

İMGE İŞLEME

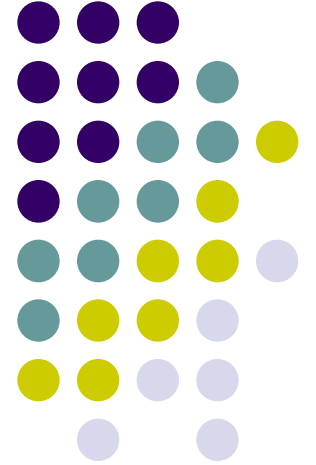
Ders-7

Morfolojik İmge İşleme



(Yrd. Doç. Dr. M. Kemal GÜLLÜ)

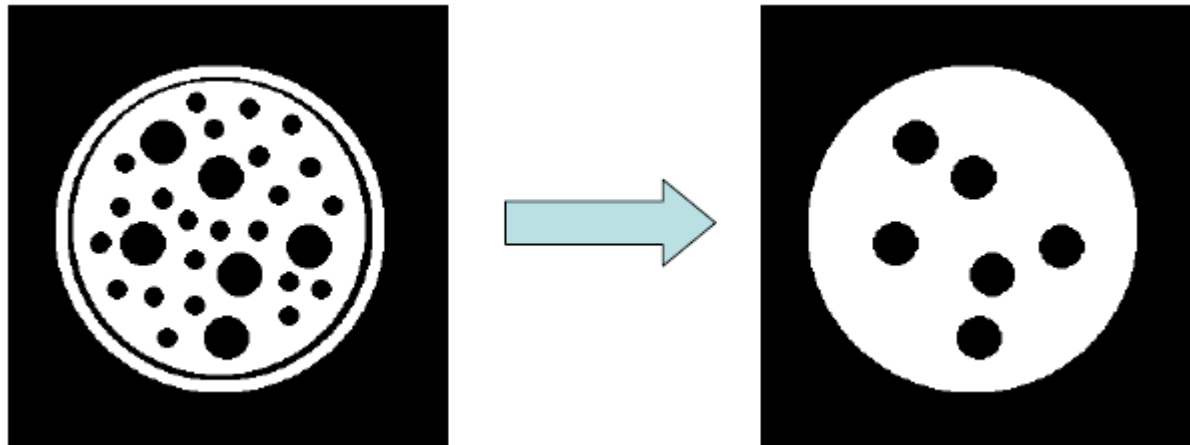
Dersin web sayfası: http://mf.kou.edu.tr/elohab/kemalg/imge_web/odev.htm



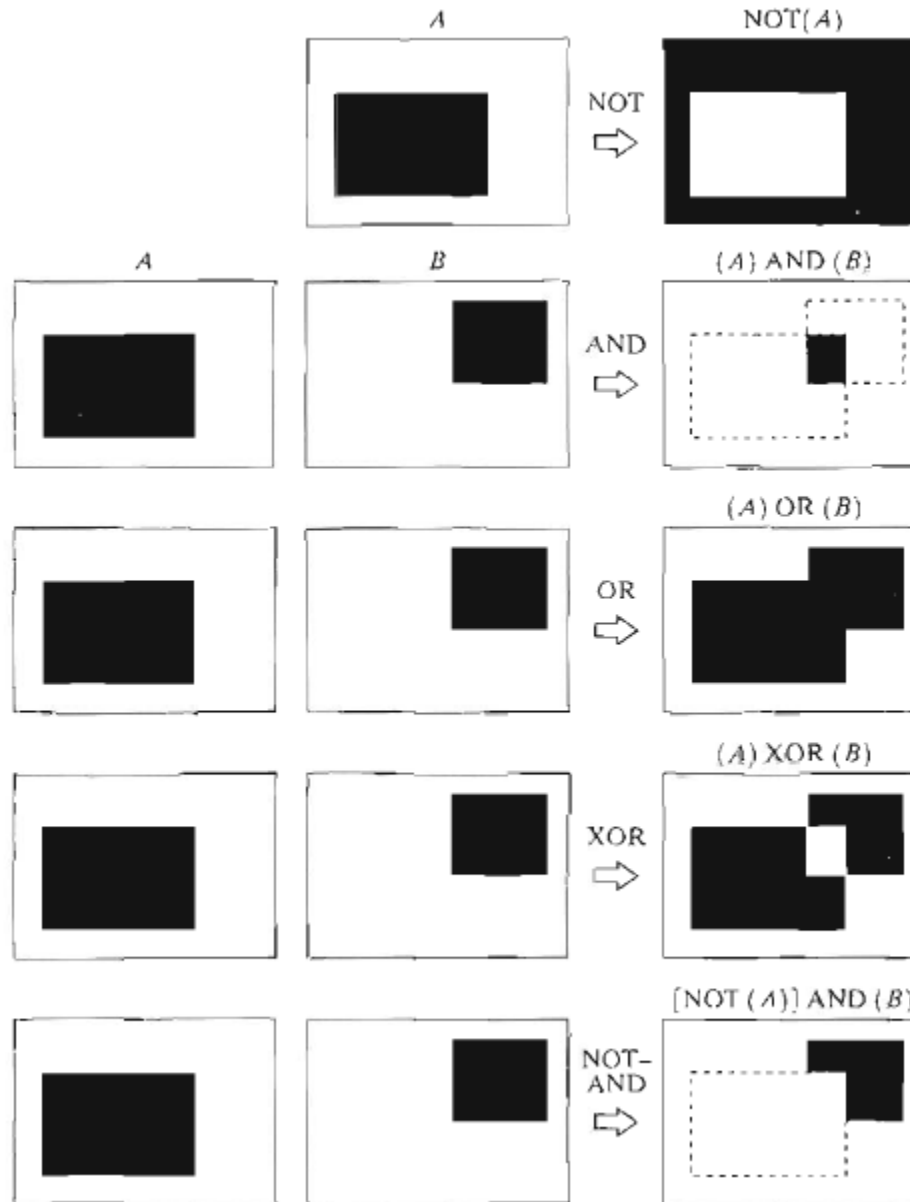
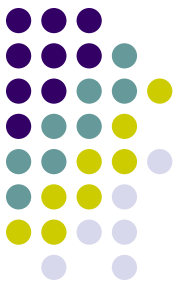
Morfoloji



- Biyolojinin canlıların şekil ve yapıları ile ilgilenen dalına morfoloji (biçim bilim) adı verilmektedir.
- Matematiksel morfoloji ise temel küme işlemlerine dayanan, imgedeki sınırlar (borders), iskelet (skeleton) gibi yapıların tanımlanması ve çıkartılması, gürültü giderimi, bölütleme gibi uygulamalar için gerekli bir araçtır.
- İmge işlemede genellikle, morfolojik süzgeçleme, inceltme (thinning), budama (pruning) gibi ön/son işlem olarak da sıkça kullanılırlar.
- Gri tonlu imgeler üzerinde de yapılabileceği gibi, genellikle ikili imgeler üzerinde yapılan işlemlerdir.



İkili İmgelerde Mantıksal İşlemler



Morfolojik İmge İşleme – Yayma ve Aşındırma

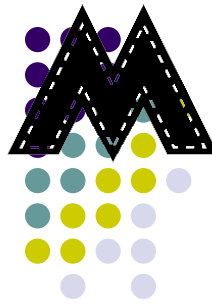


- Aşındırma (Erosion): Matematiksel morfolojinin temel operasyonlarından biridir.
- Ele alınan bölgenin sınır bölgelerinin aşındırılmasında kullanılmaktadır.



- Yayma (Dilation): Diğer bir temel morfolojik işlemdir.
- Ele alınan bölgenin sınırlarının genişletilmesinde kullanılmaktadır.

