Computational Intelligence

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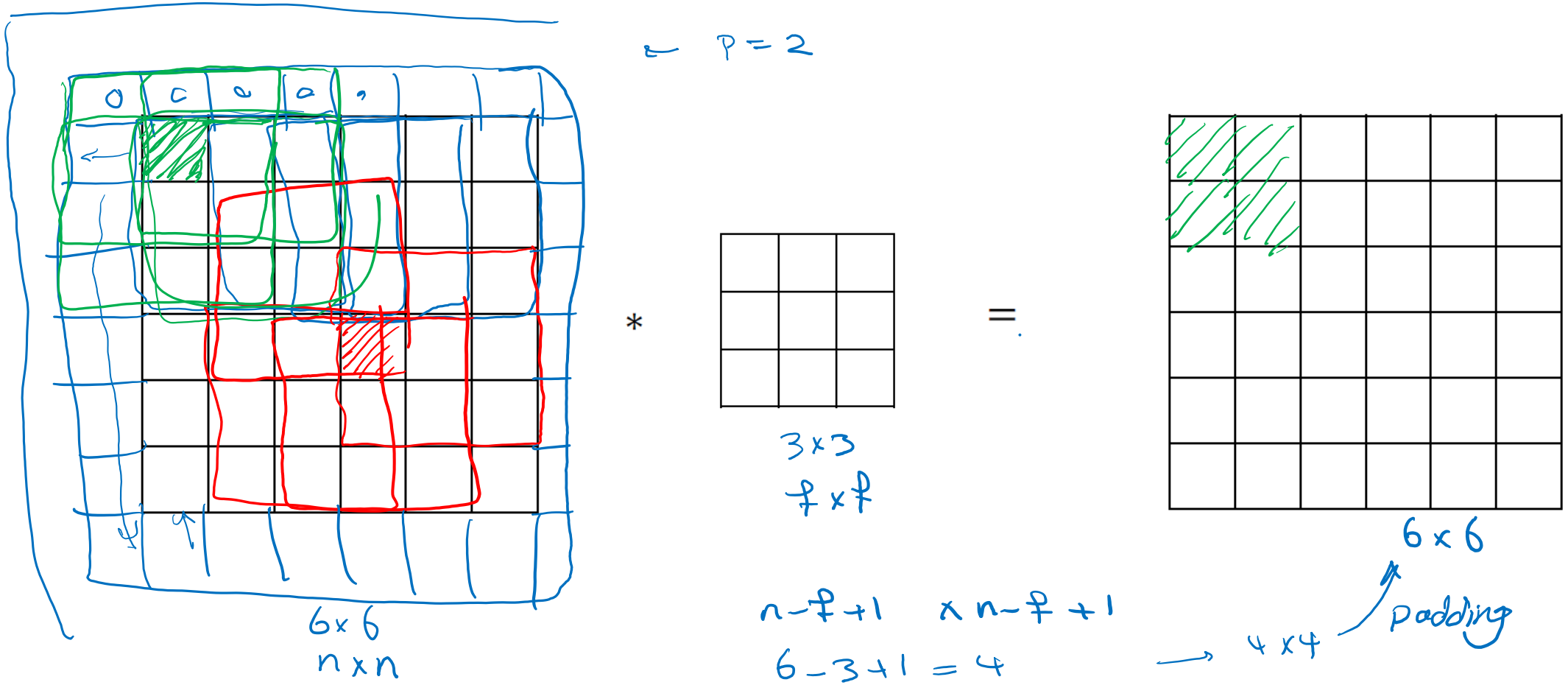
Outline

- Convolutional Neural Networks
  - Padding
  - Strided Convolutions
  - Convolutions Over Volume
  - One layer of a convolutional network

Convolutional Neural Networks: Padding

Padding

- ✓ Shrinking output
- ✓ Throwing away info from edge



Valid and Same convolutions

"Valid ": ↗ no padding

$n \times n \quad * \quad f \times f \longrightarrow n-f+1 \times n-f+1$

$6 \times 6 \quad * \quad 3 \times 3 \longrightarrow 4 \times 4$

"Same": Pad so that output size is the same as the input size.

