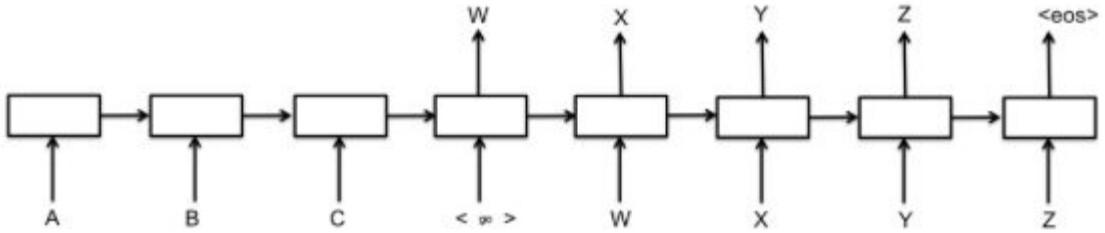
Show and Tell

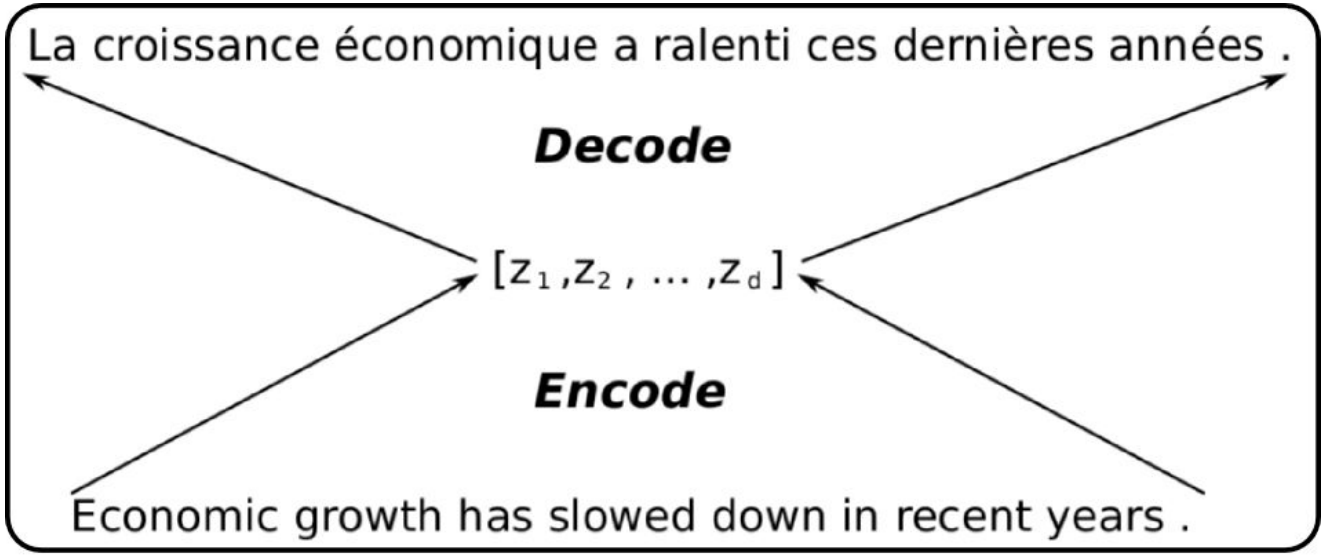
1. Intro/Demo
2. Architecture
3. Show
4. Tell

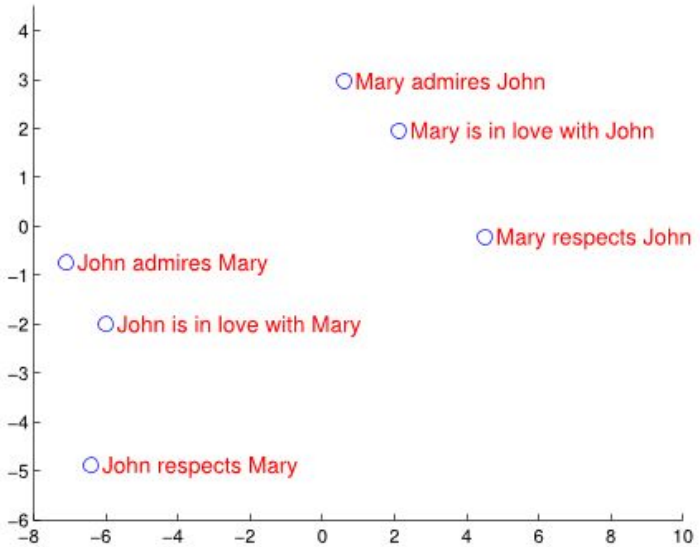
Captions for image dinner.jpg:
0) a group of people sitting around a dinner table . (p=0.014804)
1) a group of people sitting around a table with food . (p=0.003402)
2) a group of people sitting at a table with plates of food . (p=0.001879)

