Resim İşleme

Nurettin Şenyer

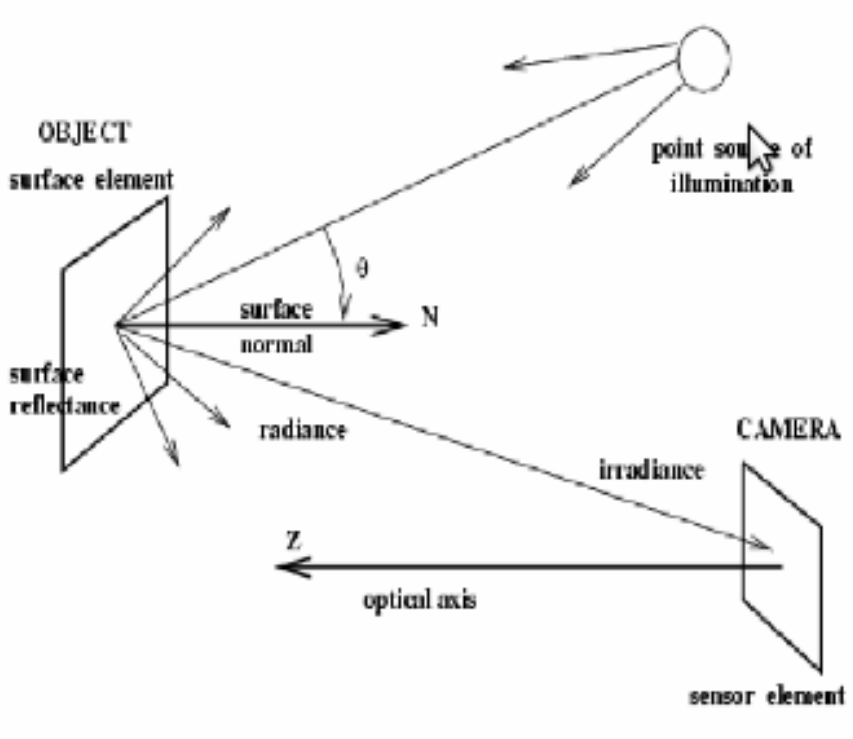
19/x

Mart, 2011

İçindekiler

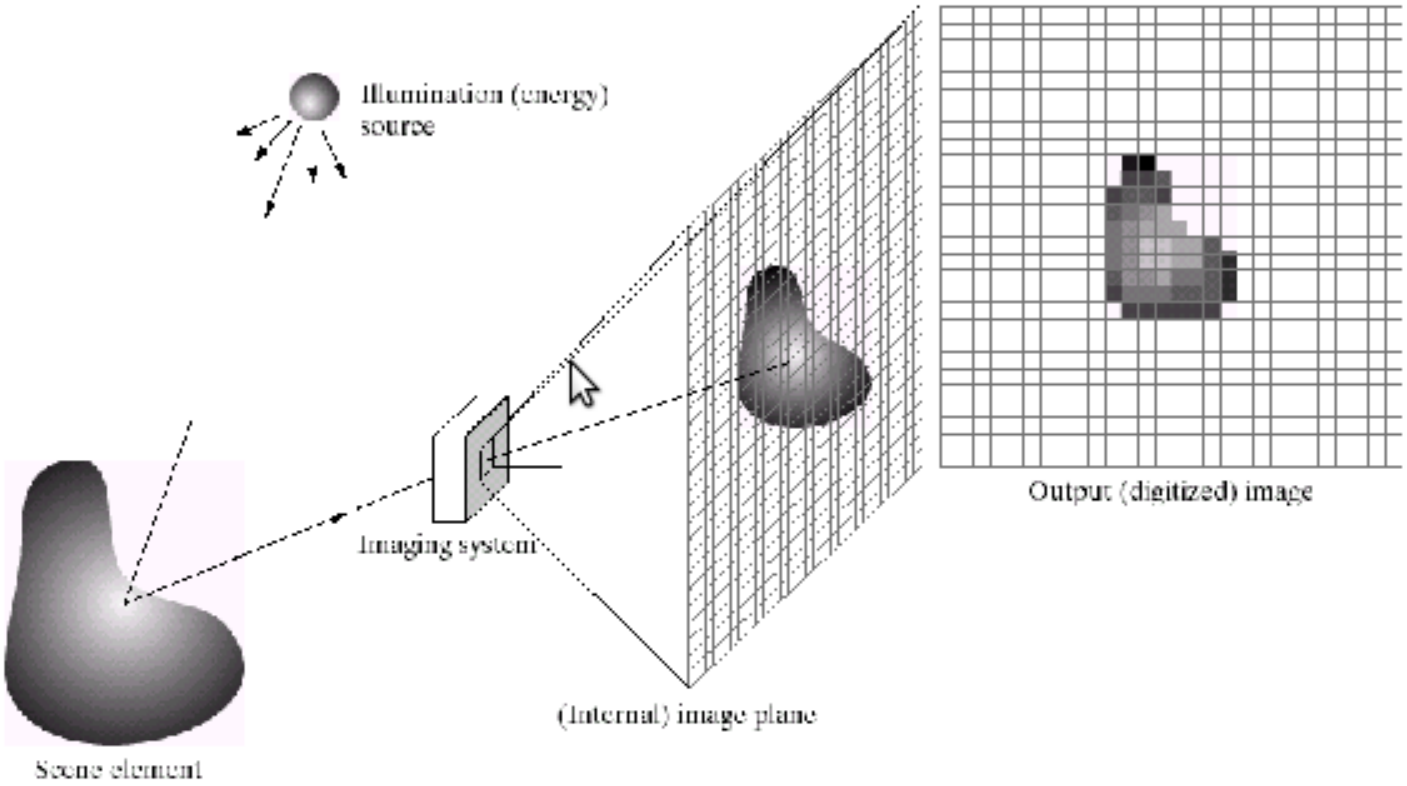
- Resim Biçimlendirme
- Nokta ve Öbek İşleme
- İkil Resim İşleme
- Yansılar Pınar Duygulu, Alyosha Efros ve Shapiro ve Stockman'den uyarlanmıştır

- ışık yüzeye düşer
- yüzey yansıtır/yutar
- sensör yansıyanı toplar
- yoğunluk (parlaklık,intensity) önemlidir
- açı önemlidir
- malzeme önemlidir



Adapted from Shapiro and Stockman

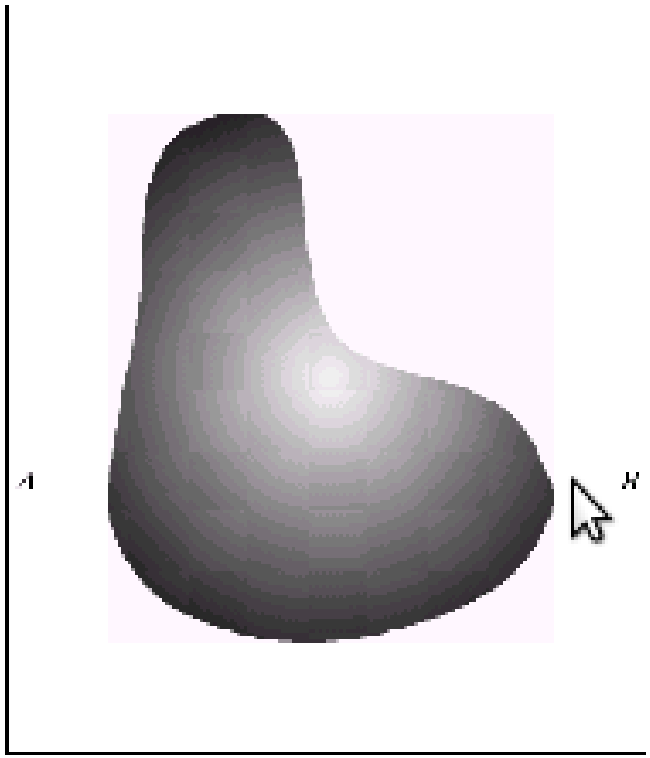
Resim Biçimlendirme: Sayısallaştırma

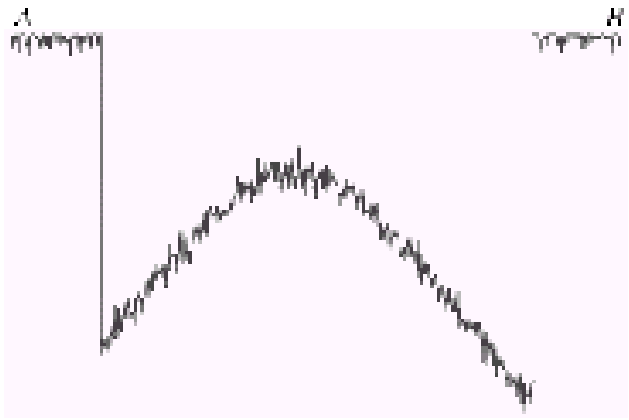


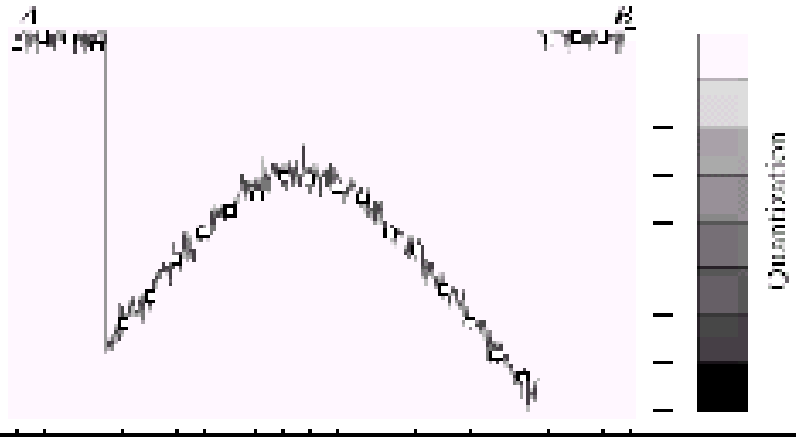
a
b c d e

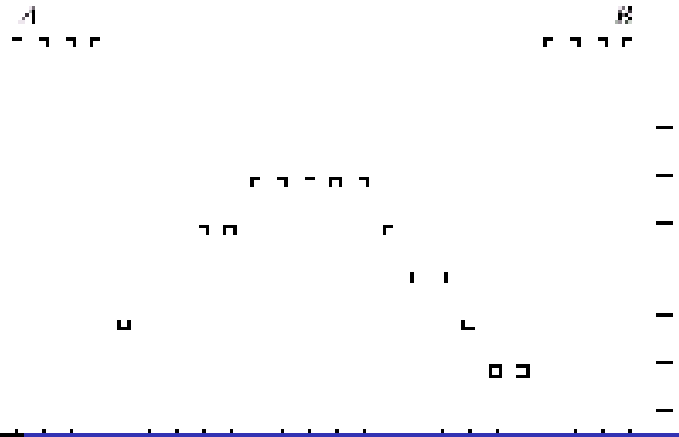
FIGURE 2.15 An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

Örnekleme ve Nicemleme: Nyquist

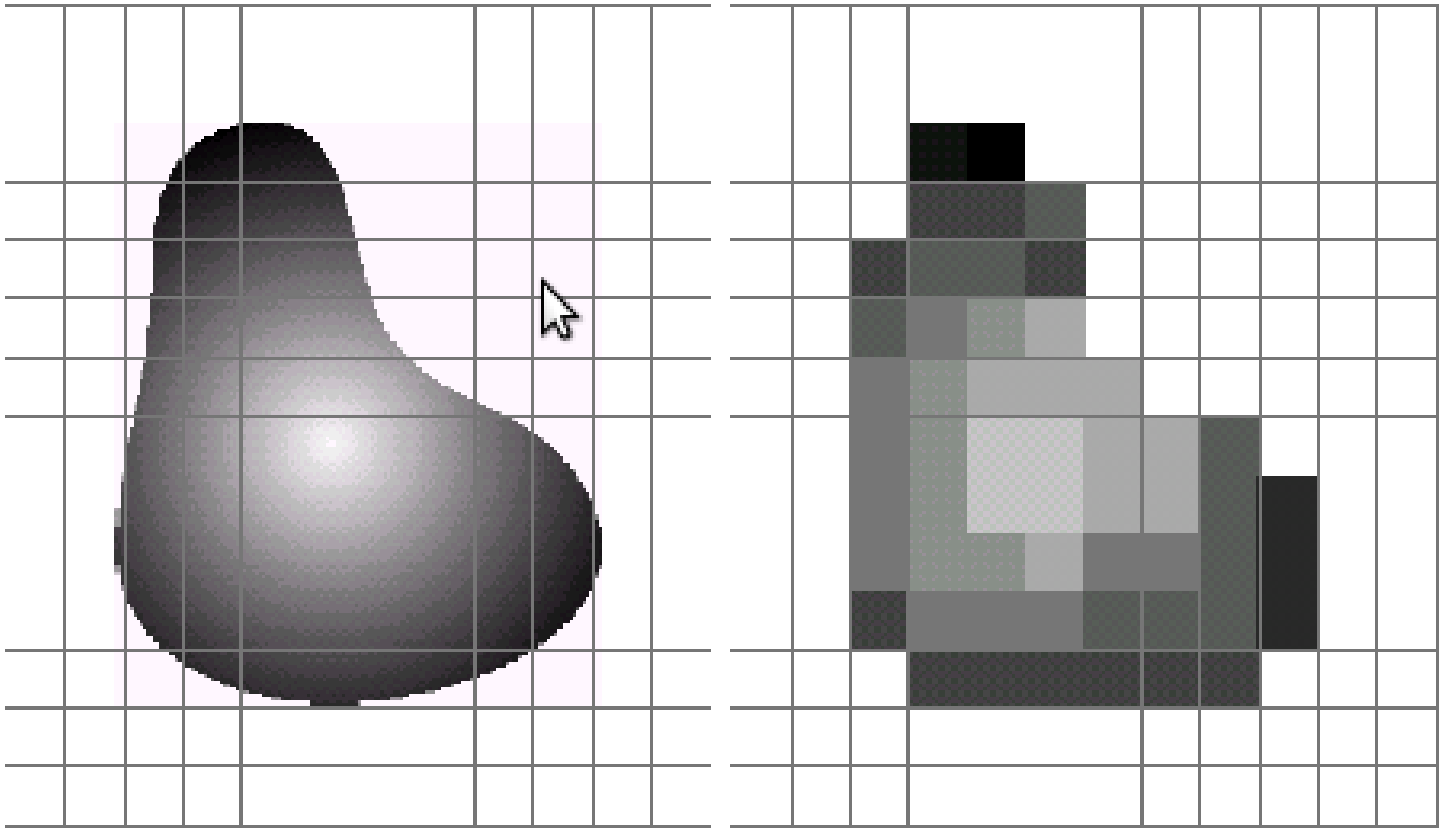








Örnekleme ve Nicemleme



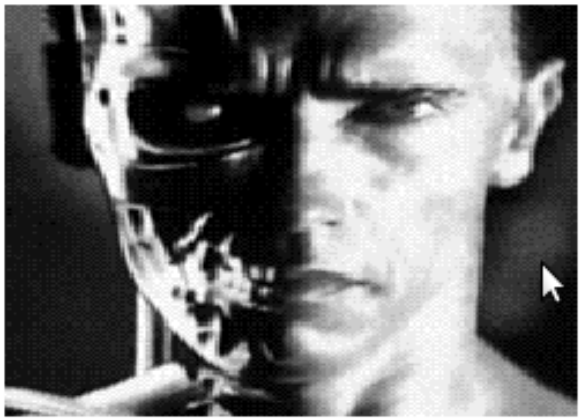
a b

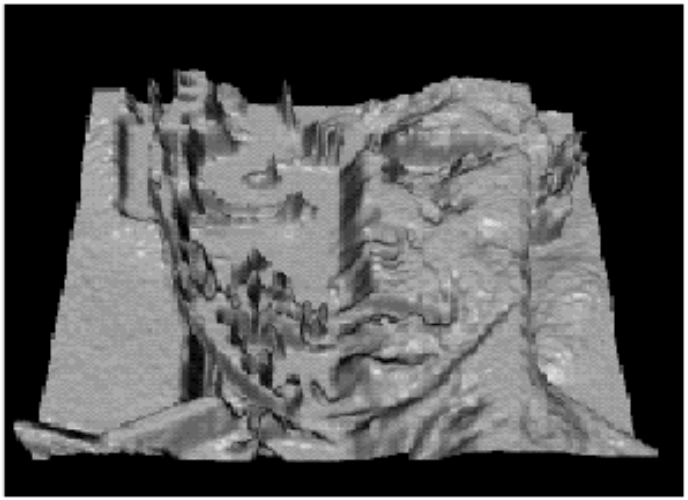
FIGURE 2.17 (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

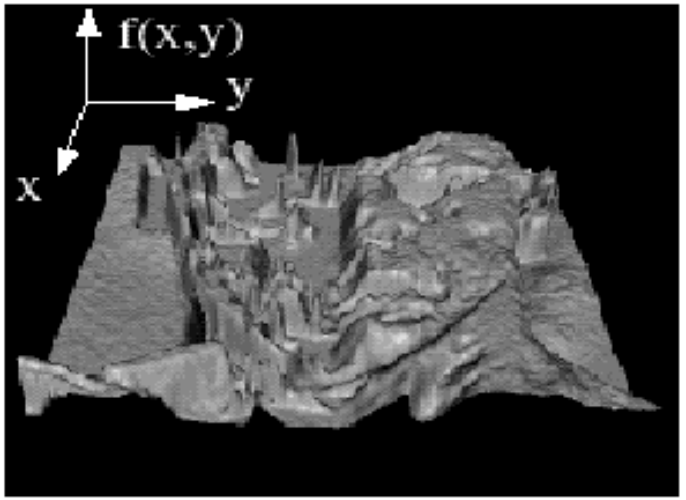
Resim nedir?

