II Redes neuronales convolucionales

Conceptos
Arquitectura
Implementación

Odin Eufracio

Actividad 5

Terminar el notebook **2.1_FNN_FashionMNIST.ipynb**

Este ejercicio nos servirá para motivar la necesidad de las **redes convolucionales.**

Operador de convolución

Hubel and Wiesel experiment.

La corteza visual (del gato) tiene unas pequeñas regiones de células que son sensibles a ciertas regiones del campo visual.

Además, las células de la corteza visual están conectadas usando una estructura por capas, las cuales *reconstruyen* el campo visual a diferentes niveles de abstracción, ***hierarchical feature extraction.***

Hubel & Wiesel 1: Intro

https://www.youtube.com/watch?v=y_I4kQ5wjiw

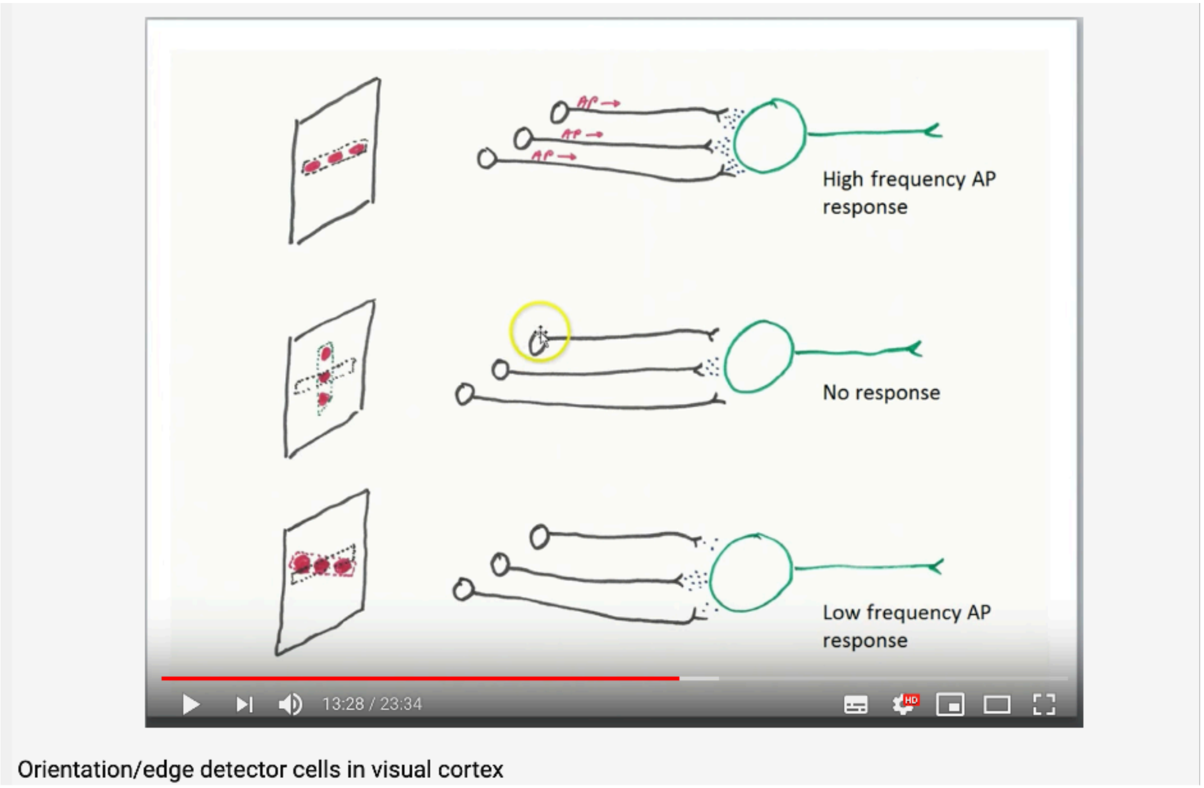
https://www.youtube.com/watch?v=IOHayh06LJ4

https://www.youtube.com/watch?v=RSNofraG8ZE

D. Hubel and T. Wiesel. **Receptive fields of single neurones in the cat's striate cortex**. Journal of Physiology, 124(3), pp. 574–591, 1959.

Hubel and Wiesel experiment.

Video interesante!



https://www.youtube.com/watch?v=v20-E_2bT2c

D. Hubel and T. Wiesel. **Receptive fields of single neurones in the cat's striate cortex**. Journal of Physiology, 124(3), pp. 574–591, 1959.

