

# Convolutional neural networks

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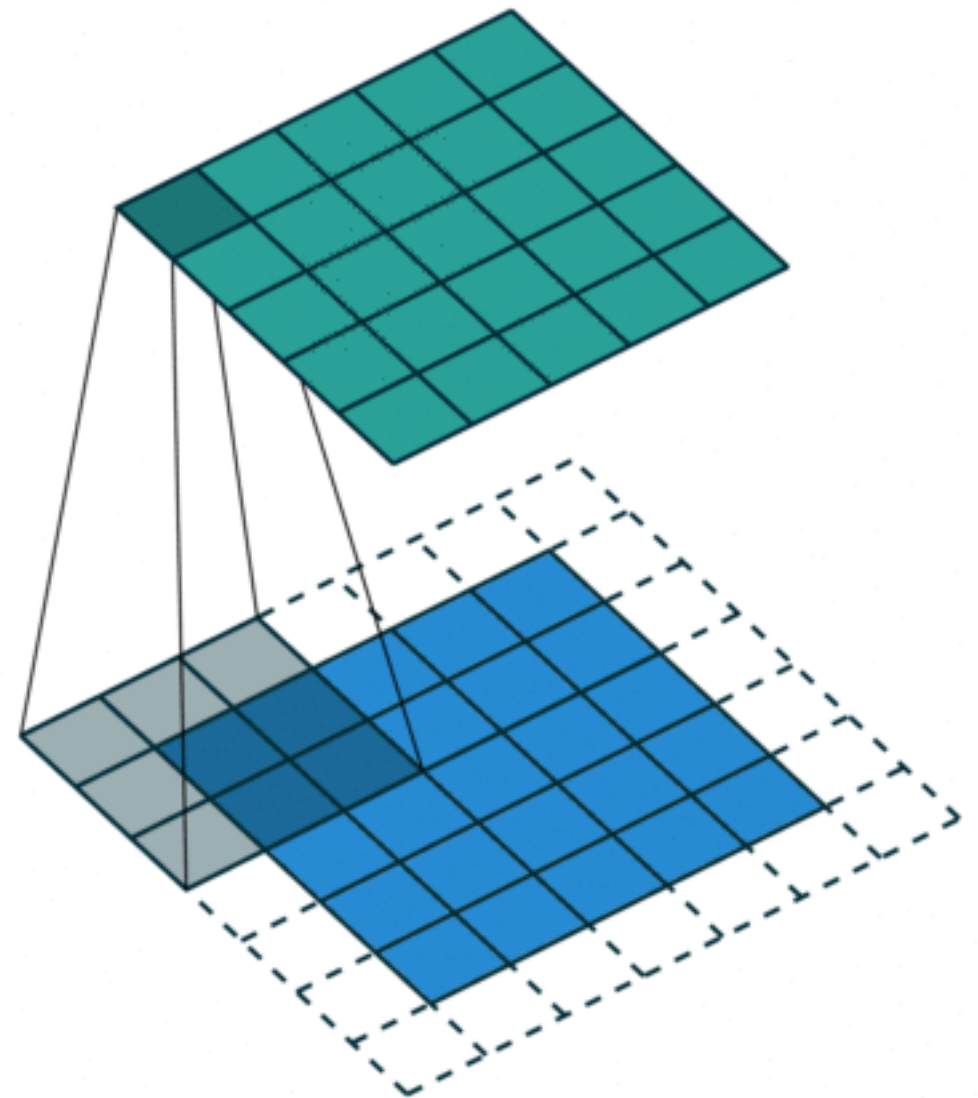
Romain Tavenard (Université de Rennes)  
Deep Learning course @EDHEC

NB: Most figures in these slides are from  
Dumoulin & Visin. A guide to convolution arithmetic for deep learning. 2016

# The convolution operator

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- 2D convolution
  - Blue: input image
  - Gray: convolution kernel
  - Cyan: activation map
- Convolution operation = Dot product between
  - convolution kernel (aka filter)
  - subpart of the input