- R^2'den R'ye haritalama yapan f işlevi olarak düşünelim
- $f(x, y)$ parlaklık değeri; $8bit$ ise $0 - 255$ değerleri
- renkli ise vektör formu: $f(x, y) = [R(x, y)G(x, y)B(x, y)]$

İşlev olarak Resim

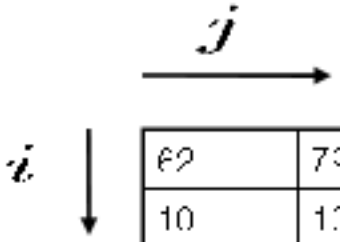






Sayısal Resim Nedir?

Örnekleme, nicemleme, ızgara etki, tamsayı değerler



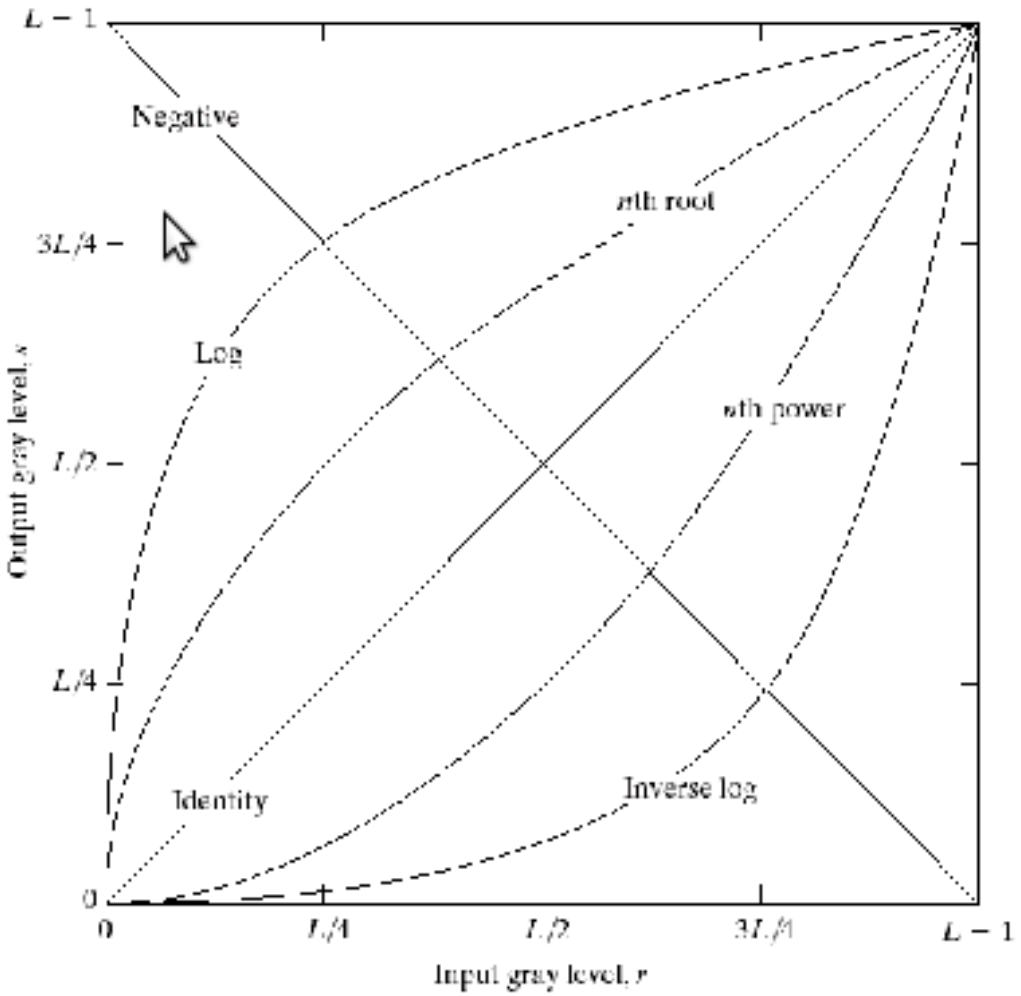
62	79	23	119	120	105	4	0
10	10	9	62	12	78	34	0
10	53	197	46	46	0	0	48
176	135	5	188	191	68	0	49
2	1	1	29	26	37	0	77
0	39	147	147	187	109	62	208
255	252	0	166	123	62	0	31
166	33	197	17	1	0	99	30

Nokta İşleme

- girdi: f ve çıktı: g; $g = T(f)$
- a) her bir pikseli bağımsız işle, piksel girdi/çıktı
- b) pikseli komşularıyla işle, tek piksel çıktı
- c) resmi işle, tek piksel/resim üret

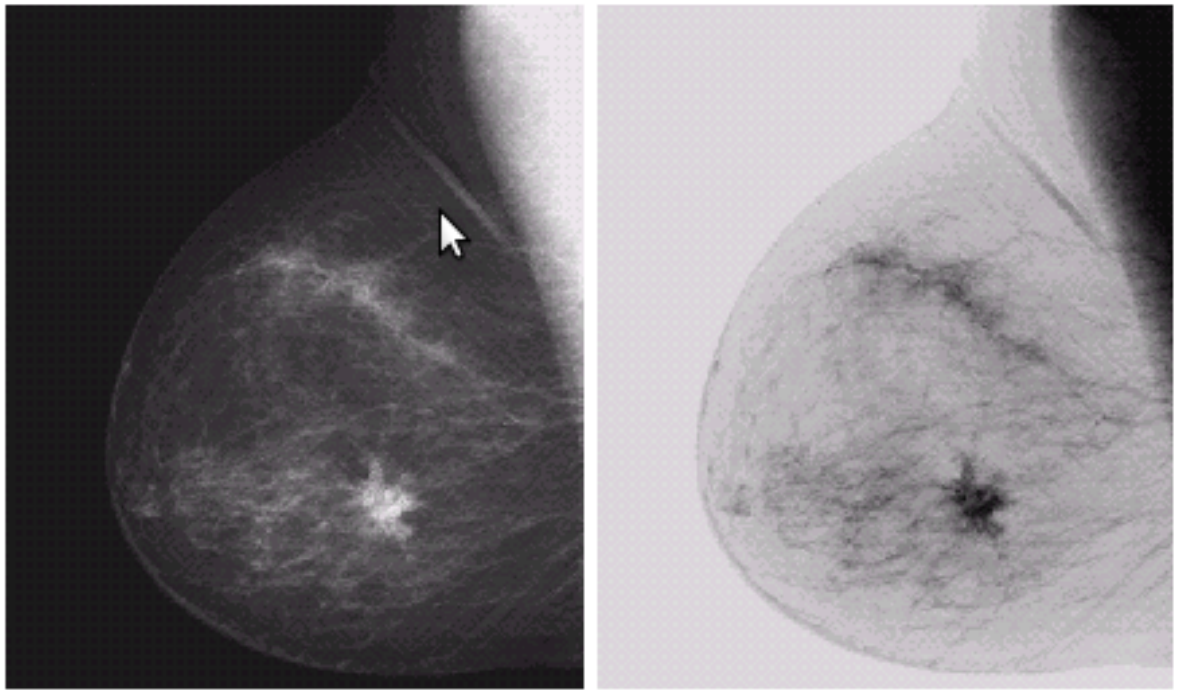
$$g = f^{\gamma}$$

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



Negatif

$$g = -f$$

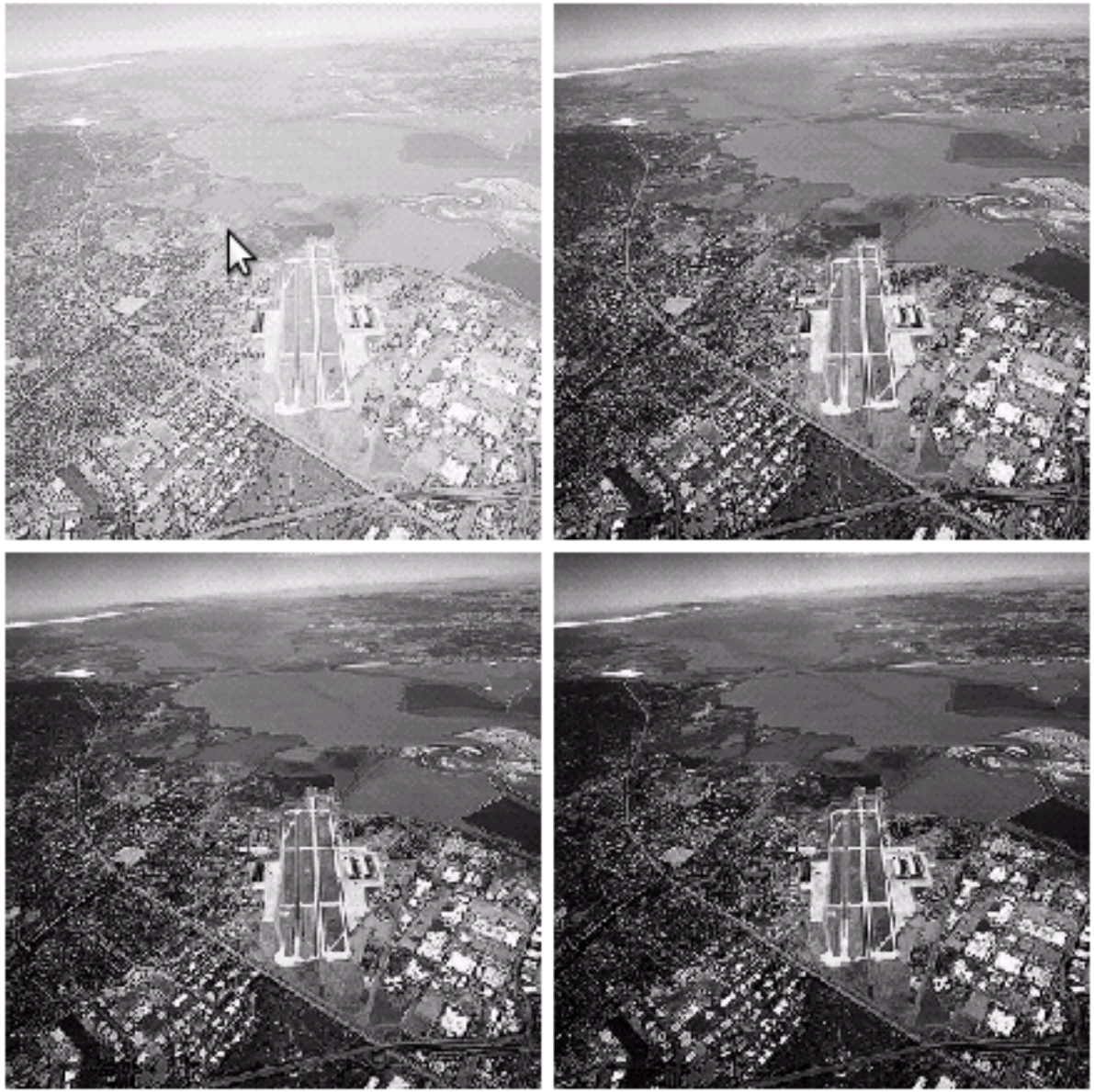


a b

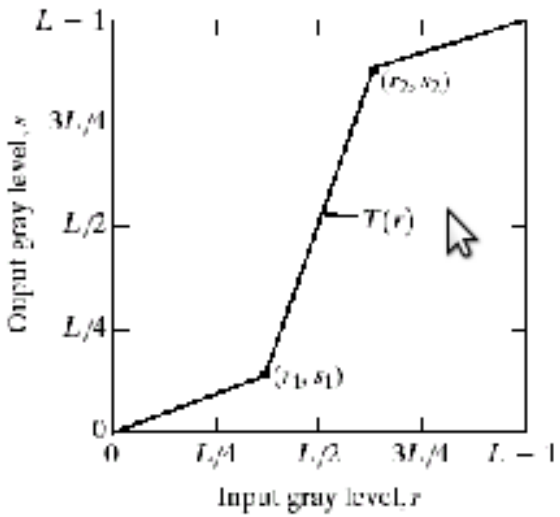
FIGURE 3.4
(a) Original digital mammogram. (b) Negative image obtained using the negative transformation in Eq. (3.2-1). (Courtesy of G.E. Medical Systems.)

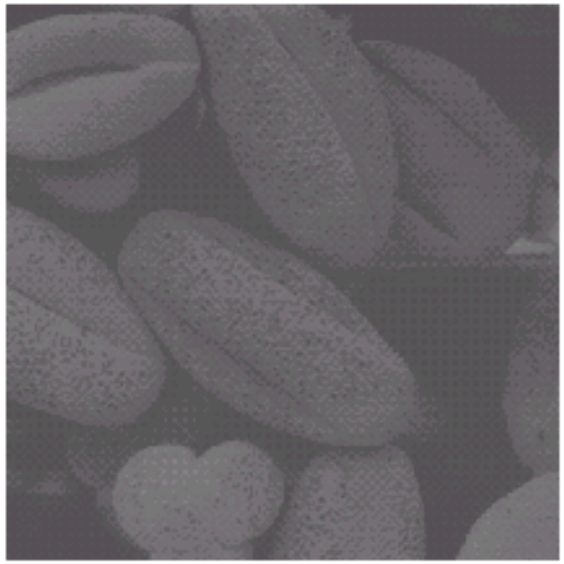
a b
c d

FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and γ 3.0, 4.0, and 5.0, respectively. (Original image for this example courtesy of NASA.)



Kontrast Yayma

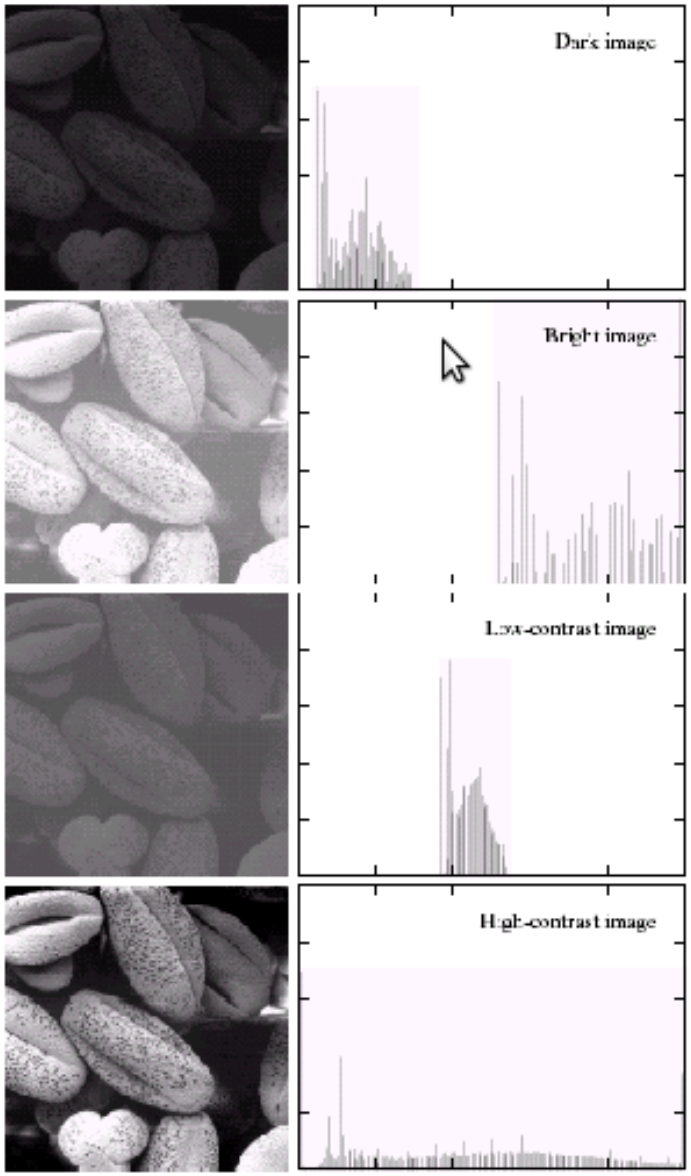




a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Histogram

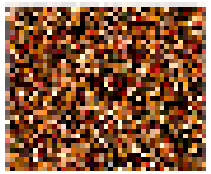


a b

FIGURE 3.15 Four basic image types: dark, light, low contrast, high contrast, and their corresponding histograms. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

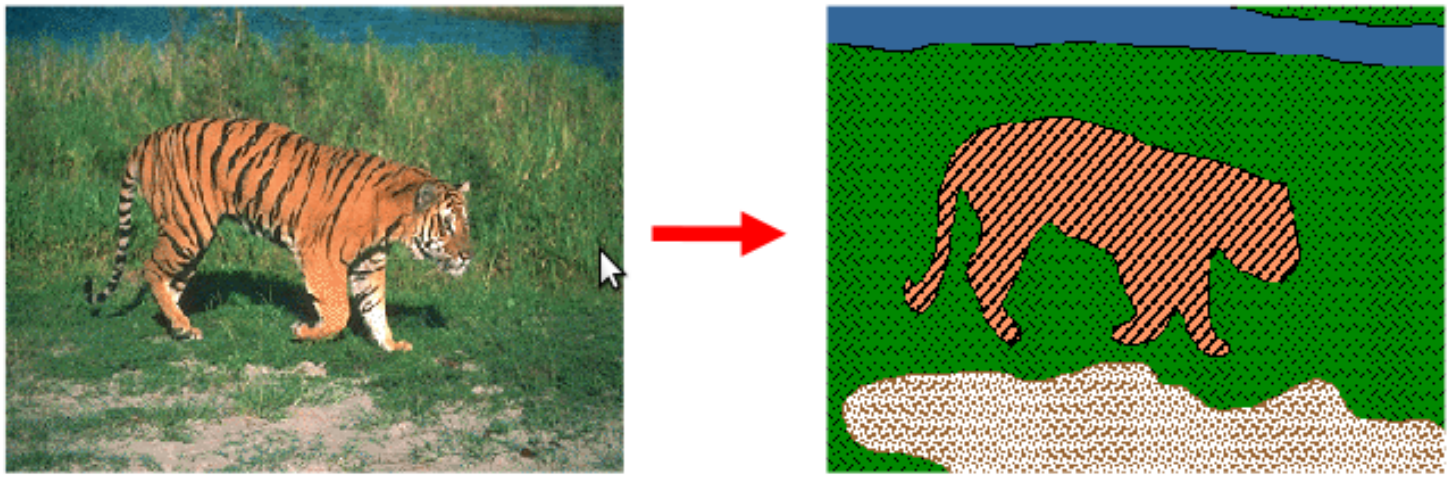
Komşuluk İlişkisi

Resimdeki tüm pikseller karıştırılırsa ne olur?