$n+2p-f+1 \times n+2p-f+1$

$n+2p-f+1 = n$

$$p = \frac{f-1}{2}$$

$5 \times 5 \Rightarrow p = \frac{5-1}{2} = 2$

$f = 5$

$p = \frac{3-1}{2} = 1$

$3 \times 3 \rightarrow f = 3$

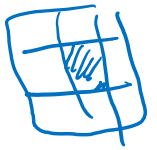
f is odd

1×1

3×3

5×5

7×7



Convolutional Neural Networks: Strided Convolutions

Strided convolution

stride = 2

2	3	7	4	6	2	9
6	6	9	8	7	4	3
3	4	8	3	8	9	7
7	8	3	6	6	3	4
4	2	1	8	3	4	6
3	2	4	1	9	8	3
0	1	3	9	2	1	4

7 × 7

*

3	4	4
1	0	2
-1	0	3

3 × 3

stride = 2

=

91	100	83
69	91	127
44	72	74

3 × 3

$n \times n \quad * \quad f \times f$

padding p stride s

$s = 2$

سایز تصویر خروجی : $\left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor \times \left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor$

$\frac{7+0-3}{2} + 1 = 2 + 1 = 3$

Summary of convolutions

$n \times n$ image $\quad$ $f \times f$ filter

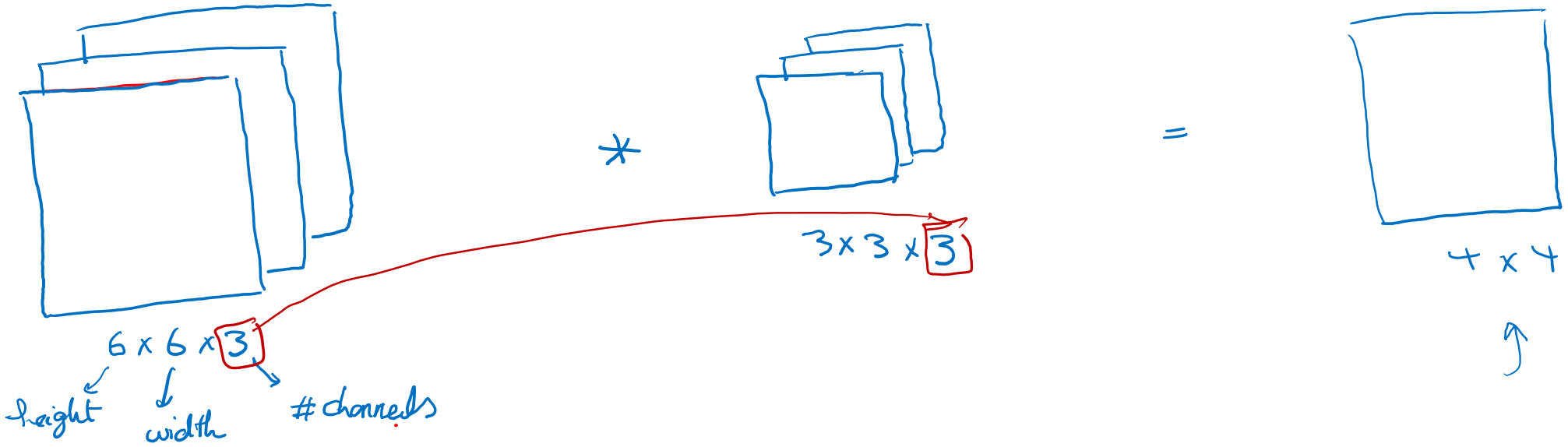
padding p $\quad$ stride s

سایز تصویر خروجی :

