Filtreler

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

5 x 5 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

Sonuç

Konvolüsyon
(Evrişim)
(Convolution)

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6		

$$4 \times 1 + 3 \times 1 + 5 \times 1 +$$
$$1 \times 0 + 2 \times 0 + 5 \times 0 +$$
$$0 \times -1 + 4 \times -1 + 2 \times -1$$
$$= 6$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	

$$1 \times 1 + 1 \times 1 + 5 \times 1 +$$
$$0 \times 0 + 4 \times 0 + 2 \times 0 +$$
$$2 \times -1 + 2 \times -1 + 0 \times -1$$
$$= 4$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2

$$0 \times 1 + 4 \times 1 + 2 \times 1 +$$
$$2 \times 0 + 2 \times 0 + 0 \times 0 +$$
$$3 \times -1 + 1 \times -1 + 4 \times -1$$
$$= -2$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5		

$$3 \times 1 + 5 \times 1 + 4 \times 1 +$$
$$2 \times 0 + 5 \times 0 + 3 \times 0 +$$
$$4 \times -1 + 2 \times -1 + 1 \times -1$$
$$= 5$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5	6	

$$2 \times 1 + 5 \times 1 + 3 \times 1 +$$
$$4 \times 0 + 2 \times 0 + 1 \times 0 +$$
$$2 \times -1 + 0 \times -1 + 2 \times -1$$
$$= 6$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5	6	2

$$4 \times 1 + 2 \times 1 + 1 \times 1 +$$
$$2 \times 0 + 0 \times 0 + 2 \times 0 +$$
$$1 \times -1 + 4 \times -1 + 0 \times -1$$
$$= 2$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5	6	2
5		

$$5 \times 1 + 4 \times 1 + 1 \times 1 +$$
$$5 \times 0 + 3 \times 0 + 1 \times 0 +$$
$$1 \times -1 + 1 \times -1 + 2 \times -1$$
$$= 5$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5	6	2
5	4	

$$5 \times 1 + 3 \times 1 + 1 \times 1 + 2 \times 0 + 1 \times 0 + 2 \times 0 + 0 \times -1 + 2 \times -1 + 3 \times -1 = 12$$

Filtreler

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

$*$

1	0	-1
1	0	-1
1	0	-1

$=$

6	4	-2
5	6	2
5	4	-4

$$2 \times 1 + 1 \times 1 + 2 \times 1 +$$
$$0 \times 0 + 2 \times 0 + 3 \times 0 +$$
$$4 \times -1 + 0 \times -1 + 5 \times -1$$
$$= -4$$

Padding

(5 x 5) * (3 x 3) => (3 x 3)

(3 x 3) * (3 x 3) => (1 x 1)

(4 x 4) * (3 x 3) => (2 x 2)

(5 x 4) * (3 x 3) => (3 x 2)

(r_h x r_w) * (k_h x k_w) =>

((r_h - k_h + 1) x (r_w - k_w + 1))

Padding

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

5 x 5 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

a	b	c	d	e
f	g	…		

Padding

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

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

a	b	c	d	e
f	g	…		

Padding

- Valid Convolution:
  - (n x n) * (f x f) => (n - f + 1) x (n - f + 1)

- Same Convolution:
  - (n x n) * (f x f) => (n x n)
  - n + 2p - f + 1 = n, p = (f - 1) / 2

Stride (Adım Boyu)

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

7 x 7 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

2		

Sonuç

Adım Boyu (Stride = 2)

Stride (Adım Boyu)

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

7 x 7 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

2	1	

Sonuç

Adım Boyu (Stride = 2)

Stride (Adım Boyu)

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

7 x 7 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

2	1	-3

Sonuç

Adım Boyu (Stride = 2)

Stride (Adım Boyu)

