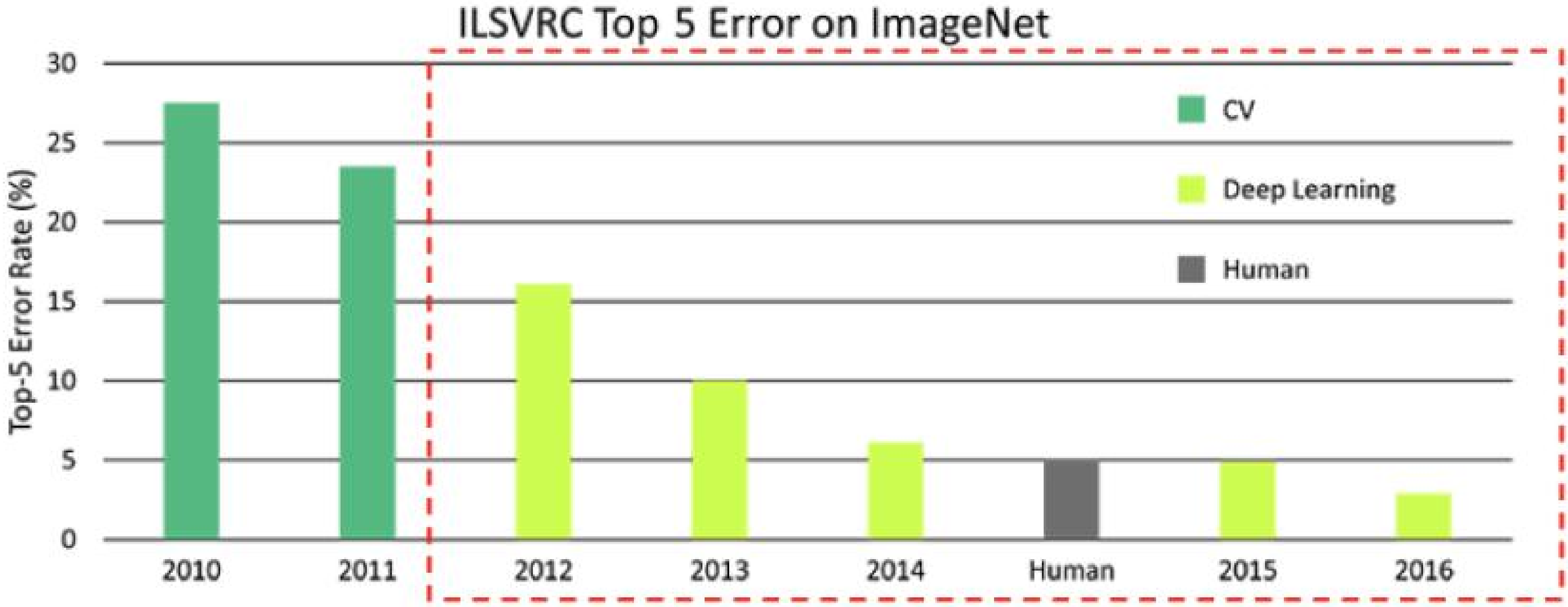
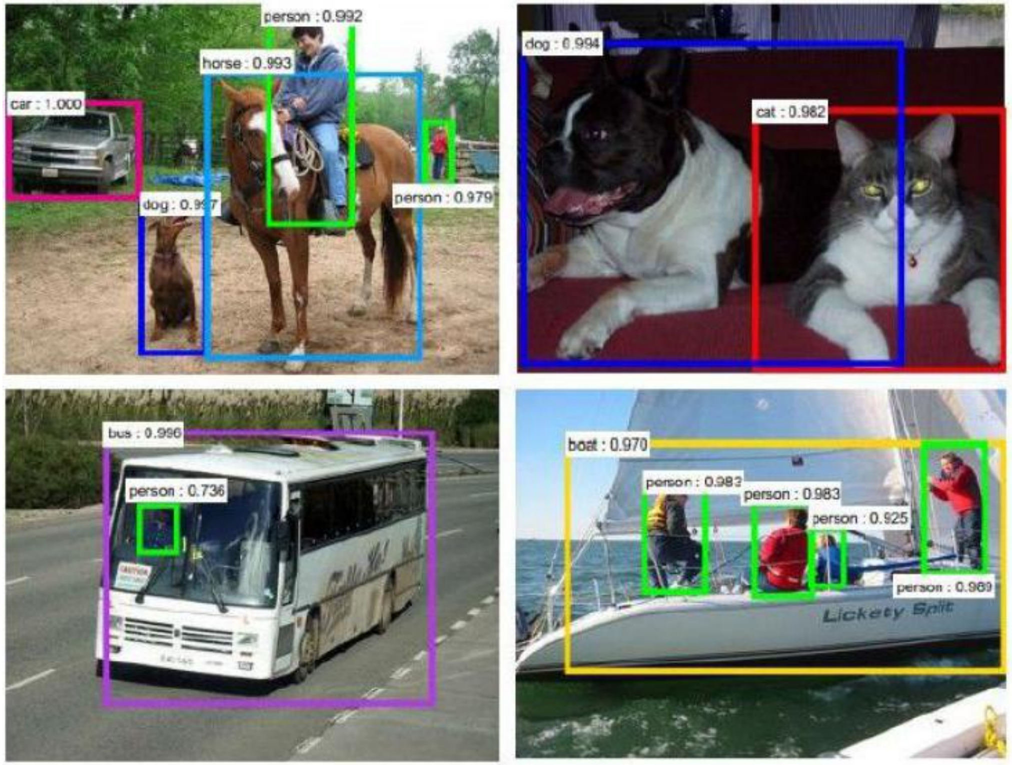
计算机视觉

- CV领域发展：

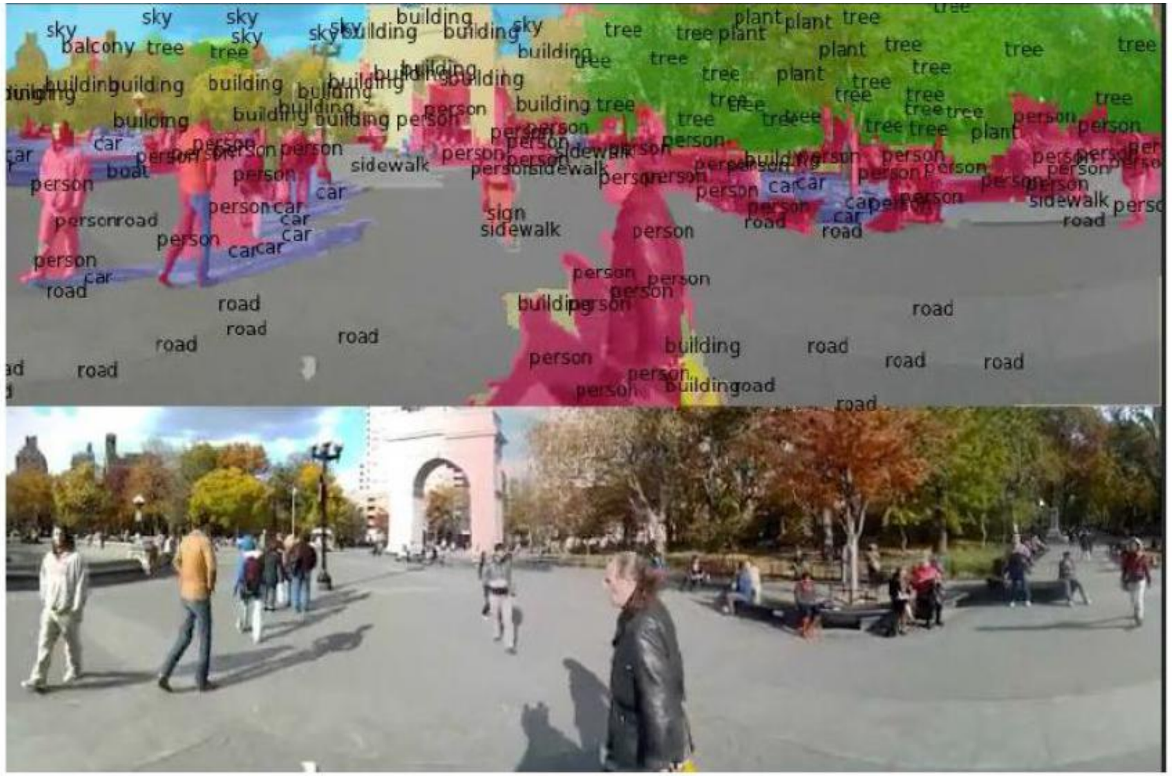


卷积神经网络:

检测任务:

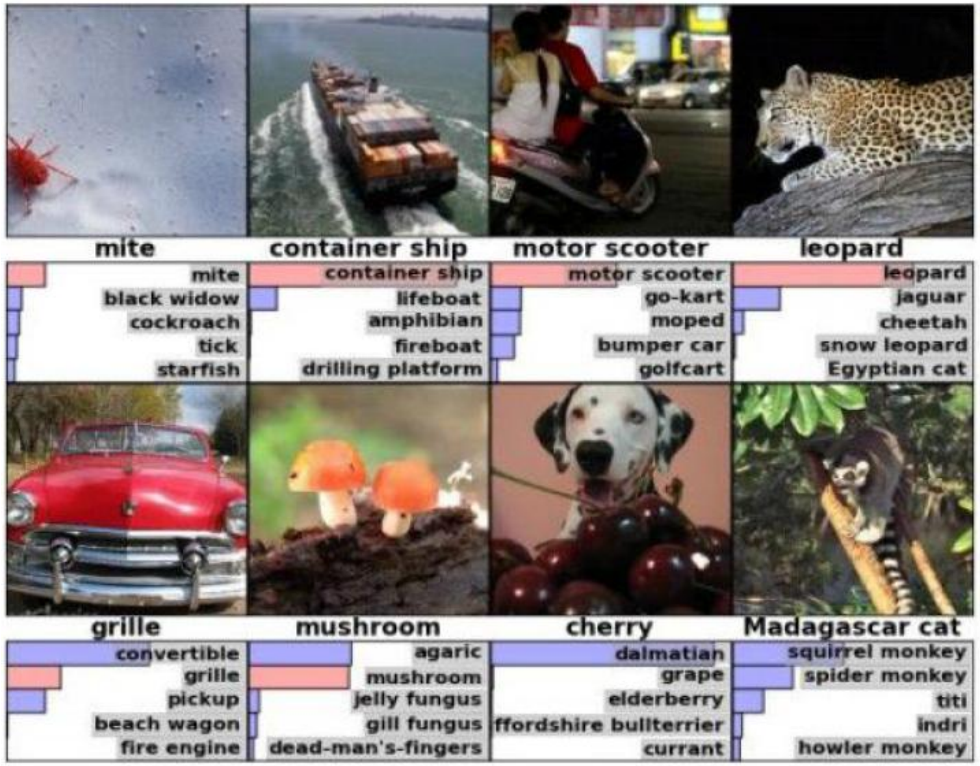


person : 0.992
horse : 0.993
car : 1.000
person : 0.979
dog : 0.994
cat : 0.982
bus : 0.996
person : 0.736
boat : 0.970
person : 0.983
person : 0.983
person : 0.925
person : 0.989
Lickety Split



卷积神经网络：

- 分类与检索：



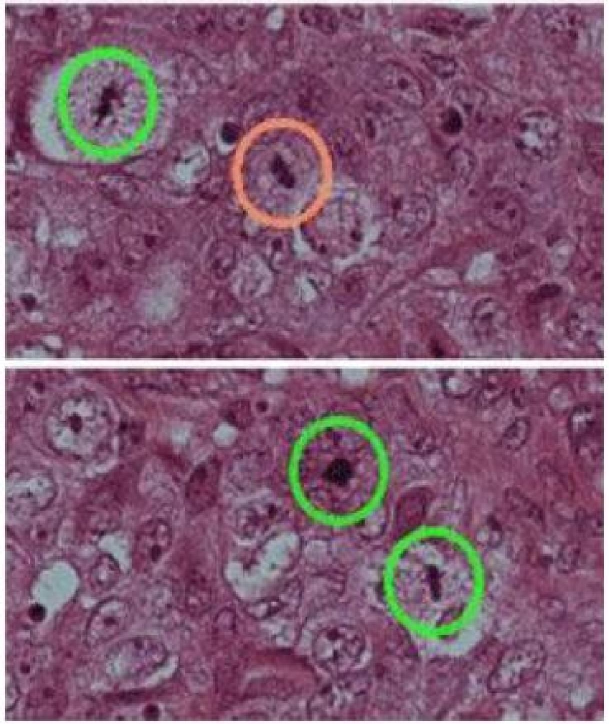
卷积神经网络：

- 超分辨率重构：

Inputs | Our result | SRGAN result | Original

卷积神经网络：

- 医学任务等：



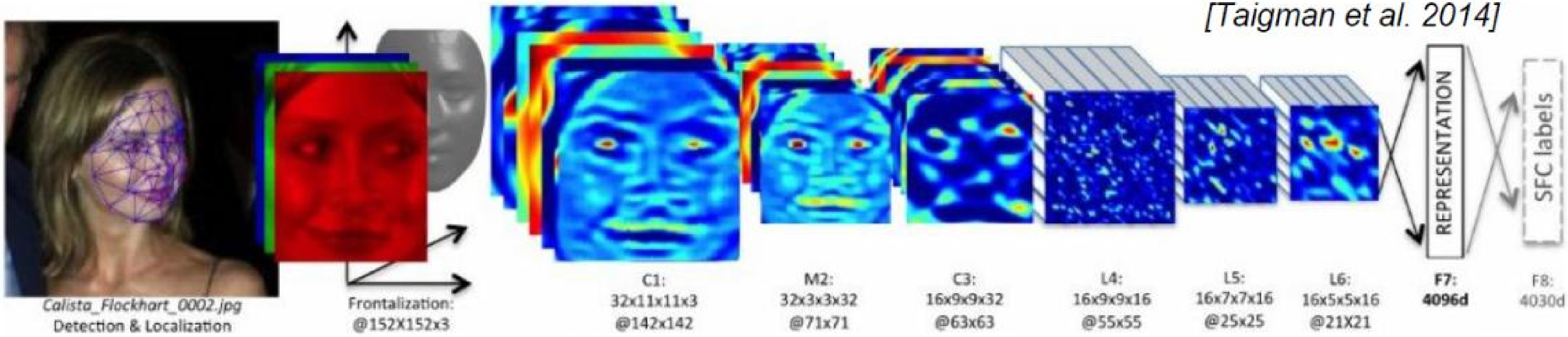
卷积神经网络：

✓ 无人驾驶：

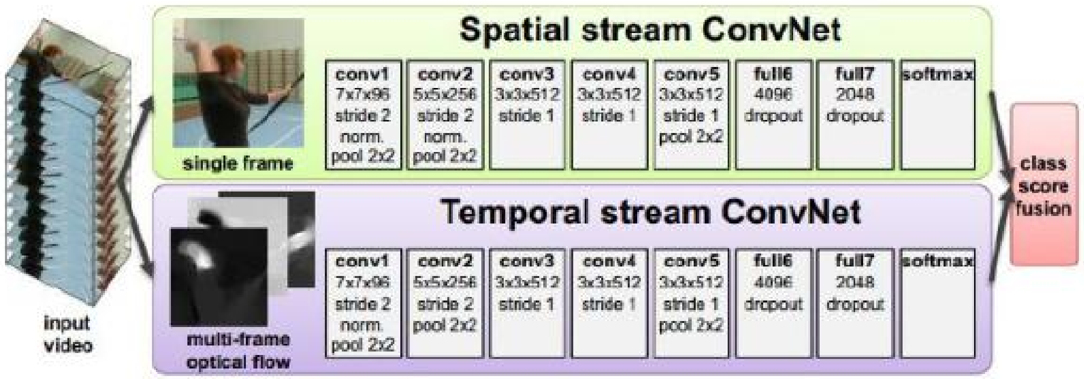
NVIDIA Tegra X1

卷积神经网络：

- 人脸识别：



[Taigman et al. 2014]

