

Deep Learning

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Direction Générale des Impôts

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Content

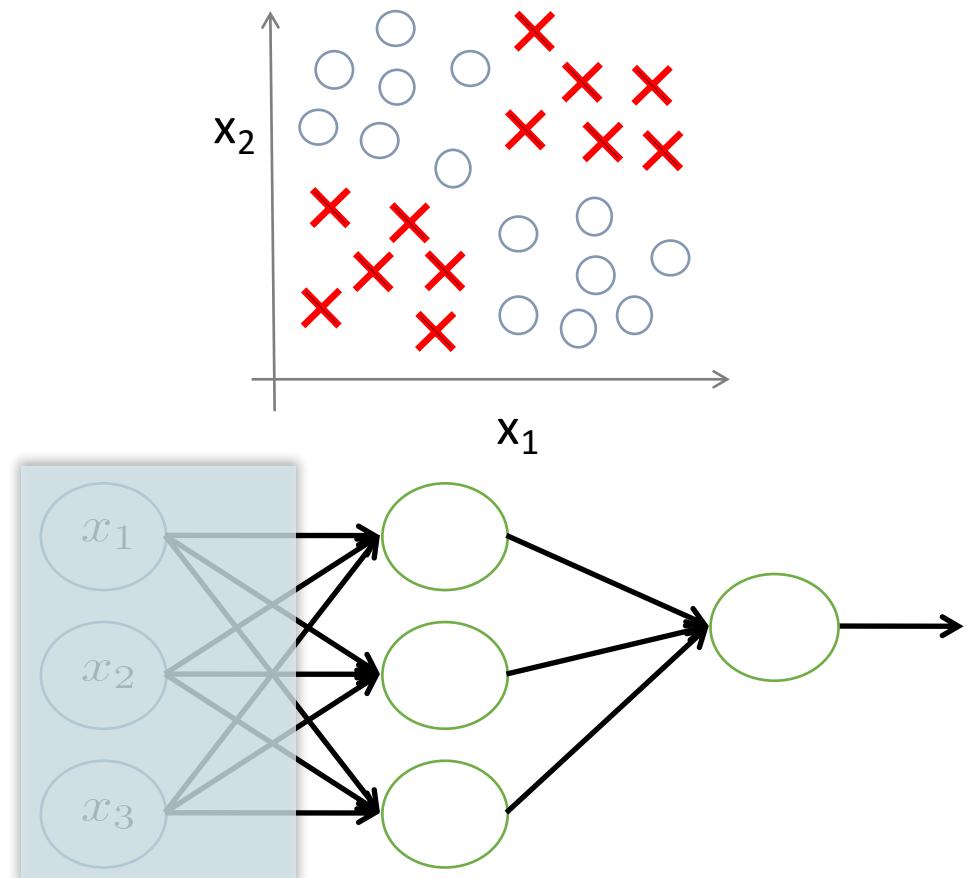
1. Artificial Neural Networks
2. Convolutional Neural Networks
3. Sequence Models
4. Generative Adversarial Networks
5. OCR using ConvNets

Artificial Neural Networks

- Why ANN?
- Example and Intuition
- Deep Neural Networks
- Activation Functions
- Loss Functions
- Reduce Overfitting

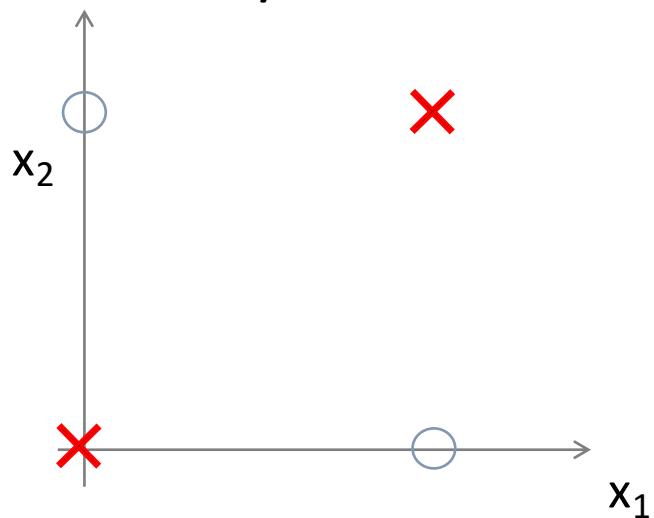
Why ANN?

- Structured vs unstructured data
- Why ANN?
 - Learn Features by it self
 - Data non linearly separable
 - Network of Perceptrons



Example and Intuition

XOR/XNOR

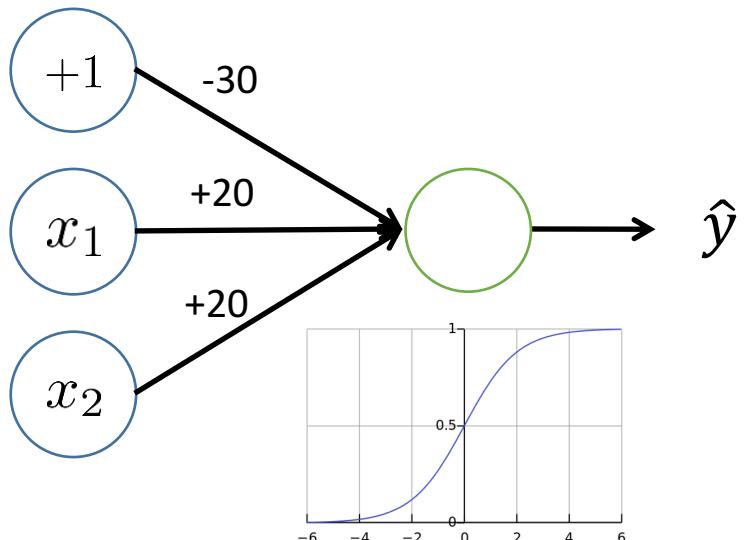


x_1	x_2	\hat{y}
0	0	1
0	1	0
1	0	0
1	1	1

x_1, x_2 are binary (0 or 1)

Example and Intuition

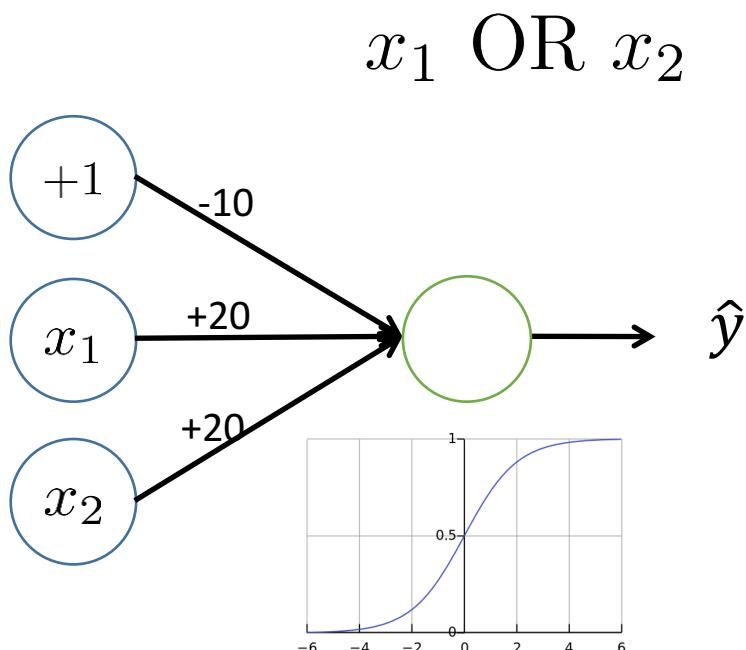
$$y = x_1 \text{ AND } x_2$$



$$x_1, x_2 \in \{0, 1\}$$

x_1	x_2	\hat{y}
0	0	≈ 0
0	1	≈ 0
1	0	≈ 0
1	1	≈ 1

Example and Intuition

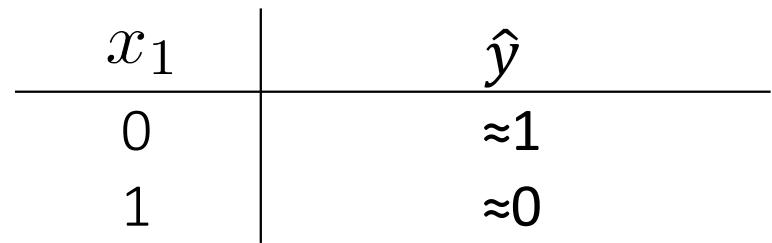
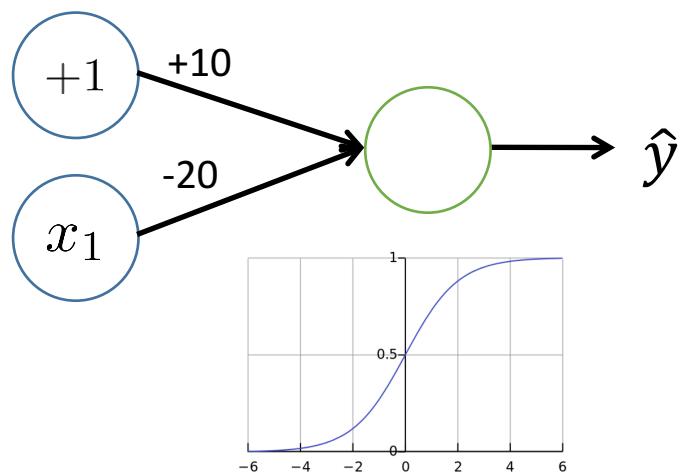