Neocognitron (1980)

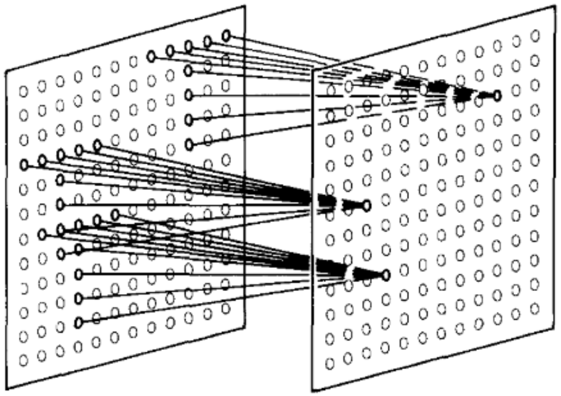


Fig. 3. Illustration showing the input interconnections to the cells within a single cell-plane

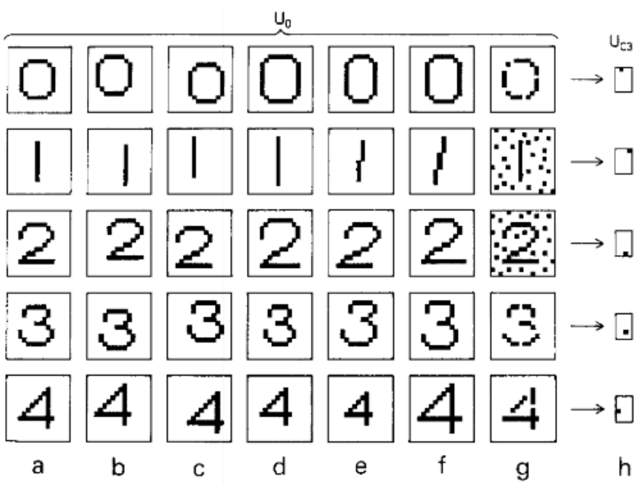


Fig. 6. Some examples of distorted stimulus patterns which the neocognitron has correctly recognized, and the response of the final layer of the network

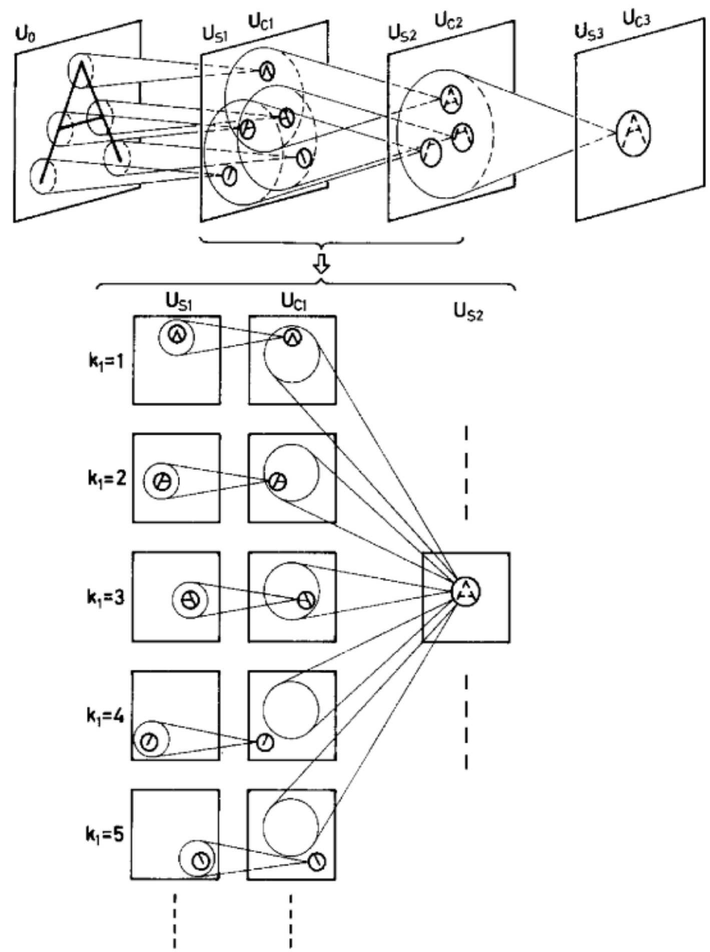


Fig. 5. An example of the interconnections between cells and the response of the cells after completion of self-organization

K. Fukushima. **Neocognitron: A self-organizing neural network model for a mechanism of pattern recognition unaffected by shift in position**. Biological Cybernetics, 36(4), pp. 193– 202, 1980.

LeNet-5 (1998)

