

Neural Networks

Nice to meet you

ARTIFICIAL INTELLIGENCE

"The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages" -The English Oxford Living Dictionary.

MACHINE LEARNING

"Machine-learning algorithms use statistics to find patterns in massive* amounts of data. And data, here, encompasses a lot of things-numbers, words, images, clicks, etc" -MIT Technology Review.

DEEP LEARNING

== Deep Neural Networks???

Neural Networks Disclaimer

NOT NEW



Connectionism
[Rosenblatt, 1958]

Perceptron
[Minsky&Papert]

**WILL NOT
SOLVE ALL
YOUR
PROBLEMS**



TSP & others

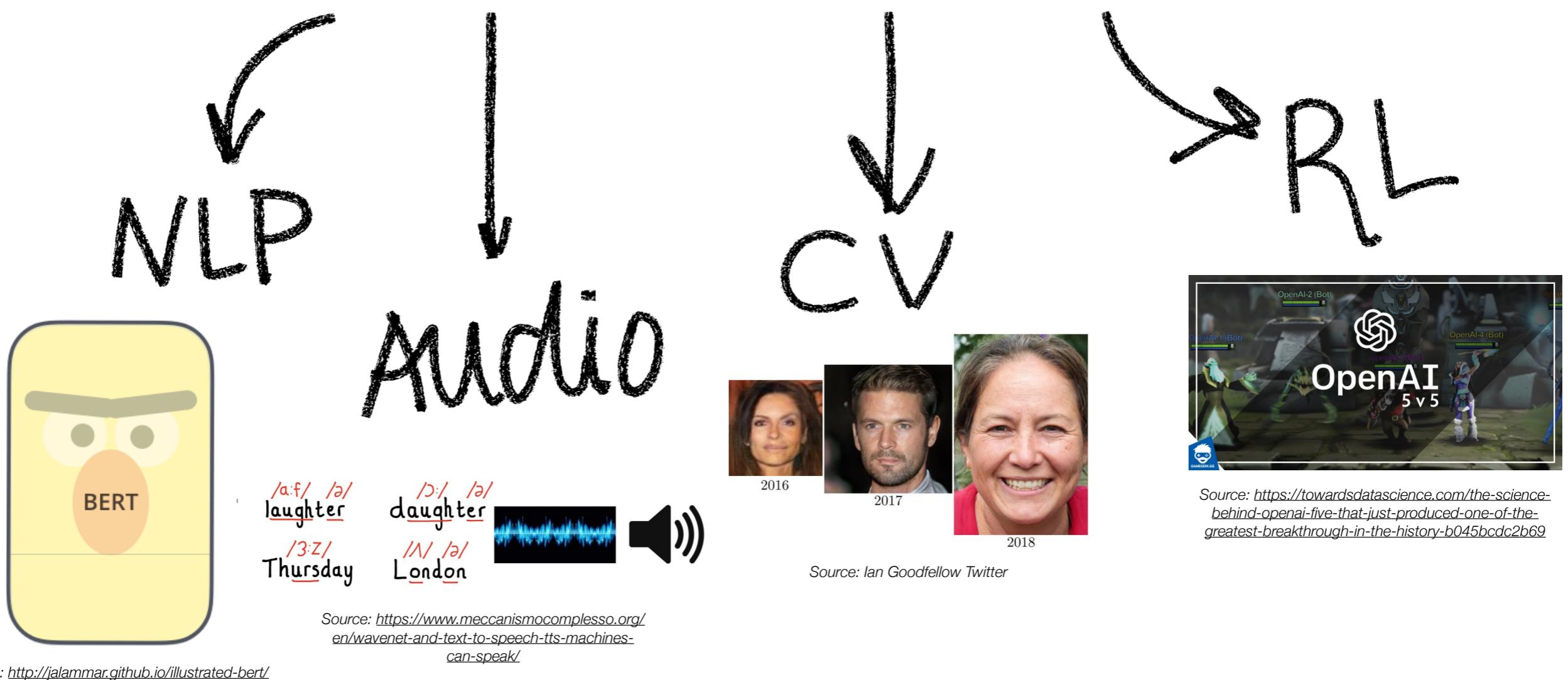
**LESS WORK THAN
“CLASSICAL” AI**



**DATA DATA DATA
DATA DATA DATA
DATA DATA DATA**

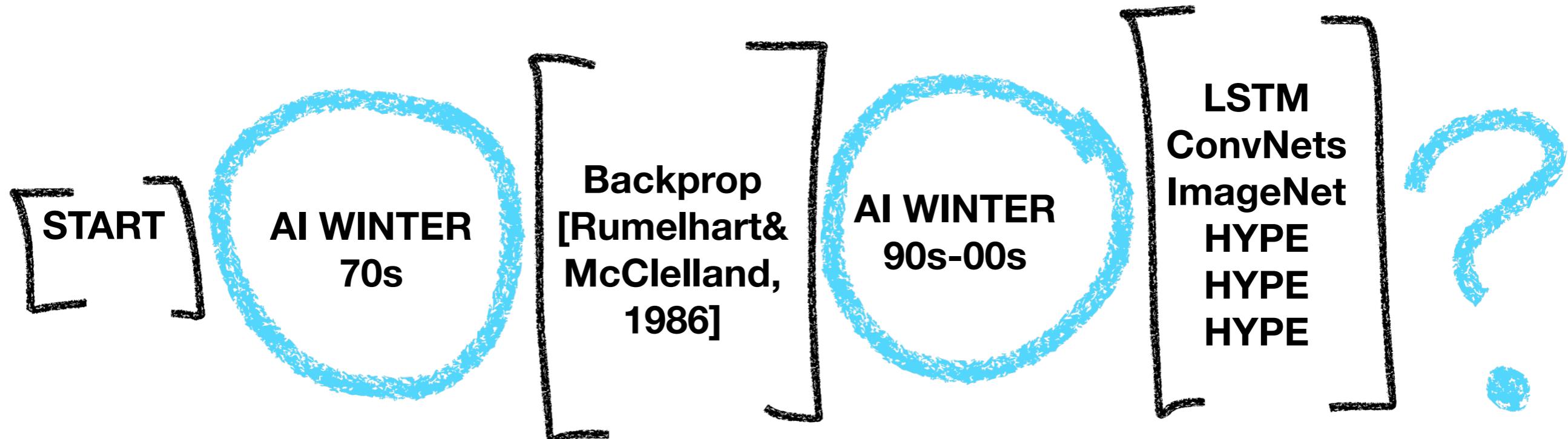
What is it about?