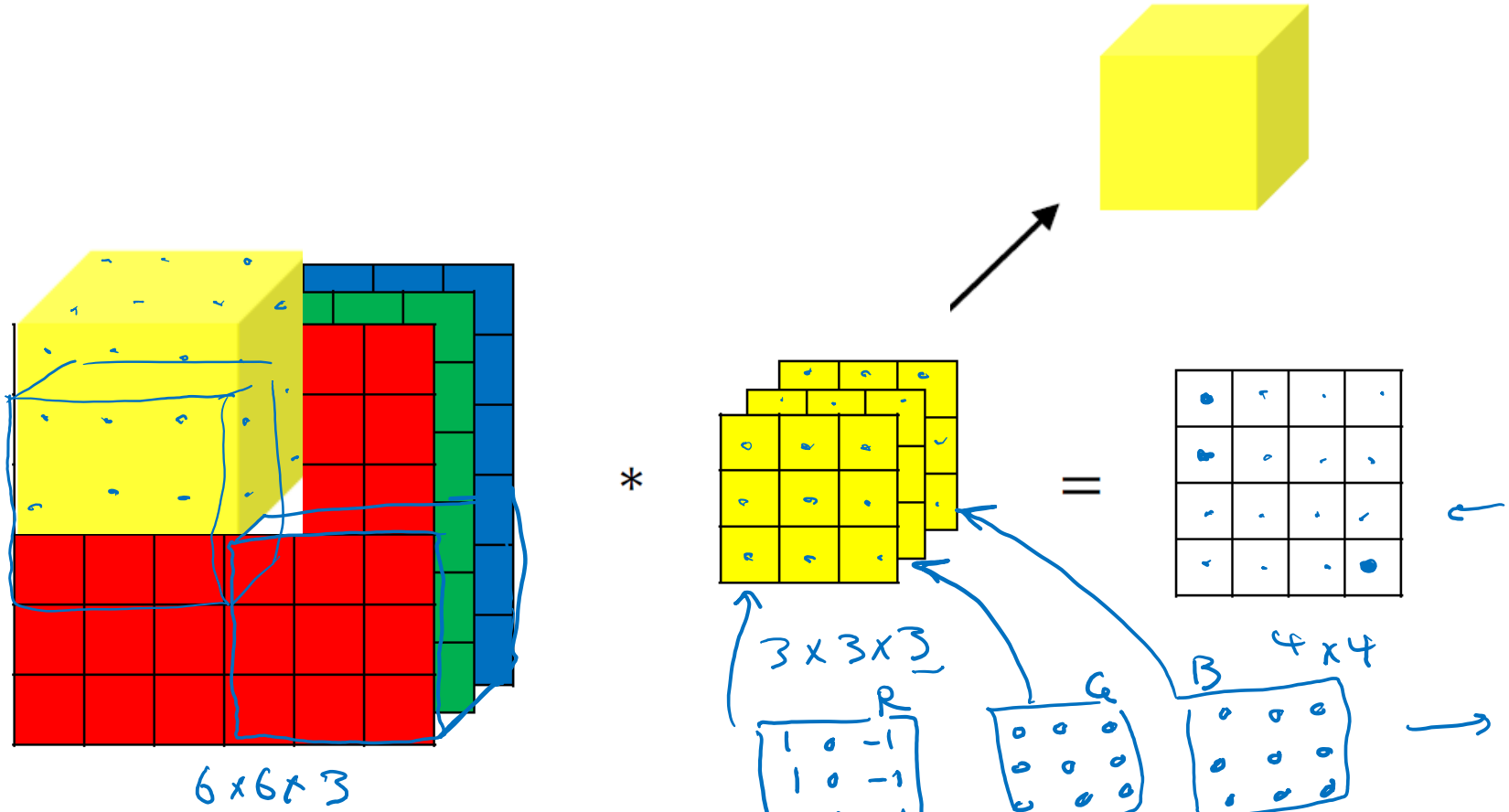
$$\left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor \times \left\lfloor \frac{n+2p-f}{s} + 1 \right\rfloor$$