$$x_1, x_2 \in \{0, 1\}$$

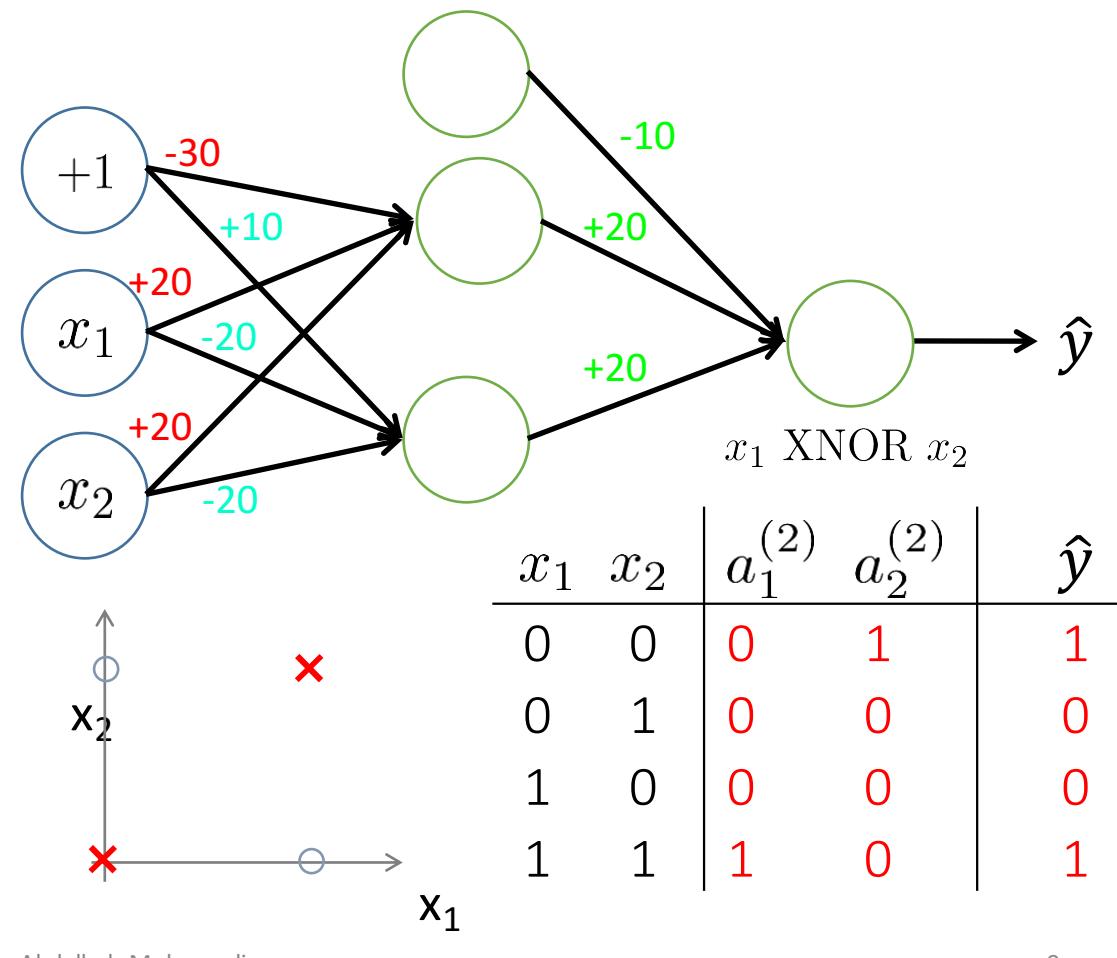
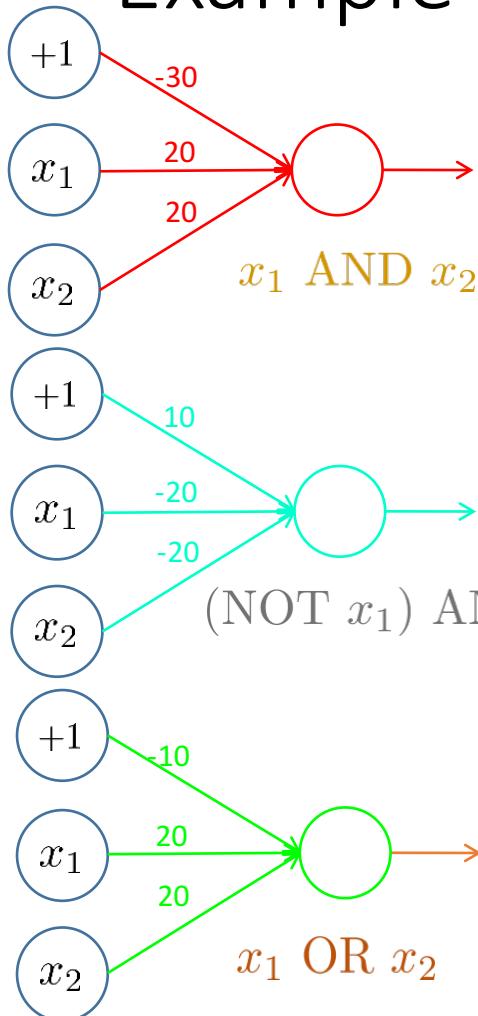
x_1	x_2	\hat{y}
0	0	≈ 0
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1	1	≈ 1