Specific practical applications of NN in different tasks

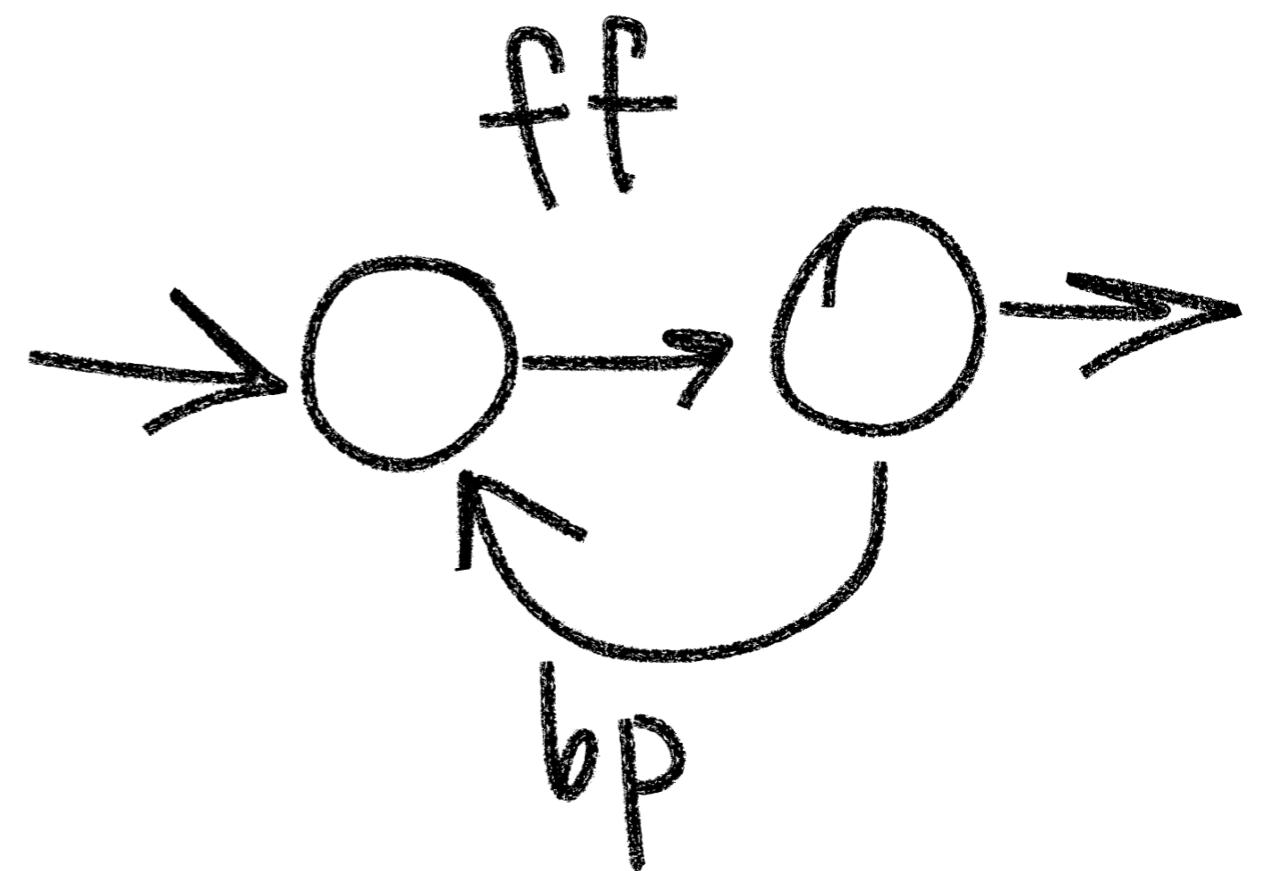
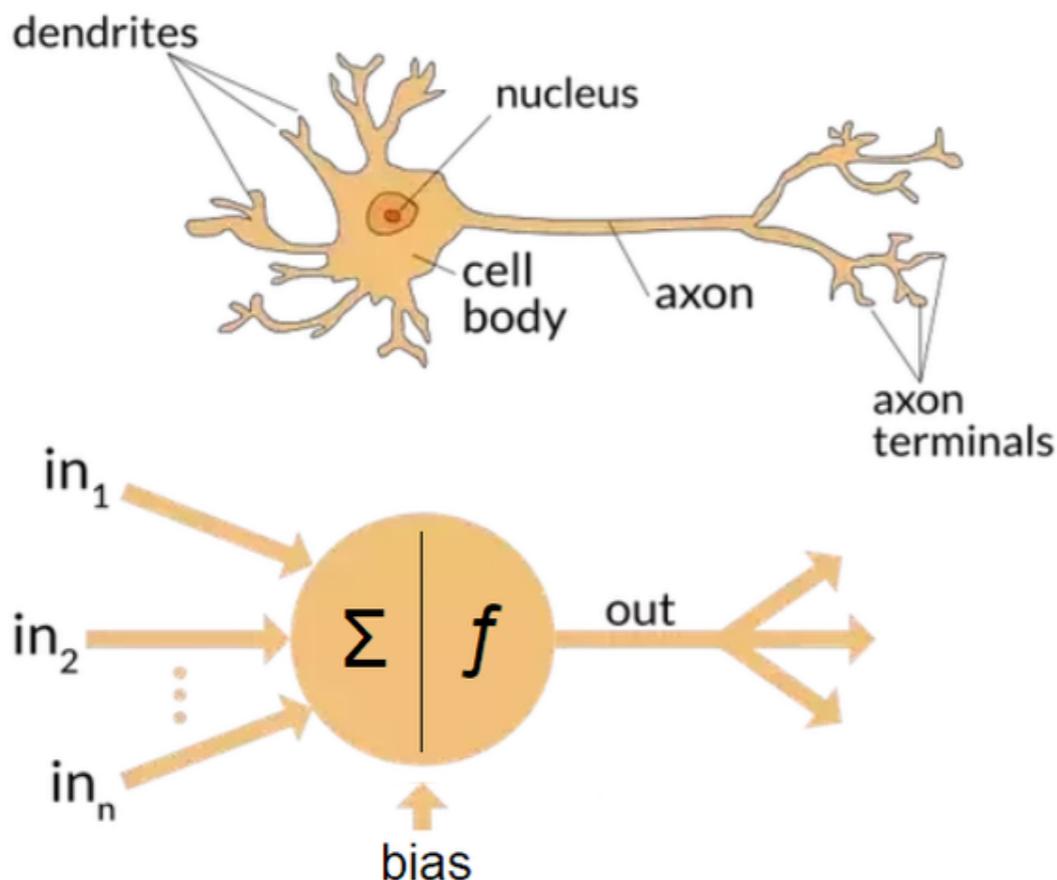


Know the history

The HYPE theory

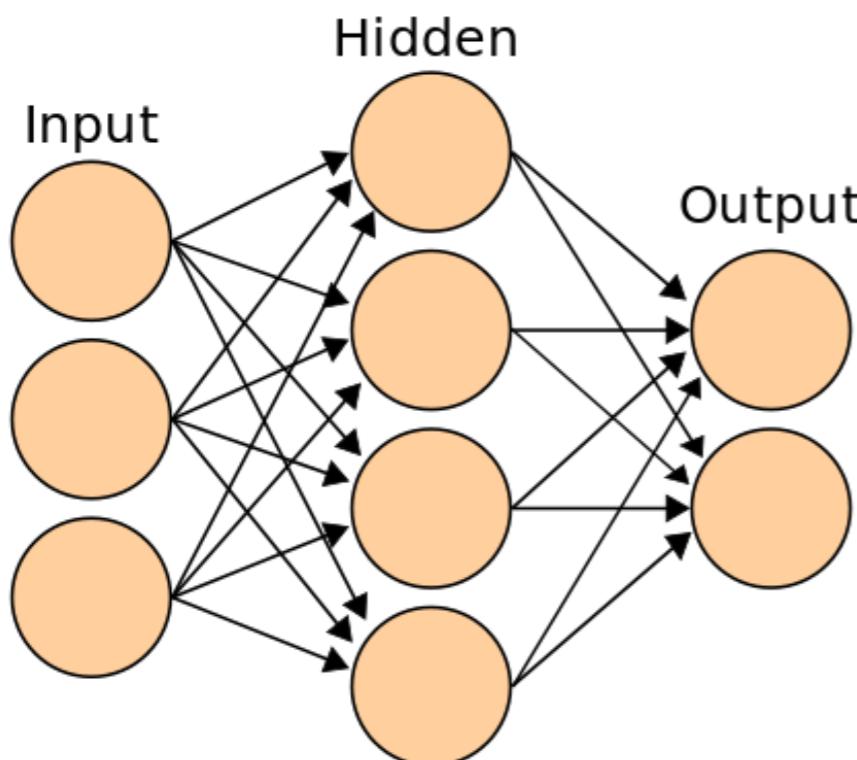


Neurons Nodes



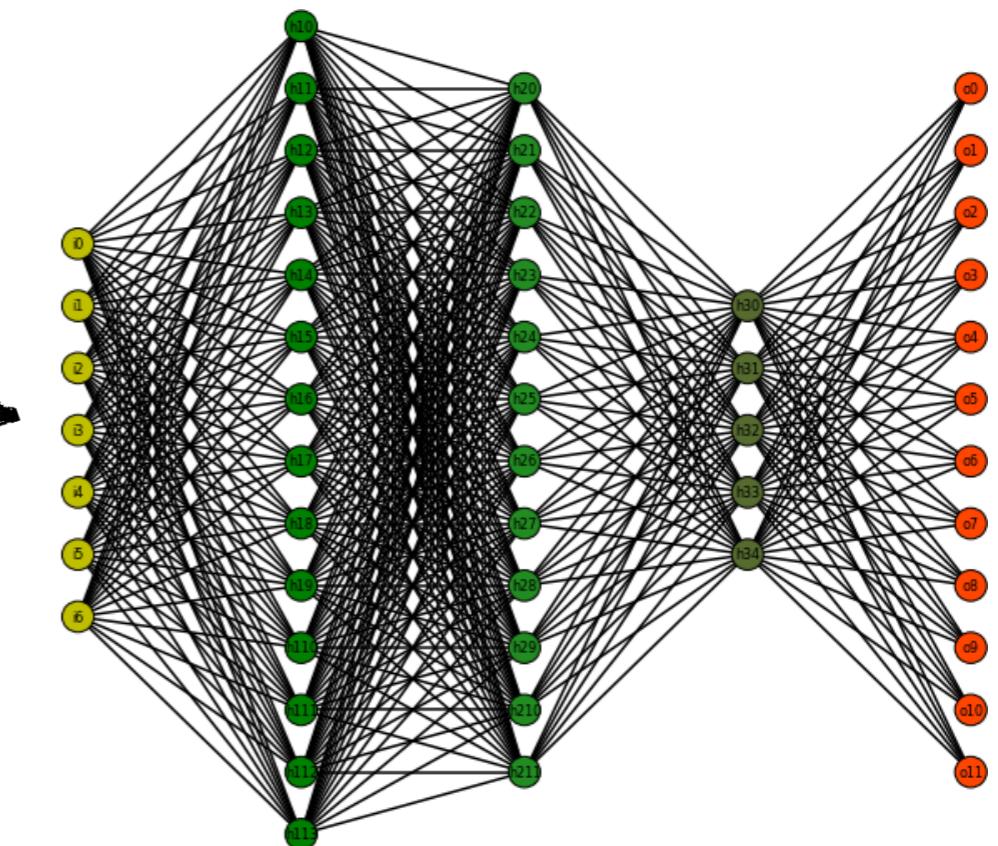
Source: <https://www.quora.com/What-is-the-difference-between-artificial-intelligence-and-neural-networks>

