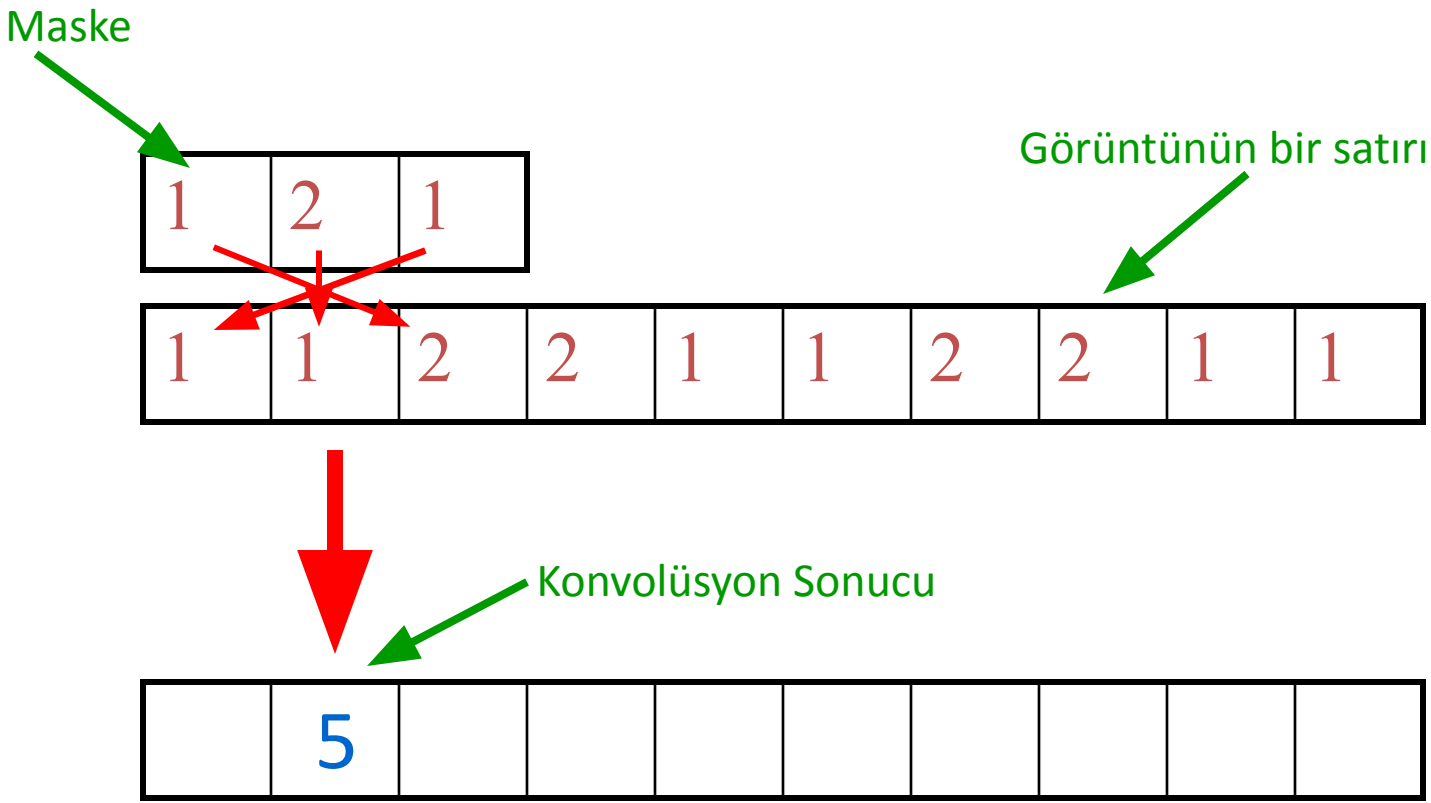
