



Lecture 08

Deep Neural Nets

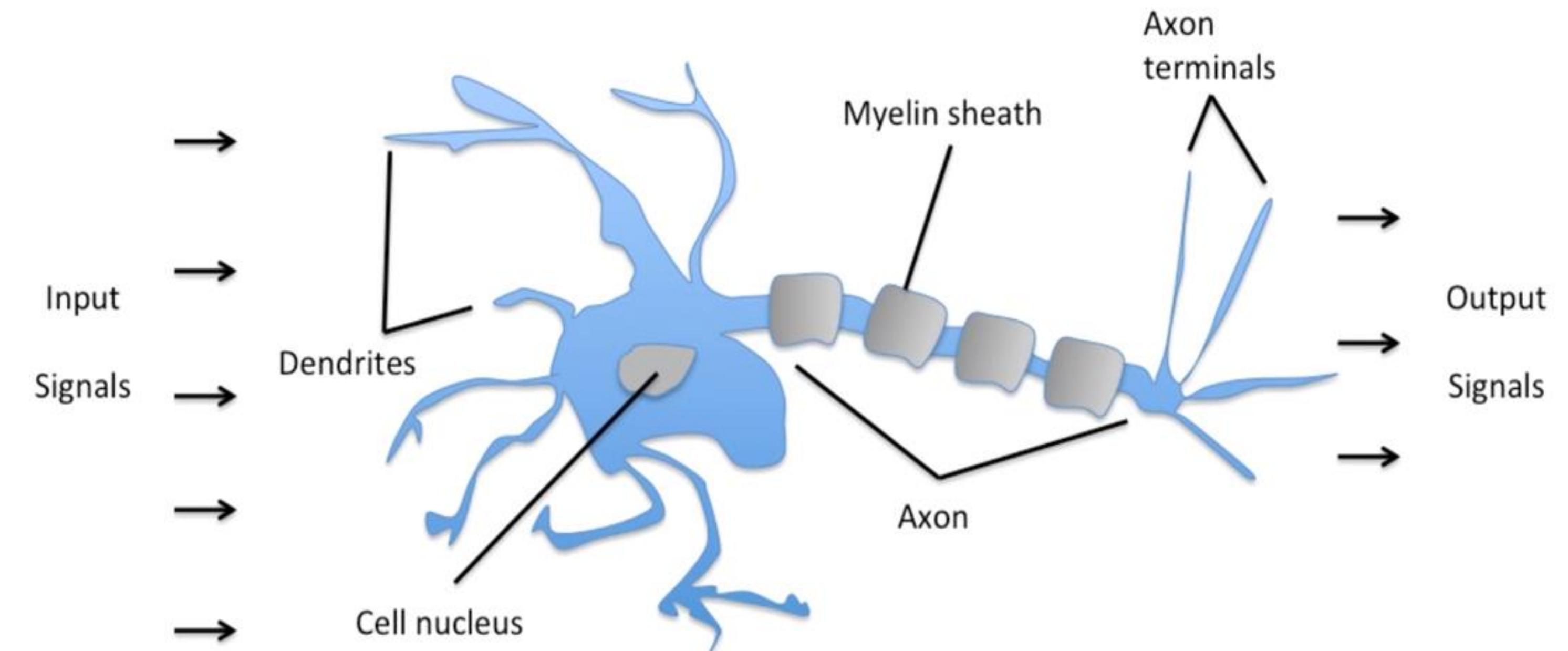
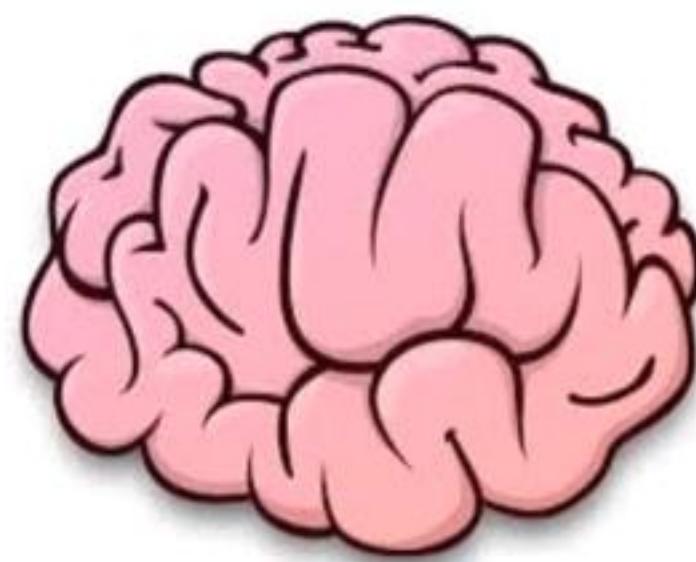
Ultimate dream: thinking machine

- The ultimate dream of mankind is a thinking machine!



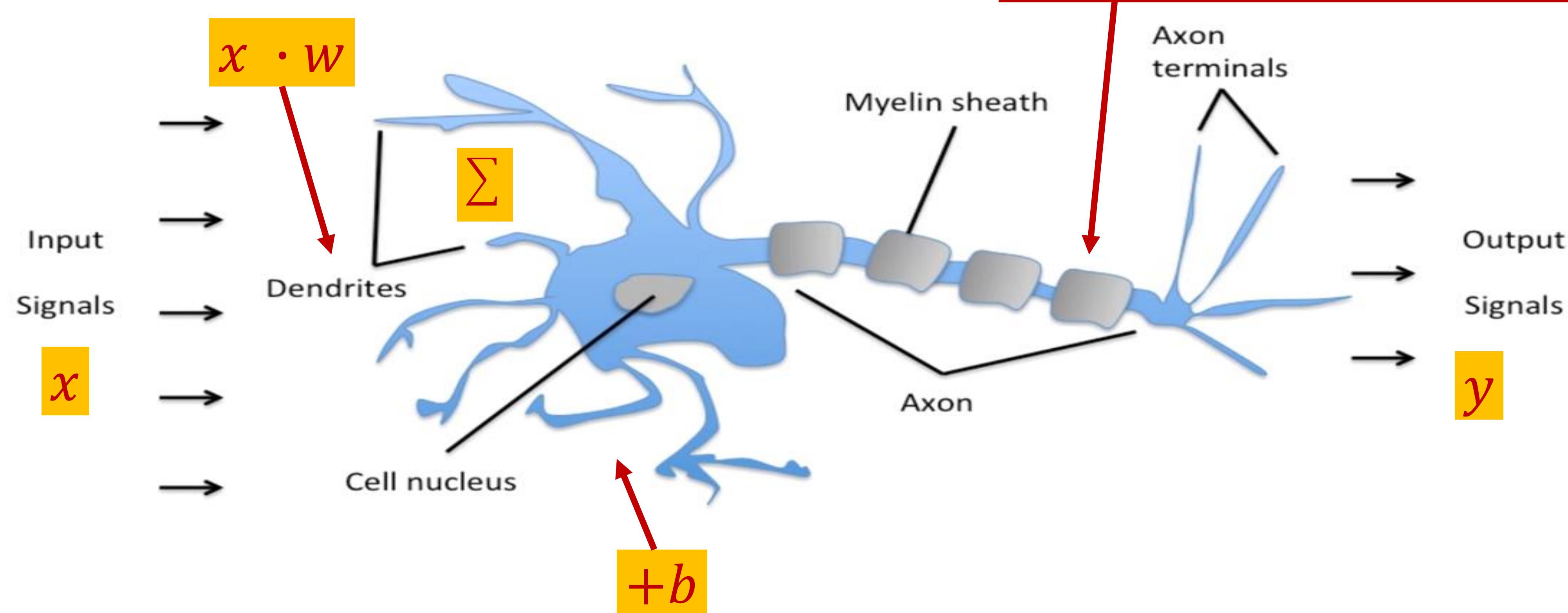
Ultimate dream: thinking machine

Schematic of a biological neuron

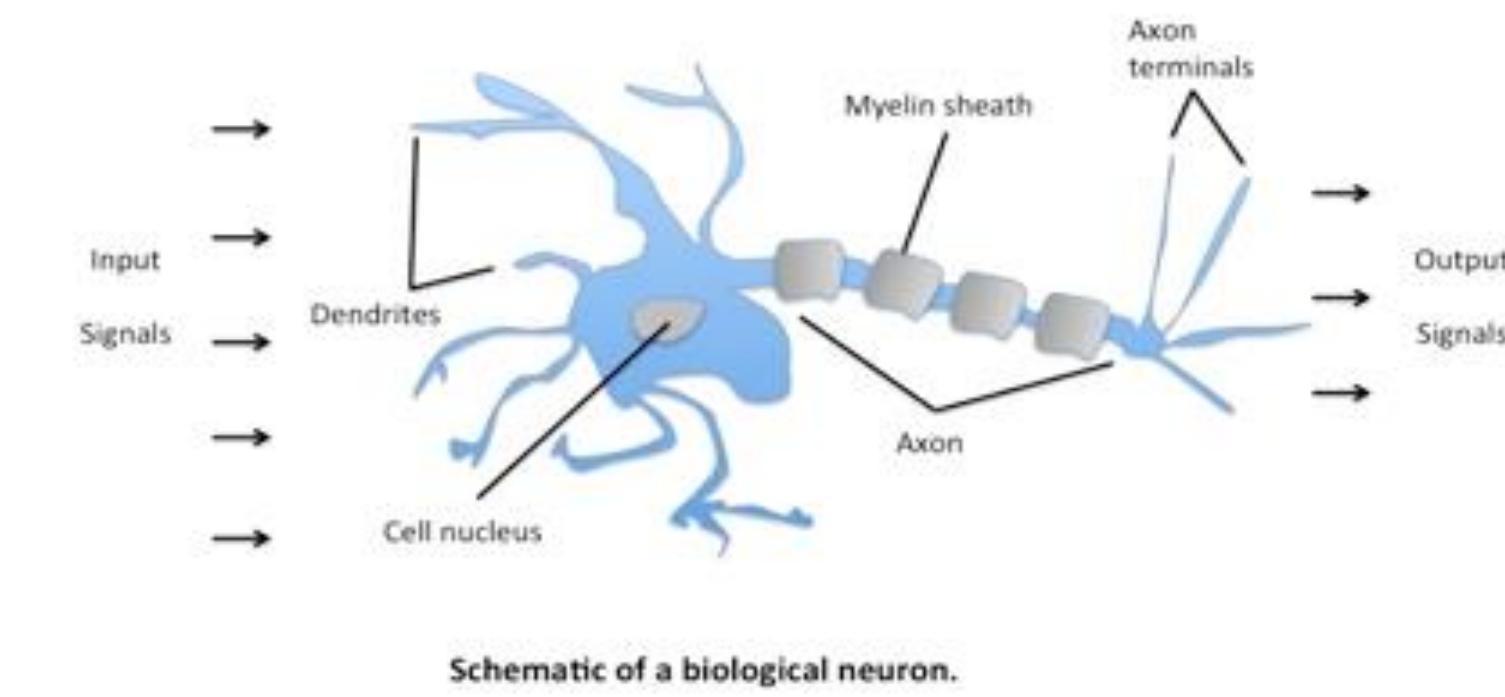
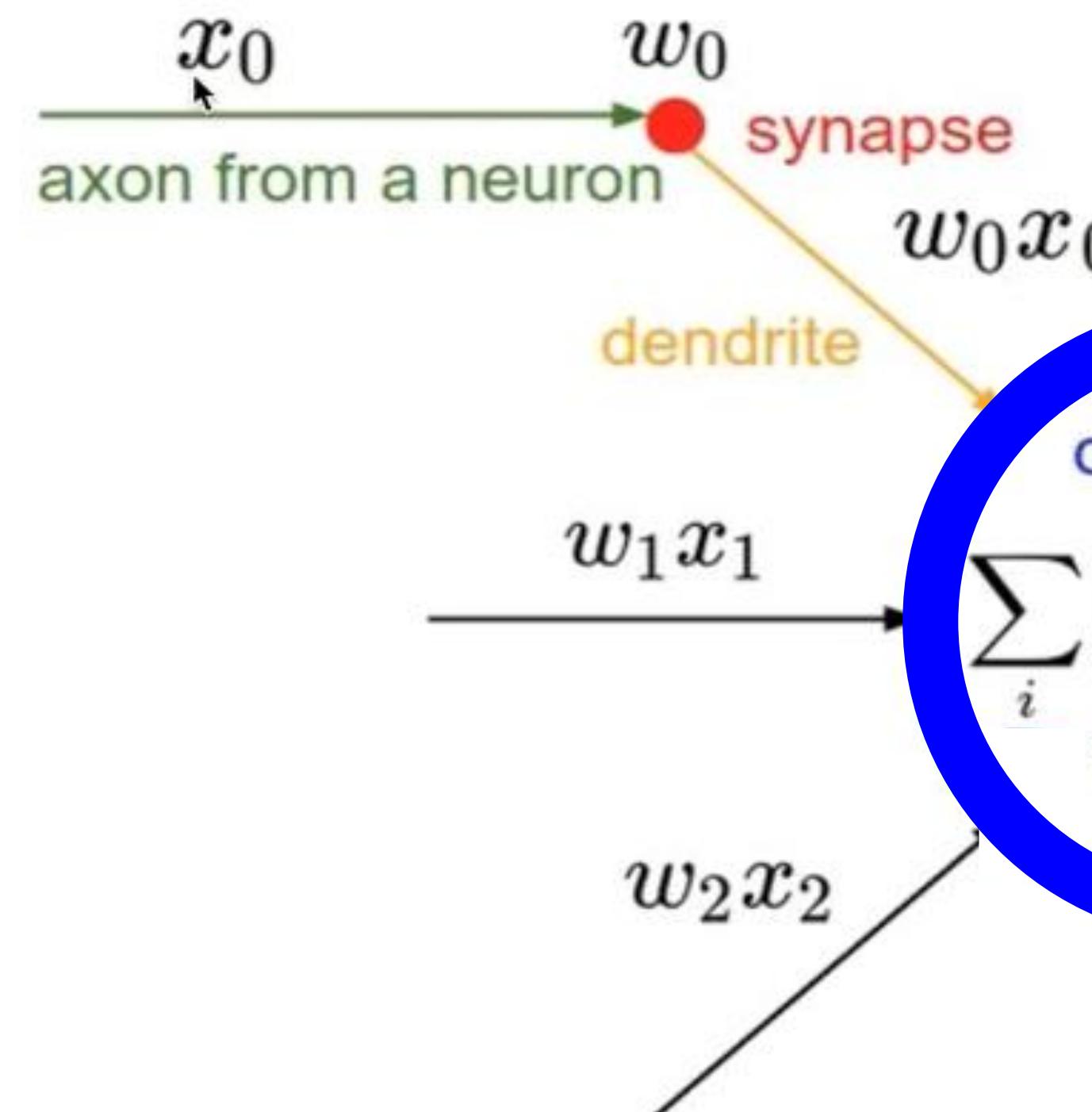


