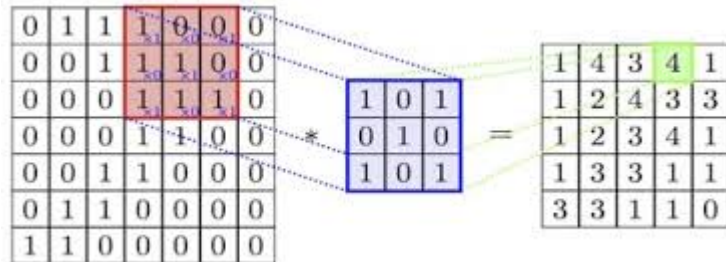


# **сверточные нейронные сети**

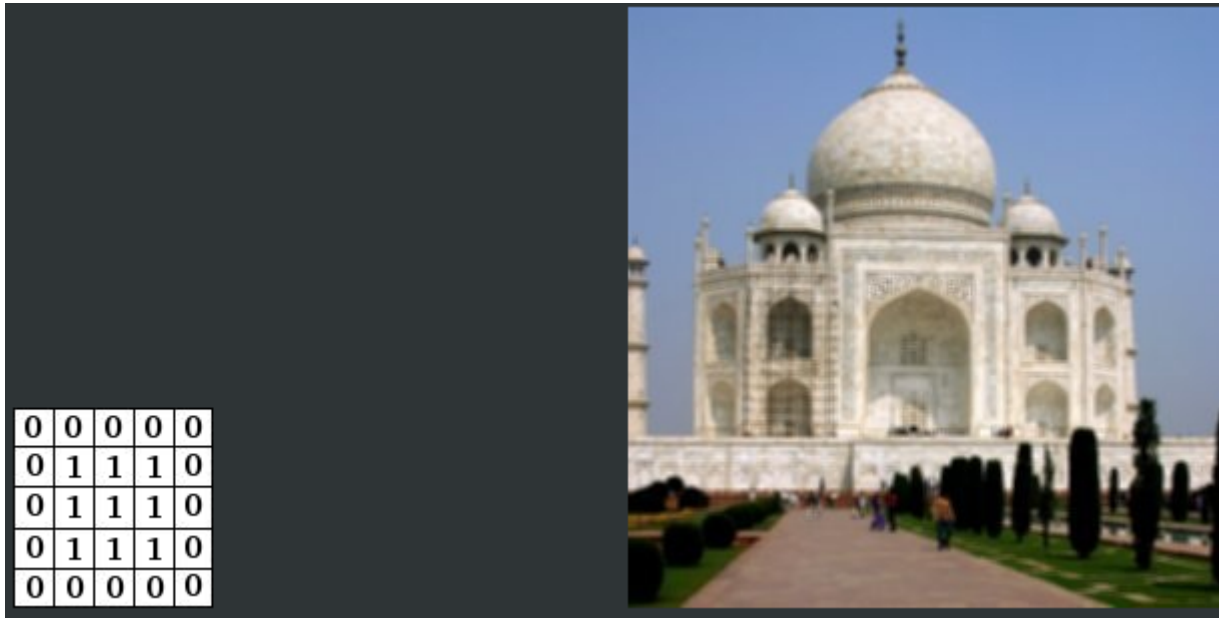
# convolutional neural network (CNN)