Convolutional Neural Networks: Convolutions over volumes

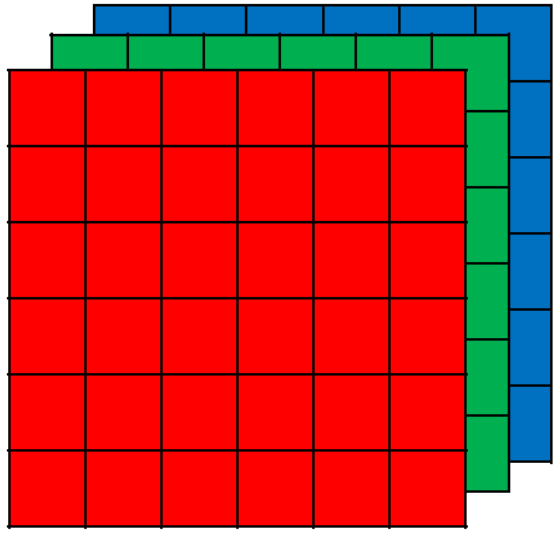
Convolutions on RGB images

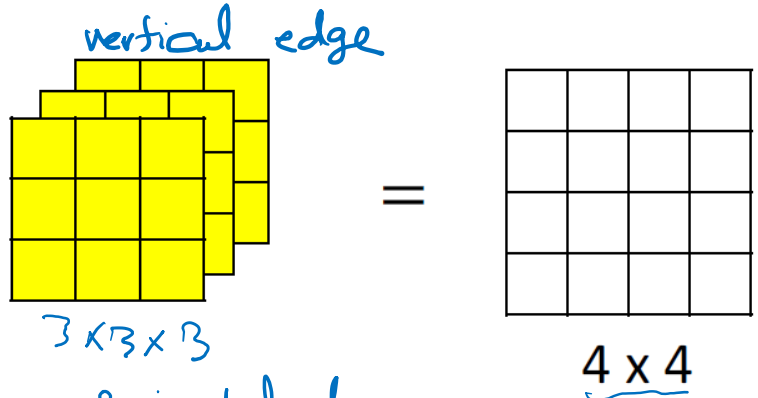


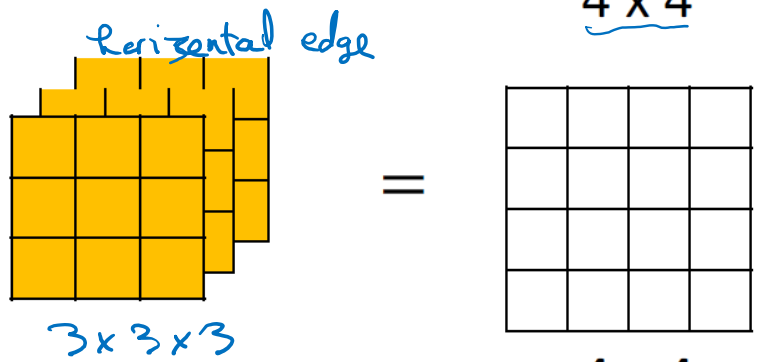
Convolutions on RGB images

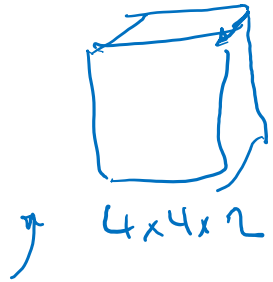


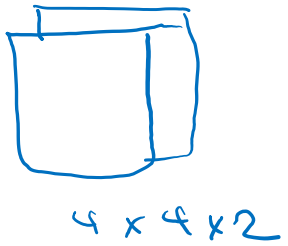
Multiple Filters

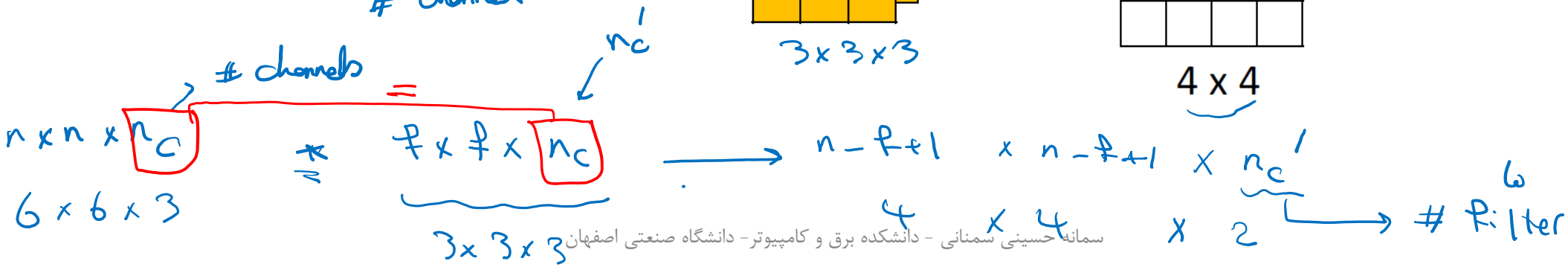