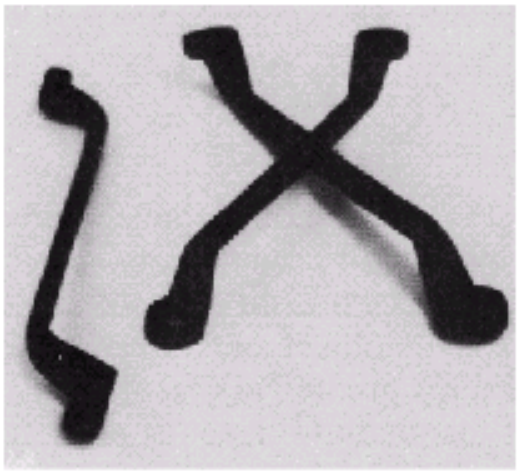
Histogramı aynıdır. Noktsal işlemden etkilenmez. Konumsal ilişki

Öbek (Blob) Çıkartma



- Blob: aralarında ilişki bulunan resim bölgesi
- nesne çıkarma, nesne silme, birleştirme vs
- genelde "blob" nesne değildir

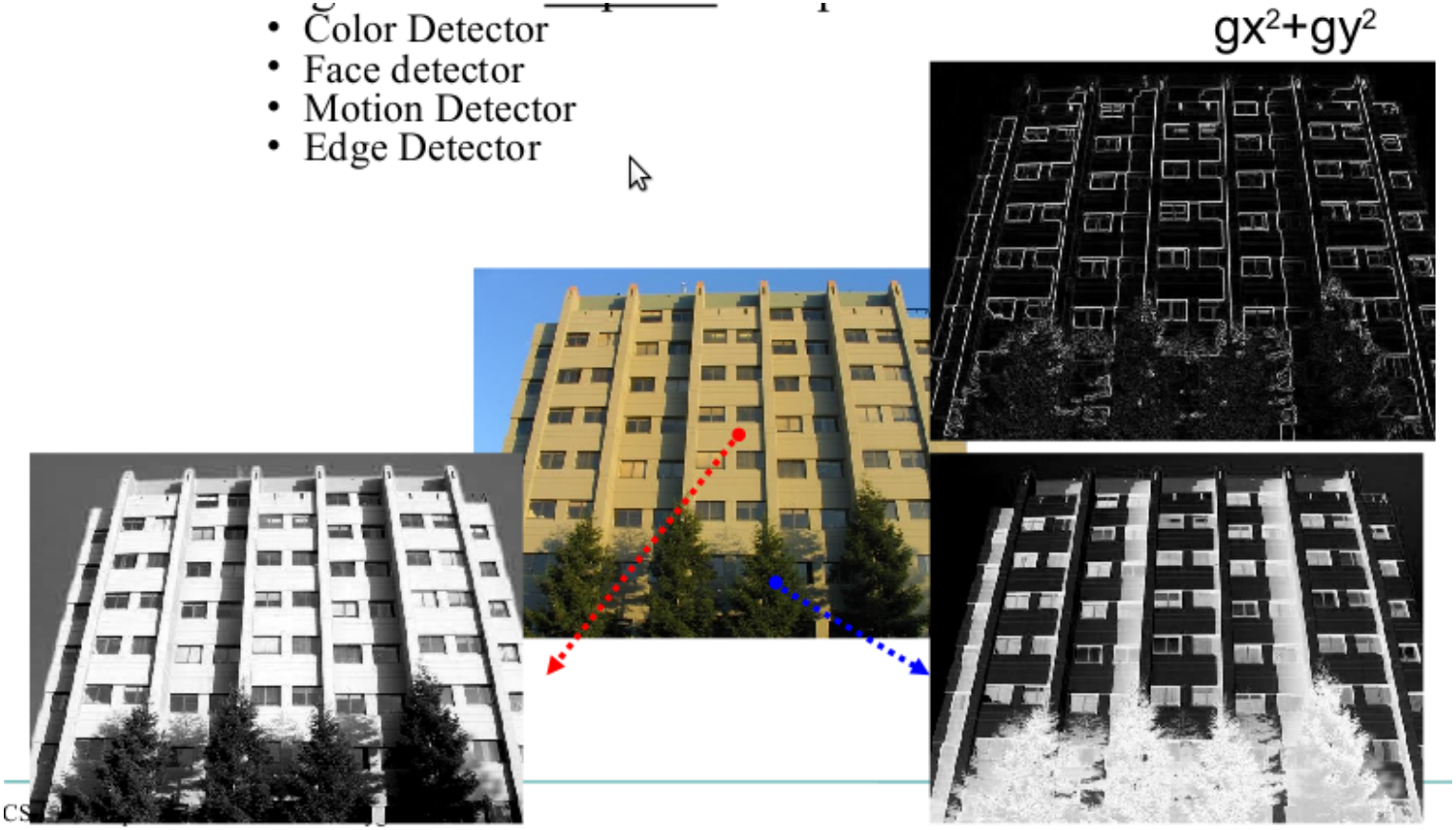
Blob Bağlılığı



Takım, blob olabilir. Ev, çimen ve gökyüzü farklı bloblardır. ‘regionprops‘, ikil resimlerde blob özniteliklerini çıkarır.

Blob'un Anlamı Nedir?

Resim, color/face/motion/edge detectorün çıkışı Şimdi Blob nedir? Yine, aralarında ilişki bulunan resim bölgeleri.



Neden faydalıdır?

AIBO
RoboSoccer
(VelosoLab)

Resim

İdeal Bölütleme

Color bölütleyici/detektör çıkışı

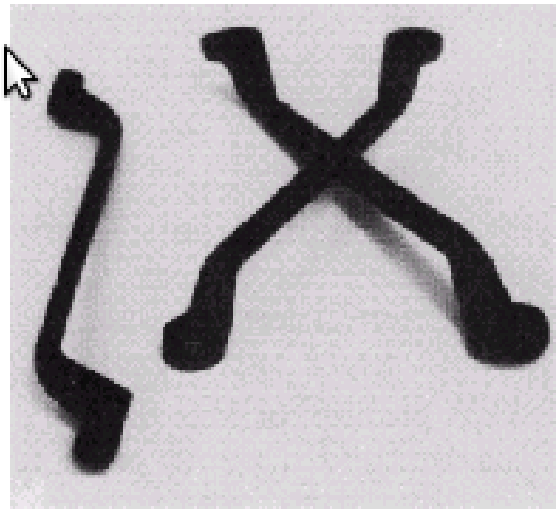
Bölütleme Sonucu

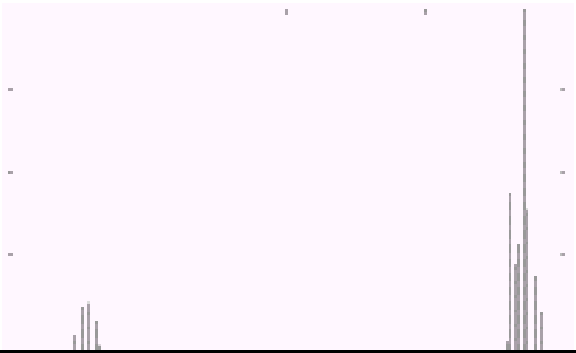
Bloblar? **DEMO**: indirilen kodlar

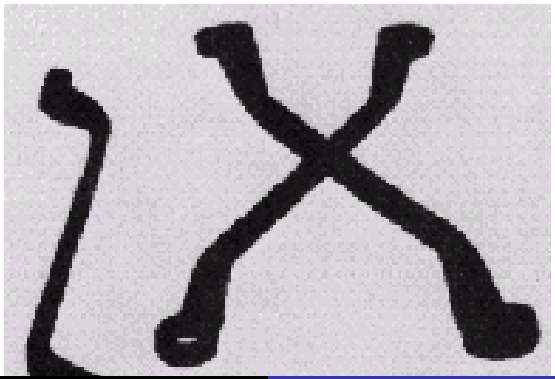
Temel eşikleme işlemi: $im(x, y) > T$ ise $bw(x, y) = 1$ T ne olacak? Otsu'nun yöntemi

Example

¿¿ T = graythreshold(I); BW = im2bw(I, T);





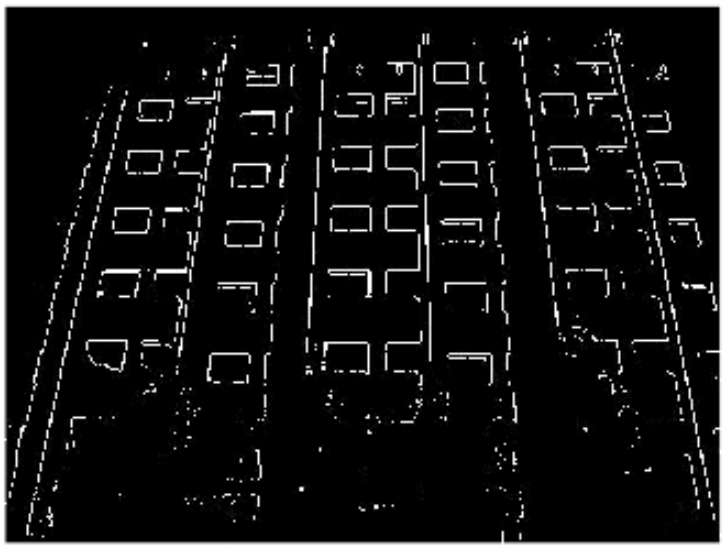


b c

FIGURE 10.28 (a) Original image. (b) Image histogram. (c) Result of global thresholding with T midway between the maximum and minimum gray levels.

Kenar algıla, sonra, Eşikle

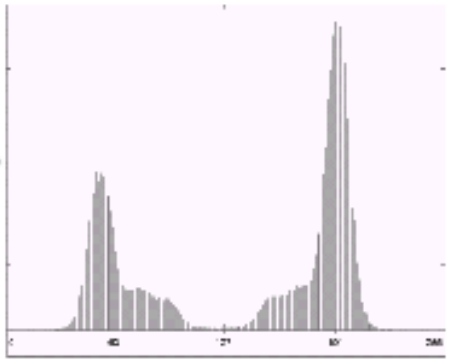
gx^2+gy^2



$gx^2+gy^2 > T$

Bazen iyi çalışır

Potansiyel problem... Gürültü...



a b
c

FIGURE 10.29
(a) Original image. (b) Image histogram. (c) Result of segmentation with the threshold estimated by iteration. (Original courtesy of the National Institute of Standards and Technology.)

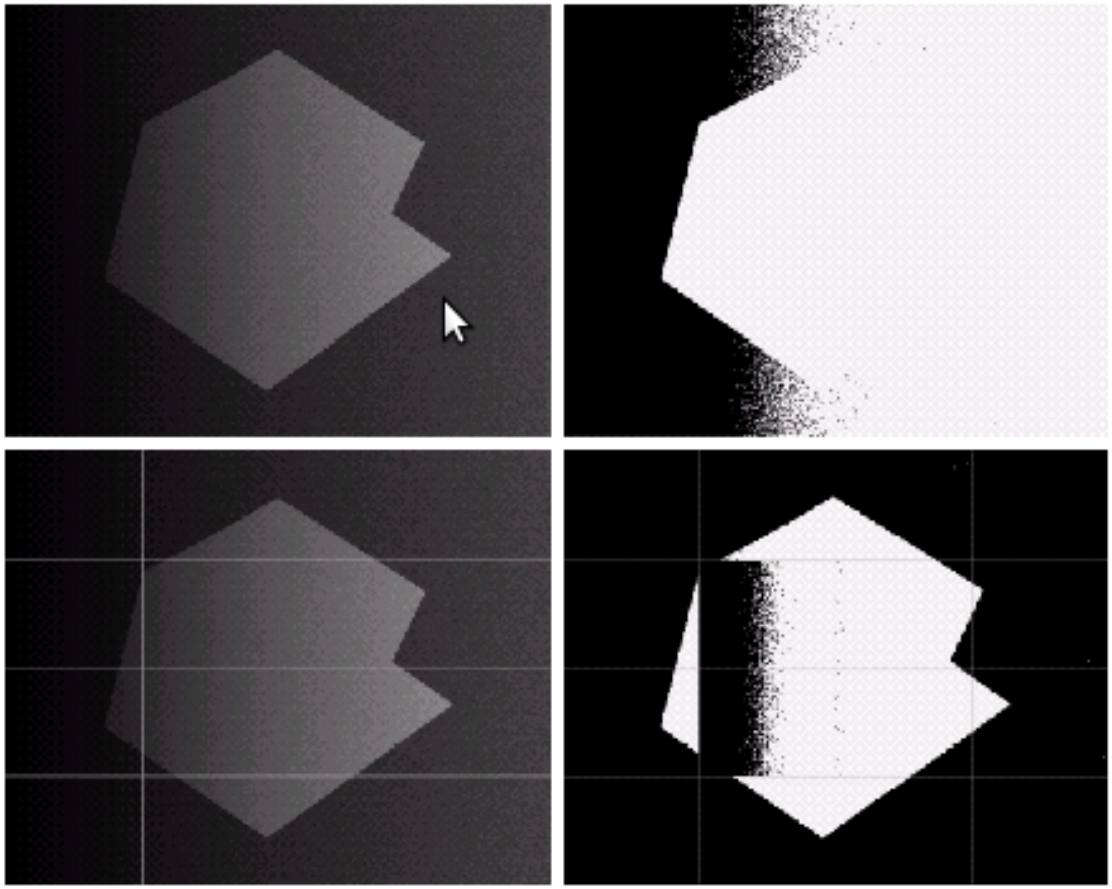
What are potential Problems?

... bazen de işe yaramaz

bu durumda da uyarlanır eşikleme

a b
c d

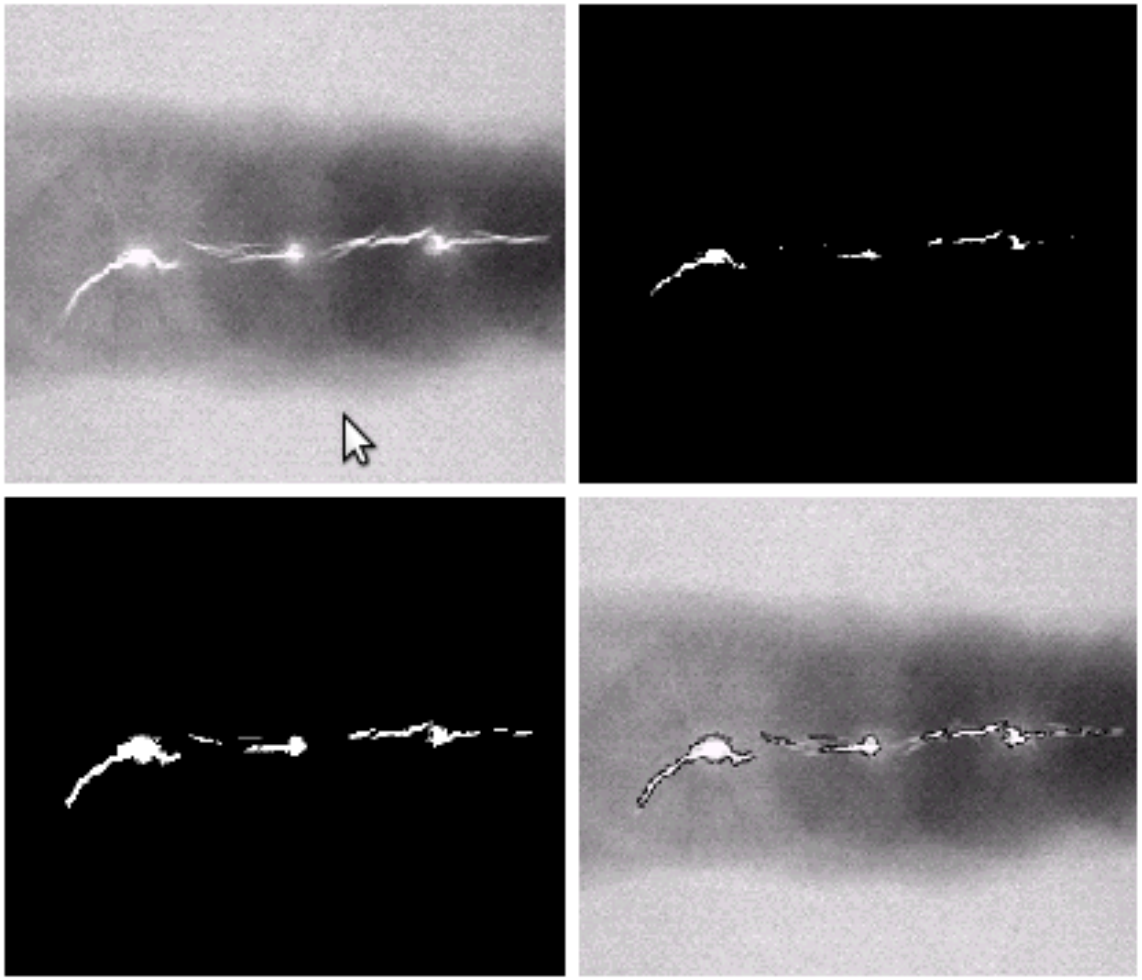
FIGURE 10.30
(a) Original image. (b) Result of global thresholding. (c) Image subdivided into individual subimages. (d) Result of adaptive thresholding.