Building Architecture



Source: <https://www.analyticsvidhya.com/blog/2014/10/ann-work-simplified/>

GO DEEPER

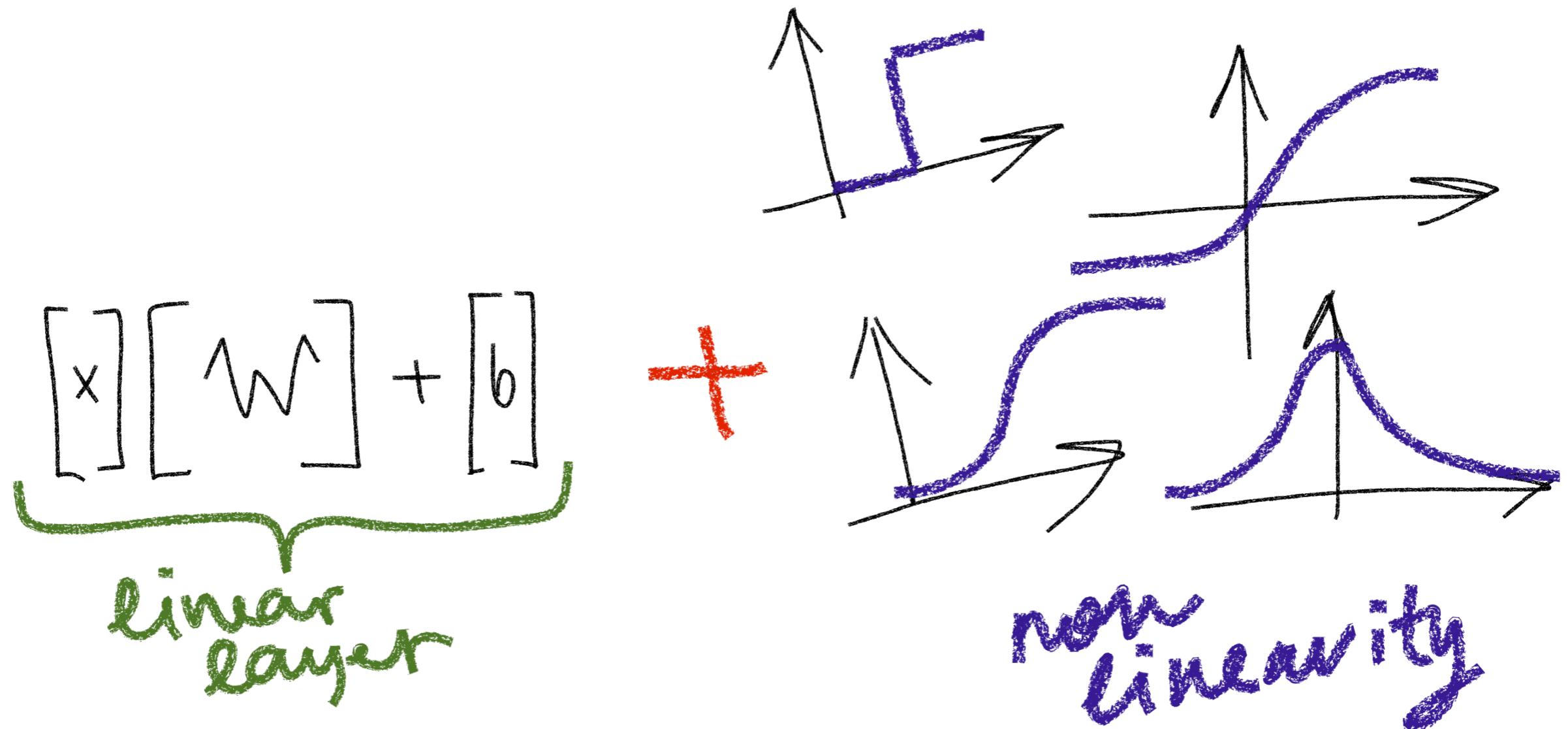


Source: https://www.python-course.eu/neural_networks_with_python_numpy.php

Getting into math



Getting into math



Task of NN

Input: objects $x_1, x_2 \dots x_n \in \mathbb{R}^d$ answers $y_1, y_2 \dots y_n \in \mathcal{Y}$

Classification $\mathcal{Y} = \{1 \dots K\}$ Regression $\mathcal{Y} = \mathbb{R}$

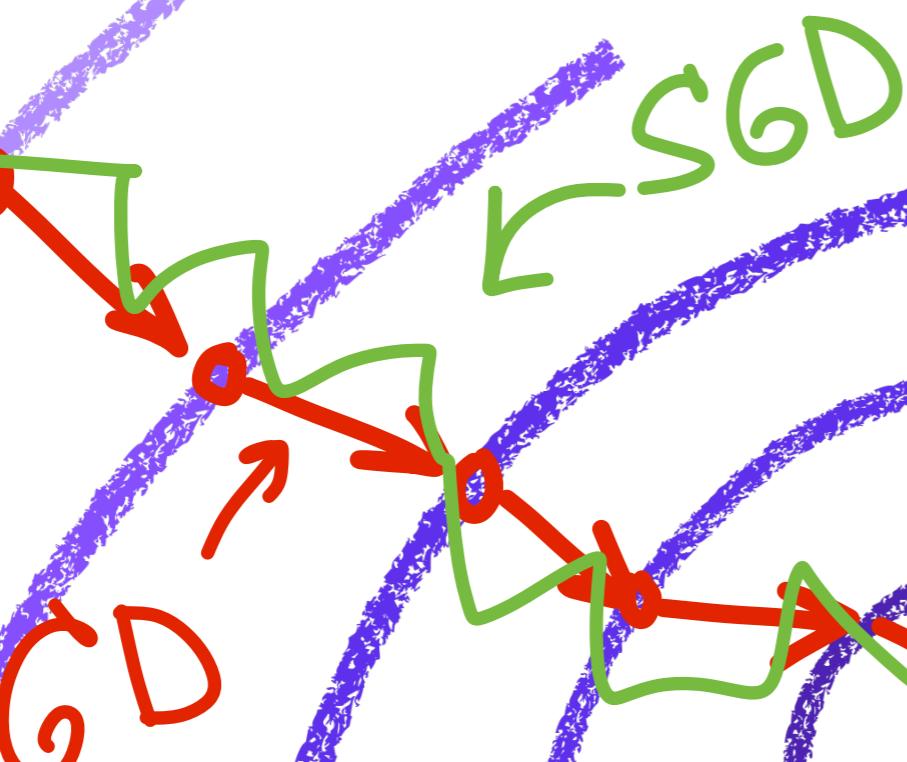
FIND $\theta = [W, b]$ ACCORDING TO (X, Y)

USE LOSS FUNCTION (OBJECTIVE)

$NN = f(x, \theta)$ VS. $y = \text{THE TRUTH}$

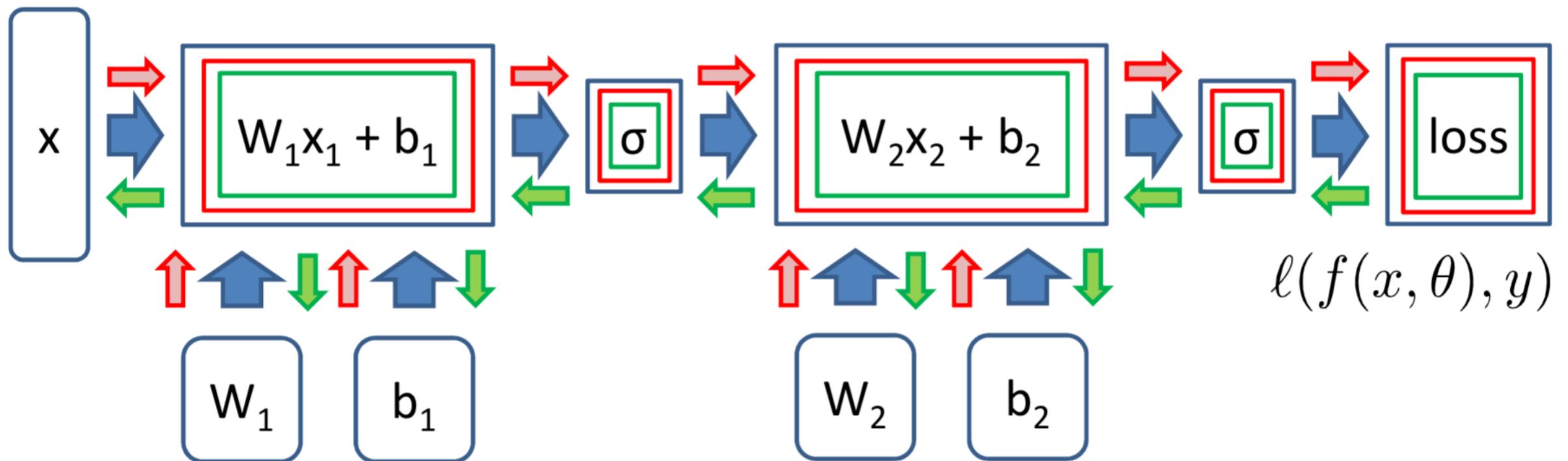
$L(f(x, \theta), y) \rightarrow \min$

How to train?