Example and Intuition

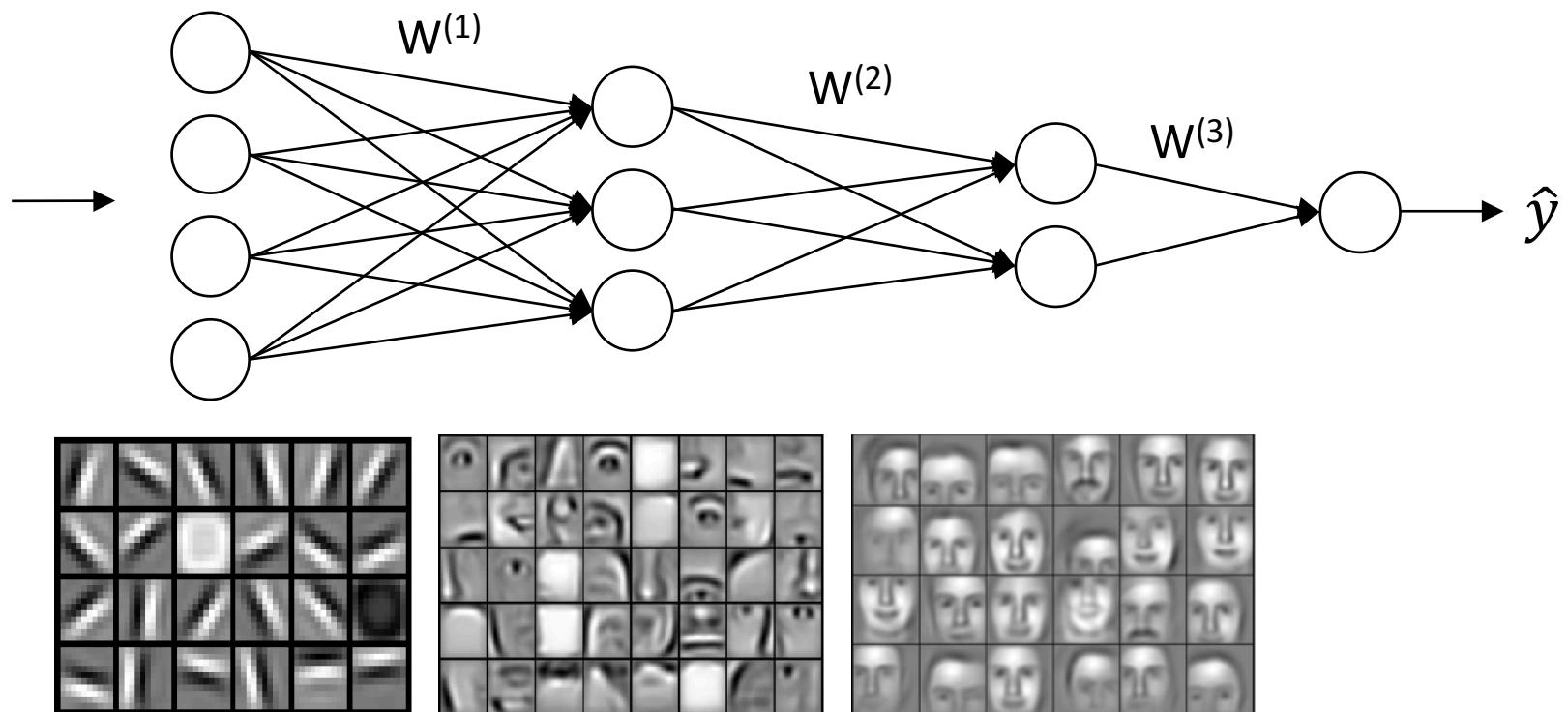
NOT x_1



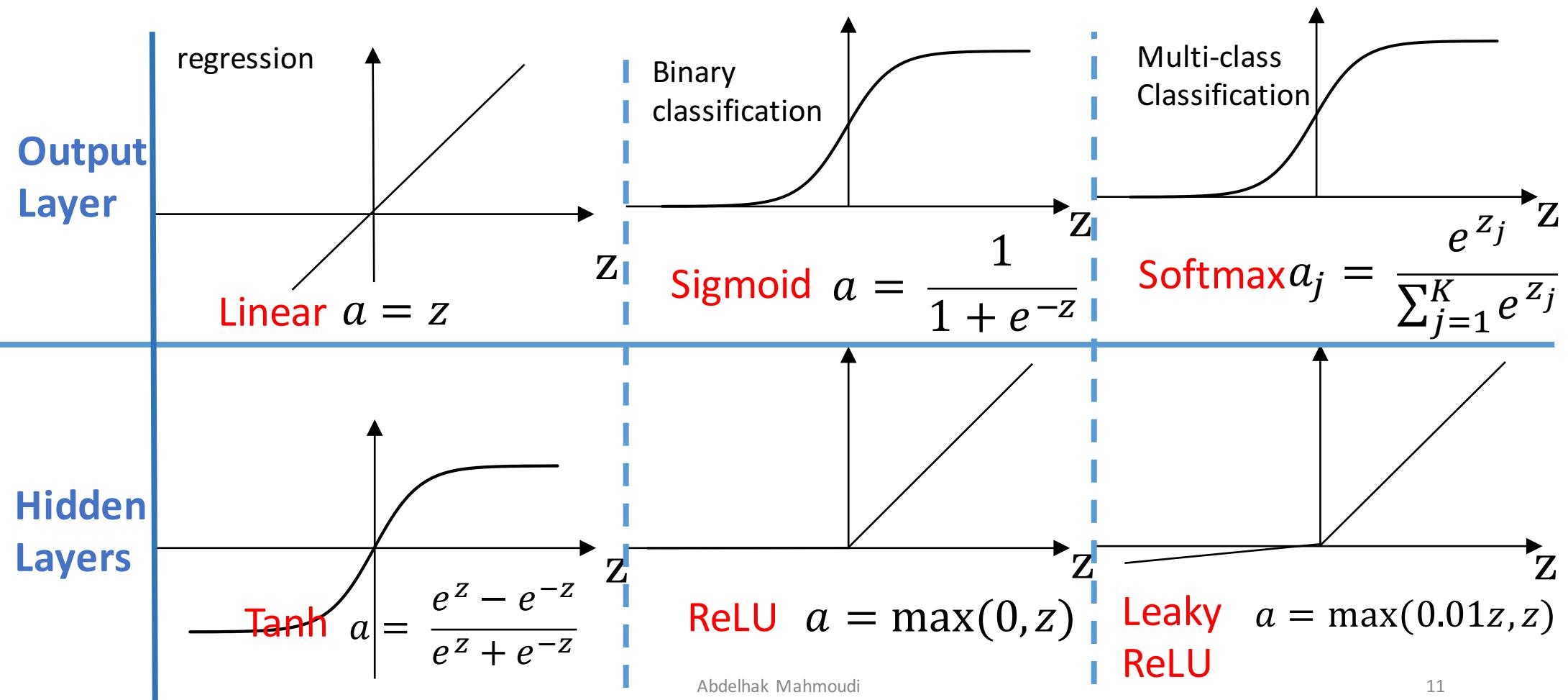
Example and Intuition



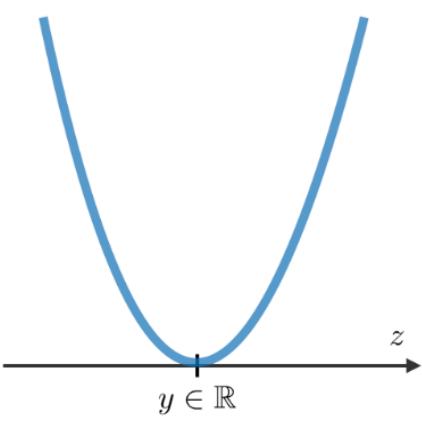
Deep Neural Networks



Activation Functions

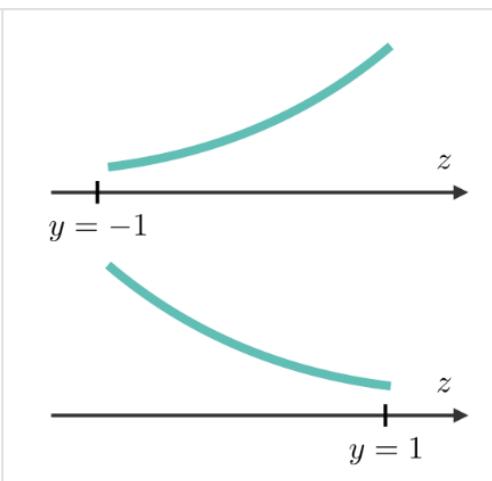


Loss functions



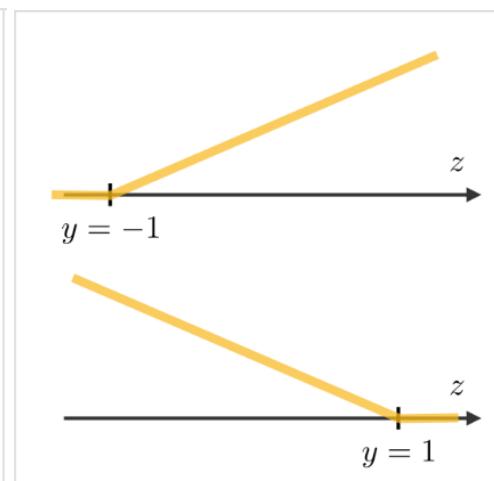
$$L_i(\hat{y}, y) = (\hat{y} - y)^2$$

Least squares loss



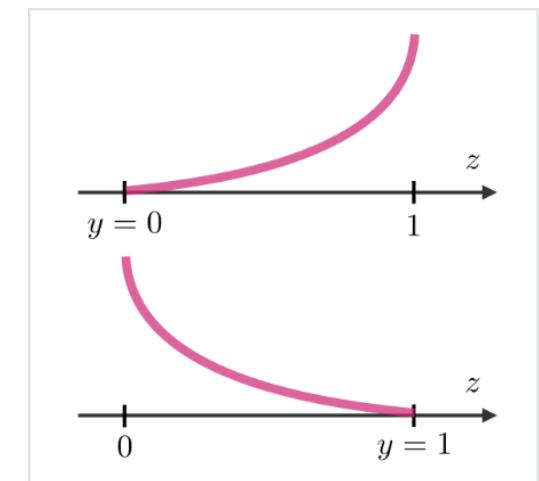
$$L_i(\hat{y}, y) = \log(1 + \exp(-\hat{y} y))$$

Logistic loss



$$L_i(\hat{y}, y) = (1 - \hat{y} y)_+$$

Hinge loss



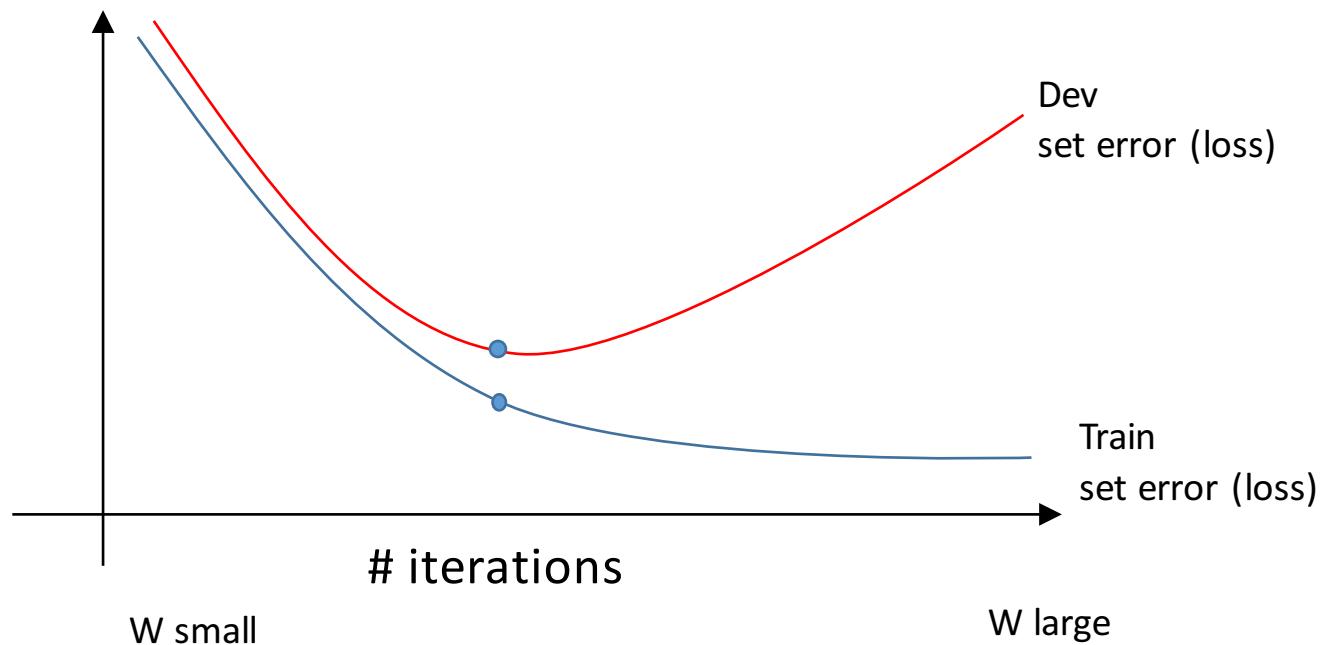
$$L_i(\hat{y}, y) = -(y \log(\hat{y}) + (1 - y) \log(1 - \hat{y}))$$