Ultimate dream: thinking machine

Schematic of a biological neuron



Activation Functions

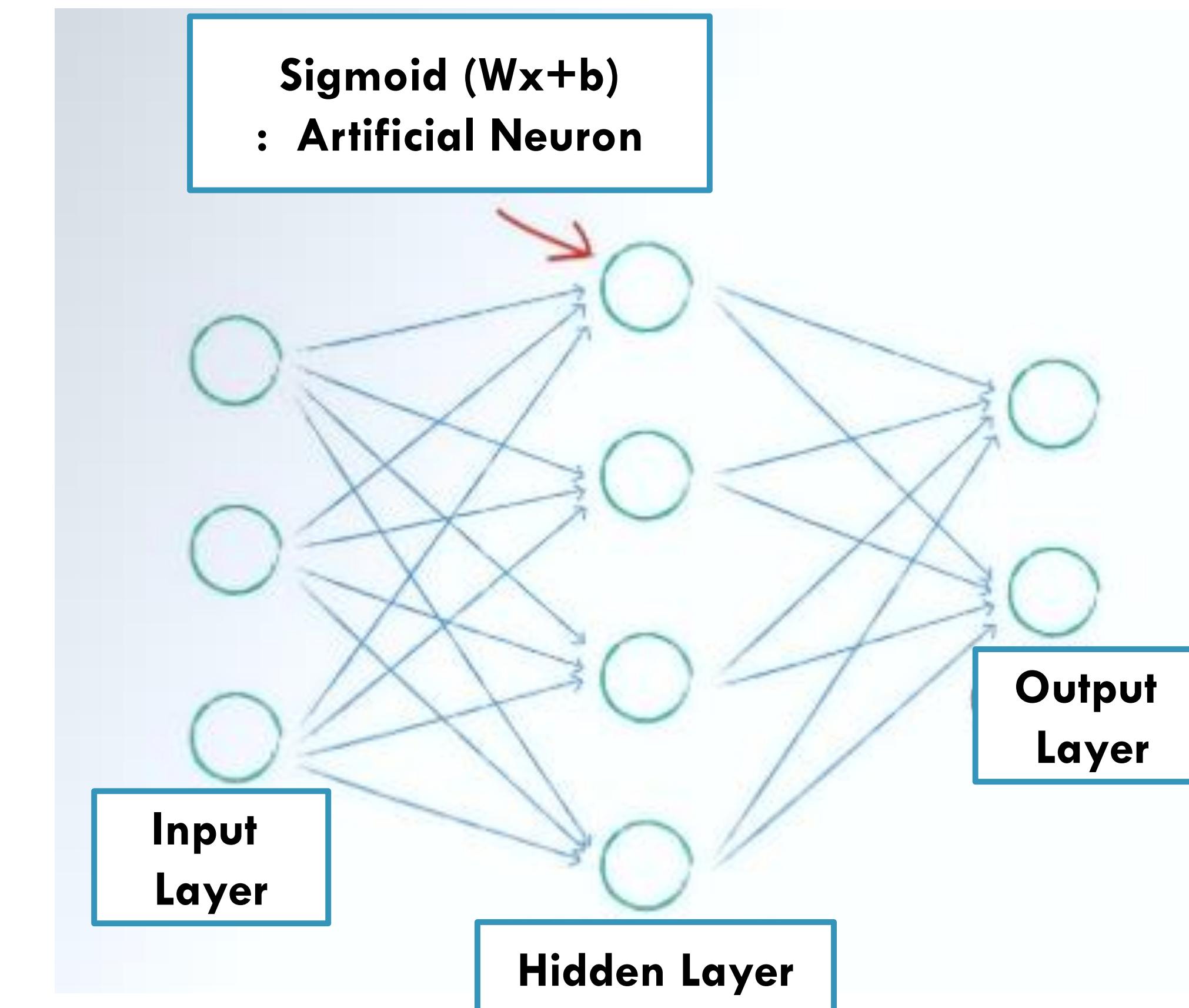
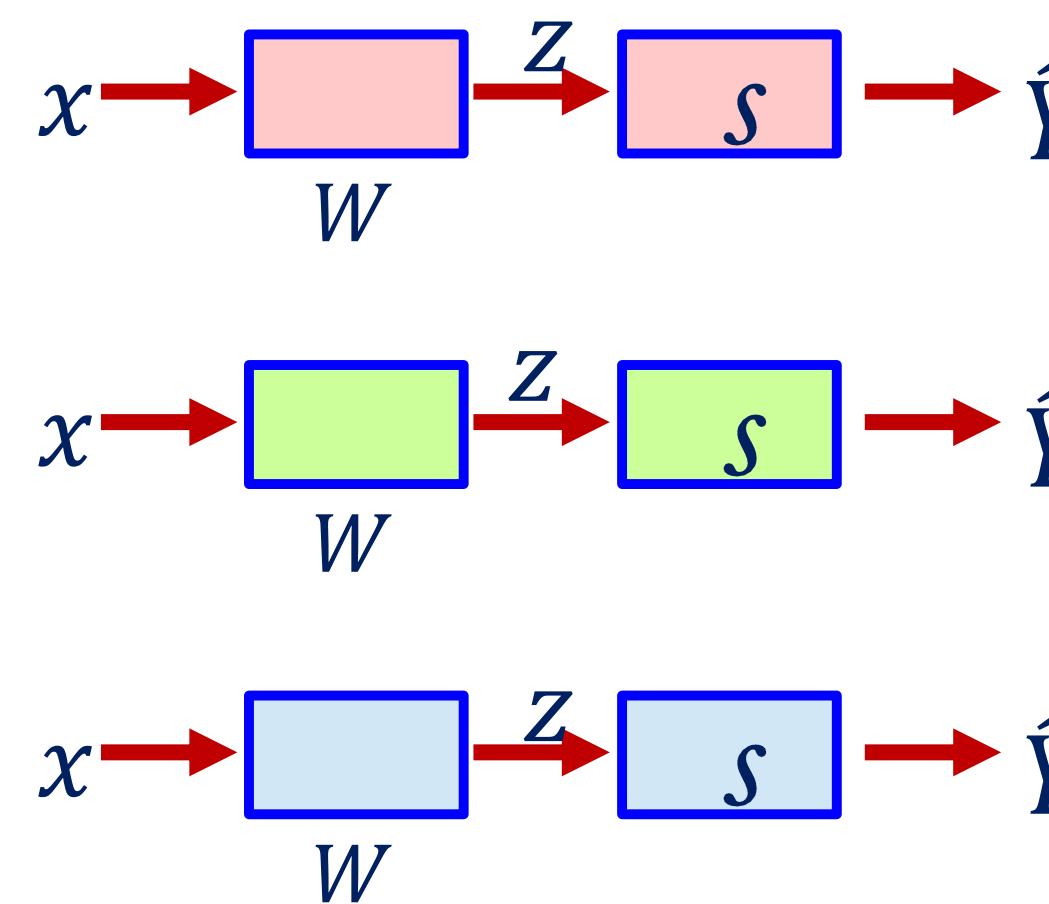


$$f \left(\sum_i w_i x_i + b \right)$$

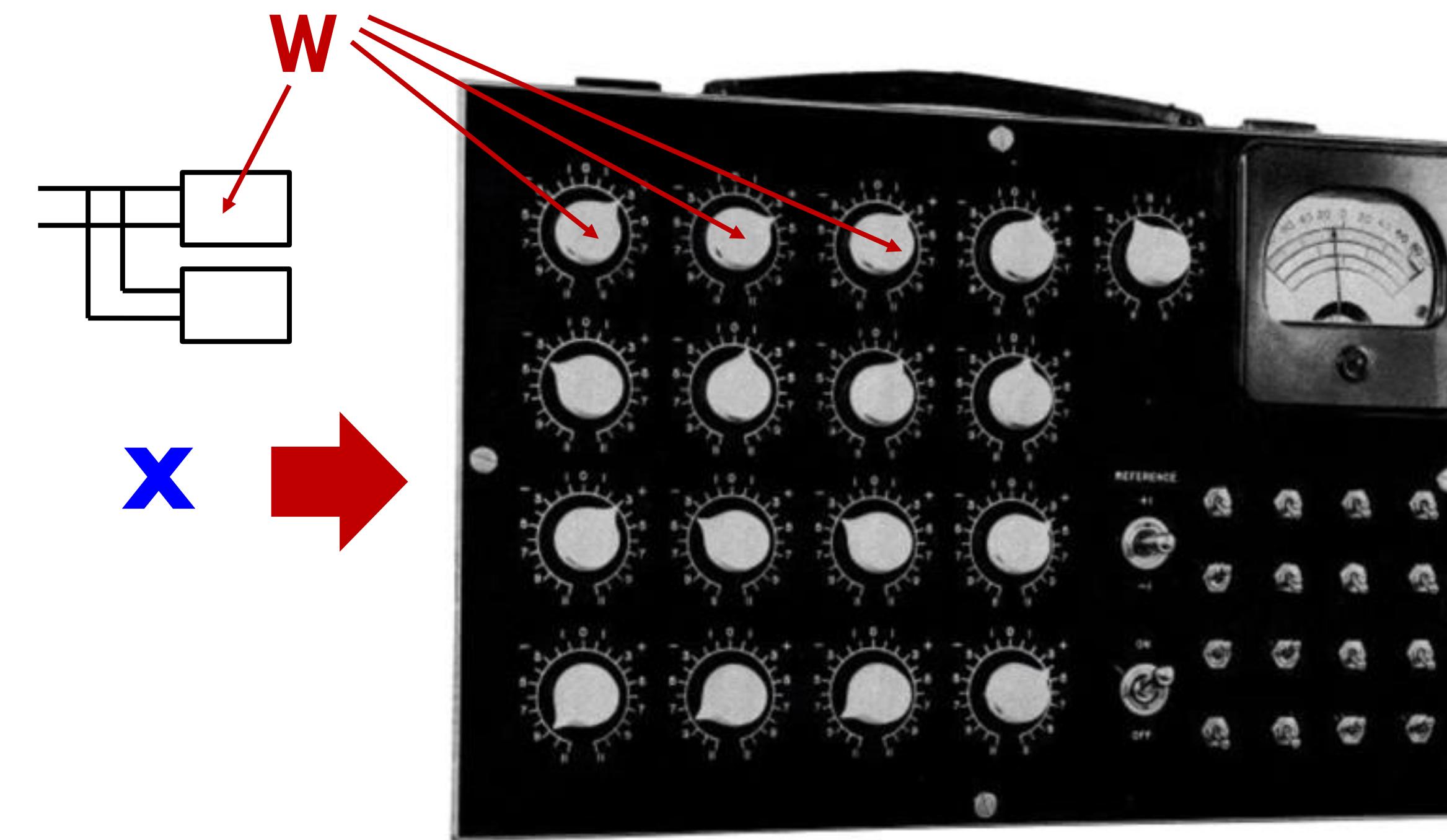
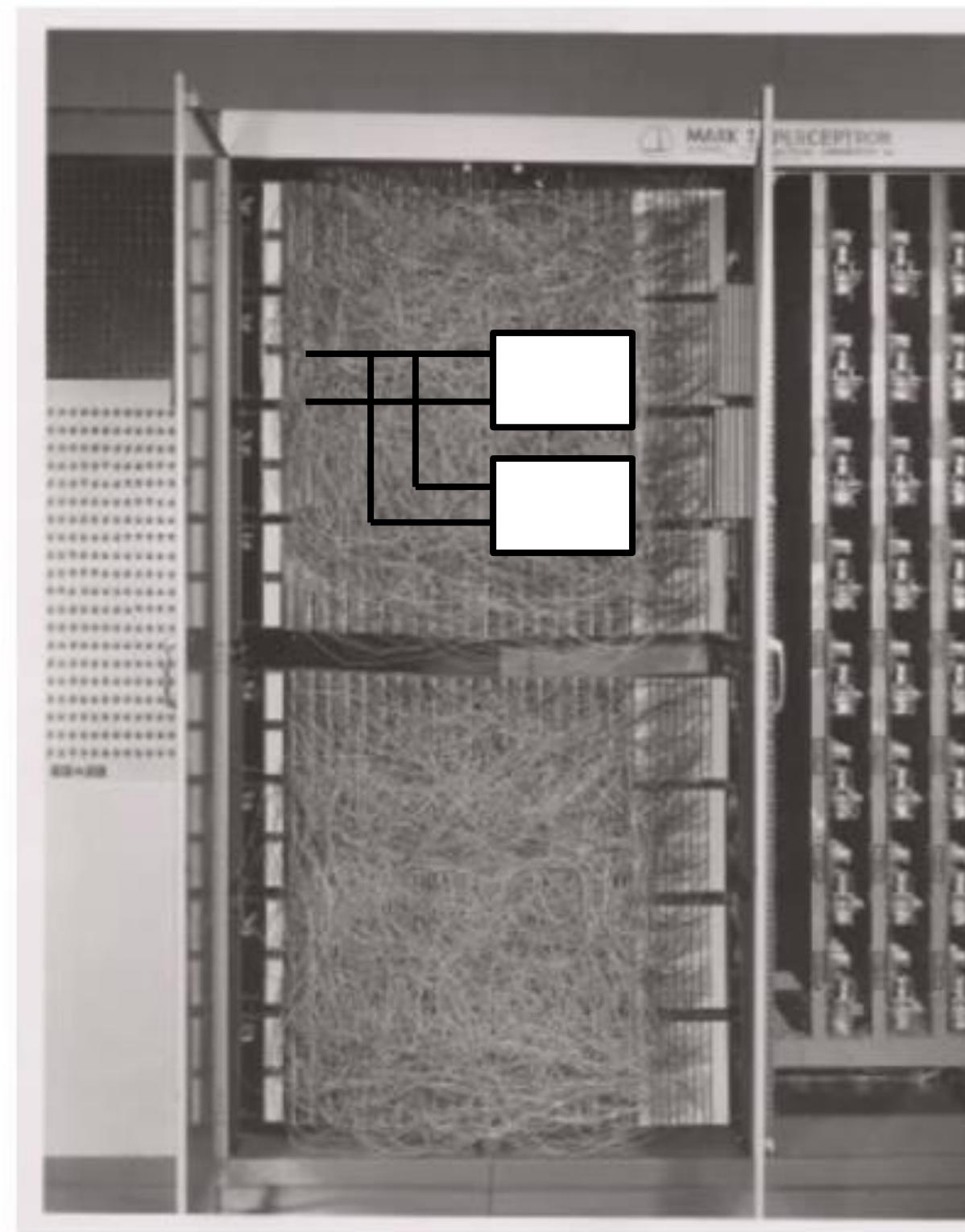
output axon

Activation function
: Sigmoid, ReLU, tanh ...