$$\theta_{t+1} \leftarrow \theta_t - \eta \nabla_{\theta} \mathcal{L}(f(x_i, \theta), y_i)$$

BackProp



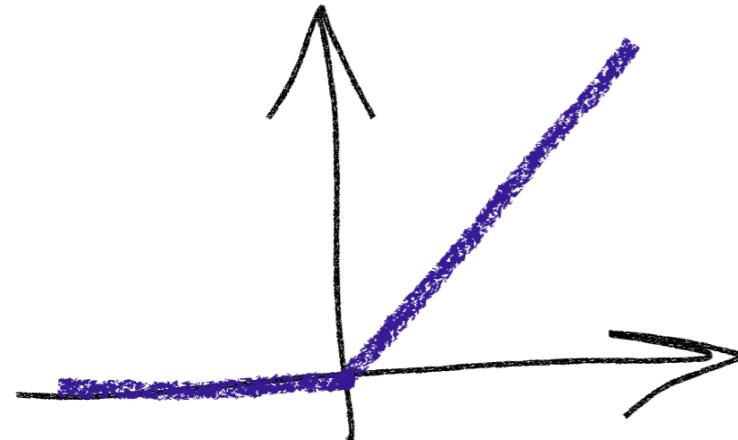
Anton Osokin, HSE, Deep Learning Course. Source: https://github.com/aosokin/dl_cshse_ami

$$\nabla_{\theta} f(\theta, g(\theta), h(\theta)) = \frac{\partial f}{\partial \theta} + \frac{\partial f}{\partial g} \nabla_{\theta} g(\theta) + \frac{\partial f}{\partial h} \nabla_{\theta} h(\theta)$$

$$\nabla_h = \frac{d}{dh} \ell(f(x, \theta), y)$$

Non linearities

Activation Functions



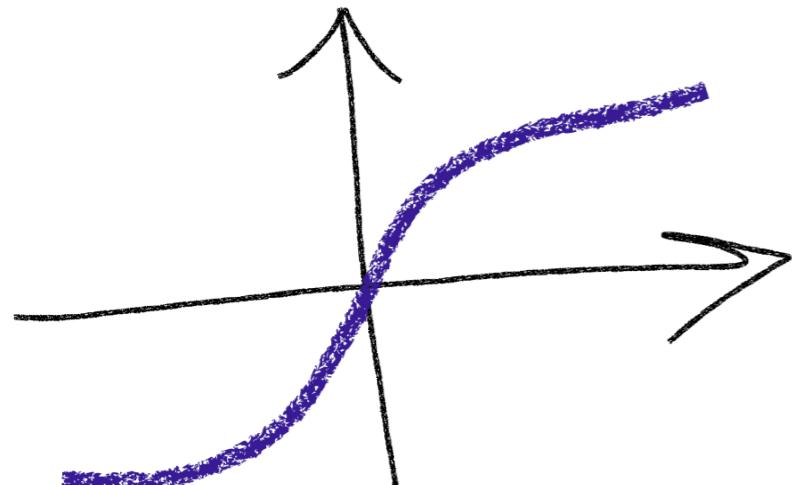
ReLU

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$



Sigmoid

$$\max(0, x)$$



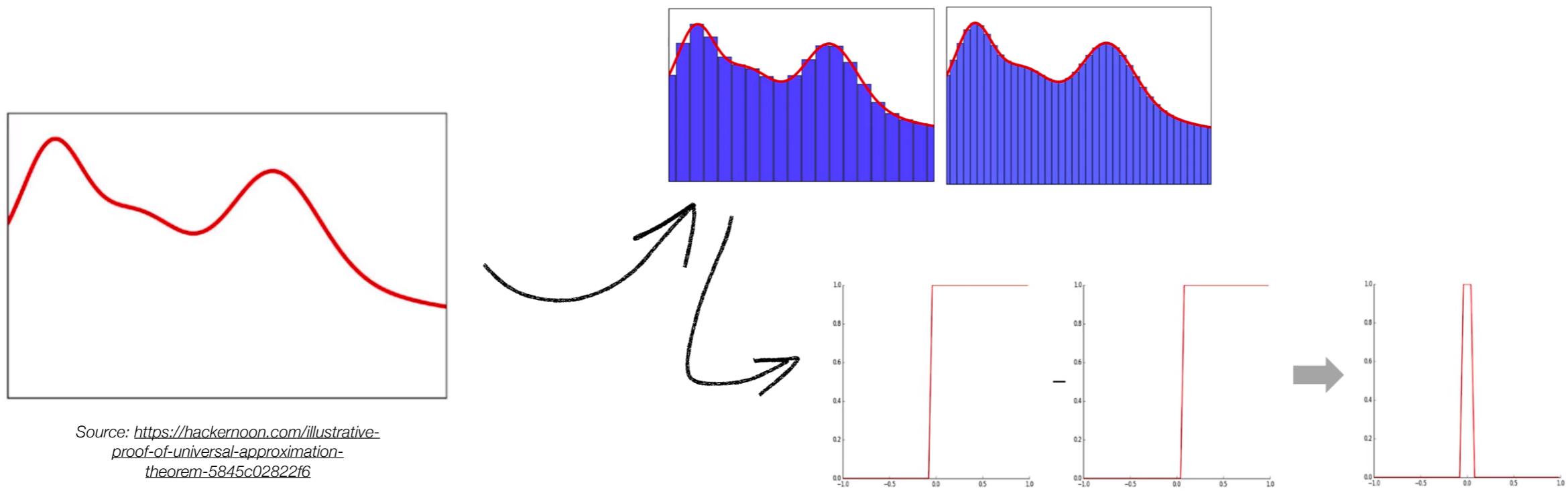
- tanh

Universal approximation theorem

[Cybenko, 1989]

In the [mathematical theory of artificial neural networks](#), the **universal approximation theorem** states that a [feed-forward](#) network with a single hidden layer containing a finite number of [neurons](#) can approximate [continuous functions](#) on [compact subsets](#) of \mathbf{R}^n , under mild assumptions on the activation function.

[Wikipedia](#)