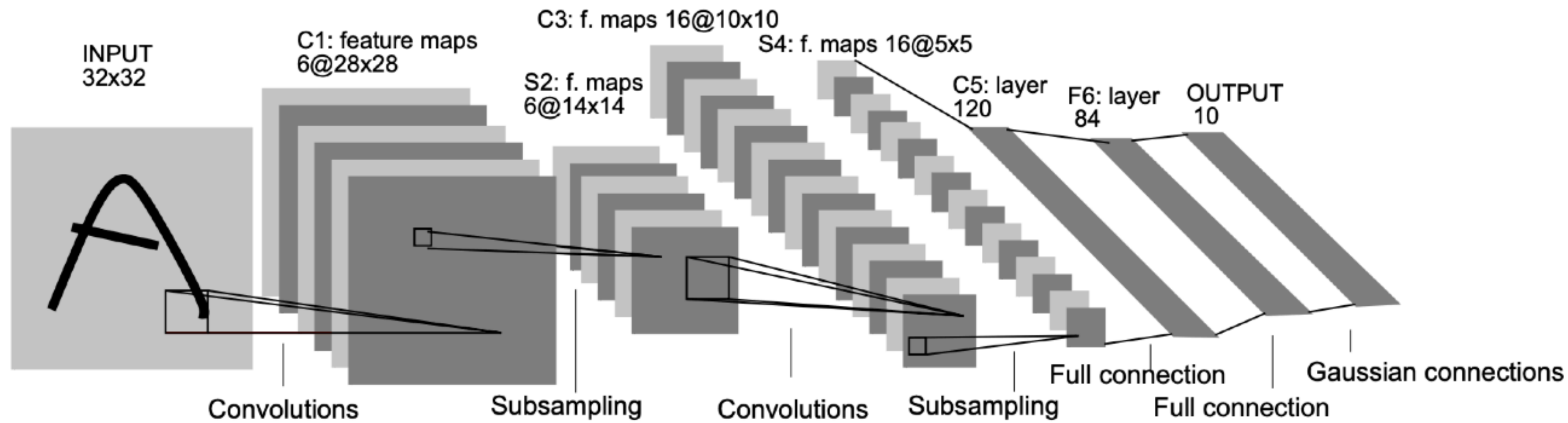


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

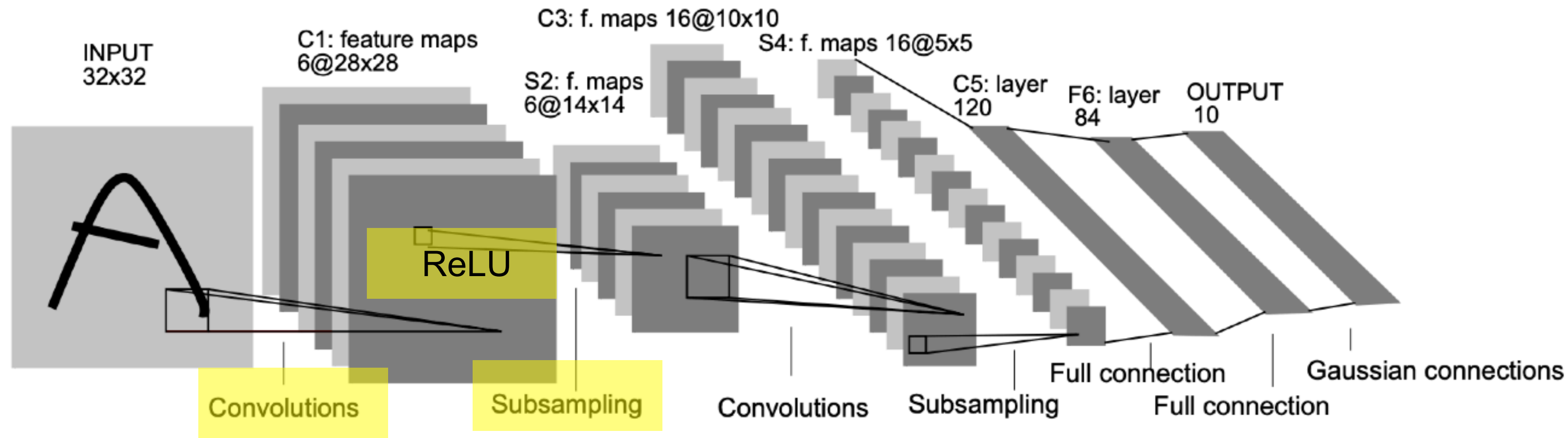
‘Godfathers of AI’ honored with Turing Award, the Nobel Prize of computing

https://www.theverge.com/2019/3/27/18280665/ai-godfathers-turing-award-2018-yoshua-bengio-geoffrey-hinton-yann-lecun

Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner. **Gradient-based learning applied to document recognition**. Proceedings of the IEEE, 86(11), pp. 2278–2324, 1998.

Componentes básicos de una CNN

Las CNN están basadas en una comprensión intuitiva de las ***relaciones espaciales.***