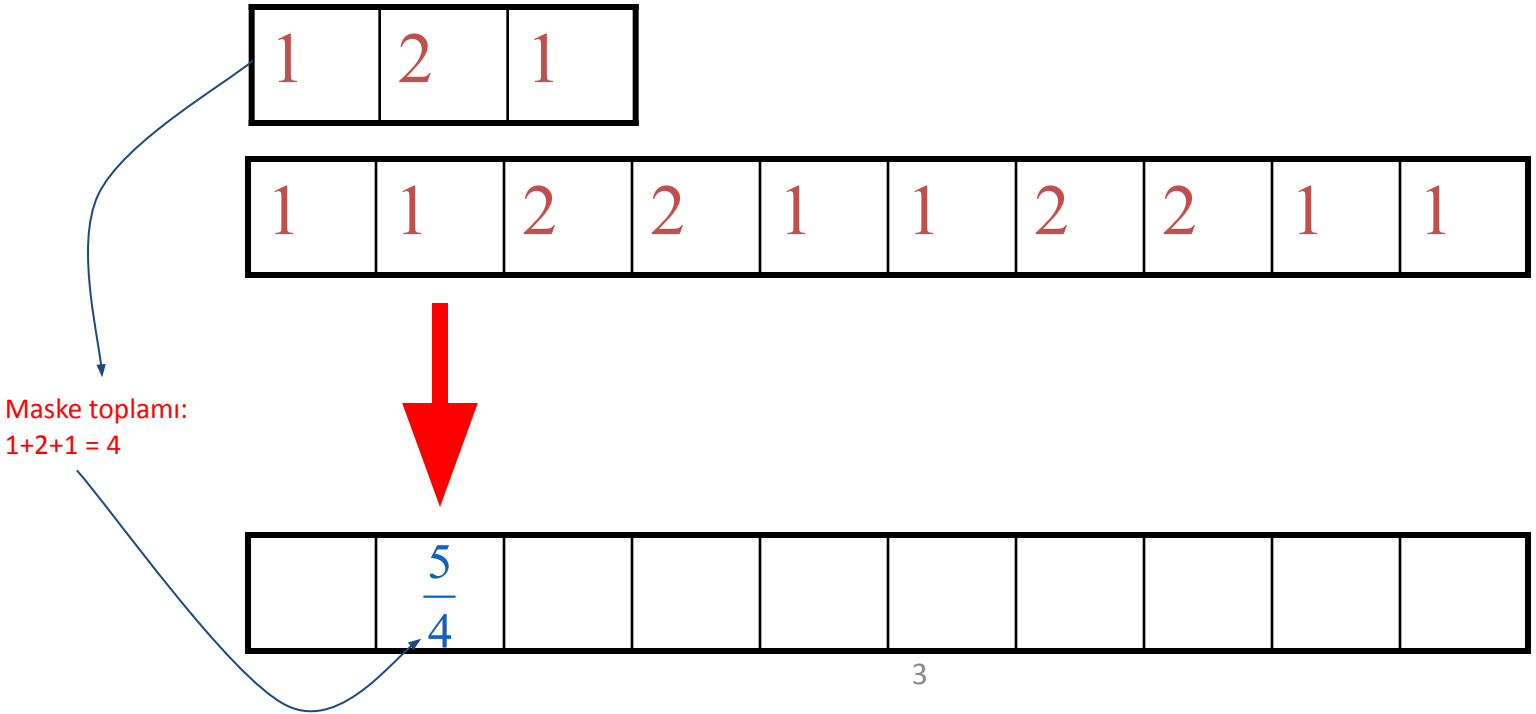
Konvolüsyon