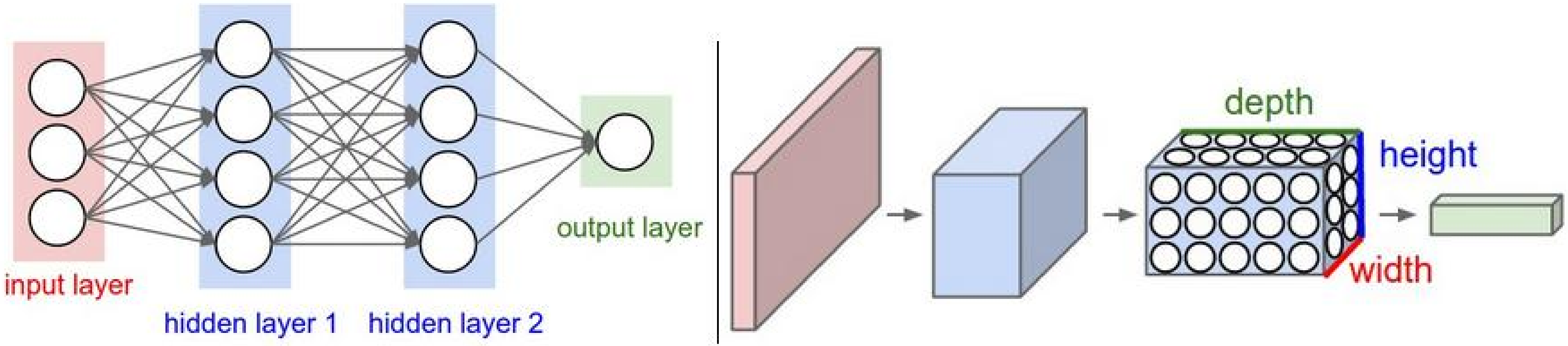


[Simonyan et al. 2014]

[Goodfellow 2014]