Region Growing

a b
c d

FIGURE 10.40
(a) Image showing defective welds. (b) Seed points. (c) Result of region growing. (d) Boundaries of segmented defective welds (in black). (Original image courtesy of X-TEK Systems, Ltd.).



Region Growing

- seed pikseli seç: z_{seed} (ör.histogramdaki tepe noktası)
- komşu pikselleri denetle: z; eğer seed'e benziyorsa region'a ekle
- ::::: benzerlik (region membership criterion): ort.parlaklık, varyans, renk, doku, hareket, şekil/boyut, vs
- ::::: ör. $|z - z_{seed}| < T$
- region'a eklenen her bir piksel için 2. adımı yinele

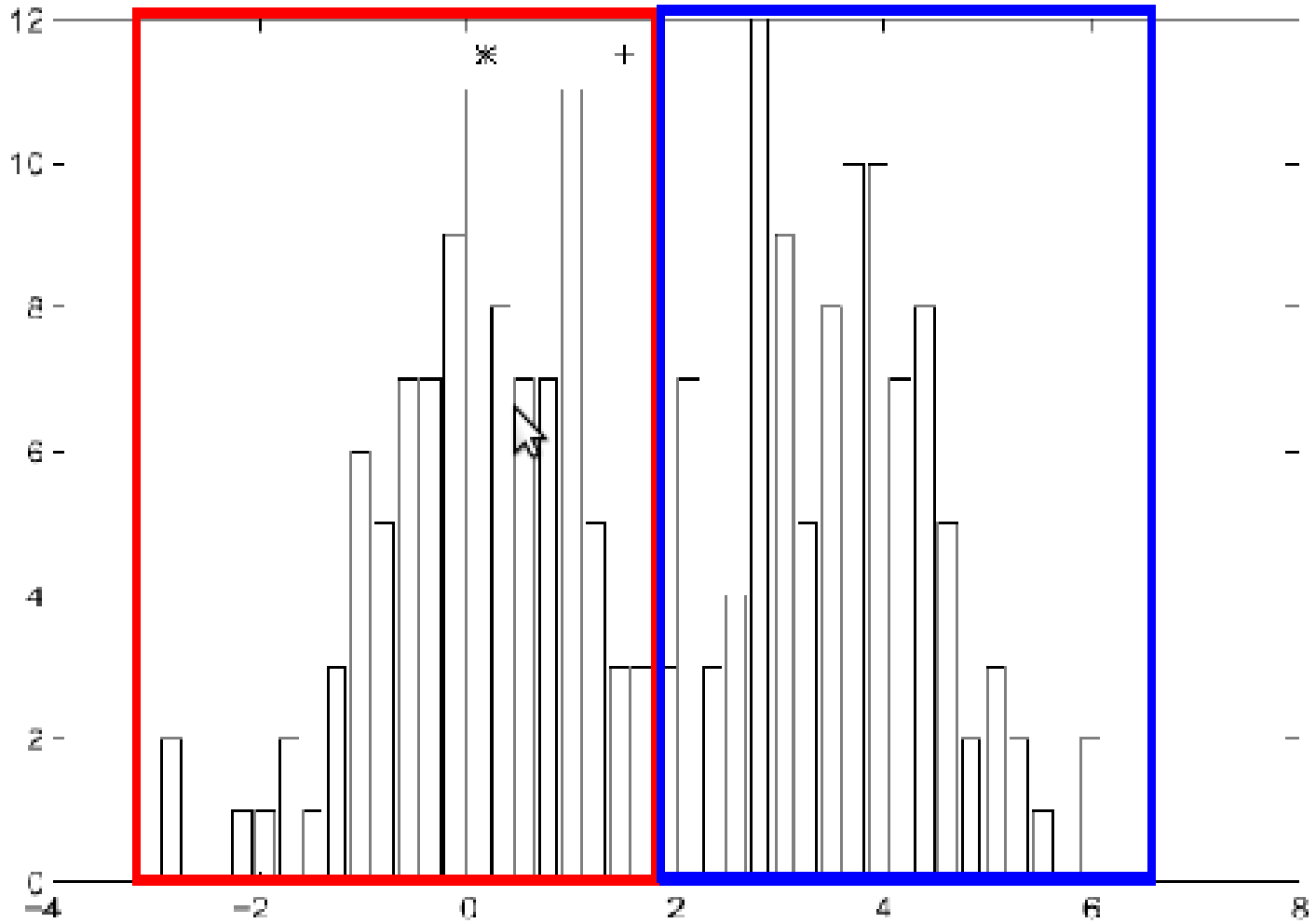
DEMO: Region Growing

Renk temelli Blob Bölütleme

- N renkle başla, K renge in
- histogramdaki modlara bak

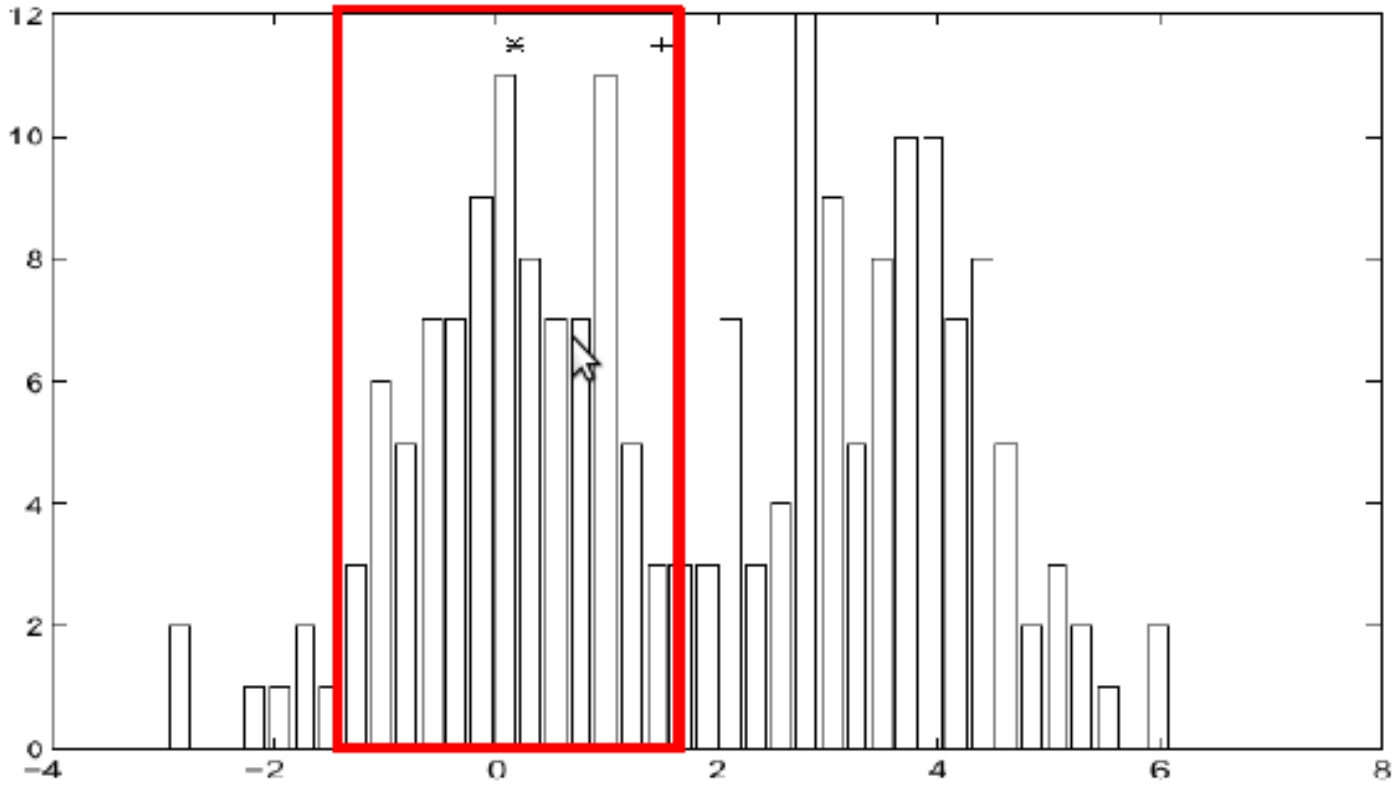
histogramdaki modları bulma

kaç mode var?



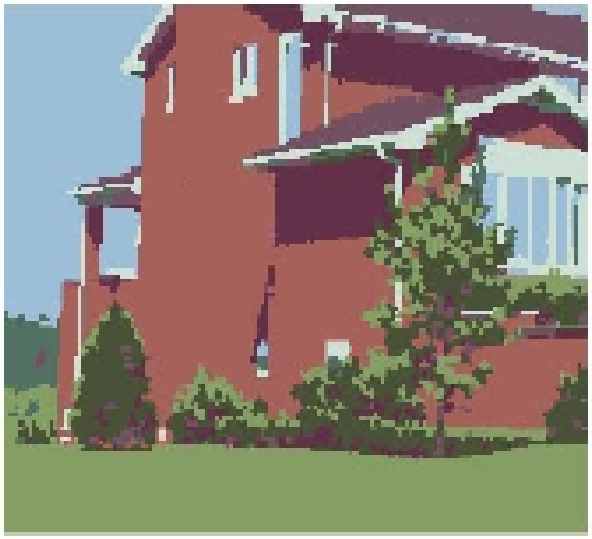
Mean-shift (Comaniciu ve Meer)

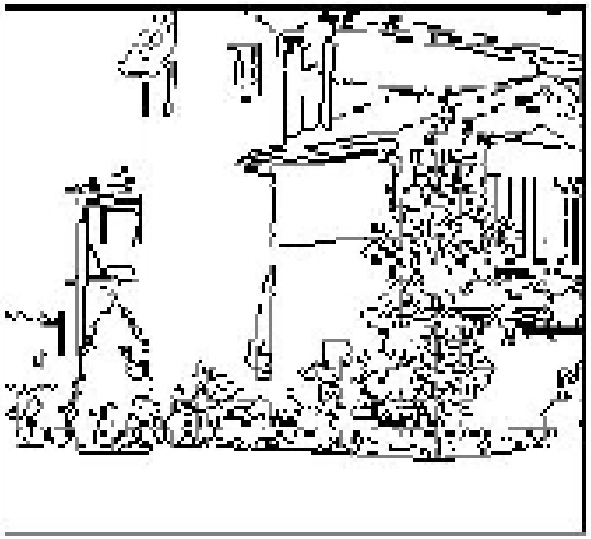
parametrik olmayan öznitelik uzayı analiz tekniğidir.



- rastgele seed ve sabit boyutlu pencereyle başla
- pencerenin ağırlık merkezini hesapla ("mean")
- mean'e arama penceresini kaydır
- yakınsayıncaya kadar 2. adımı yinele

Mean-shift (Comaniciu ve Meer)





More Examples: http://www.caip.rutgers.edu/~comanici/segm_images.html

Böylesi bir resmi nasıl idare edeceğiz?

Mesele

‘blob != nesne‘

Şekilbilimsel Resim İşleme ...

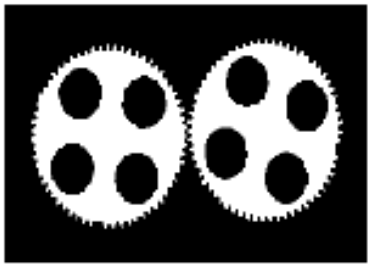
0 represents the background

1 represents the foreground

```
0001001000010000
0001111000010000
0001001000010000
```

Uygulama Alanları

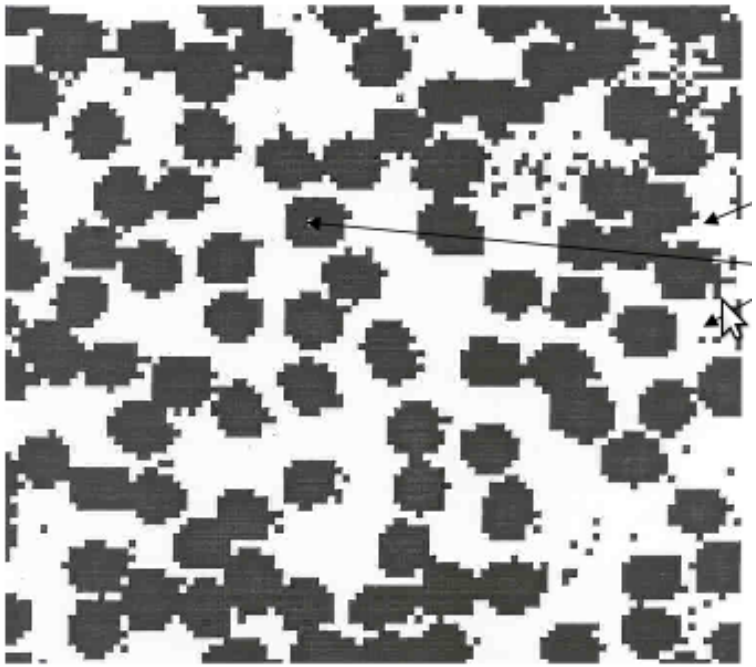
Döküman analizi, endüstri, tıp, ...



İşlemler

- arkaplandan ve diğerlerinden nesneyi ayırmak
- her bir nesneye ait pikselleri bir araya getir
- her bir nesne için öznitelikleri hesapla

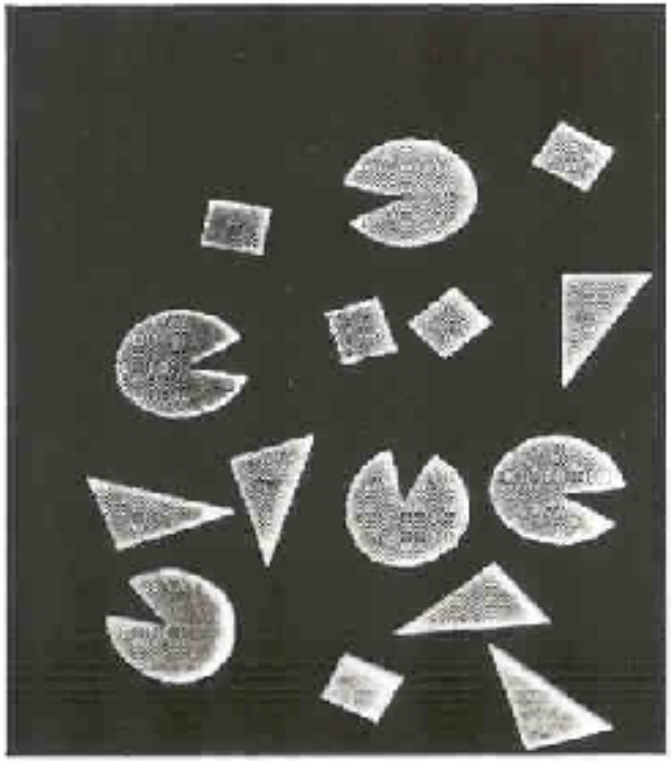
Örnek: kırmızı kan hücreleri



- çok sayıda ayrı nesne var
- bazıları birbirine dokunuyor - kötü! - ayır
- tuz ve biber gürültüsü var (eşiklemeden gelen) - filtrele
- bu veriden nasıl faydalanılabilir?