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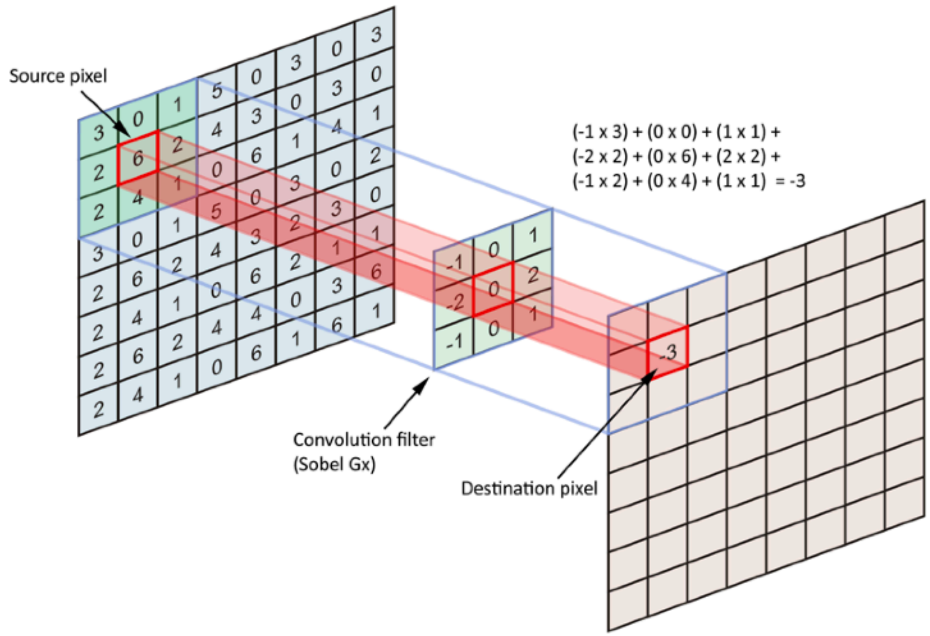
Convolution + ***ReLU*** + ***Pooling*** + ***(Dense)***

Estos ***operadores*** ayudan a ***extraer / mantener*** relaciones espaciales.

Convolución (modificador de imágenes)

Las redes neuronales convolucionales **CNN**, son redes que usan el **operador de convolución** en al menos una capa (en realidad lo usan muchas veces!)



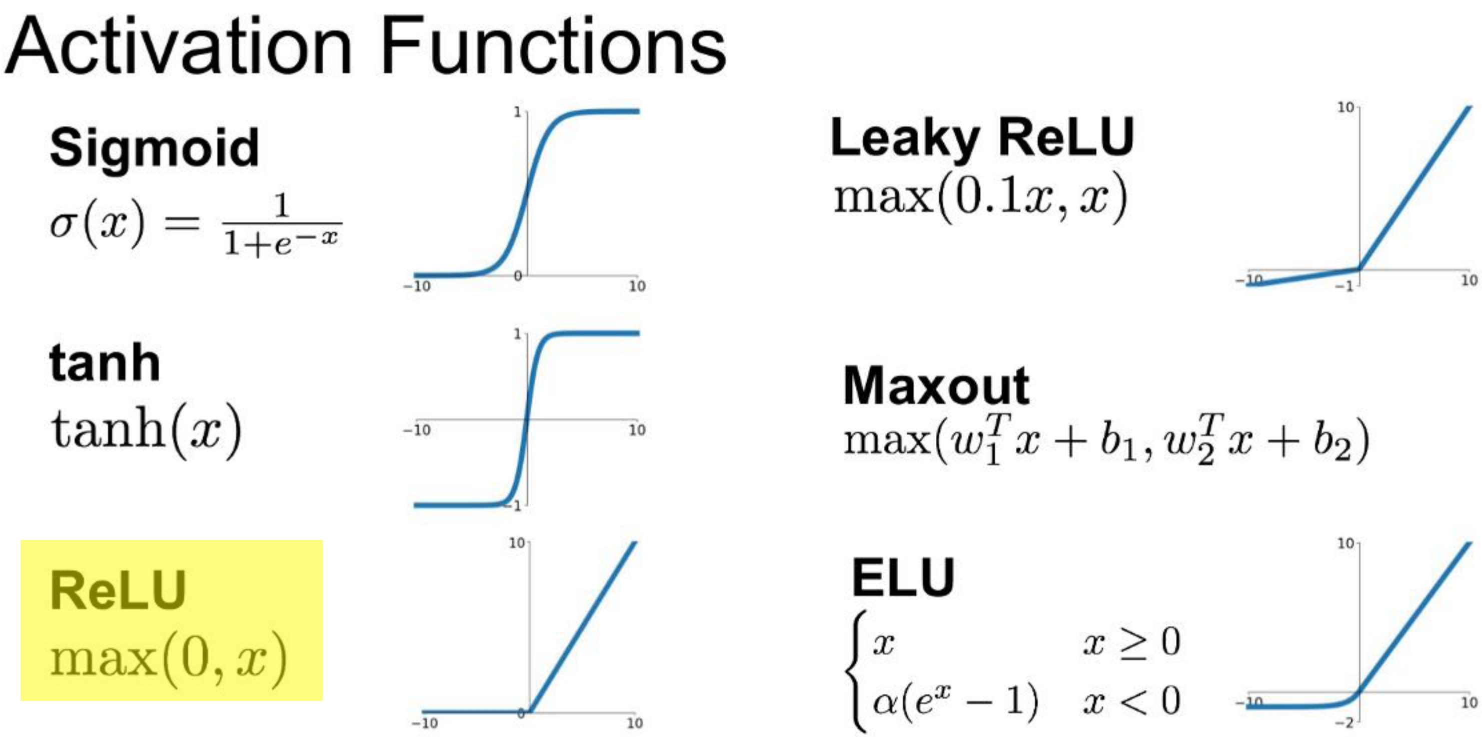
Jugar con **kernel:** http://setosa.io/ev/image-kernels/