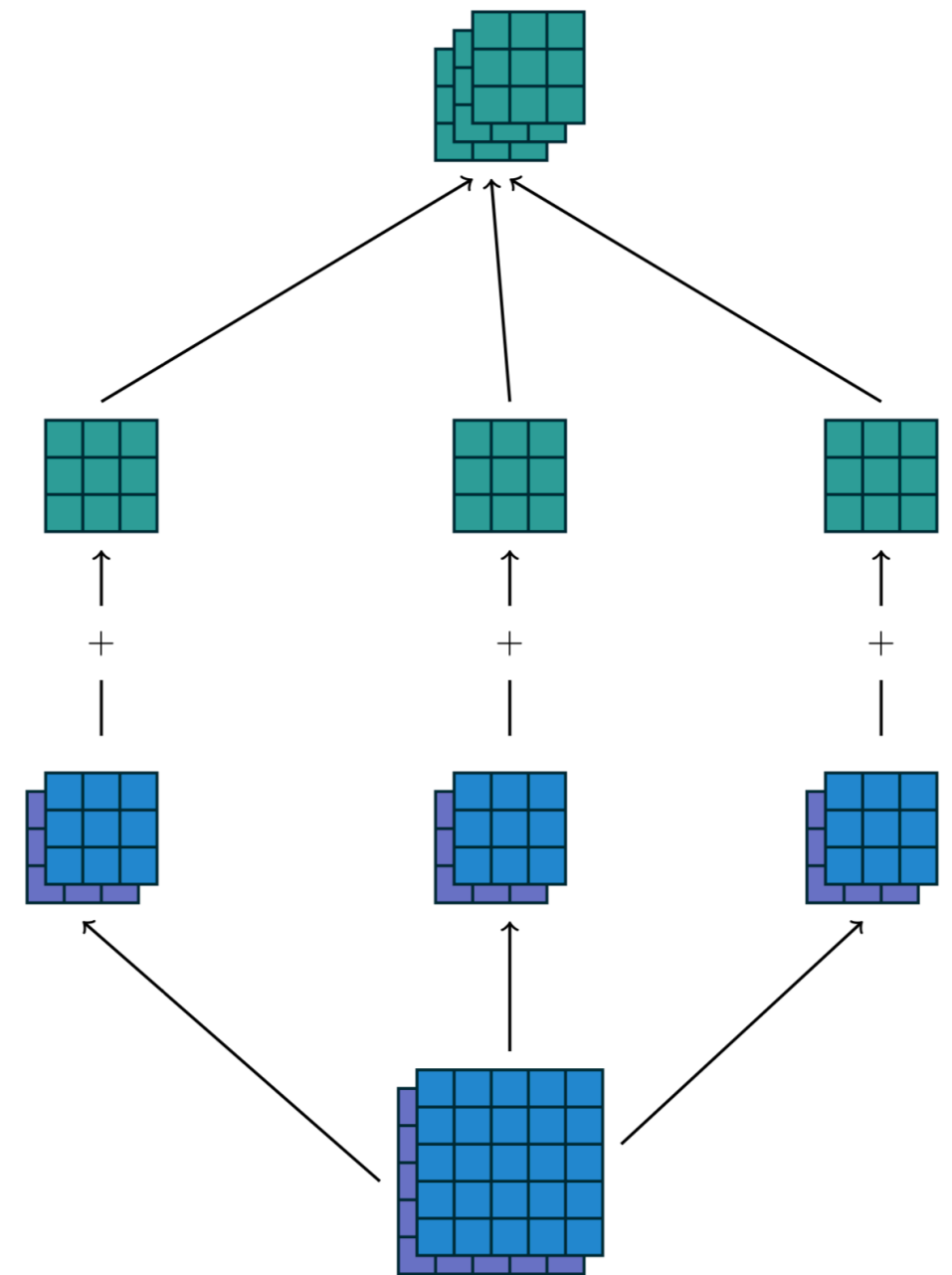
# Convolutional layers in NN (1/2)

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- A convolution layer is made of
  - convolution kernels
  - biases (1 per kernel)
  - an activation function
- Useful because
  - reduces #parameters
  - encodes translation invariance