Morfolojik İmge İşleme – Yayma



- Morfolojik operatörlerin iki girişi vardır:
 1. Yayılacak imge,
 2. Yayma işleminin şeklini belirleyen yapı elemanı (structure element).
- Z^2 uzayında verilen A ve B kümeleri için yayma işlemi aşağıdaki gibi tanımlanmaktadır:

$$A \oplus B = \left\{ z \mid \left(\hat{B} \right)_z \cap A \neq \emptyset \right\}$$

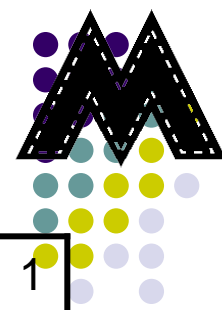
\hat{B} : B 'nin bire tümleyeni

A : işlenecek imge

B : yapı elemanı

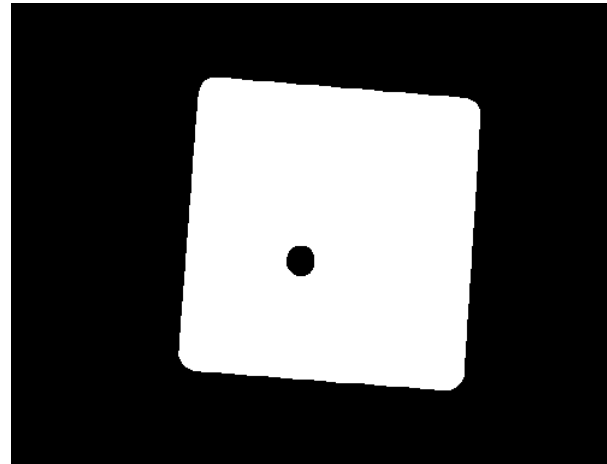
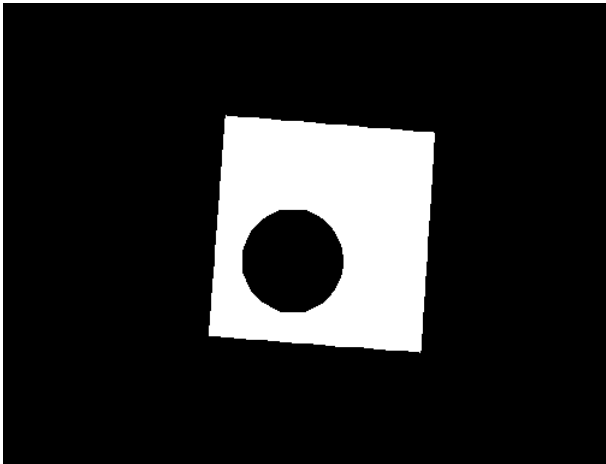
Yayma operatörü

Morfolojik İmge İşleme – Yayma

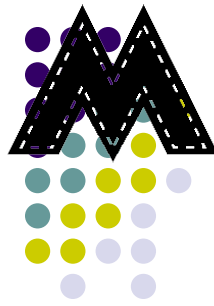


| | | |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

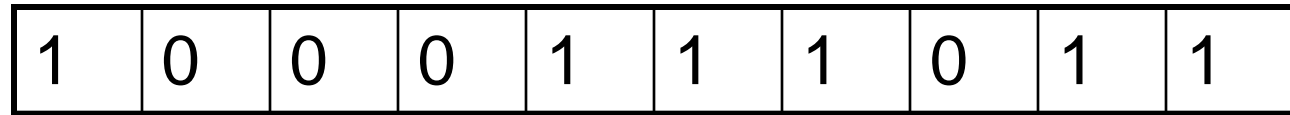
- Yapı elemanı, yayma işleminin nasıl yapılacağını belirlemektedir.



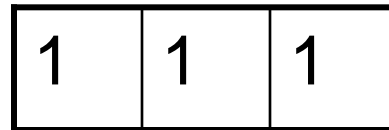
Morfolojik İmge İşleme – Yayma



Input image



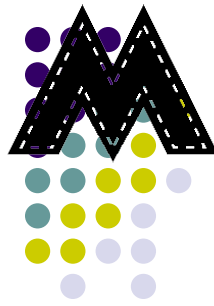
Structuring Element



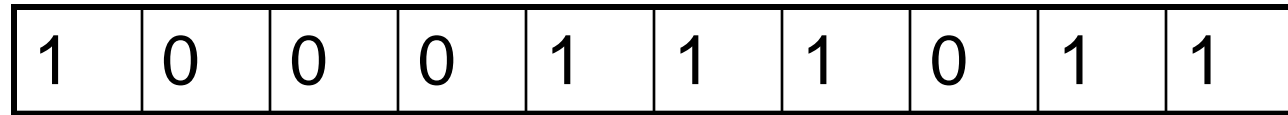
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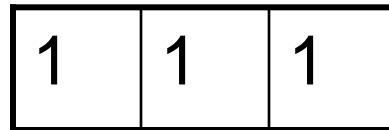
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Input image



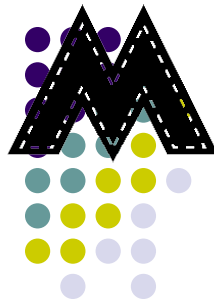
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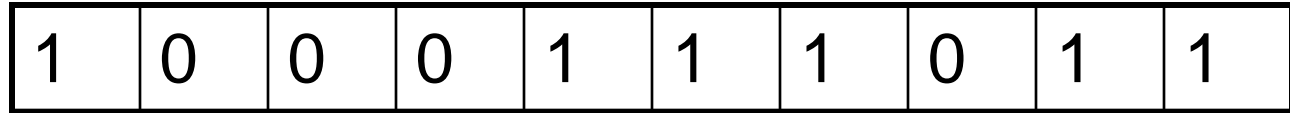
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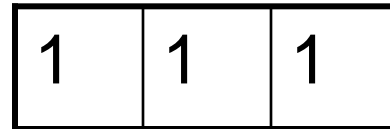
Morfolojik İmge İşleme – Yayma



Input image



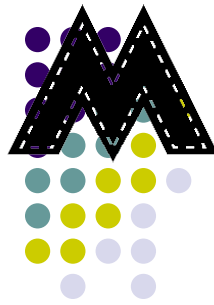
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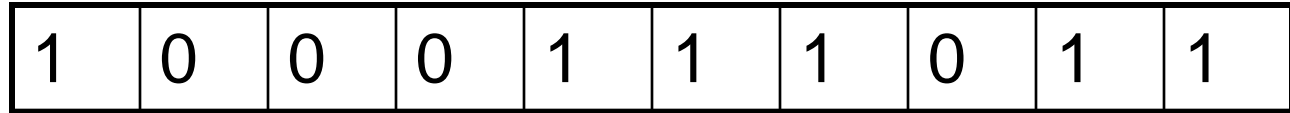
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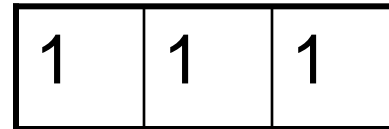
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Input image



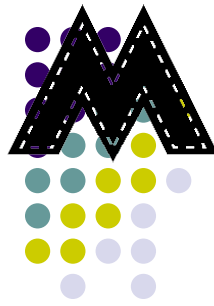
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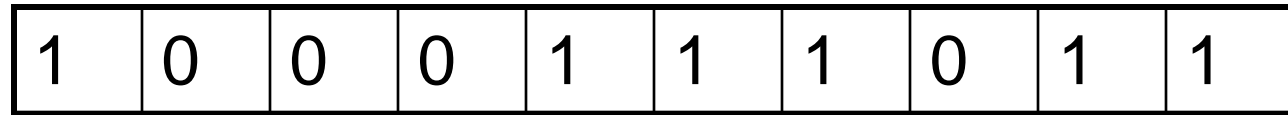
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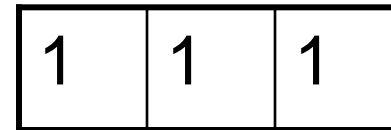
Morfolojik İmge İşleme – Yayma



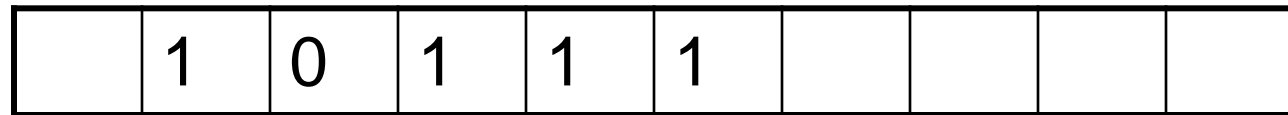
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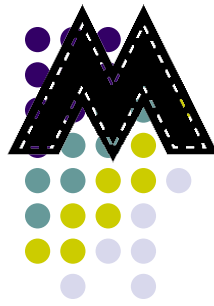
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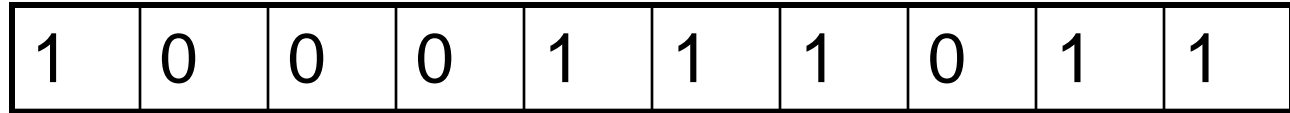
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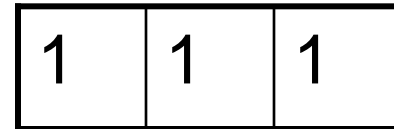
Morfolojik İmge İşleme – Yayma