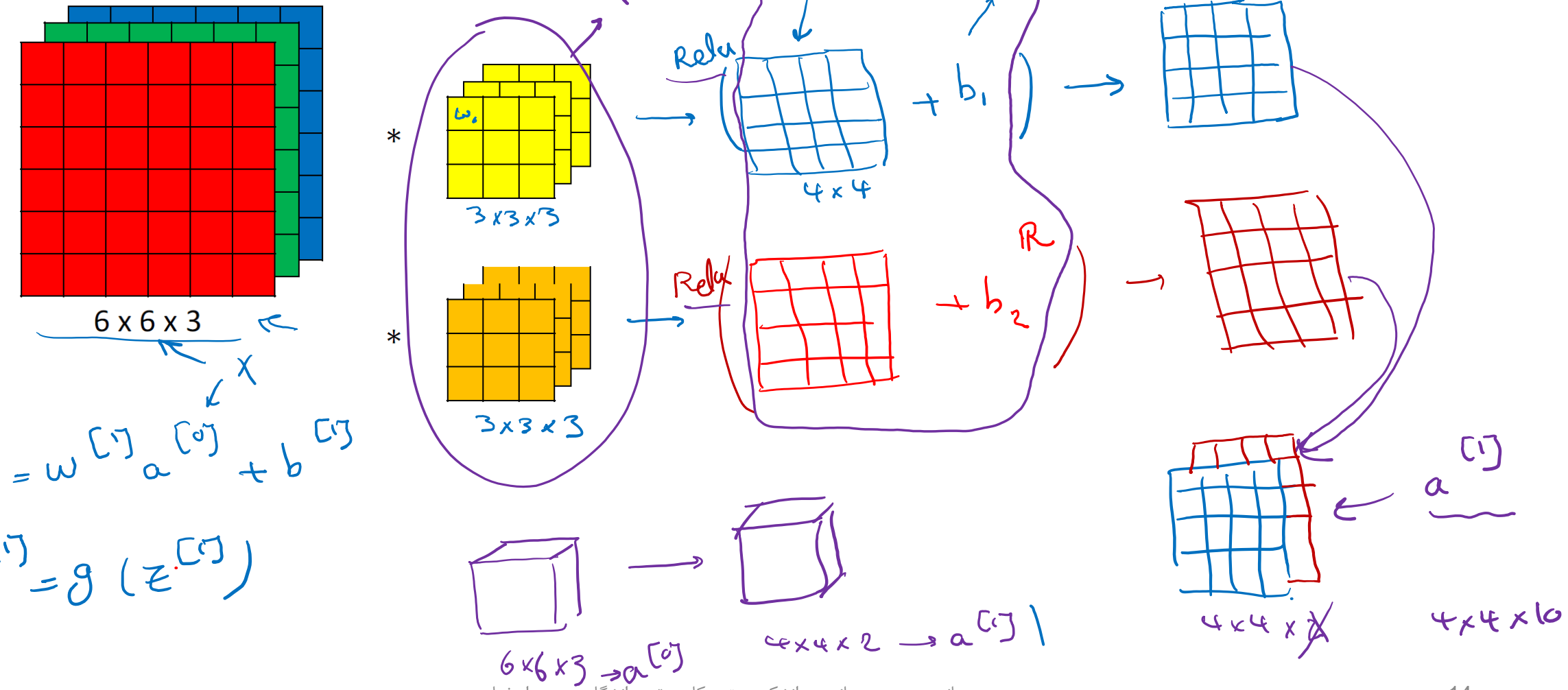






Convolutional Neural Networks:
One layer of a convolutional network

Example of a layer



$$z^{[1]} = w^{[1]} a^{[0]} + b^{[1]}$$

$$a^{[1]} = g(z^{[1]})$$

$a^{[1]}$

Core Foundation Review

- Convolutional Neural Networks
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  - Strided Convolutions
  - Convolutions Over Volume
  - One layer of a convolutional network