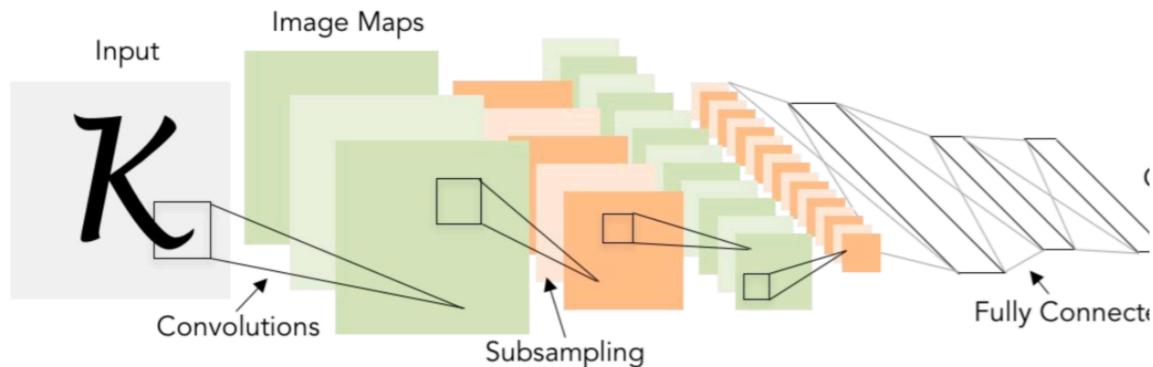


The general idea

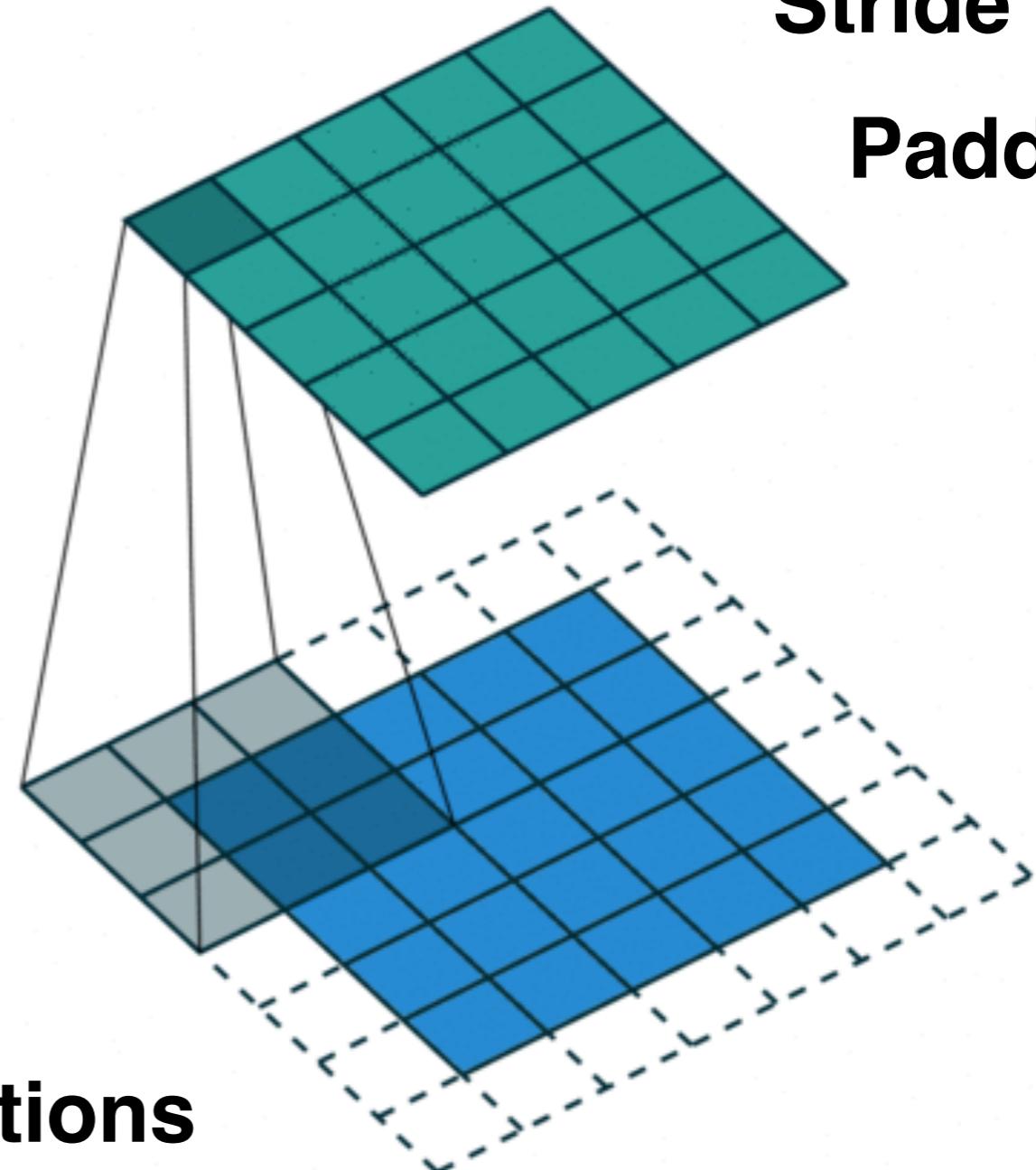
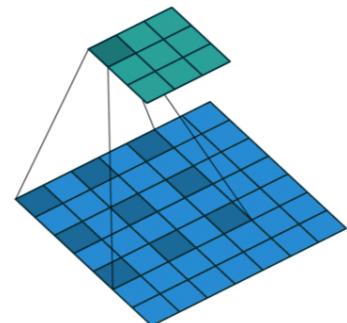
<https://playground.tensorflow.org/>

Convolutions

Kernel Size
Stride
Padding

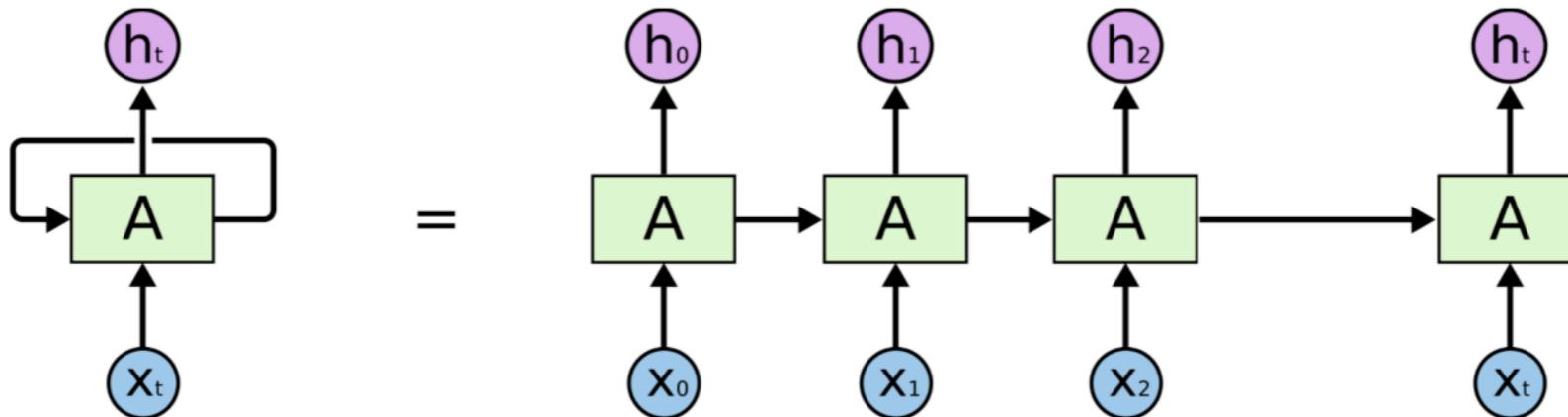


**The first Convolutional
Neural Network – LeNet-5**
[LeCun, Bottou, Bengio,
Haffner 1998]

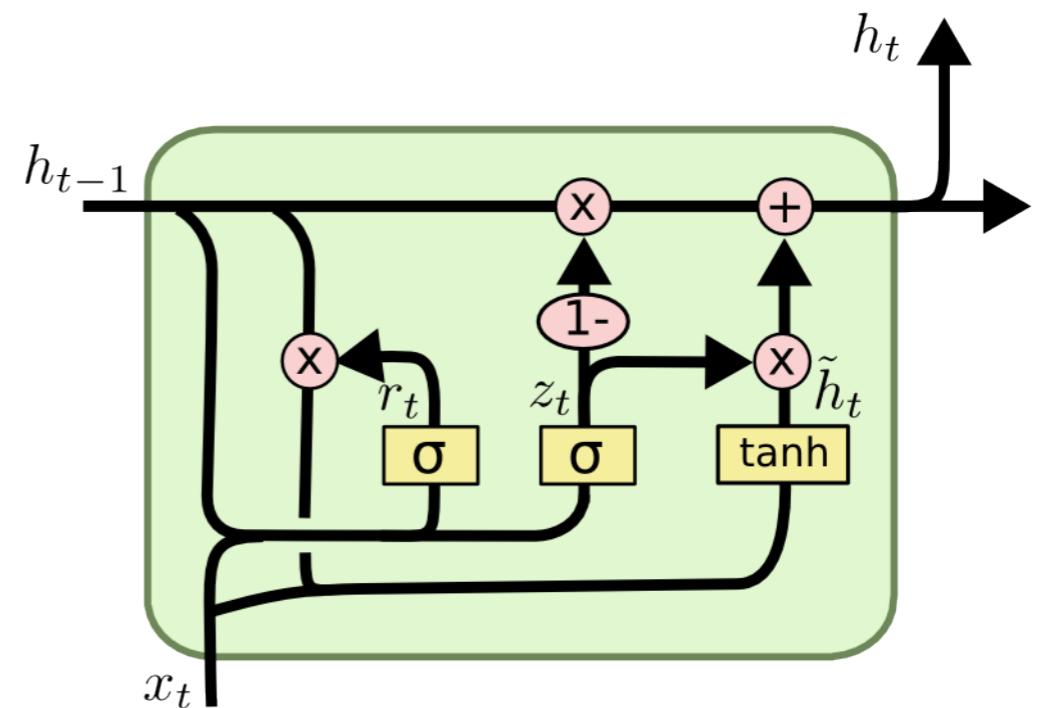
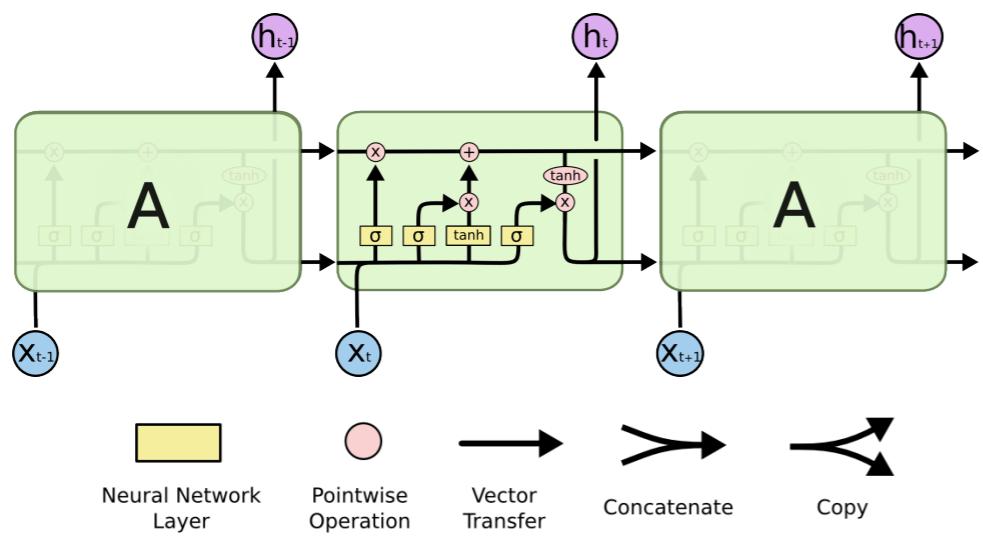