Logistic regression units

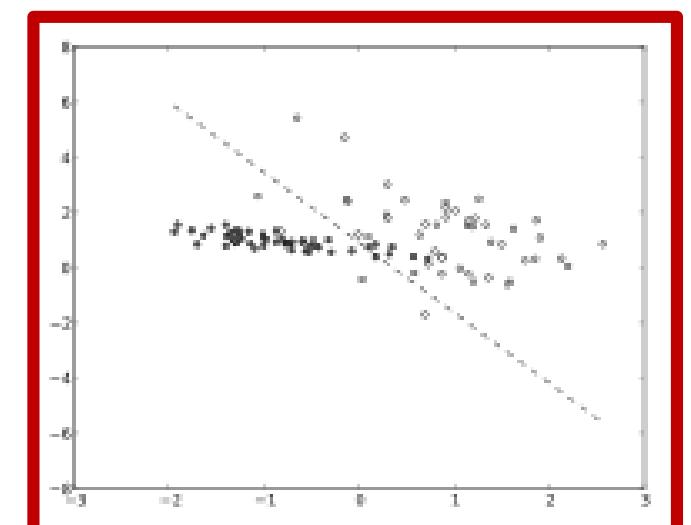


Hardware implementations



Frank Rosenblatt, ~1957: Perceptron

Widrow and Hoff, ~1960: Adaline/Madaline



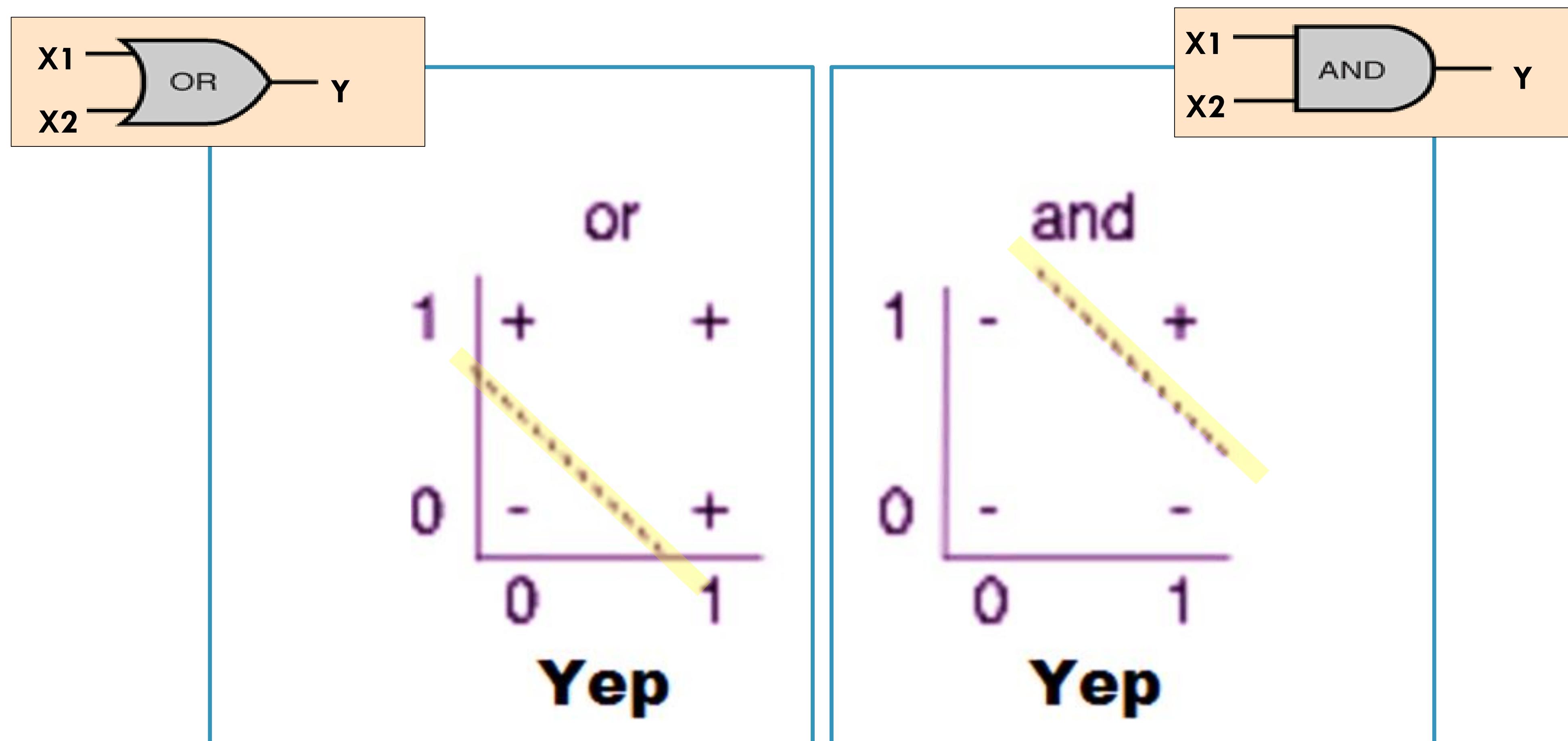


False Promises

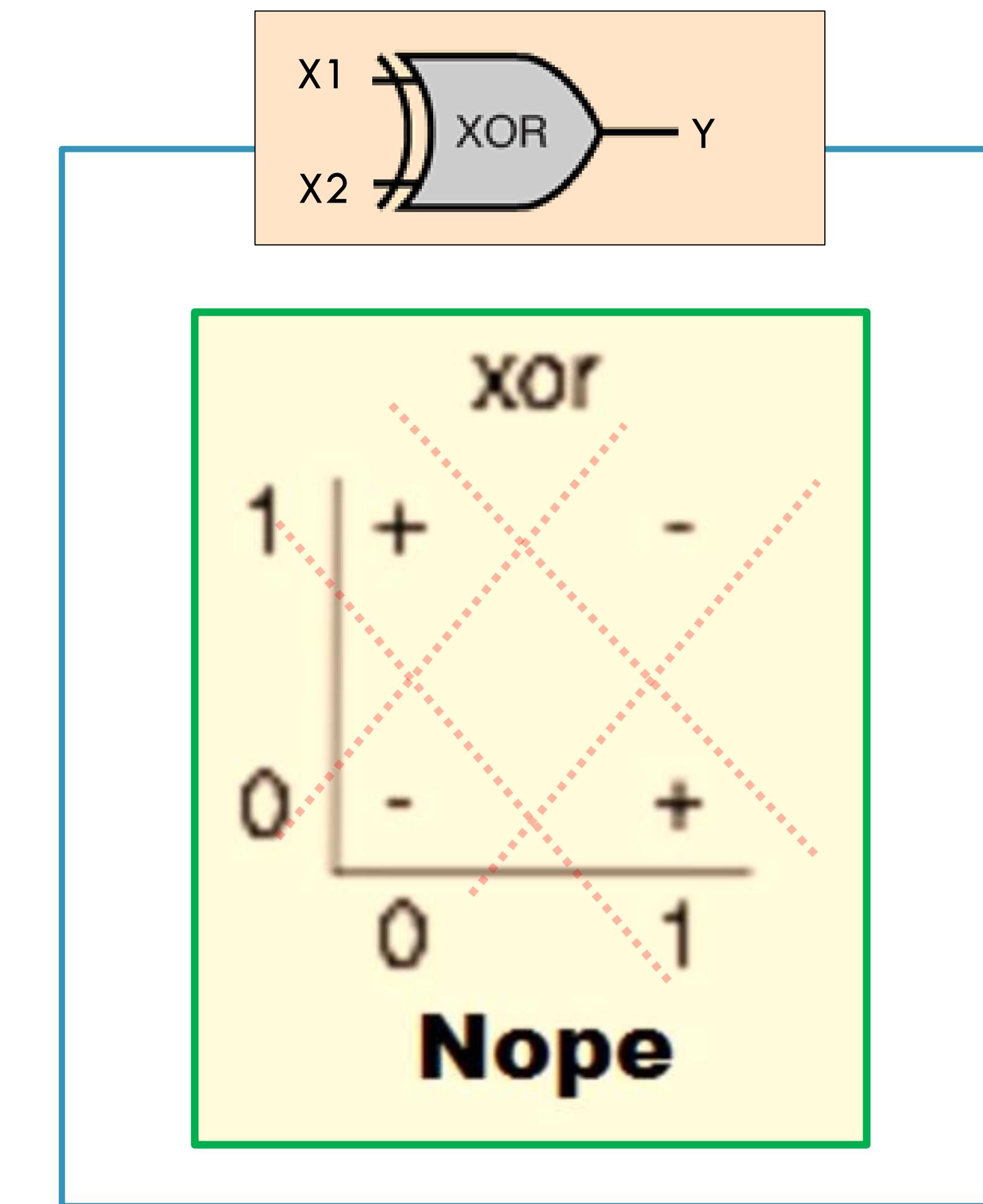
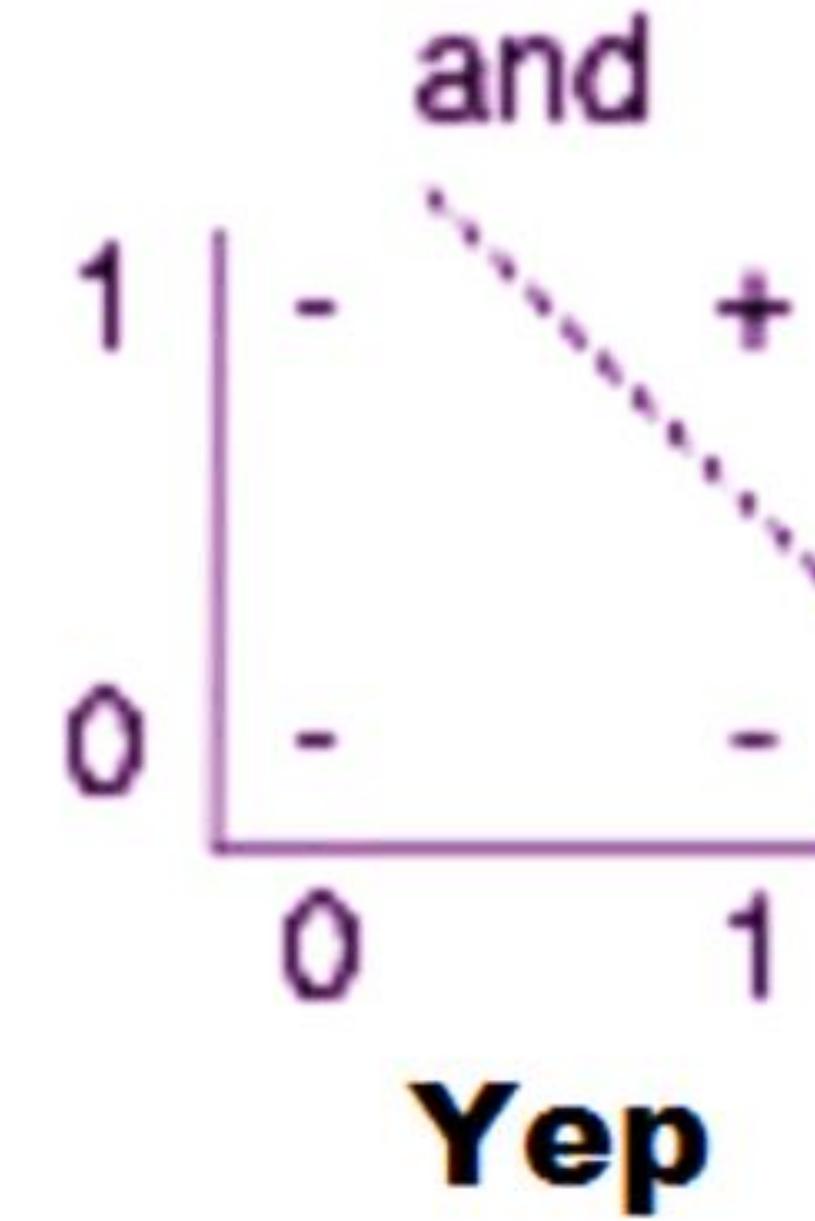
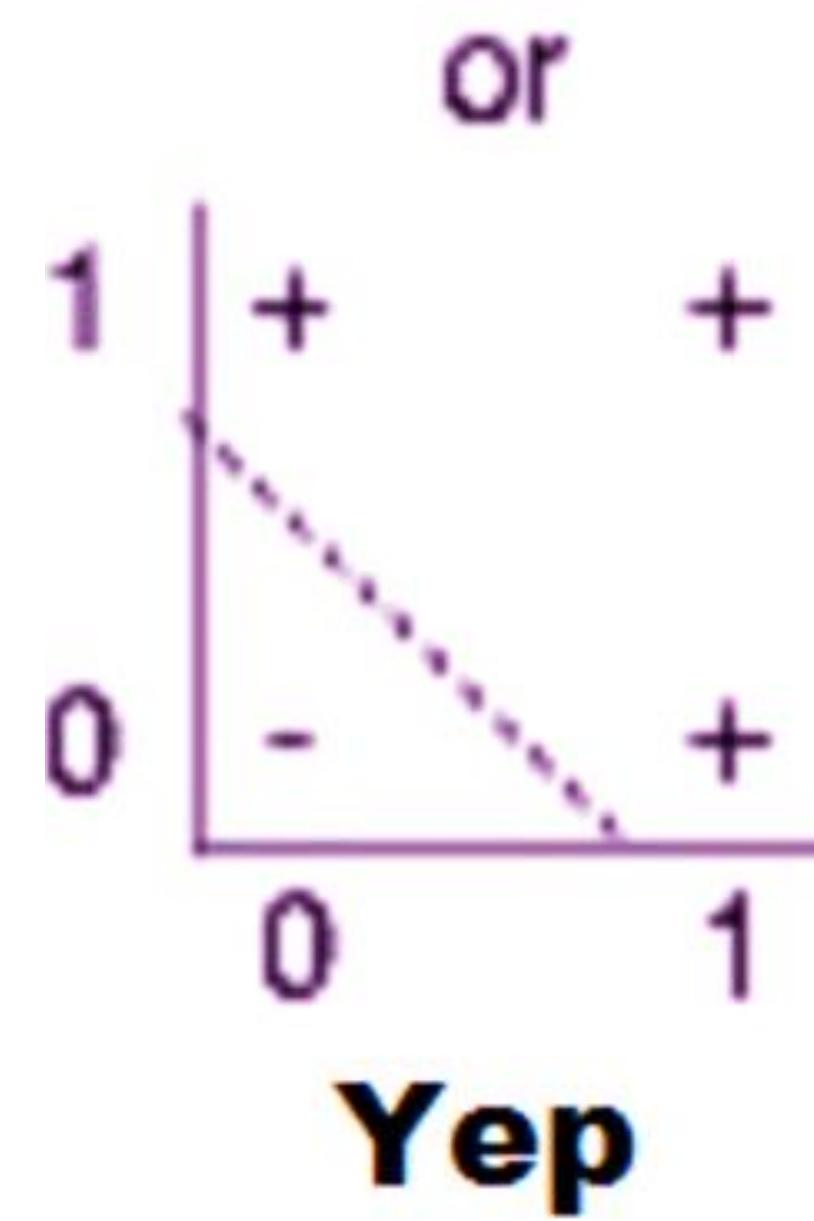
- “The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence ... Dr. Frank Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers”

New York Times July 08, 1958

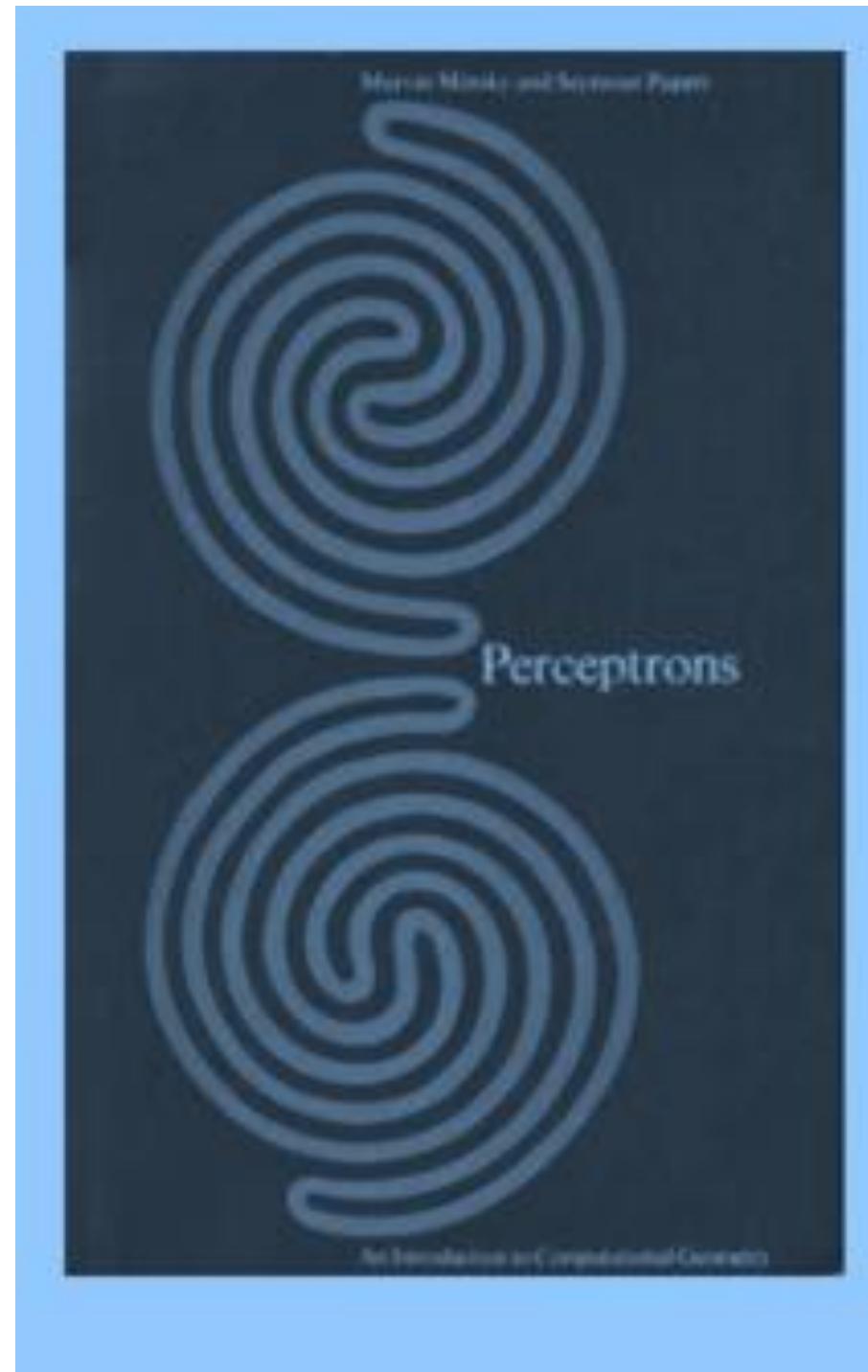
(Simple) AND/OR problem: linearly separable?