Cross Entropy loss

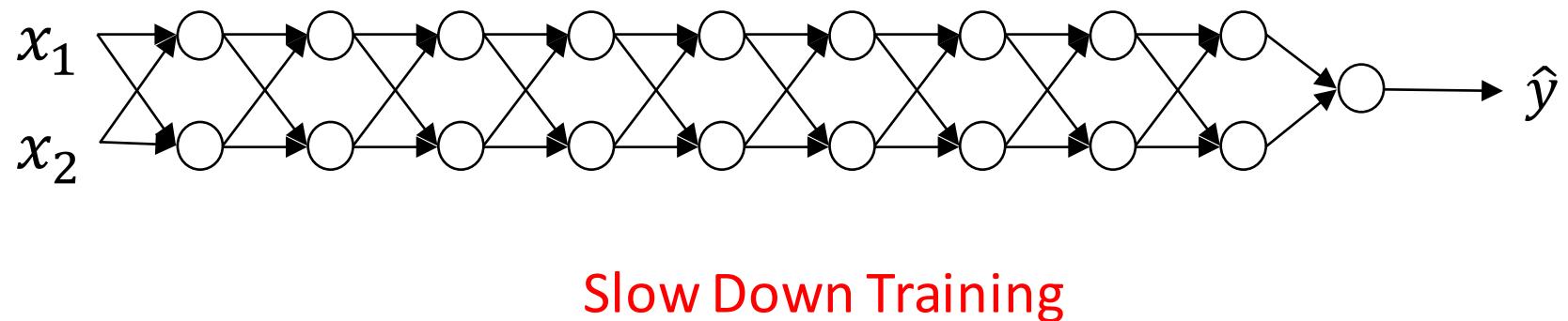
$$\text{With } K \text{ classes: } L_i(\hat{y}, y) = - \sum_{k=1}^K y_k \log(\hat{y}_k)$$

Reduce Overfitting

- Regularization
- Dropout
- Data Augmentation
- Early Stopping

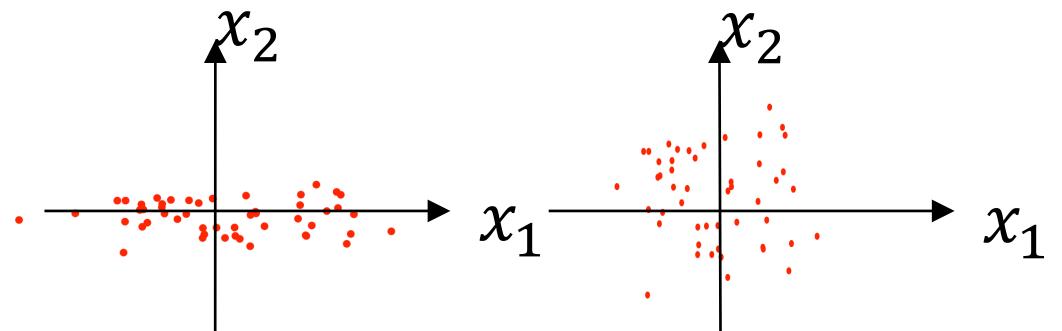


Vanishing/exploding gradients

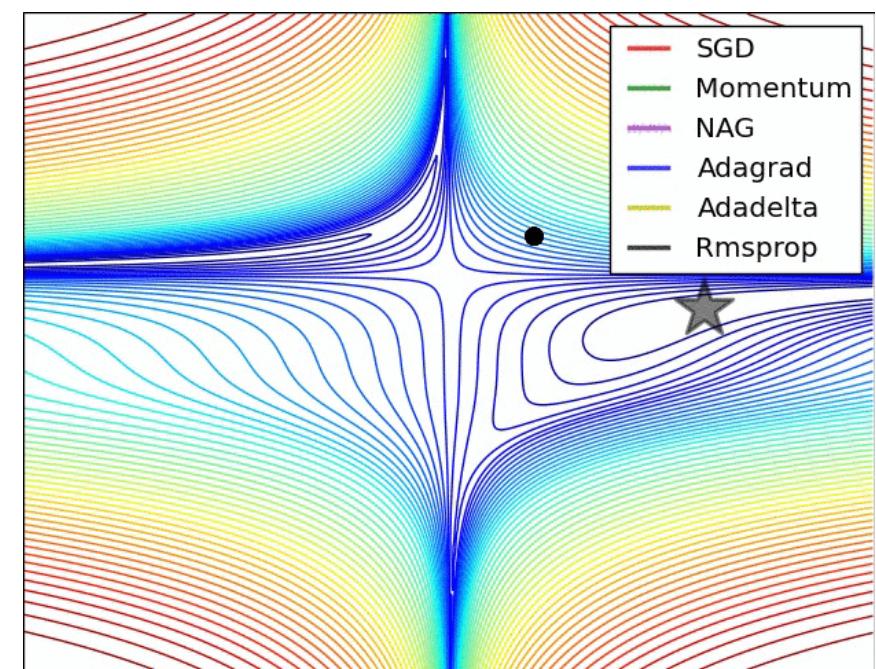
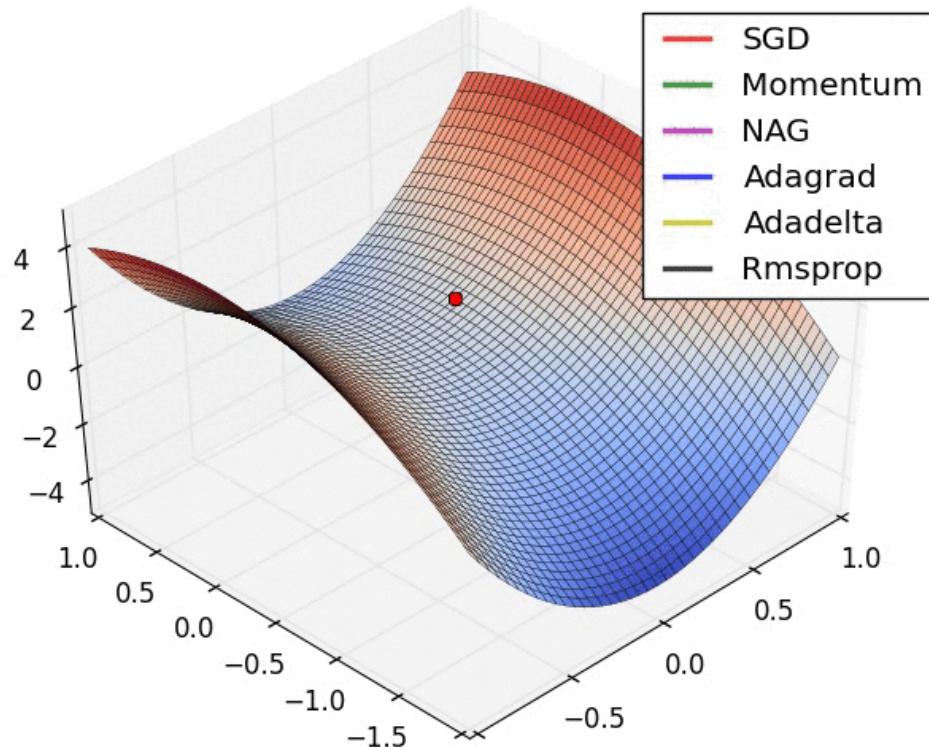


Speedup Training

- Batch Normalization
- Random Initialization
 - Glorot, He, etc.
- Gradient Checking



Optimization Methods



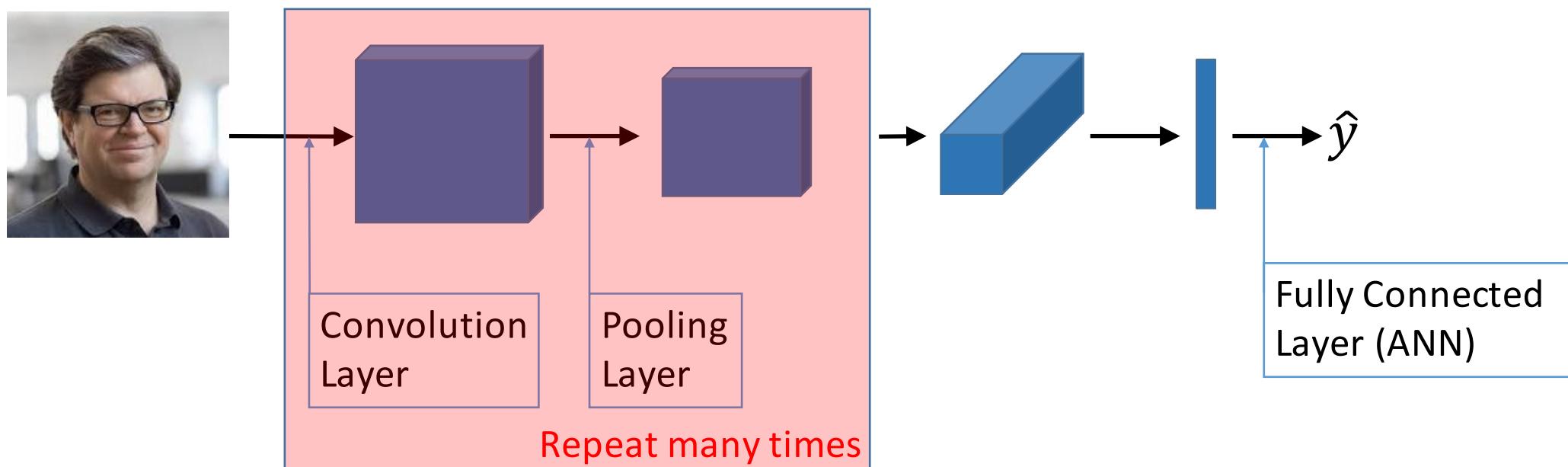
Tune Hyper-parameters

- α, L, s_l , mini-batch size, epochs, etc.
- $\beta, \beta_1, \beta_2, \varepsilon$, etc. (optimization hyper-parameters)
- Etc.