卷积神经网络：

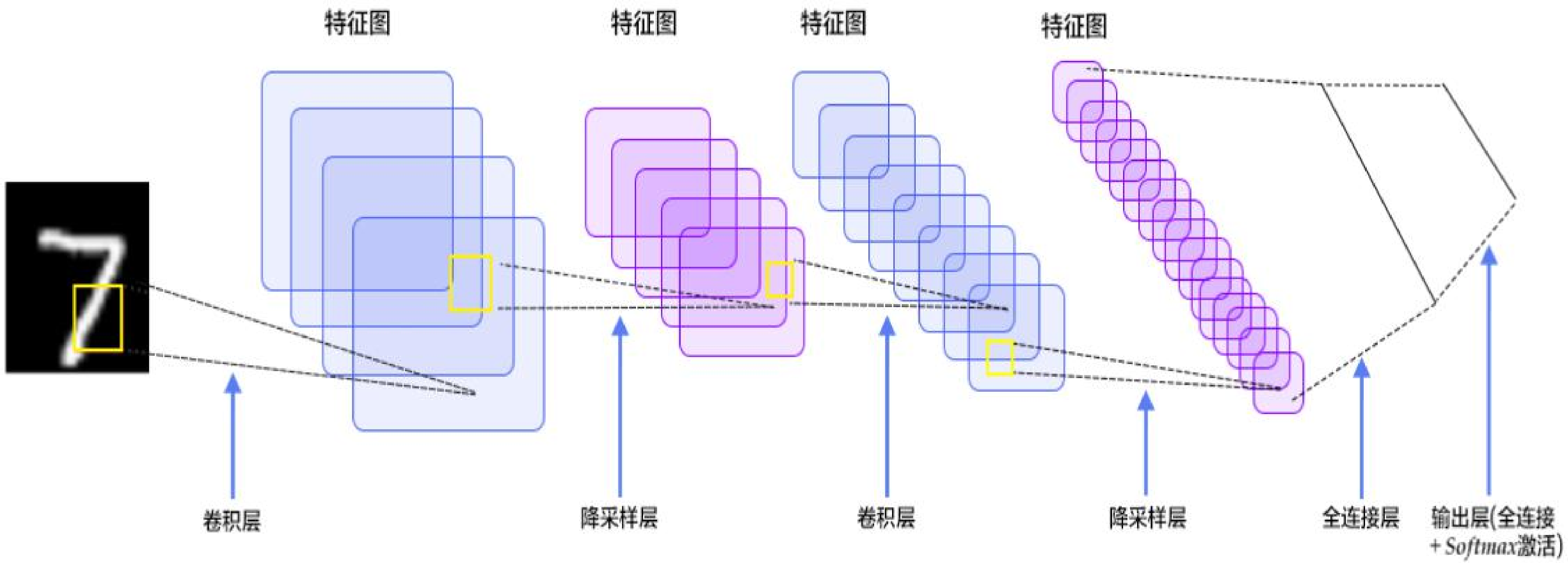
✓ 卷积网络与传统网络的区别：



卷积神经网络：

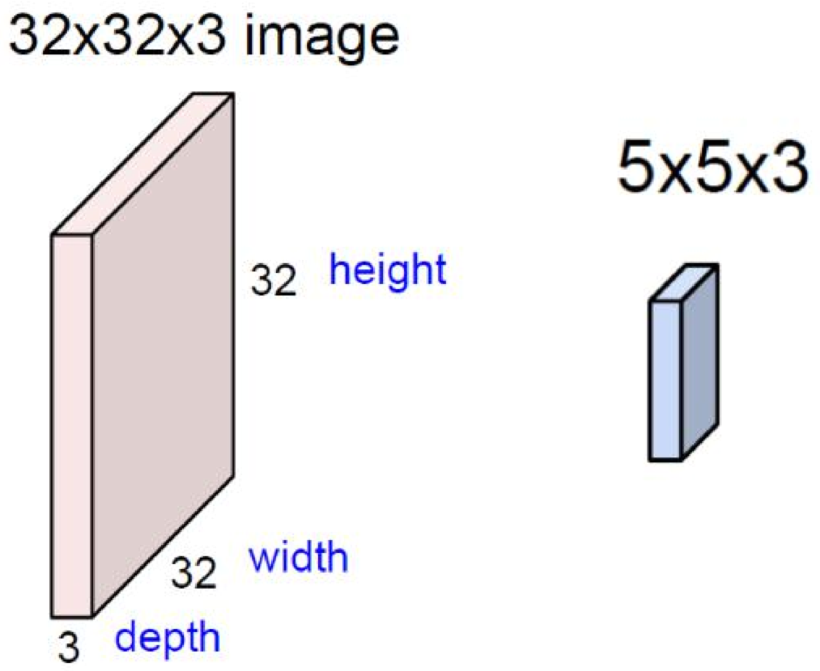
- 整体架构：

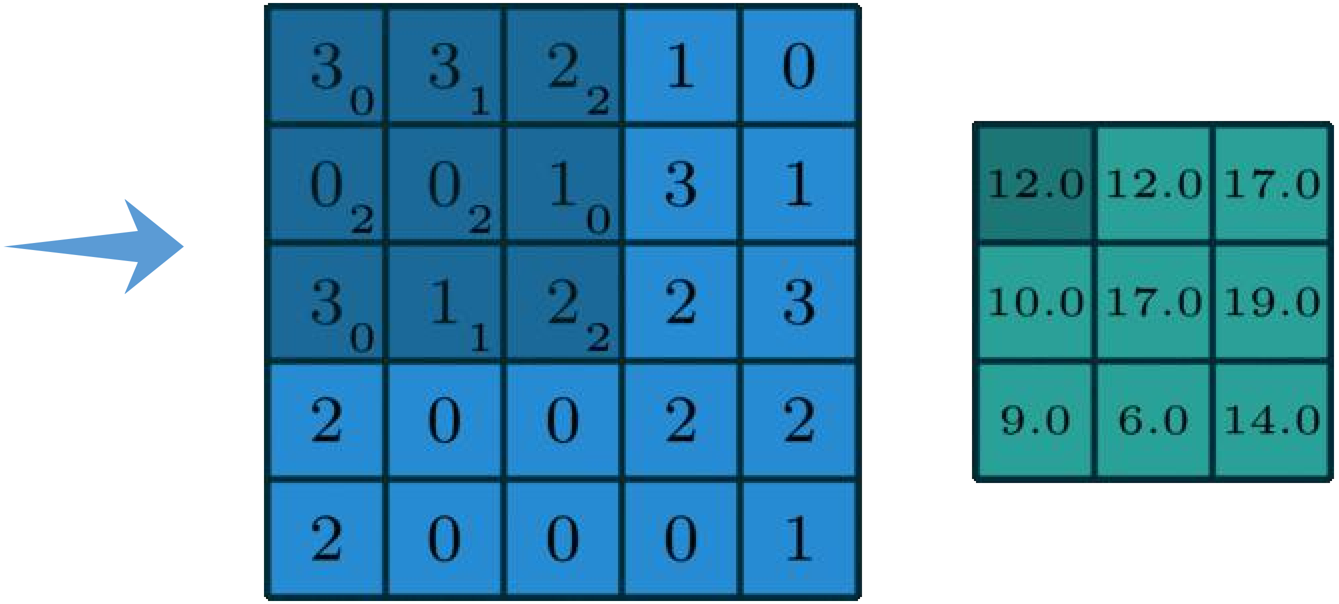
- 输入层
- 卷积层
- 池化层
- 全连接层



卷积神经网络：

- 卷积做了一件什么事？





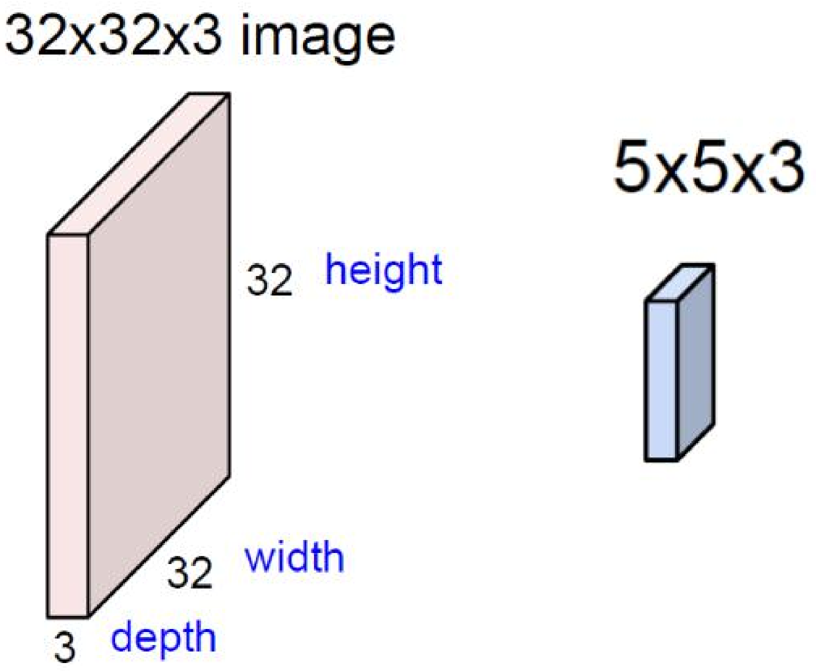
卷积神经网络：

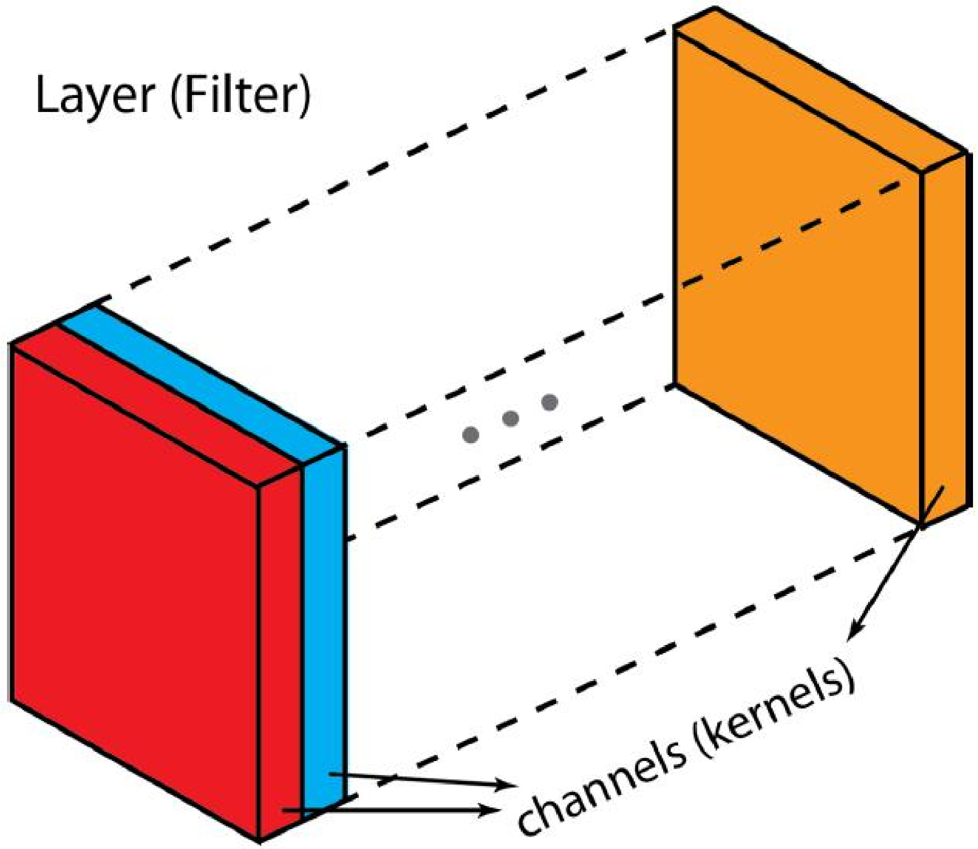
- 图像颜色通道

Original image (RGB) R channel G channel B channel

卷积神经网络：

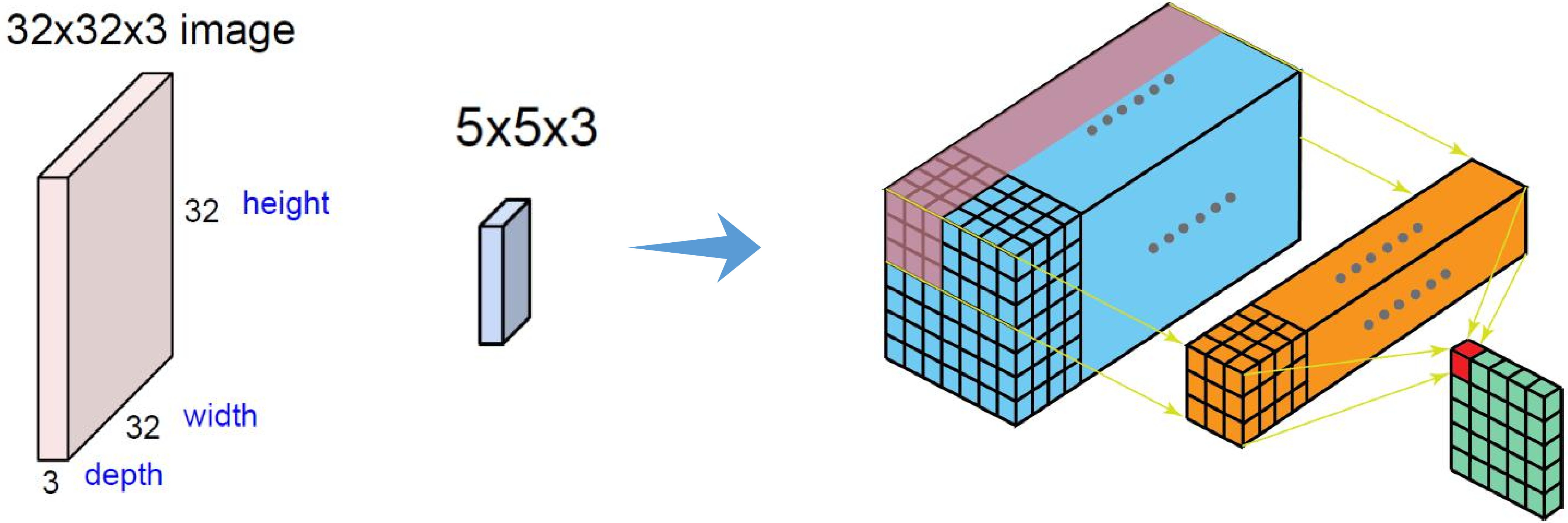
- ✓ 卷积做了一件什么事？





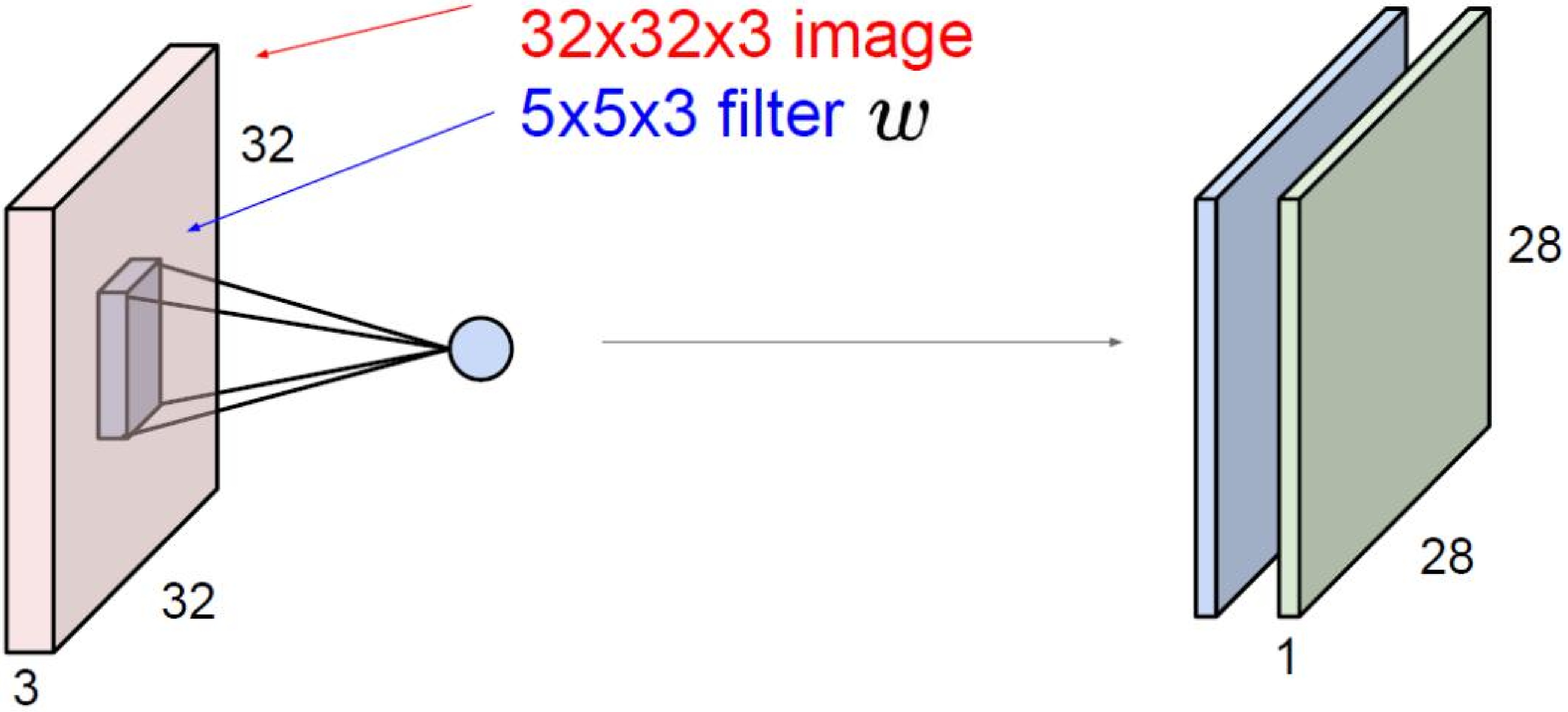
卷积神经网络：

- 卷积做了一件什么事?