(Simple) XOR problem: linearly separable?

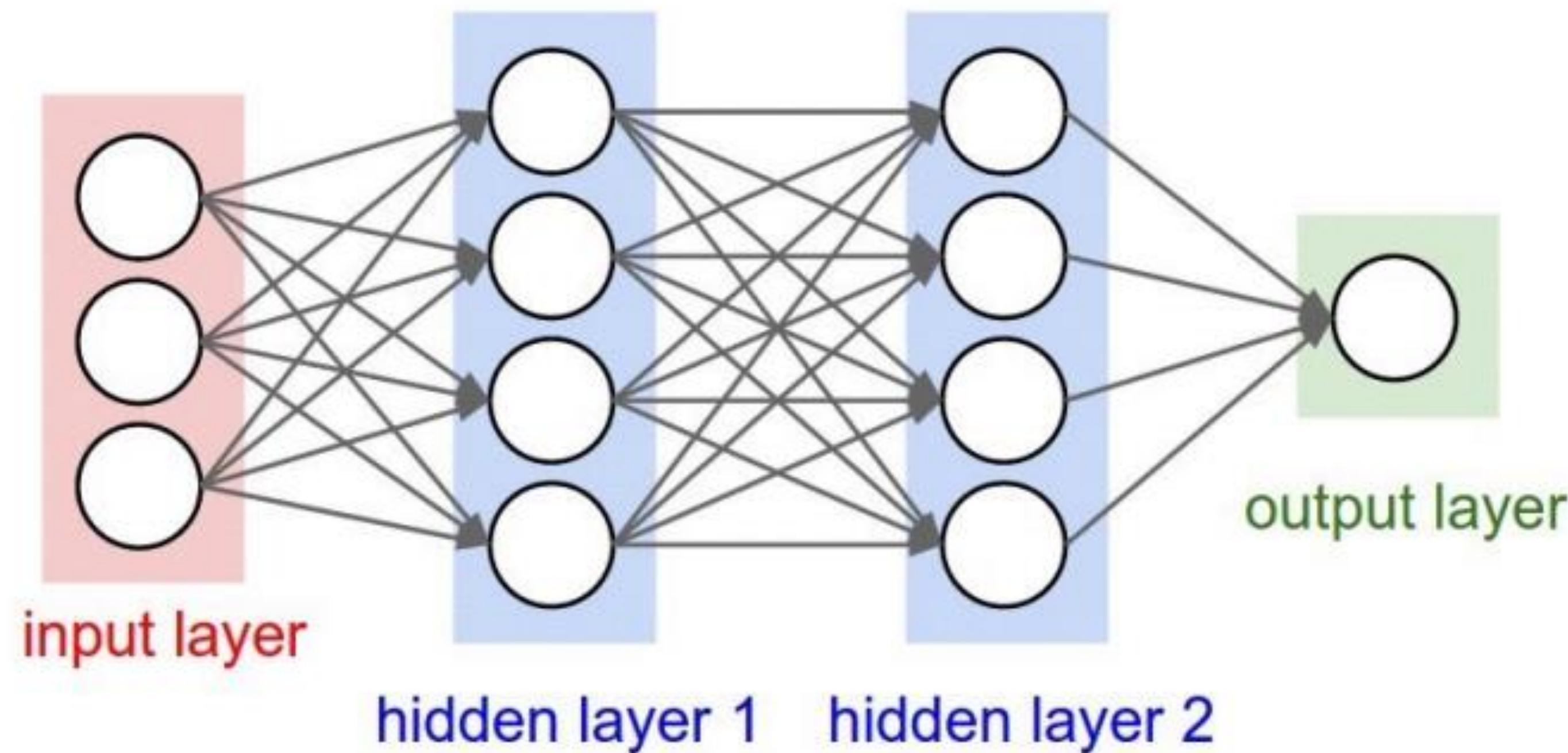


Perceptrons (1969) : by Marvin Minsky, founder of the MIT AI Lab



- We need to use **MLP, multilayer perceptrons** (multilayer neural nets)
- No one on earth had found a viable way to train MLPs good enough to learn such simple functions.

No one on earth had found a viable way to train

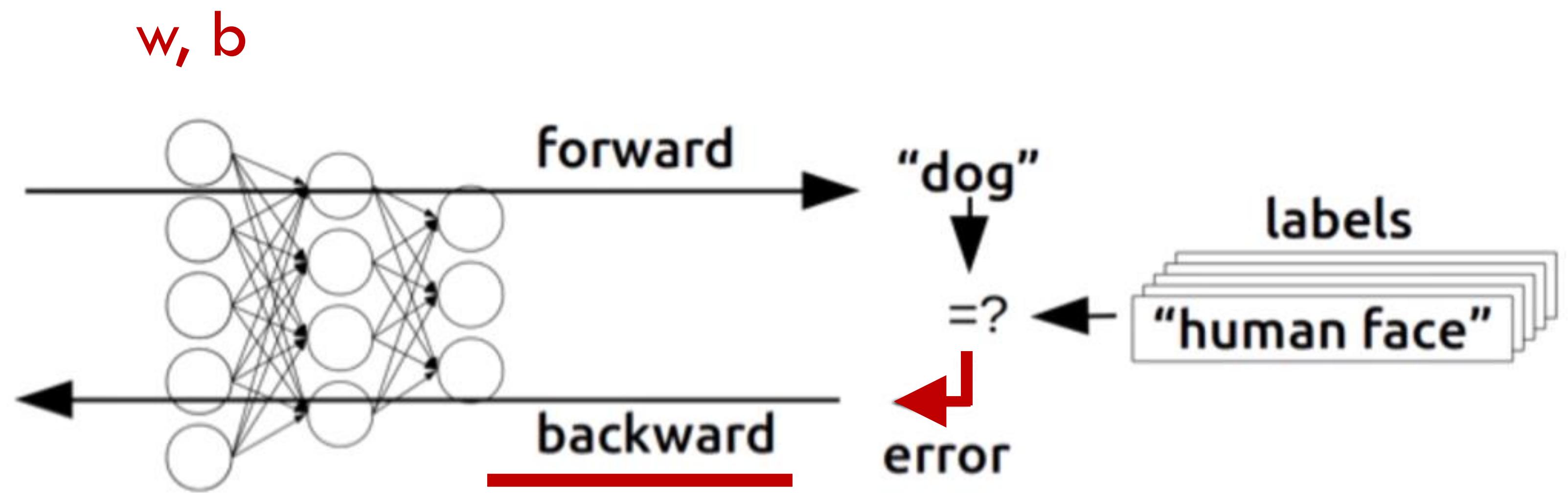
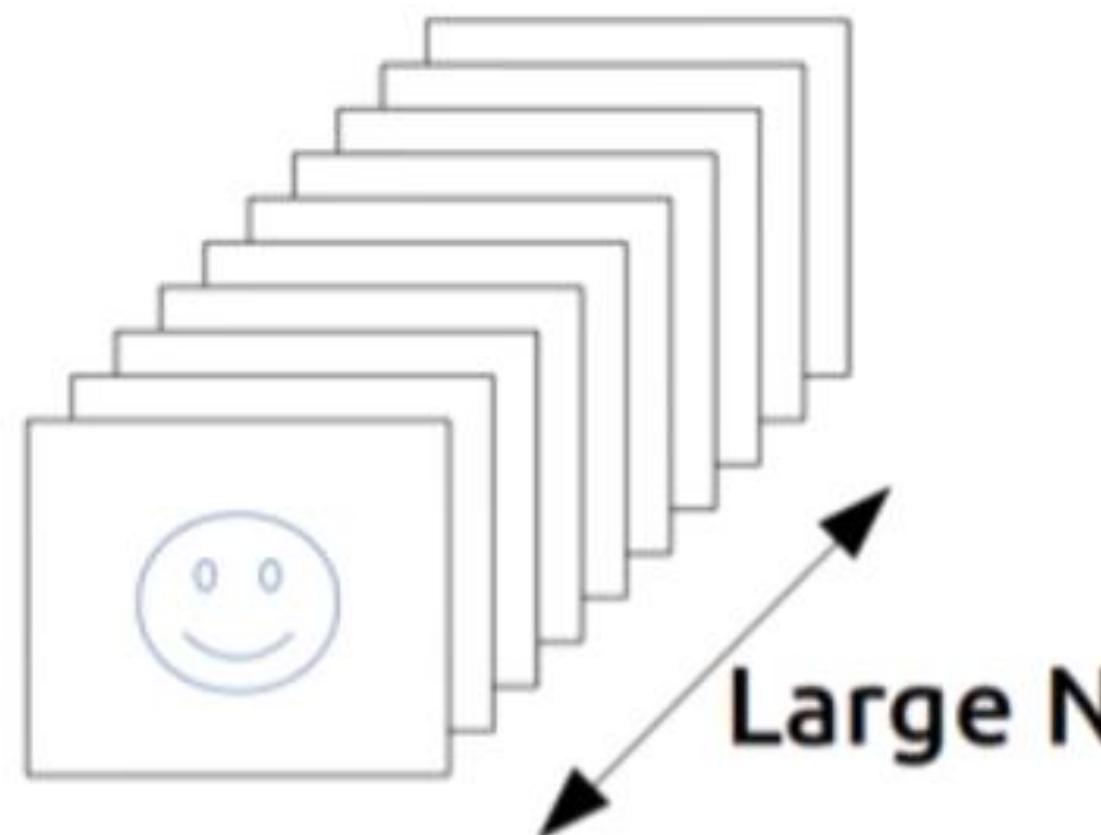


*Marvin Minsky, 1969

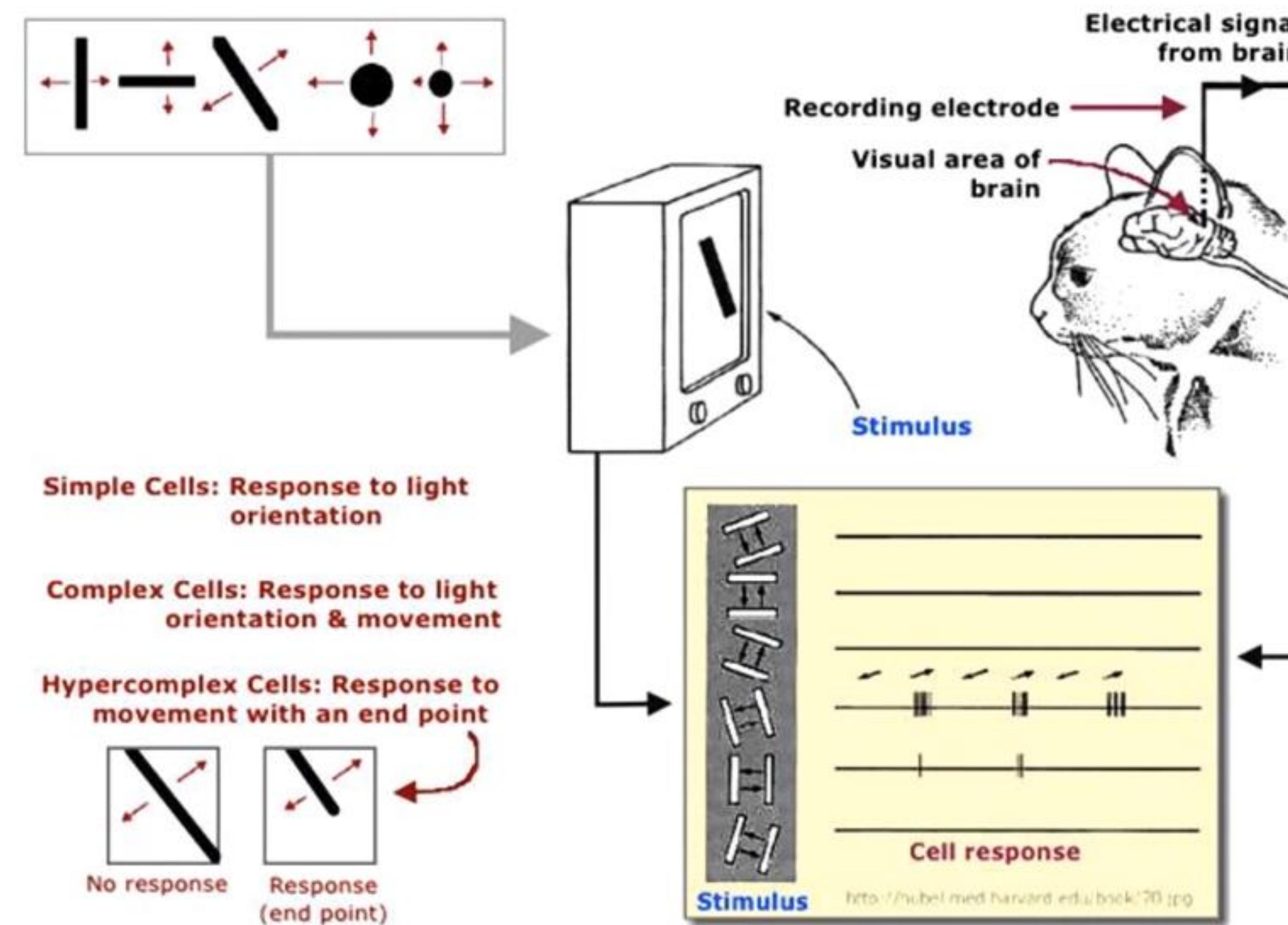
Backpropagation : (1974, 1982 by Paul Werbos, 1986 by Hinton)