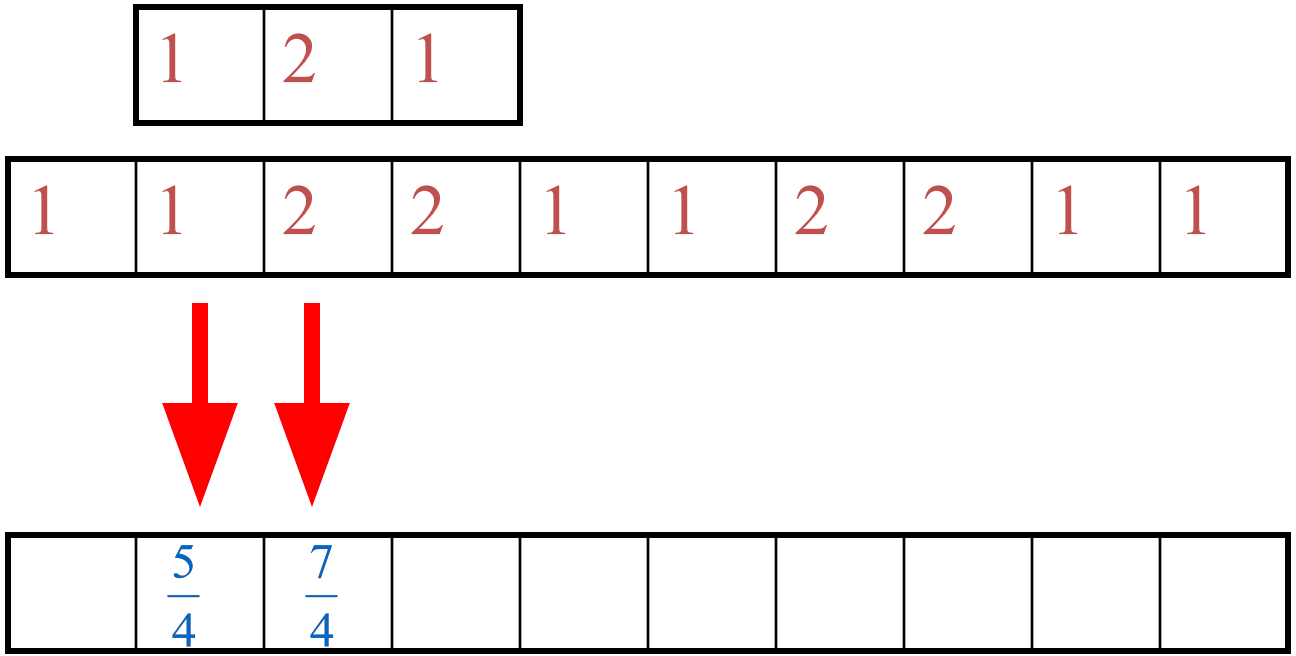
1D


Maske
1 2 1
Görüntünün bir satırı
1 1 2 2 1 1 2 2 1 1
Konvolüsyon Sonucu
5

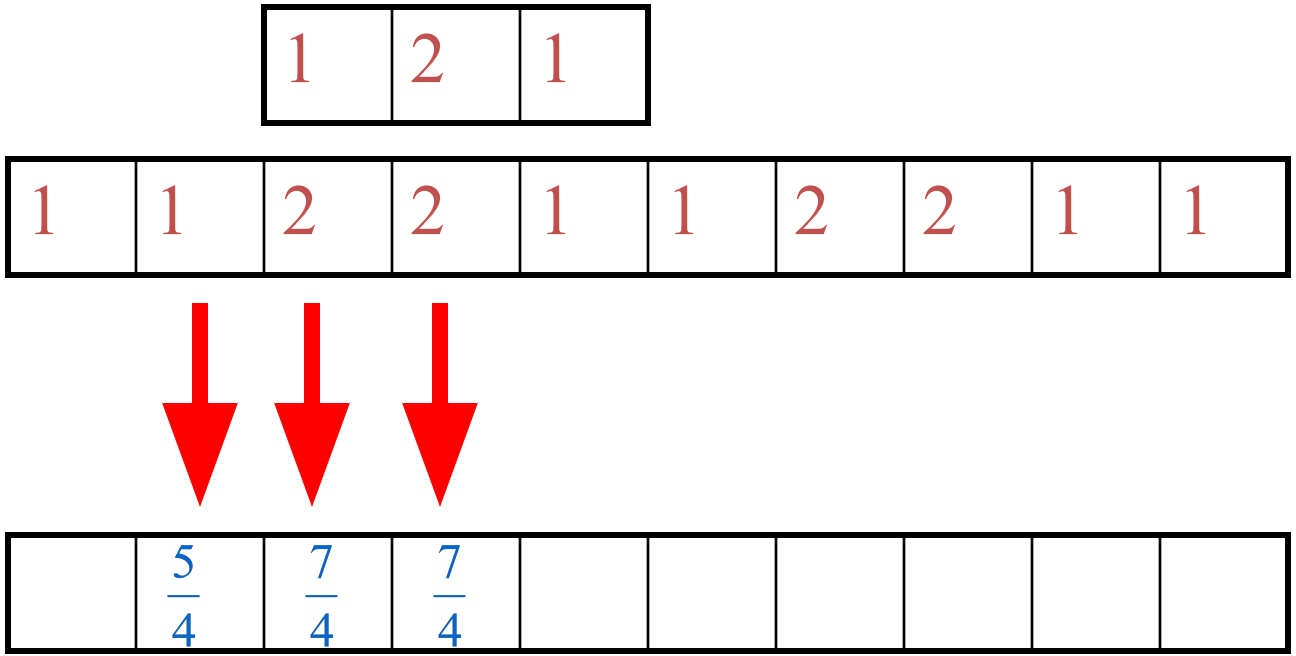
1D



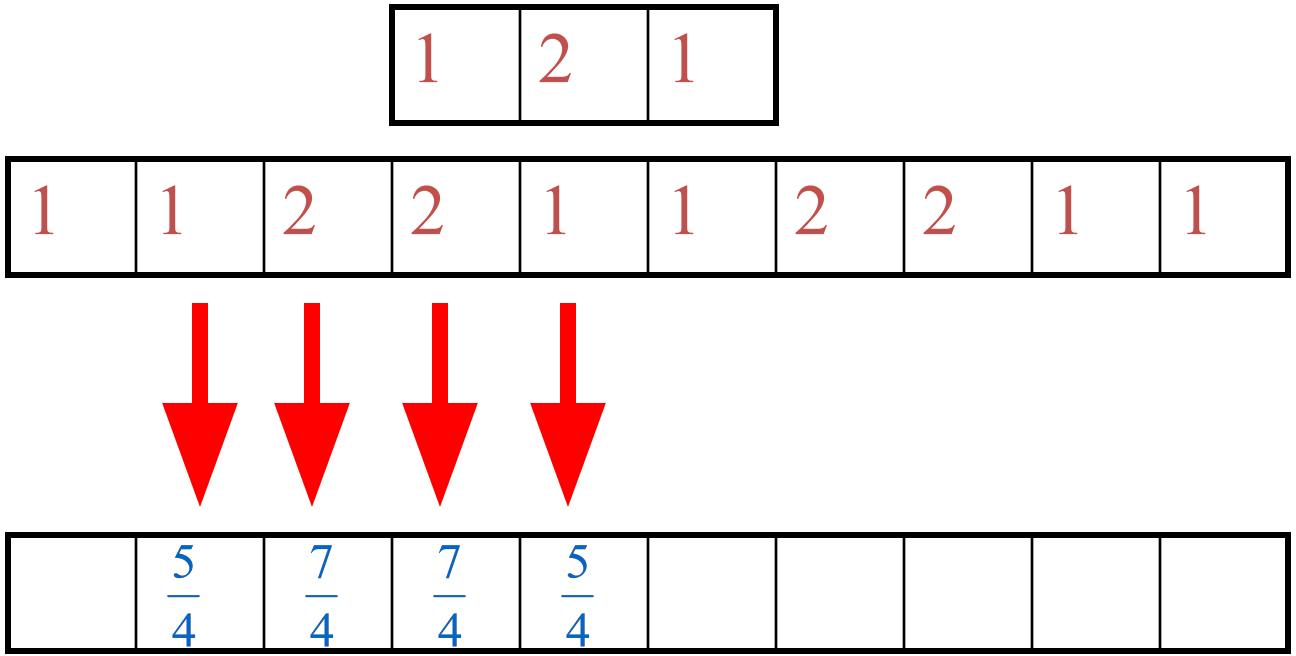
1D



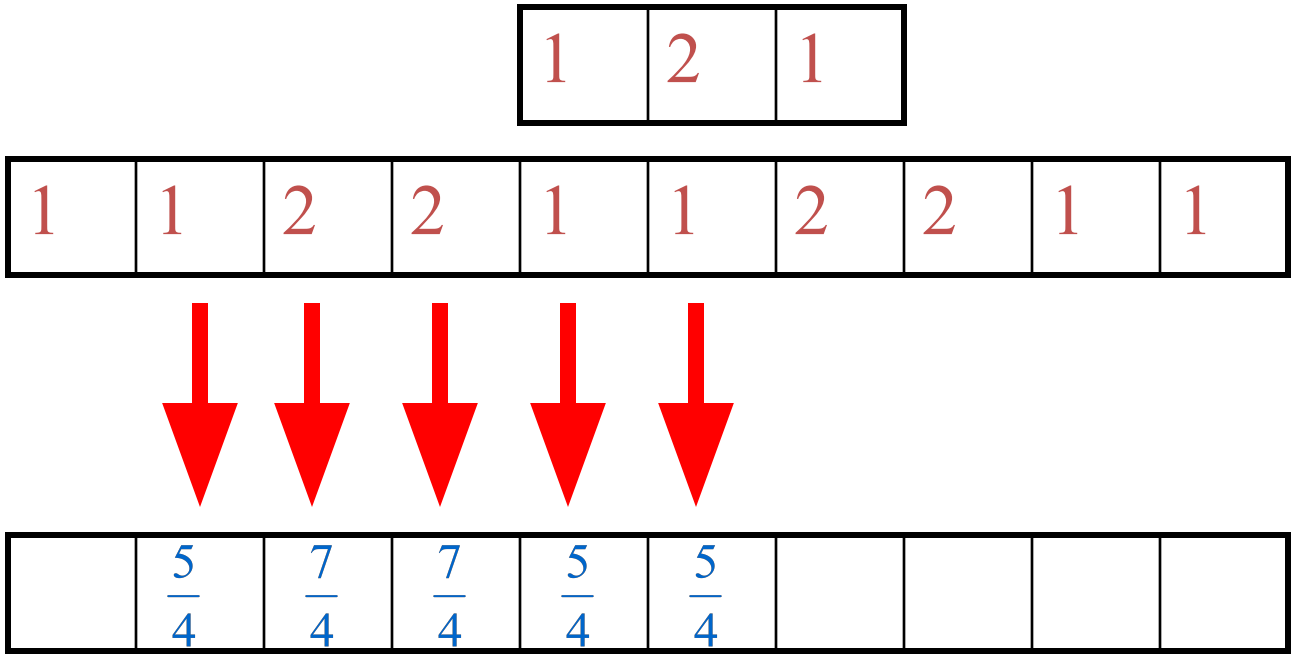
1D



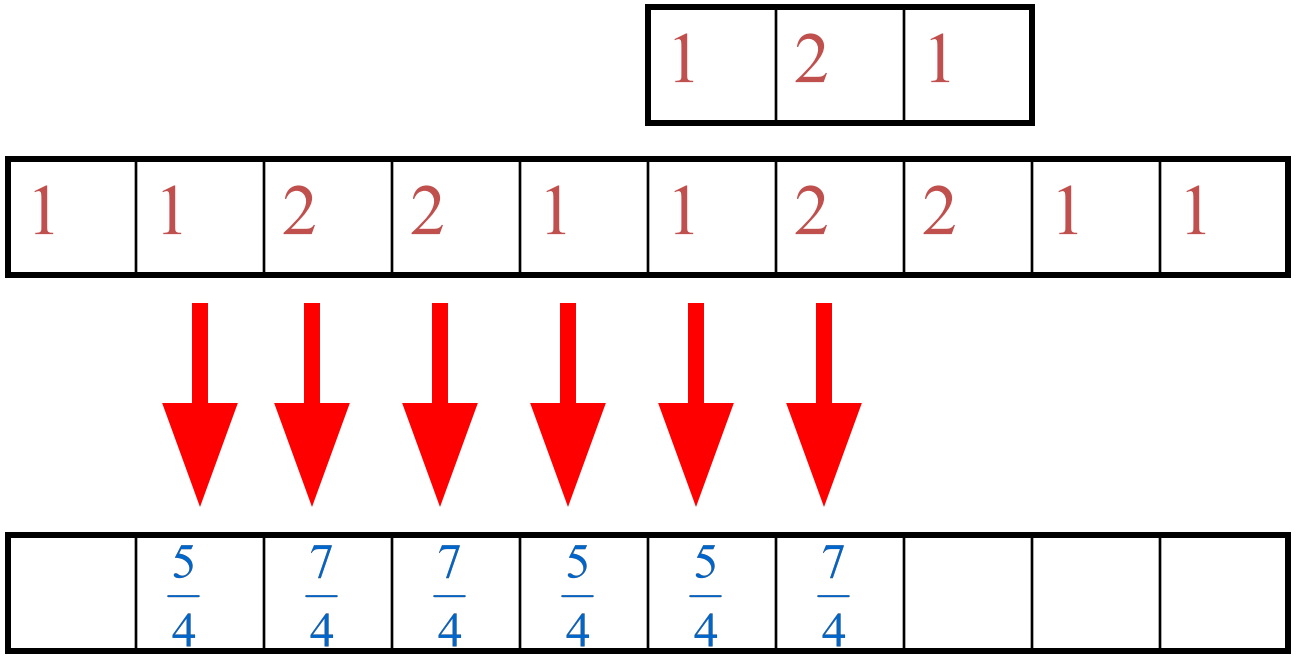
1D



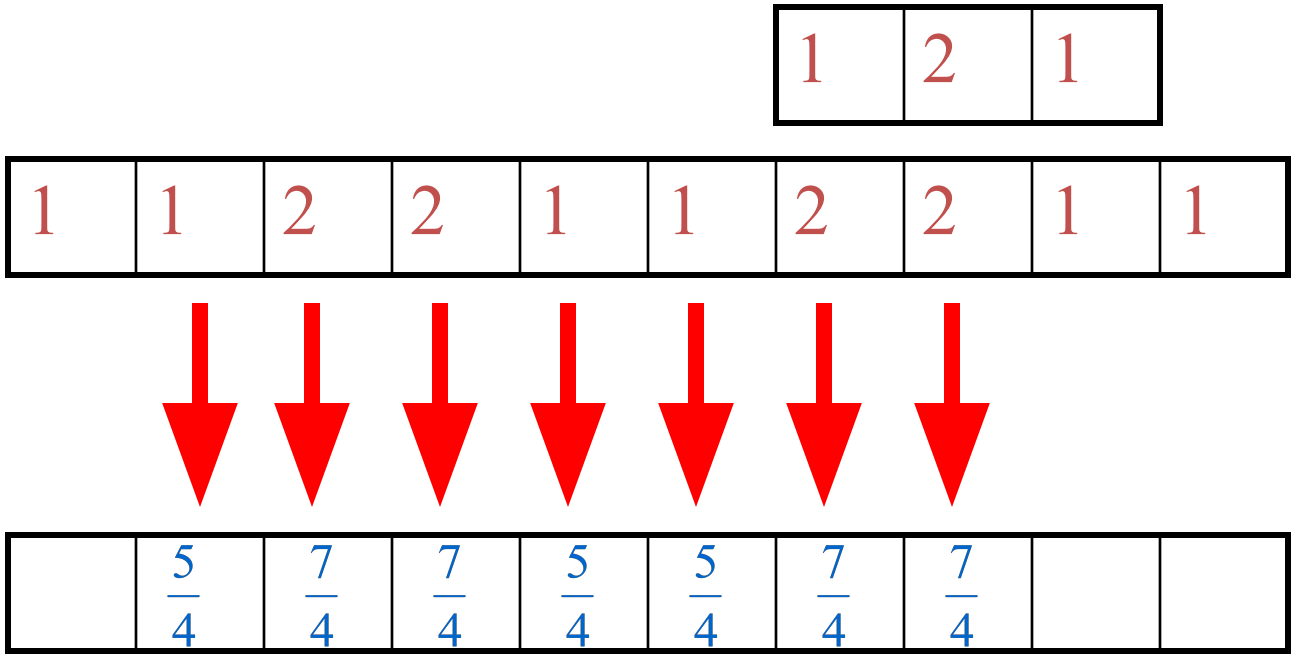
1D



1D

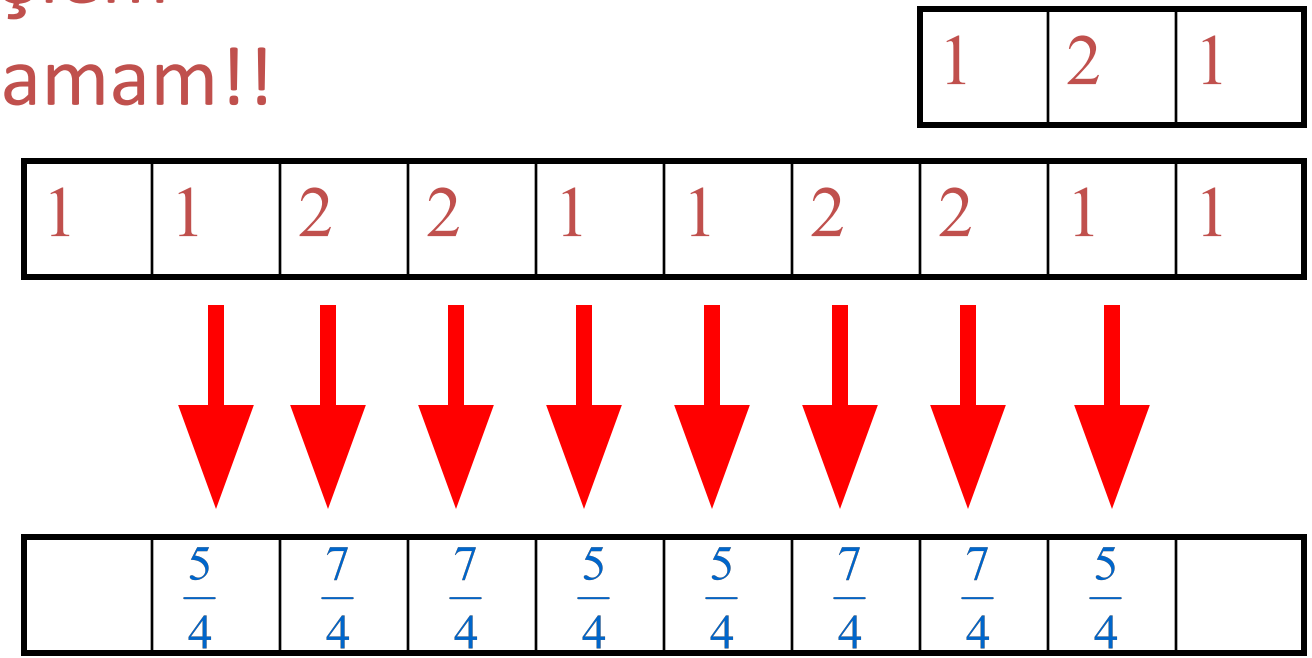


1D