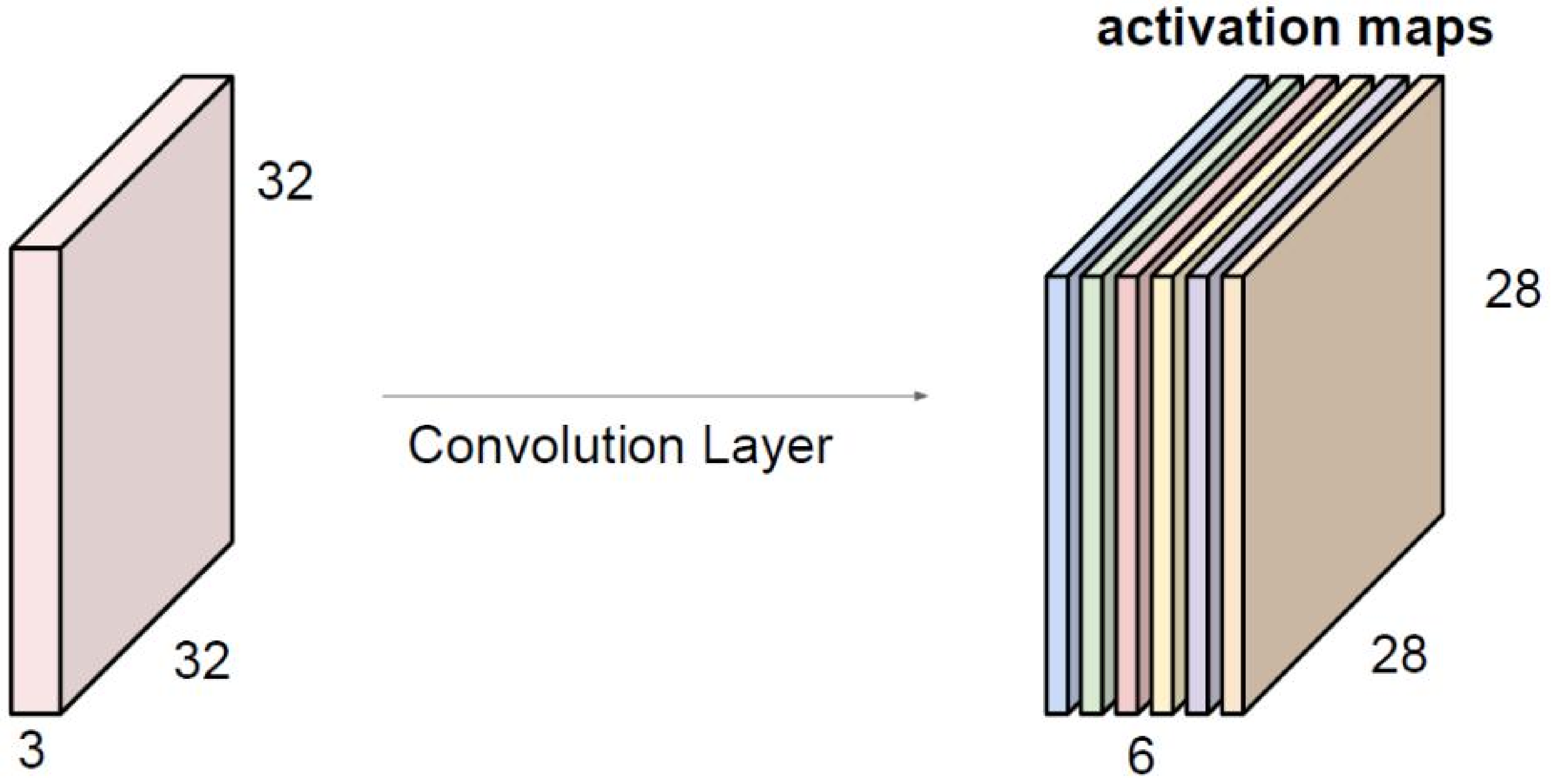
卷积神经网络：

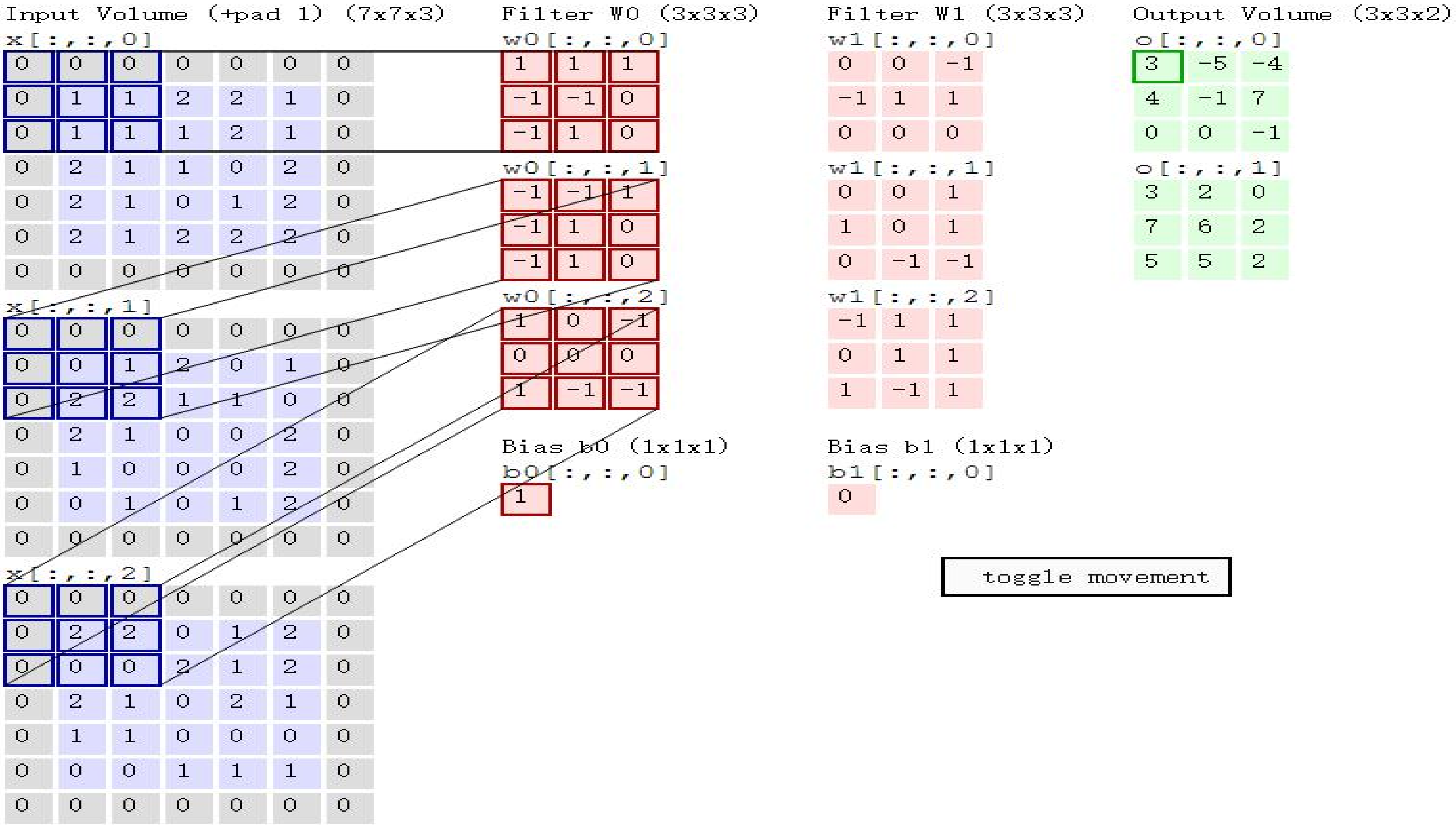
- 特征图个数

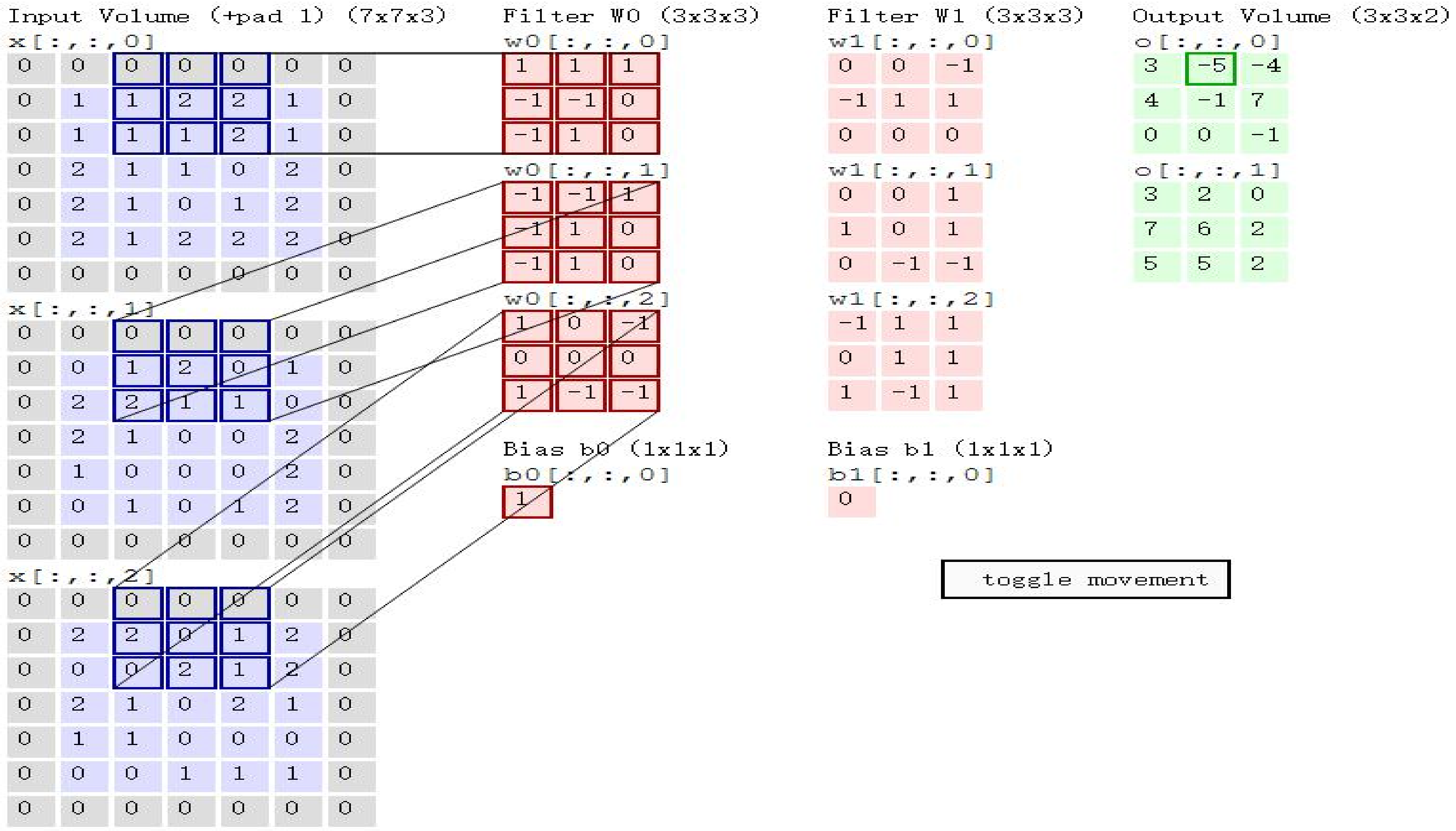


卷积神经网络：

- 特征图个数




Input Volume (+pad 1) (7x7x3)
x[:,:,0]
0 0 0 0 0 0 0
0 1 1 2 2 1 0
0 1 1 1 2 1 0
0 2 1 1 0 2 0
0 2 1 0 1 2 0
0 2 1 2 2 2 0
0 0 0 0 0 0 0
x[:,:,1]
0 0 0 0 0 0 0
0 0 1 2 0 1 0
0 2 2 1 1 0 0
0 2 1 0 0 2 0
0 1 0 0 0 2 0
0 0 1 0 1 2 0
0 0 0 0 0 0 0
x[:,:,2]
0 0 0 0 0 0 0
0 2 2 0 1 2 0
0 0 0 2 1 2 0
0 2 1 0 2 1 0
0 1 1 0 0 0 0
0 0 0 1 1 1 0
0 0 0 0 0 0 0
Filter W0 (3x3x3)
w0[:,:,0]
1 1 1
-1 -1 0
-1 1 0
w0[:,:,1]
-1 -1 1
-1 1 0
-1 1 0
w0[:,:,2]
1 0 -1
0 0 0
1 -1 -1
Bias b0 (1x1x1)
b0[:,:,0]
1
Filter W1 (3x3x3)
w1[:,:,0]
0 0 -1
-1 1 1
0 0 0
w1[:,:,1]
0 0 1
1 0 1
0 -1 -1
w1[:,:,2]
-1 1 1
0 1 1
1 -1 1
Bias b1 (1x1x1)
b1[:,:,0]
0
Output Volume (3x3x2)
o[:,:,0]
3 -5 -4
4 -1 7
0 0 -1
o[:,:,1]
3 2 0
7 6 2
5 5 2
toggle movement



Input Volume (+pad 1) (7x7x3)
x[:,:,0]
0 0 0 0 0 0 0
0 1 1 2 2 1 0
0 1 1 1 2 1 0
0 2 1 1 0 2 0
0 2 1 0 1 2 0
0 2 1 2 2 2 0
0 0 0 0 0 0 0
x[:,:,1]
0 0 0 0 0 0 0
0 0 1 2 0 1 0
0 2 2 1 1 0 0
0 2 1 0 0 2 0
0 1 0 0 0 2 0
0 0 1 0 1 2 0
0 0 0 0 0 0 0
x[:,:,2]
0 0 0 0 0 0 0
0 2 2 0 1 2 0
0 0 0 2 1 2 0
0 2 1 0 2 1 0
0 1 1 0 0 0 0
0 0 0 1 1 1 0
0 0 0 0 0 0 0
Filter W0 (3x3x3)
w0[:,:,0]
1 1 1
-1 -1 0
-1 1 0
w0[:,:,1]
-1 -1 1
-1 1 0
-1 1 0
w0[:,:,2]
1 0 -1
0 0 0
1 -1 -1
Bias b0 (1x1x1)
b0[:,:,0]
1
Filter W1 (3x3x3)
w1[:,:,0]
0 0 -1
-1 1 1
0 0 0
w1[:,:,1]
0 0 1
1 0 1
0 -1 -1
w1[:,:,2]
-1 1 1
0 1 1
1 -1 1
Bias b1 (1x1x1)
b1[:,:,0]
0
Output Volume (3x3x2)
o[:,:,0]
3 -5 -4
4 -1 7
0 0 -1
o[:,:,1]
3 2 0
7 6 2
5 5 2
toggle movement

Input Volume (+pad 1) (7x7x3)

x[:,:,0]

0	0	0	0	0	0	0
0	1	1	2	2	1	0
0	1	1	1	2	1	0
0	2	1	1	0	2	0
0	2	1	0	1	2	0
0	2	1	2	2	2	0
0	0	0	0	0	0	0

x[:,:,1]

0	0	0	0	0	0	0
0	0	1	2	0	1	0
0	2	2	1	1	0	0
0	2	1	0	0	2	0
0	1	0	0	0	2	0
0	0	1	0	1	2	0
0	0	0	0	0	0	0

x[:,:,2]

0	0	0	0	0	0	0
0	2	2	0	1	2	0
0	0	0	2	1	2	0
0	2	1	0	2	1	0
0	1	1	0	0	0	0
0	0	0	1	1	1	0
0	0	0	0	0	0	0

Filter W0 (3x3x3)

w0[:,:,0]

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

w0[:,:,1]

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

w0[:,:,2]

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

Bias b0 (1x1x1)

b0[:,:,0]

1

Filter W1 (3x3x3)

w1[:,:,0]

0	0	-1
-1	1	1
0	0	0

w1[:,:,1]

0	0	1
1	0	1
0	-1	-1

w1[:,:,2]

-1	1	1
0	1	1
1	-1	1

Bias b1 (1x1x1)

b1[:,:,0]

0

Output Volume (3x3x2)

o[:,:,0]

3	-5	-4
4	-1	7
0	0	-1

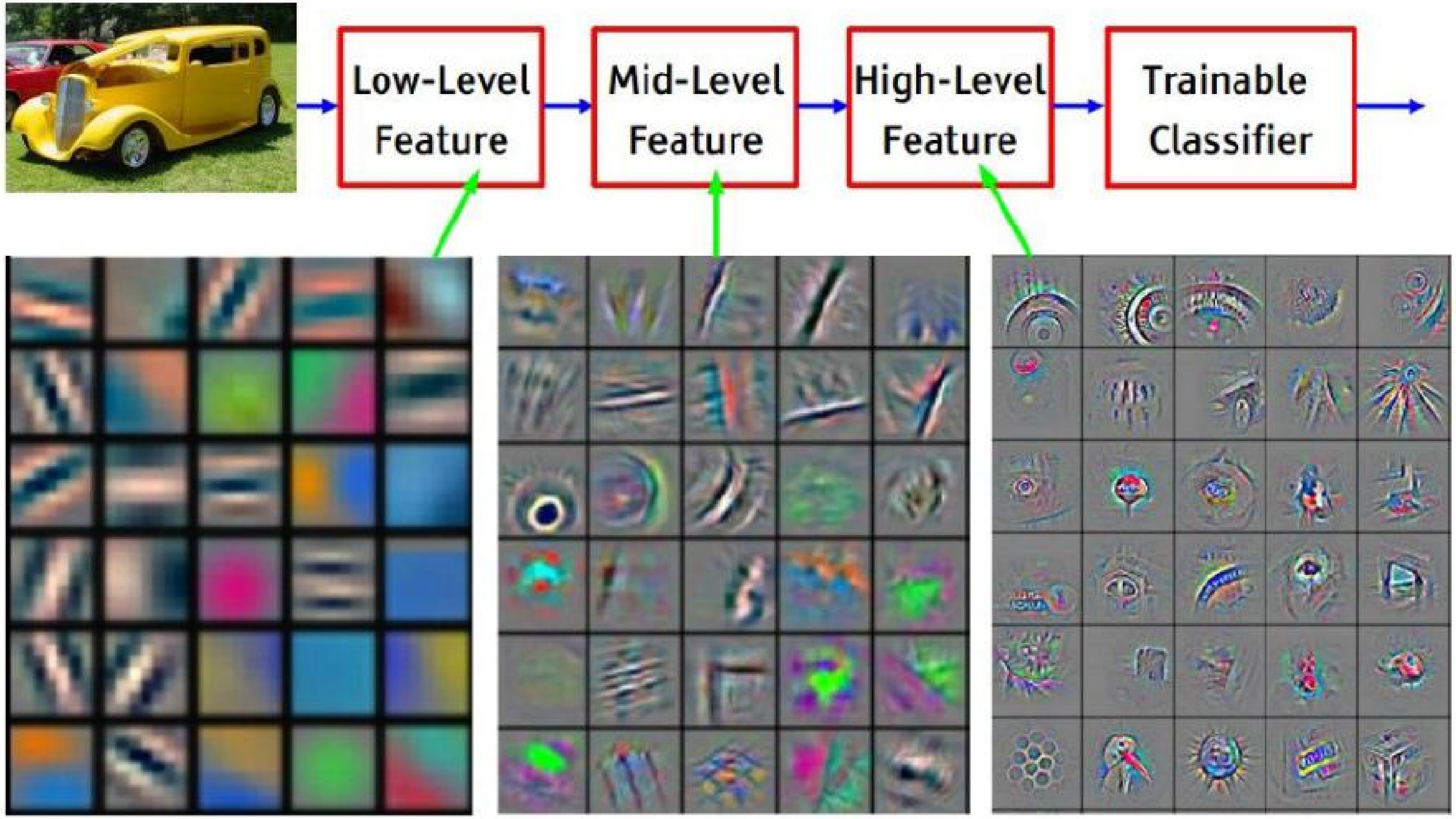
o[:,:,1]