# Convolutional layers in NN (2/2)

- Multiple input channel case
  - sum the response over all channels
- Multiple kernel case
  - each kernel leads to one output channel

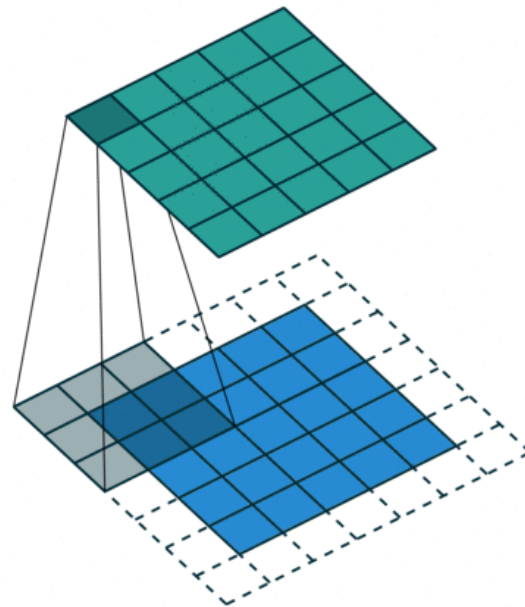


2 input channels, 3 kernels

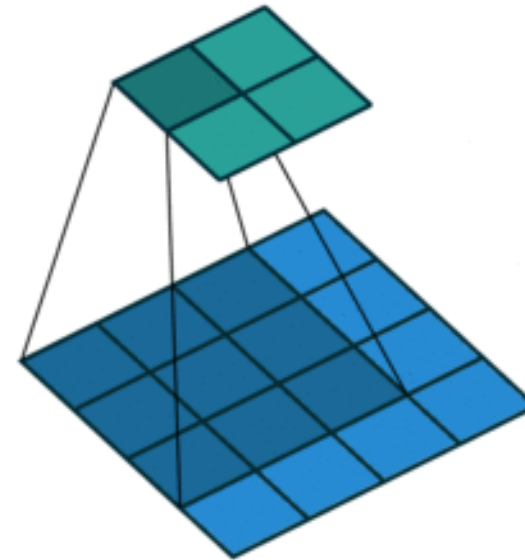
# Convolutional layers in NN: hyper parameters

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- Padding

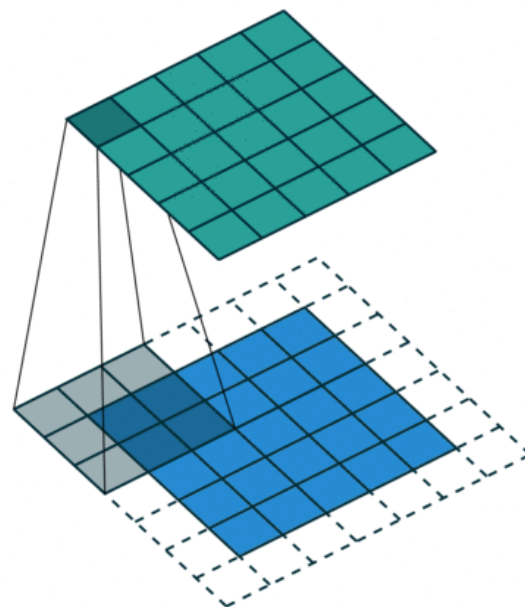


padding="same"

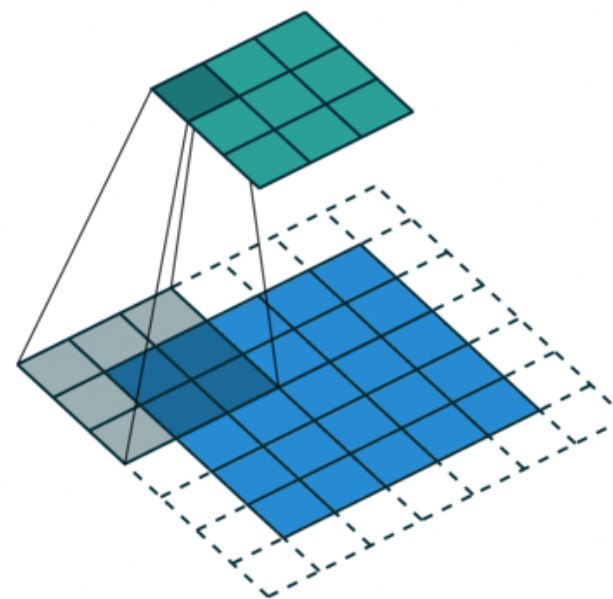


padding="valid"