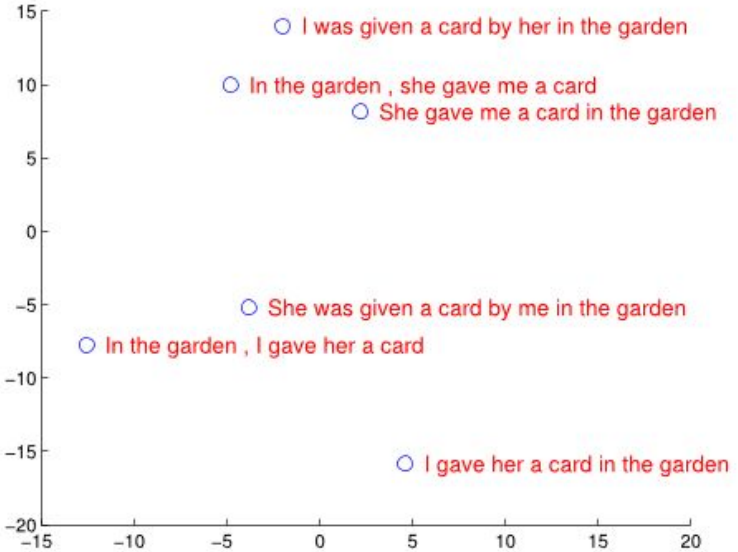
Encoder-Decoder



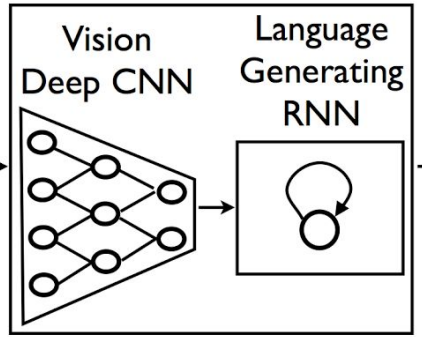
“Sequence to Sequence Learning with Neural Networks” (Sutskever, 2014)


La croissance économique a ralenti ces dernières années .
Decode
[z1 ,z2 , ... ,zd]
Encode
Economic growth has slowed down in recent years .





PCA projection of LSTM hidden states



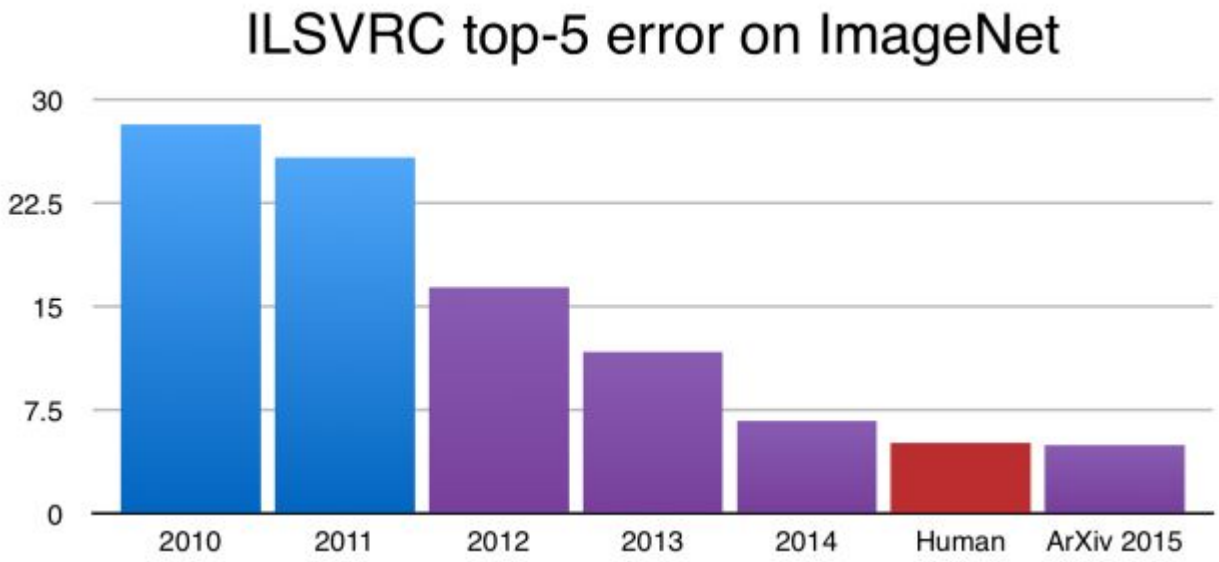
A group of people shopping at an outdoor market.