3	2	0
7	6	2
5	5	2

toggle movement

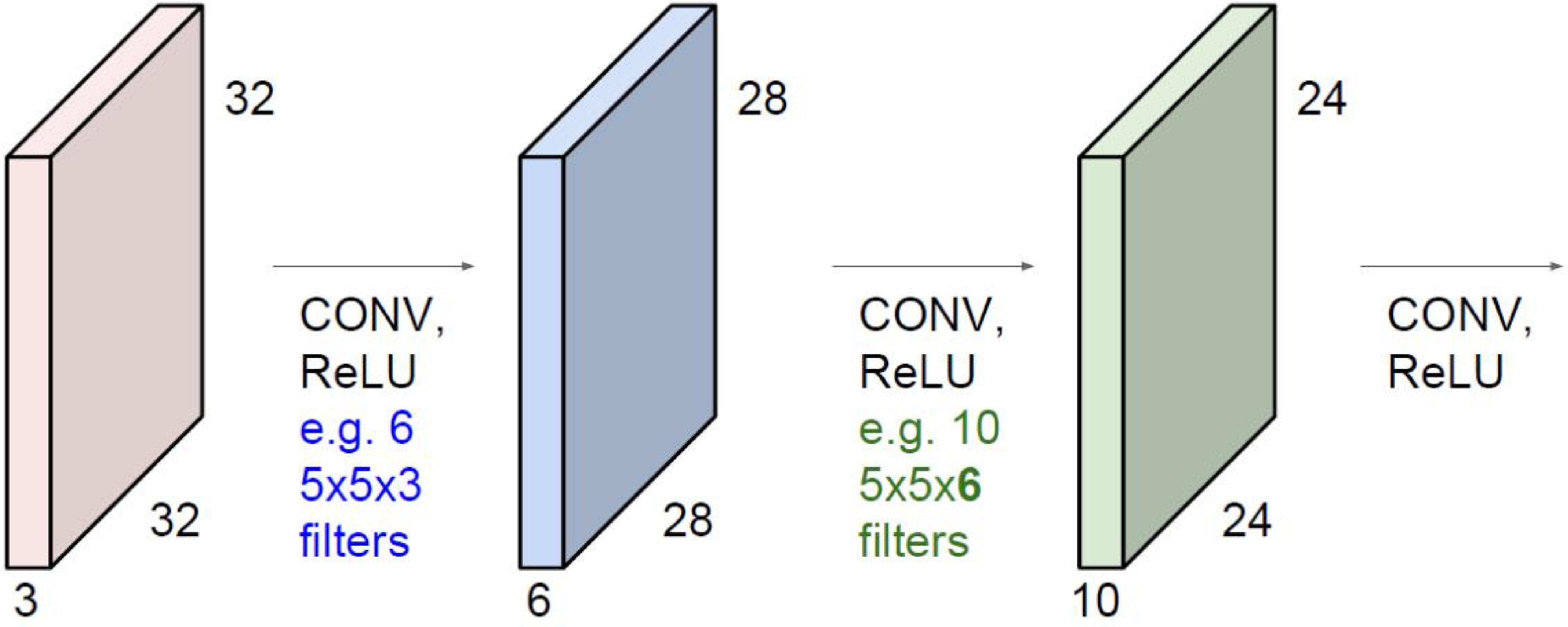
卷积神经网络：

- 只做一次卷积就可以了吗？



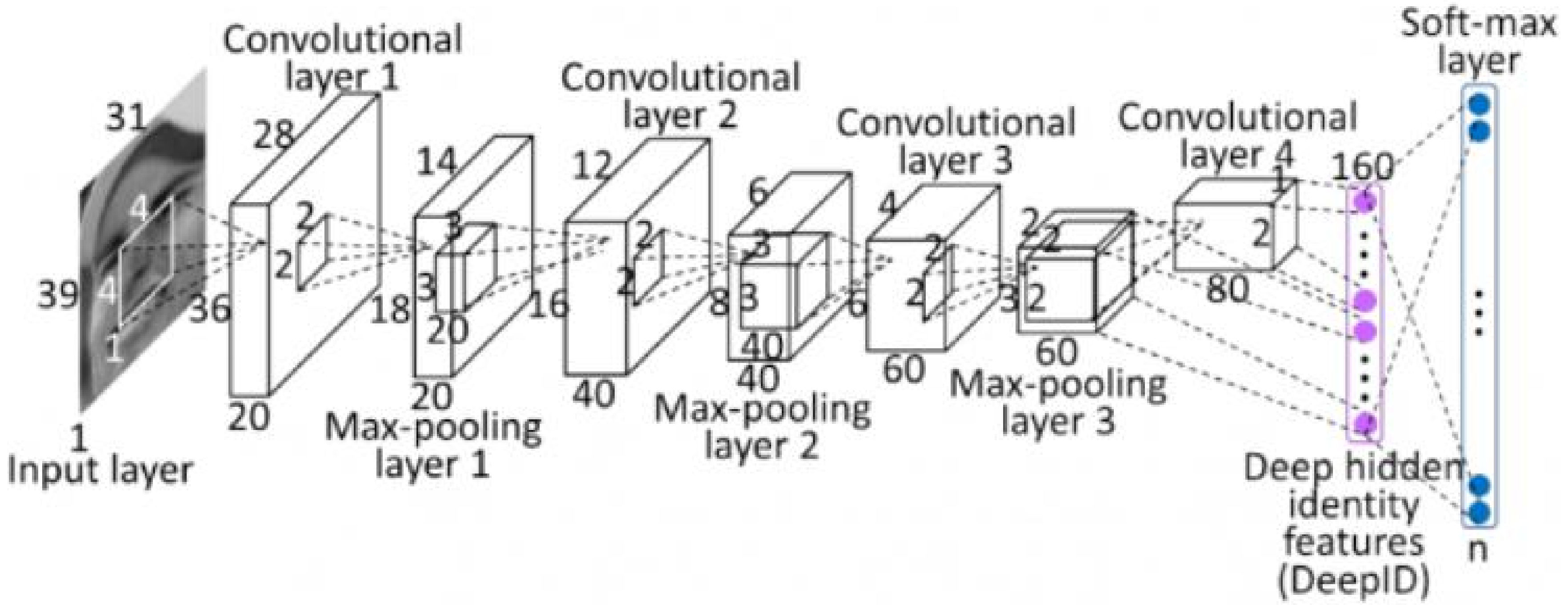
卷积神经网络：

- 堆叠的卷积层



卷积神经网络：

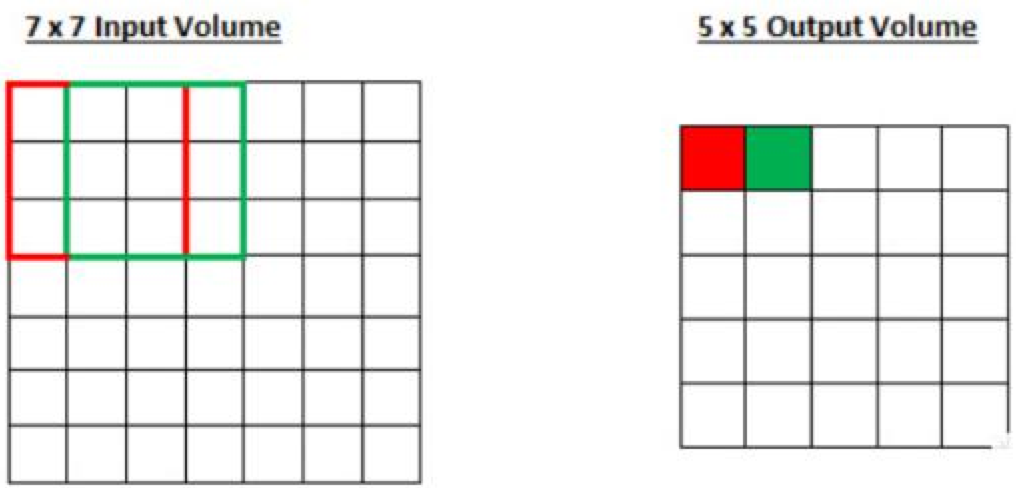
- 卷积层涉及参数：
  - 滑动窗口步长
  - 卷积核尺寸
  - 边缘填充
  - 卷积核个数



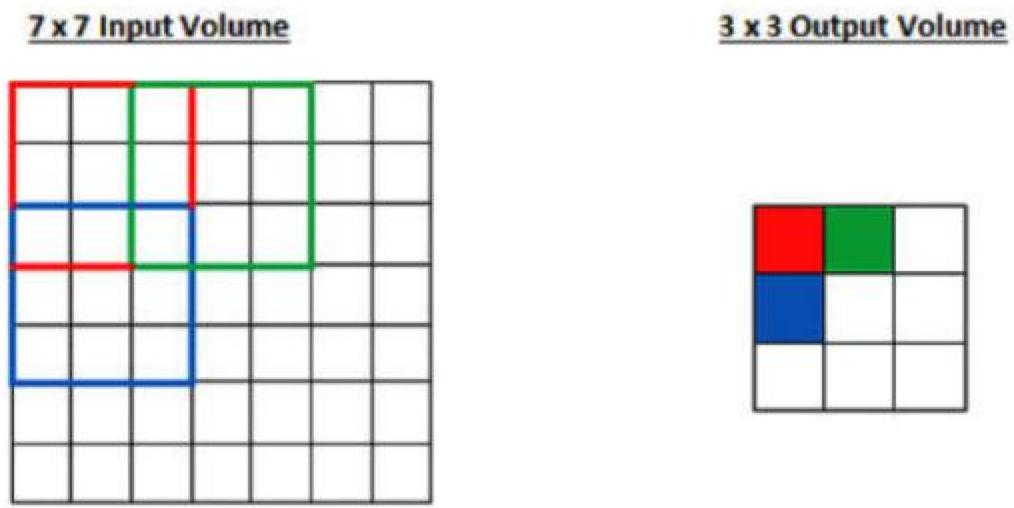
卷积神经网络：

- 步长：

步长为1的卷积：

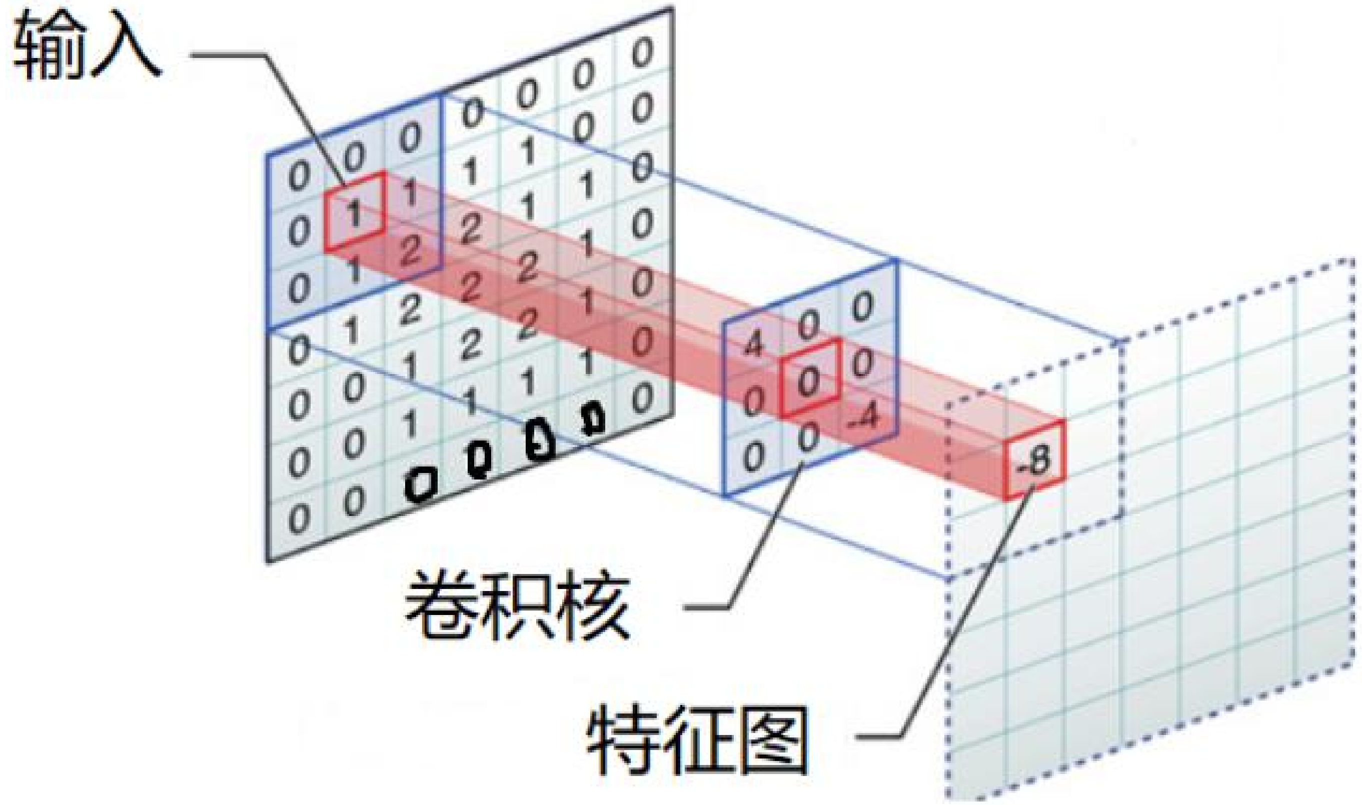


步长为2的卷积：



卷积神经网络：

- 边界填充：

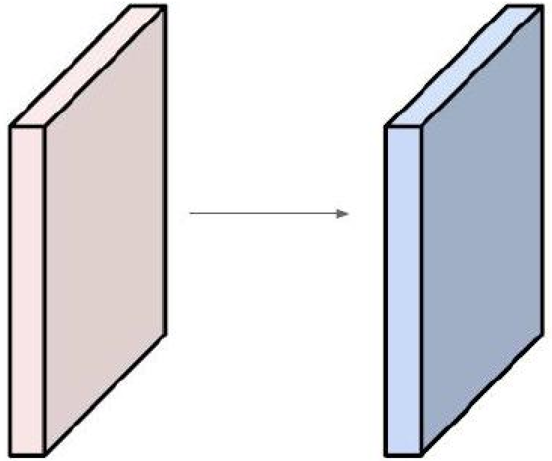


卷积神经网络：

卷积结果计算公式：

长度： $$H_2 = \frac{H_1 - F_H + 2P}{S} + 1$$

宽度： $$W_2 = \frac{W_1 - F_W + 2P}{S} + 1$$



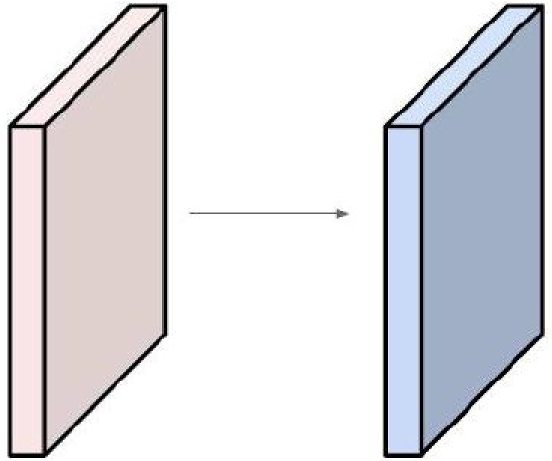
其中W1、H1表示输入的宽度、长度；W2、H2表示输出特征图的宽度、长度；F表示卷积核长和宽的大小；S表示滑动窗口的步长;P表示边界填充(加几圈0)。

