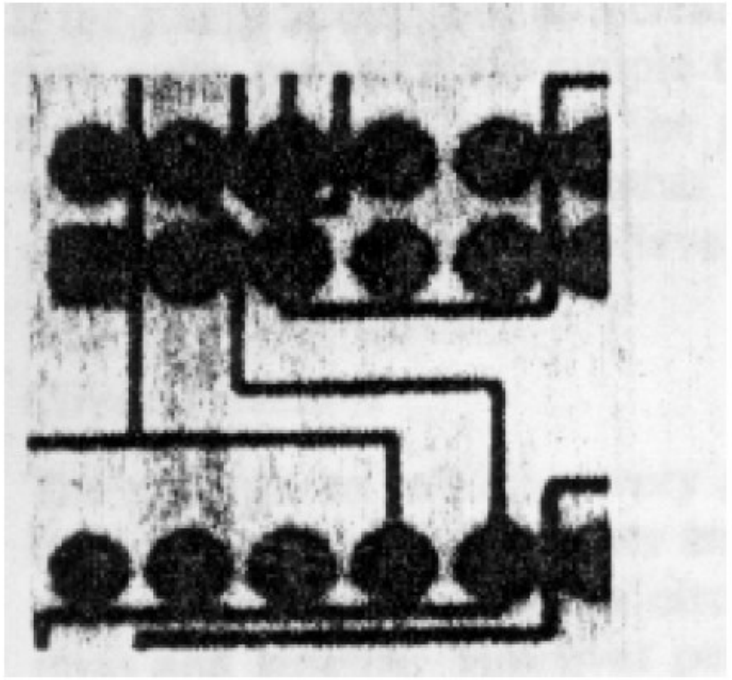
FIGURE 9.21 (a) Sequence of rotated structuring elements used for thinning. (b) Set A. (c) Result of thinning with the first element. (d)–(i) Results of thinning with the next seven elements (there was no change between the seventh and eighth elements). (j) Result of using the first element again (there were no changes for the next two elements). (k) Result after convergence. (l) Conversion to m-connectivity.