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

7 x 7 Resim

*

1	0	-1
1	0	-1
1	0	-1

3 x 3 Filtre

=

2	1	-3
-7		

Sonuç

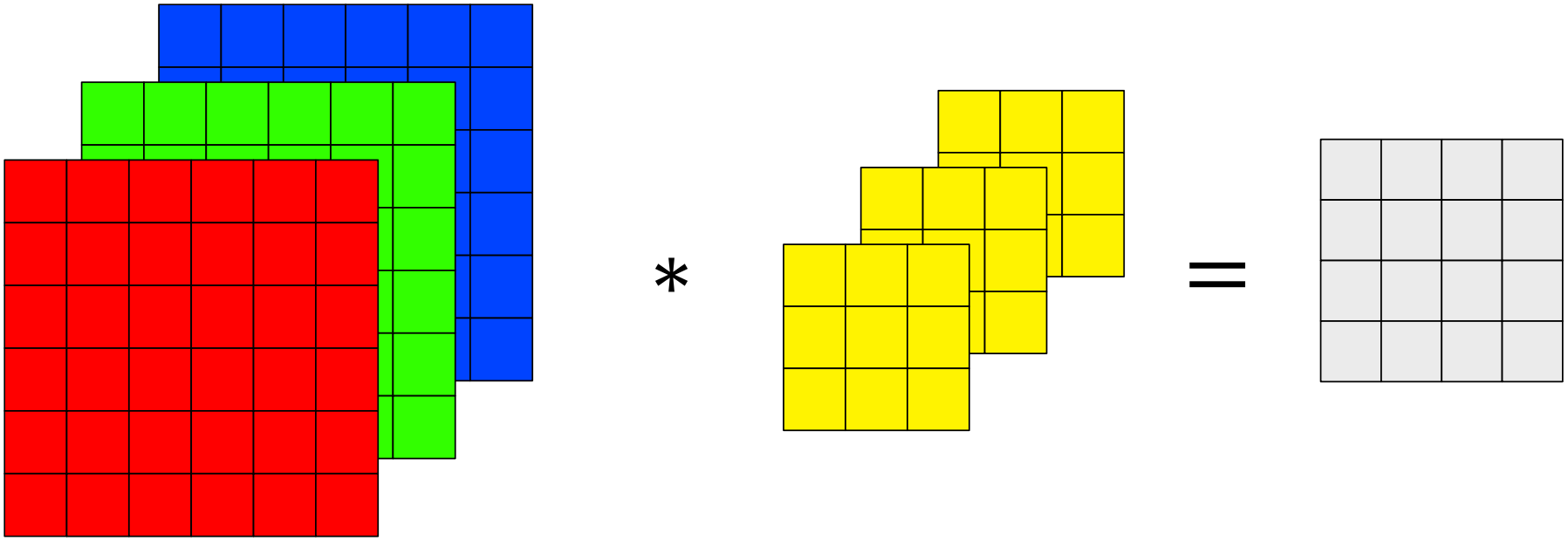
Adım Boyu (Stride = 2)

Stride (Adım Boyu)

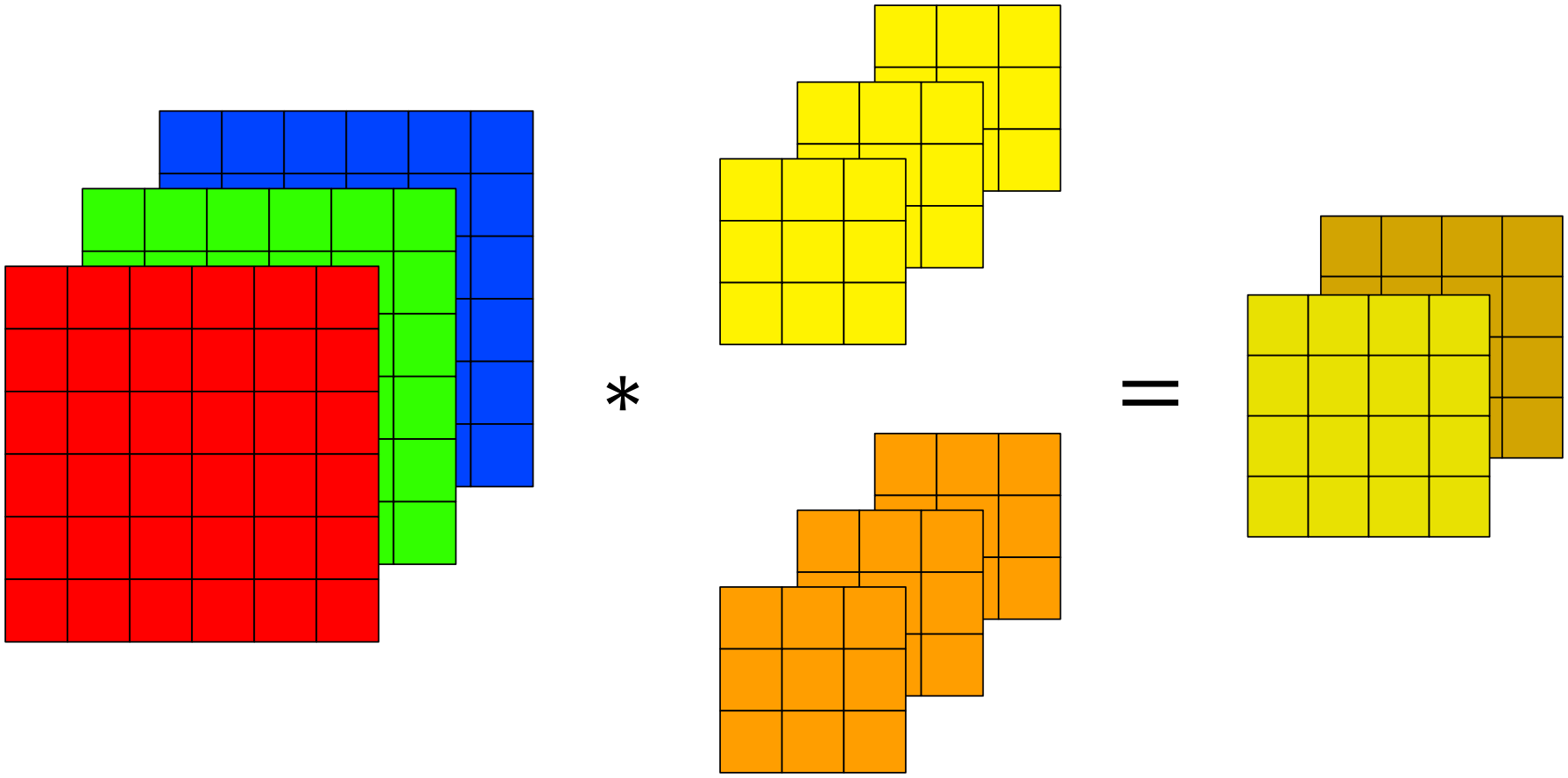
$$(n \times n) * (f \times f) \rightarrow (r \times r)$$