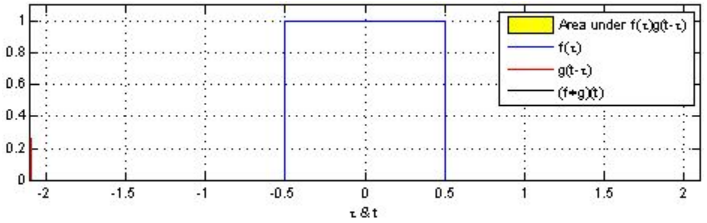


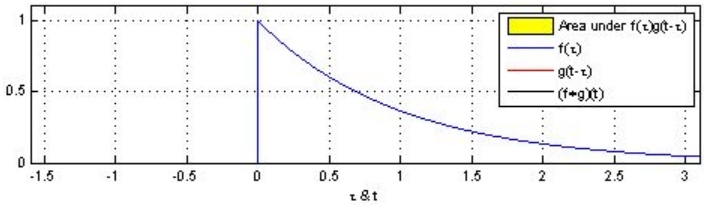
1D

İşlem tamam!!



1D





$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau)\, g(t-\tau)\, d\tau$$

$$(f * g)(t) = \int_{0}^{t} f(\tau)\, g(t-\tau)\, d\tau \quad \text{for} \quad f, g : [0, \infty) \to \mathbb{R}$$

2D

- Maske iki boyutlu olmalı, Örneğin:
  3x3, 5x5, 7x7, ….

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

Giriş