There are many vegetables at the fruit stand.

ImageNet/Large Scale Visual Recognition Challenge

Classification

- 1.2 million images in training set
- 100,000 test set
- 1000 categories
- Predict 5 out of 1000

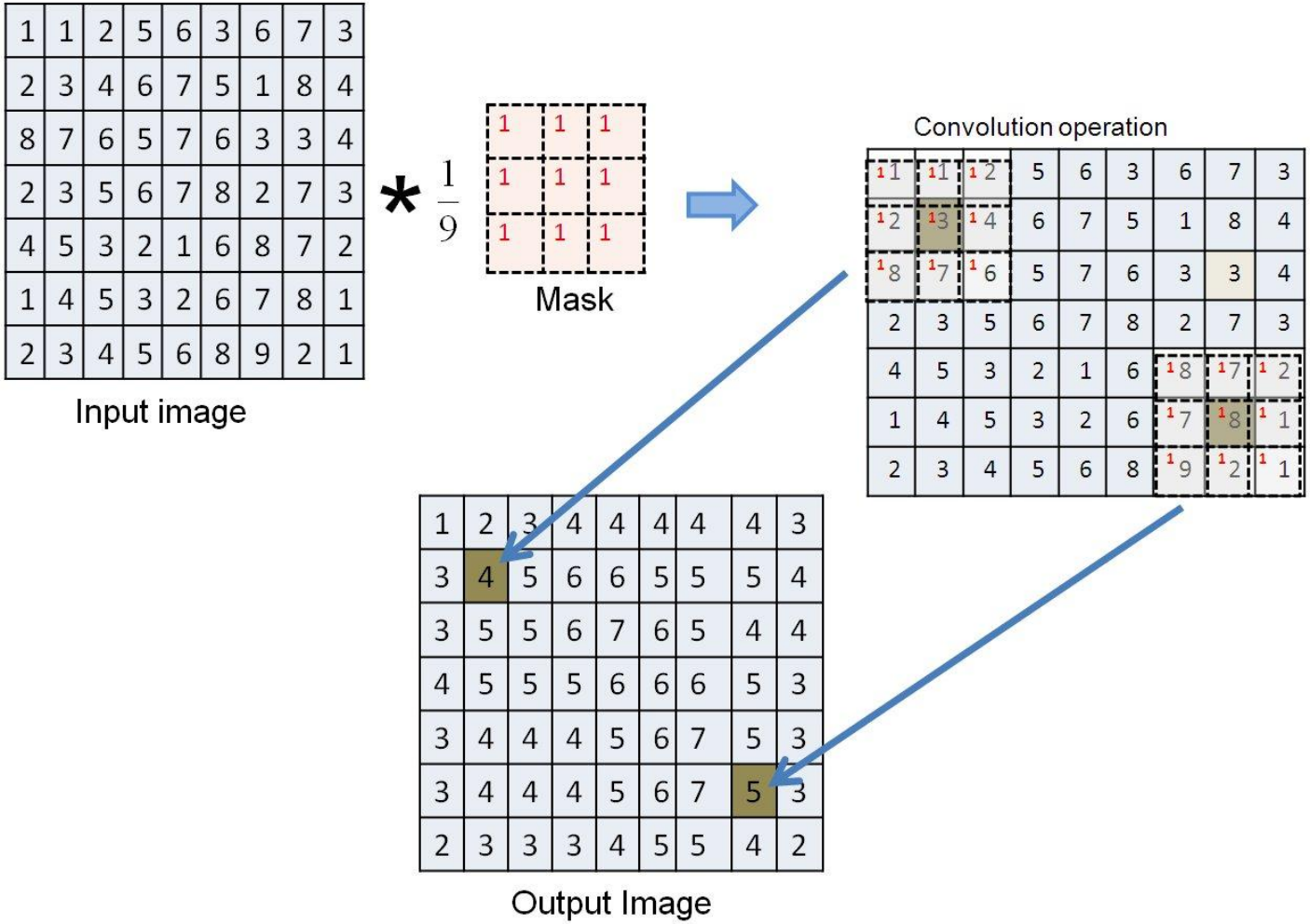

ILSVRC top-5 error on ImageNet
30
22.5
15
7.5
0
2010
2011
2012
2013
2014
Human
ArXiv 2015

Convolution

I_{11}	I_{12}	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}