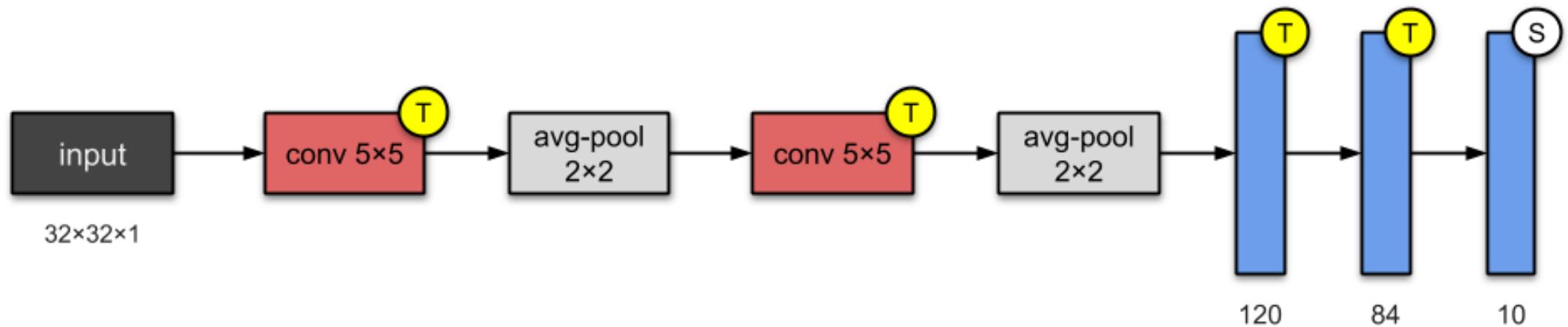
Convolutional Neural Networks

- General Architecture
- Existing Architectures
- Transfer Learning
- CNN for Computer Vision

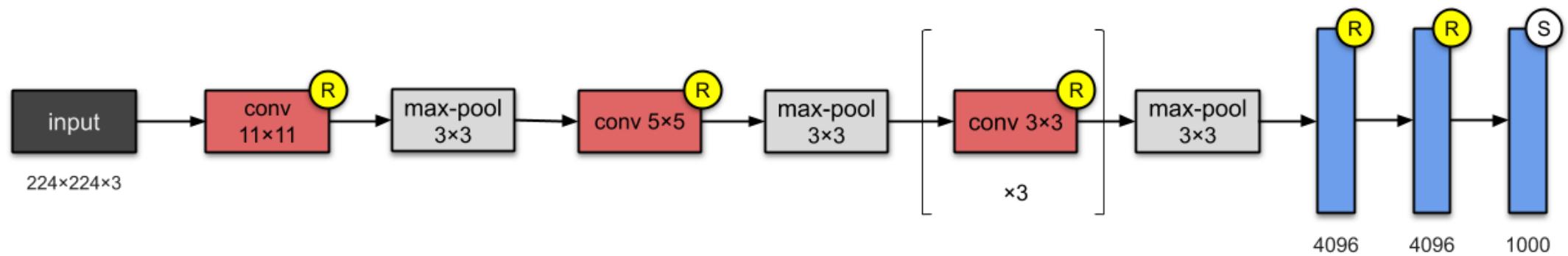
CNN: General Architecture



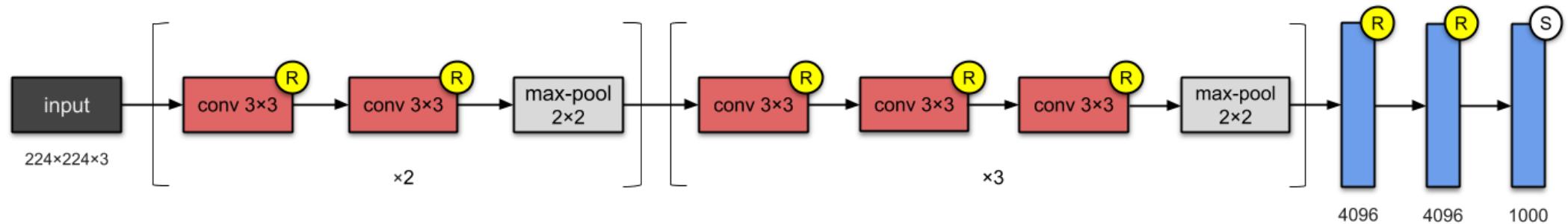
LeNet-5 (60K parameters, 1998)



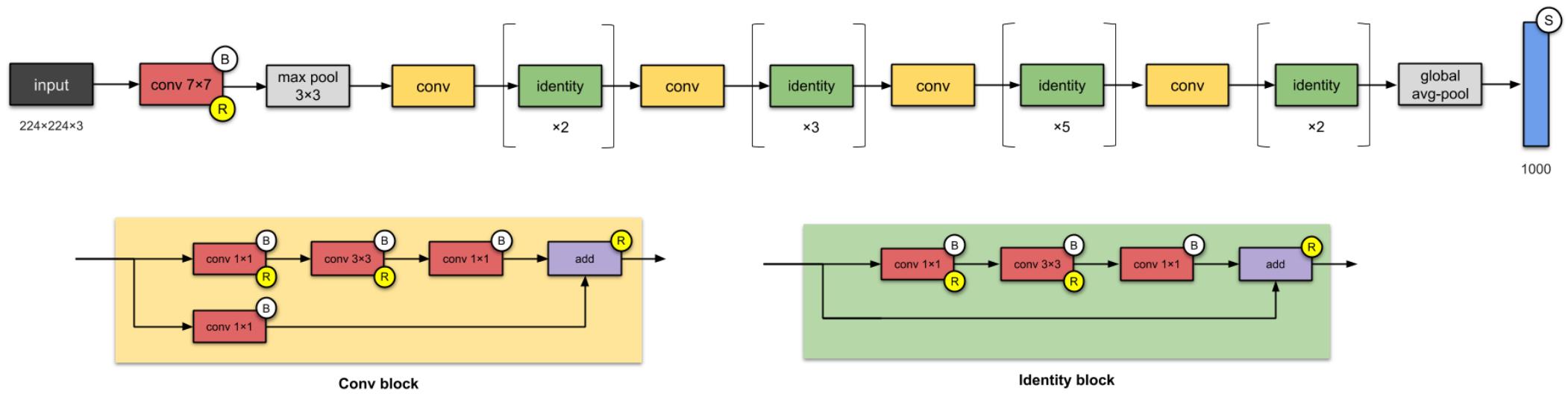
AlexNet (60M parameters, 2012)



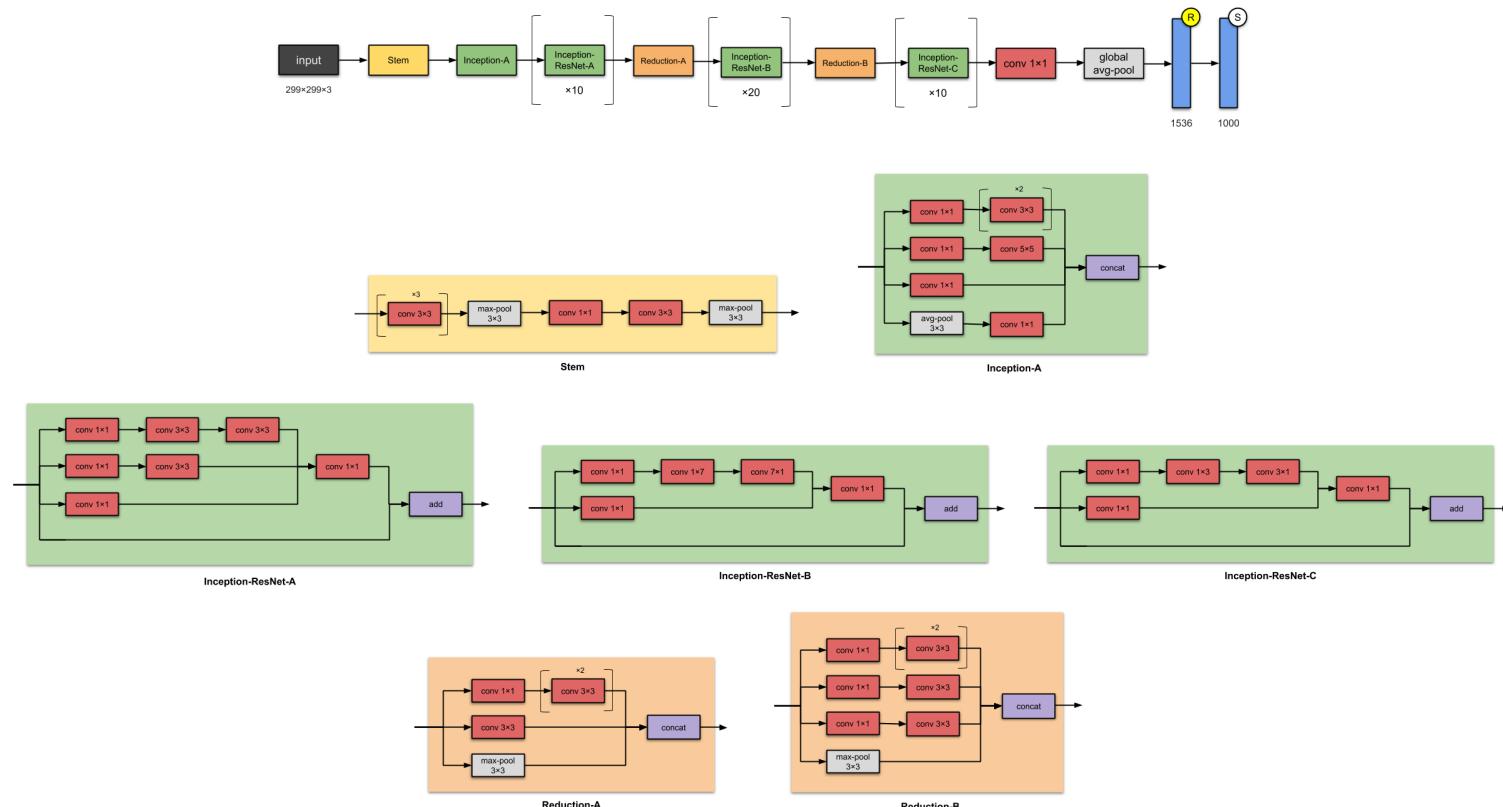
VGG-16 (138M parameters, 2015)