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

Çıkış

	$\frac{12}{9}$				

2D

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

Giriş

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

Çıkış

	$\frac{12}{9}$	$\frac{11}{9}$			

2D

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

Giriş

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

Çıkış

	$\frac{12}{9}$	$\frac{11}{9}$	$\frac{14}{9}$		

2D

w

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

Matlab Komutu

```
f = imread('img1.bmp');
w = [1 1 1;1 1 1;1 1 1]/9;
g = conv2(f, w, 'same');
```

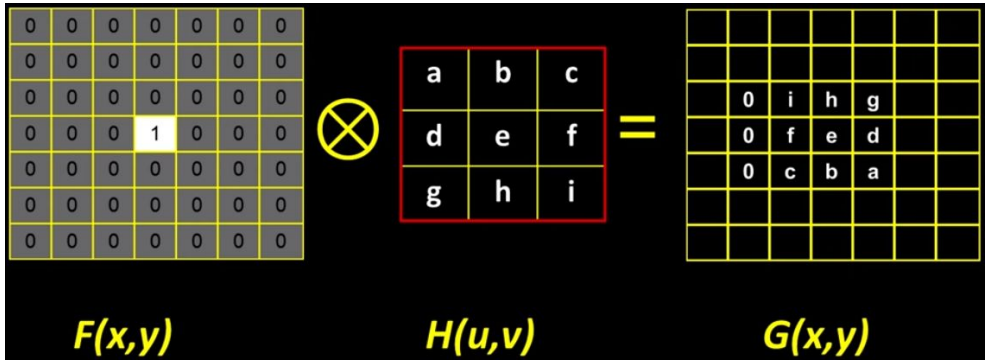
f

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

g

	$\frac{12}{9}$	$\frac{11}{9}$	$\frac{14}{9}$		
	$\frac{13}{9}$	$\frac{11}{9}$	$\frac{13}{9}$		
	$\frac{16}{9}$	$\frac{12}{9}$	$\frac{11}{9}$		

Konvolüsyonda Maske Neden Ters Çevrilir?



Impulse görüntüyle Korelasyon yapıldığında görüntü tersine döner.
Ancak Konvolüsyon yapıldığında orjinal görüntünün kendisi elde edilir.

Impulse fonksiyonu sistem hakkında bilgi sahibi olmak için kullanılır.

Uygulama alanı ve Matlab kullanımı

UYGULAMA ALANLARI

- Nokta, Çizgi, Kenar Yakalama
- Nesne Yakalama
- Yumuşatma, Keskinleştirme
- Gürültü temizleme
- Morfolojik işlemler