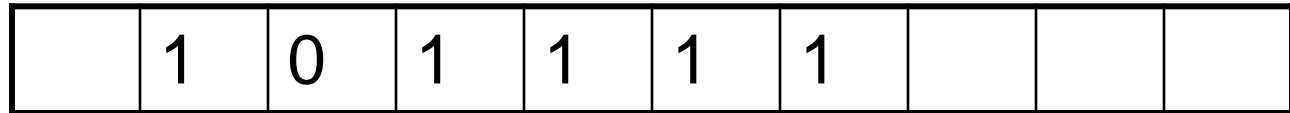
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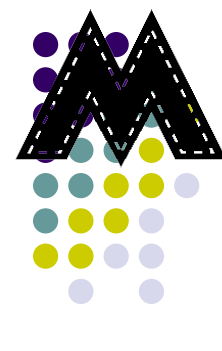
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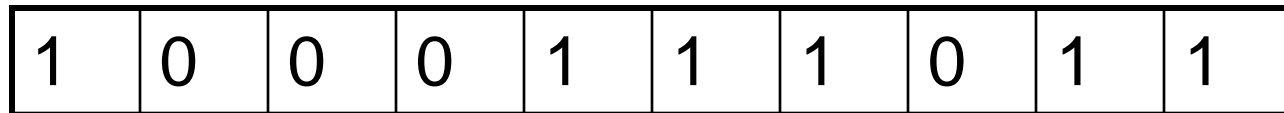
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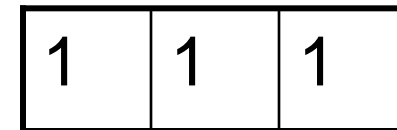
Morfolojik İmge İşleme – Yayma



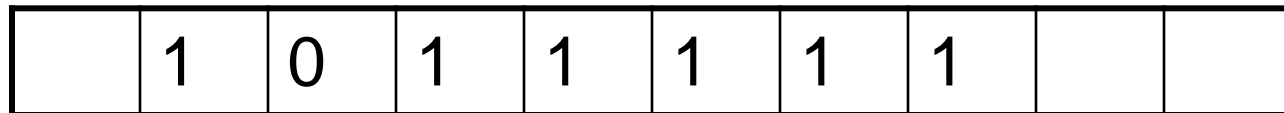
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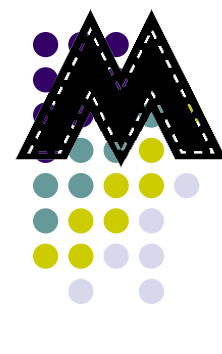
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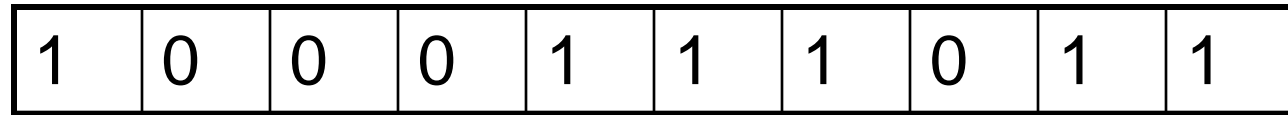
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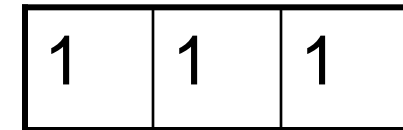
Morfolojik İmge İşleme – Yayma



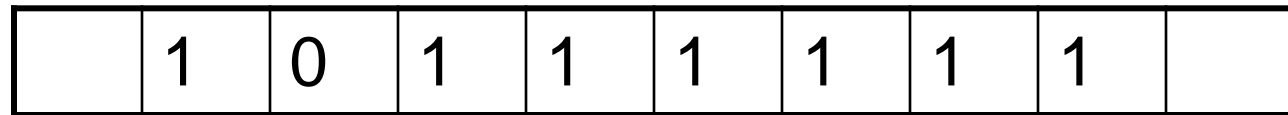
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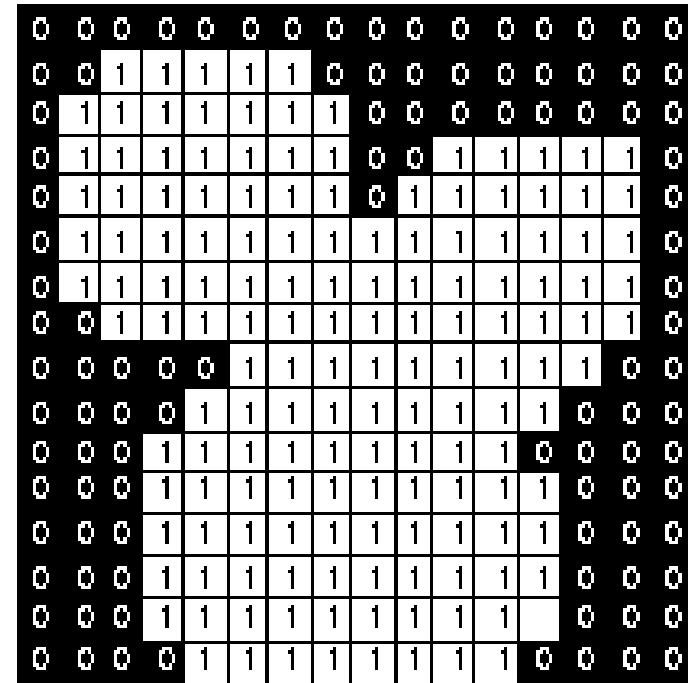
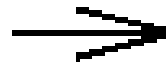
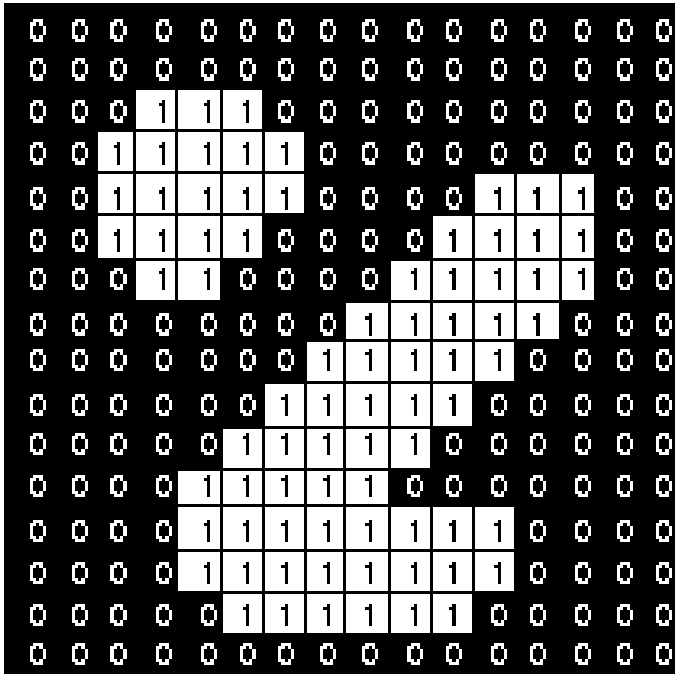
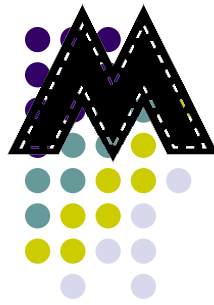
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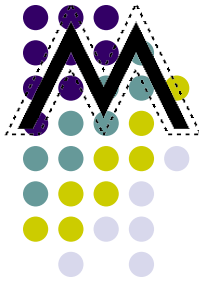
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Morfolojik İmge İşleme – Yayma

