

Redes Neuronales Convolucionales

Estructura de una ConvNet

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NOS QUEDAMOS EN ...

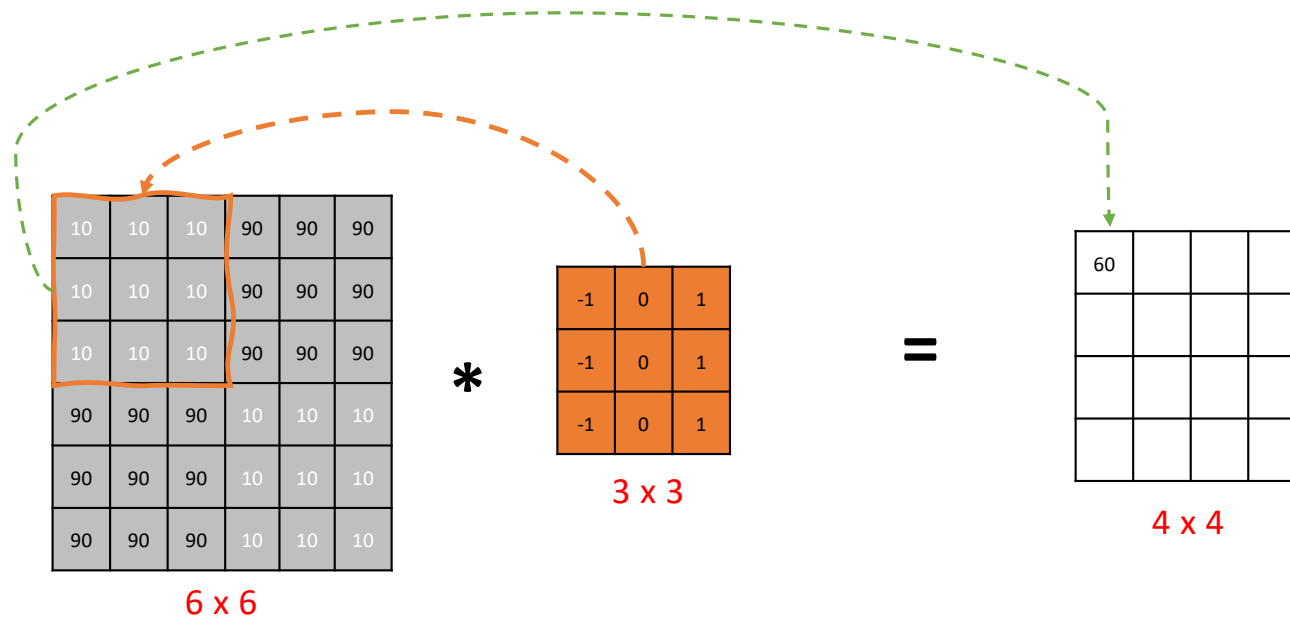
- ❑ Segmentación de imágenes
- ❑ Convolución
 - Convolución con Padding
 - Convolución con Stride

HOY ...