- Strides



strides=1



strides=2

# Pooling (aka subsampling) layers in NN

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- Max pooling / Average pooling
- Hyper-parameters
  - pool size
  - strides (use None in keras)
  - padding (use "valid" in keras)

3	3	2	1	0
0	0	1	3	1
3	1	2	2	3
2	0	0	2	2
2	0	0	0	1

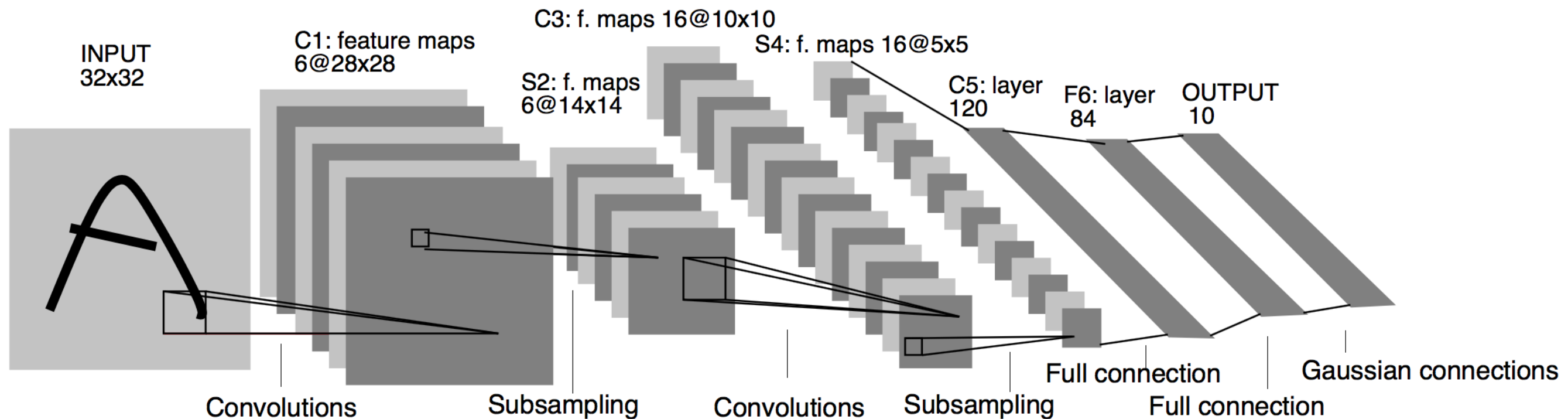
3.0	3.0	3.0
3.0	3.0	3.0
3.0	2.0	3.0

pool\_size=3, strides=1  
(not recommended)