- '63' ayrı nesne algılanmıştır
- tek hücre alanı yaklaşık olarak '50''dir
- gürültü spotları var
- hüvre pıhtıları

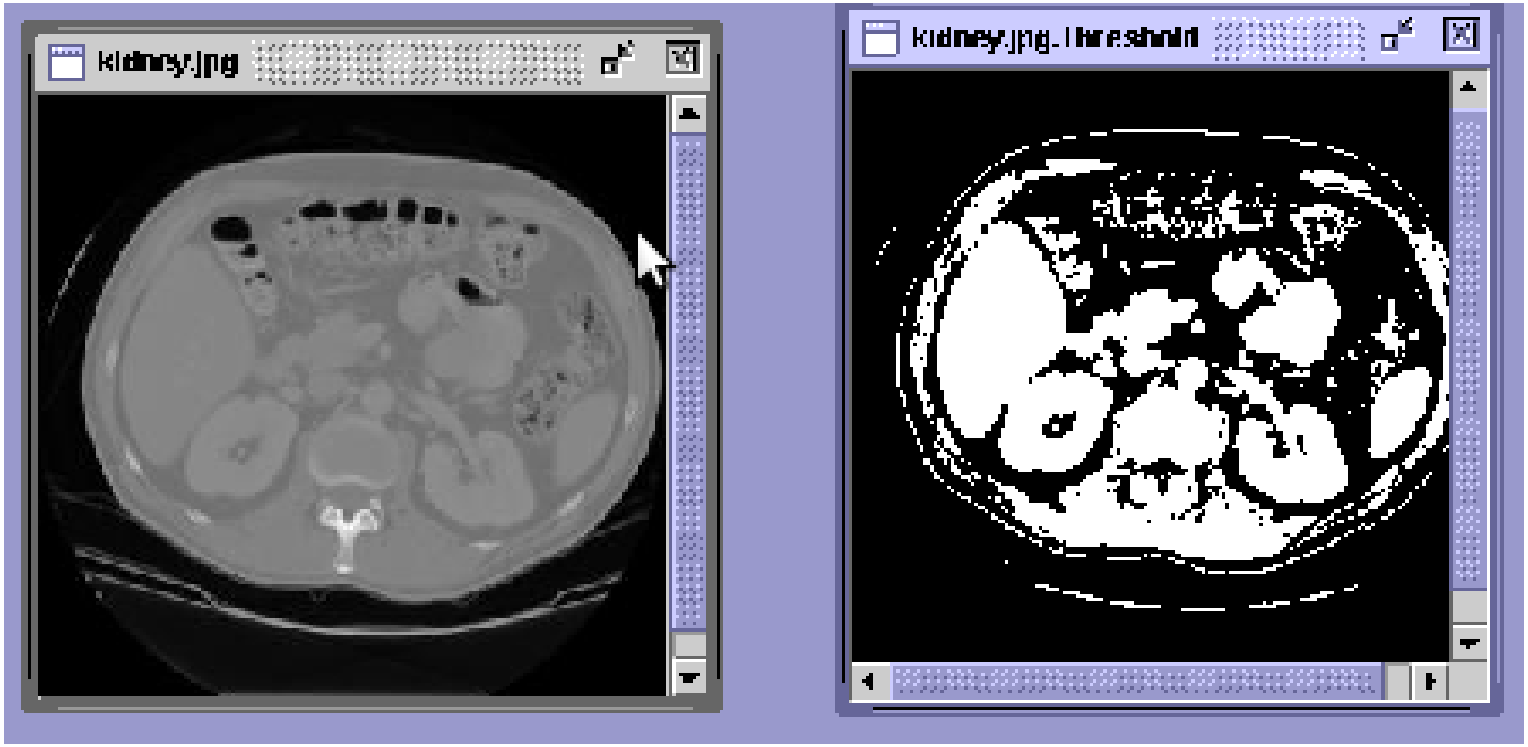
Daha denetlenebilir resimler



- kaç nesne? ‘15‘ nesne
- nerede?
- alanları?
- kaç tür?

- daha basit geometrili nesne
- daha basit arkaplan
- nesneler ayrılabilir durumda

Eşikleme



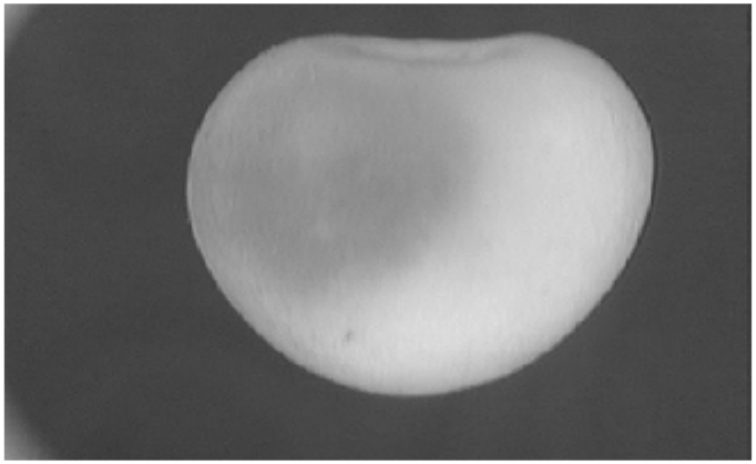
İkil resimler, eşiklemeyle gri resimlerden elde edilebilir.

Eşikleme için varsayımlar

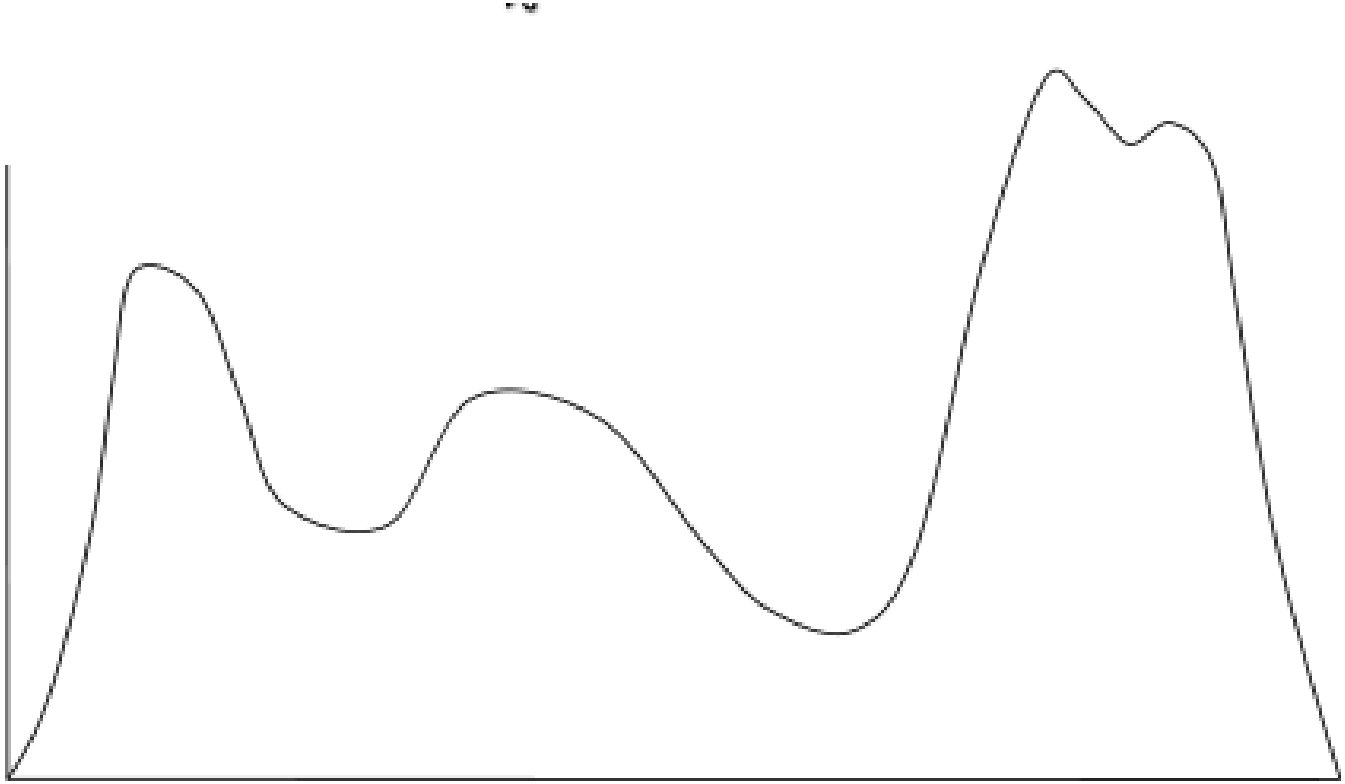
- ilgilendiğimiz nesne arkaplandan farklı bir dağılıma sahip olmalıdır
- bölgeye ait pikseller, yalnızca parlaklık yardımıyla elde edilebilir
- :: $parlaklik > T$, $parlaklik < T$ veya $T_1 < parlaklik < T_2$
- basit sahnelerde işe yarar
- doğal/karmaşık sahnelerde işe yaramaz

Eşik seçiminde histogramın kullanımı

- ‘3‘ bölgeli kiraz resmi
- arkaplan siyah
- normal/kaliteli kiraz, parlaktır
- çürük kiraz ise orta parlaklıktadır
- histogram iki kiraz bölgesini gösterir

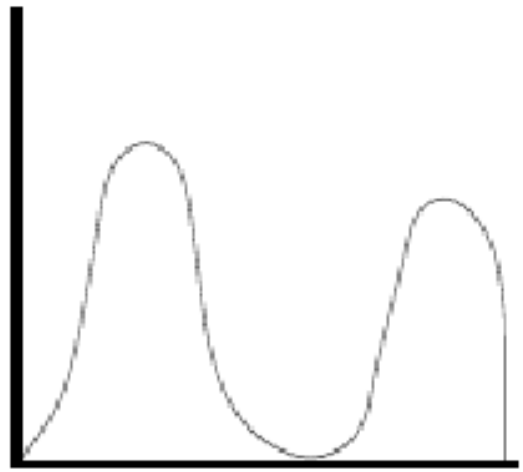


bir resimdeki iki veya daha fazla bölgeyi histogram temelinde nasıl ayırabiliriz?

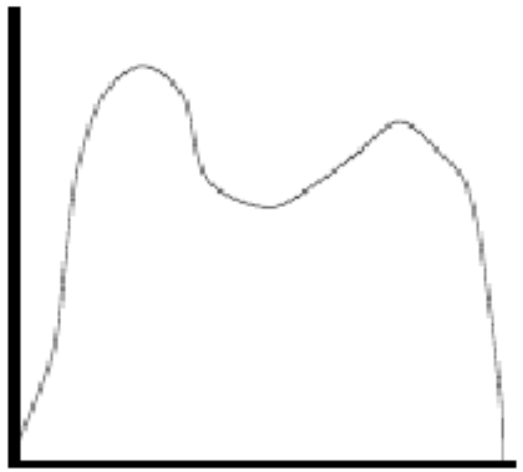


Eşik Seçimi

Tepe ve çukurları algıla



Two distinct modes



Overlapped modes

İki farlı mod, örtüşen modlar

Eşik Seçimi

- iki modlu histogramda iki mod arasındaki en derin vadiyi bul
- histograma iki veya daha fazla Gauss eğrisi uydur
- dinamik eşikleme

Eşikleme sonucunda temizlik

- daha iyi ayırt etme için sınırdaki nesne piksellerini sil
- boşlukları doldur
- küçük nesneleri sil
- (son ikisi tuz-biber gürültüsüdür)

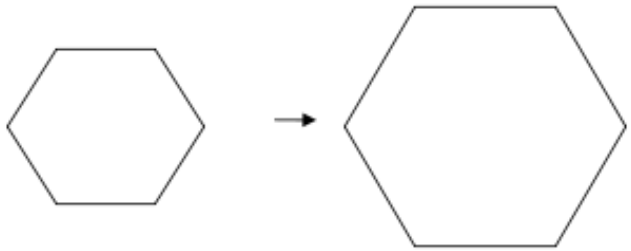
Matematiksel Şekilbilim

- iki temel işlem: **dilation** ve **erosion**
- ve bunların kombinasyonu: **opening**, **closing**, ...

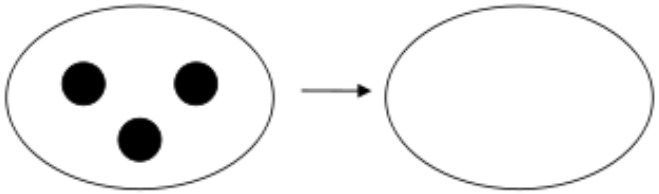
Dilation - genişletme

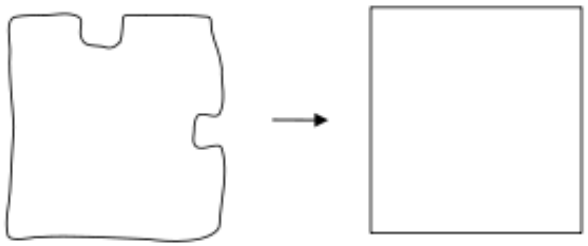
It can be used for

1. growing features



2. filling holes and gaps



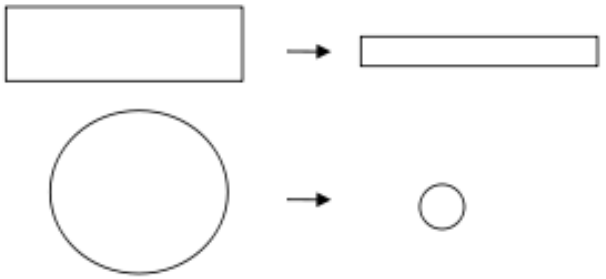


Erosion

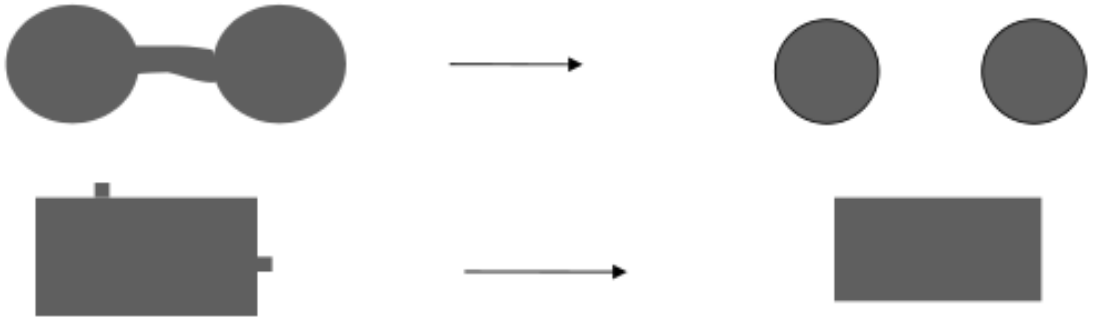
Erosion - daraltma

It can be used for

1. shrinking features



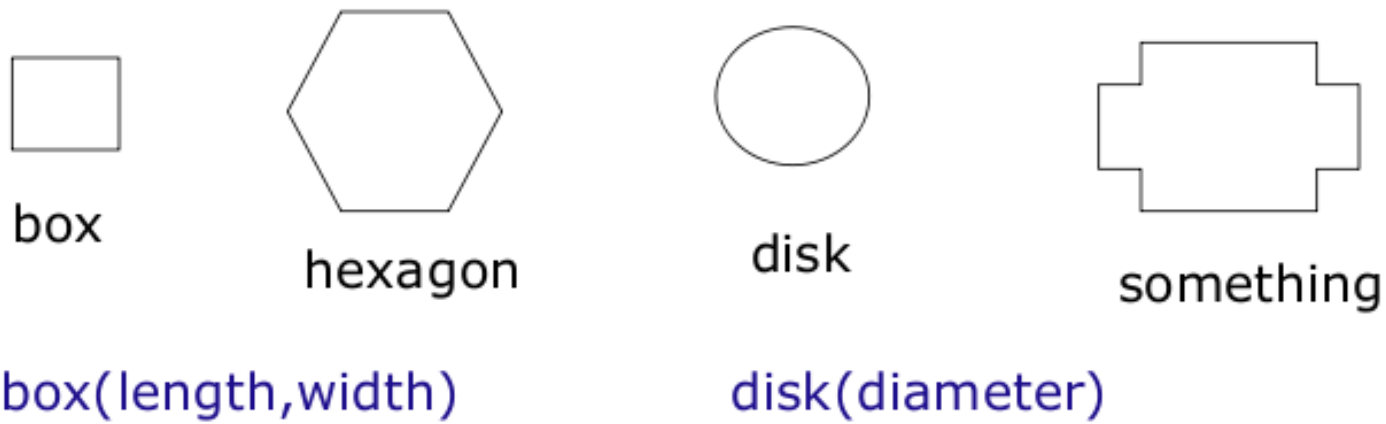
2. Removing bridges, branches and small protrusions



Kan hücre örneğini hatırlayın.

Yapı Elemanı

- yapı elemanı, şekil maskesidir
- şekli ve boyutu vardır

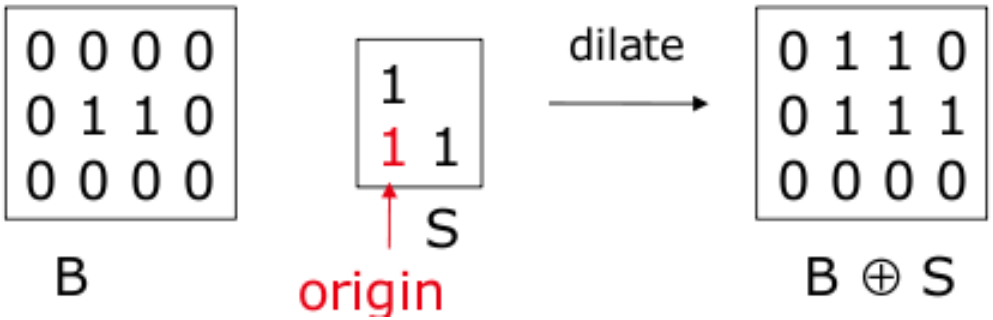


box(length,width) disk(diameter)

Dilation yapı elemanıyla

B: ikil resim ve S: yapı elemanıdır,

dilate(B,S) takes binary image B, places the origin of structuring element S over each 1-pixel, and ORs the structuring element S into the output image at the corresponding position.