Dilated Convolutions
a.k.a. atrous convolutions

Recurrent



Long-short-term-memory (LSTM)



Now, problems, go

1. DATA



2. OVERFITTING



3. LOCAL MINIMUM



4. NUMBER OF PARAMETERS



5. TIME



Just a few personal faves

Image Processing

[Gatys et. al., 2015]



Source: <https://www.youtube.com/watch?v=1HJSMR6LW2g>



Sources: <https://www.wired.com/story/deepfakes-getting-better-theyre-easy-spot/>

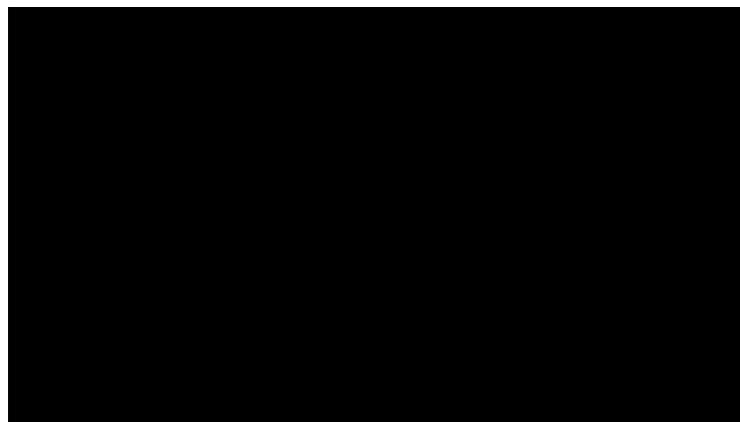


Source: <https://towardsdatascience.com/real-time-video-neural-style-transfer-9f6f84590832>

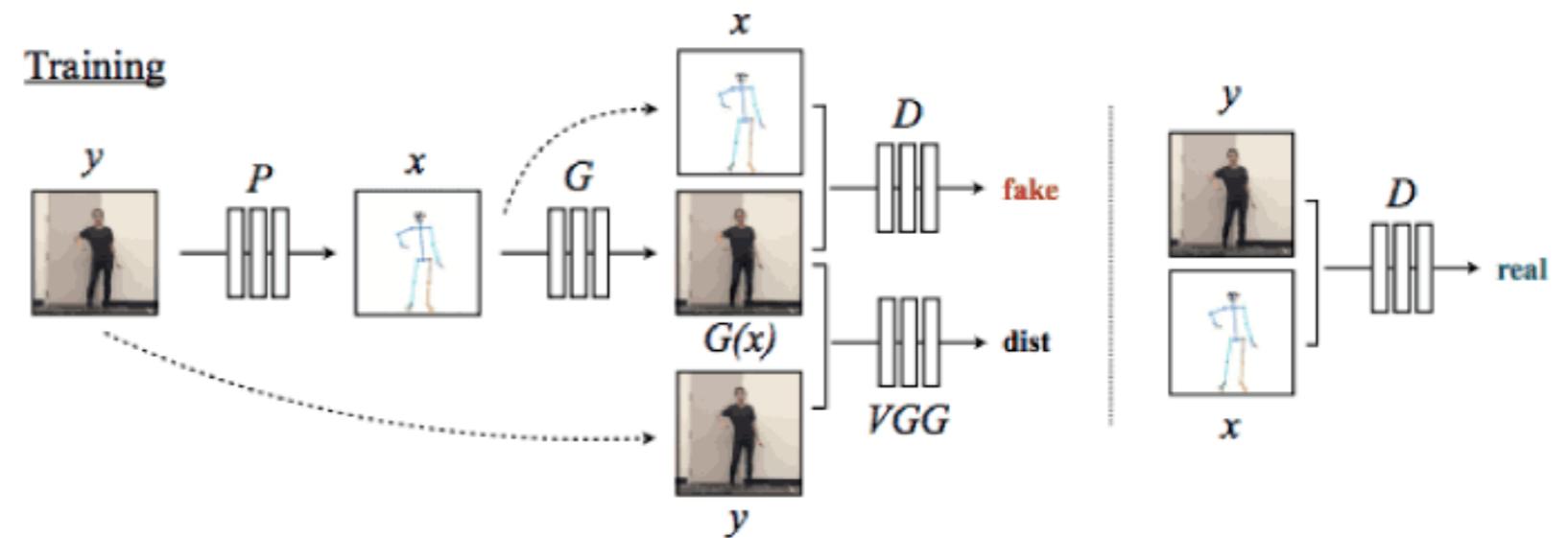


GANs (Generative Adversarial Networks)

[Goodfellow et. al., 2014]



Everybody dance now



<https://www.youtube.com/watch?v=PCBTZh41Ris>

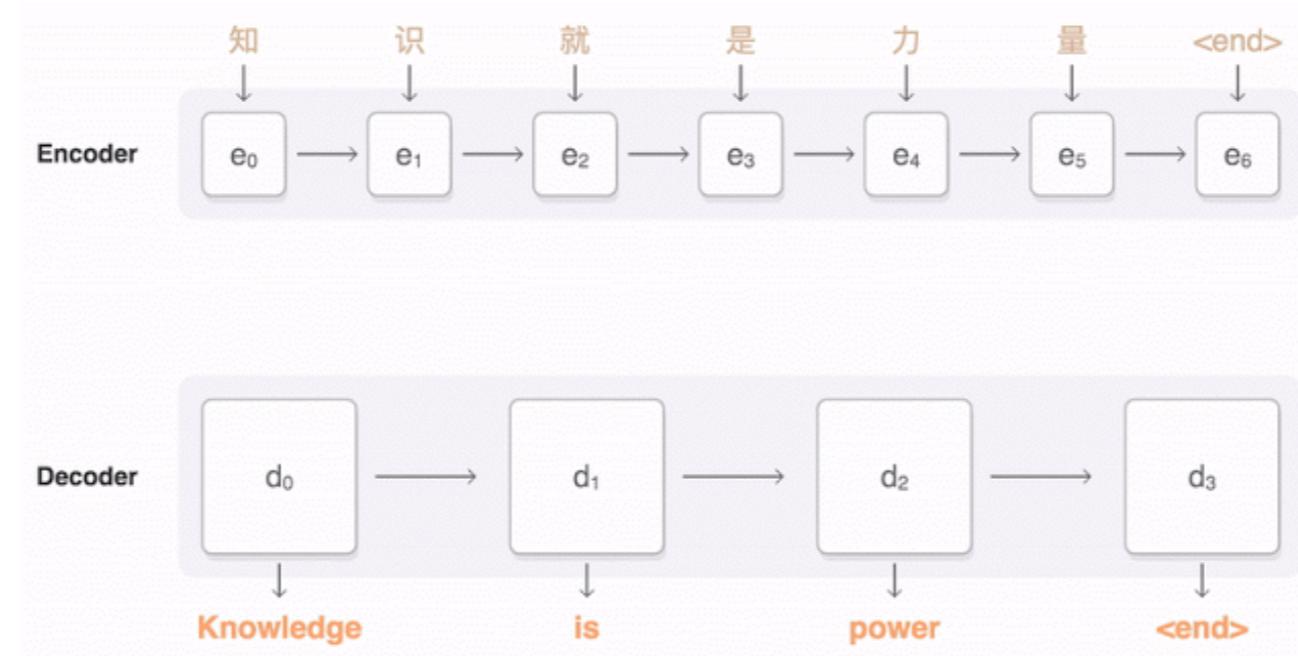


MACHINE TRANSLATION



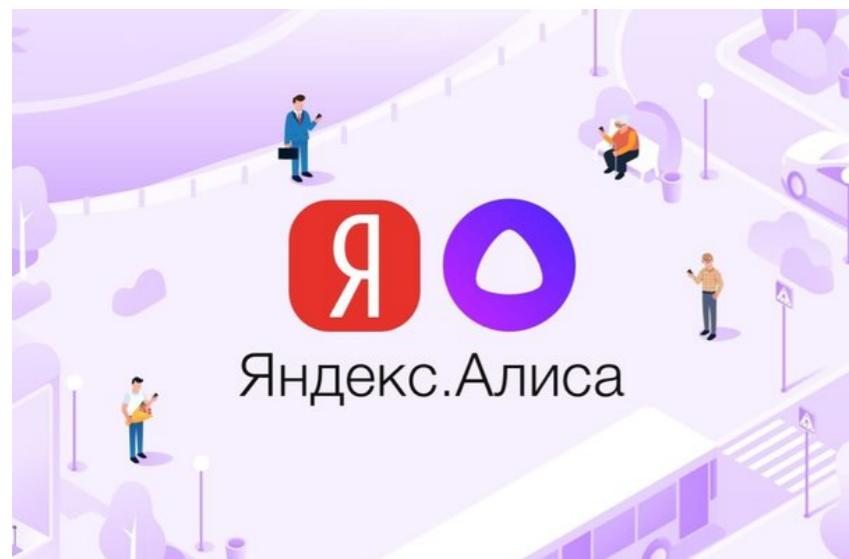
Input sentence:	Translation (PBMT):	Translation (GNMT):	Translation (human):
李克強此行將啟動中加總理年度對話機制，與加拿大總理杜魯多舉行兩國總理首次年度對話。	Li Keqiang premier added this line to start the annual dialogue mechanism with the Canadian Prime Minister Trudeau two prime ministers held its first annual session.	Li Keqiang will start the annual dialogue mechanism with Prime Minister Trudeau of Canada and hold the first annual dialogue between the two premiers.	Li Keqiang will initiate the annual dialogue mechanism between premiers of China and Canada during this visit, and hold the first annual dialogue with Premier Trudeau of Canada.