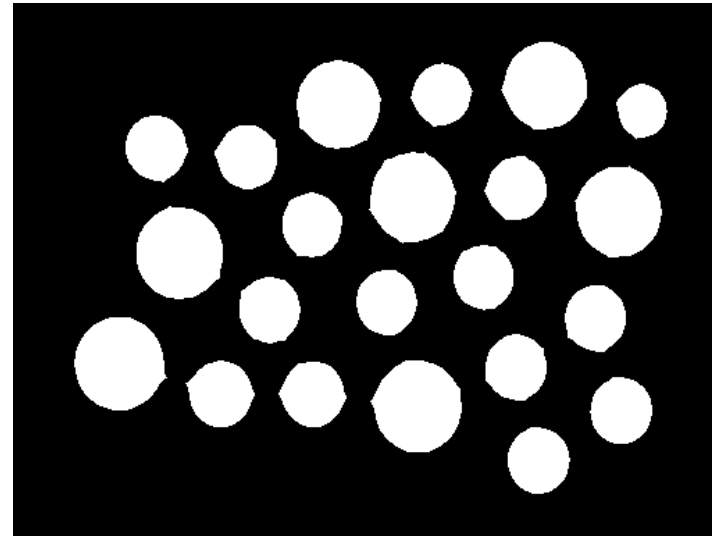
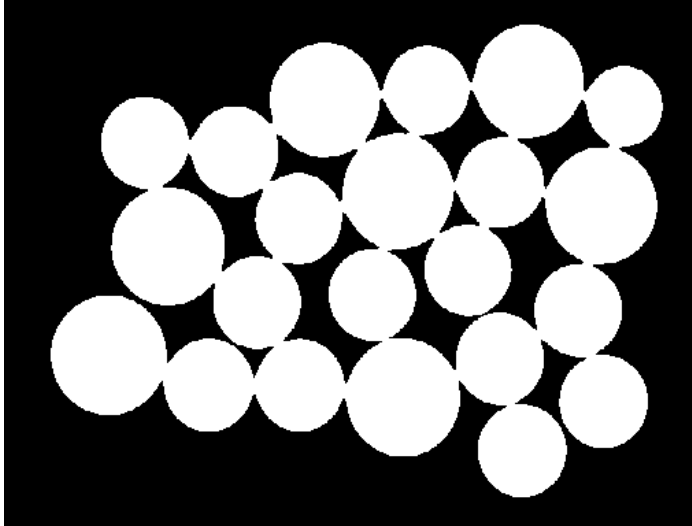


Morfolojik İmge İşleme – Aşındırma

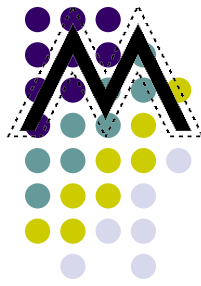


- Z^2 uzayında verilen A ve B kümeleri için aşındırma işlemi

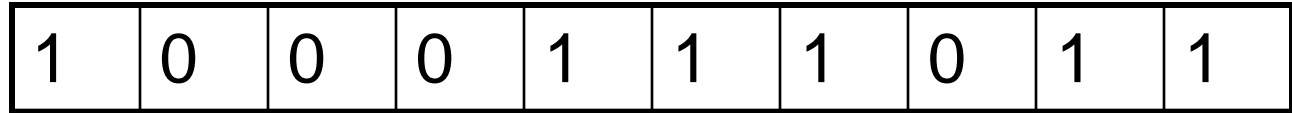
$$A \ominus B = \left\{ z \mid (B)_z \subseteq A \right\}$$



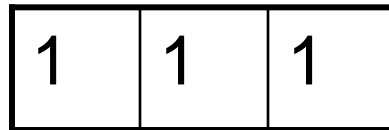
Morfolojik İmge İşleme – Aşındırma



Input image



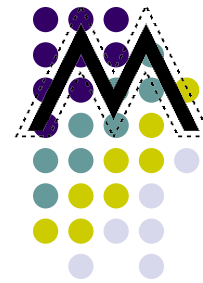
Structuring Element



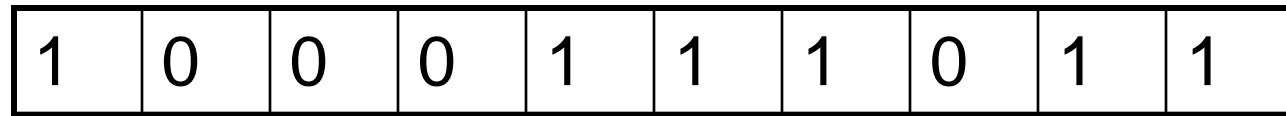
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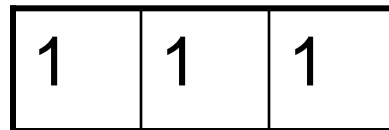
Morfolojik İmge İşleme – Aşındırma



Input image



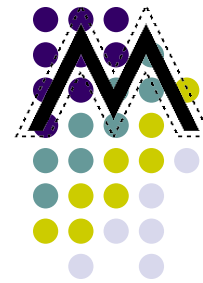
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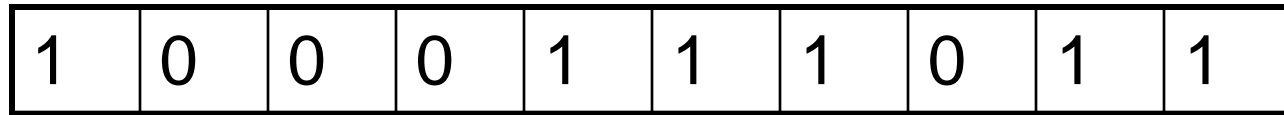
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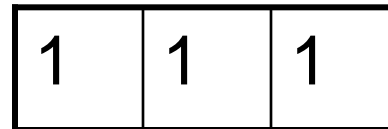
Morfolojik İmge İşleme – Aşındırma



Input image



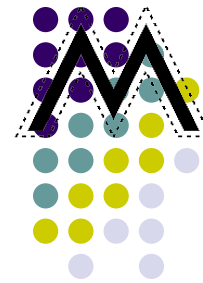
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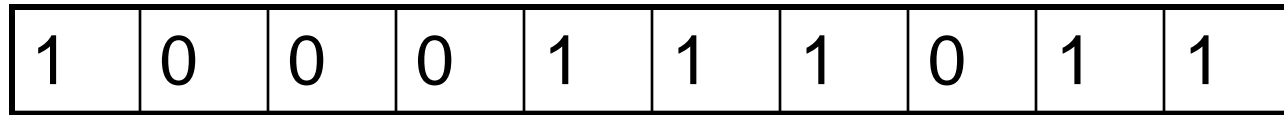
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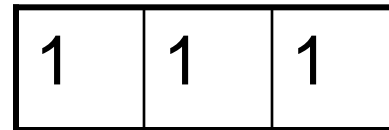
Morfolojik İmge İşleme – Aşındırma



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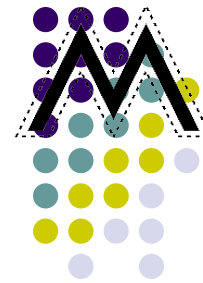
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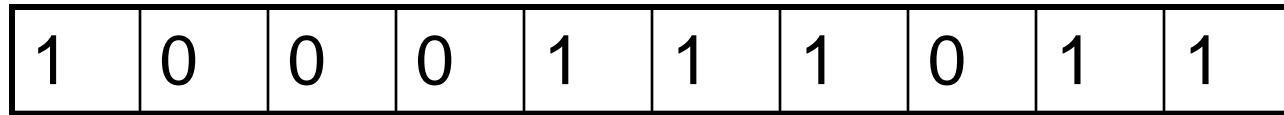
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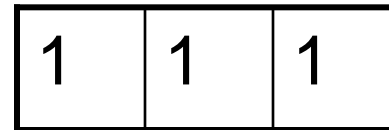
Morfolojik İmge İşleme – Aşındırma



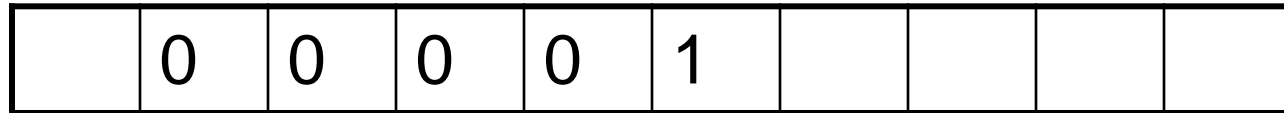
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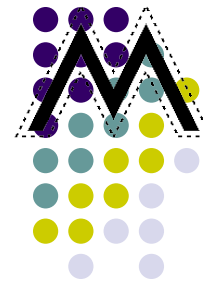
Structuring Element



Output Image



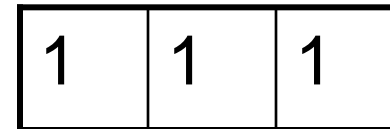
Morfolojik İmge İşleme – Aşındırma



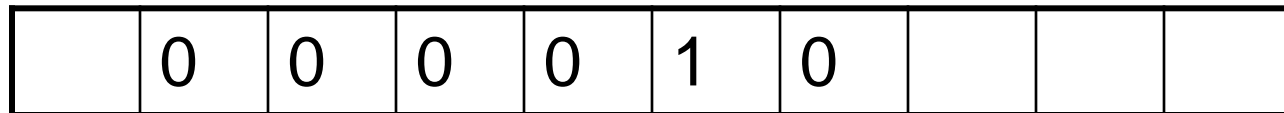
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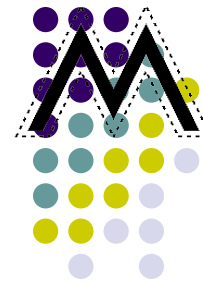
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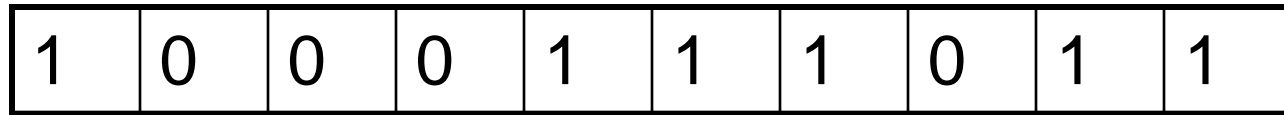
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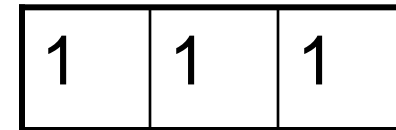
Morfolojik İmge İşleme – Aşındırma