ResNets50 (25.5M parameters, 2015)

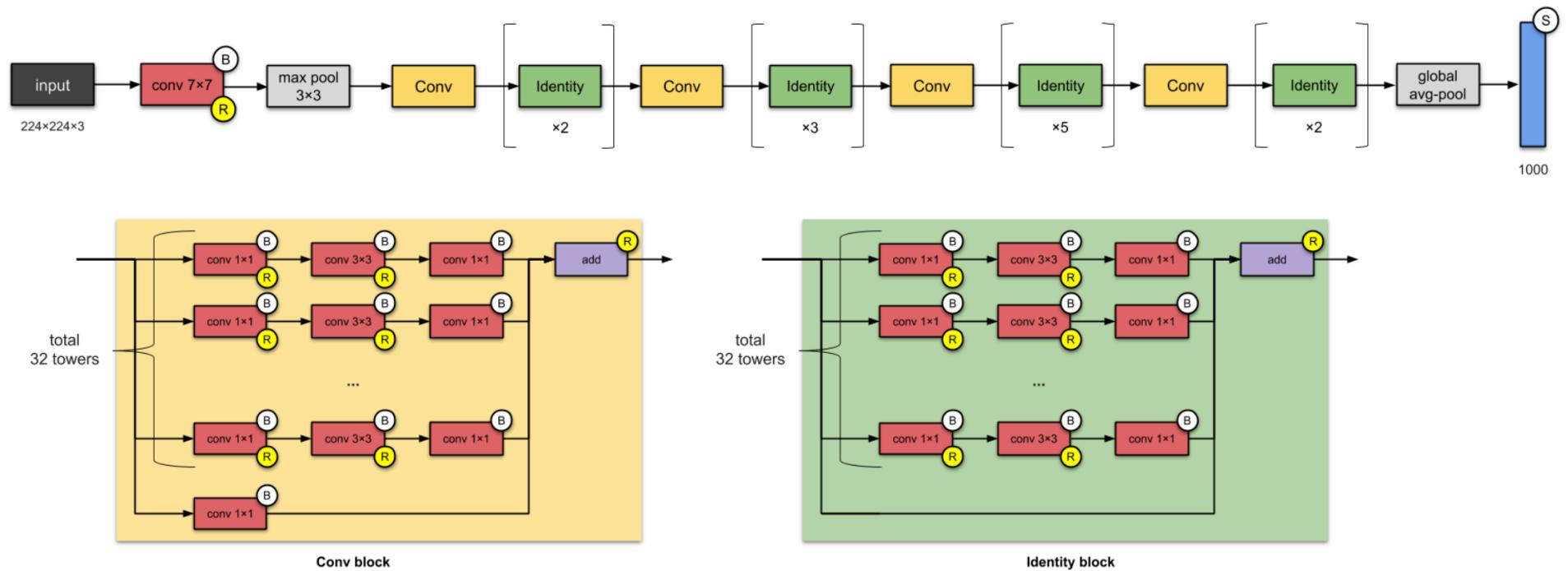


Inception-ResNet-V2 (56M parameters, 2016)



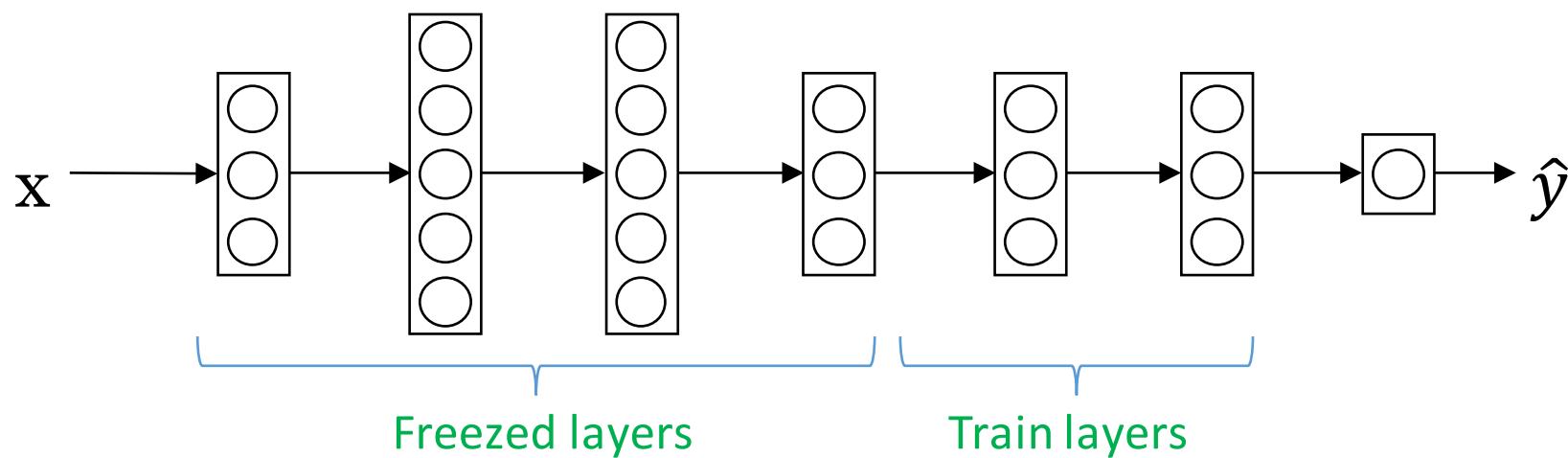
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ResNeXt50(25M parameters, 2017)



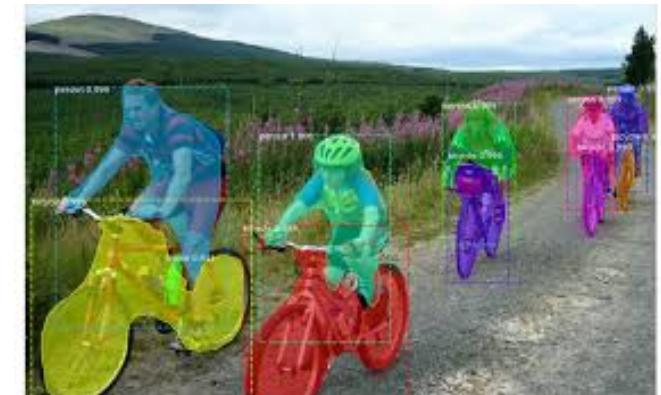
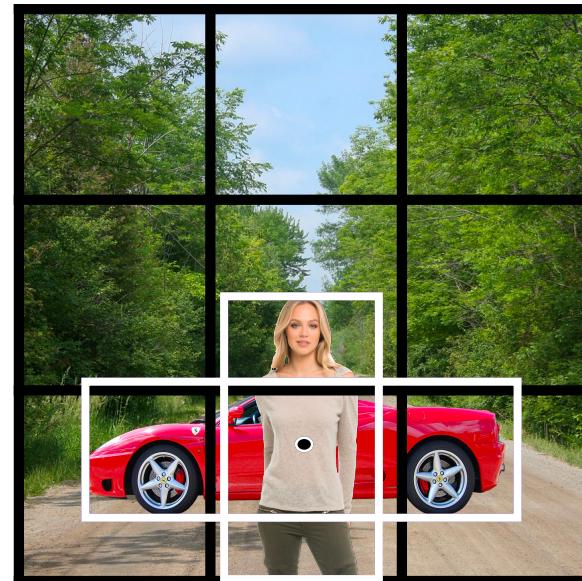
Transfer learning

- **Very few data:** Rather than training the network from scratch, you can use weights already learned from another task.
- **Not enough data:** Download the architecture and the weights as well
- **Enough data**, use the transferred weights as **initialization weights**.