Training



Visual neurophysiology

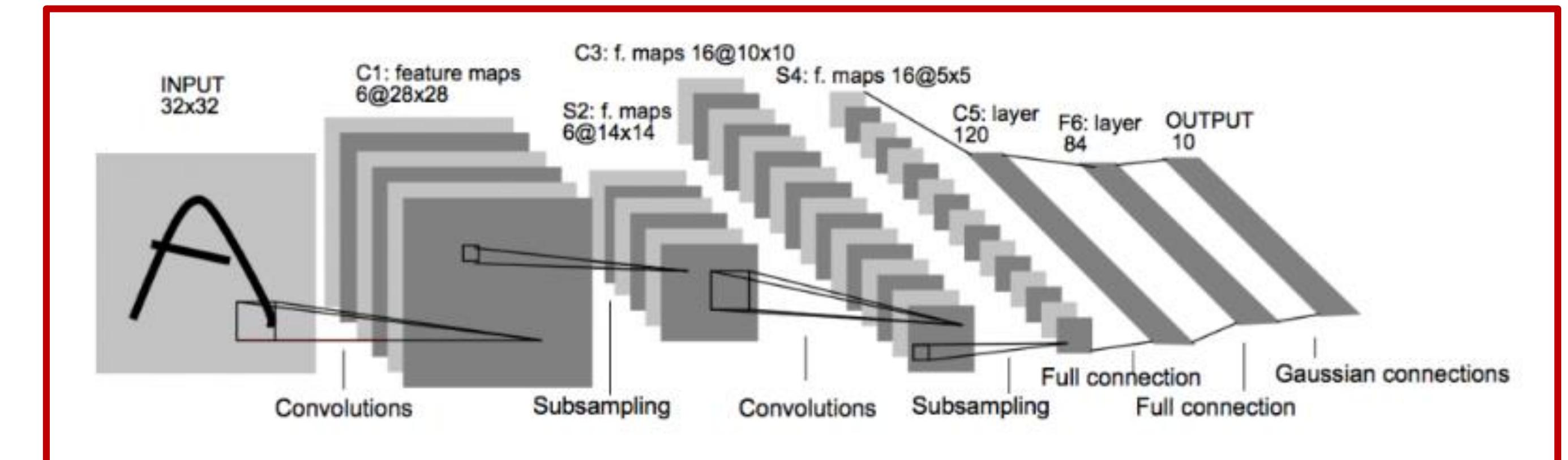
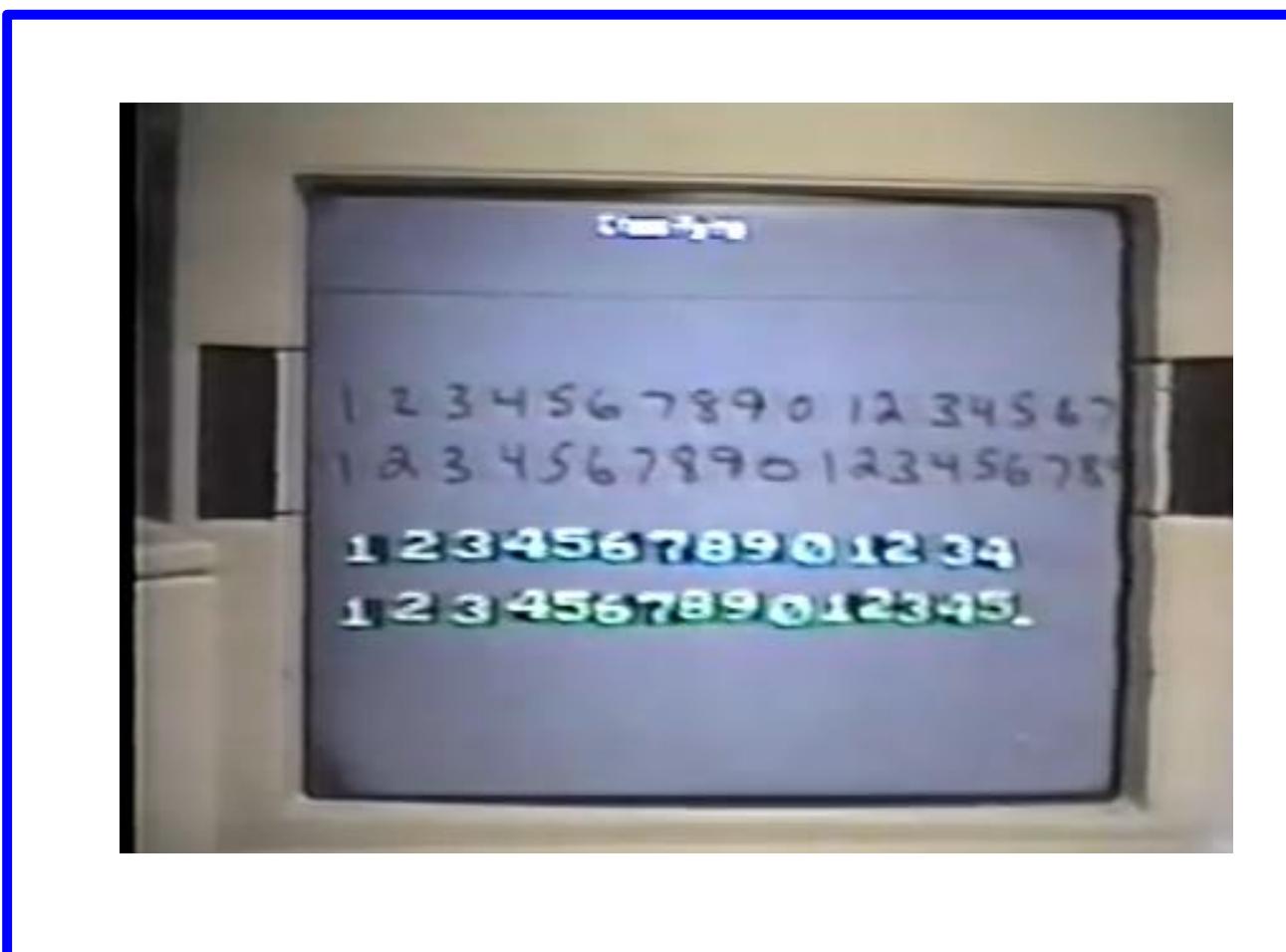


Hubel & Wiesel, 1959

CNN : Convolutional Neural Networks (by Yann Lecun)

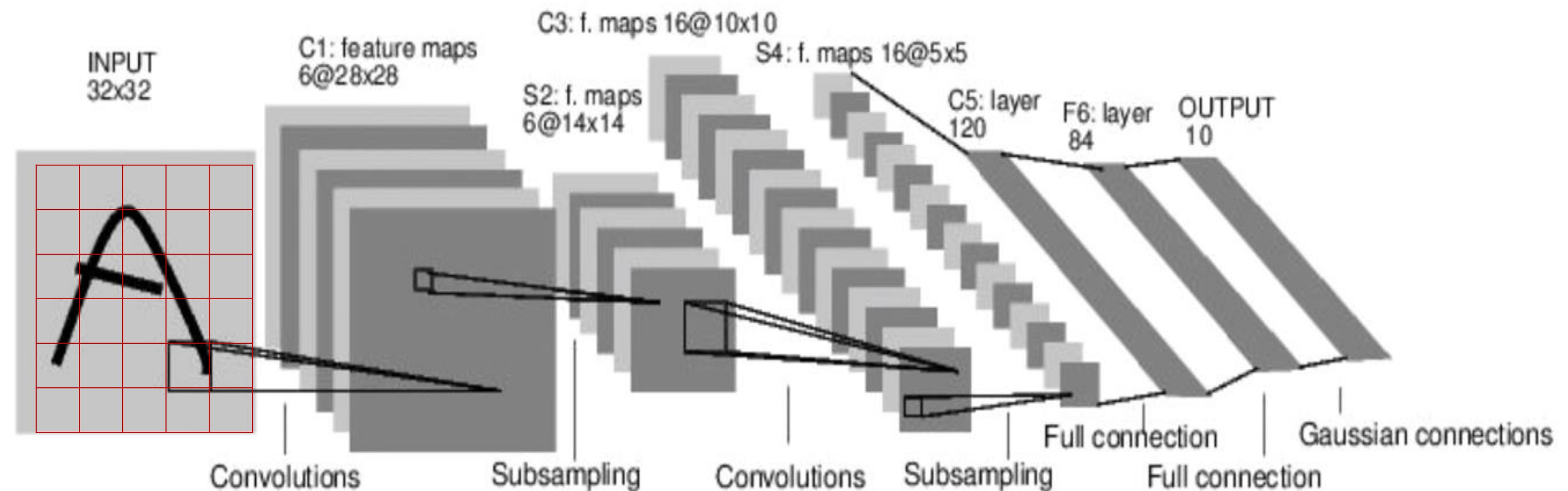
Yann Lecun (1989)

“Handwritten digit recognition with a back-propagation network”



Yann Lecun (1998)
“Gradient-Based Learning Applied to Document Recognition”

CNN : Convolutional Neural Networks

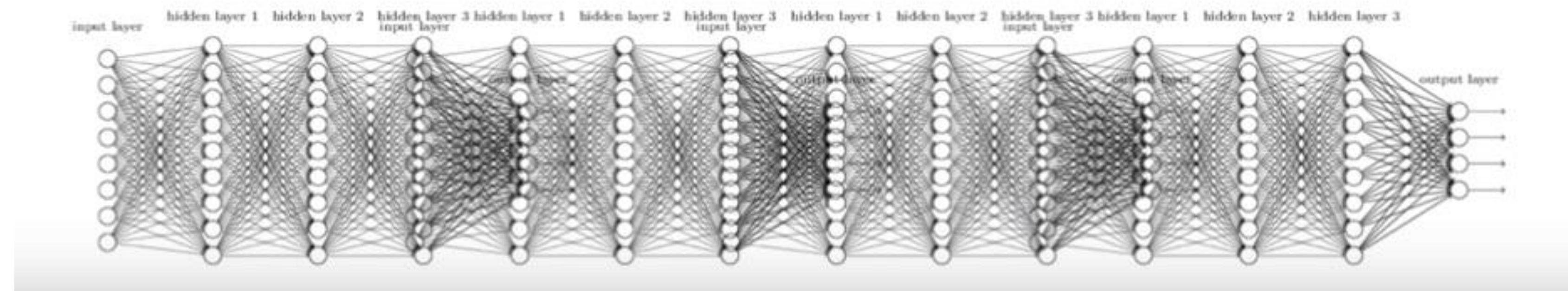


“At some point in the late 1990s, one of these systems was reading 10 to 20% of all the checks in the US.”

[LeNet-5, LeCun 1980]

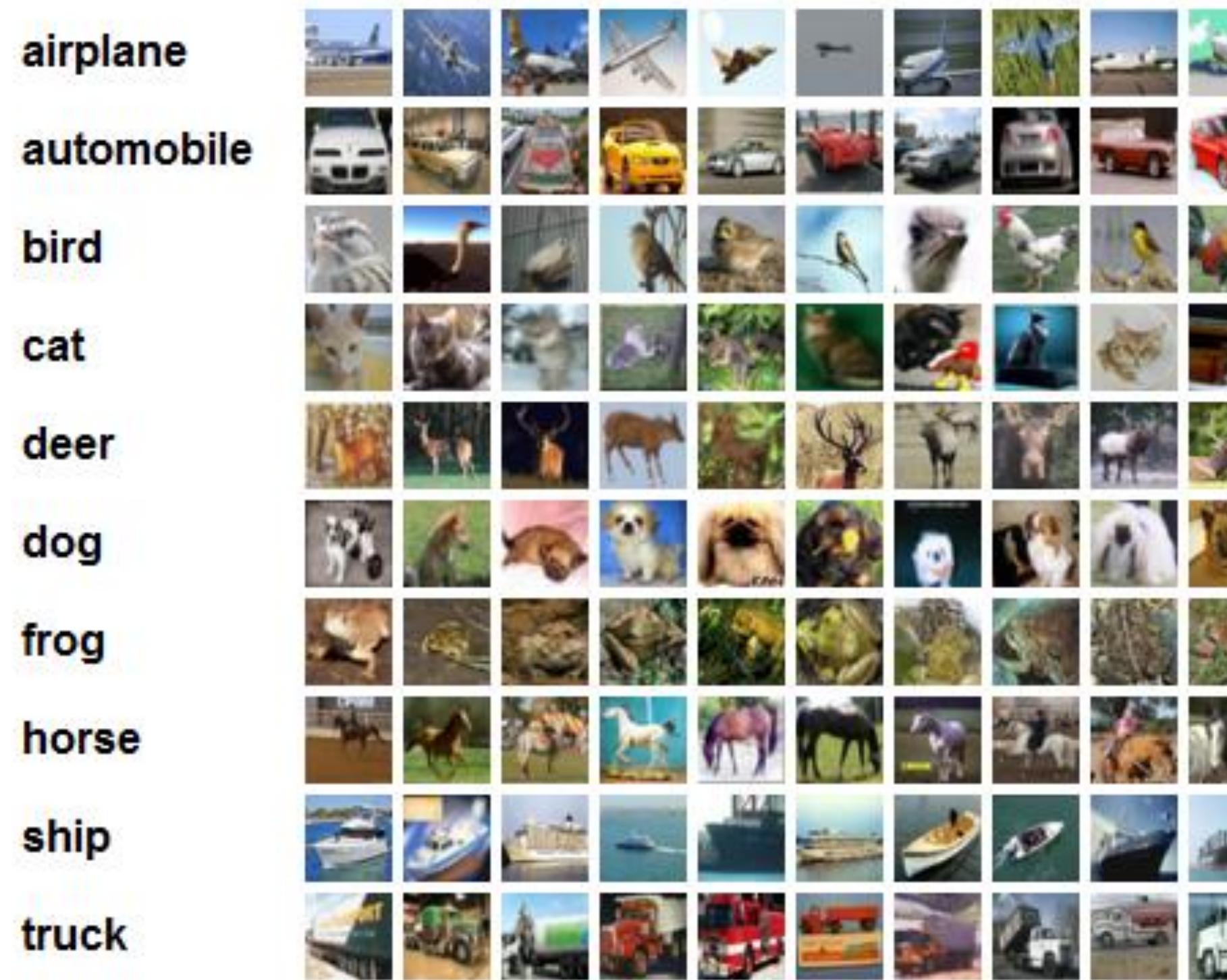
A Big Problem

- Backpropagation just did not work well for **normal neural nets** with many layers
- Other rising machine learning algorithms: **SVM**, **RandomForest**, etc.
- 1995 “Comparison of Learning Algorithms For Handwritten Digit Recognition” by LeCun et al. found that this **new approach** worked better