Motivation: convolution matrix detection

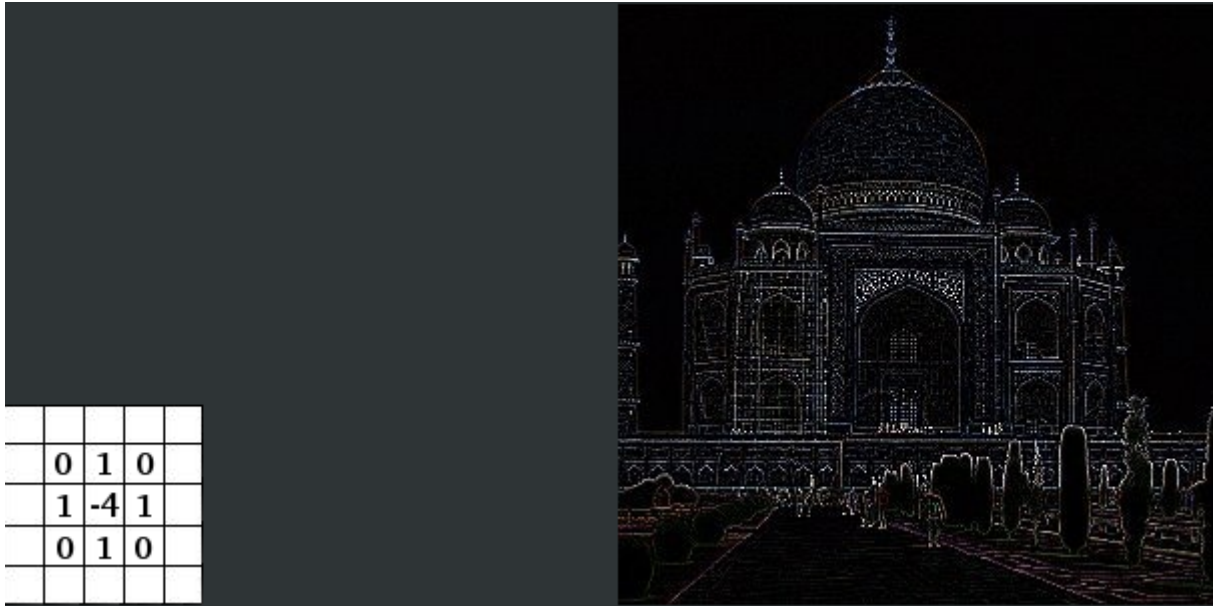


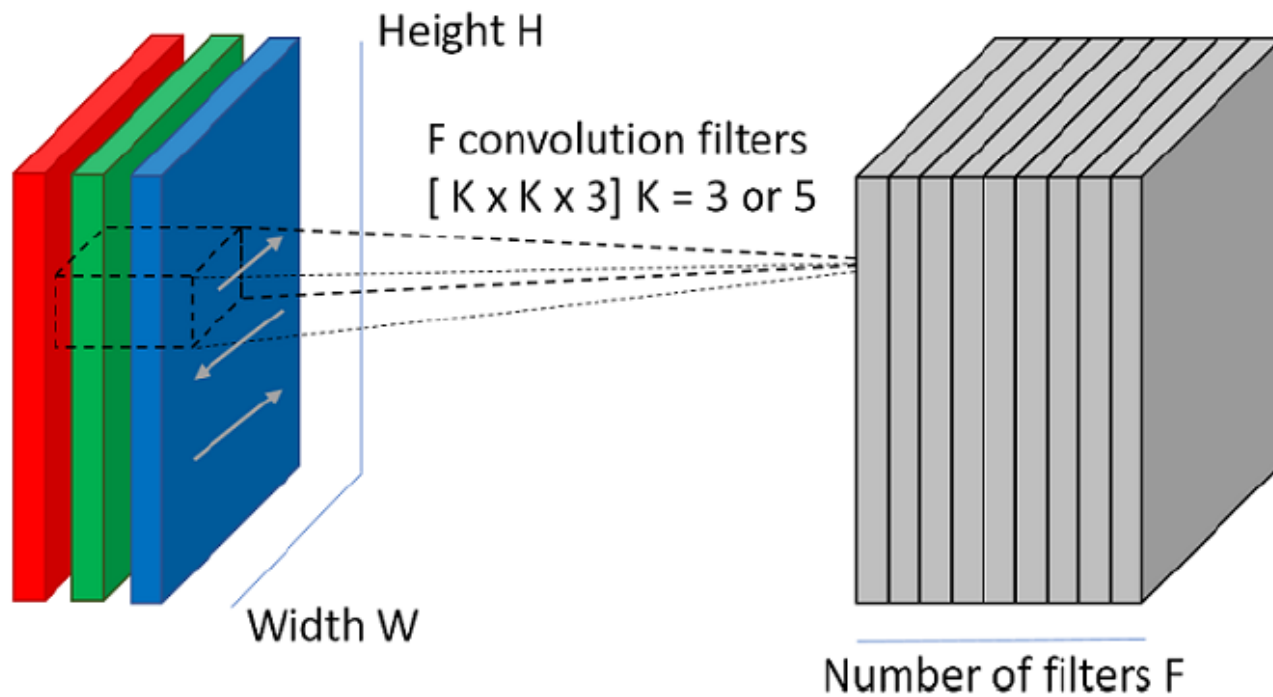


blur



edge

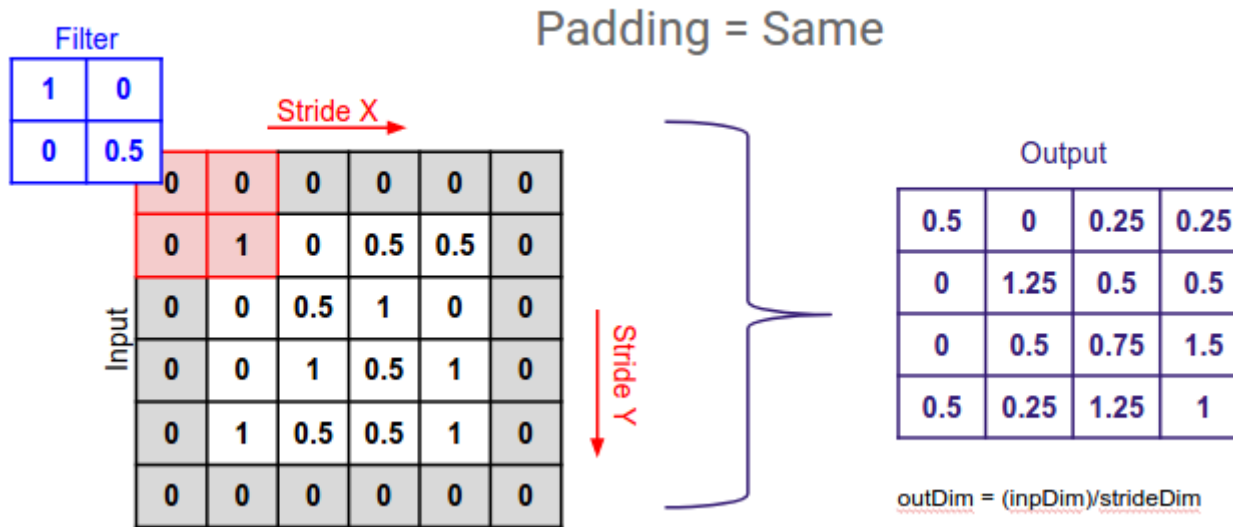




