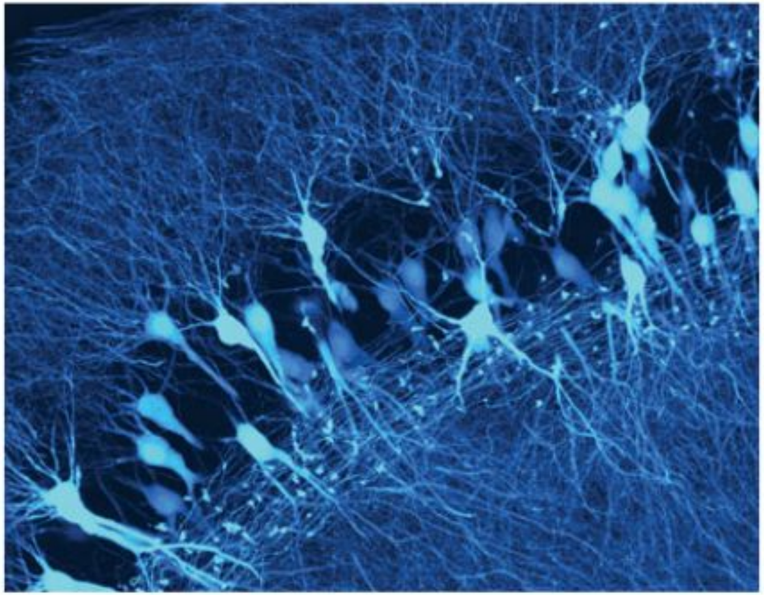
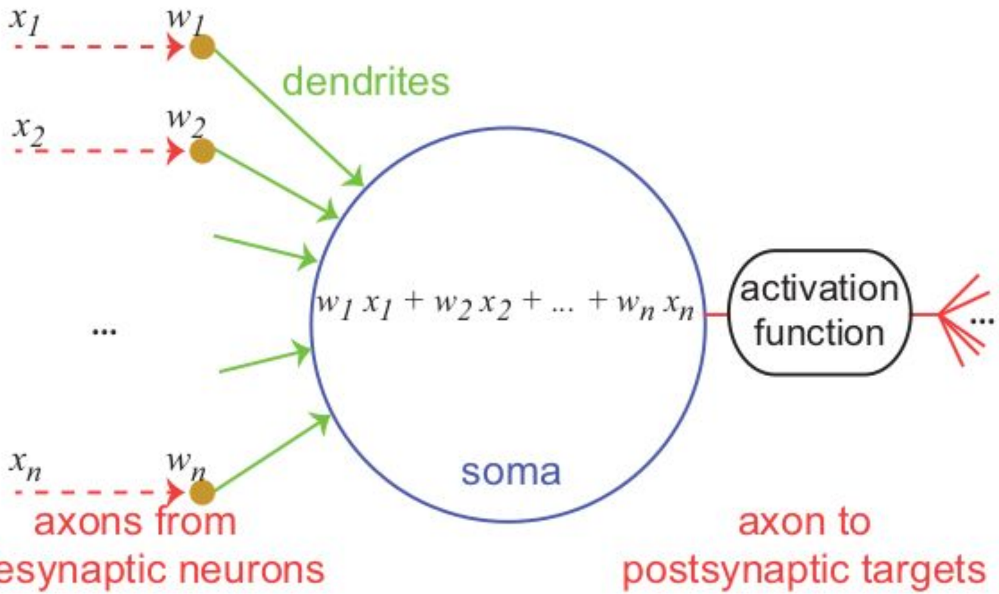
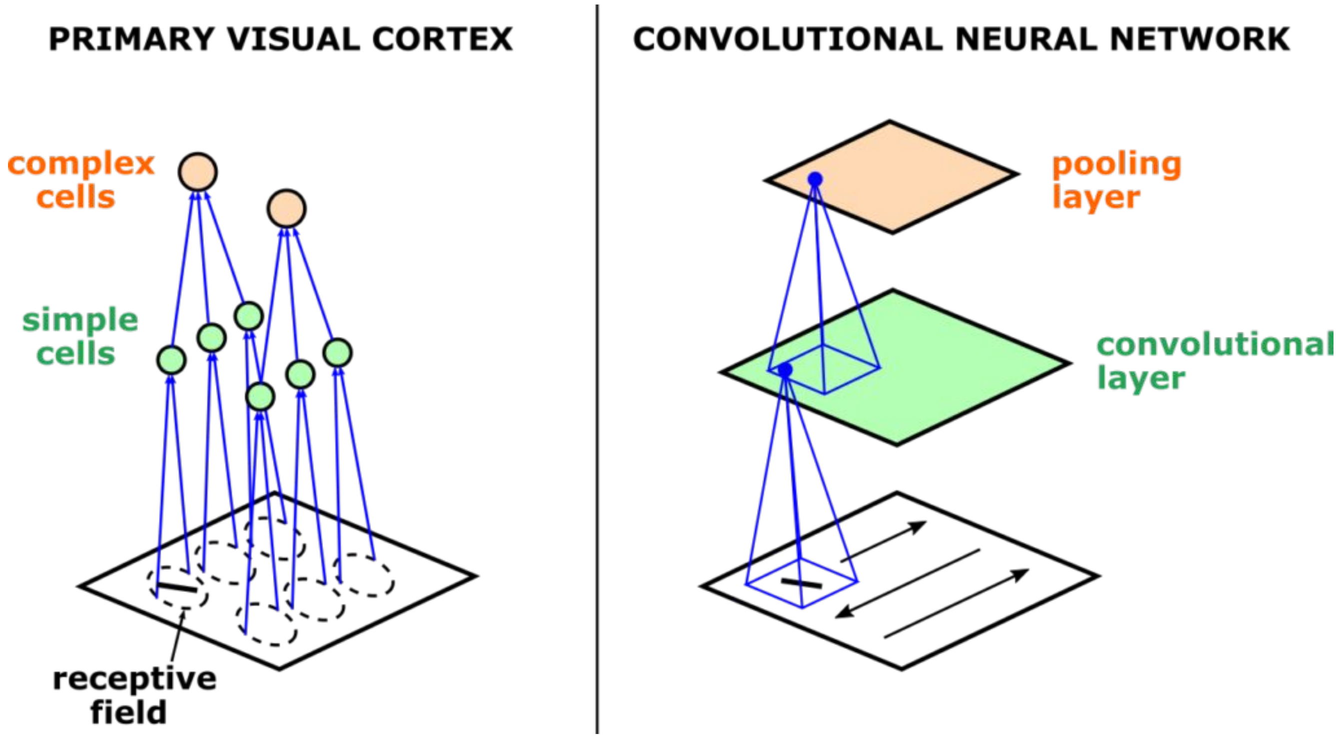
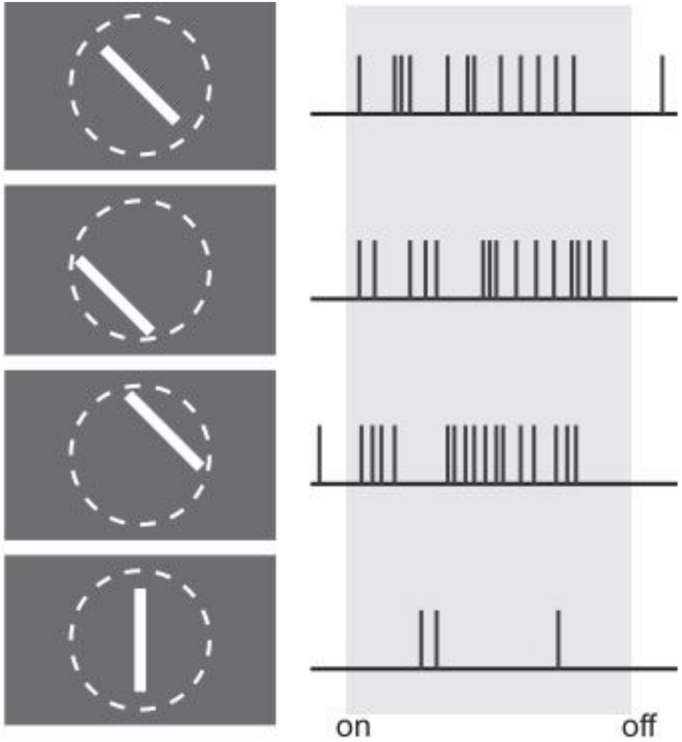


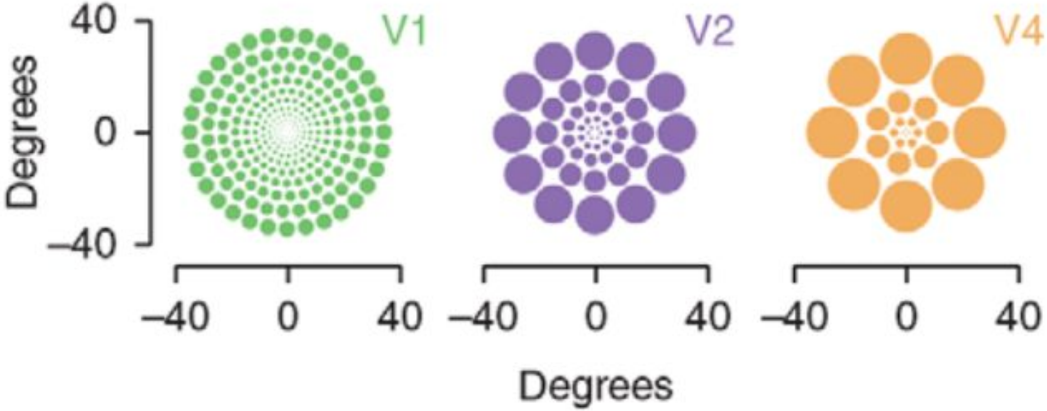


From real neurons to computational units.

Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.


PRIMARY VISUAL CORTEX
CONVOLUTIONAL NEURAL NETWORK
complex cells
simple cells
receptive field
pooling layer
convolutional layer

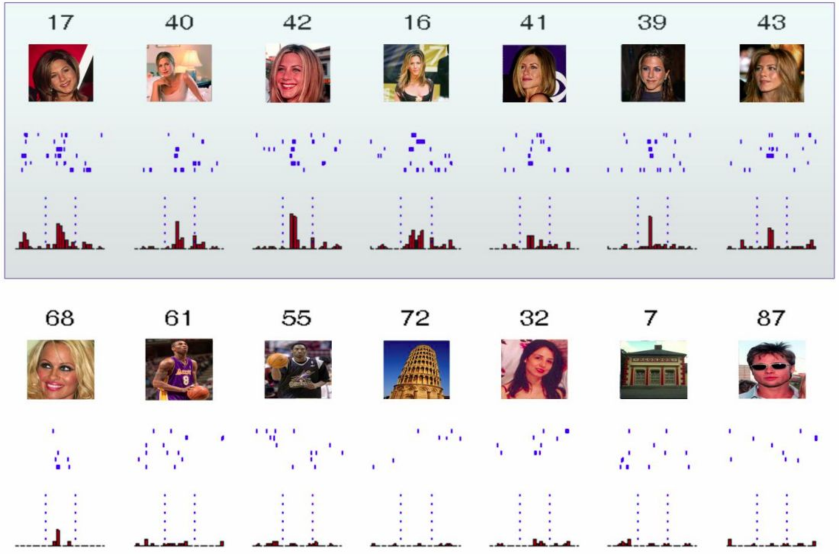




Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.

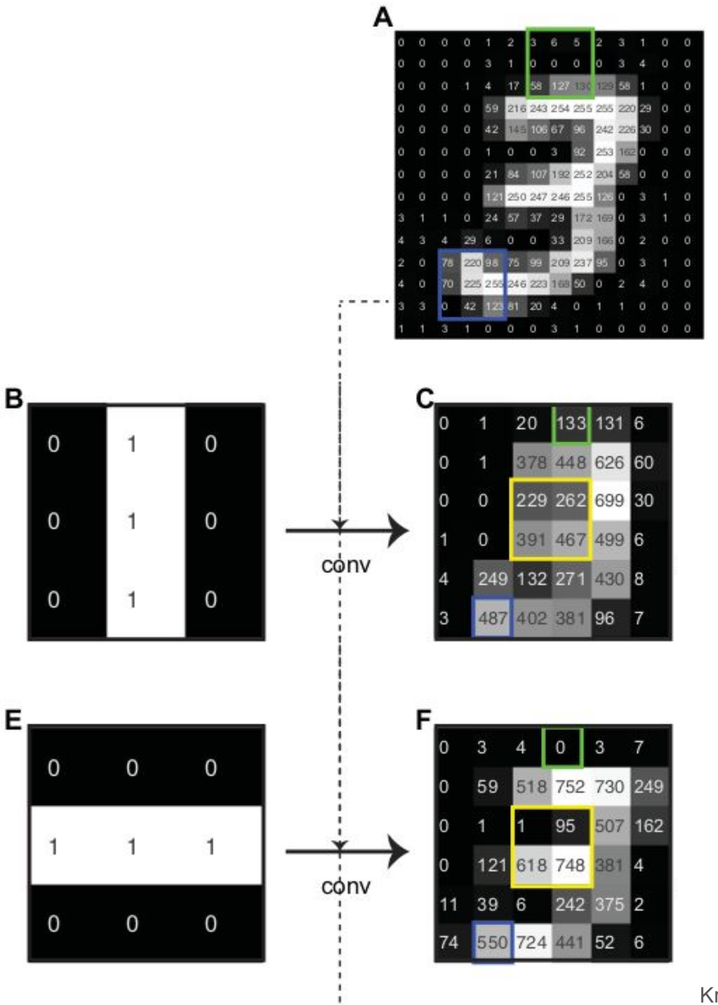
Invariant visual representation by single neurons in the human brain

R. Quian Quiroga[1,2]†, L. Reddy[1], G. Kreiman[3], C. Koch[1] & I. Fried[2,

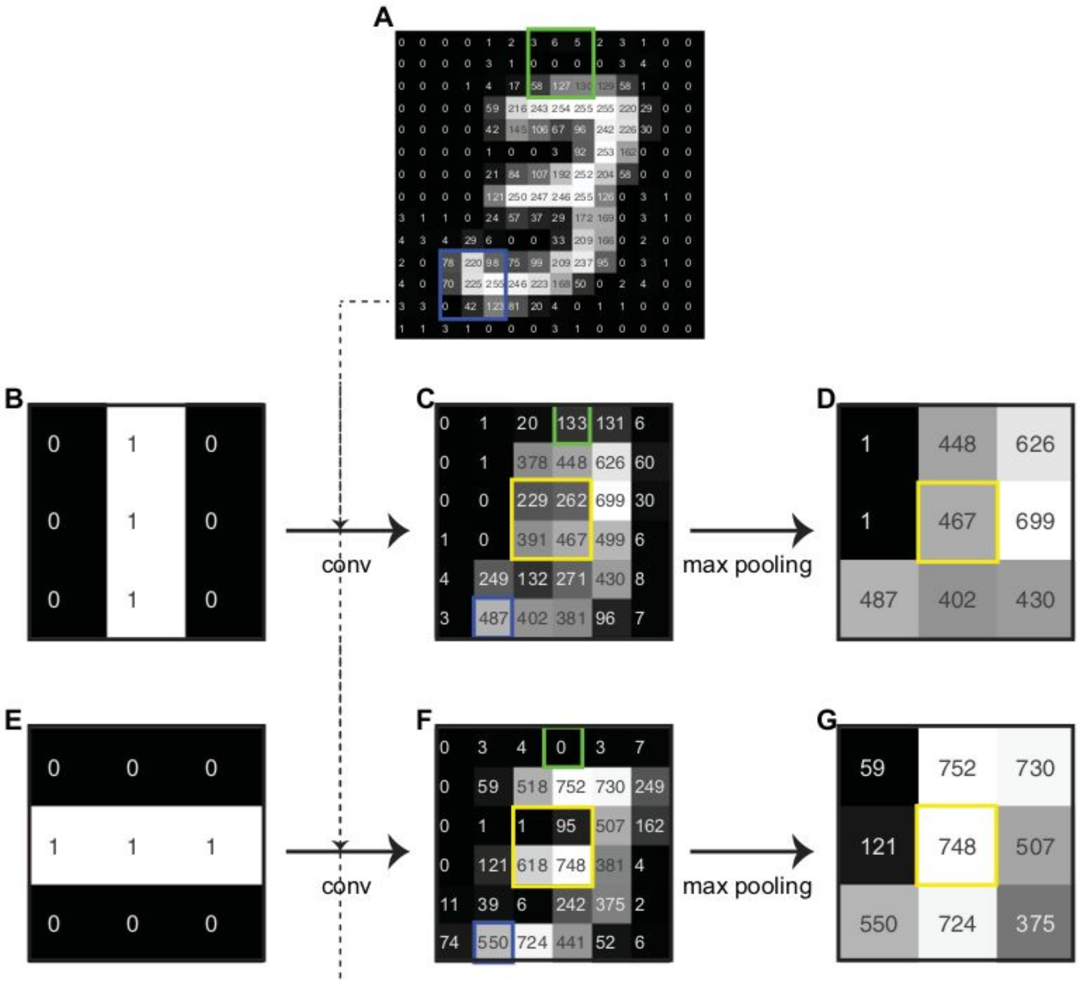


It takes a fraction of a second to recognize a person or an object even when seen under strikingly different conditions. How such a robust, high-level representation is achieved by neurons in the human brain is still unclear[1–6]. In monkeys, neurons in the upper stages of the ventral visual pathway respond to complex images such as faces and objects and show some degree of invariance to metric properties such as the stimulus size, position and viewing angle[2,4,7–12]. We have previously shown that neurons in the human medial temporal lobe (MTL) fire selectively to images of faces, animals, objects or scenes[13,14]. Here we report on a remarkable

Figure 1 | A single unit in the left posterior hippocampus activated exclusively by different views of the actress Jennifer Aniston.



Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.



Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.

Kernel 1

$$* \begin{bmatrix} 1/4 & 0 & -1/4 \\ 1/4 & 0 & -1/4 \\ 1/4 & 0 & -1/4 \end{bmatrix}$$

Kernel 2

$$* \begin{bmatrix} -1/4 & -1/4 & -1/4 \\ 0 & 0 & 0 \\ 1/4 & 1/4 & 1/4 \end{bmatrix}$$

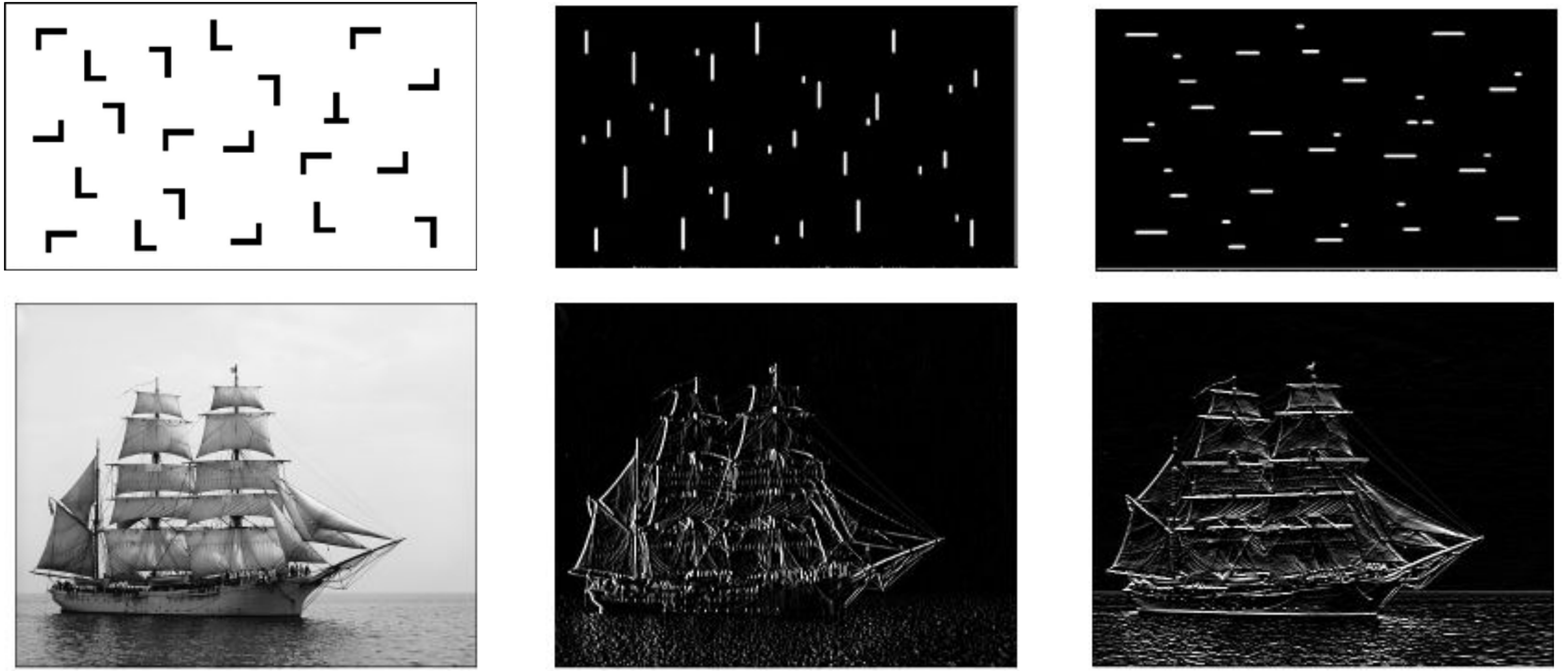
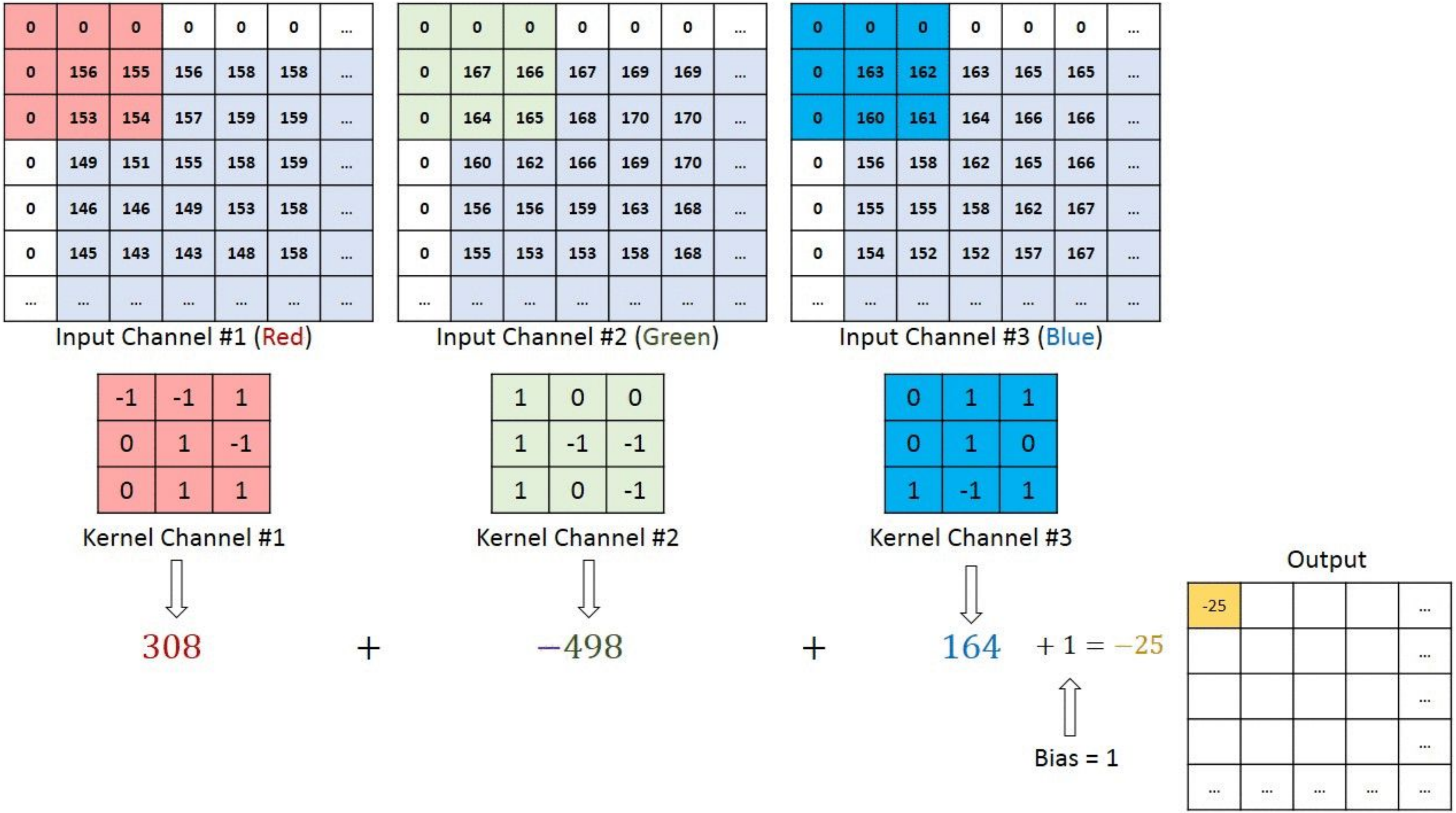
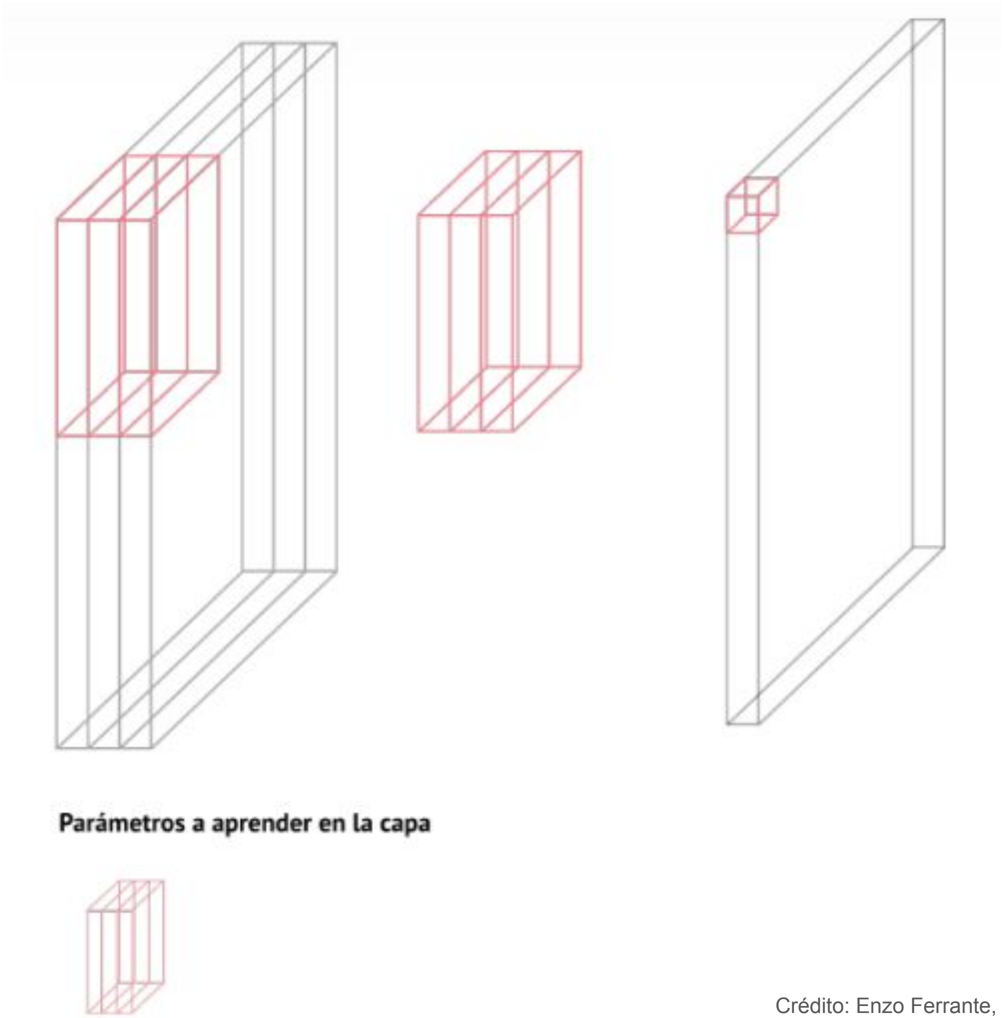
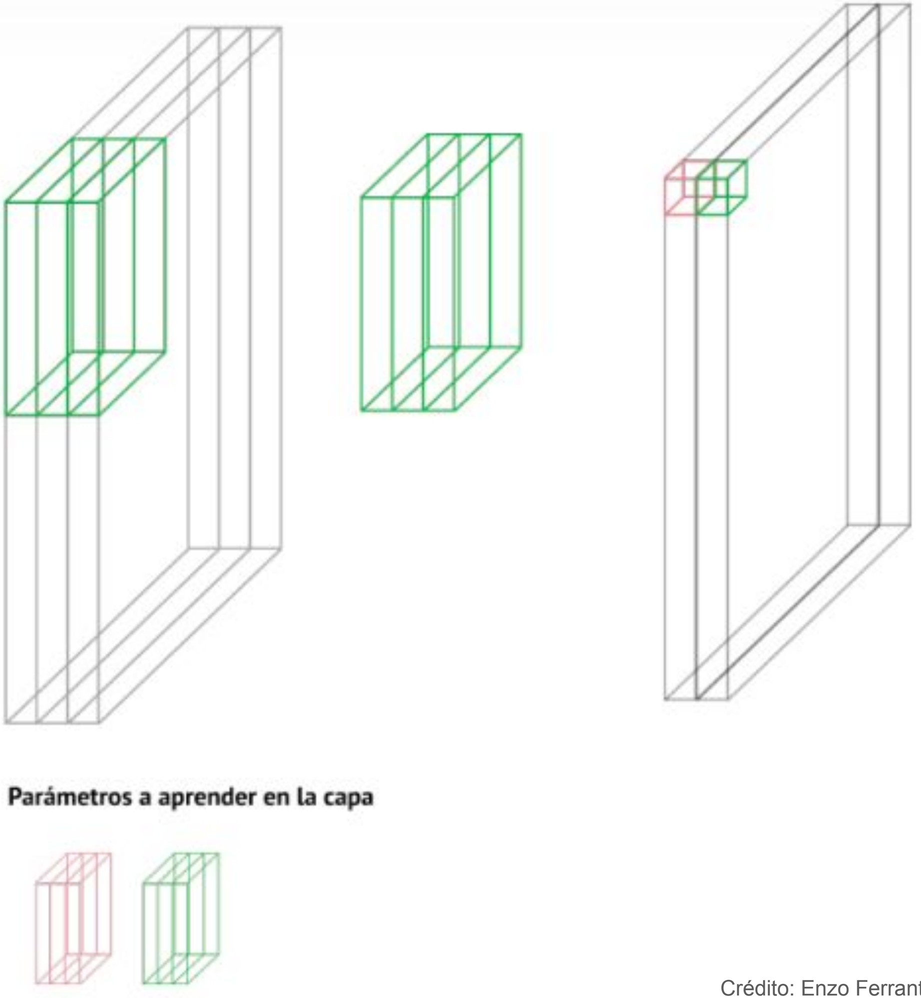