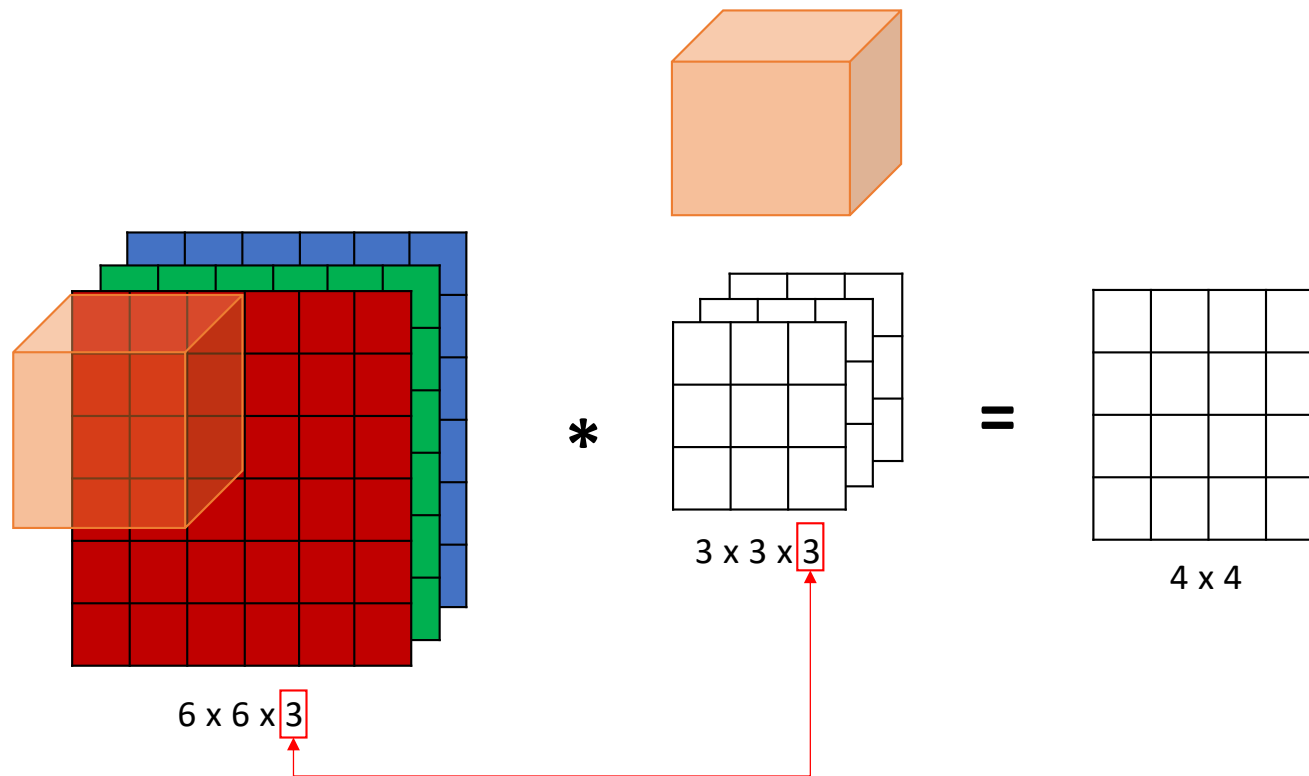
□ Estructura de una ConvNet

- Convolución sobre N canales
- Una capa convolucional
- Ejemplo de una ConvNet
- Tipos de capas

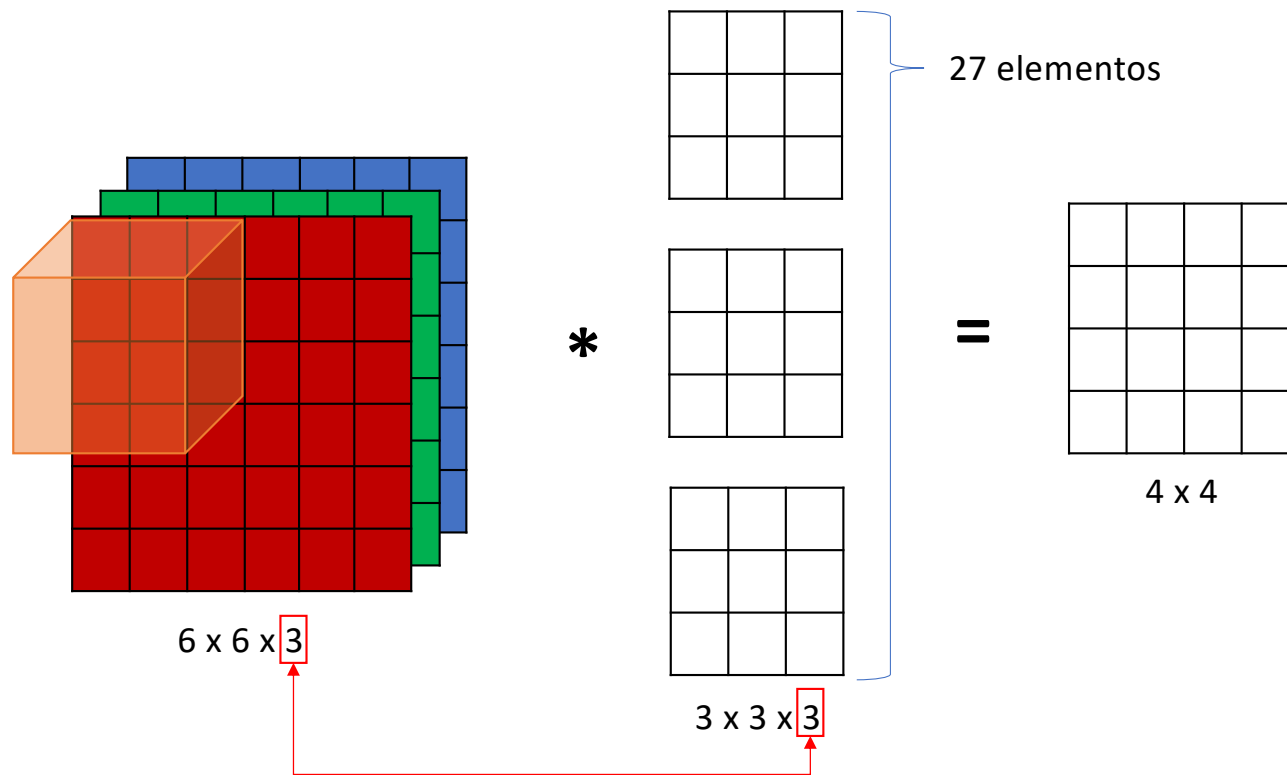
Convolución sobre 1 canal (Escala de grises)