Input Layer (RGB pixels)  
[H x W x 3]

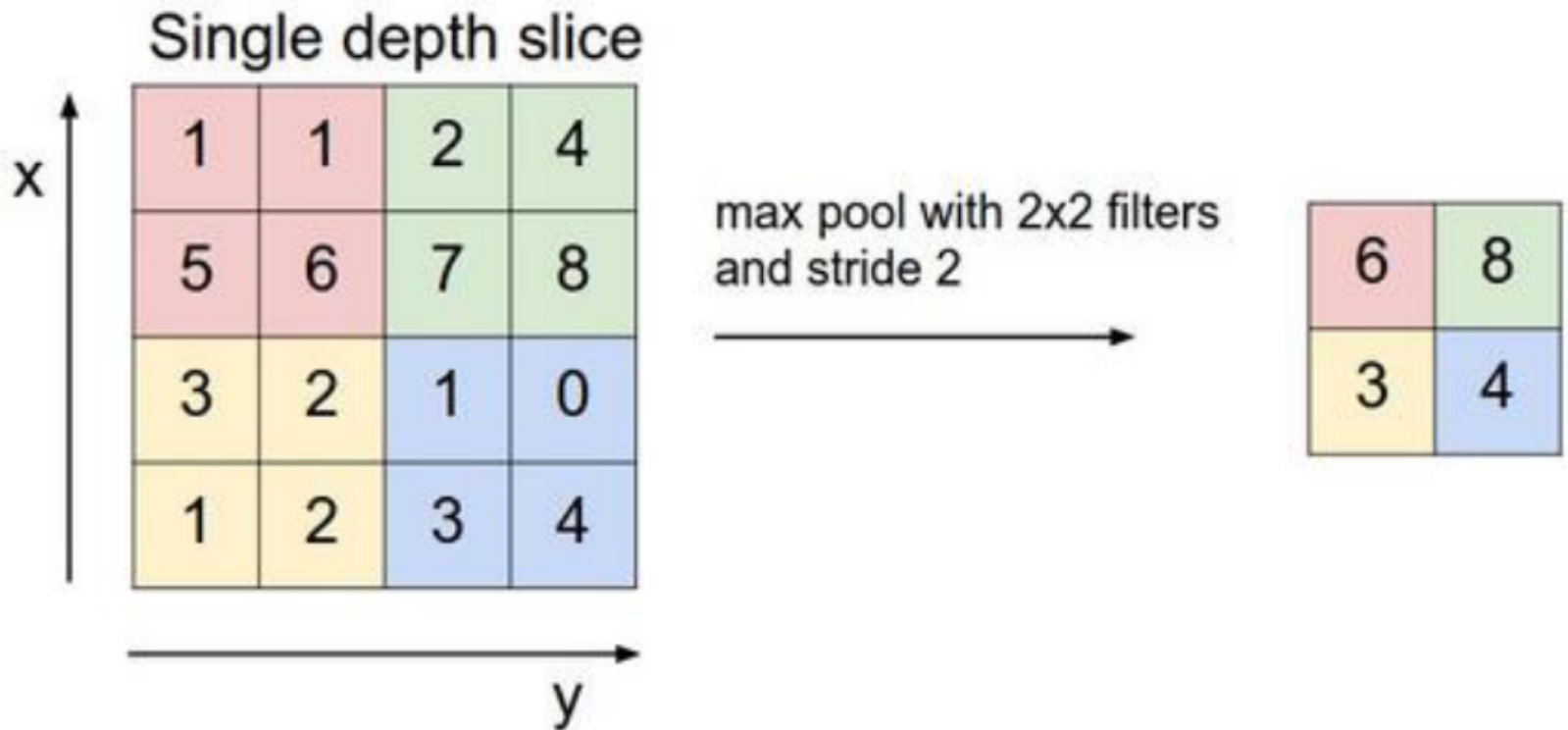
Convolution Layer Output  
[H x W x F]  
assuming stride=1 and zero padding