Imagen | **Feature map 1** | **Feature map 2**

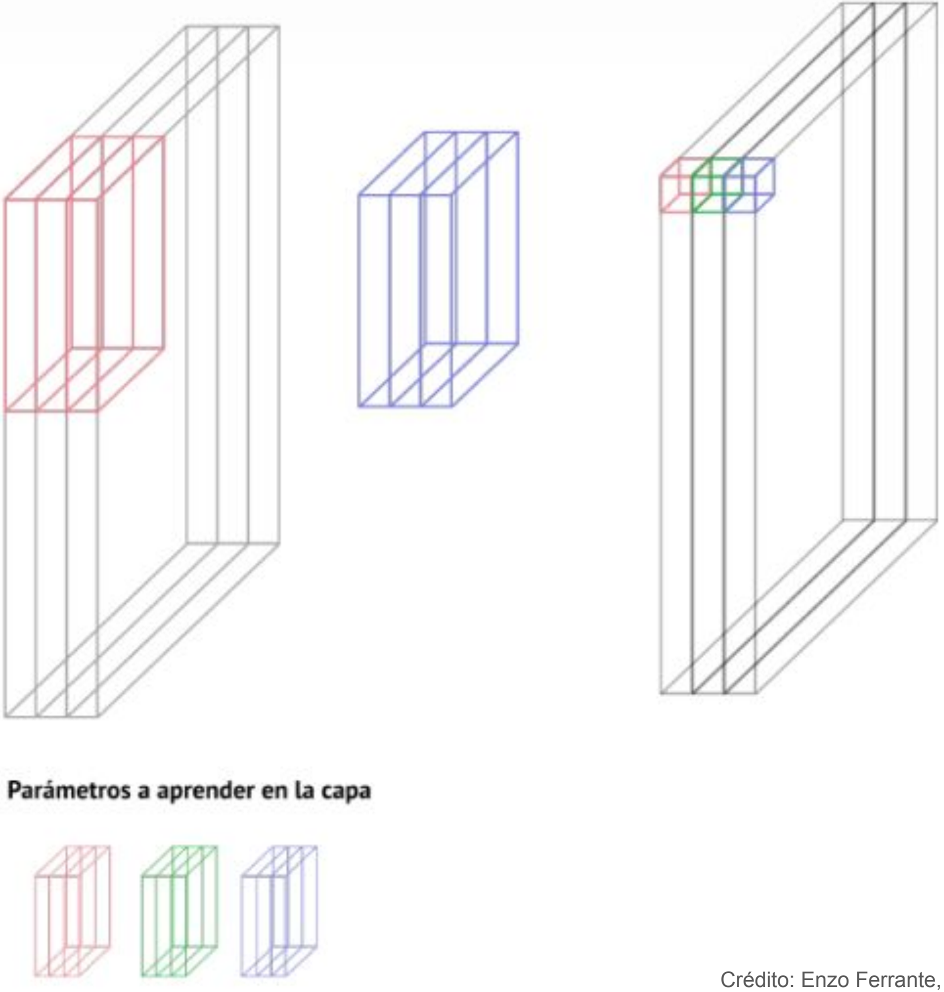

Input Channel #1 (Red)
Input Channel #2 (Green)
Input Channel #3 (Blue)
Kernel Channel #1
Kernel Channel #2
Kernel Channel #3
308
+
−498
+
164
+ 1 = −25
Bias = 1
Output
-25