# Convolutional model zoo

## 1. LeNet [LeCun *et al.*, 1989]

- 60k parameters

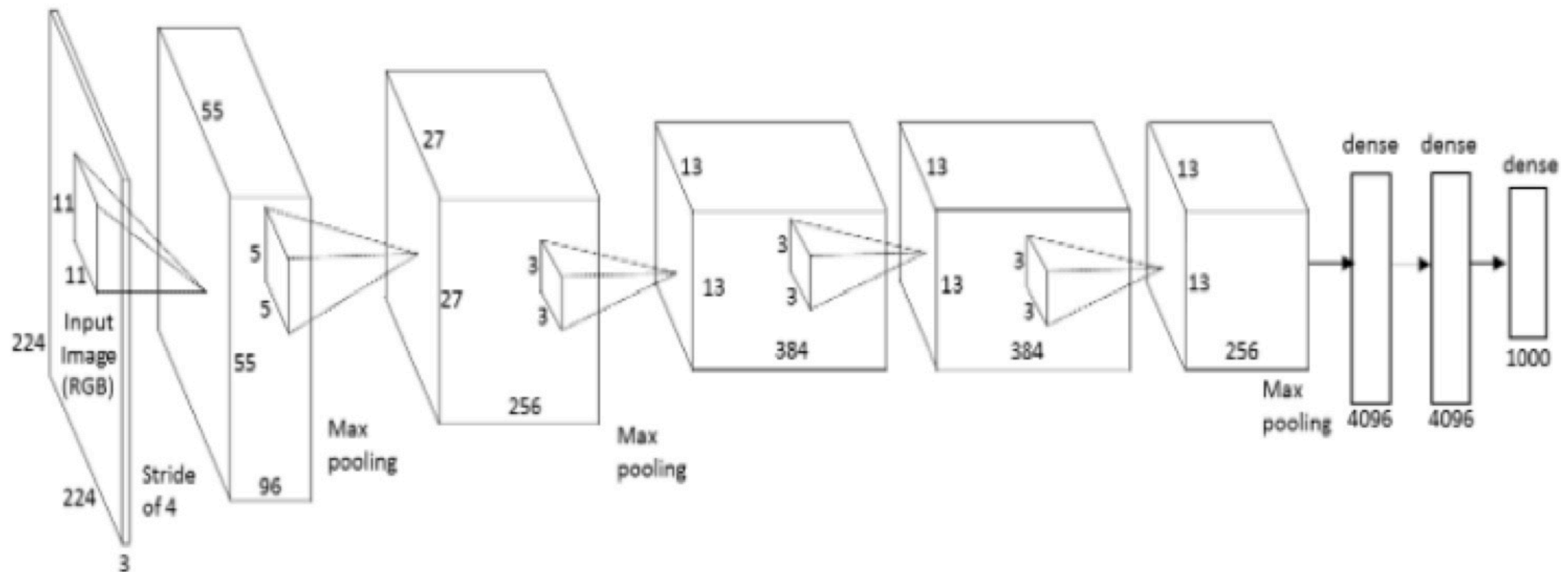


# Convolutional model zoo

## 2. AlexNet [Krizhevsky *et al.*, 2012]

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- 60M parameters

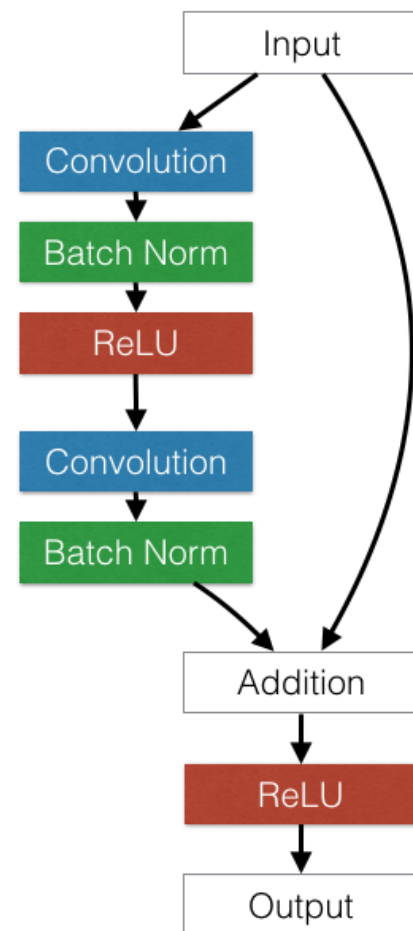




# Convolutional model zoo

## 3. Residual Networks [He *et al.*, 2016]

- Aims at facing the *vanishing gradient* effect
- ResNet-110: ~2M parameters



Q: How do I know what architecture to use?

A: don't be a hero.

1. Take whatever works best on ILSVRC (latest ResNet)
2. Download a pretrained model
3. Potentially add/delete some parts of it
4. Finetune it on your application.



Andrej Karpathy,  
Deep Learning Summer School,  
2016