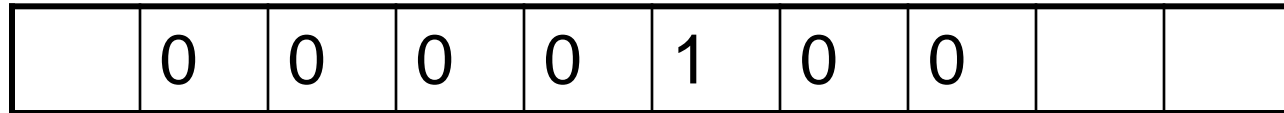
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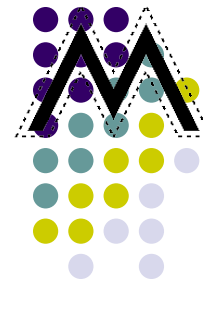
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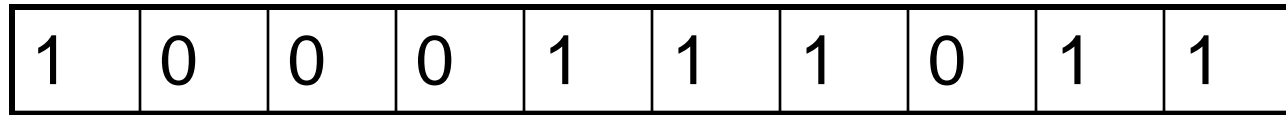
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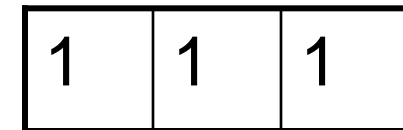
Morfolojik İmge İşleme – Aşındırma



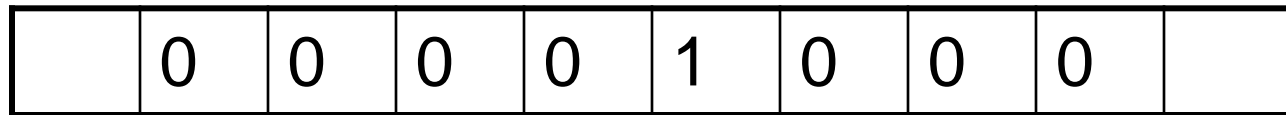
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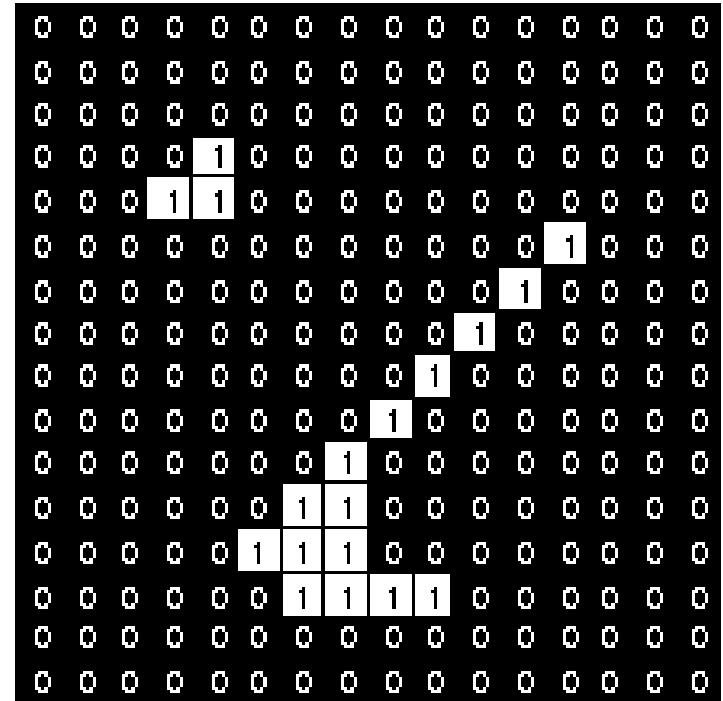
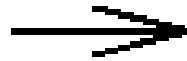
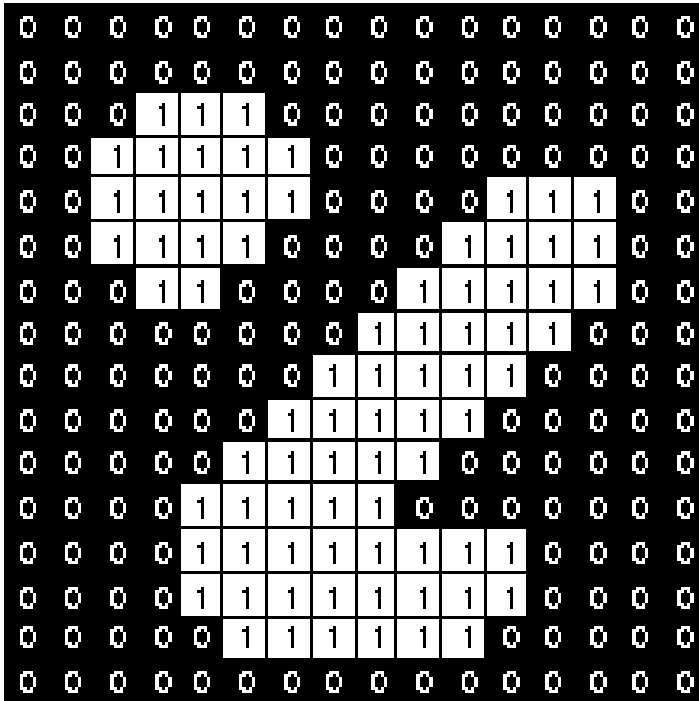
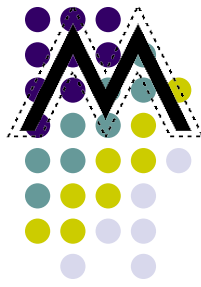
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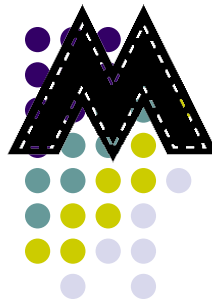
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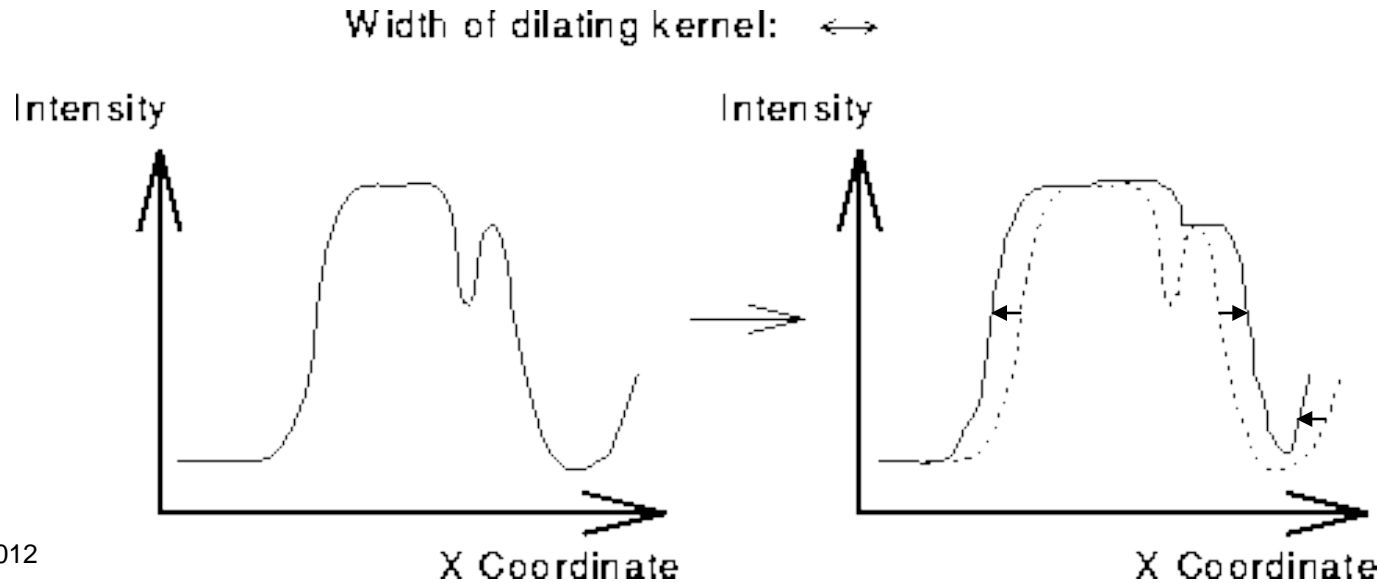
Morfolojik İmge İşleme – Aşındırma