I_{21}	I_{22}	I_{23}	I_{24}	I_{25}	I_{26}	I_{27}	I_{28}	I_{29}
I_{31}	I_{32}	I_{33}	I_{34}	I_{35}	I_{36}	I_{37}	I_{38}	I_{39}
I_{41}	I_{42}	I_{43}	I_{44}	I_{45}	I_{46}	I_{47}	I_{48}	I_{49}
I_{51}	I_{52}	I_{53}	I_{54}	I_{55}	I_{56}	I_{57}	I_{58}	I_{59}
I_{61}	I_{62}	I_{63}	I_{64}	I_{65}	I_{66}	I_{67}	I_{68}	I_{69}

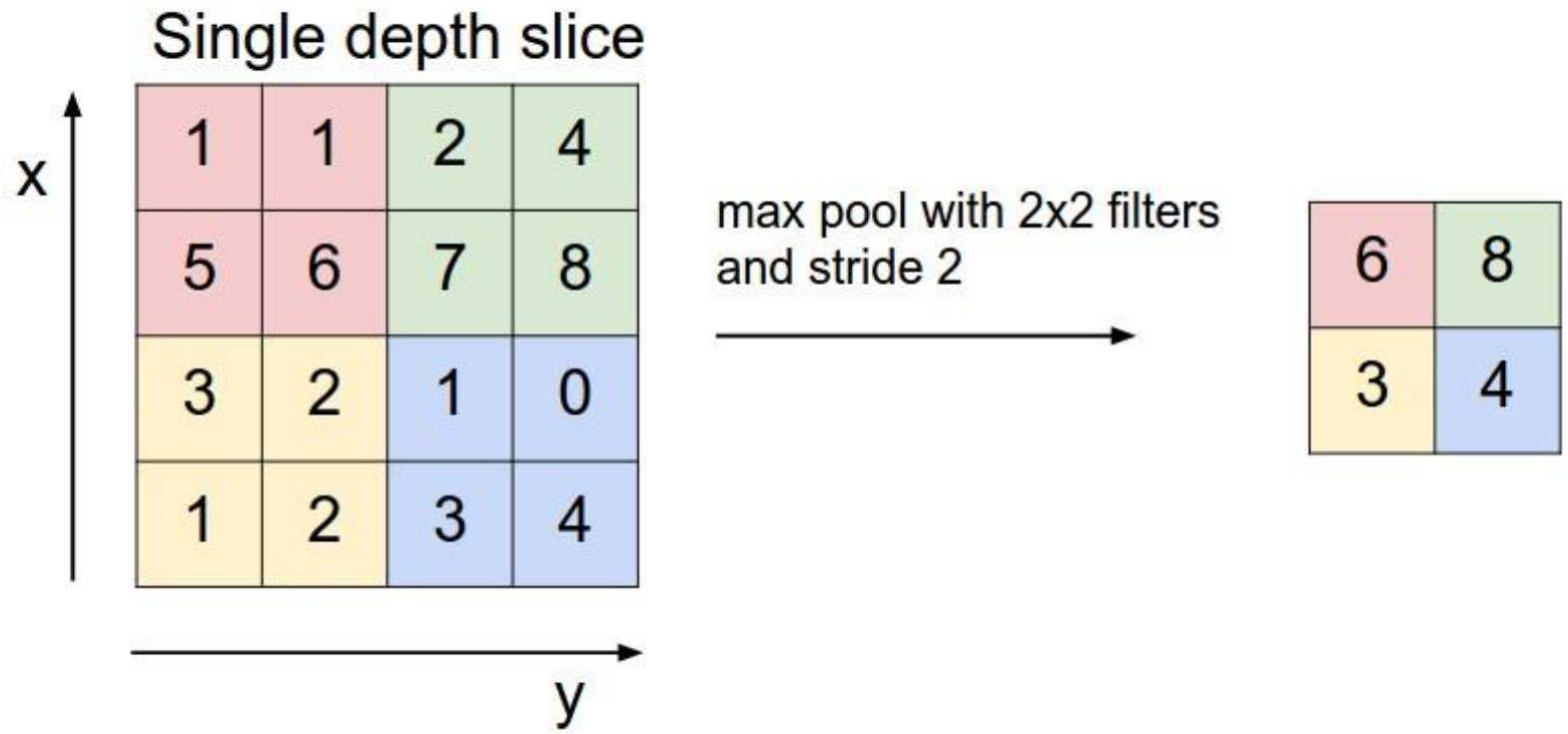
K_{11}	K_{12}	K_{13}
K_{21}	K_{22}	K_{23}