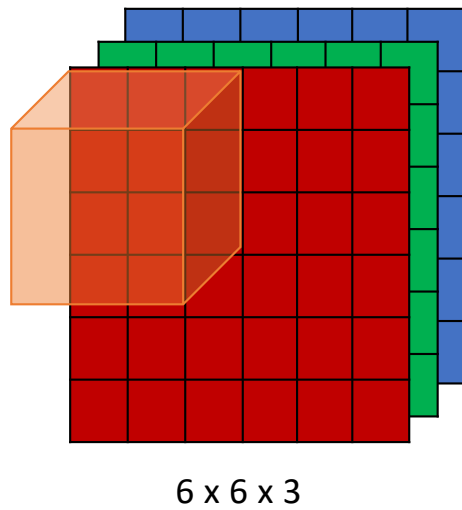
Convolución sobre N canales (RGB)



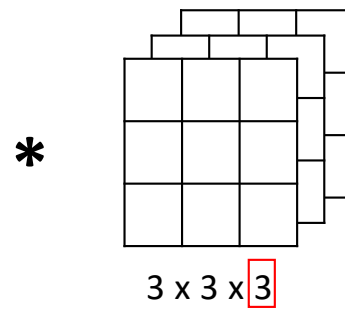
Convolución sobre N canales (RGB)



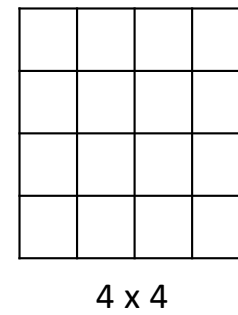
Múltiples filtros



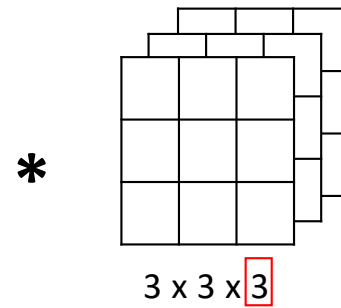
Bordes verticales



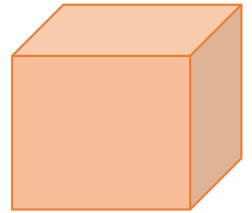
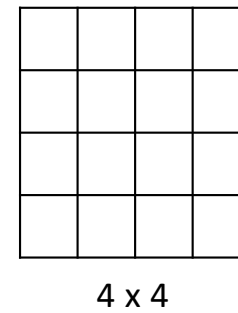
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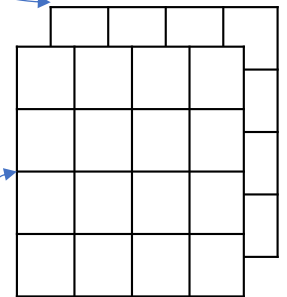
Bordes horizontales