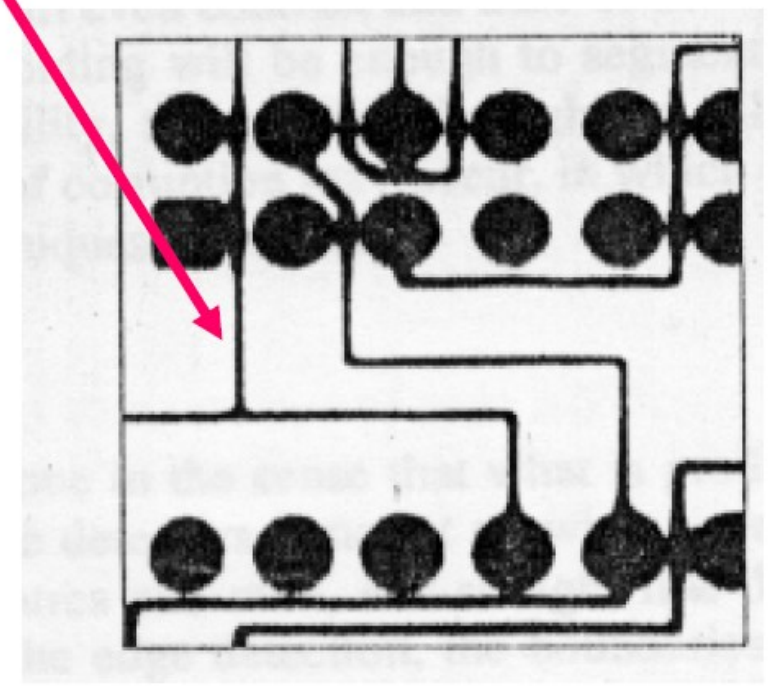
İnceltme Örneği



İnceltme Örneği

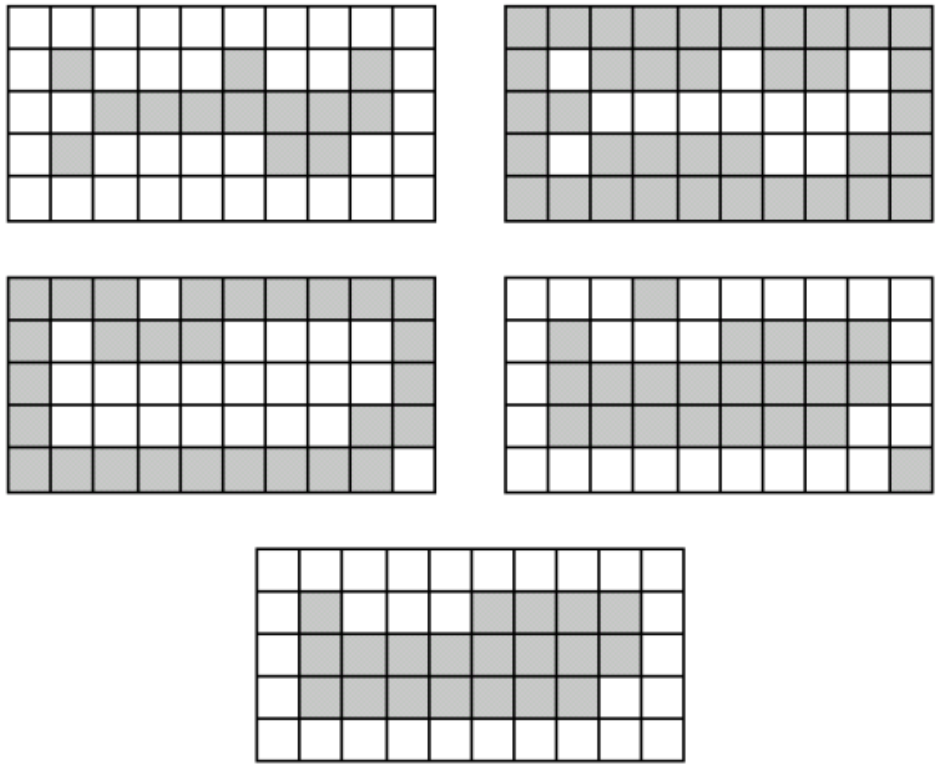
All lines are thinned to one pixel width
Now you can check connectivity





Kalınlaştırma

$$A \odot B = A \cup (A \circledast B)$$

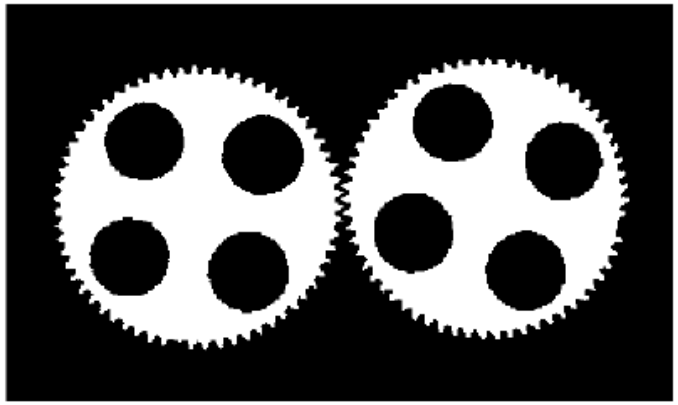


a b
c d
e

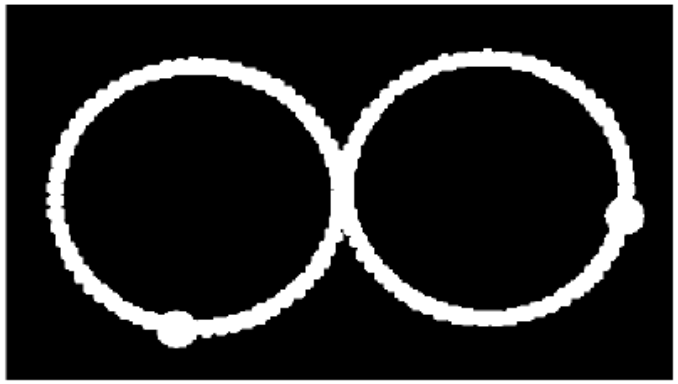
FIGURE 9.22 (a) Set A. (b) Complement of A. (c) Result of thinning the complement of A. (d) Thickened set obtained by complementing (c). (e) Final result, with no disconnected points.