$$O(i,j) = \sum_{k=1}^{m} \sum_{l=1}^{n} I(i+k-1, j+l-1) K(k,l)$$

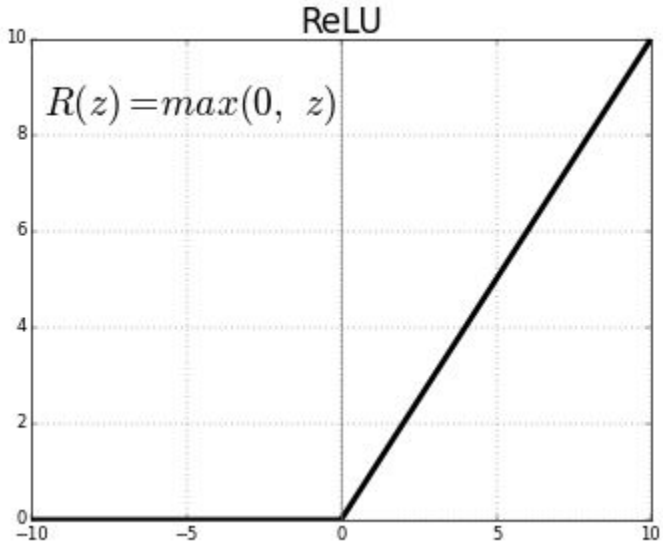

1 1 2 5 6 3 6 7 3
2 3 4 6 7 5 1 8 4
8 7 6 5 7 6 3 3 4
2 3 5 6 7 8 2 7 3
4 5 3 2 1 6 8 7 2
1 4 5 3 2 6 7 8 1
2 3 4 5 6 8 9 2 1
Input image
* 1/9
1 1 1
1 1 1
1 1 1
Mask
Convolution operation
1 2 3 4 4 4 4 4 3
3 4 5 6 6 5 5 5 4
3 5 5 6 7 6 5 4 4
4 5 5 5 6 6 6 5 3
3 4 4 4 5 6 7 5 3
3 4 4 4 5 6 7 5 3
2 3 3 3 4 5 5 4 2
Output Image