# padding stride



# Pooling layer

maxpool layer

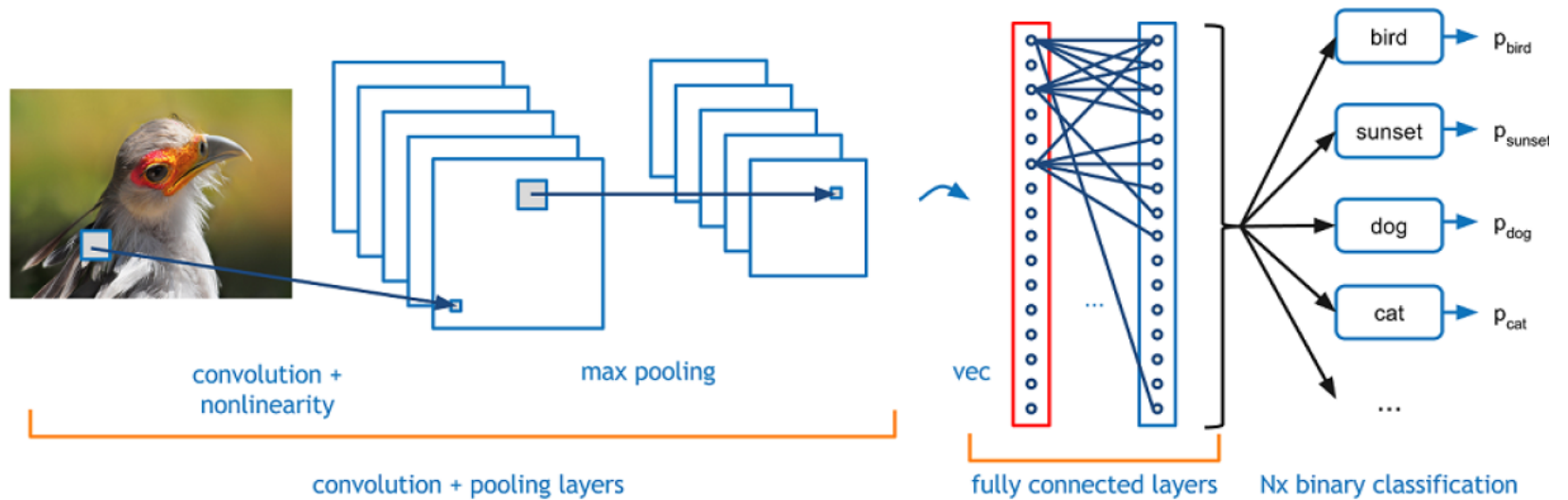




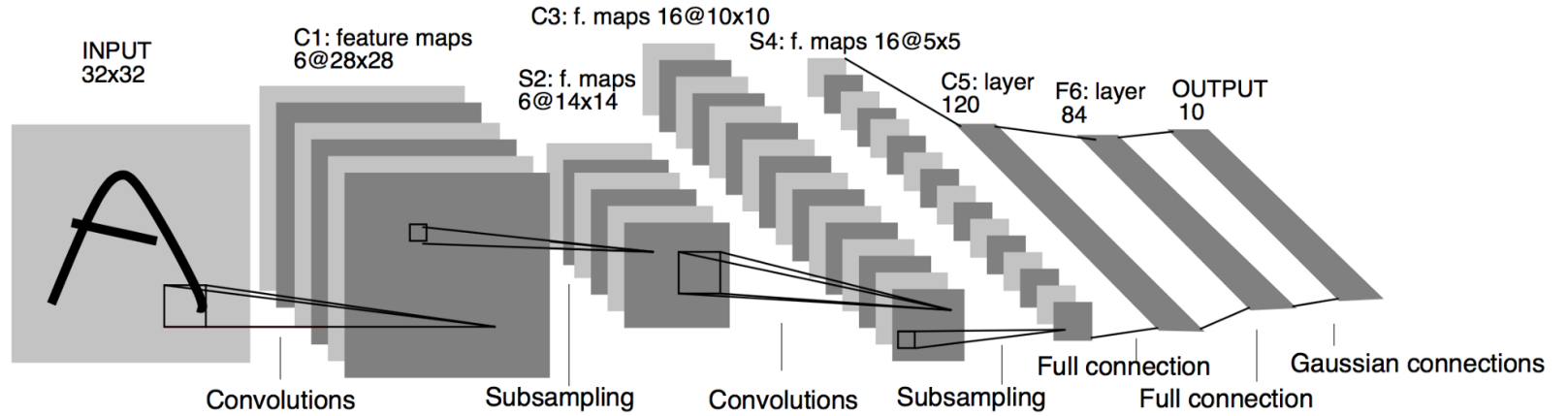
**дифференцирование maxpool**

весь градиент уходит по максимуму.