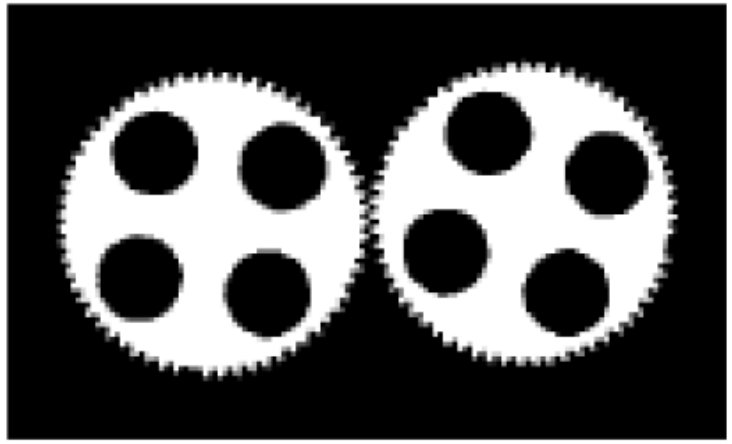
Morfoloji ne kadar Güçlü?

- Uygulamaya bağlıdır.
- Temiz ya da temize yakın görüntülerde istenilen işlemleri yapabilir.
- Örneğin

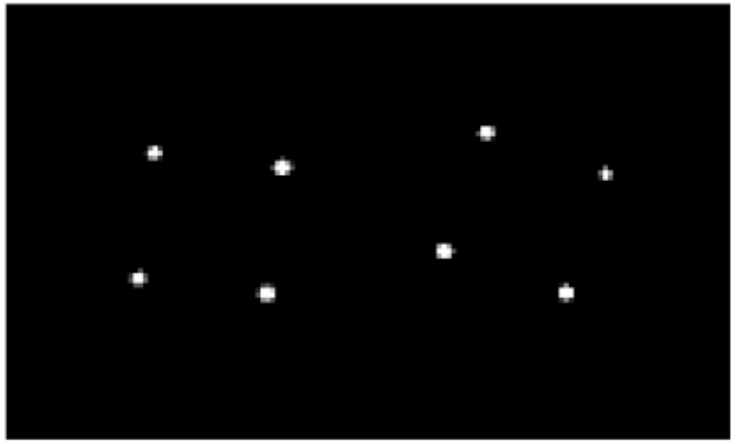


- Dişli Diş Kontrolü

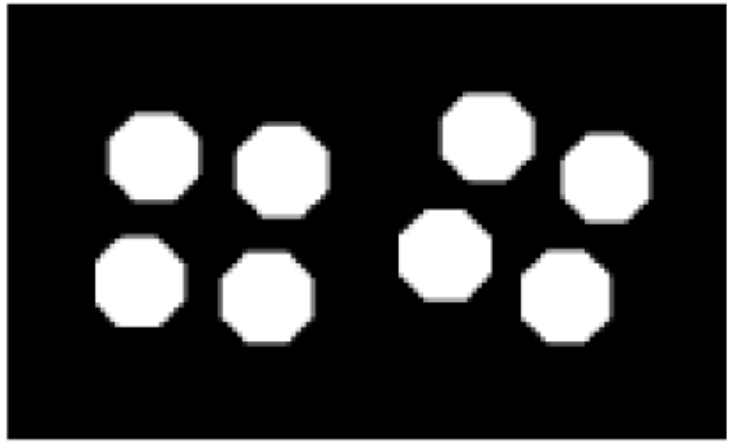




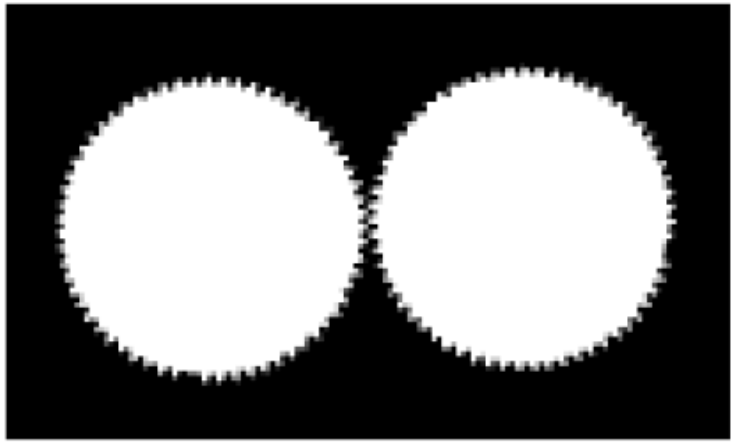
a) Original image B



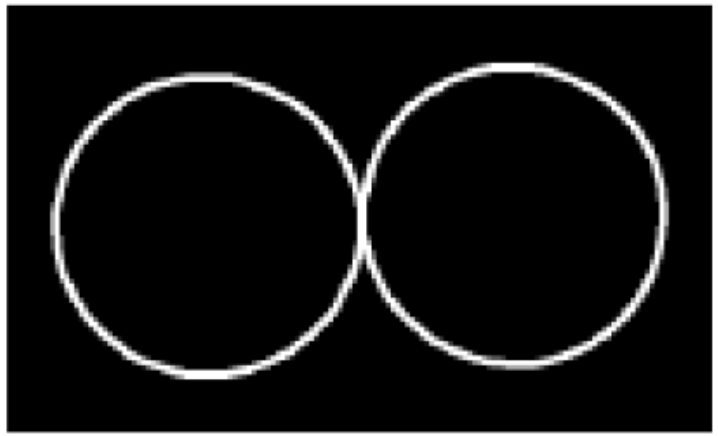