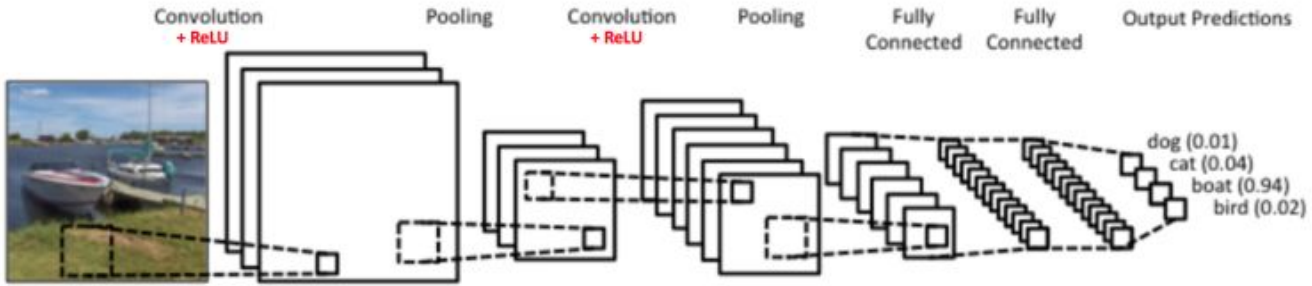
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

Max Pooling

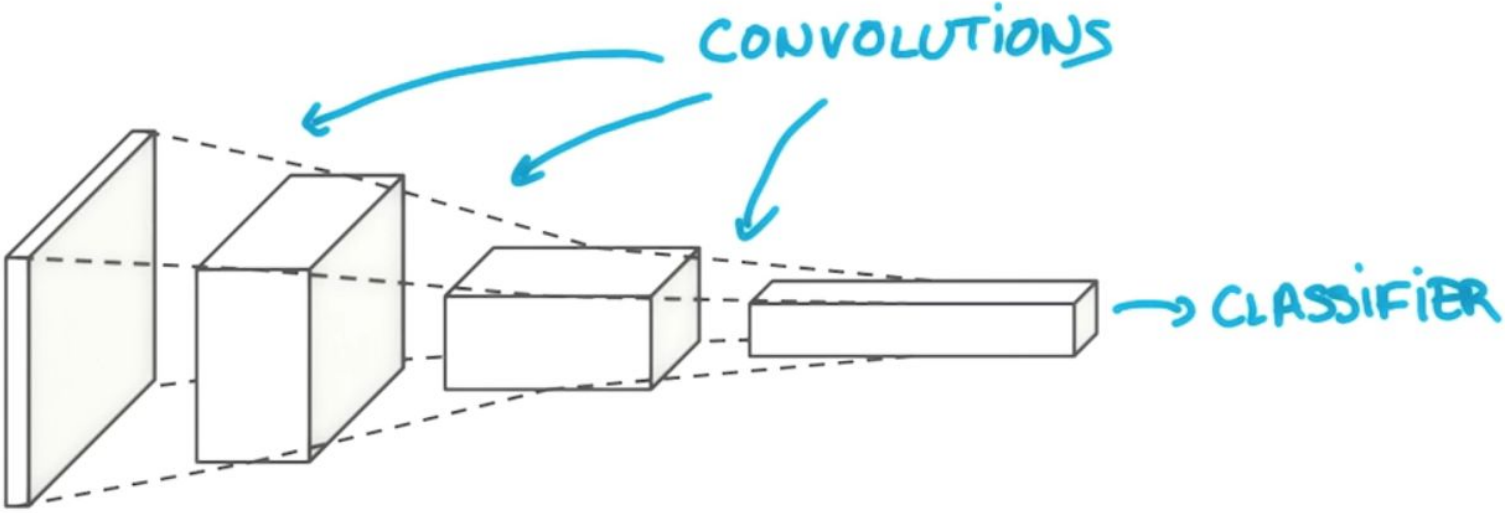

Single depth slice
x
y
1 1 2 4
5 6 7 8
3 2 1 0
1 2 3 4
max pool with 2x2 filters
and stride 2
6 8
3 4

ReLu




Convolution
+ ReLU
Pooling
Convolution
+ ReLU
Pooling
Fully
Connected
Fully
Connected
Output Predictions
dog (0.01)
cat (0.04)
boat (0.94)
bird (0.02)