Diferentes filtros (kernels), diferentes efectos + *Padding* + *Stride*

La convolución como una **multiplicación de matrices** $h(W * z + b)$

[Imagen tomada de] https://datascience.stackexchange.com/questions/23183/why-convolutions-always-use-odd-numbers-as-filter-size

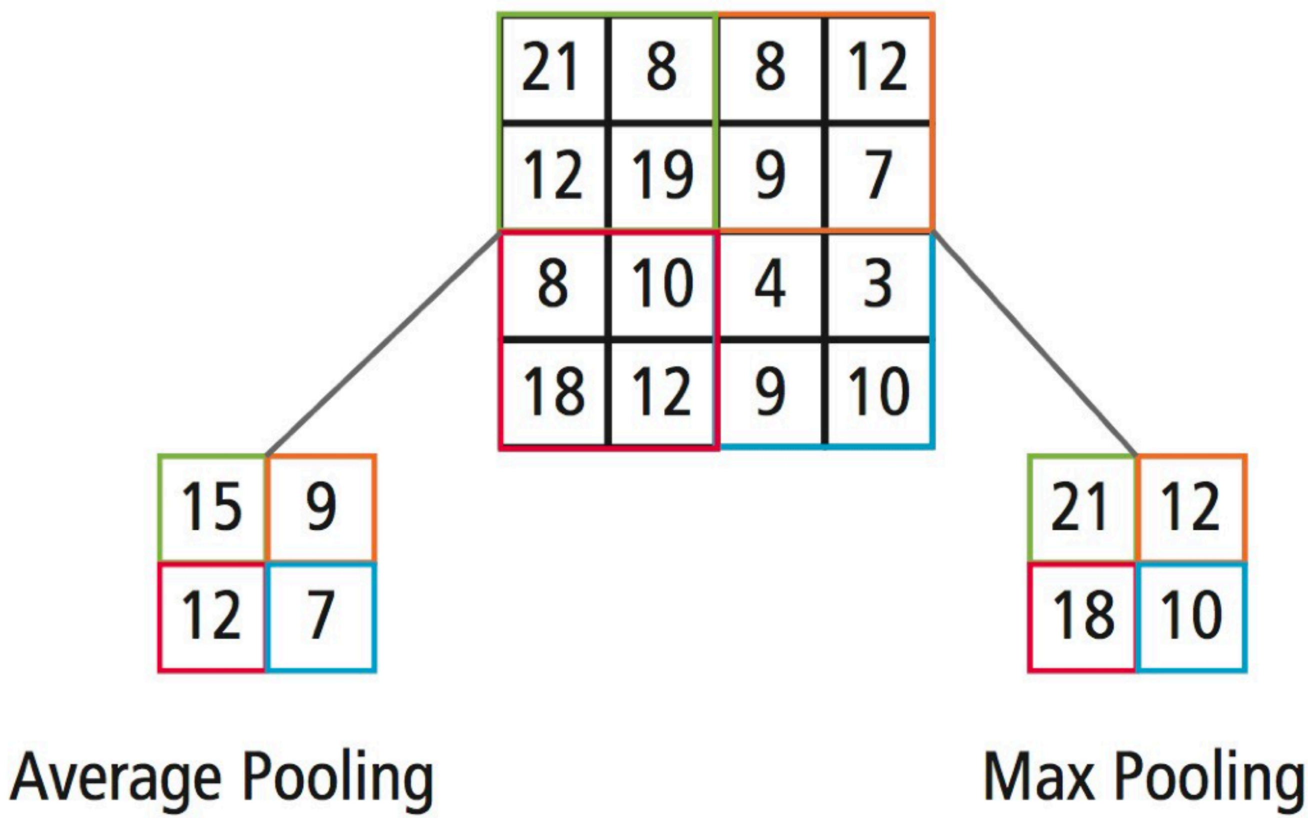
Función de activación ReLU: no-negatividad



Efecto de no-negatividad? Es lo natural? Solo combinaciones aditivas?