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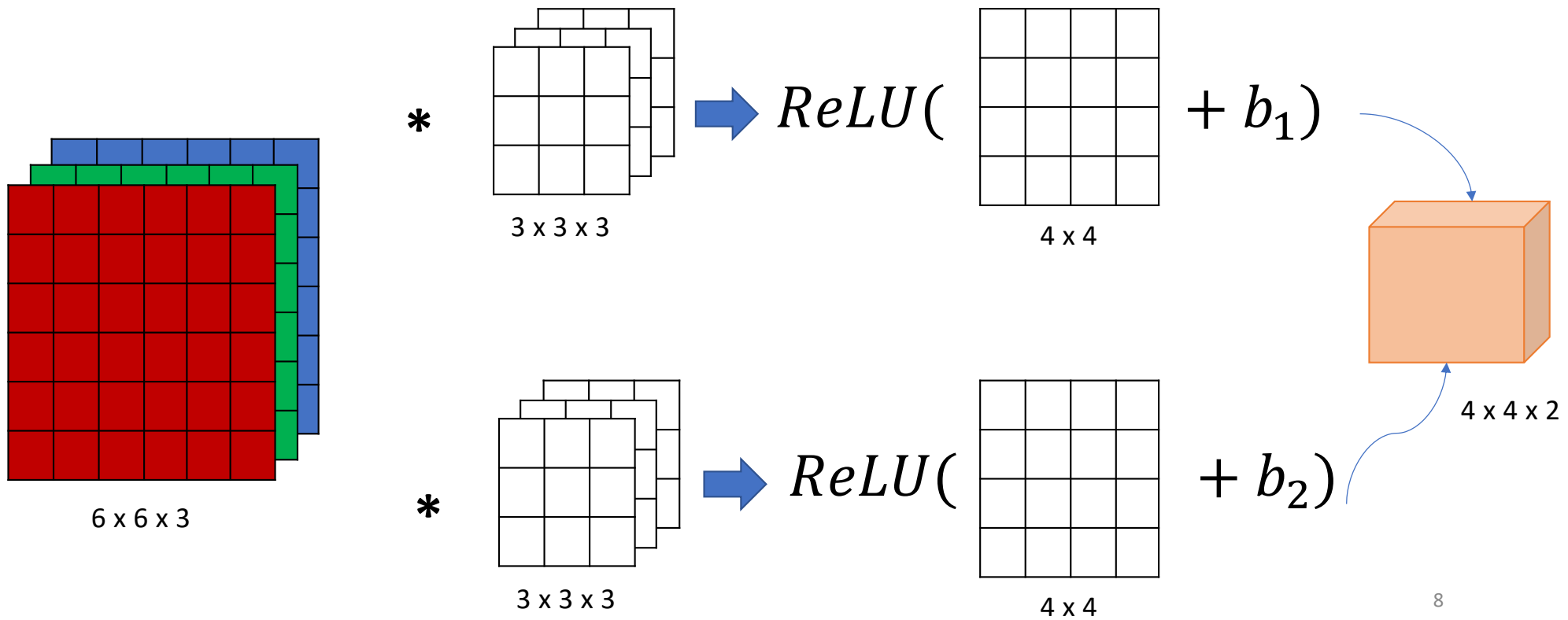
4 x 4 x 2