CIFAR

CIFAR-10 data set



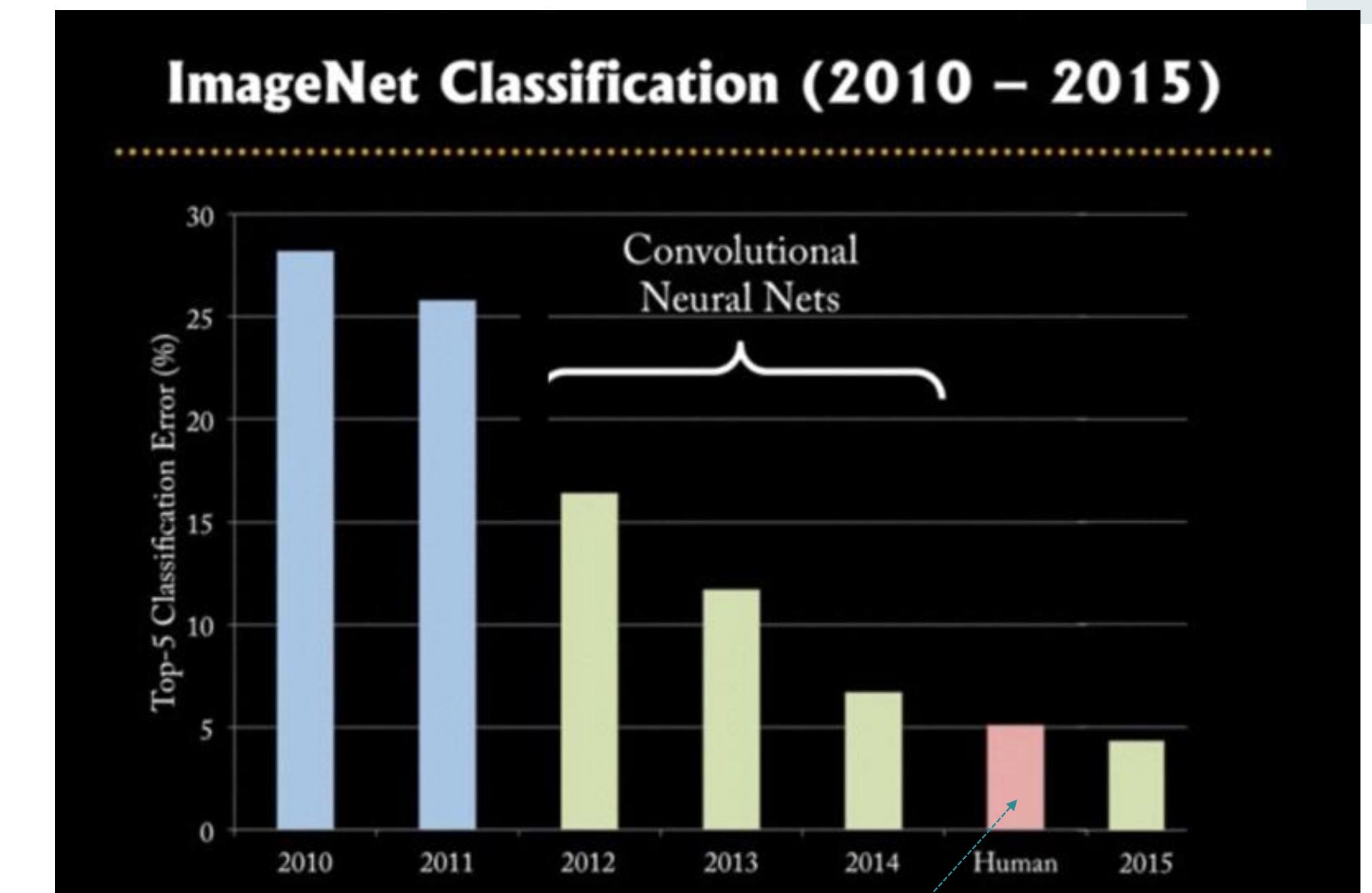
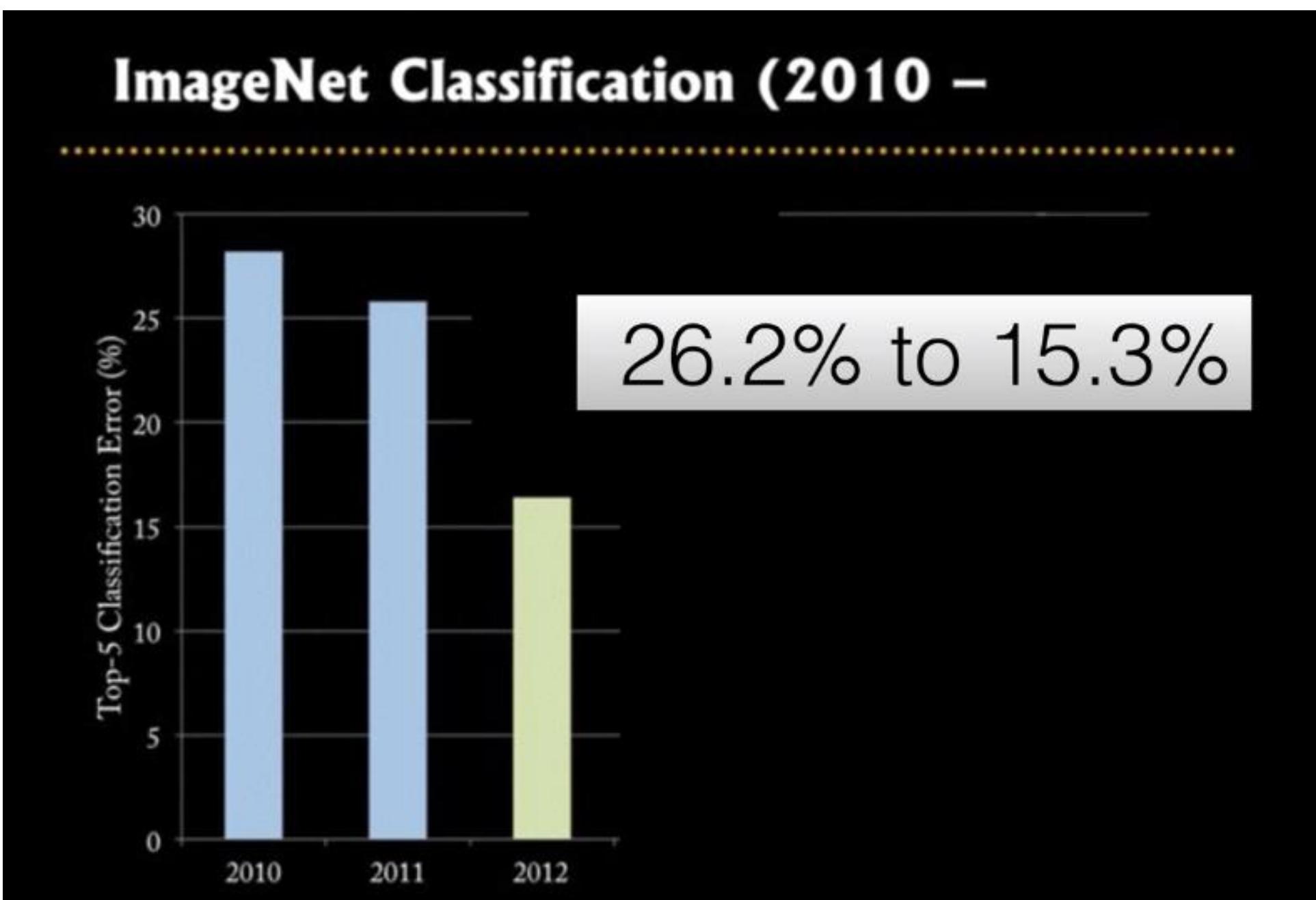
CIFAR
CANADIAN INSTITUTE
for ADVANCED RESEARCH



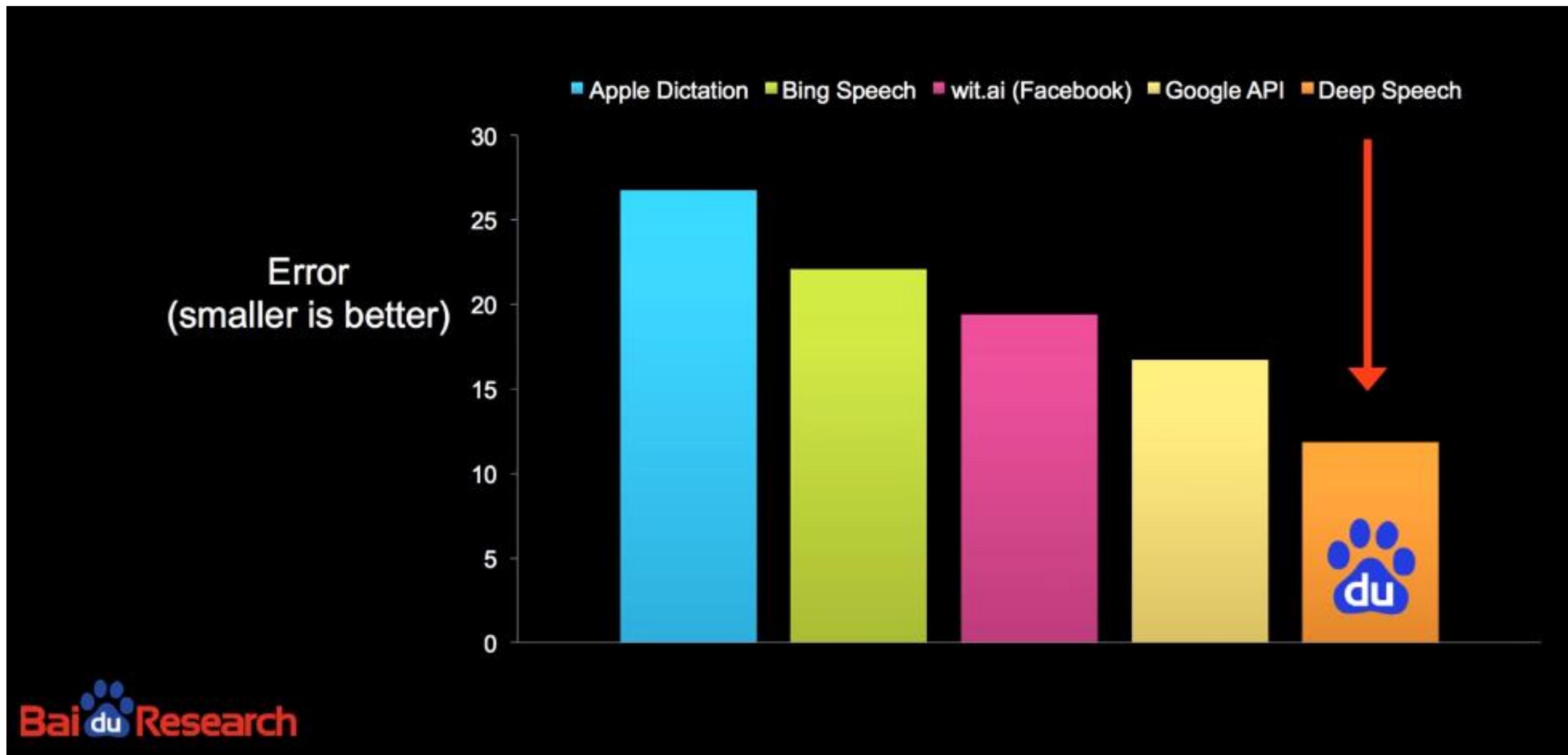
Breakthrough in 2006 and 2007 by Hinton and Bengio

- Neural networks with many layers really could be trained well, if **the weights are initialized in a clever way rather than randomly**.
- **Deep machine learning methods are more efficient for difficult problems** than shallow methods.
- **Renaming to Deep Nets, Deep Learning**.