# convolutional neural network



# LeNet 1998



# Imagenet Image Recognition

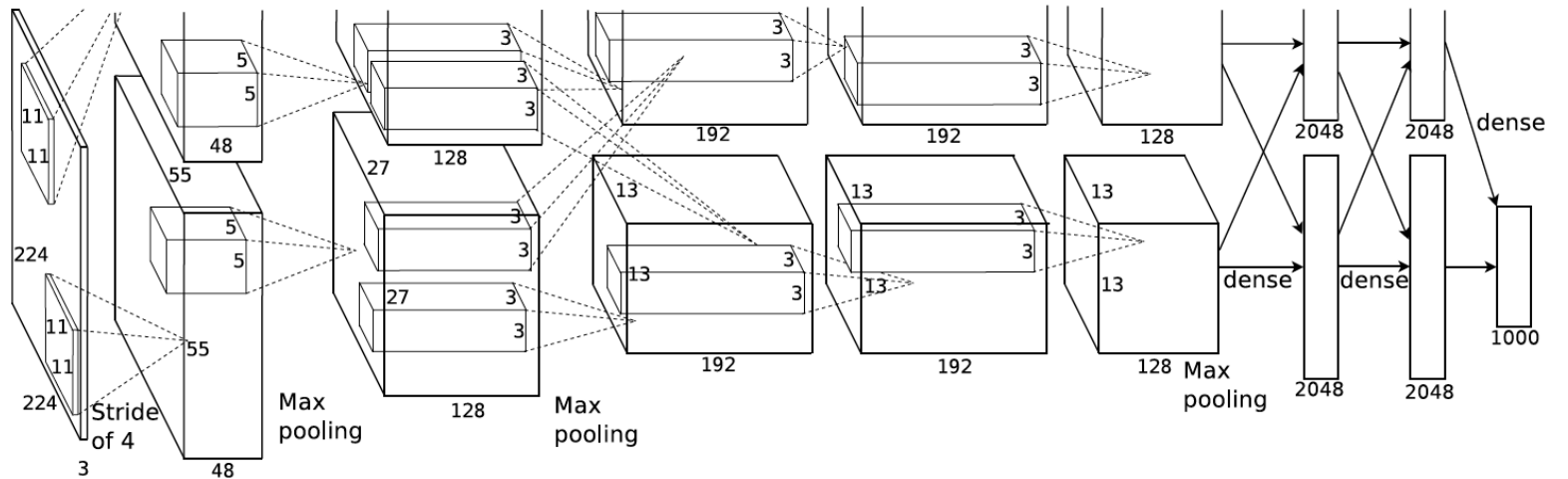


# AlexNet

2012

15,4 top5 error

~60M параметров



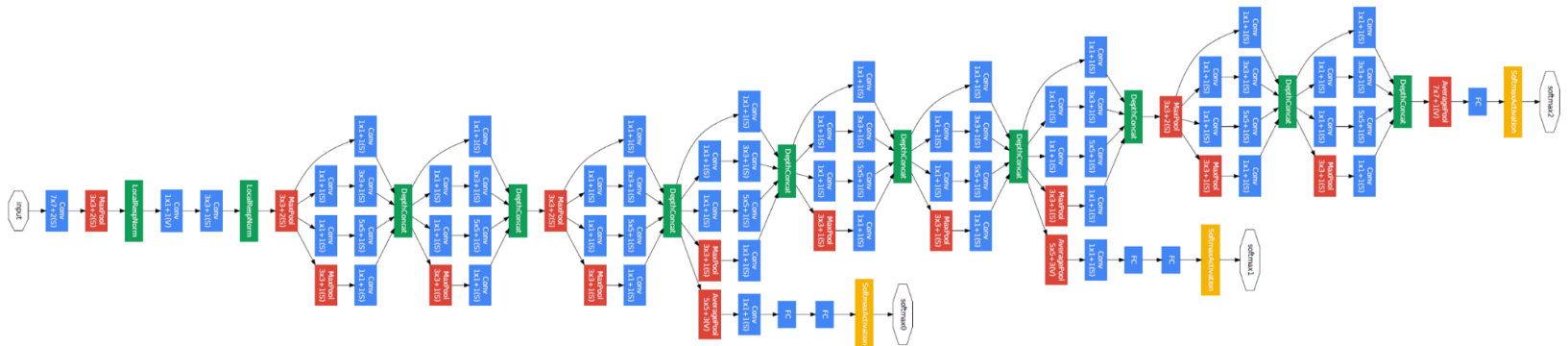