Source: <https://www.topbots.com/5-ways-deep-learning-improves-your-daily-digital-ux-life/>

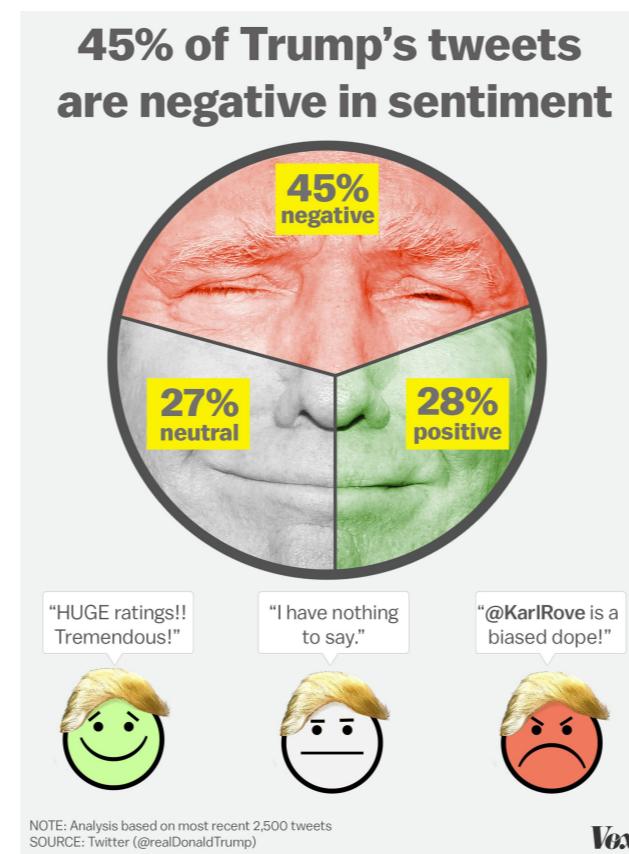


Source: <https://www.topbots.com/5-ways-deep-learning-improves-your-daily-digital-ux-life/>

Other text things



Source: <https://zen.yandex.ru/media/id/592d384a8e557de2f707bd26/vstrecha-v-gostiah-u-alisy-razrabotka-navykov-dlia-golosovogo-pomosnika-5b4ca64c1f242d00a9b975b3>



Source: <https://www.vox.com/2016/5/16/11603854/donald-trump-twitter>



Source: https://twitter.com/neural_machine

Audio Action



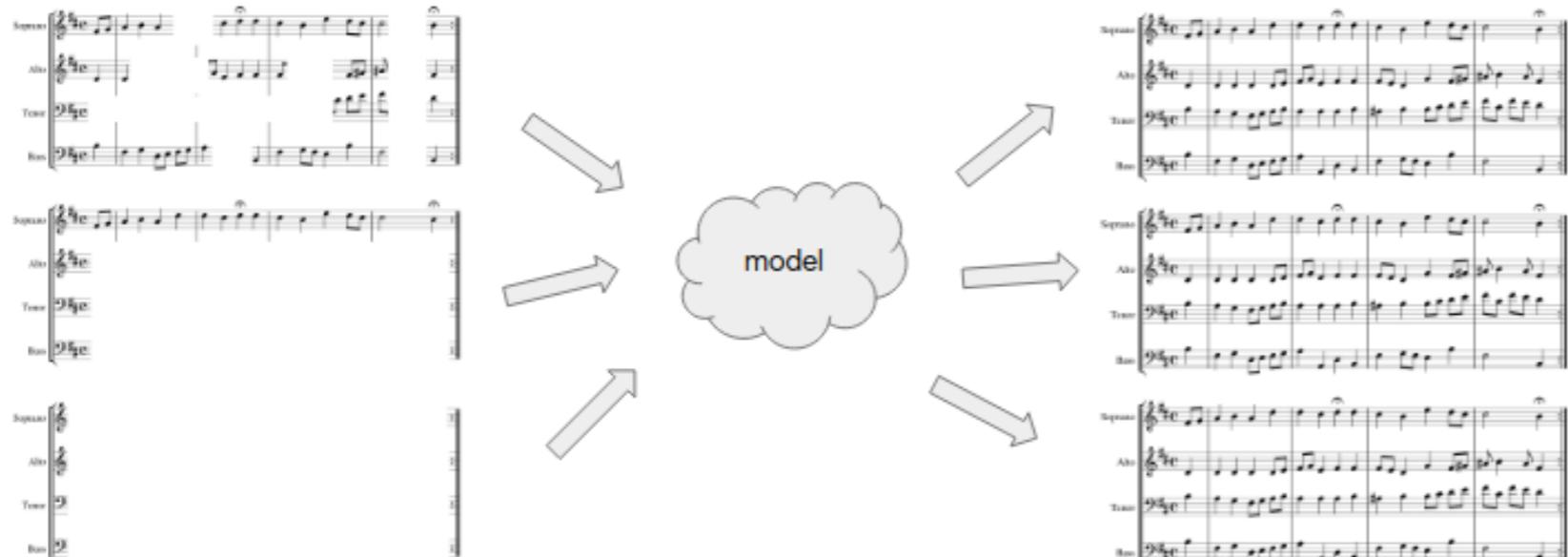
Google DeepMind



11 Seconds

WAVENET: A Generative Model for Raw Audio

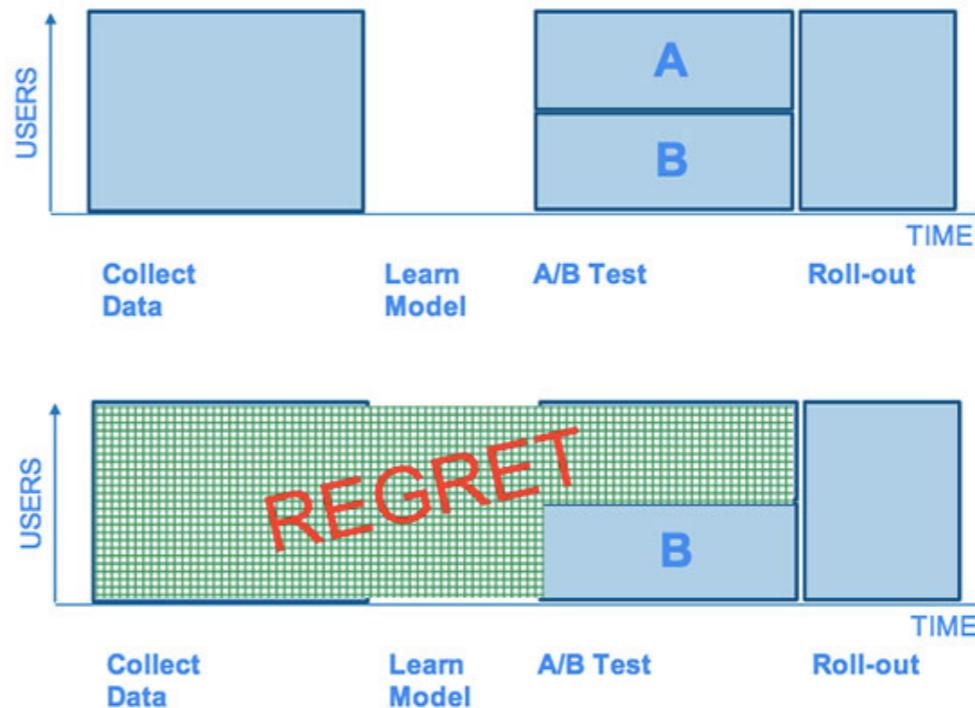
<https://deepmind.com/blog/article/wavenet-generative-model-raw-audio>



<https://magenta.tensorflow.org/coconet>



Recommendations



Source: <https://www.topbots.com/5-ways-deep-learning-improves-your-daily-digital-ux-life/>