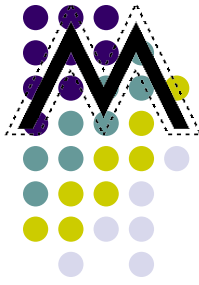
Morfolojik İmge İşleme – Gri Tonlu Yayma



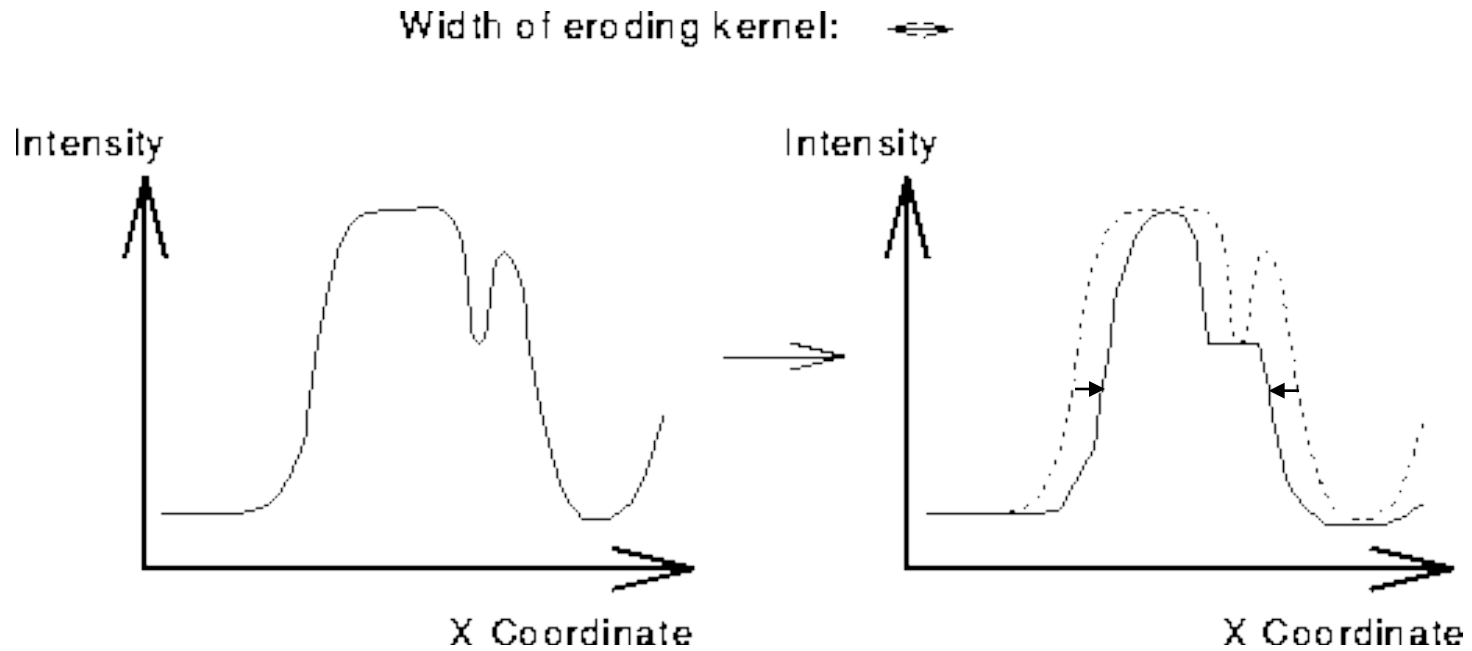
- Morfolojik operasyonlar ikili imgelere uygulanabileceği gibi, gri tonlu imgeler için de tanımlıdır.
- Gri tonlu imgede yayma işlemi, imgedeki koyu tonlu bölgeleri açmaktadır.
- İmgede koyu tonlu bölgelerle çevrili parlak bölgeler genişlerken, parlak bölgelerle çevrili koyu tonlu bölgeler zayıflamakta, hatta yapı elemanı ve koyu tonlu bölgenin boyutuna bağlı olarak kaybolabilmektedir.



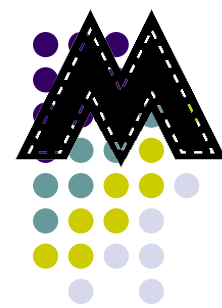
Morfolojik İmge İşleme – Gri Tonlu Aşındırma



- Gri tonlu imgede aşındırma işlemi, imgenin parlaklığını arttırmaktadır.
- İmgede koyu tonlu bölgelerle çevrili parlak bölgeler daralırken, parlak bölgelerle çevrili koyu tonlu bölgeler genişlemektedir.



Morfolojik İmge İşleme – Gri Tonlu Morfoloji



Let $F, K \subseteq E^{N-1}$ and $f : F \rightarrow E$ and $k : K \rightarrow E$ where E is the Euclidean Space.

Dilation $f \oplus k : F \oplus K \rightarrow E$ can be computed as:

$$(f \oplus k)(x) = \max_{\substack{z \in K \\ x-z \in F}} \{f(x-z) + k(z)\}$$

Erosion $f \ominus k : F \ominus K \rightarrow E$ can be computed as:

$$(f \ominus k)(x) = \min_{z \in K} \{f(x+z) - k(z)\}$$

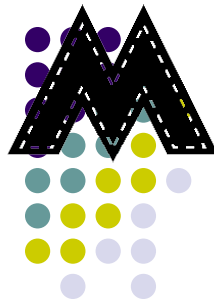
Opening $f \circ k : F \circ K \rightarrow E$ can be computed as:

$$(f \ominus k) \oplus k$$

Closing $f \bullet k : F \bullet K \rightarrow E$ can be computed as:

$$(f \oplus k) \ominus k$$

Morfolojik İmge İşleme – Gri Tonlu Morfoloji



- İşlemler basitleştirilirse:

Given a *zero-height flat structuring element* k , i.e. $k(x) = 0$ for all x , dilation can be computed as

$$(f \oplus k)(x) = \max_{x \in F} \{f(x)\}$$

max filter

likewise, erosion can be computed as

$$(f \ominus k)(x) = \min_{x \in F} \{f(x)\}$$

min filter

Morfolojik İmge İşleme – Açma ve Kapama



- Açma ve kapama, yayma ve aşındırma işlemlerinin iki değerli imgeye ardışıl uygulanmasıyla yapılan işlemlerdir.
- Açma (Opening):