# GoogleNet

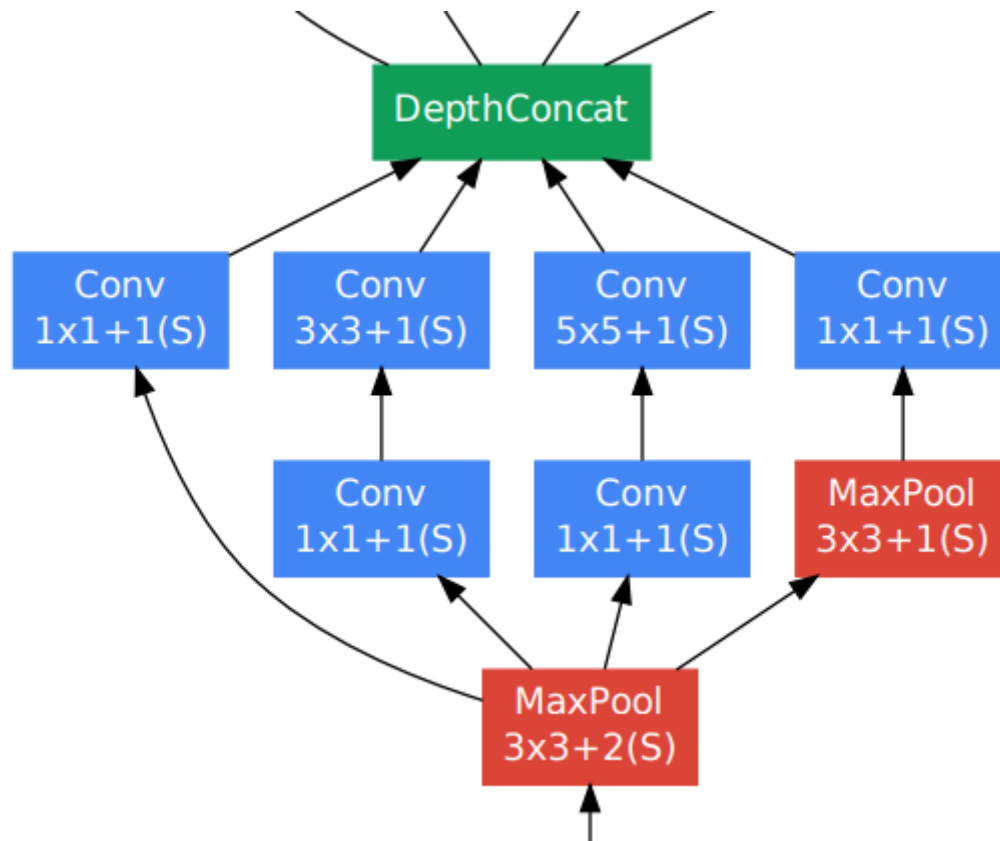
## inception

2014

6,6% top 5 error, ~5M параметров

- синие - сверточные
- красные - maxpool
- зеленые - конкатенируют
- желтые - предсказания





- 1x1 светка уменьшила параметры