Una capa convolucional

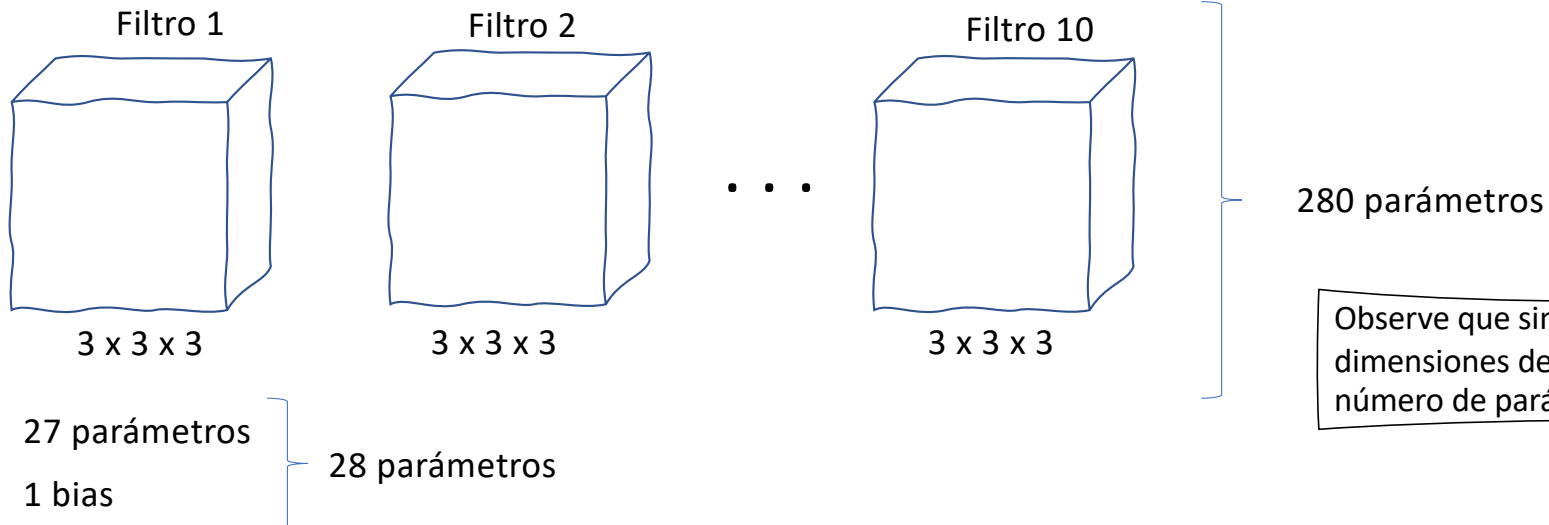
$$z^{[1]} = W^{[1]}a^{[0]} + b^{[1]}$$

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



Número de parámetros en una capa convolucional

Si tenemos 10 filtros de dimensiones $3 \times 3 \times 3$ en una capa de una red neuronal, ¿cuántos parámetros tiene la capa?



Veamos un poco de notación

Si l es una capa convolucional:

$f^{[l]}$ Tamaño del filtro

$p^{[l]}$ Padding

$s^{[l]}$ Stride

$n_C^{[l]}$ Número de filtros

Entrada de la capa l :

$$n_H^{[l-1]} \times n_W^{[l-1]} \times n_C^{[l-1]}$$

Salida de la capa l :

$$n_H^{[l]} \times n_W^{[l]} \times n_C^{[l]}$$

$$n_H^{[l]} = \left\lfloor \frac{n_H^{[l-1]} + 2p^{[l]} - f^{[l]}}{s^{[l]}} + 1 \right\rfloor$$

$$n_W^{[l]} = \left\lfloor \frac{n_W^{[l-1]} + 2p^{[l]} - f^{[l]}}{s^{[l]}} + 1 \right\rfloor$$

Veamos un poco de notación

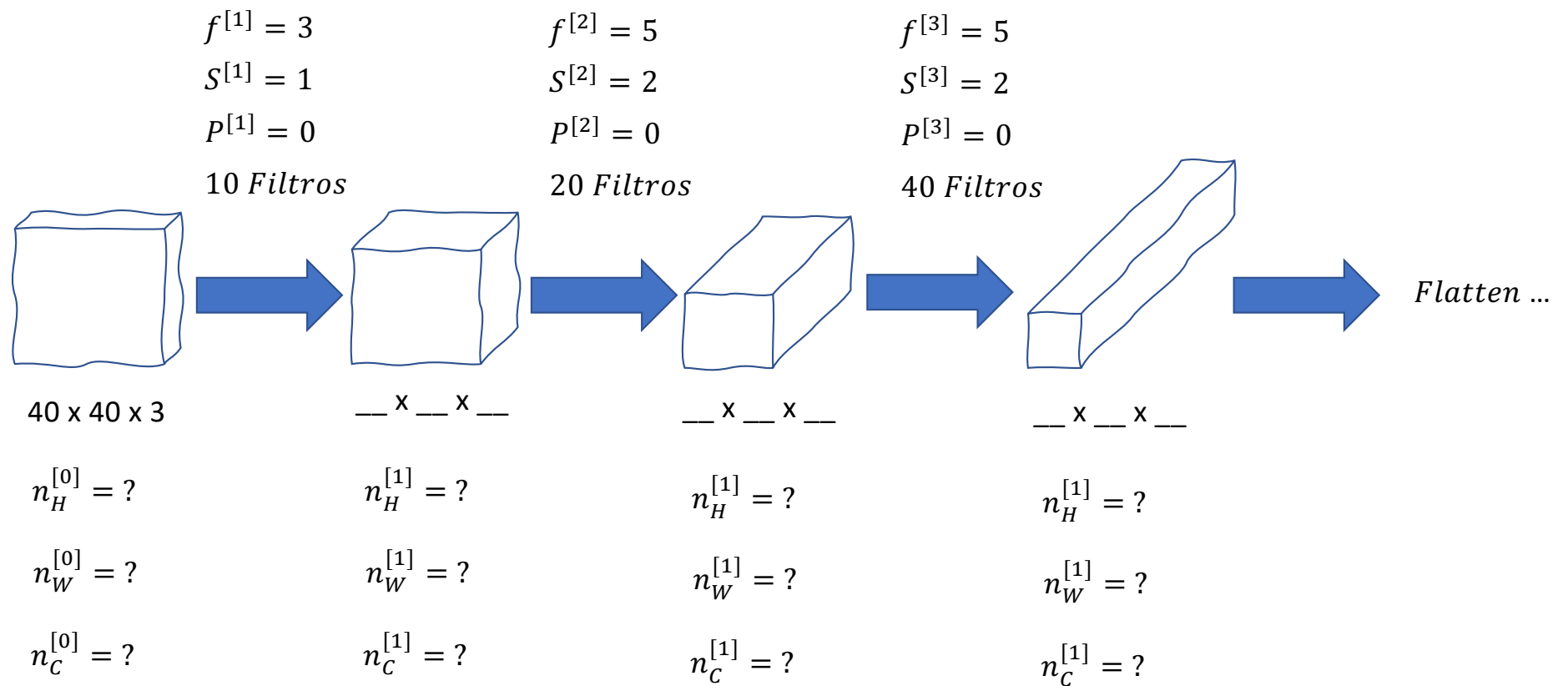
Cada filtro es: $f^{[l]} \times f^{[l]} \times n_c^{[l-1]}$