Classification Error Rate



Speech recognition errors



AlphaGo

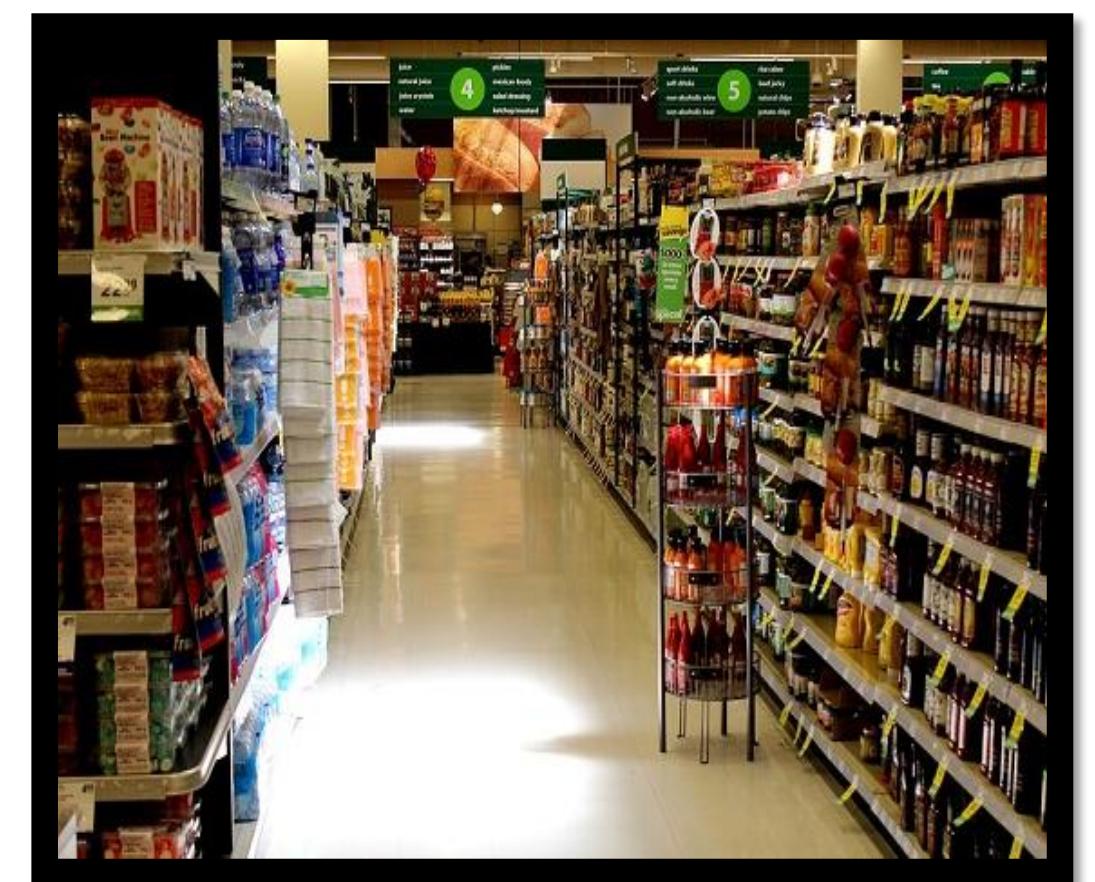
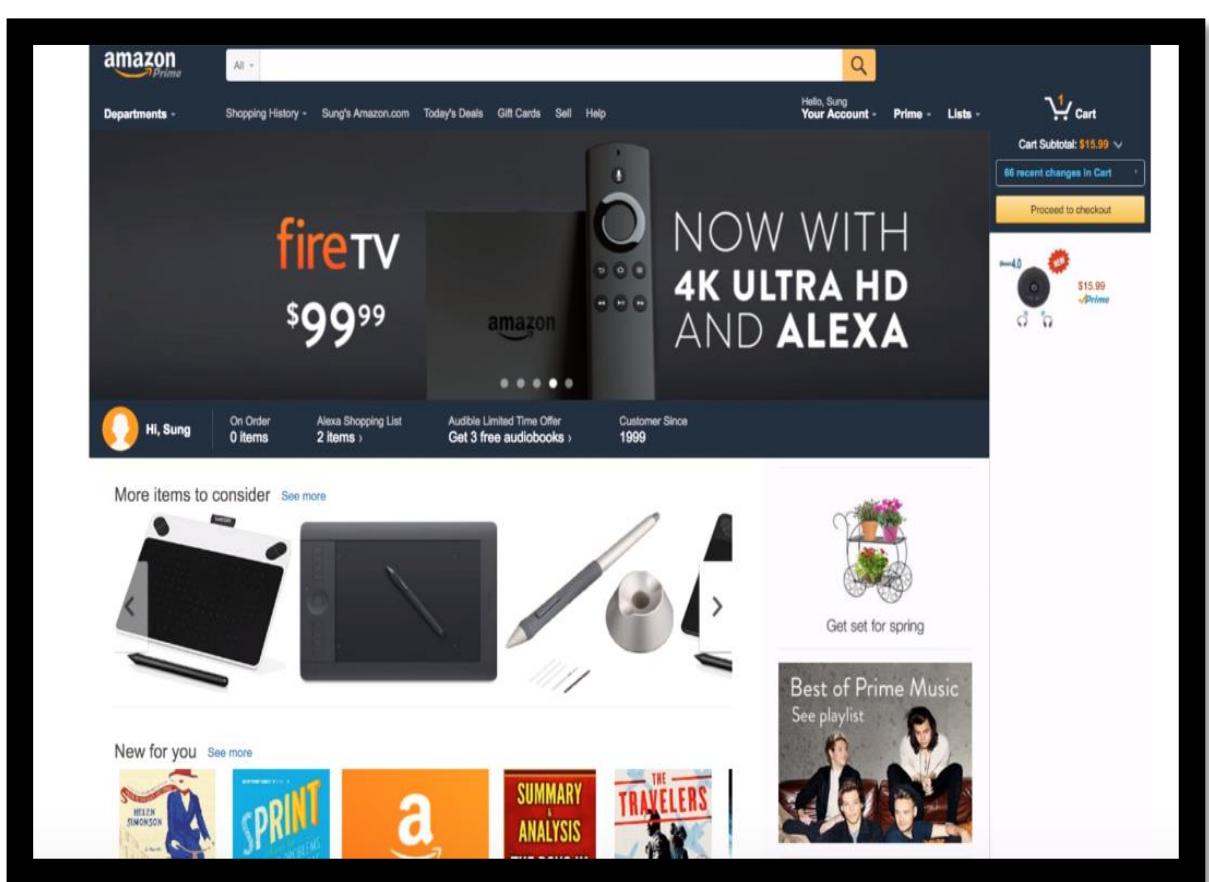
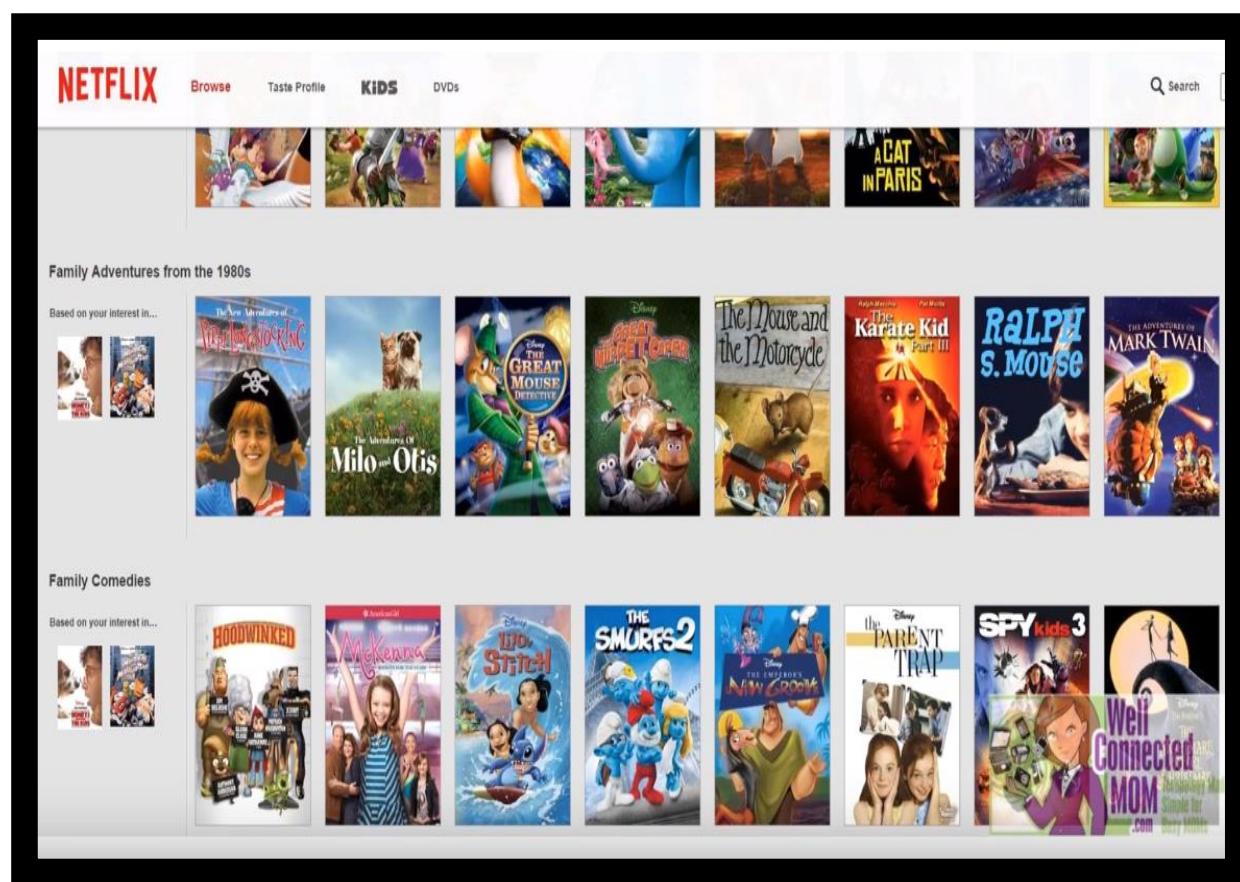
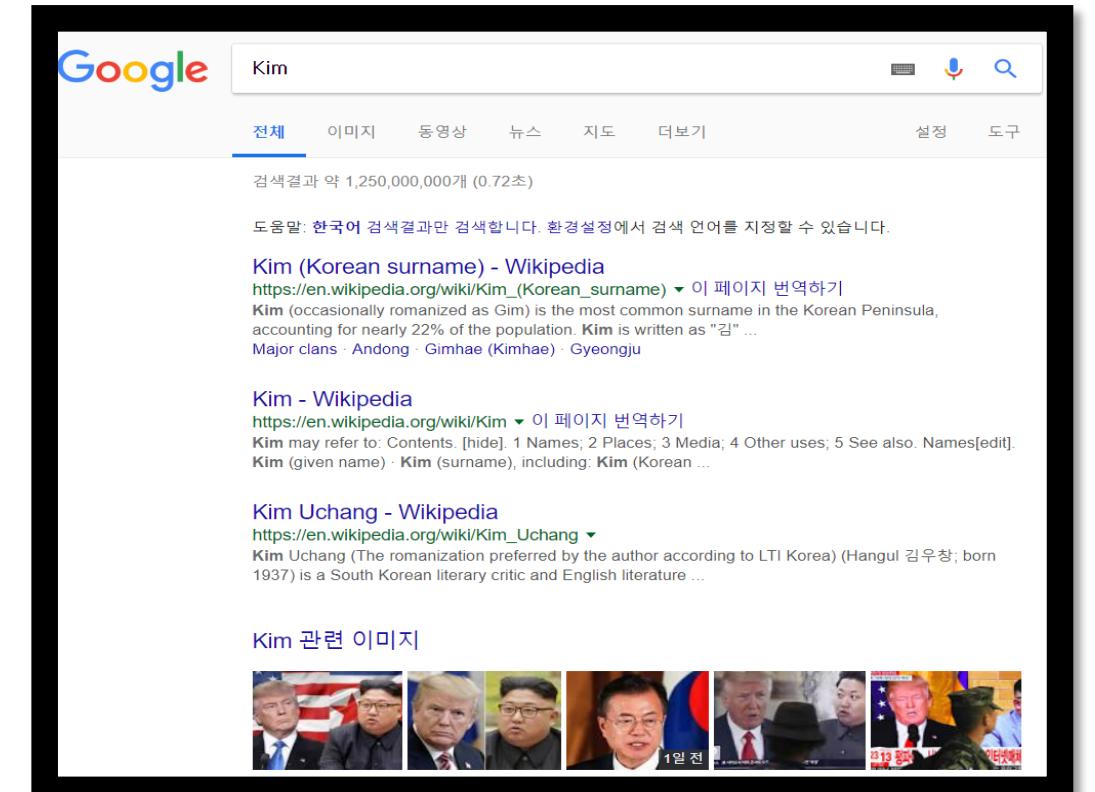
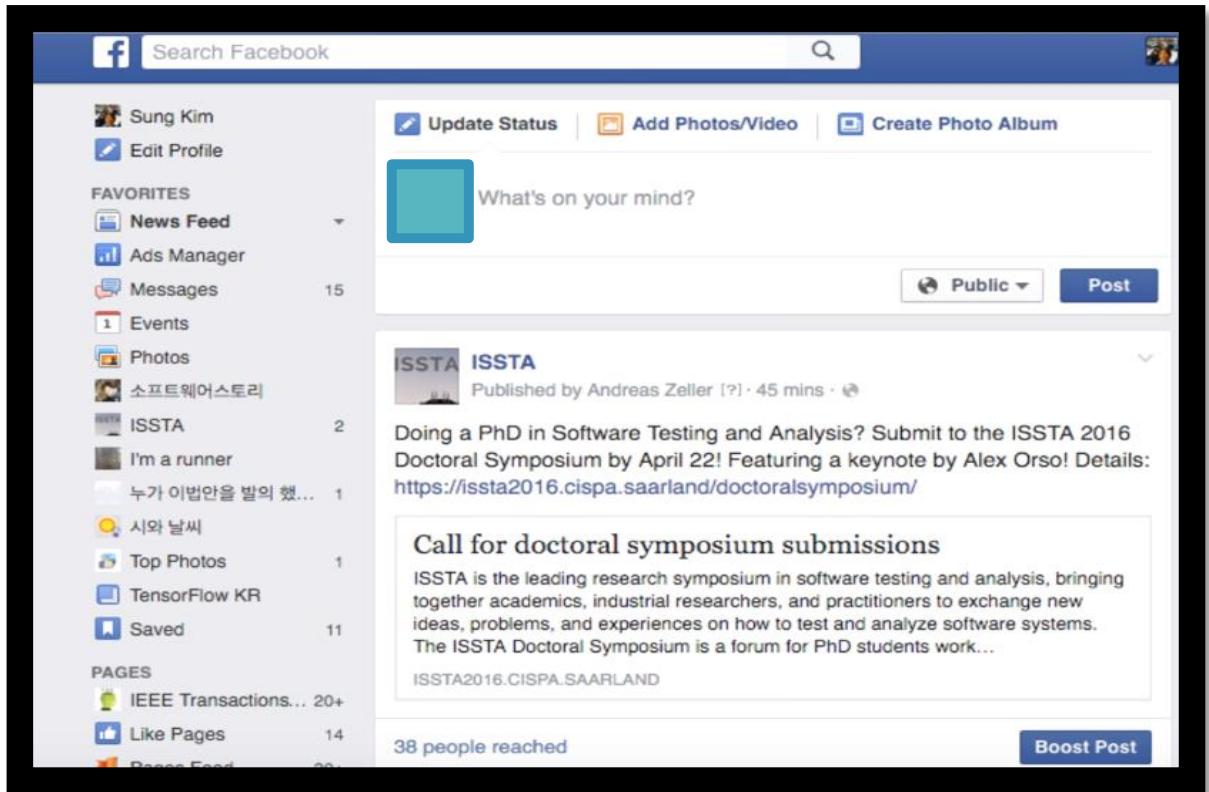
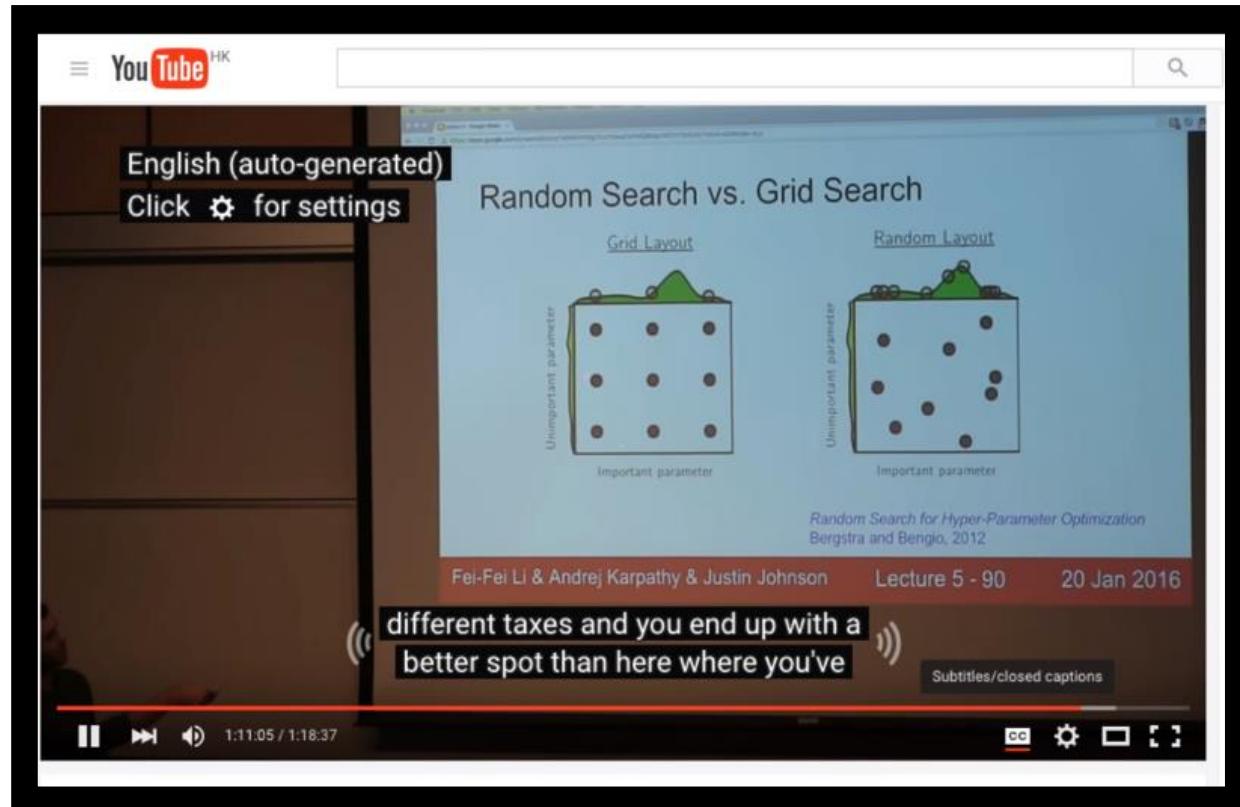