- вспомогательные классификаторы



# VGG

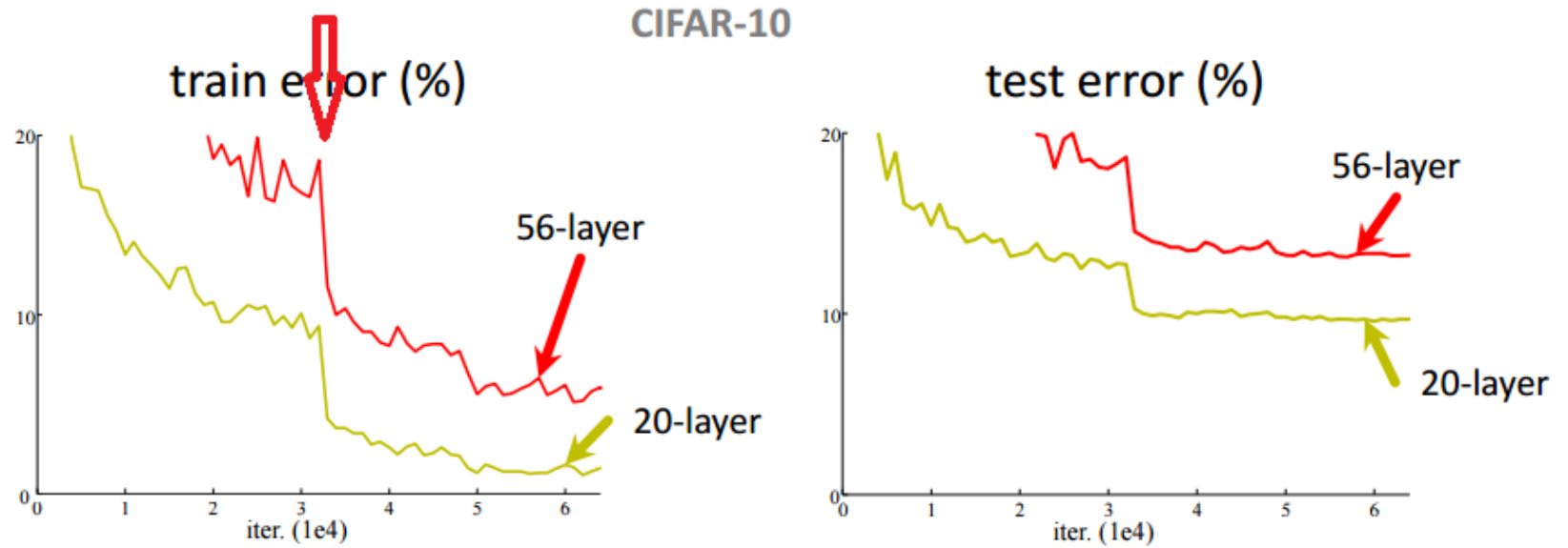
2014, 6.8% top 5 error

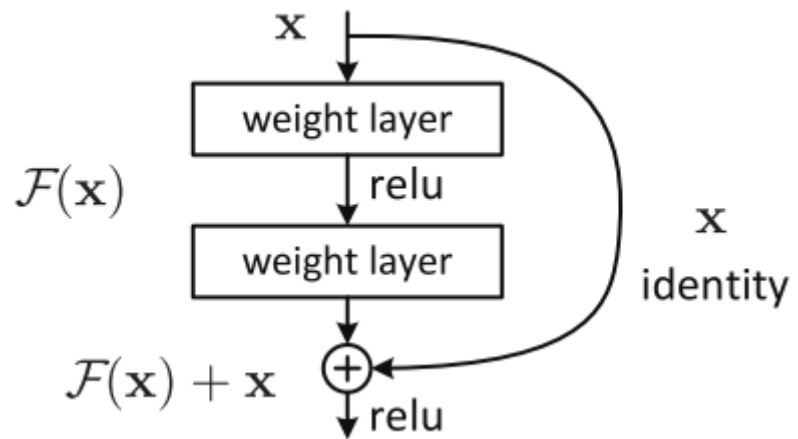
хорошо подходит для "переноса знаний" transfer learning