Яндекс

Маркет



Google Play

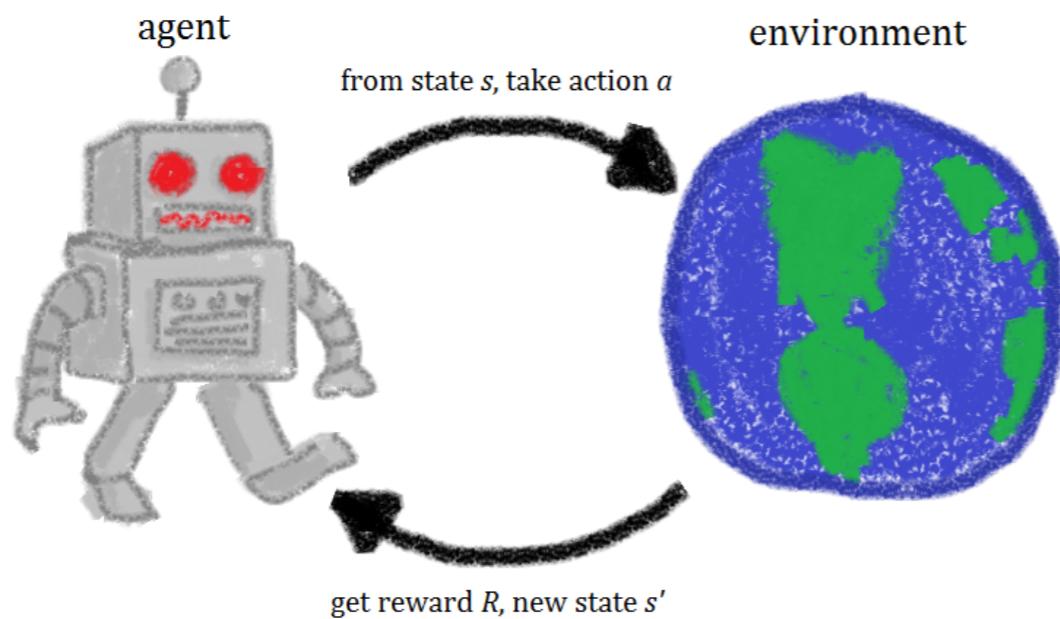
amazon



You Tube

Reinforcement Learning

[DeepMind, 2016]



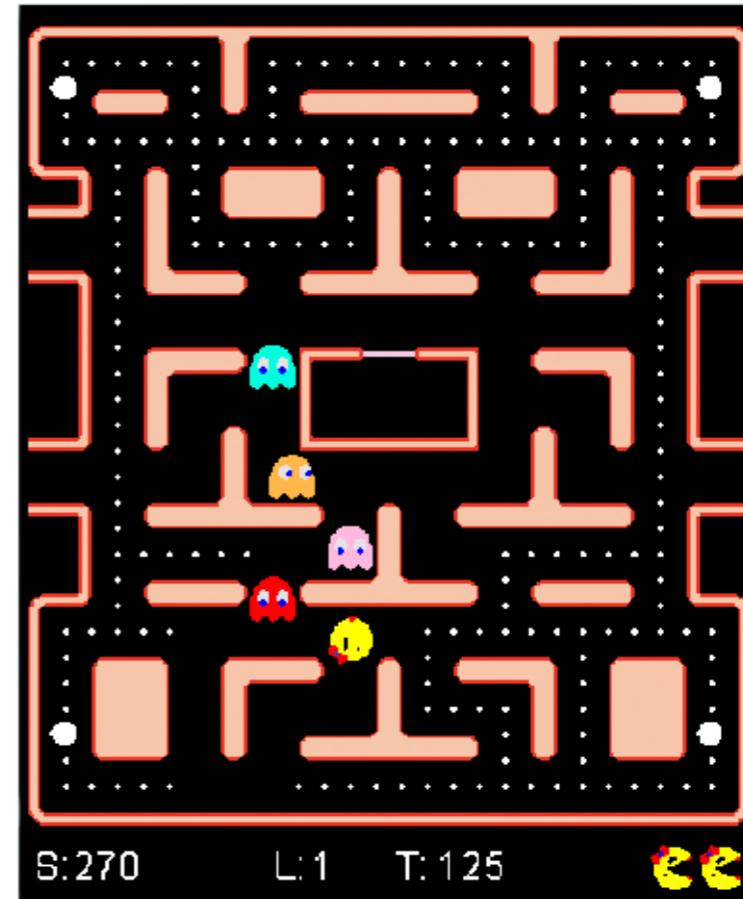
Source: <https://research.zalando.com/welcome/mission/research-projects/sample-efficient-reinforcement-learning/>



Source: <https://blog.insightdatascience.com/reinforcement-learning-from-scratch-819b65f074d8>

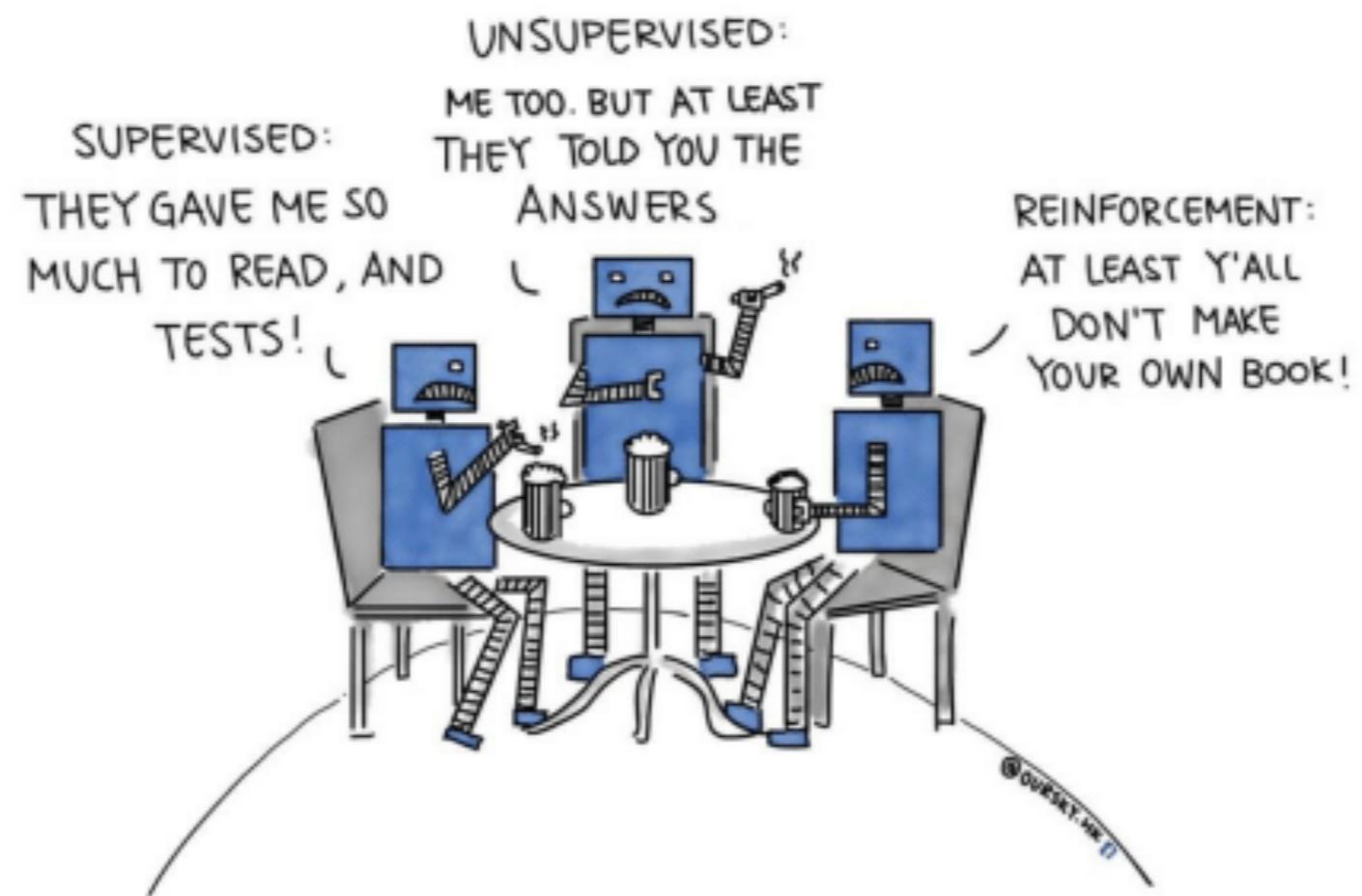


Source: <https://towardsdatascience.com/the-science-behind-openai-five-that-produced-one-of-the-greatest-breakthroughs-in-the-history-b045bc0c2b69>



Source: <https://www.semanticscholar.org/paper/Training-Pac-Man-bots-using-reinforcement-learning-Dom%C3%ADnguez-Est%C3%A9vez-S%C3%A1nchez-Ruiz-Granados/9262e1f326e0f9de9d9a0497211cd40dd2767a22>





[OC] Machine learning

FIN.

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