卷积神经网络：

卷积结果计算公式：

长度：$H_2 = \frac{H_1 - F_H + 2P}{S} + 1$

宽度：$W_2 = \frac{W_1 - F_W + 2P}{S} + 1$

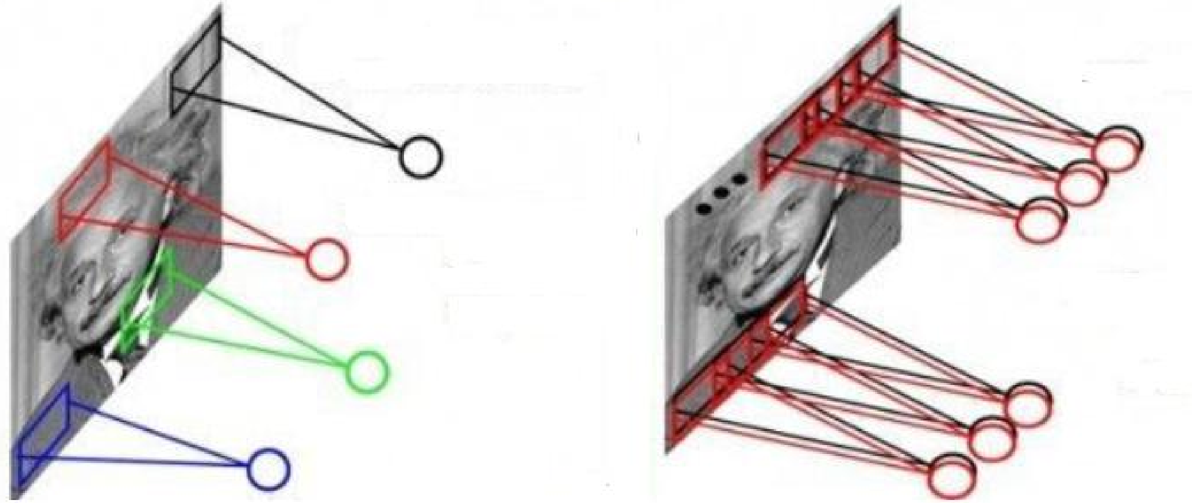


如果输入数据是32*32*3的图像，用10个5*5*3的filter来进行卷积操作，指定步长为1，边界填充为2，最终输入的规模为?

(32-5+2*2)/1 + 1 = 32，所以输出规模为32*32*10，经过卷积操作后也可以保持特征图长度、宽度不变。

卷积神经网络：

- 卷积参数共享：

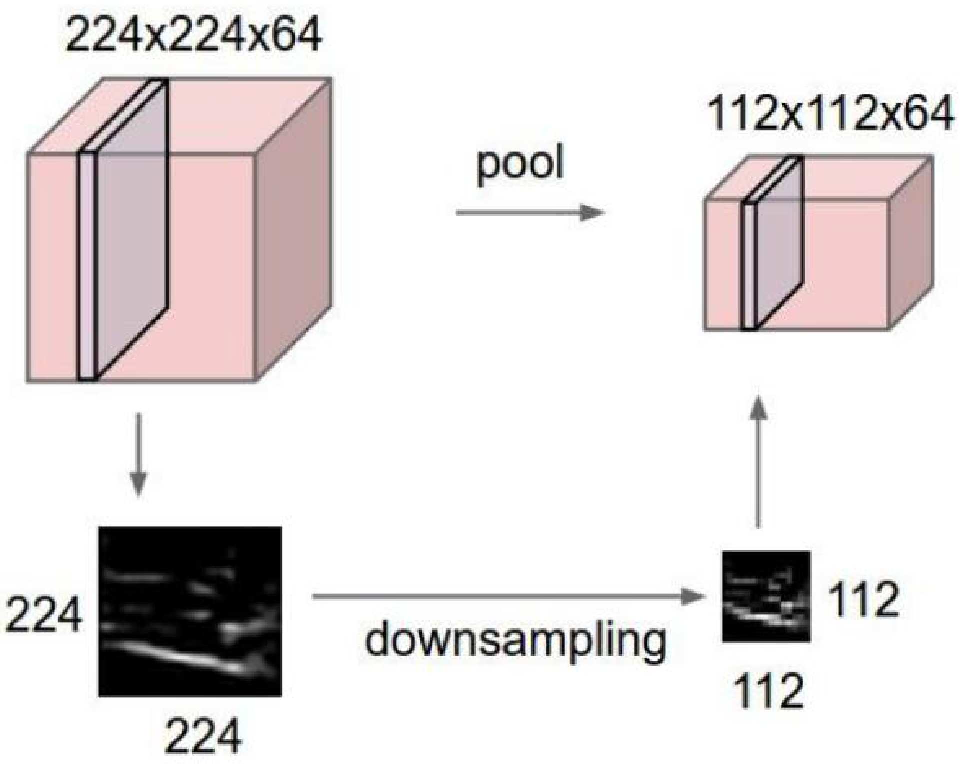


数据依旧是32*32*3的图像，继续用10个5*5*3的filter来进行卷积操作，所需的权重参数有多少个呢？

5*5*3 = 75，表示每一个卷积核只需要75个参数，此时有10个不同的卷积核，就需要10*75 = 750个卷积核参数，不要忘记还有b参数，每个卷积核都有一个对应的偏置参数，最终只需要750+10=760个权重参数。

卷积神经网络:

- 池化层:

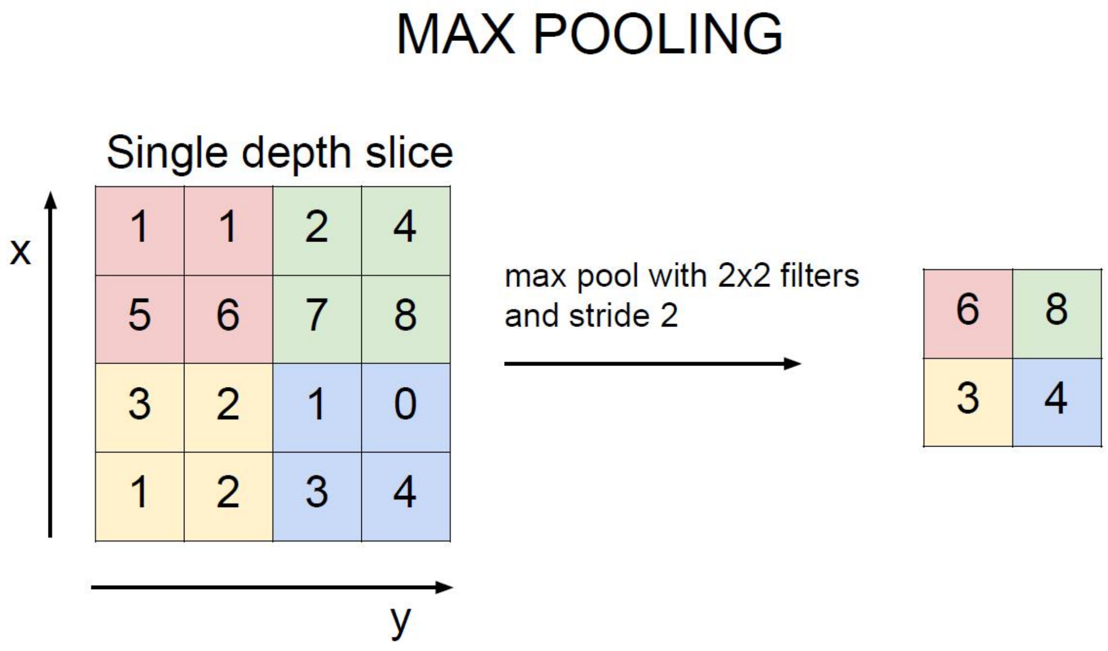


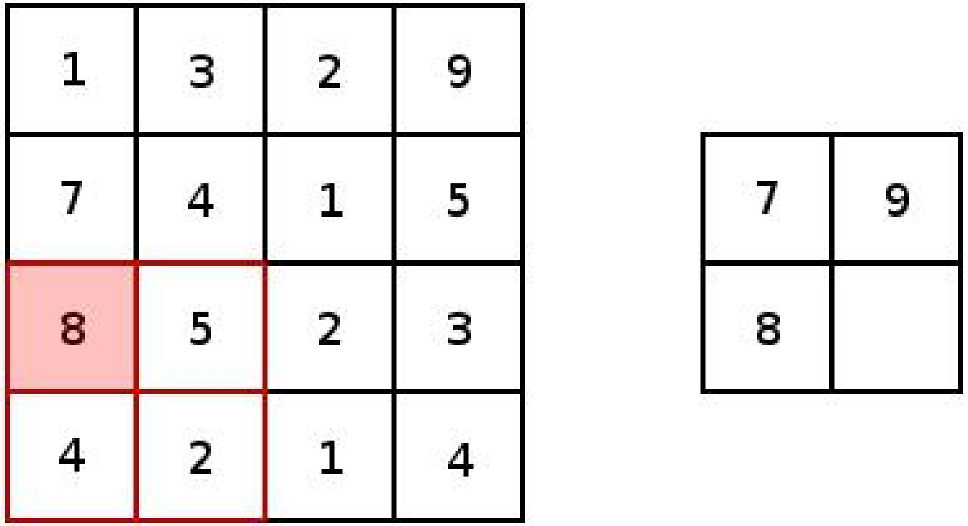
1	3	2	9
7	4	1	5
8	5	2	3
4	2	1	4

7	9
8	

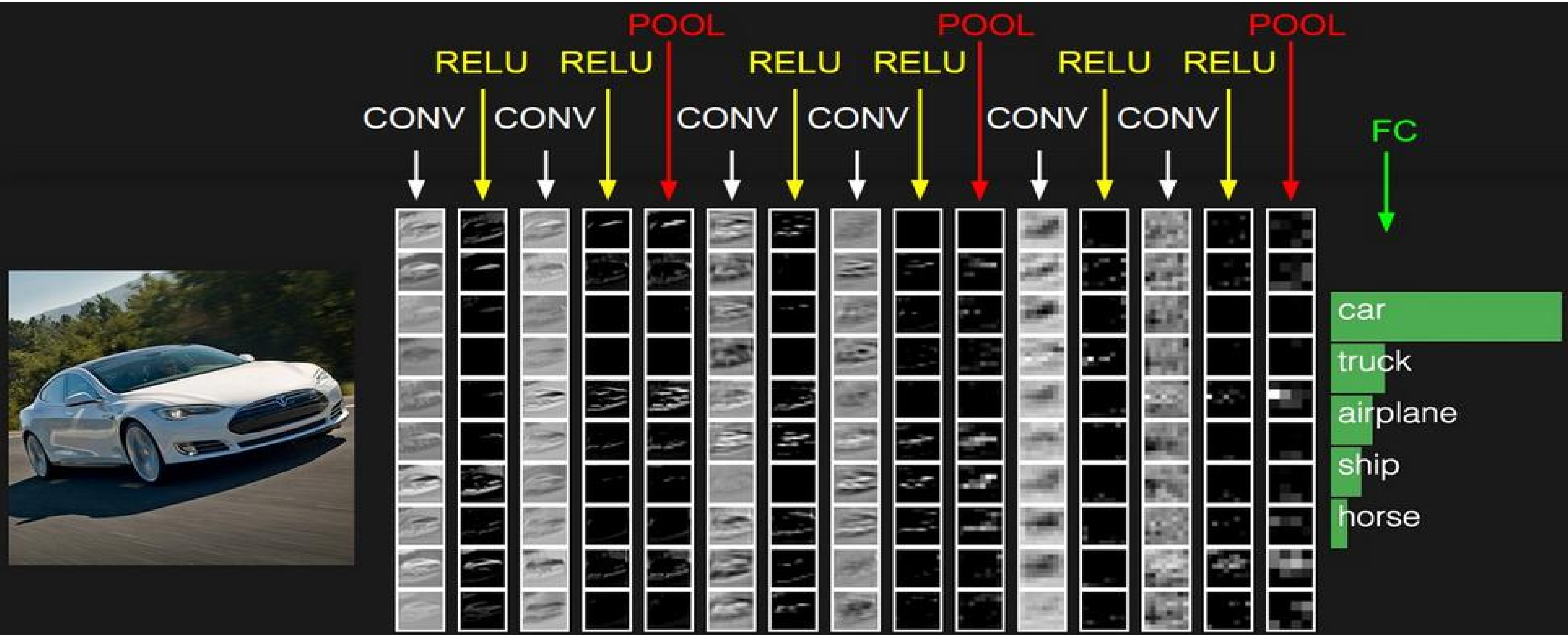
卷积神经网络:

- 最大池化:


MAX POOLING
Single depth slice
x
y
1 1 2 4
5 6 7 8
3 2 1 0
1 2 3 4
max pool with 2x2 filters
and stride 2
6 8
3 4

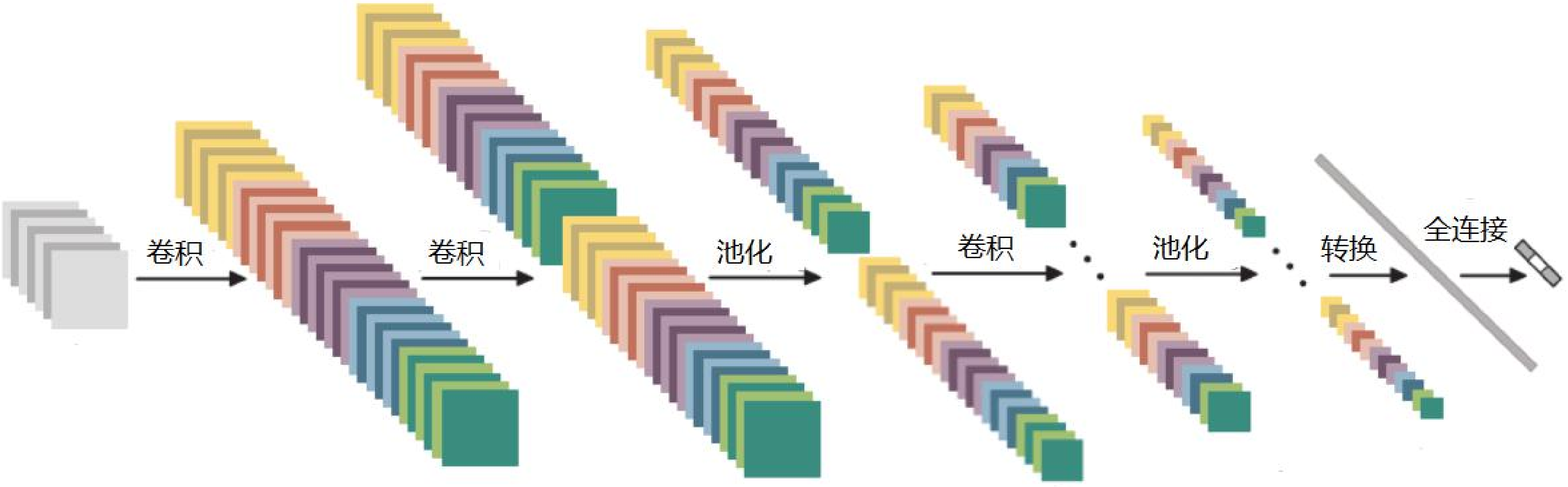

1 3 2 9
7 4 1 5
8 5 2 3
4 2 1 4
7 9
8

卷积神经网络：


POOL
RELU
RELU
POOL
RELU
RELU
POOL
RELU
RELU
CONV
CONV
CONV
CONV
CONV
CONV
FC
car
truck
airplane
ship
horse

卷积神经网络：

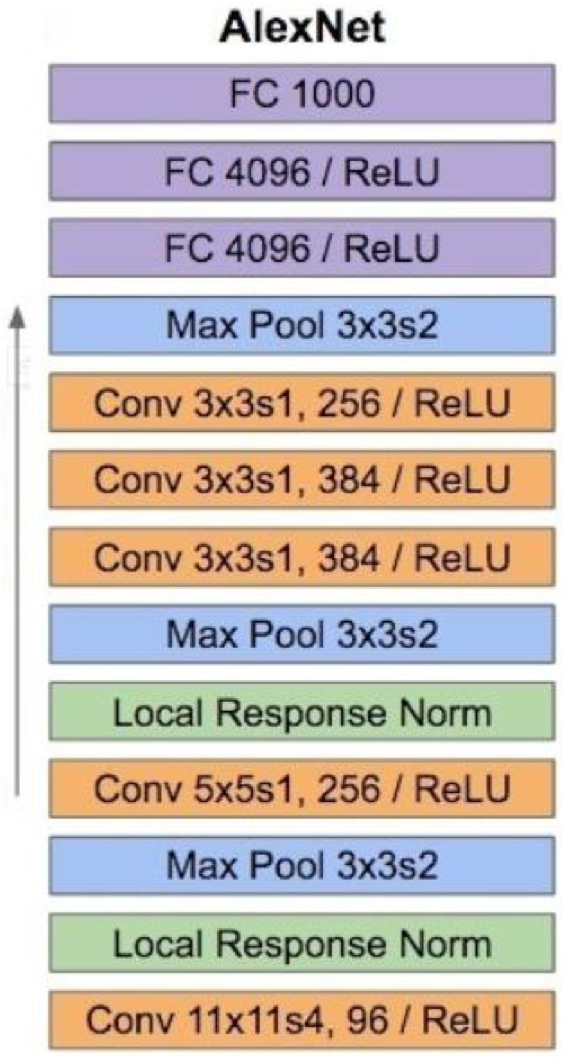
✓ 特征图变化：



卷积神经网络：

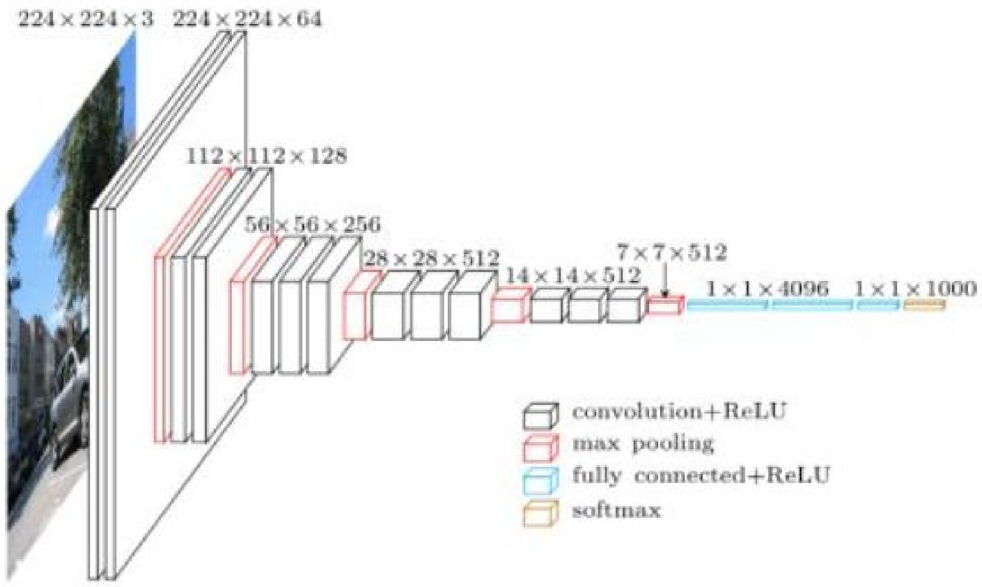
经典网络-Alexnet：

[227x227x3] INPUT
[55x55x96] CONV1: 96 11x11 filters at stride 4, pad 0
[27x27x96] MAX POOL1: 3x3 filters at stride 2
[27x27x96] NORM1: Normalization layer
[27x27x256] CONV2: 256 5x5 filters at stride 1, pad 2
[13x13x256] MAX POOL2: 3x3 filters at stride 2
[13x13x256] NORM2: Normalization layer
[13x13x384] CONV3: 384 3x3 filters at stride 1, pad 1
[13x13x384] CONV4: 384 3x3 filters at stride 1, pad 1
[13x13x256] CONV5: 256 3x3 filters at stride 1, pad 1
[6x6x256] MAX POOL3: 3x3 filters at stride 2
[4096] FC6: 4096 neurons
[4096] FC7: 4096 neurons
[1000] FC8: 1000 neurons (class scores)



卷积神经网络：

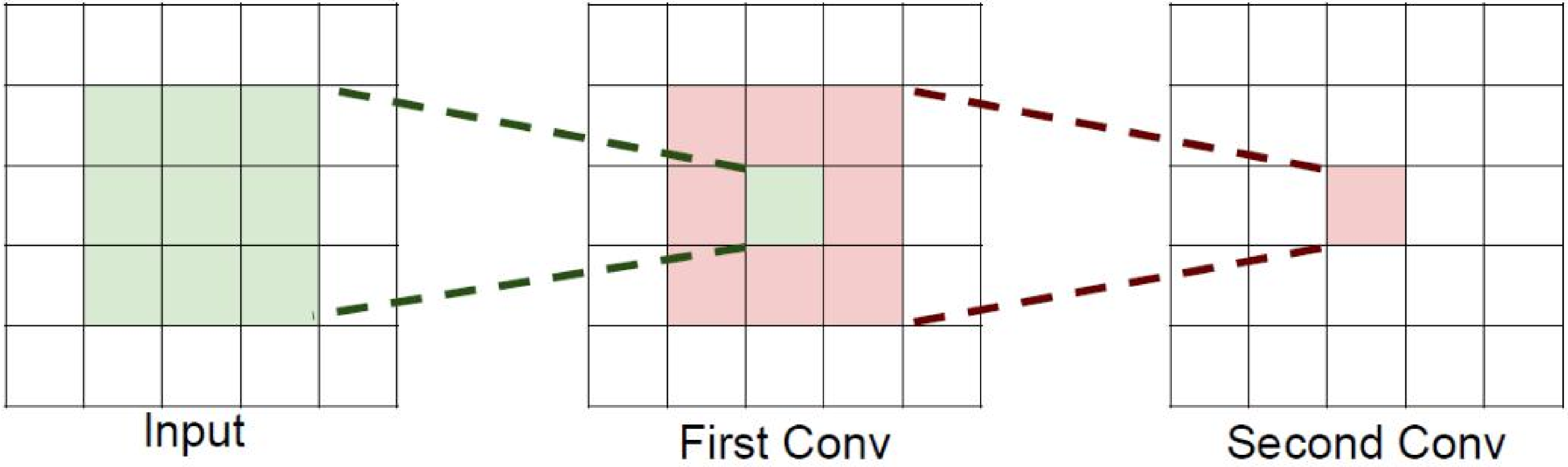
✓ 经典网络-Vgg：



ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 × 224 RGB image)					
conv3-64	conv3-64 **LRN**	conv3-64 **conv3-64**	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 **conv3-128**	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 **conv1-256**	conv3-256 conv3-256 **conv3-256**	conv3-256 conv3-256 conv3-256 **conv3-256**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

卷积神经网络：

- 感受野：



如果堆叠3个3*3的卷积层，并且保持滑动窗口步长为1，其感受野就是7*7的了，这跟一个使用7*7卷积核的结果是一样的，那为什么非要堆叠3个小卷积呢？

卷积神经网络：

感受野

- 假设输入大小都是h*w*c，并且都使用c个卷积核(得到c个特征图)，可以来计算一下其各自所需参数：

一个7*7卷积核所需参数：

$= C \times (7 \times 7 \times C) = \mathbf{49\ C^2}$

3个3*3卷积核所需参数：

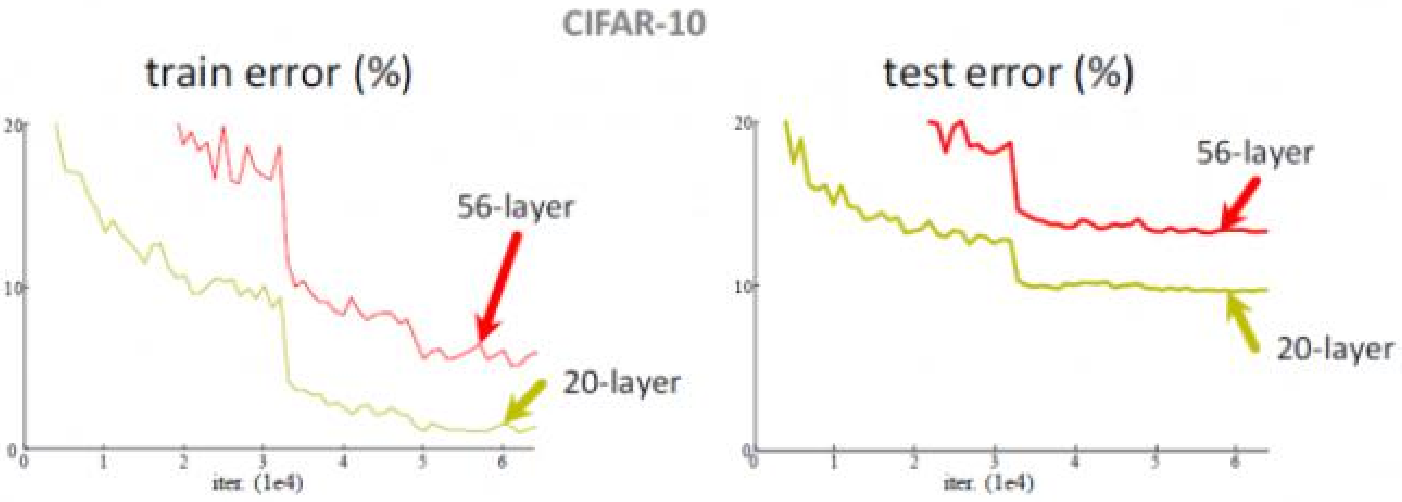
$= 3 \times C \times (3 \times 3 \times C) = \mathbf{27\ C^2}$

- 很明显，堆叠小的卷积核所需的参数更少一些，并且卷积过程越多，特征提取也会越细致，加入的非线性变换也随着增多，还不会增大权重参数个数，这就是VGG网络的基本出发点，用小的卷积核来完成体特征提取操作。