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 <b>LRN</b>	conv3-64 <b>conv3-64</b>	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 <b>conv3-128</b>	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 <b>conv1-256</b>	conv3-256 conv3-256 <b>conv3-256</b>	conv3-256 conv3-256 conv3-256 <b>conv3-256</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

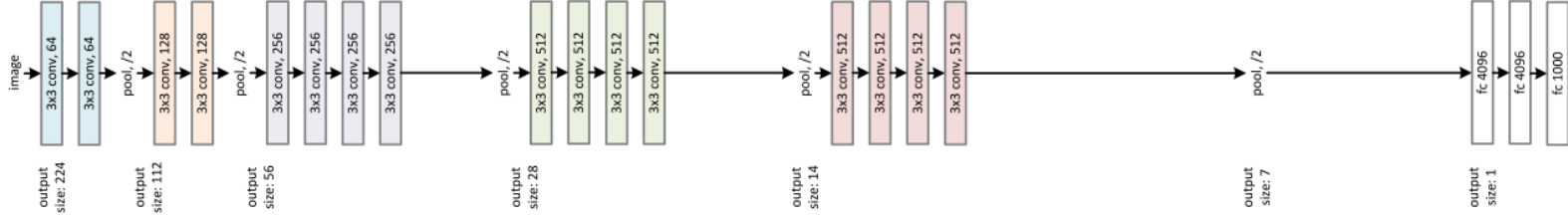
# ResNet

2015

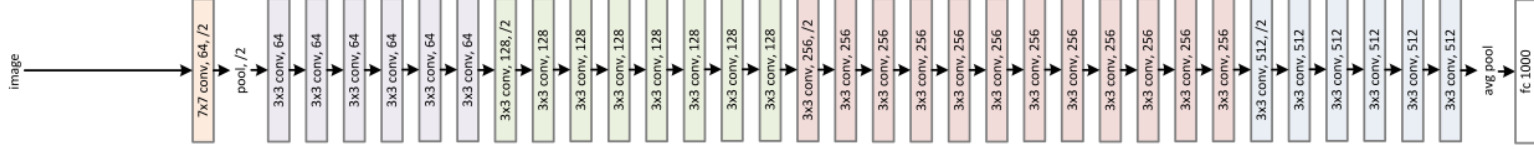




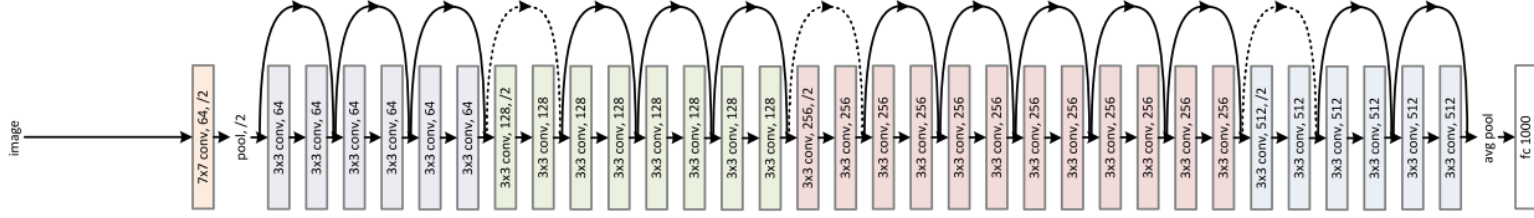
VGG-19



34-layer plain



34-layer residual



## Отступление

Функция конкурентного сходства или **FRiS-функция** – мера сходства двух объектов, исчисляемая относительно некоторого иного объекта.

$$S(u, x|x') = \frac{\rho(u, x') - \rho(u, x)}{\rho(u, x') + \rho(u, x)}$$