[Imagen tomada de] http://www.programmersought.com/article/1060528072/

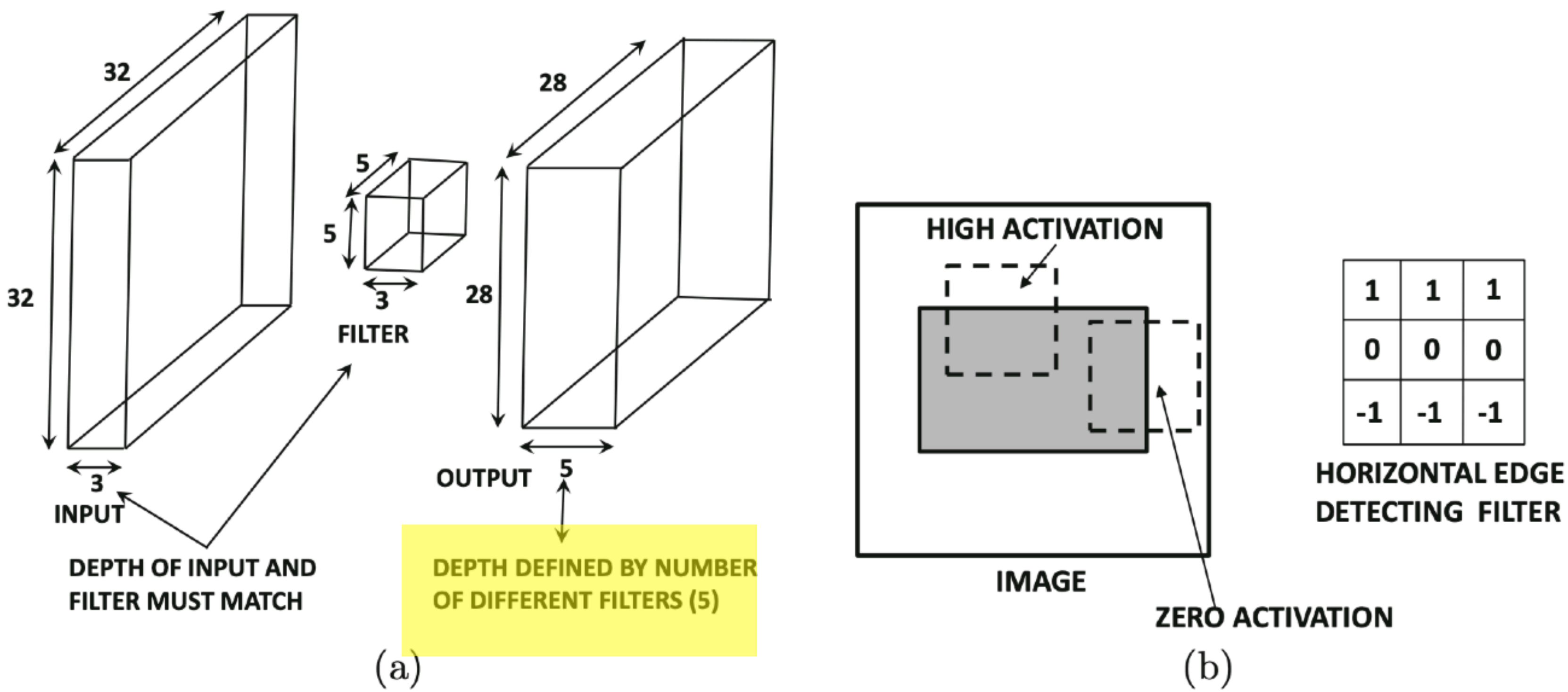
Pooling: submuestreo



Downsampling: Conveniente (velocidad) +. *Translation Invariance*

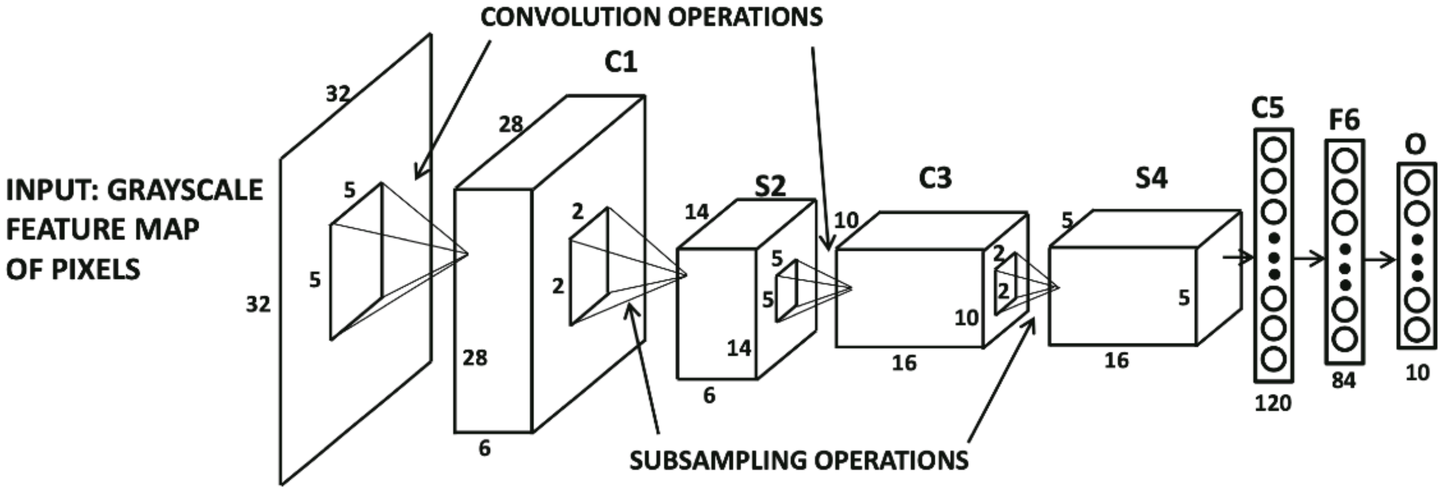
[Imagen tomada de] http://www.davidsbatista.net/blog/2018/03/31/SentenceClassificationConvNets/