Crédito: Enzo Ferrante, Curso de Aprendizaje Profundo Exactas-UBA



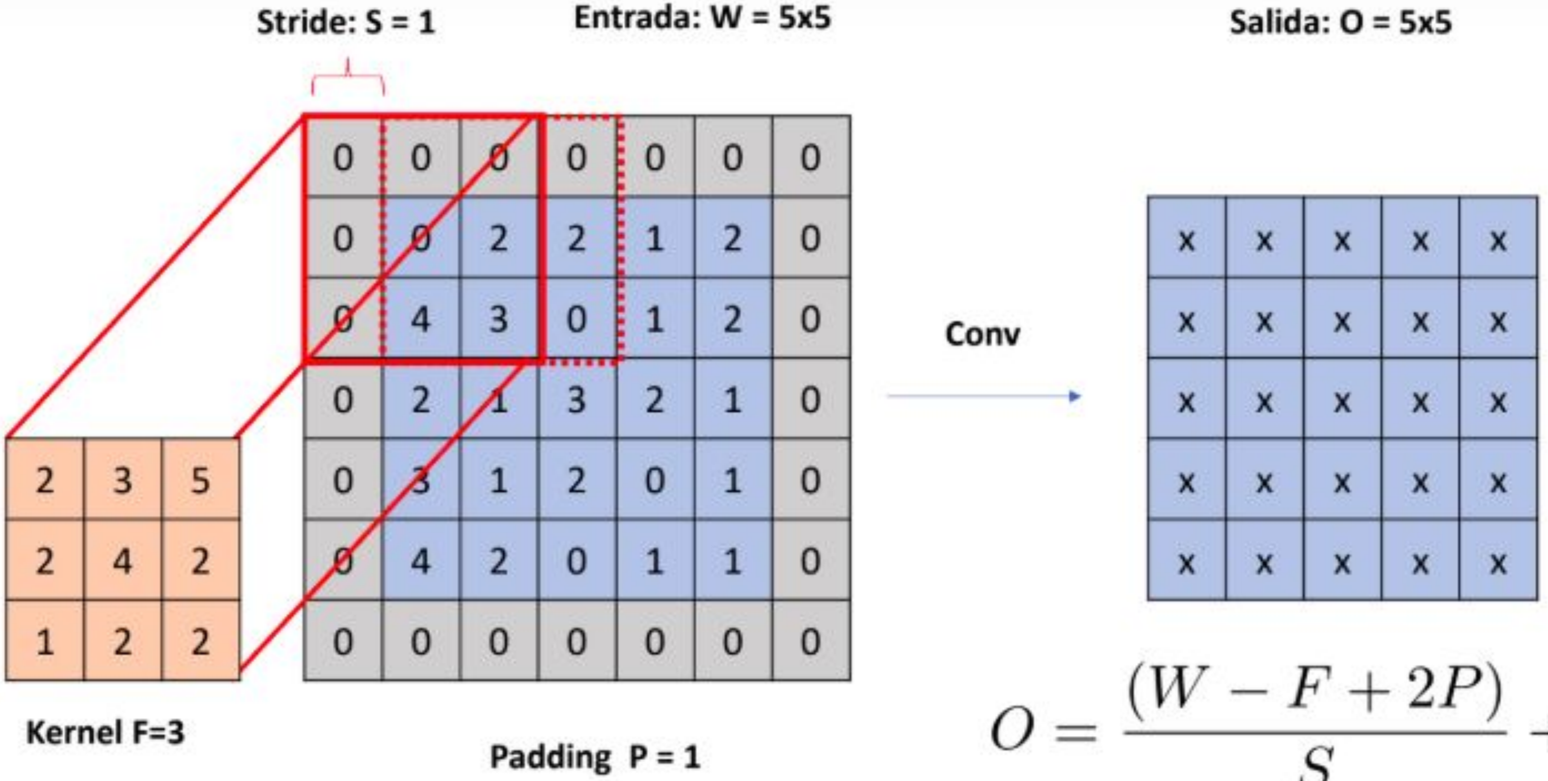
Crédito: Enzo Ferrante, Curso de Aprendizaje Profundo Exactas-UBA



Crédito: Enzo Ferrante, Curso de Aprendizaje Profundo Exactas-UBA

Hiperparámetros de una capa convolucional

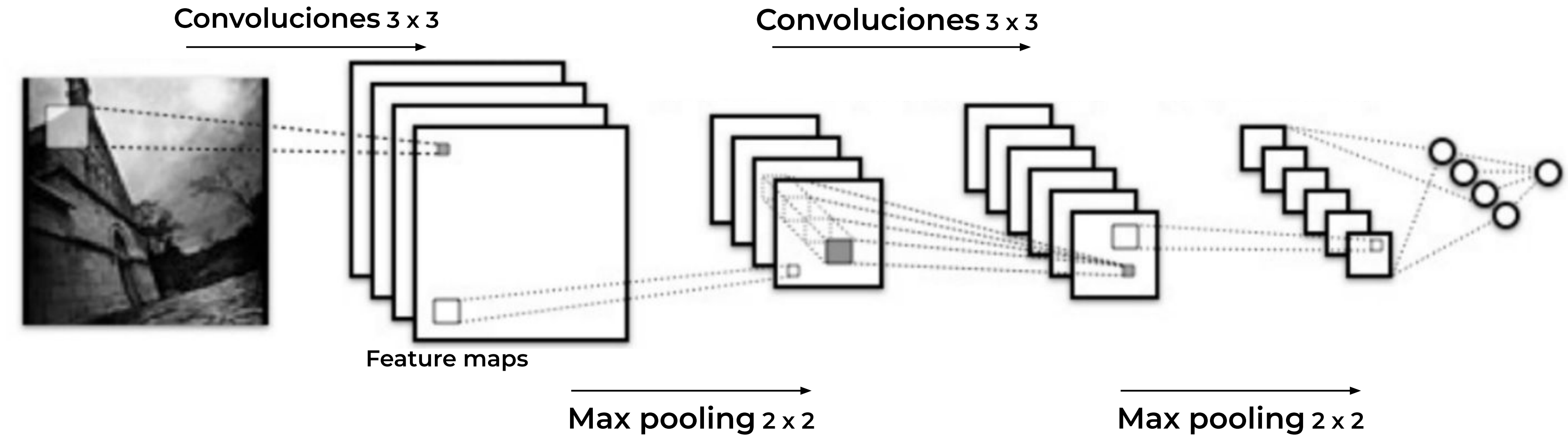
Relación entrada/salida

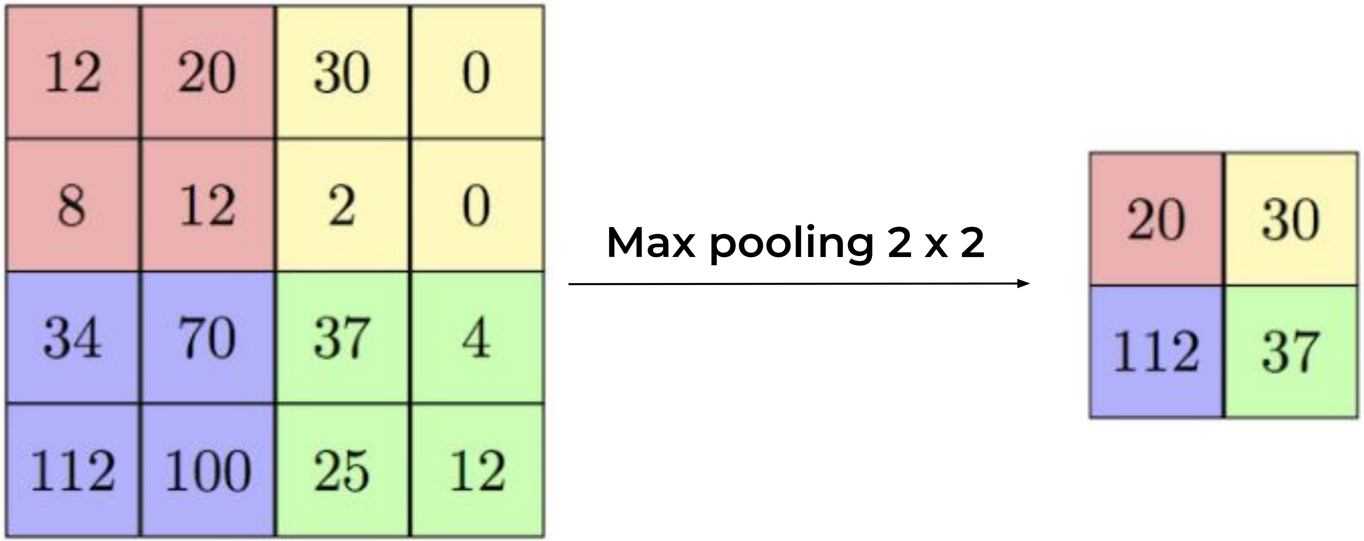


$$O = \frac{(W - F + 2P)}{S} + 1$$

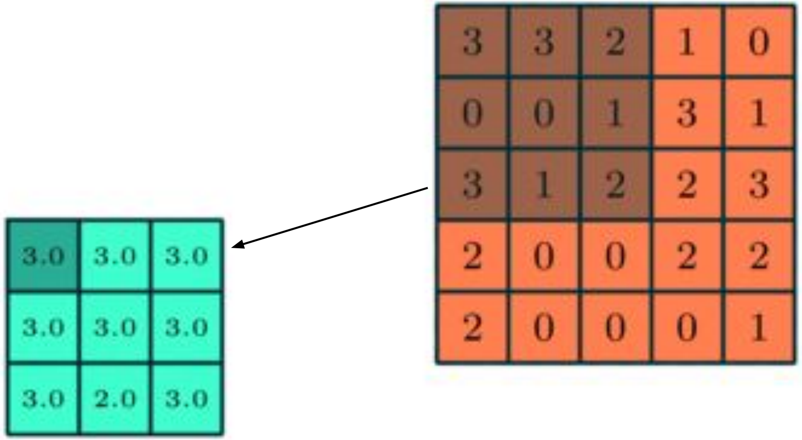
Crédito: Enzo Ferrante, Curso de Aprendizaje Profundo Exactas-UBA