$$r = \frac{n + 2p - f}{s} + 1$$

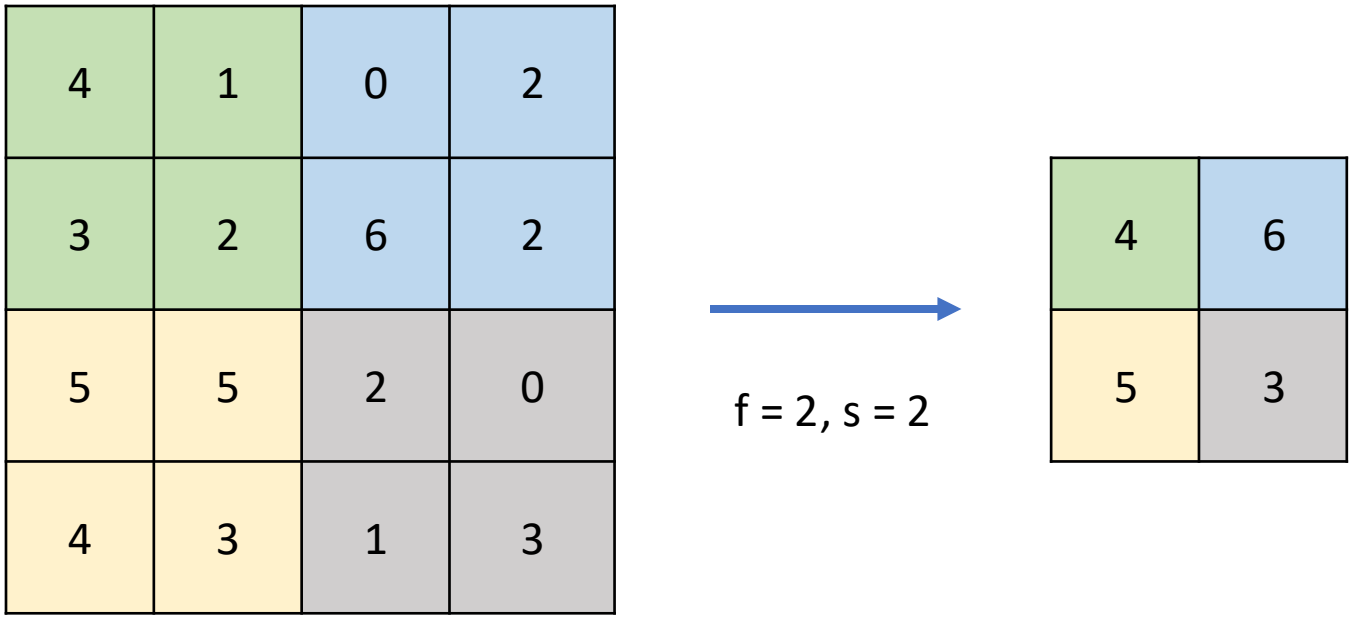
Çok Boyutlu Convolution



Çok Boyutlu Convolution



Pooling: Max Pooling



Pooling: Average Pooling