Dilation

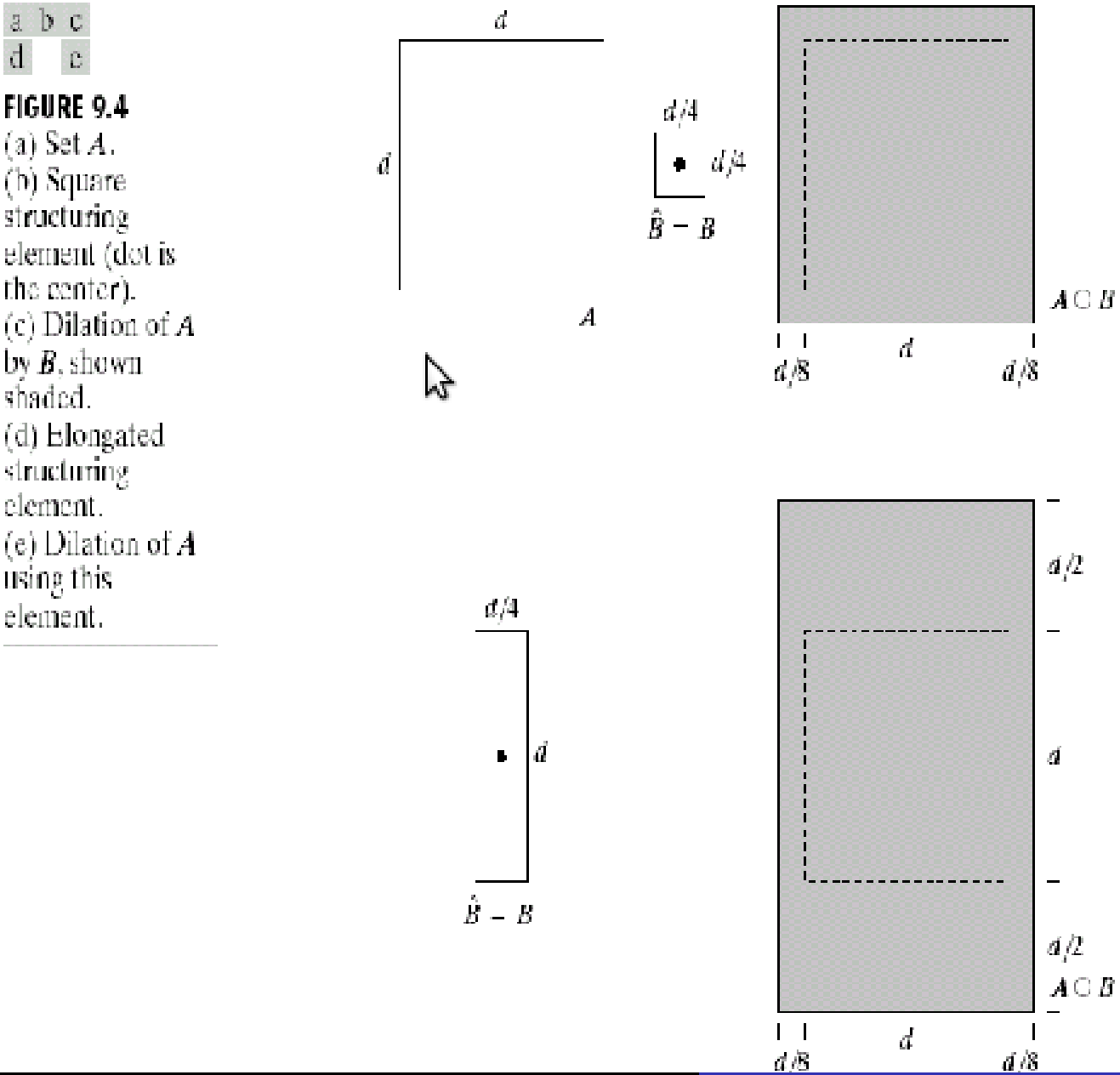
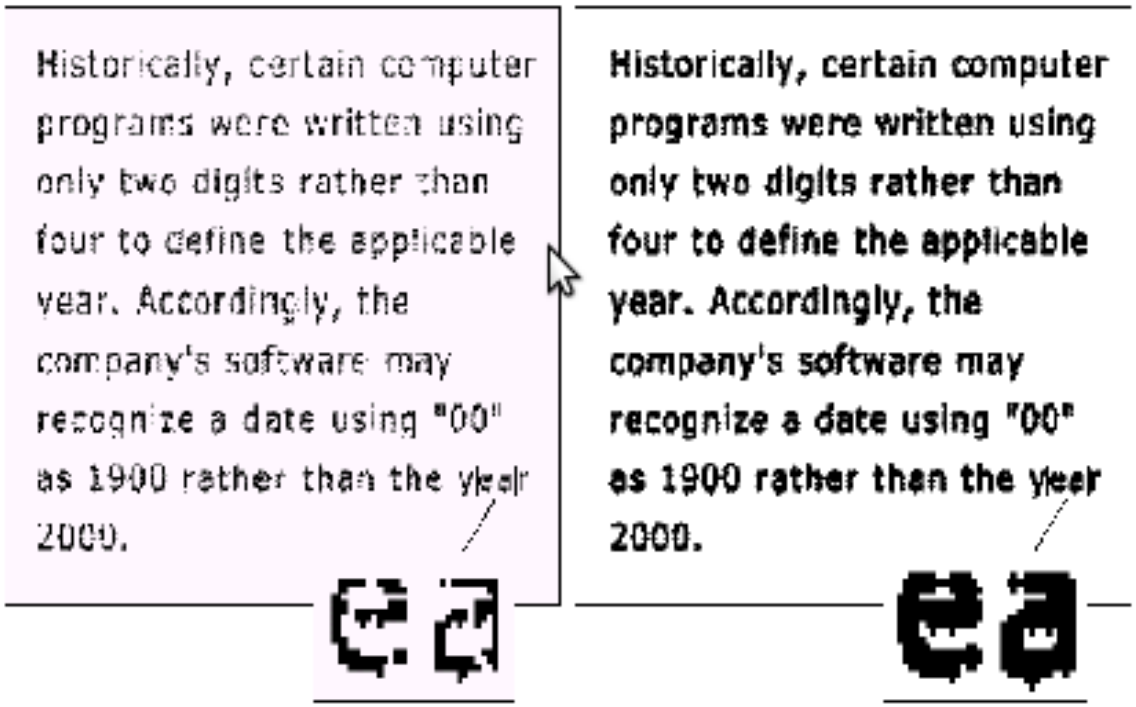


FIGURE 9.4
(a) Set A.
(b) Square structuring element (dot is the center).
(c) Dilation of A by B, shown shaded.
(d) Elongated structuring element.
(e) Dilation of A using this element.

Dilation



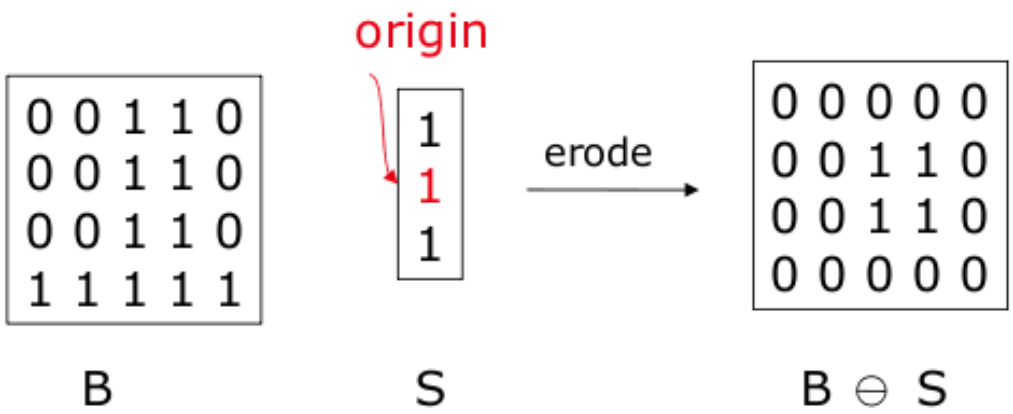
a c
b

FIGURE 9.5
(a) Sample text of poor resolution with broken characters (magnified view). (b) Structuring element. (c) Dilation of (a) by (b). Broken segments were joined.

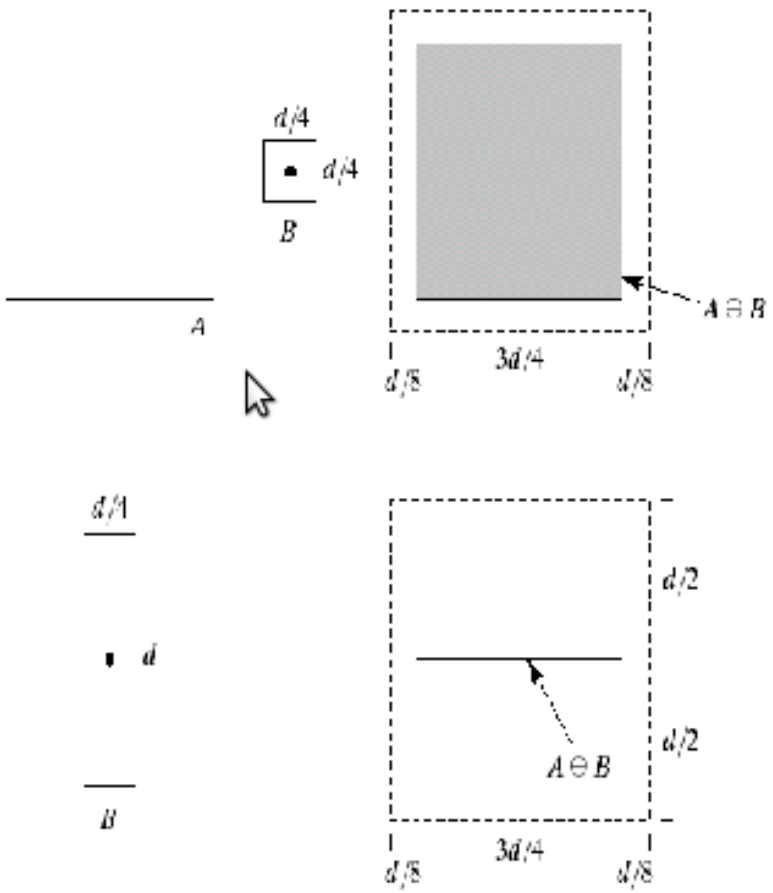
0	1	0
1	1	1
0	1	0

Erosion yapı elemanıyla

erode(B,S) takes a binary image B, places the origin of structuring element S over every pixel position, and ORs a binary 1 into that position of the output image only if every position of S (with a 1) covers a 1 in B.



Erosion



a b c
d e

FIGURE 9.6 (a) Set A. (b) Square structuring element. (c) Erosion of A by B, shown shaded. (d) Elongated structuring element. (e) Erosion of A using this element.

Erosion

Original image

Eroded image

Erosion

Eroded once

Eroded twice

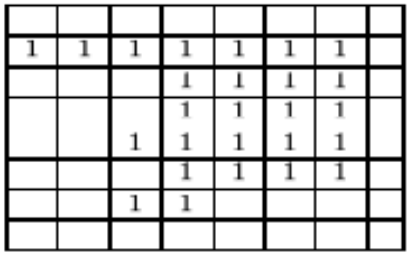
Opening ve Closing

- closing: önce erosion sonra dilation
- opening: önce dilation sonra erosion

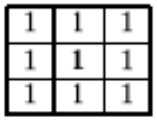
Opening ve Closing

- opening: nesnenin kontörlerini yumuşatır $A \circ B = (A \ominus B) \oplus B$
- closing: kontörleri yumuşat; boşlukları doldur $A \bullet B = (A \oplus B) \ominus B$
- 'bwmorph''ı kurcalayın.

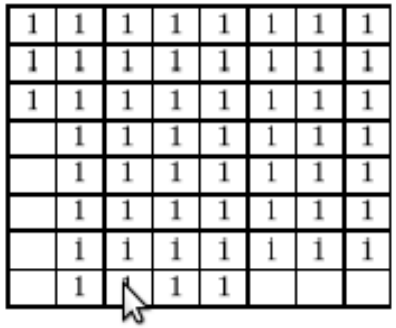
örnek 1



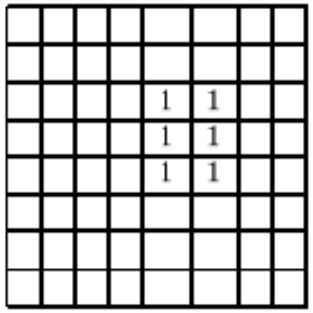
a) Binary image B



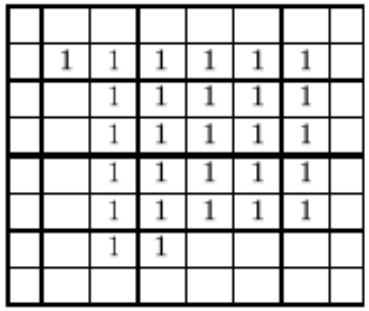
b) Structuring Element S



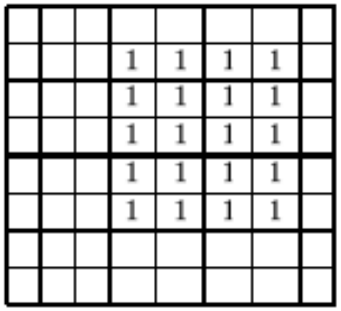
c) Dilation $B \oplus S$



d) Erosion $B \ominus S$



e) Closing $B \bullet S$



f) Opening $B \circ S$

örnek 1: deneme

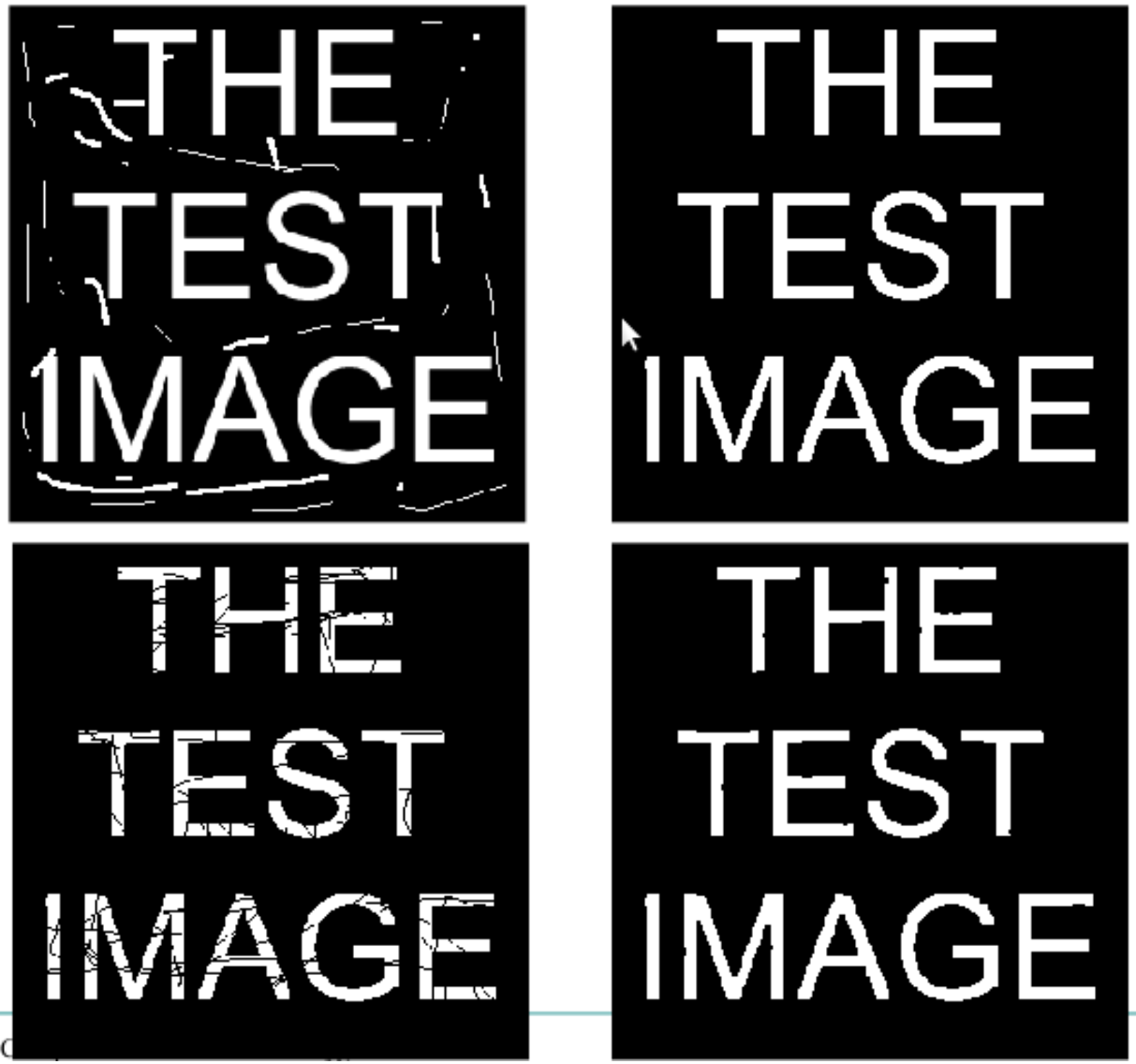
B

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

S

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

Opening ve Closing

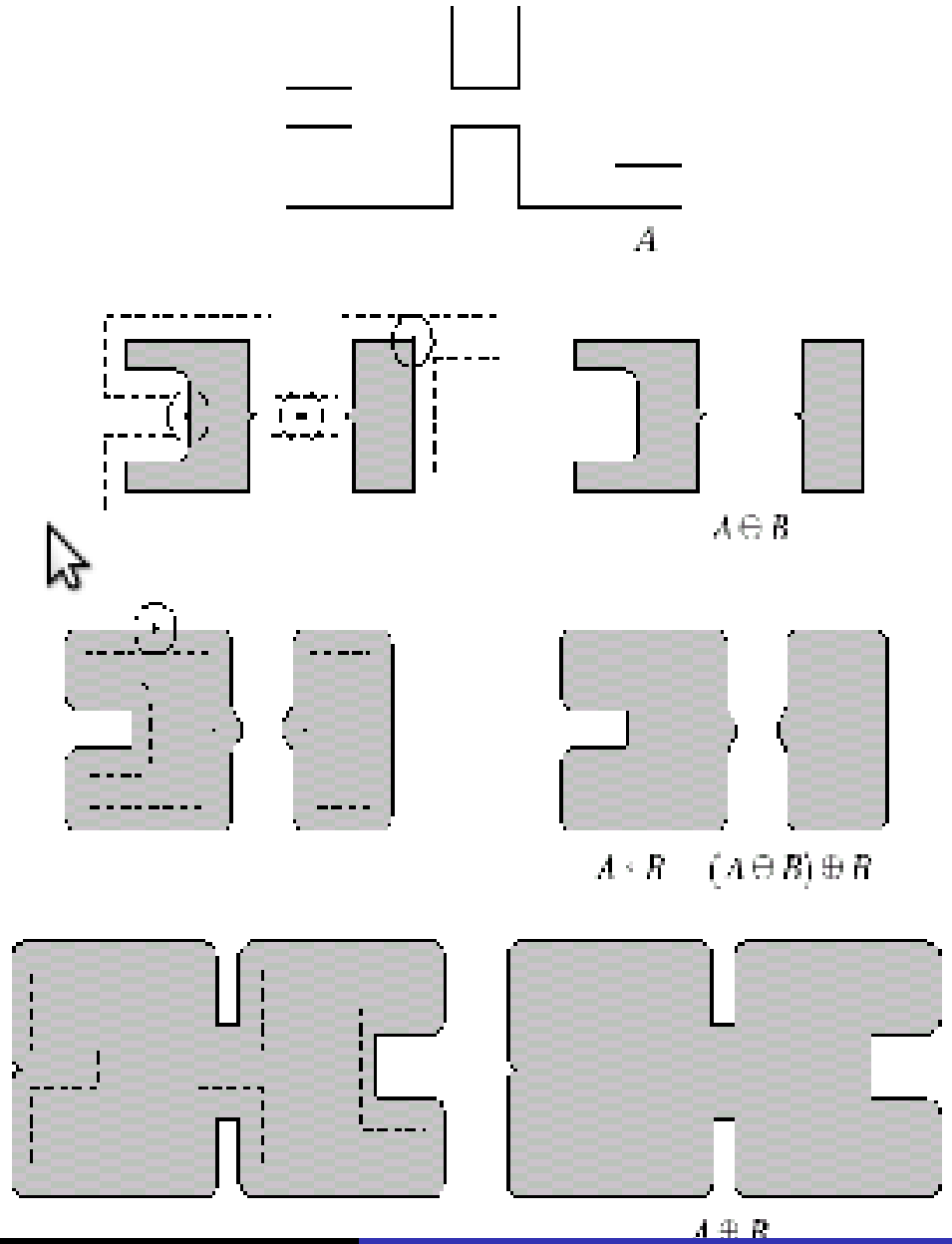


OPENING: 2xeroded + 2xdilated; gürültüden kurtulduk CLOSING: dilated + eroded: bosluklar dolduruldu