Estructura de una CNN

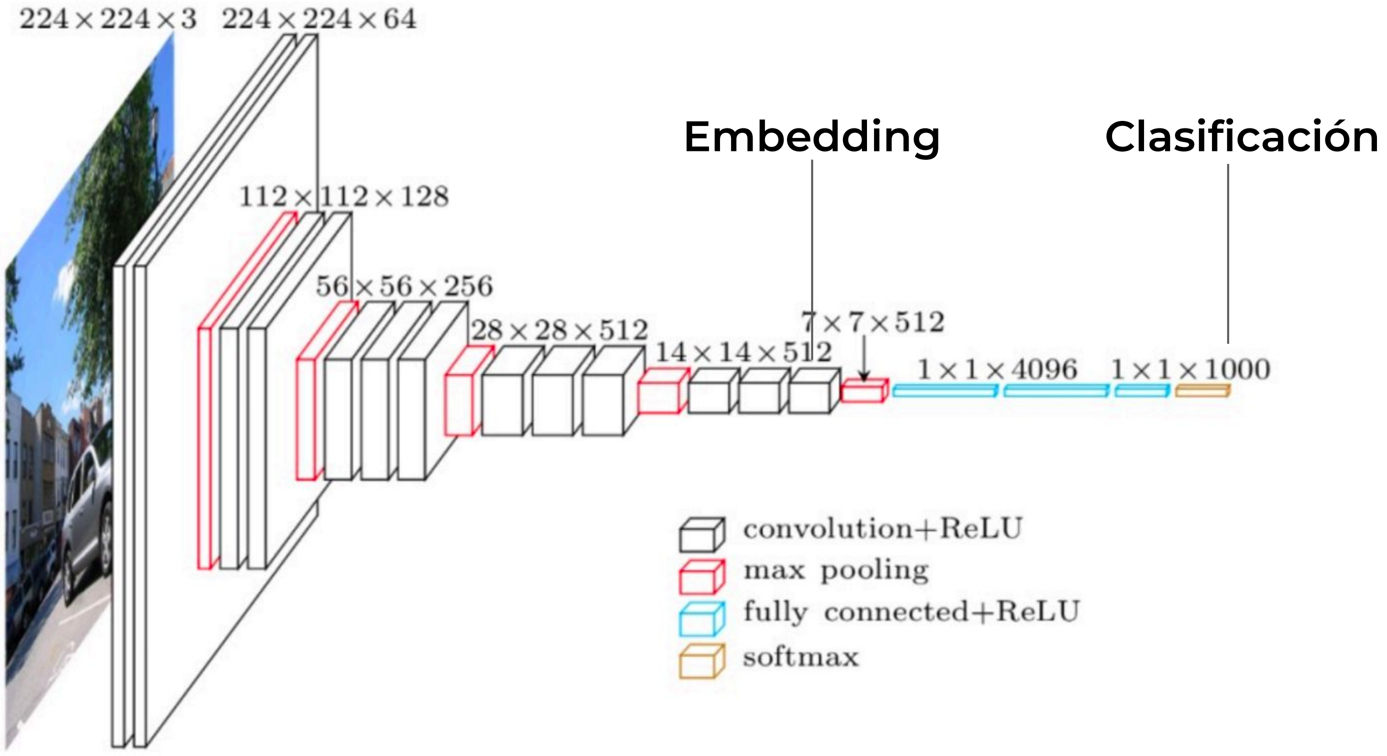



12 20 30 0
8 12 2 0
34 70 37 4
112 100 25 12
Max pooling 2 x 2
20 30
112 37

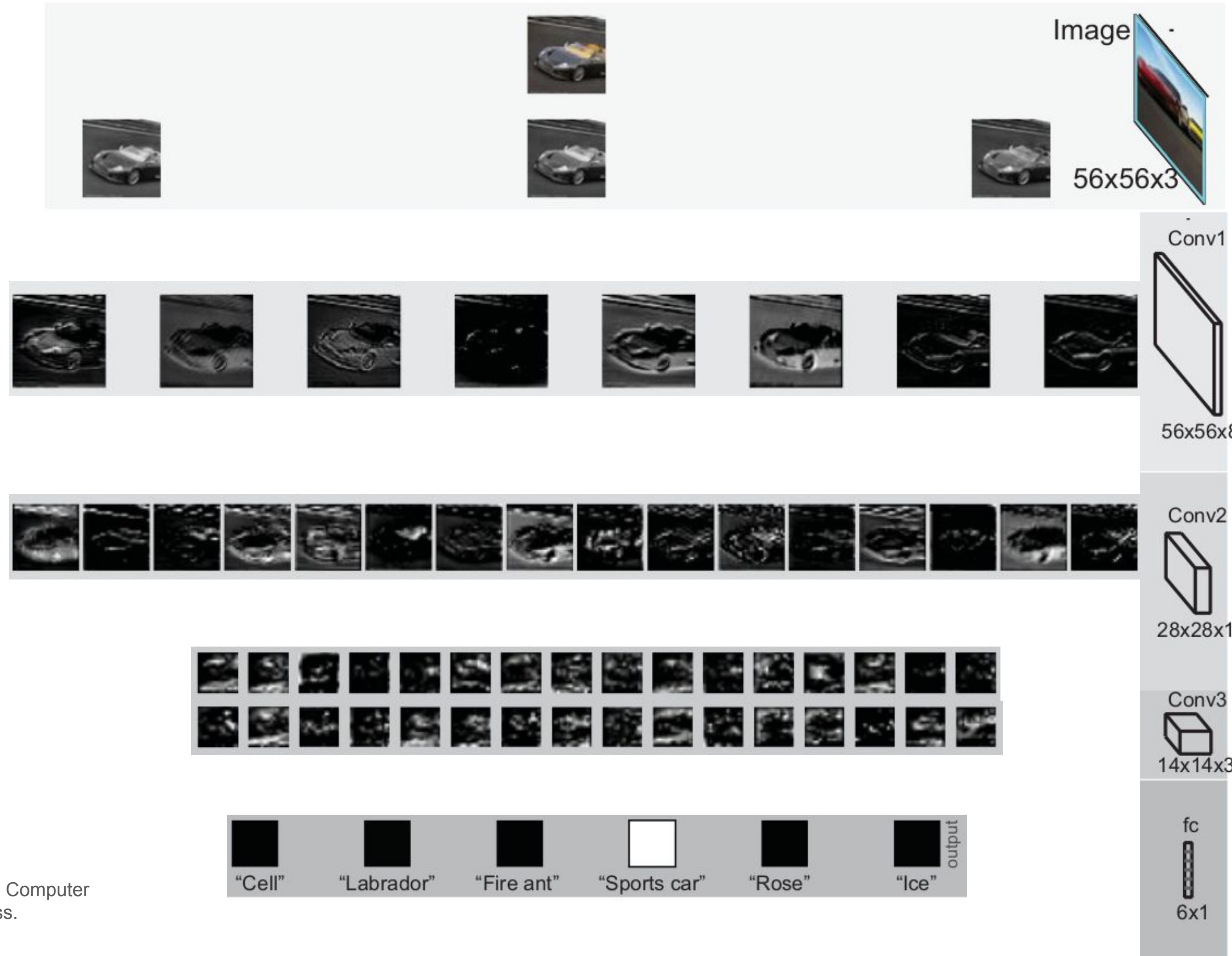
Max pooling



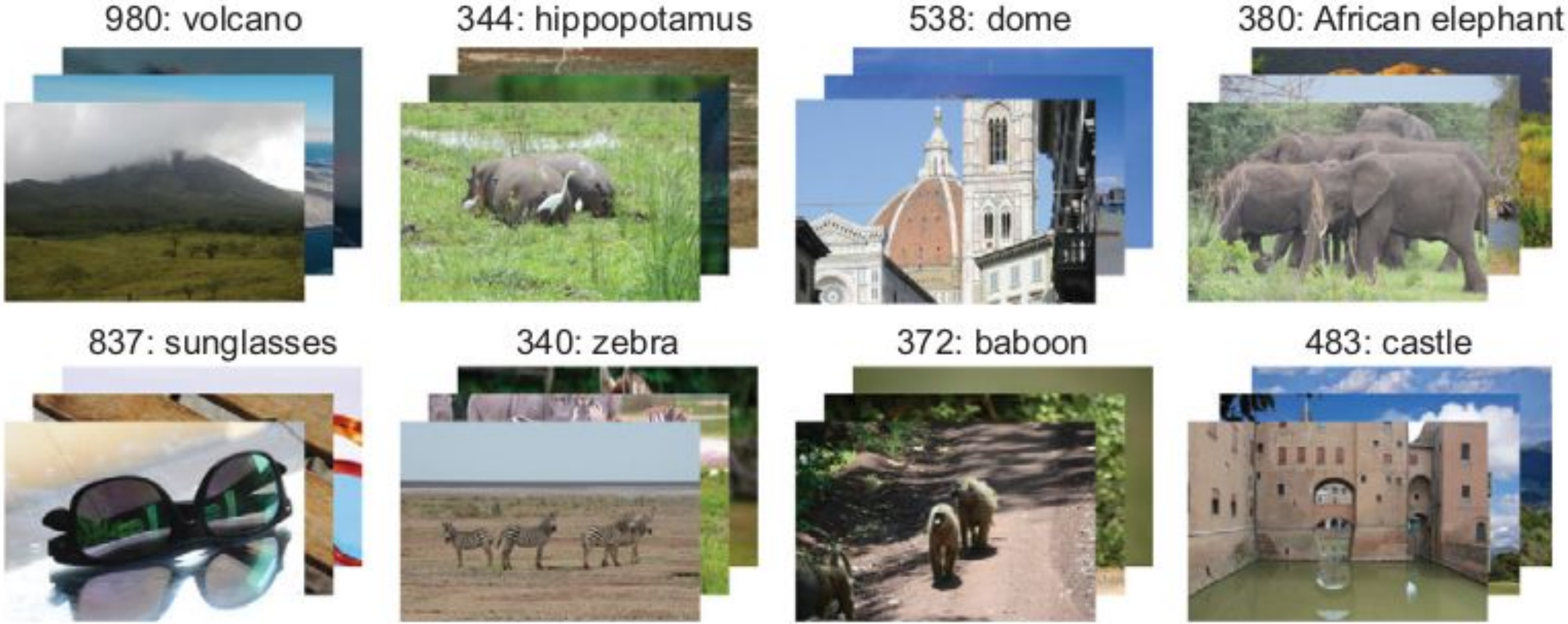