CNN for Computer Vision

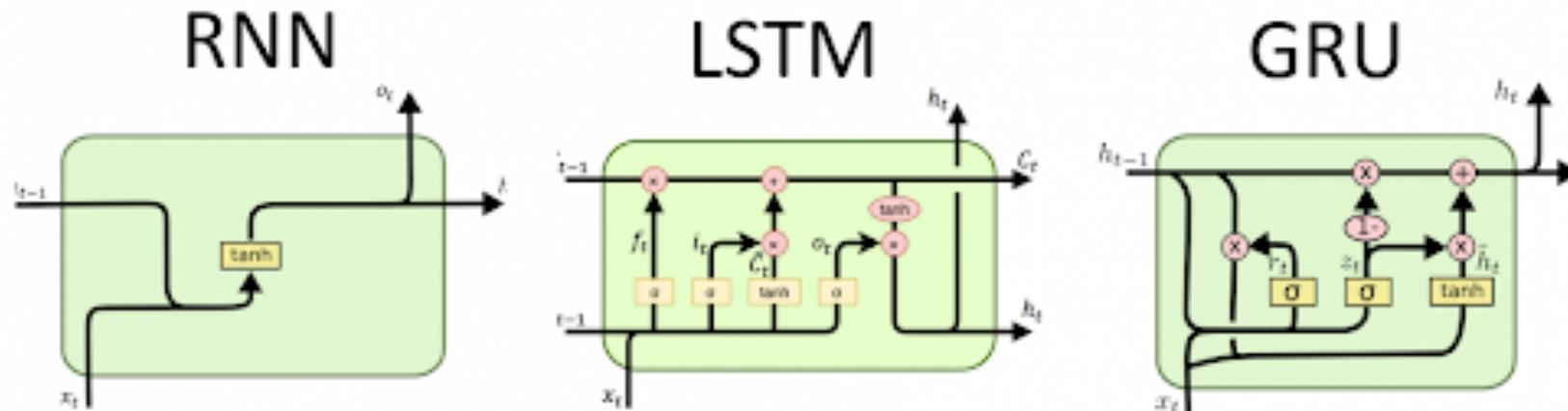
- YOLO
- R-CNN
- Fast R-CNN
- Faster R-CNN
- Mask-RCNN
- Info-RCNN
- Cycle-RCNN
- Etc.



Sequence Models

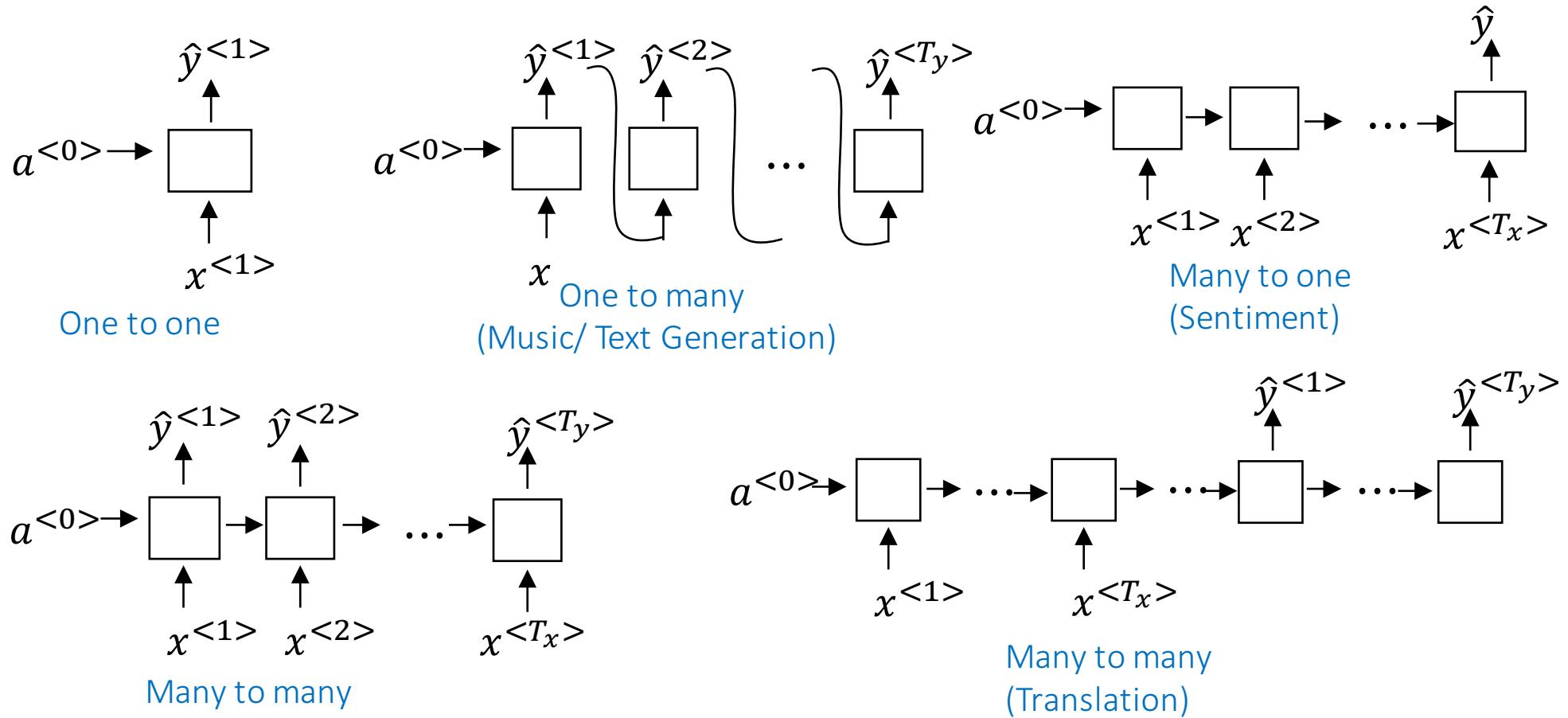
- Recursive Neural Networks, LSTM and GRU
- Sequence to Sequence Models
- Applications

RNN, LSTM, GRU



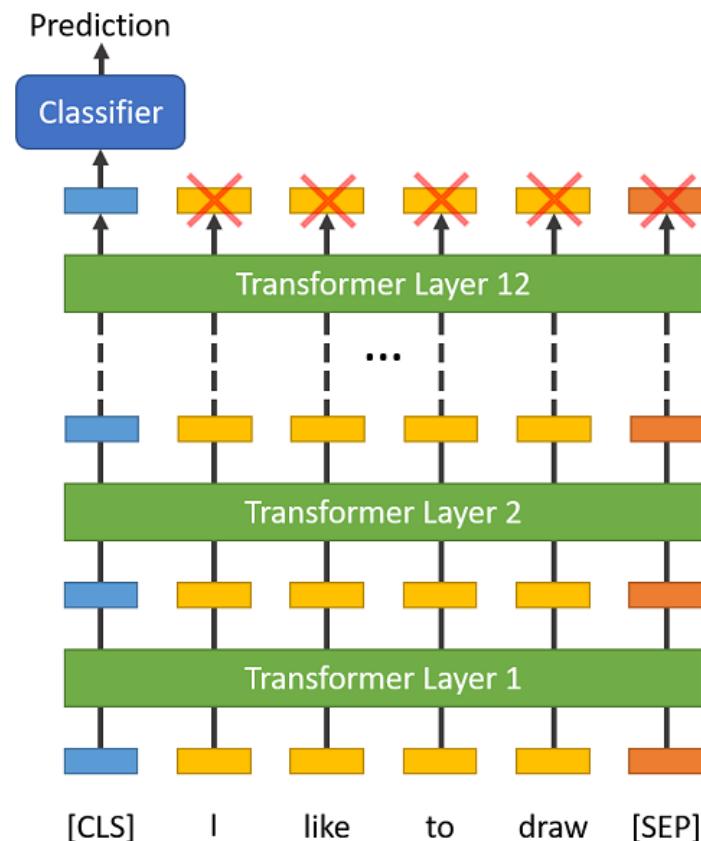
Gradient vanish/explode
Short sequences

Seq2Seq Models



Seq2Seq for NLP

- RNN
- LSTM
- Word2Vec
- GRU
- Attention
- Bidirectional LSTM
- Transformer (Attention is all what you need!)
- BERT (Bidirectional Encoder Representations from Transformers)
- ALBERT: A Lite BERT