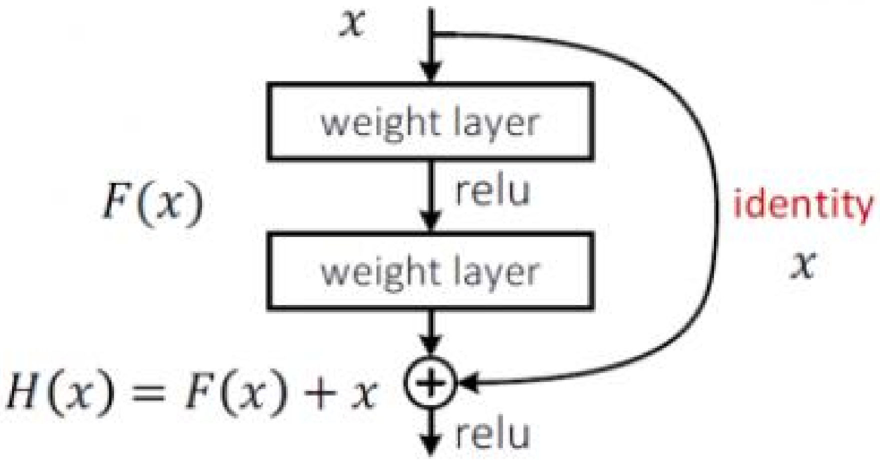
卷积神经网络：

- 经典网络-Resnet

  - 深层网络遇到的问题：

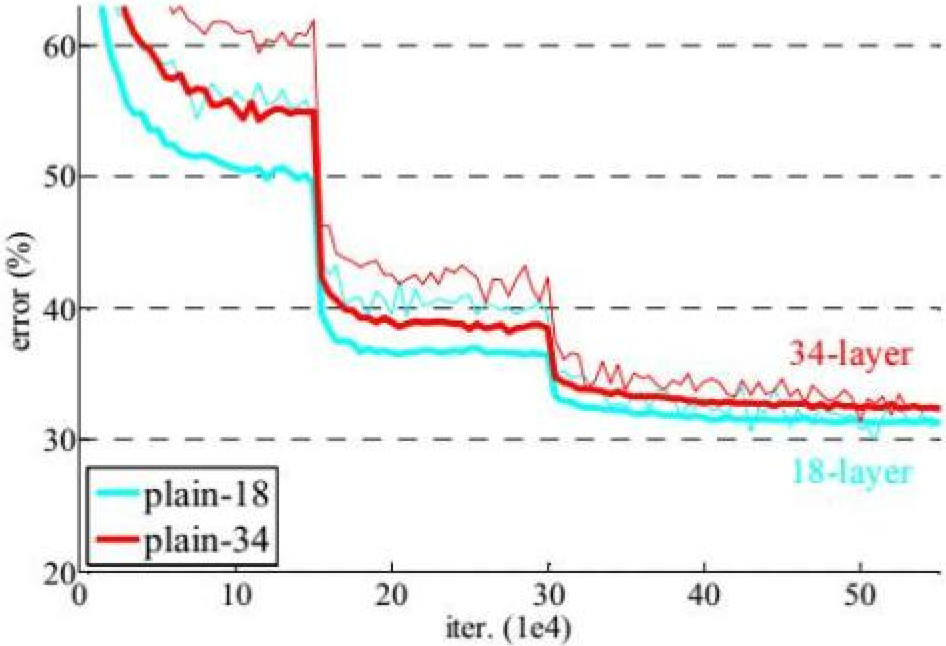


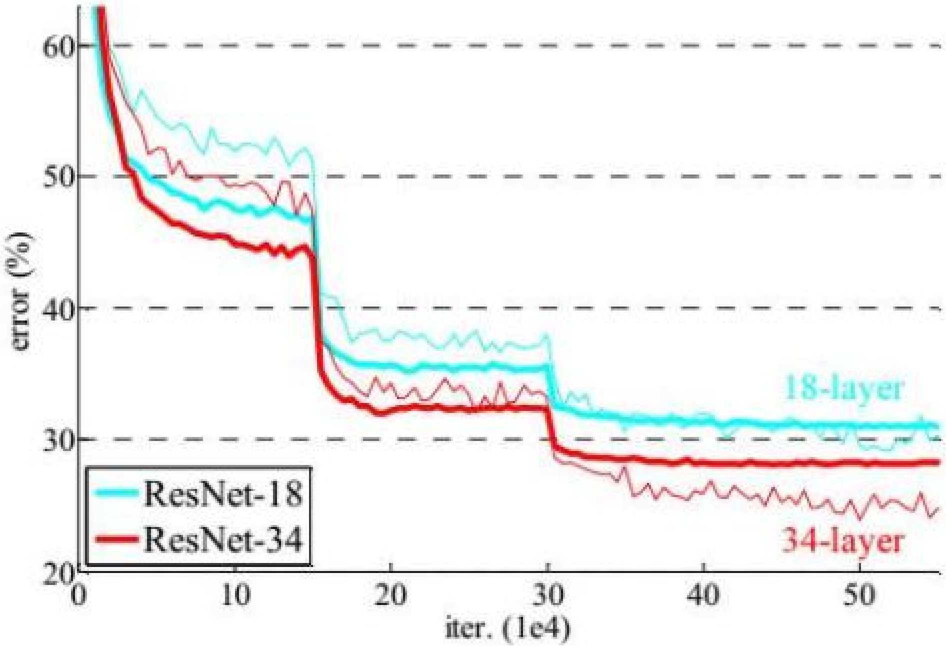
  - 解决方案：



卷积神经网络：

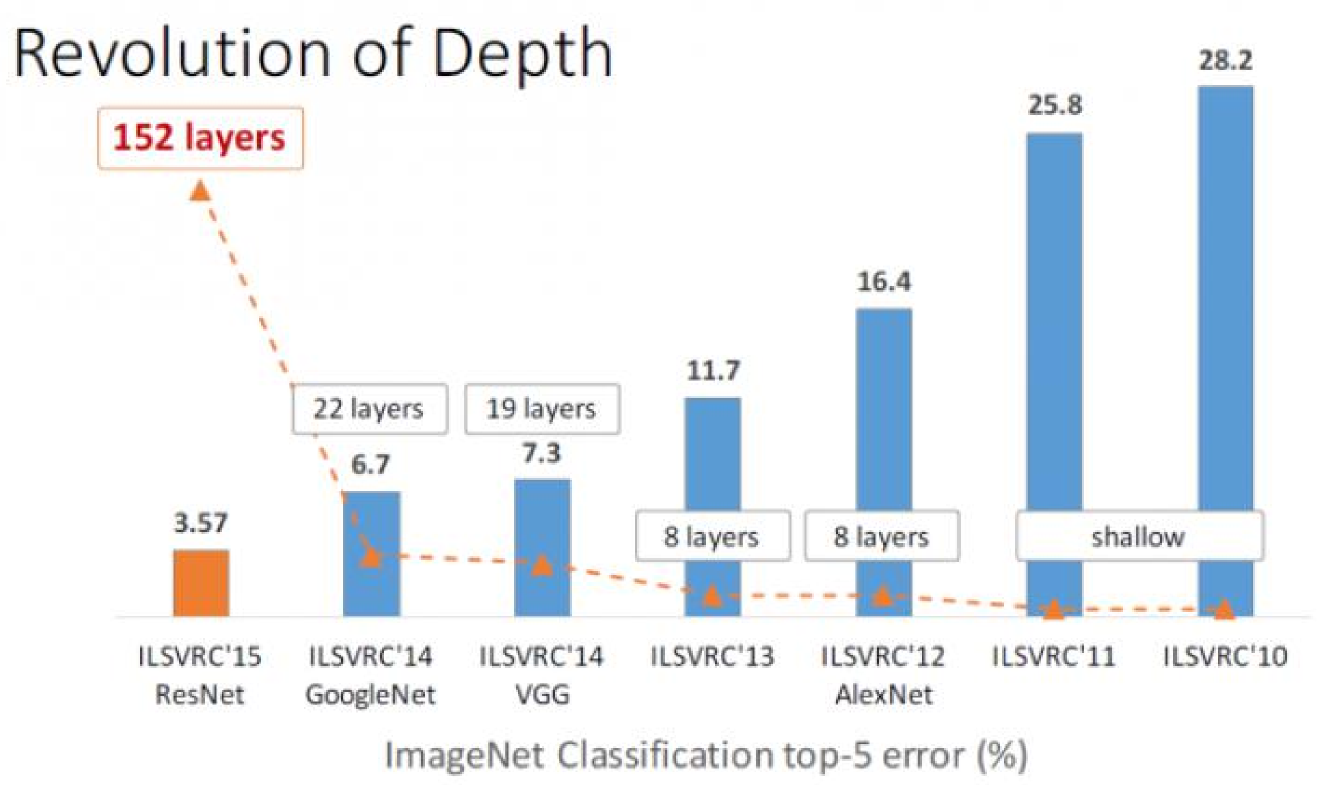
- 经典网络-Resnet

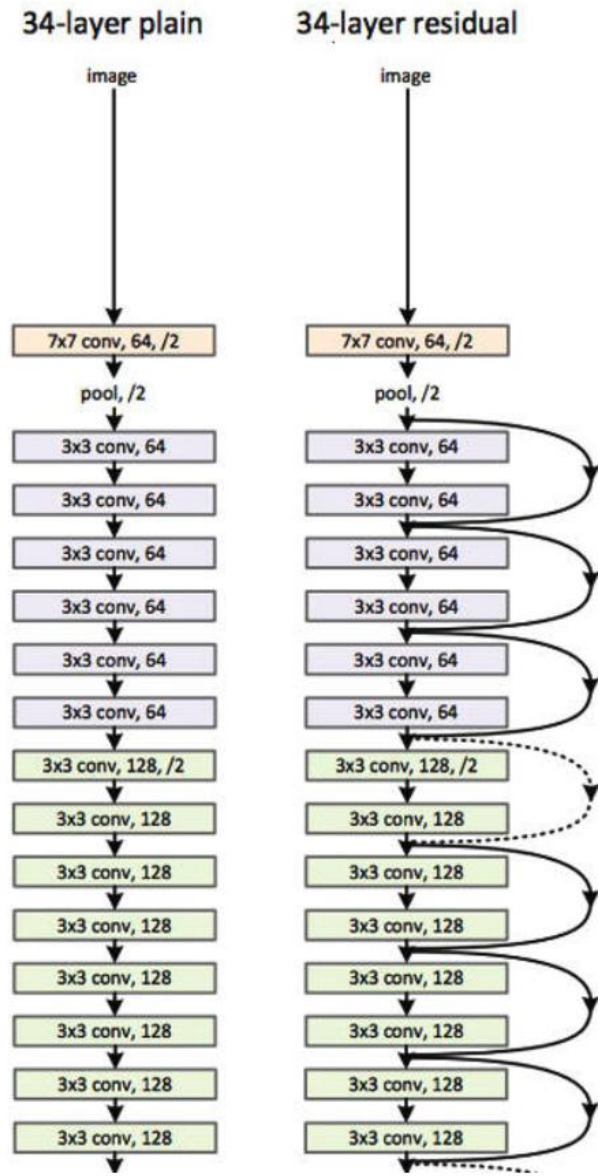




卷积神经网络：

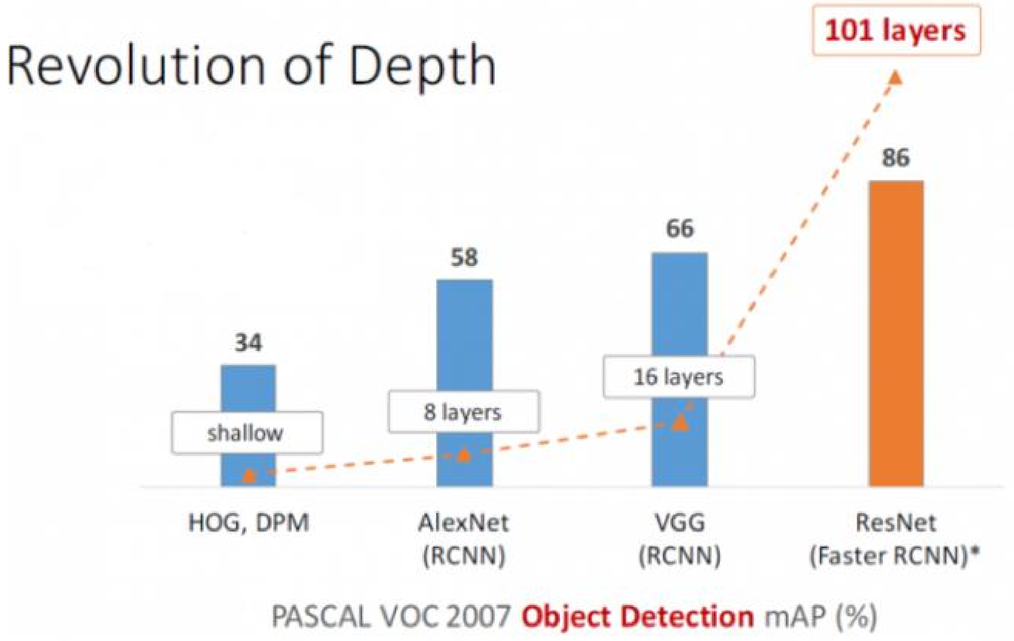
经典网络-Resnet

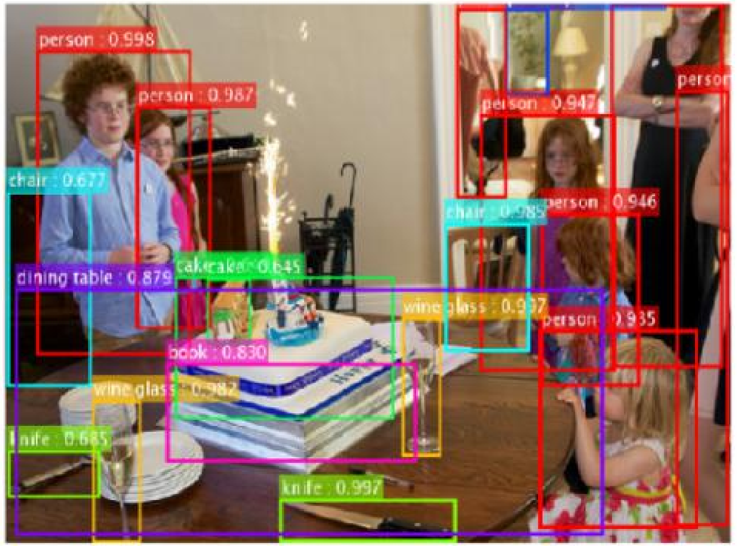




卷积神经网络：

经典网络-Resnet





ResNet's object detection result on COCO