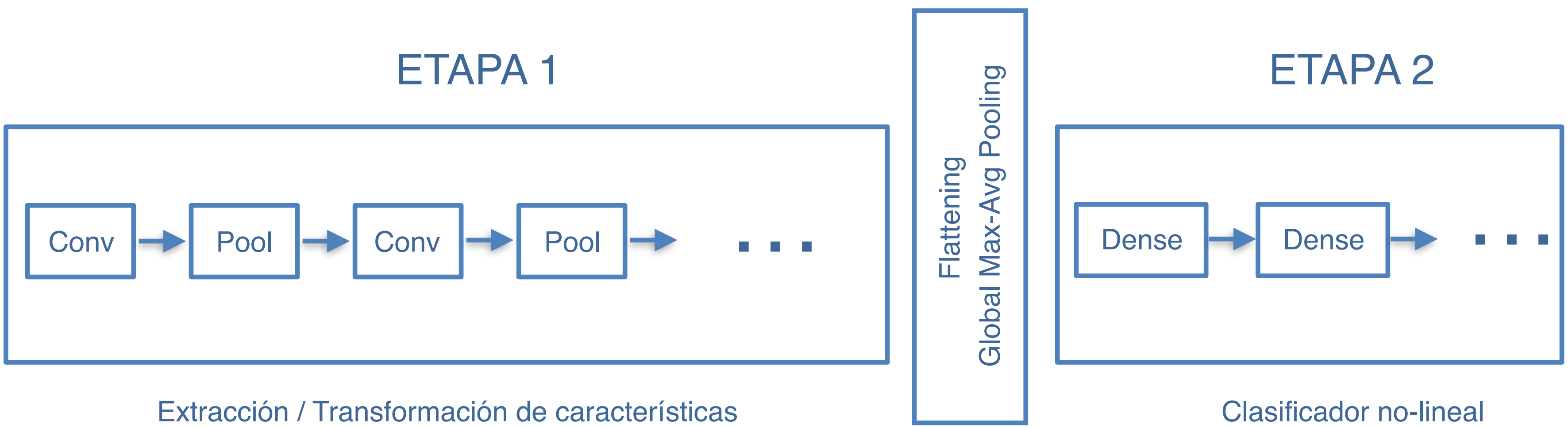
Pooling: submuestreo



[Imagen tomada de] Charu C. Aggarwal. (2018). **Neural Networks and Deep Learning**. Springer International Publishing