Opening ve Closing

a
b c
d e
f g
h i

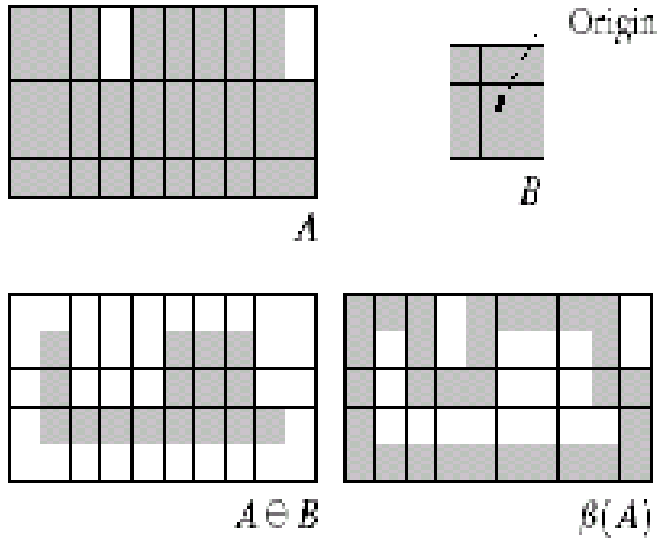
FIGURE 9.10
Morphological opening and closing. The structuring element is the small circle shown in various positions in (b). The dark dot is the center of the structuring element.



Sınır Çıkarım

a b
c d

FIGURE 9.13 (a) Set A. (b) Structuring element B. (c) A eroded by B. (d) Boundary, given by the set difference between A and its erosion.



Sınır Çıkarım

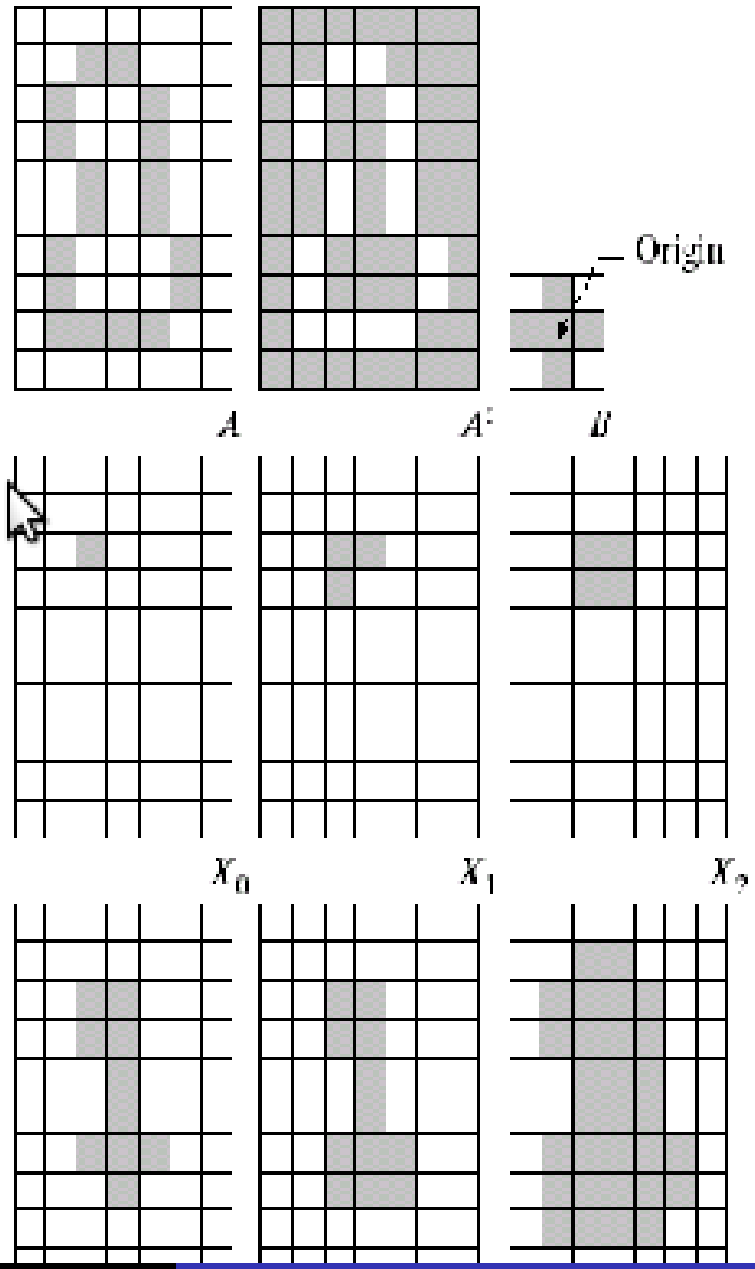
a b

FIGURE 9.14
(a) A simple binary image, with 1's represented in white. (b) Result of using Eq. (9.5-1) with the structuring element in Fig. 9.13(b).

Bölge Doldurma

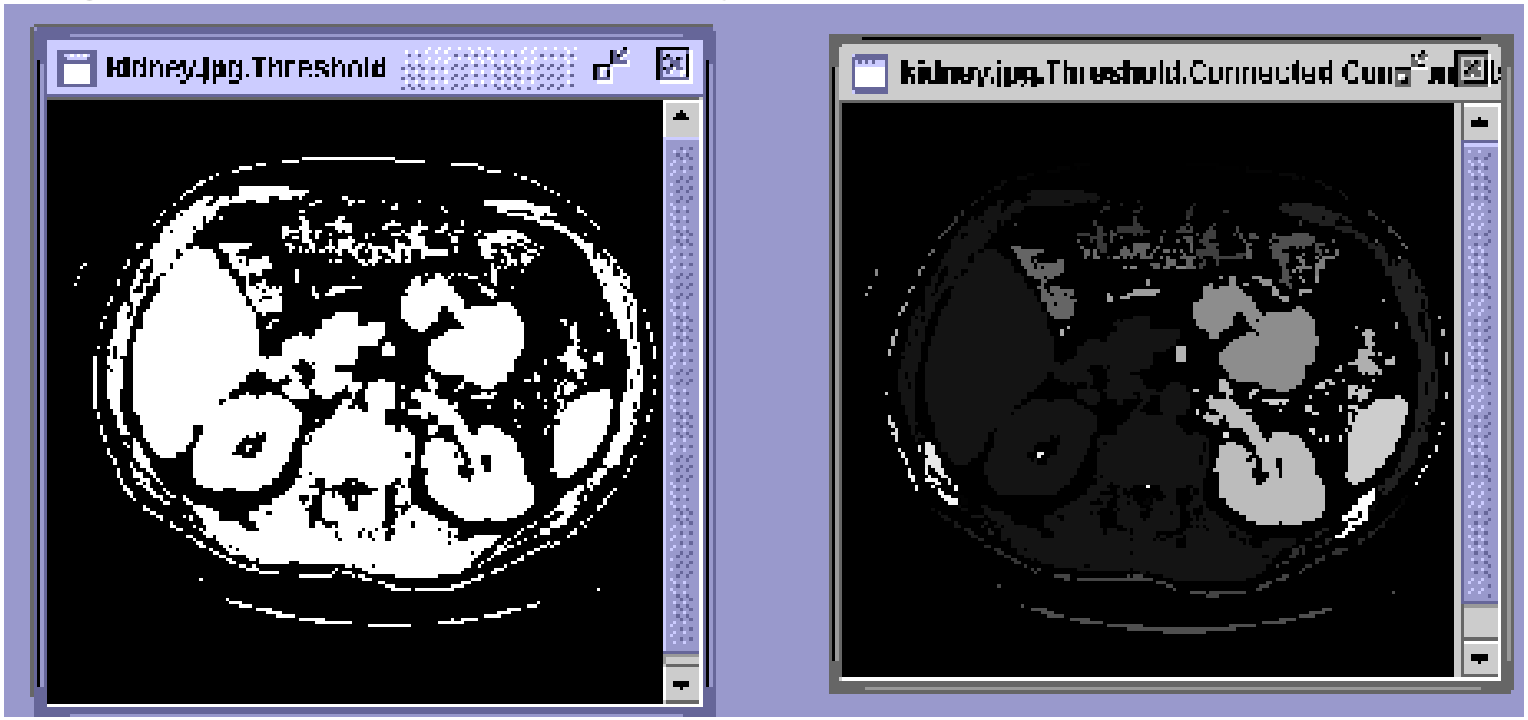
a b c
d e f
g h i

FIGURE 9.15
Region filling.
(a) Set A.
(b) Complement of A.
(c) Structuring element B.
(d) Initial point inside the boundary.
(e)–(h) Various steps of Eq. (9.5-2).
(i) Final result [union of (a) and (h)].

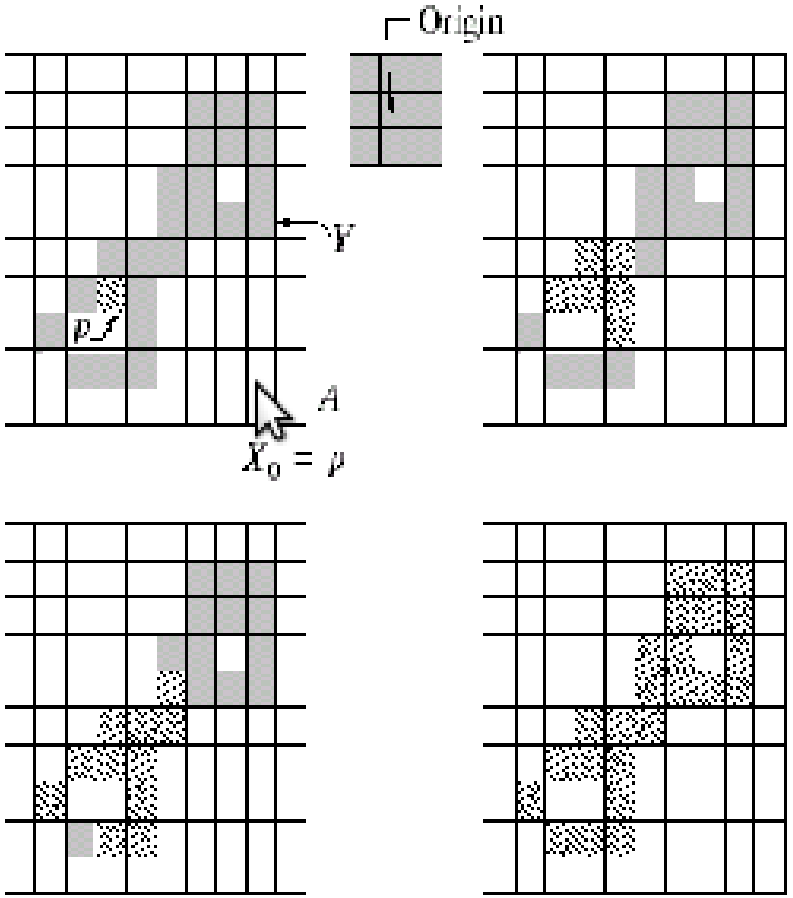


Bağlı Bileşen Etiketleme

ikil resmi elde et, bağlı piksel kümesini belirle ve analiz et
bağlı bileşen işlemleri, ikil resim alır ve etiket resmini döndürür.
Değerler ‘0‘ ve pozitif tamsayılardır.



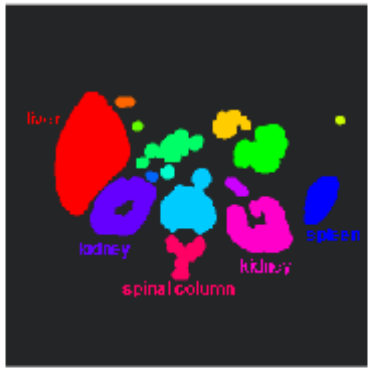
Bağlı Bileşen Ayrıştırma



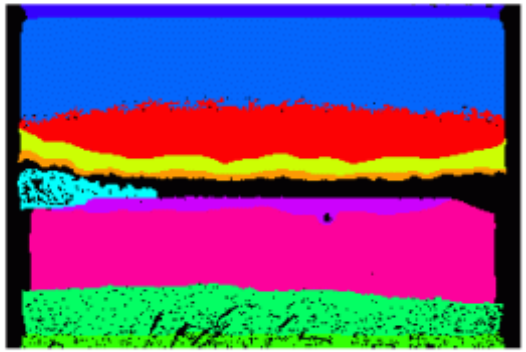
a b c
d e

FIGURE 9.17 (a) Set A showing initial point p (all shaded points are valued 1, but are shown different from p to indicate that they have not yet been found by the algorithm). (b) Structuring element. (c) Result of first iterative step. (d) Result of second step. (e) Final result.

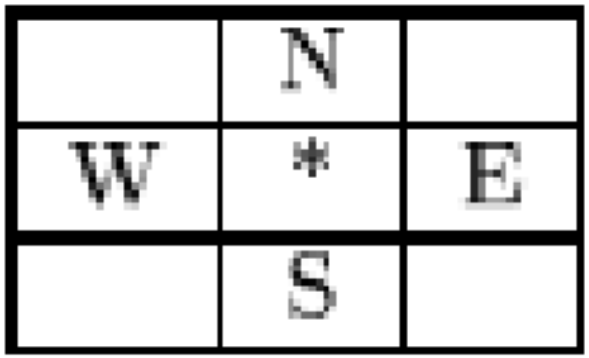
sözde renklendirme olarak etiketleme



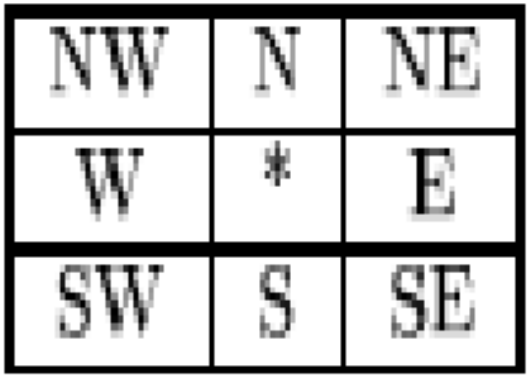
connected components of 1's from thresholded image



connected components of cluster labels



4-neighborhood



8-neighborhood

4-lü ve 8-li komşuluk

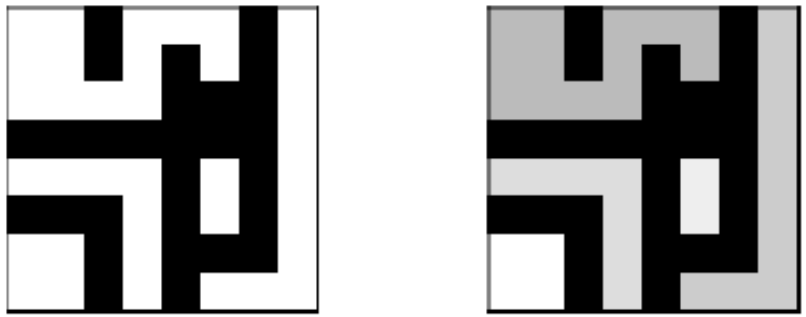
Özyineli etiketleme

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

a) binary image

1	1	0	1	1	1	0	2
1	1	0	1	0	1	0	2
1	1	1	1	0	0	0	2
0	0	0	0	0	0	0	2
3	3	3	3	0	4	0	2
0	0	0	3	0	4	0	2
5	5	0	3	0	0	0	2
5	5	0	3	0	2	2	2