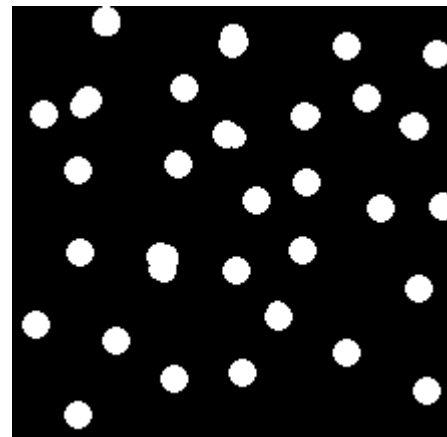
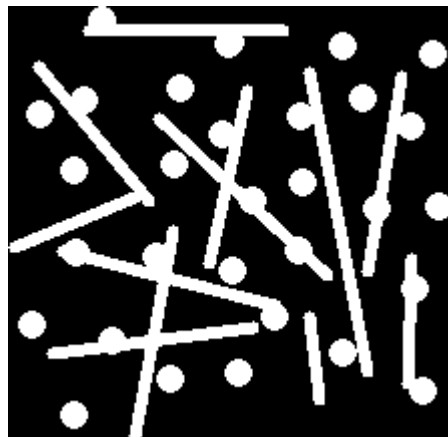
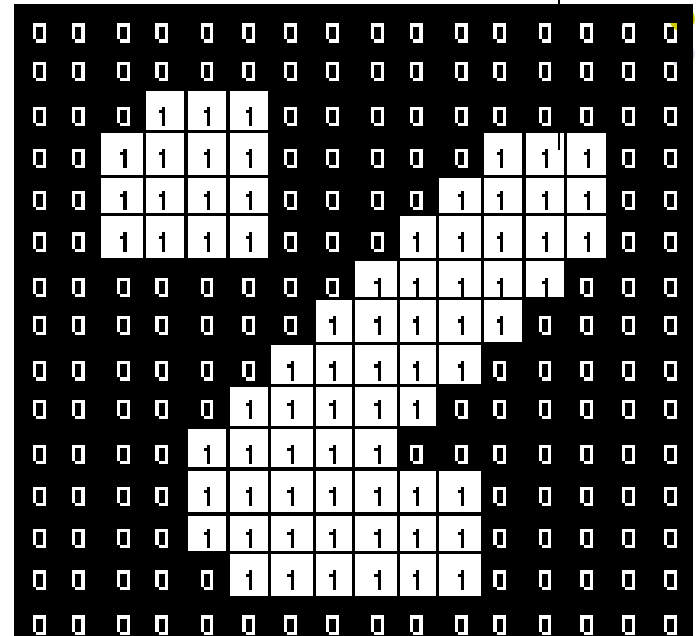
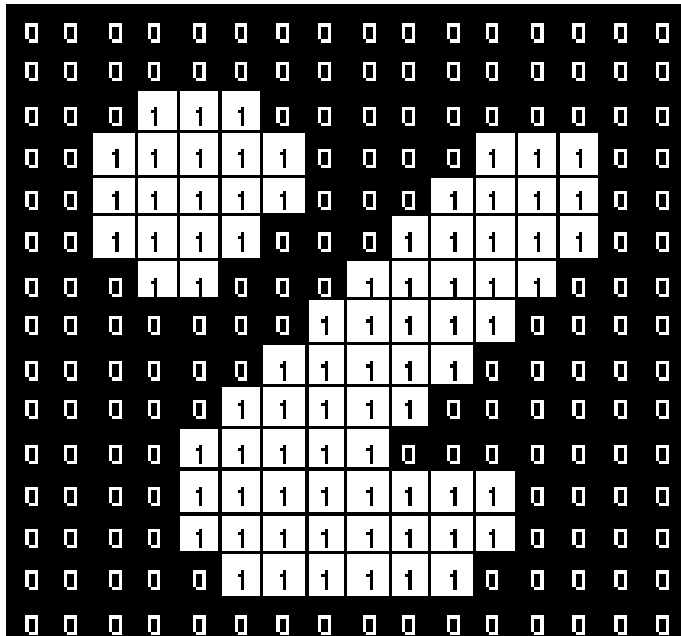
$$A \circ B = (A \ominus B) \oplus B$$

- Kapama (Closing):

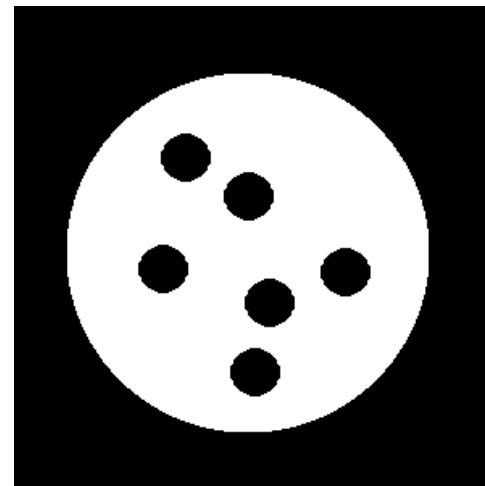
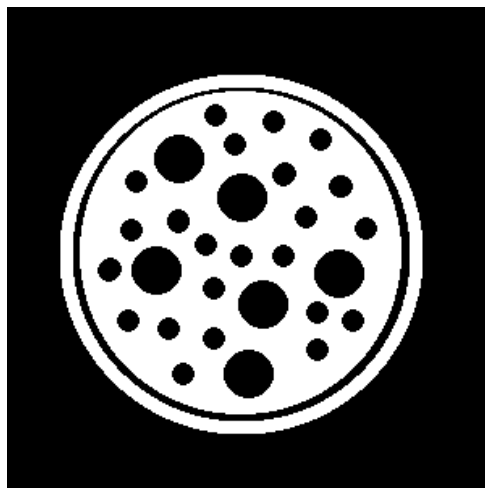
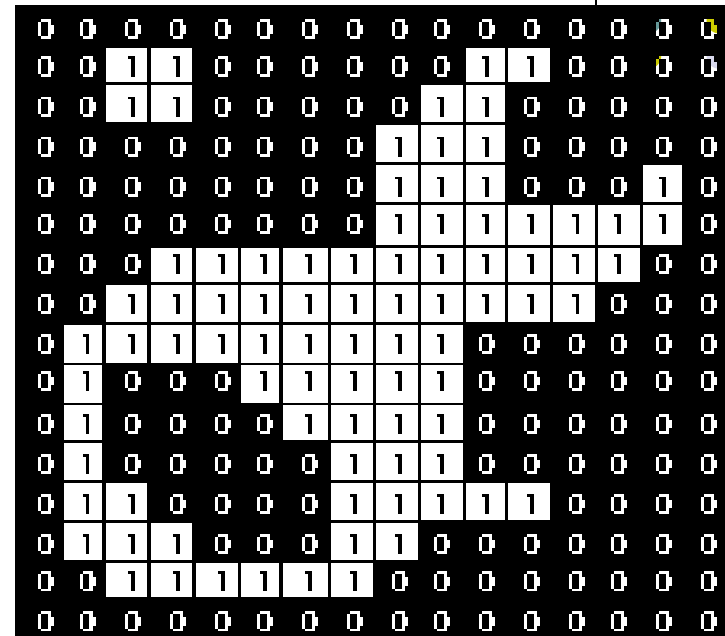
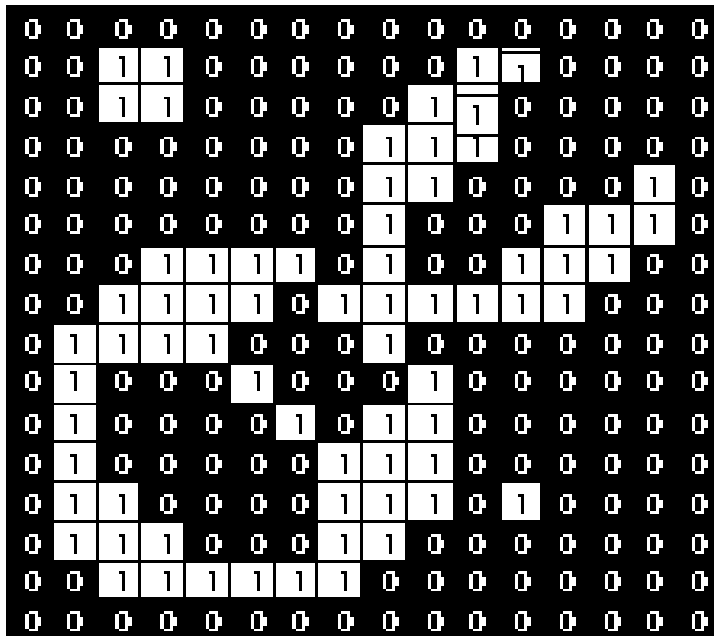
$$A \bullet B = (A \oplus B) \ominus B$$

MATLAB’da açma işlemi için **imopen** fonksiyonu, kapama işlemi için **imclose** fonksiyonu kullanılmaktadır.