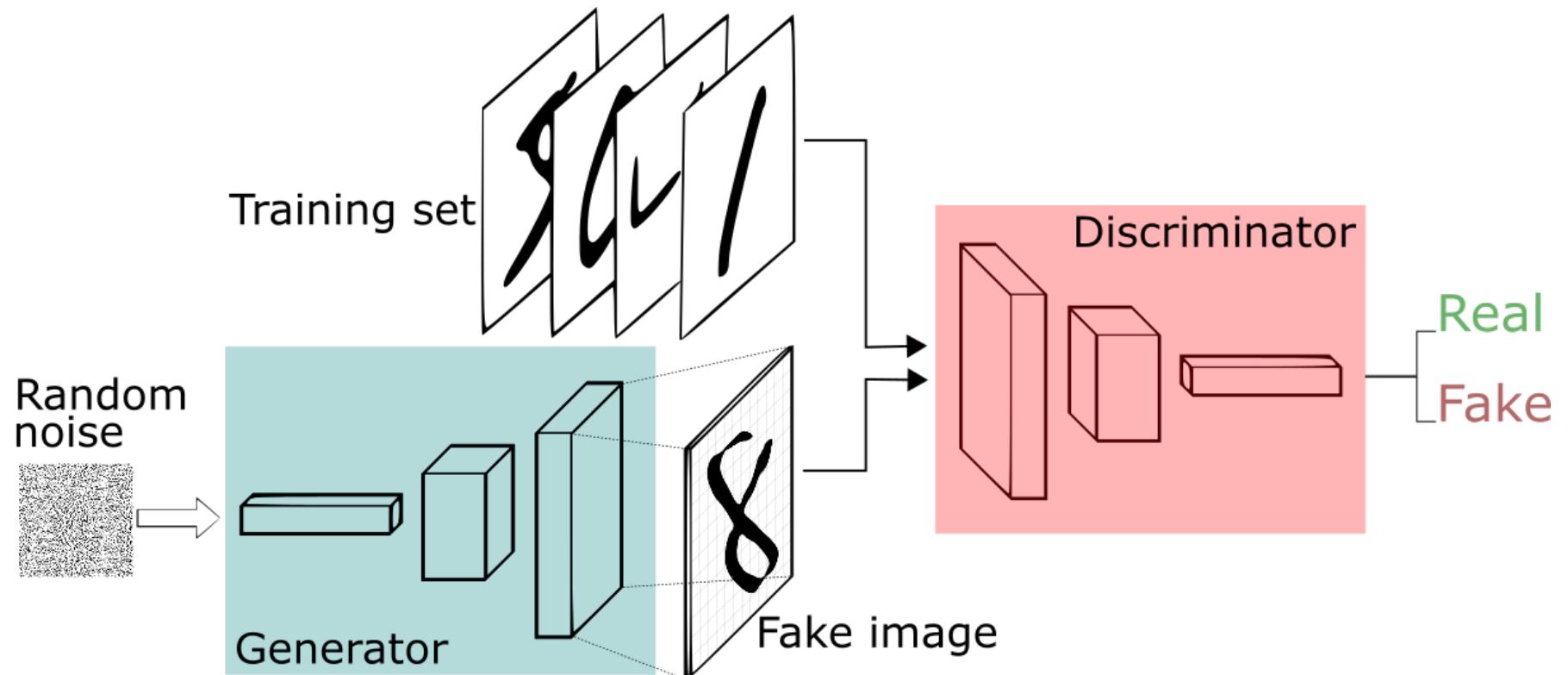


Seq2Seq Models: Applications

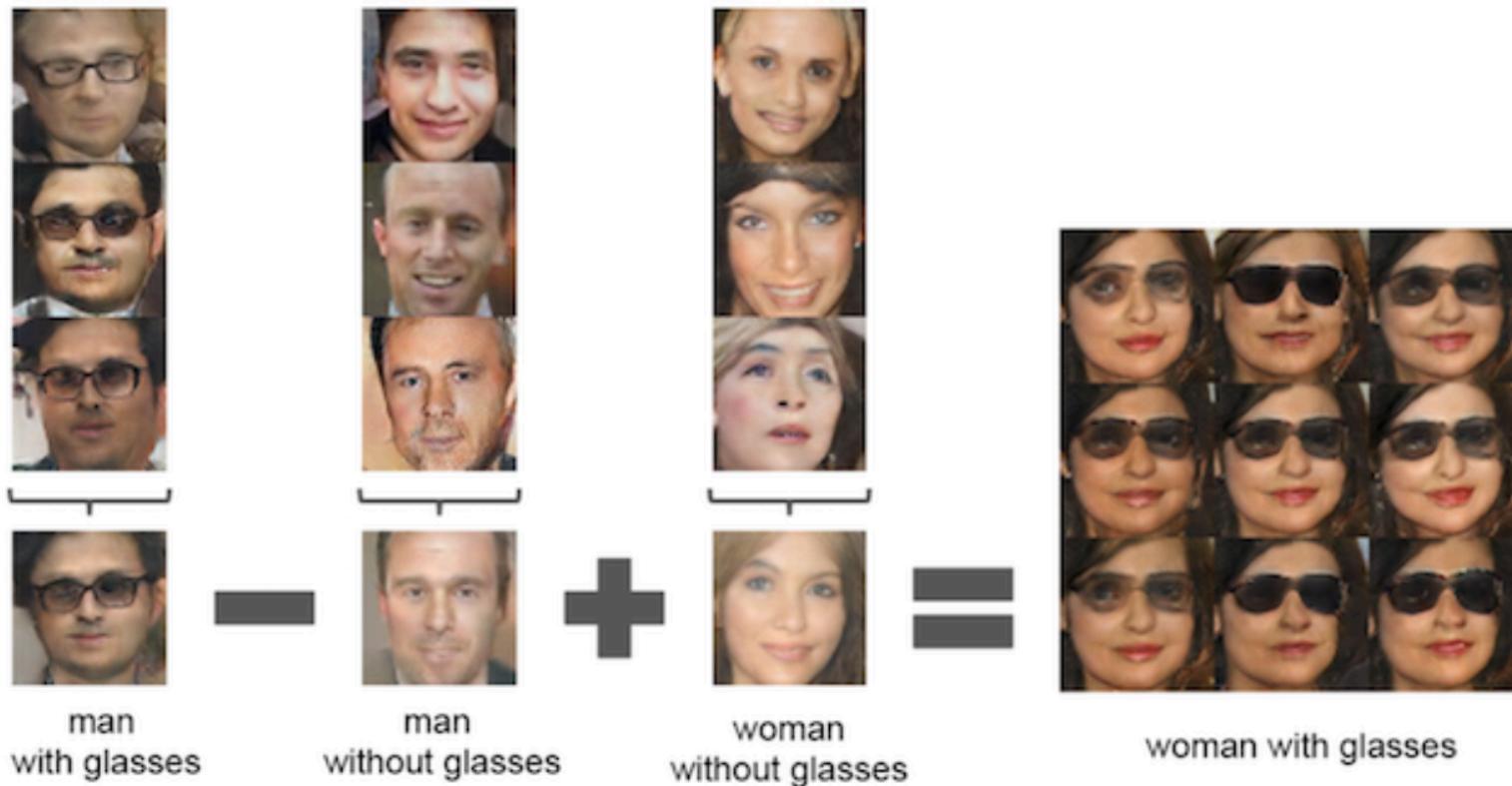
- Sentiment classification
- Machine translation
- Name entity recognition
- Spam Detection
- Customer Queries Tagging
- Topics Classification
- Speech recognition
- Music generation
- Video activity recognition
- DNA sequence analysis
- Etc.

Generative Adversarial Networks

Generative Adversarial Networks



Generative Adversarial Networks



Example of Vector Arithmetic for GAN-Generated Faces. Taken from Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks, 2015.

Optical Character Recognition

- OCR: Tesseract

OCR Applications

- Document Recognition
(Passport, Id Card, etc.)
- Text Recognition
- Digits Recognition
- Handwritten Texts
Recognition
- Etc.



170 A BOOK OF HOMAGE TO SHAKESPEARE

BITS OF TIMBER: SOME OBSERVATIONS ON
SHAKESPEARIAN NAMES—‘SHYLOCK’;
‘POLOMIUS’; ‘MALVOLIO’

I

SHAKESPEARE in *The Merchant of Venice*, as elsewhere, unconsciously divined the germ of the myth on which his genius worked. Endless analogues are quoted for the two stories blended in the play; and we know Shakespeare's debt to the *Pecorone* of Ser Giovanni Fiorentino and the rest. The legend, I feel sure, represents an early homilist's attempt to exemplify the two texts: 'Greater love hath no man than this, that a man lay down his life for his friends,' and 'Christ also loved the church and gave himself for it'. The vivid exposition of these texts produced in due course the legend of 'the Pound of Flesh', and 'the Wooing of the Lady'. Under the cover of a similitude—a different allegory—the texts are well expounded in the early English book known as *The Nuns' Rule*; and the teacher there adds, in order to drive home the lesson, 'Do not men account him a good friend who layeth his pledge in Jewry to release his companion? God Almighty laid himself in Jewry for us,' &c.¹

The older play on the subject, shown in London at the Bull before 1580, may well have contained some abstract characters, linking it to the Morality drama. Shakespeare's *Merchant of Venice*, starting as a study of usury, in its treatment of the theme gives glimpses of the suggested origin of the legend; and the play is rightly named after the *Merchant*, whose part is one of simple dignity, and not after Shylock, the predominant character of the play. Portia's great plea for mercy, epitomizing a whole Moral play, reveals, as it were, the inmost significance of the Lady of Belmont, as originally personifying the soul, or salvation, or the Church, and links her to the far-spread beautiful allegory of 'The Four Daughters of God'.²

¹ *Acrene Riwle*, ed. Morton (Camden Society), p. 394; the date of the book is about 1225.

² From this point of view it is interesting to recall such earlier plays as *The Three Ladies of London*, and *The Three Lords and Three Ladies of London*, by Robert Wilson.

OCR Challenges

- Complex Backgrounds,
- Noise,
- Lightning,
- Different Font,
- Hand Written Text
- Geometrical Distortions,
- Structured/Unstructured text
- Etc.



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