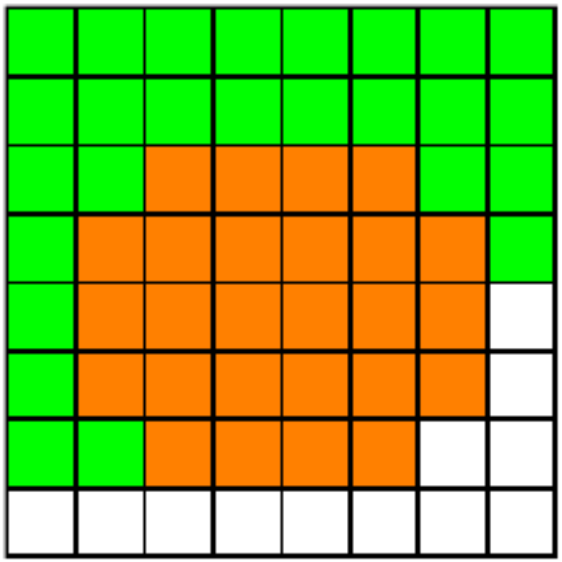
b) connected components labeling



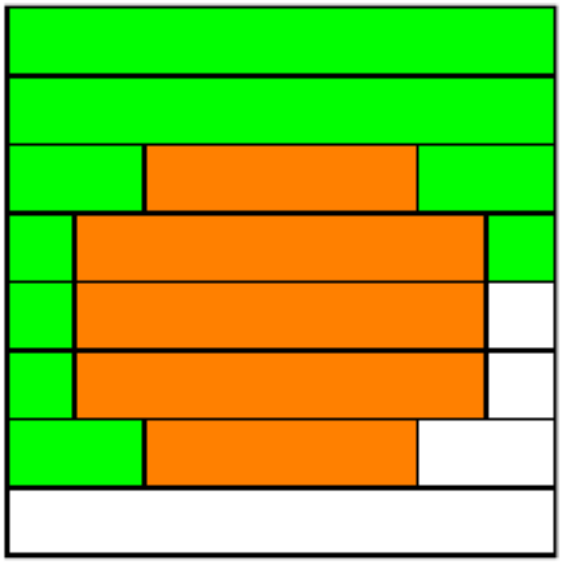
c) binary image and labeling, expanded for viewing

İlk adım: RLC

benzer piksel gruplarına her bir resim satırlarını bölütle (bunlara run denir)
her bir run, sürekliliğe sahip renk değerlerini içeren satırın başlangıç ve bitimini saklar

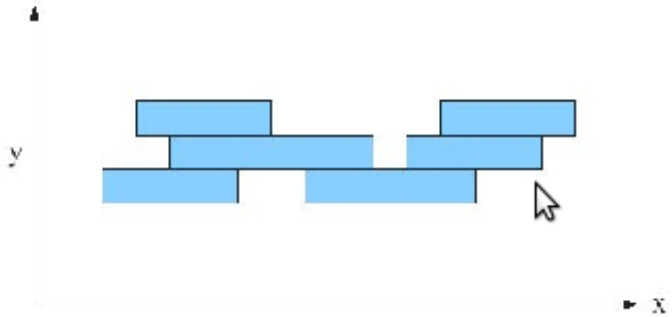


Original image

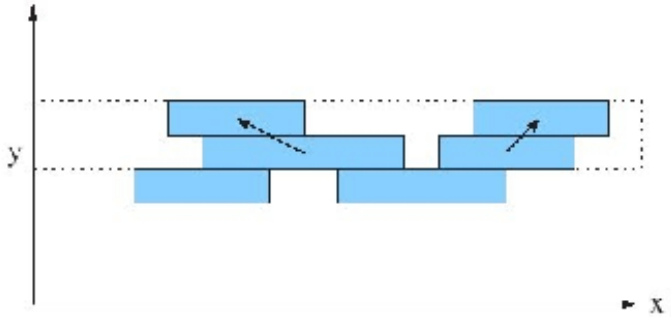


RLE image

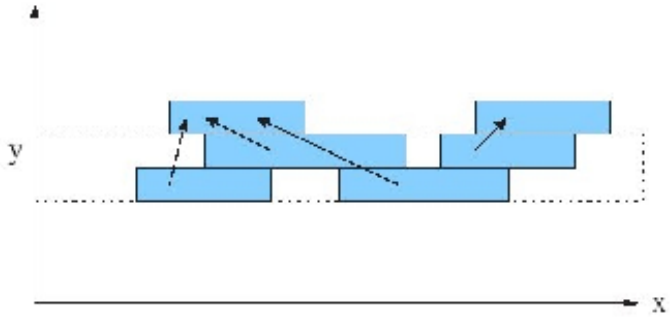
İkinci adım: bölgeleri birleştir



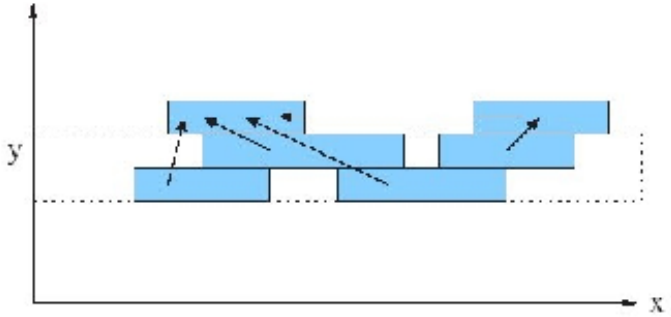
1: Runs start as a fully disjoint forest



2: Scanning adjacent lines, neighbors are merged



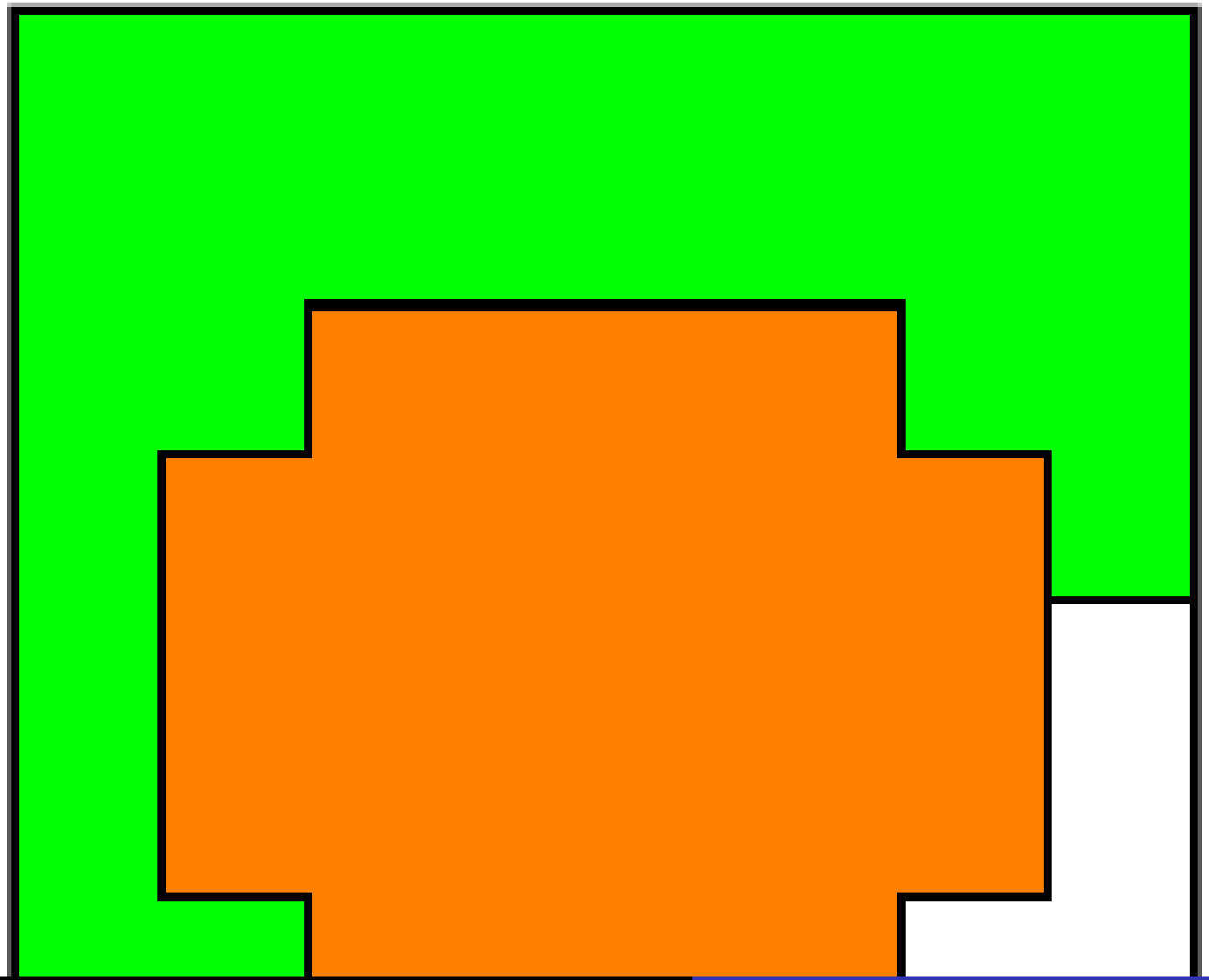
3: New parent assignments are to the furthest parent



4: If overlap is detected, latter parent is updated

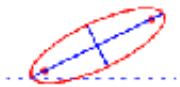
Sonuçlar

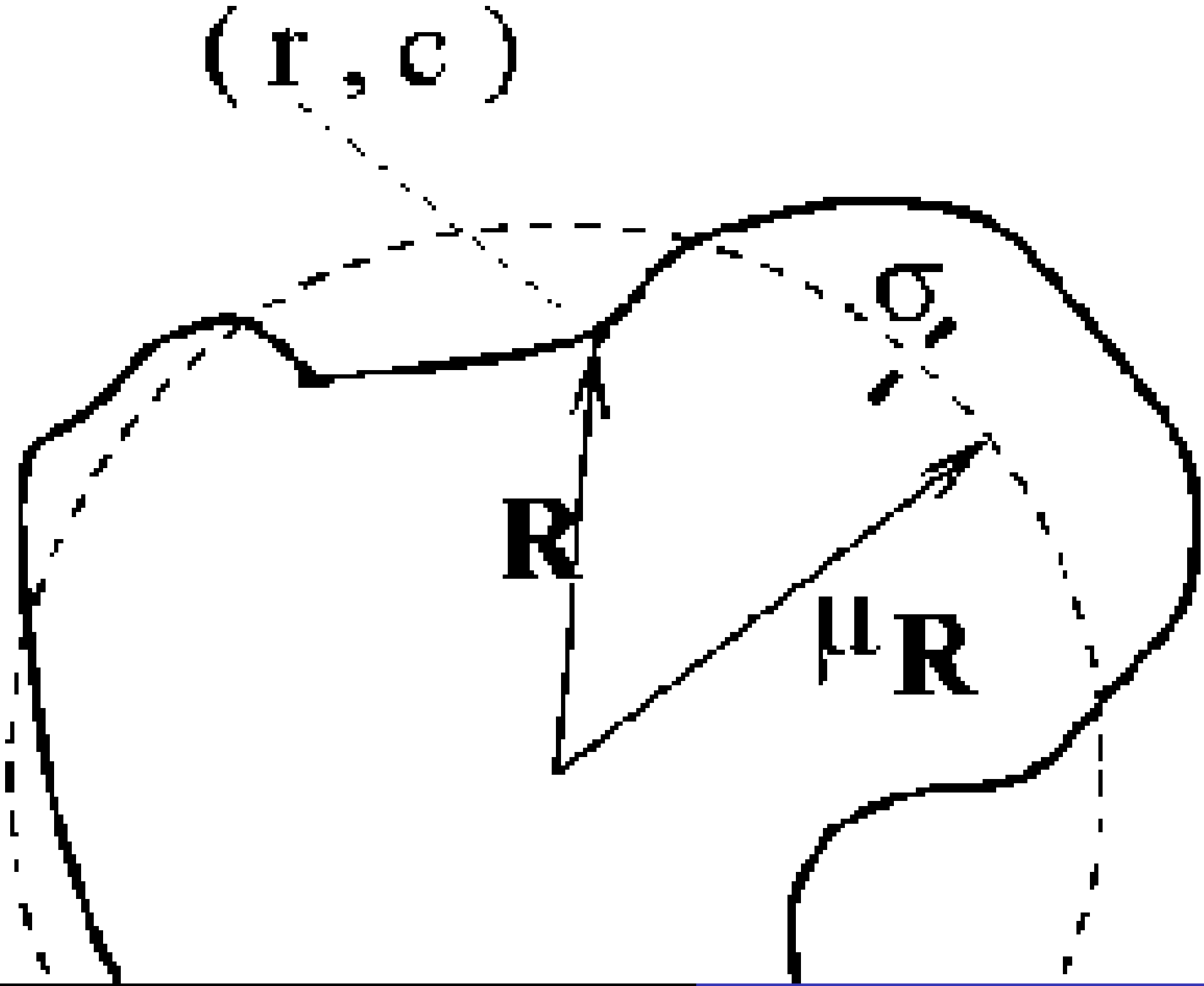
runlar, çok satırlı bölgelerde birleştirildi
pikseller yerine resim, sürekliliğe sahip bölgeleri tanımlıyor



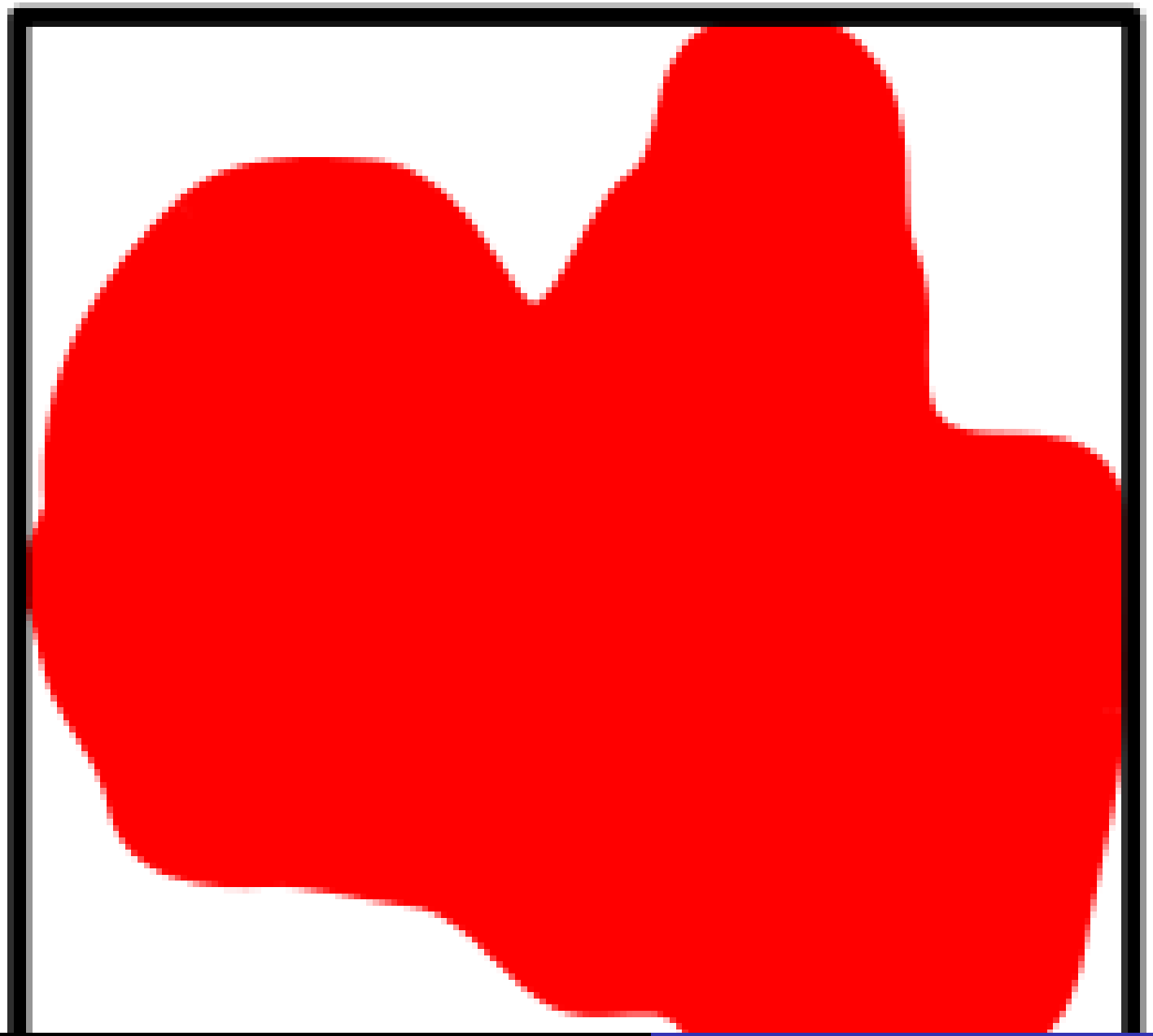
Blob Özellikleri

- bloblarla ne yapacağız?
- hesaplar neler olabilir?
- alan/perimeter/oran
- kütle merkezi/elips/ortalama renk değeri
- vs
- bunlar blobu sınıflandırmada yardımcı olabilir




(r , c)
σ
R
μR

bounding box



$M_{ij} = \sum_i \sum_j x^i y^j I(x, y)$
örneğin M_{00} alanı verirken, $(M_{10}/M_{00}, M_{01}/M_{00})$ merkezi verir
Matlab'da 'immoment(im, i, j)'