CONVOLUTIONAL PYRAMID



256x256 RGB → 128x128x16 → 64x64x64 → 32x32x256 …

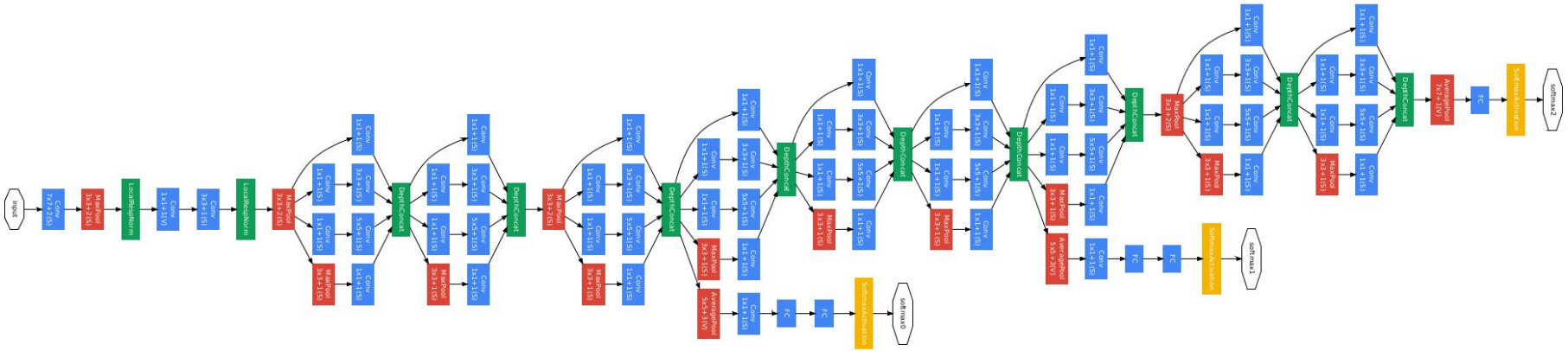
SPACE → DEPTH = SEMANTIC REPRESENTATION

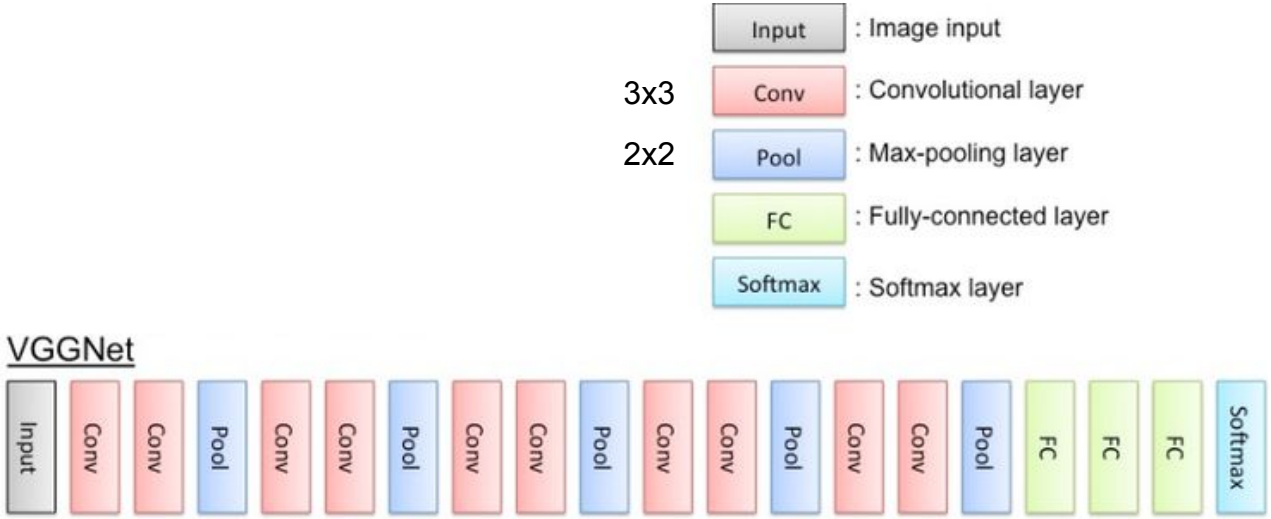
Going deeper with convolutions, 2014 (GoogLenet)