Pesos: $f^{[l]} \times f^{[l]} \times n_c^{[l-1]} \times n_c^{[l]}$

Bias: $(1, 1, 1, n_c^{[l]})$

Activación: $a^{[l]} = n_H^{[l]} \times n_W^{[l]} \times n_C^{[l]}$

Ejemplo de una ConvNet simple



Tipos de capas en ConvNets

- ☐ Convolutacional CONV
- ☐ Pooling POOL
- ☐ Fully connected FC

Capa POOL (Max pooling)

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 1 |
| 1 | 1 | 9 | 2 |
| 3 | 2 | 3 | 1 |
| 2 | 1 | 6 | 5 |

4 x 4



$$f^{[l]} = 2$$
$$s^{[l]} = 2$$

| | |
|---|---|
| 2 | 9 |
| 3 | 6 |

2 x 2

¡ No hay parámetros que aprender!

Capa POOL (Max pooling)

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 1 |
| 1 | 1 | 9 | 2 |
| 3 | 2 | 3 | 1 |
| 2 | 1 | 6 | 5 |

4 x 4



$$f^{[l]} = 2$$

$$s^{[l]} = 2$$

| | |
|---|---|
| 2 | 9 |
| 3 | 6 |

2 x 2

Capa POOL (Max pooling)

| | | | | | |
|----|----|----|----|----|----|
| 1 | 5 | 10 | 90 | 33 | 90 |
| 10 | 7 | 5 | 9 | 90 | 2 |
| 10 | 4 | 10 | 90 | 90 | 90 |
| 12 | 32 | 6 | 1 | 10 | 7 |
| 23 | 43 | 9 | 2 | 5 | 8 |
| 32 | 12 | 8 | 3 | 4 | 9 |

6 x 6



?

$$f^{[l]} = 3$$

$$s^{[l]} = 1$$

Capa POOL (Max pooling)

| | | | | | | | |
|----|----|----|----|----|----|----|--|
| | 1 | 5 | 10 | 00 | 22 | 90 | |
| 1 | 5 | 10 | 90 | 33 | 90 | | |
| 10 | 7 | 5 | 9 | 90 | 2 | | |
| 10 | 4 | 10 | 90 | 90 | 90 | | |
| 12 | 32 | 6 | 1 | 10 | 7 | | |
| 23 | 43 | 9 | 2 | 5 | 8 | | |
| 32 | 12 | 8 | 3 | 4 | 9 | | |

6 x 6 x 2



?

$$f^{[l]} = 3$$

$$s^{[l]} = 1$$

Capa POOL (Average pooling)

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 1 |
| 1 | 1 | 9 | 2 |
| 3 | 2 | 3 | 1 |
| 2 | 1 | 6 | 5 |

4 x 4



$$f^{[l]} = 2$$

$$s^{[l]} = 2$$

| | |
|--|--|
| | |
| | |

2 x 2

¡ No hay parámetros que aprender!