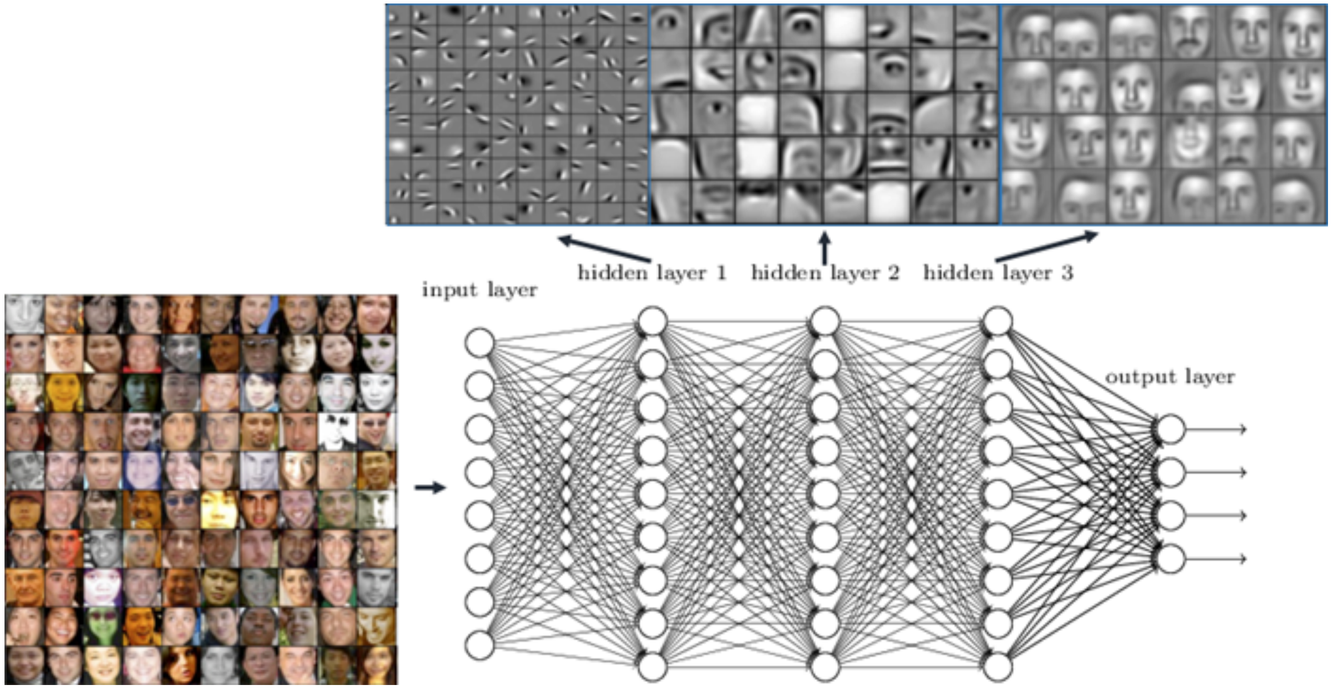
Arquitectura CNN

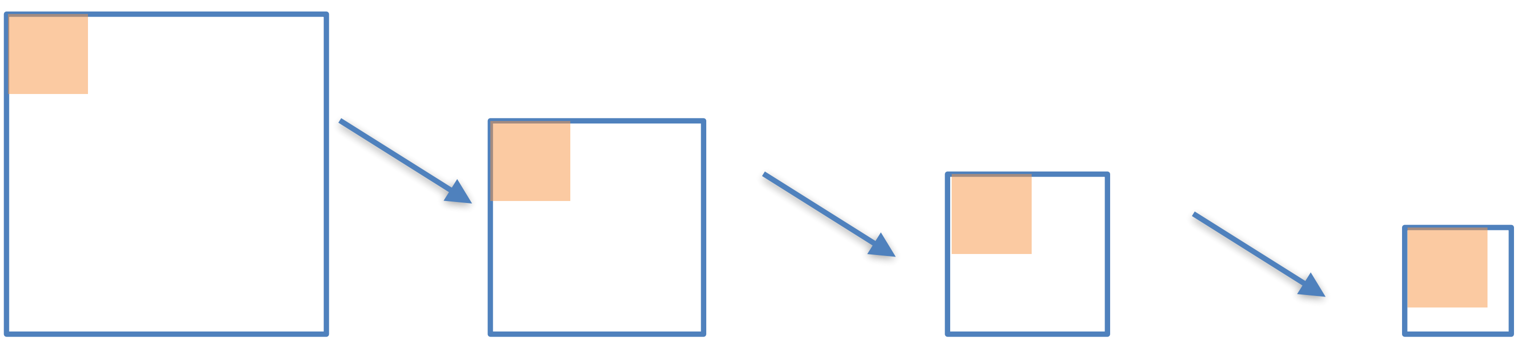




[Imagen tomada de] Charu C. Aggarwal. (2018). **Neural Networks and Deep Learning**. Springer International Publishing

Arquitectura CNN: *hierarchical feature extraction*





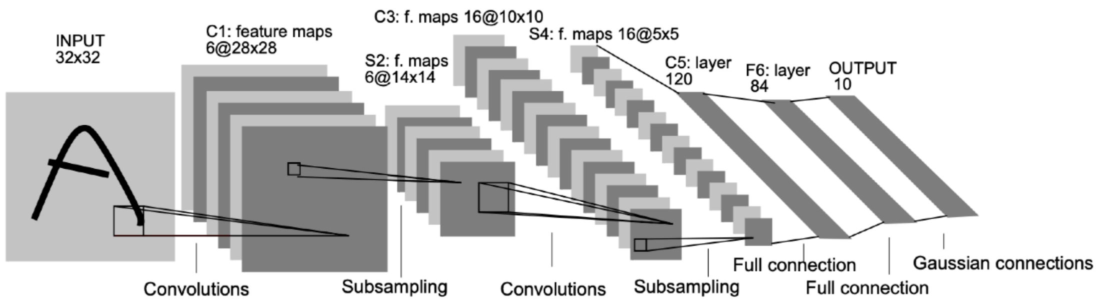
[Imagen tomada de] https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a

Arquitectura CNN: *guías generales*

Filtros pequeños : 3x3, 5x5, 7x7

Repetir: Conv + Pool + Conv + Pool + Conv + Pool + …

Incrementar el numero de *feature maps*



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En las ultimas capas totalmente conectadas, **disminuir** poco a poco.

[Imagen tomada de] https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a

Nota: reducción de *dimensiones durante las capas*

Como afectan las dimensiones al aplicar el operar de convolución

$h(W * z + b)$ **->** $\text{Img}_{out} = \text{Img}_{in} * w$

$$dim(\text{Img}_{in}) = w \times h \times c$$
$$dim(w) = k \times k \times c \times f$$
$$dim(\text{Img}_{out}) = w^{'} \times h^{'} \times f$$

Como afectan las dimensiones al aplicar *convolution**(f)*** &*padding**(p)*** & *stride**(s)***
(solo una dimensión)

$$dim(\text{Img}_{in}) = w \times h \times c$$

$$w^{'} = (w - f + 2p)/s + 1$$

Actividad 6

“Jugar” con http://scs.ryerson.ca/~aharley/vis/conv/flat.html

Terminar el notebook **2.2_CNN_FashionMNIST.ipynb**

Terminar el notebook **2.3_CNN_CIFAR.ipynb**

Retroalimentación.

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