M. Lin: Network In Network, 2013

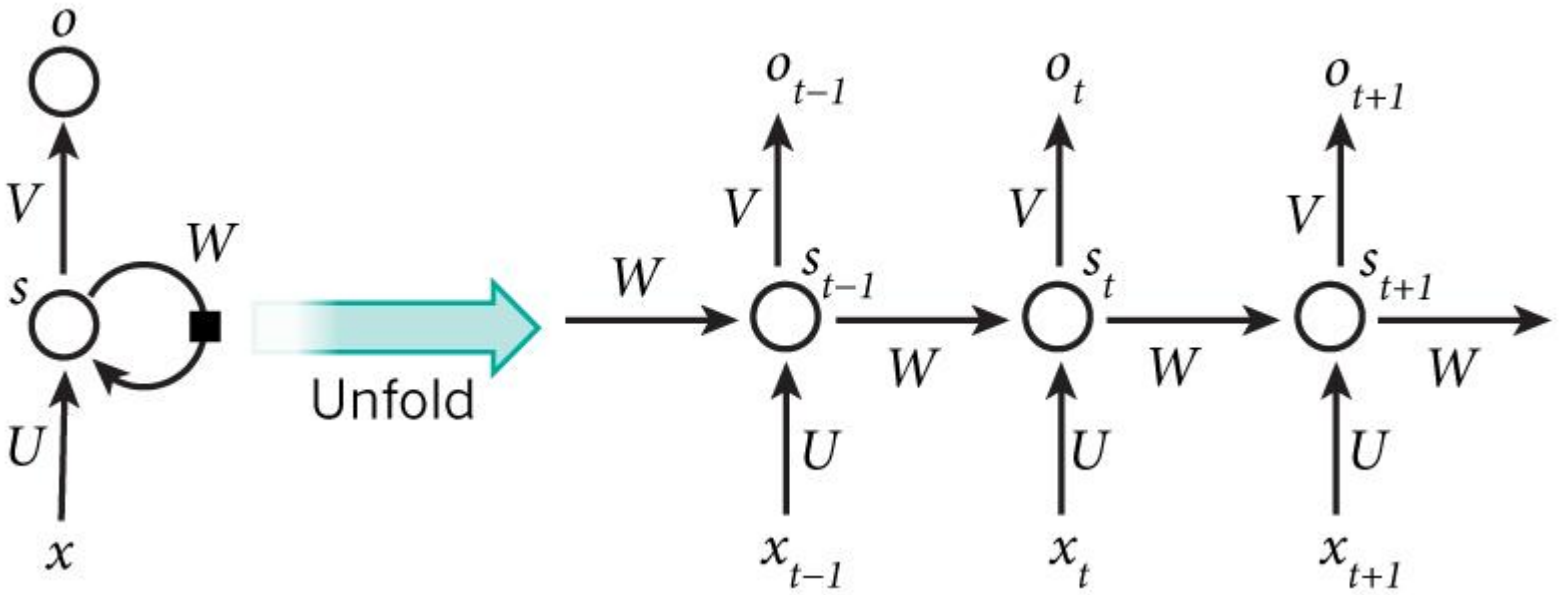
Provable bounds for learning some deep representations, 2014

Parameters: 4M VS 140M (VGGNet)

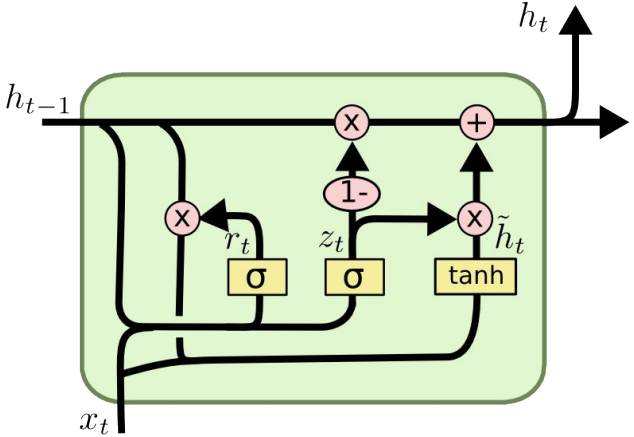



Input : Image input
3x3
Conv : Convolutional layer
2x2
Pool : Max-pooling layer
FC : Fully-connected layer
Softmax : Softmax layer
VGGNet
Input
Conv
Conv
Pool
Conv
Conv
Pool
Conv
Conv
Pool
Conv
Conv
Pool
Conv
Conv
Pool
FC
FC
FC
Softmax

RNN



LSTM



$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$

$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$

$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$

$$h_t = (1 - z_t) * h_{t-1} + z_t * \tilde{h}_t$$