Arquitectura de VGG-16



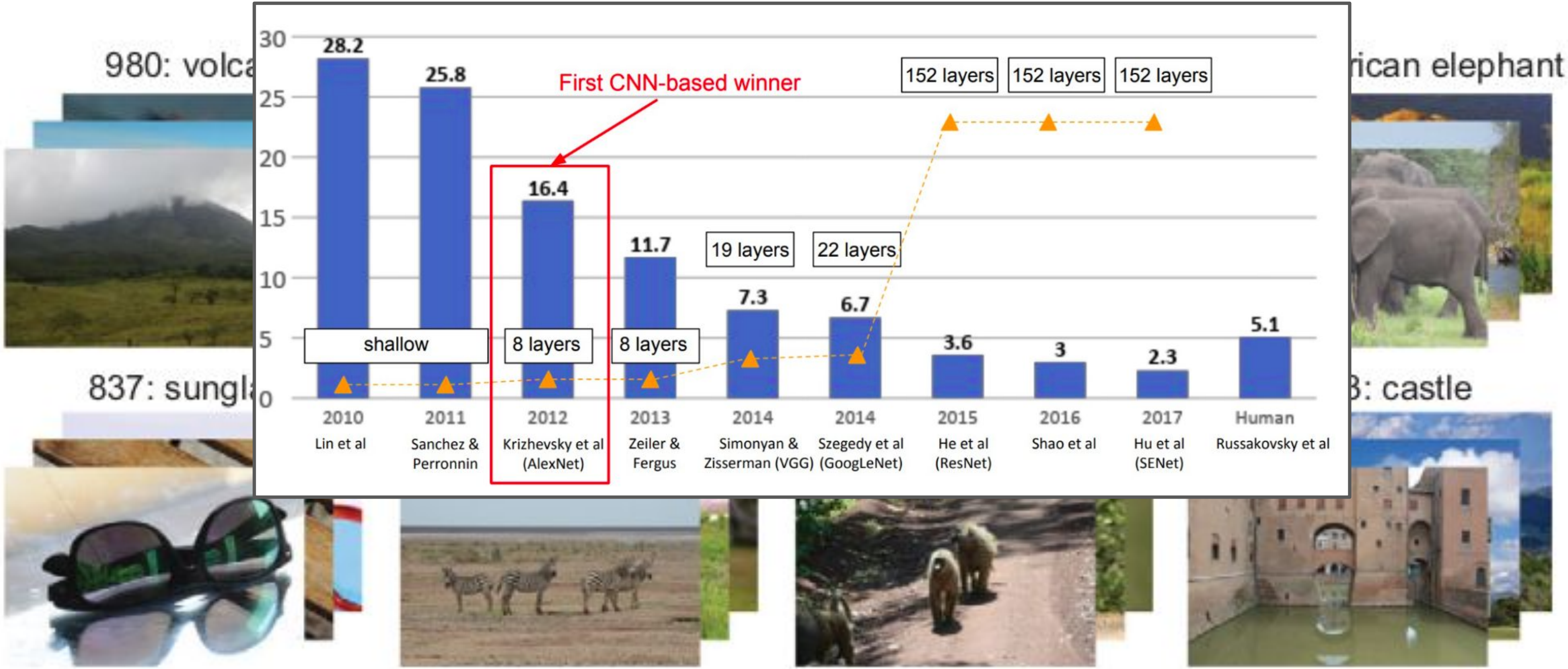
Simonyan K, Zisserman A. Very Deep Convolutional Networks for Large-Scale Image Recognition. 2015



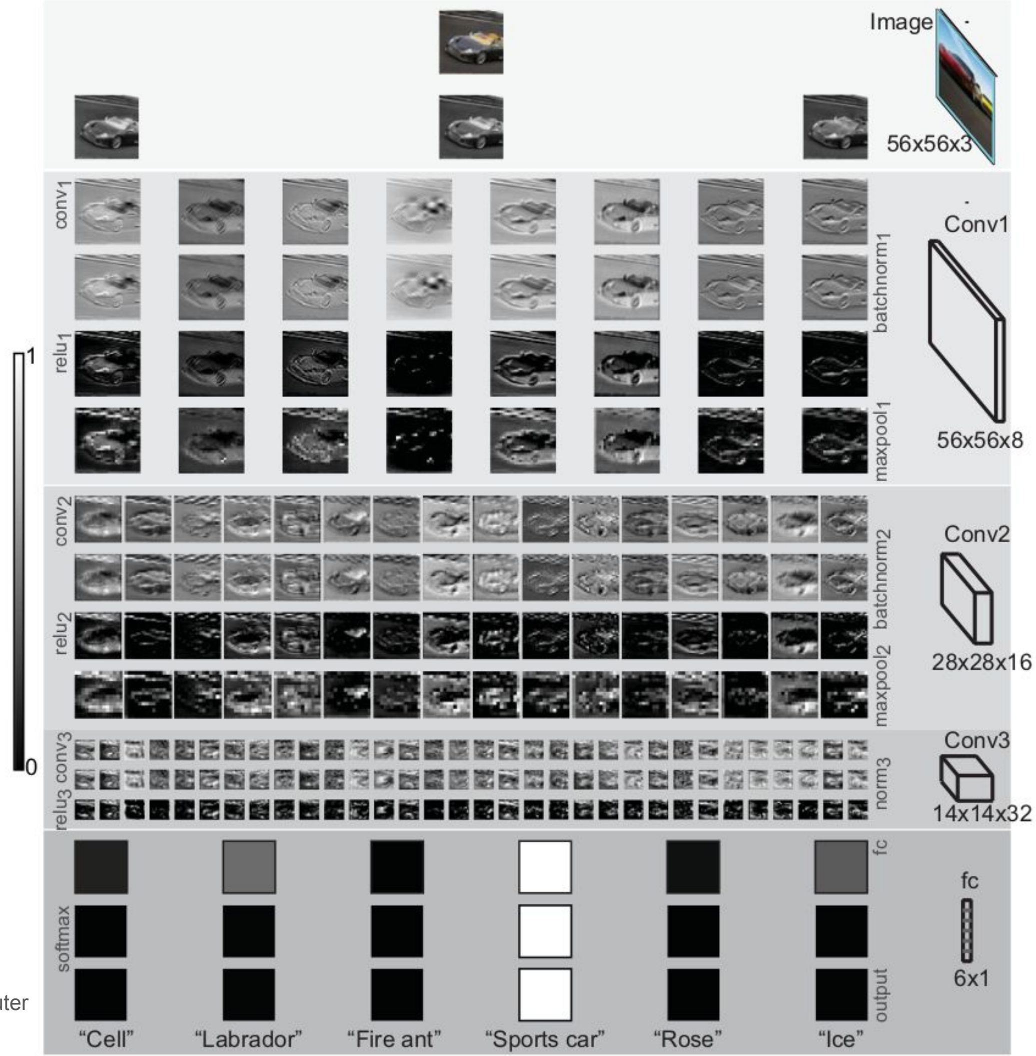
Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.



Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.



Kreiman, G. (2021) Biological and Computer Vision. Cambridge University Press.



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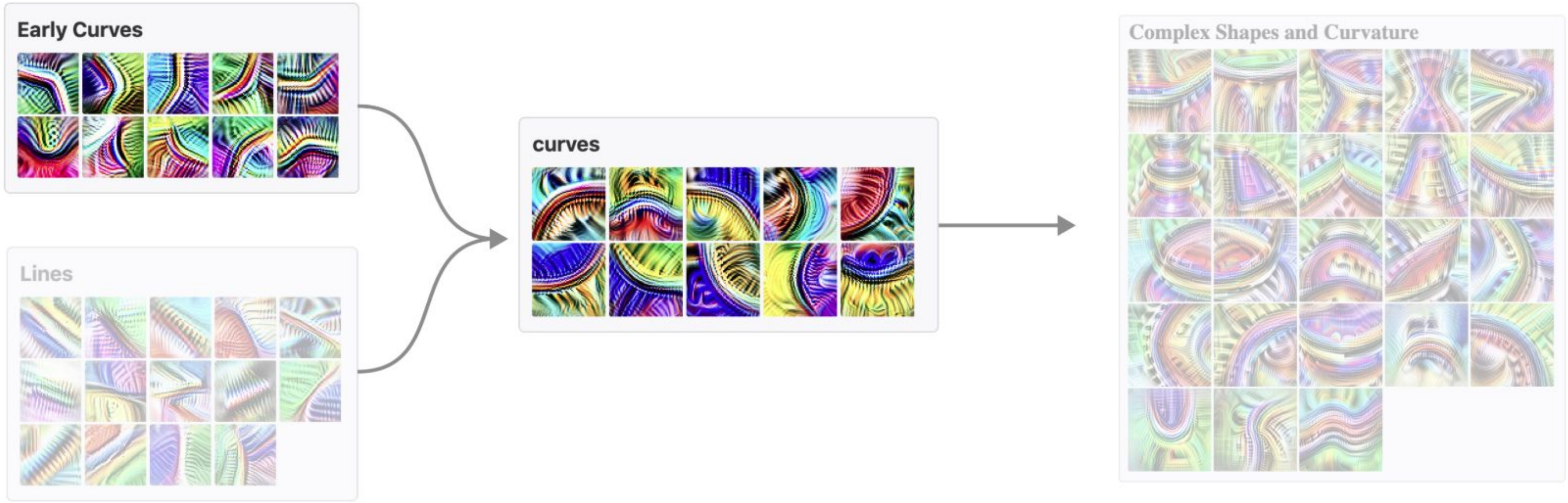
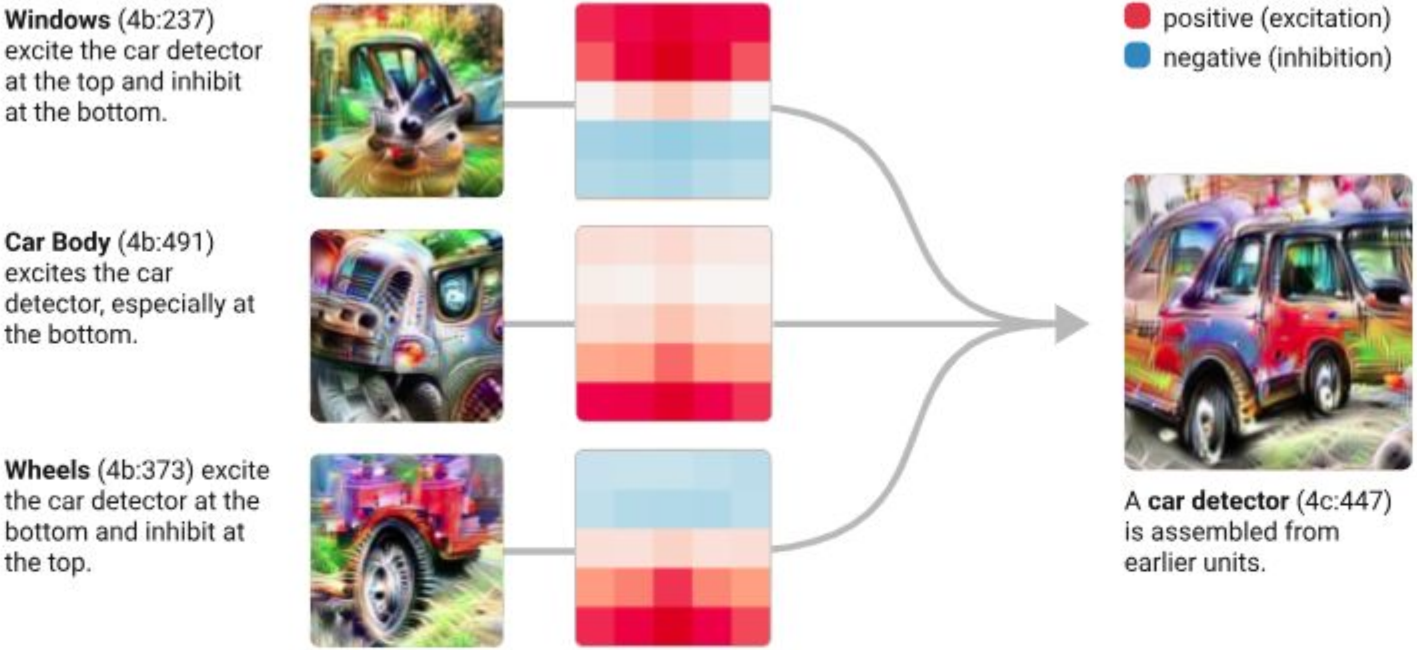


Chris Olah, et al. https://distill.pub/2020/circuits/zoom-in/



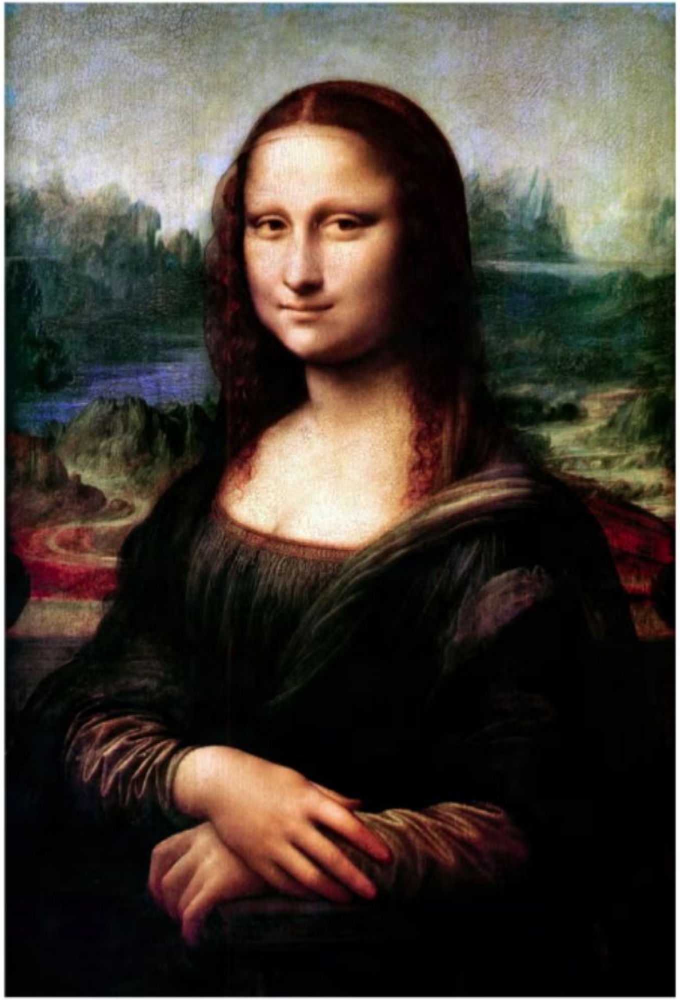
Chris Olah, et al. https://distill.pub/2020/circuits/zoom-in/

```python
import torch
import torch.nn as nn
import torch.nn.functional as F
from torchvision import datasets, transforms
from torch.utils.data import DataLoader

class CNN(nn.Module):
    def __init__(self):
        super().__init__()
        self.conv1 = nn.Conv2d(3, 32, 3, padding=1)
        self.conv2 = nn.Conv2d(32, 64, 3, padding=1)
        self.pool = nn.MaxPool2d(2)
        self.fc1 = nn.Linear(64 * 8 * 8, 128)
        self.fc2 = nn.Linear(128, 10)
    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(x.size(0), -1)
        x = F.relu(self.fc1(x))
        return self.fc2(x)

```

NORMAL test.py [+] utf-8 | unix | python 11% 6:1



Menor nivel de detalle

Alto nivel de detalle

Livingstone, Vision and Art, Abrams Press, 2002