b) $B1 = B \ominus hole\_ring$



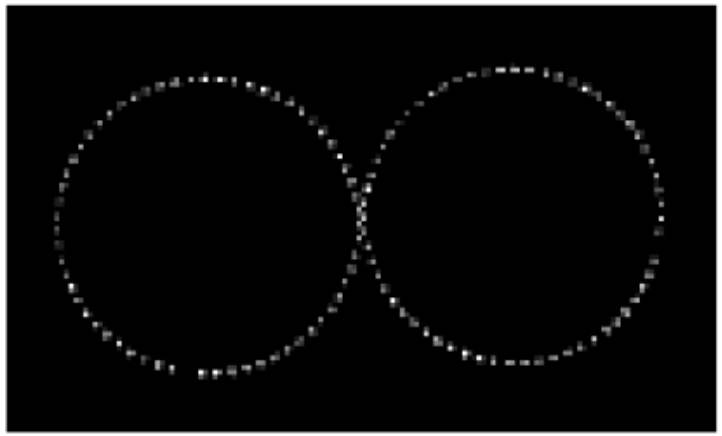
c) $B2 = B1 \oplus hole\_mask$



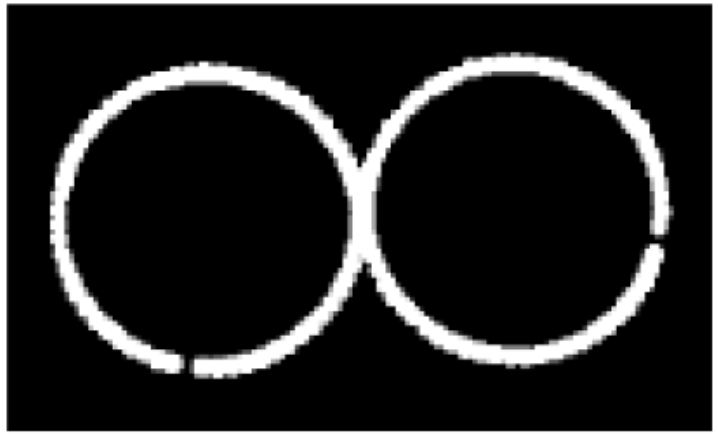
d) $B3 = B\ OR\ B2$



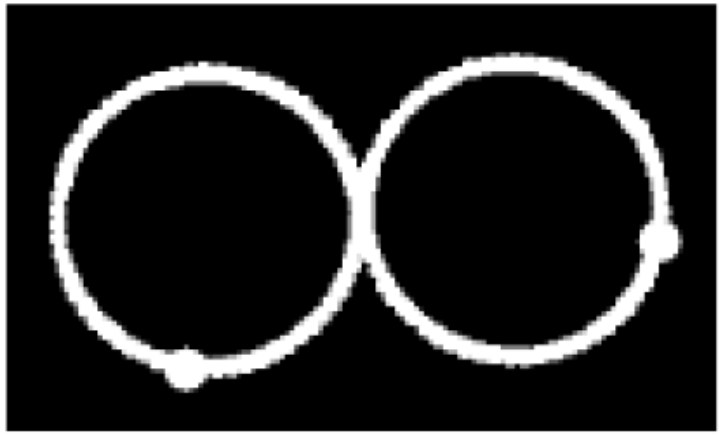
e) $B7$



f) $B8 = B\ AND\ B7$



g) $B9 = B8 \oplus tip\_spacing$



h) $RESULT = \left((B7 - B9) \oplus defect_{cue}\right)\ OR\ B9$