MATLAB KULLANIMI

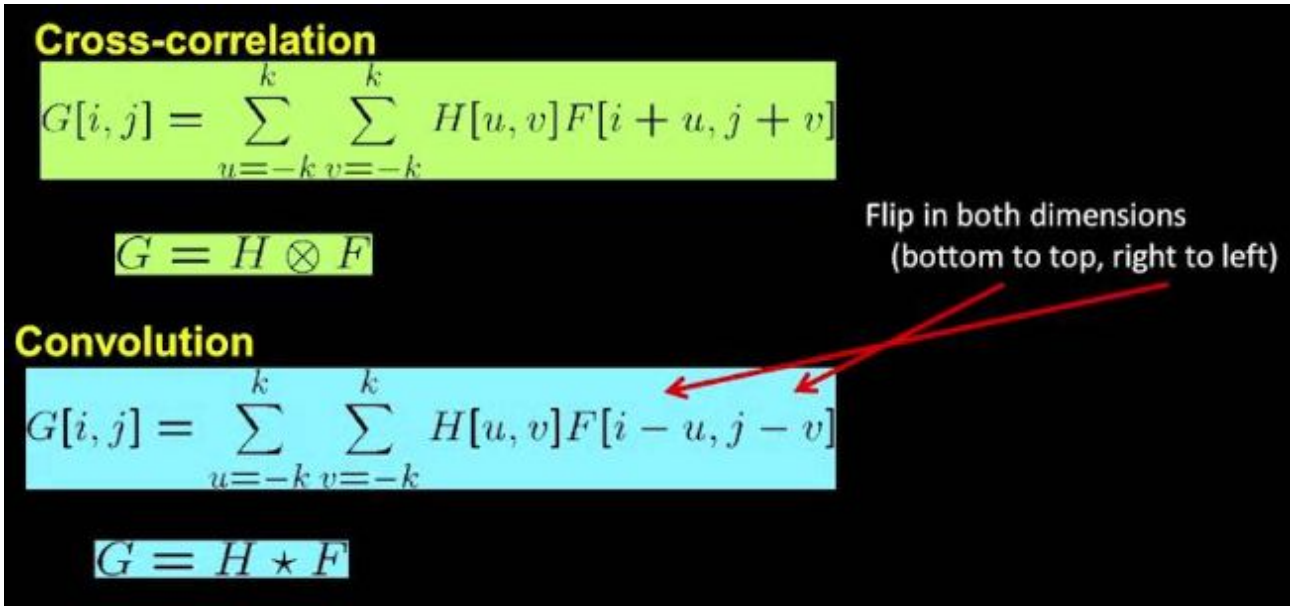
conv: 1-D Convolution.

– *C = conv(A, B)* convolves vectors A and B.

conv2: Two dimensional convolution.

– C = conv2(A, B) performs the 2-D convolution of matrices A and B.

Matematiksel olarak



Konvolüsyonun özellikleri

- Linear & shift invariant
- Commutative:

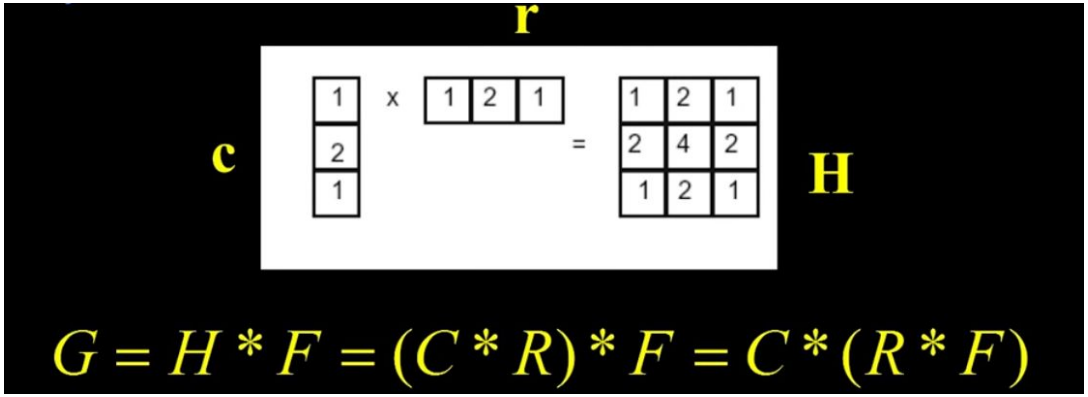
  $f * g = g * f$
- Associative

  $(f * g) * h = f * (g * h)$
- Identity:

  unit impulse e = [..., 0, 0, 1, 0, 0, ...]. $f * e = f$
- Differentiation: $\frac{\partial}{\partial x}(f * g) = \frac{\partial f}{\partial x} * g$

<u>Hesaplama Karmaşıklığı</u>
NxN görüntü
WxW filtre (kernel, maske)
NxNxWxW ⇒ N^2W^2

Konvolüsyon maskesinin ayrılabilirliği



Böylece herbiri WxNxN maliyetinde iki konvolüsyon işlemi yapılır.
Bu ise klasik konvolüsyon işlemini oldukça hızlandırır:

$$2 \cdot W \cdot N^2 << W^2 \cdot N^2$$

Sınır işlemleri (padding)