Morfolojik İmge İşleme – Açma



Morfolojik İmge İşleme – Kapama



Morfolojik İmge İşleme – Sınır Çıkarma

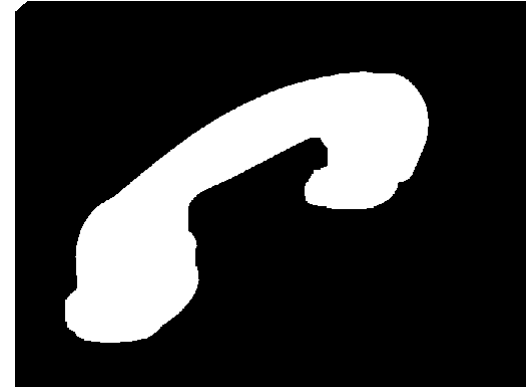
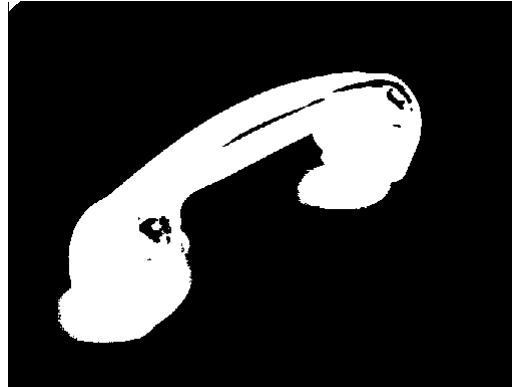
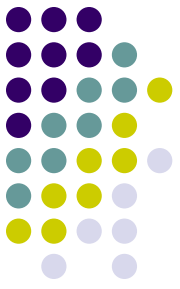


$$\beta(A) = A - (A \ominus B)$$

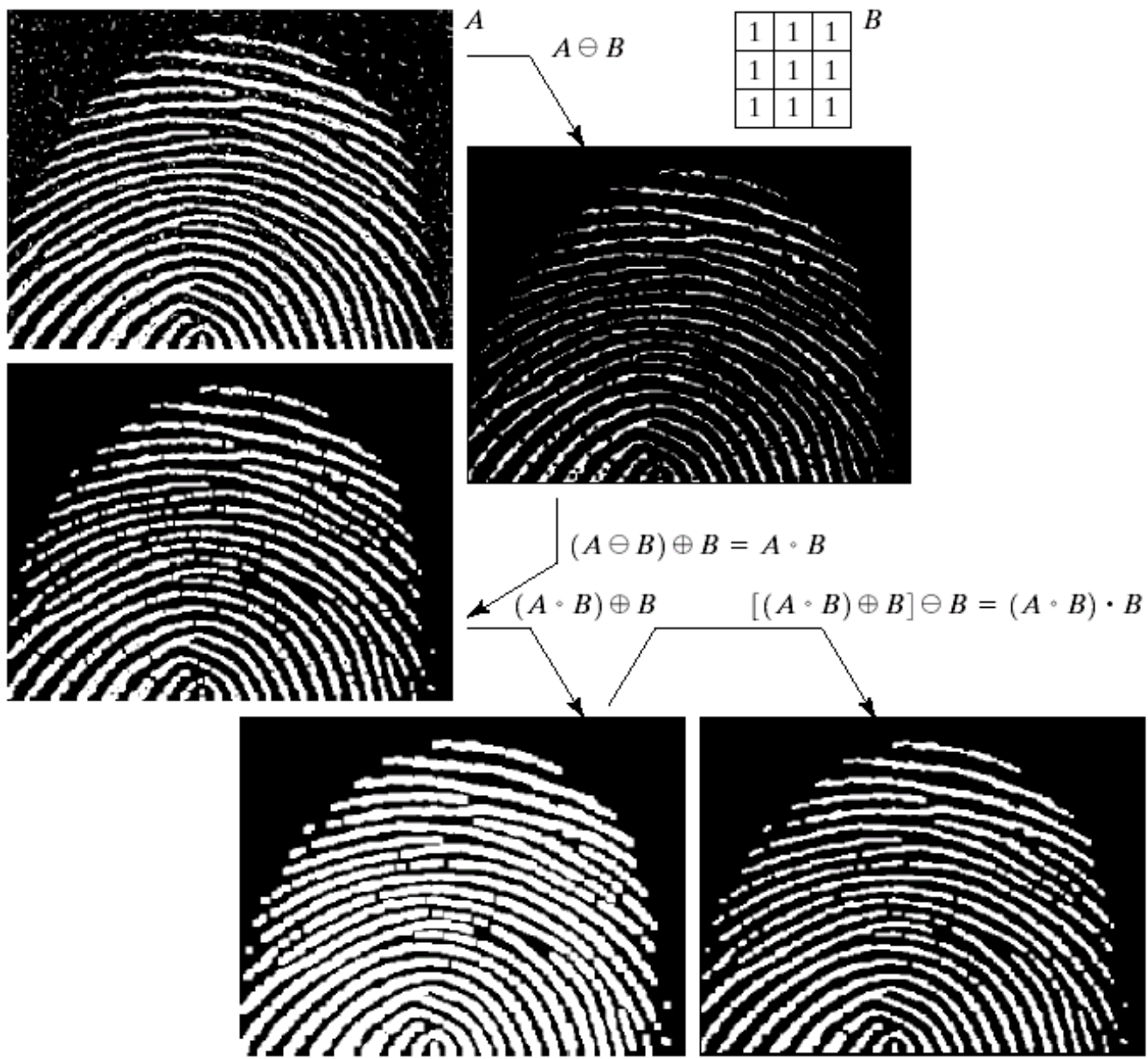
A kümesinin
sınırları



Morfolojik İmge İşleme – Uygulamalar



Morfolojik İmge İşleme – Uygulamalar



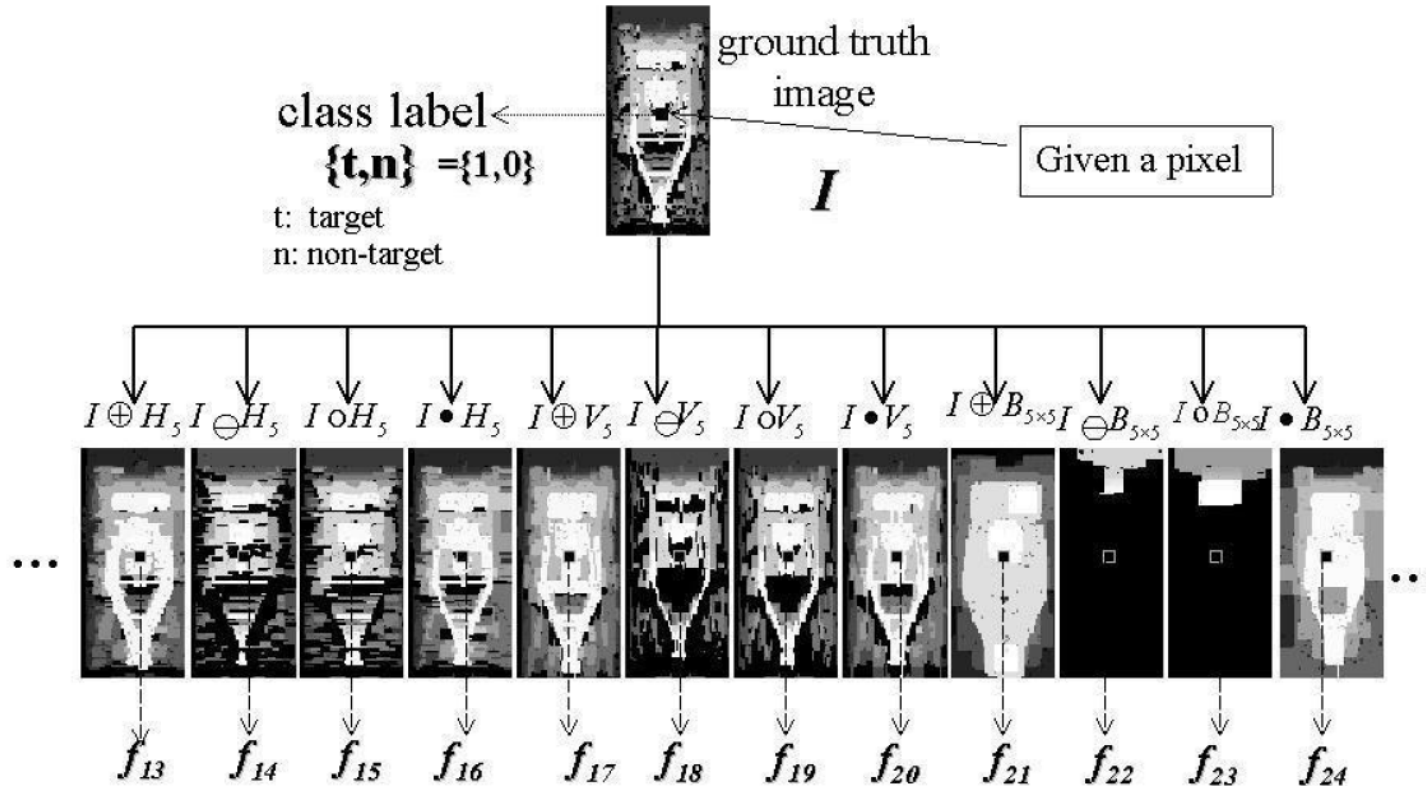
a b
 c d
 e f

FIGURE 9.11
 (a) Noisy image.
 (c) Eroded image.
 (d) Opening of A .
 (e) Dilation of the opening.
 (f) Closing of the opening. (Original image for this example courtesy of the National Institute of Standards and Technology.)

Morfolojik İmge İşleme – Uygulamalar (Gri ton)



Hedef Algılama:



Morfolojik İmge İşleme – Uygulamalar (Gri ton)



Distance hesabı
(bwdist) eklenecek