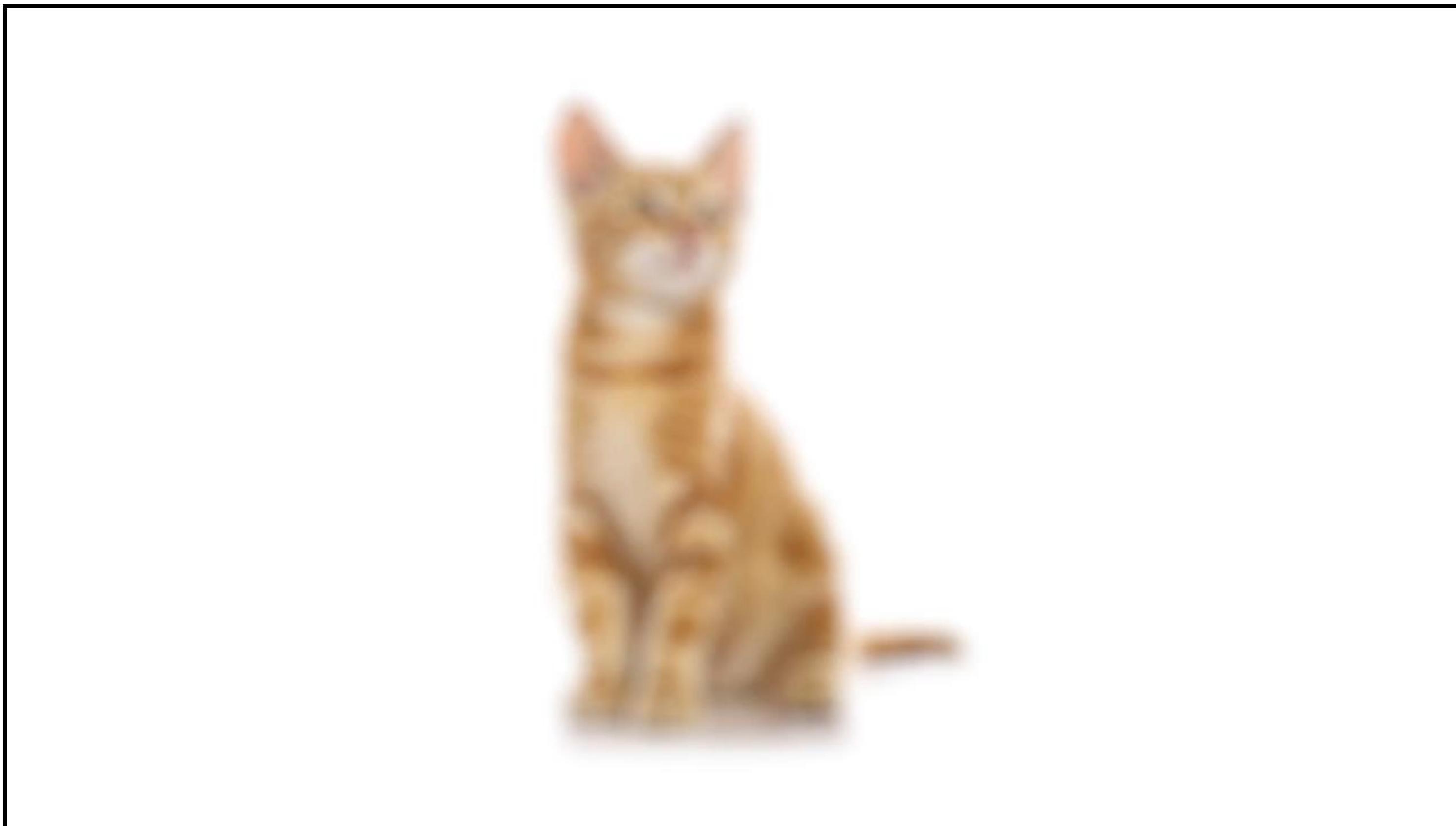
Geoffrey Hinton's summary of findings up to today

- Our labeled datasets were thousands of times too small
- Our computers were millions of times too slow.
- We initialized the weights in a stupid way.
- We used the wrong type of non-linearity(sigmoid).

Why should I care?

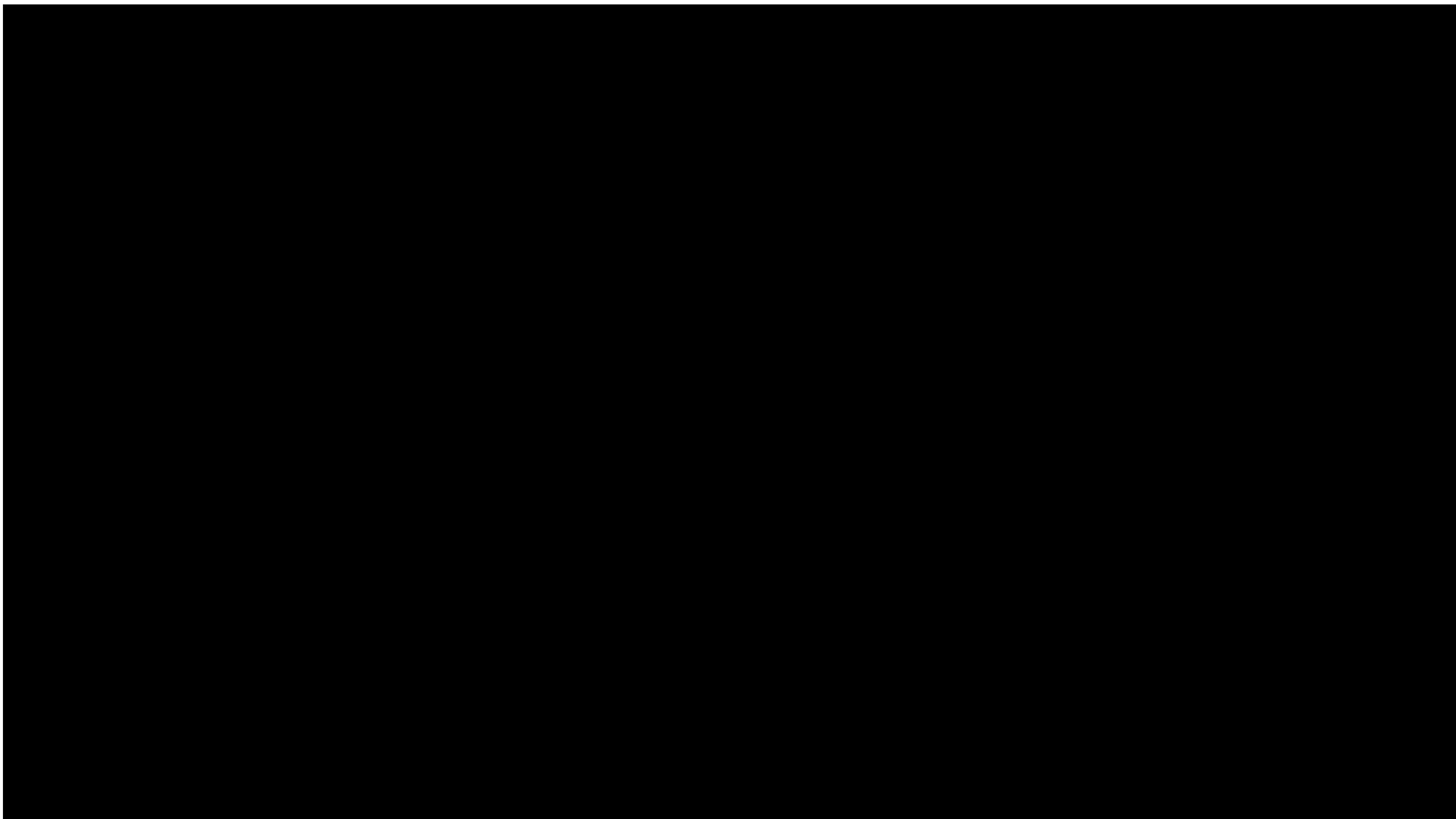


Why should I care?



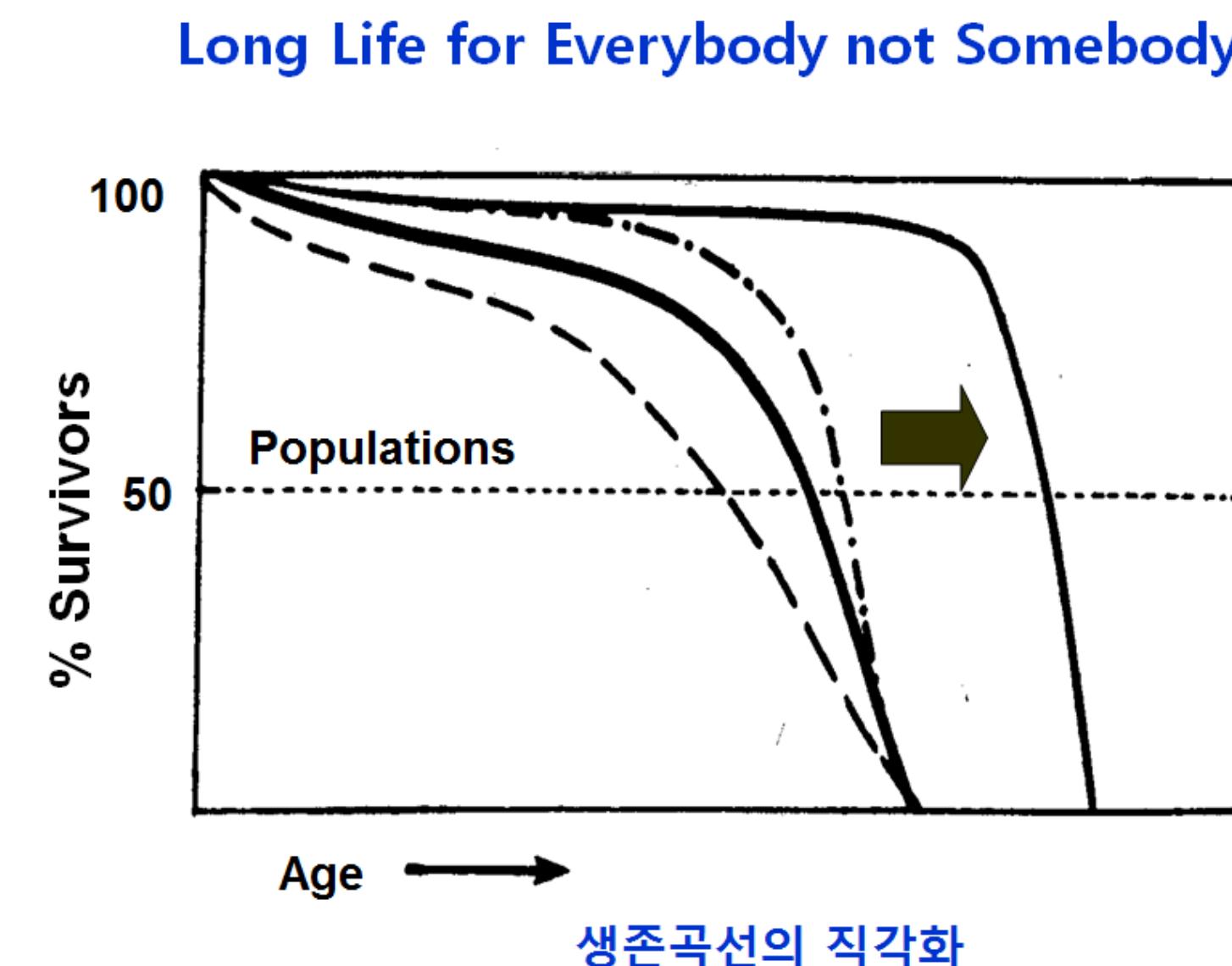
Why should I care?

A.I. Duet



Why should I care?

- IBM Watson : 미국 주요 병원에서 암 진단 및 치료법 조언, 국내 주요 대학병원에도 도입
 - 2013년 투입 전 : 60만 건 진단서, 200만 쪽 전문서적, 150만 명의 환자 기록을 학습
 - 정확도 비교 : 폐암 진단에서 Watson 90% , 의사 50 %



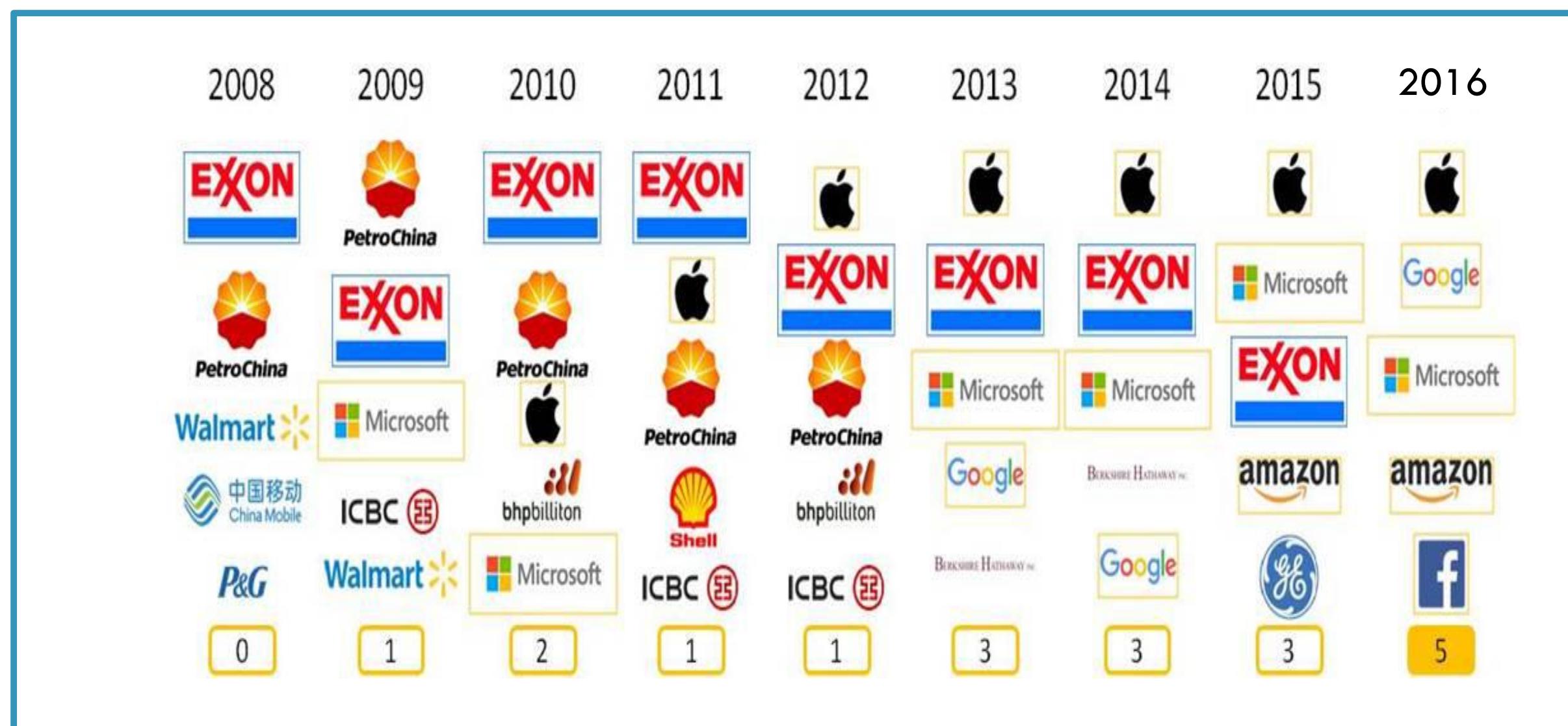
Why should I care?

- 컴퓨터가 스스로 사고 팔고를 결정 – **Algorithm Trading**
→ 주식 거래의 70%이상을 SW알고리즘으로 수행 (미국)
- 자율 SW agent : 새로운 경제 체제를 지탱하는 근본으로 기능할 것
→ 프로그램 경제 (**programmable economy**)



Why should I care?

SW & A.I. 세계 경제를 움직인다.



Air B&B

Uber

UBEER
이동중

UberX
uberXL
UberBLACK
SUV
ACCESS

Air B&B

BEAUTIFUL APARTMENT PARIS BASTILLE
Paris, Île-de-France, France ★★★★★(234)

Momo Entire home/apt 2 Guests 1 Bedroom 1 Bed

Tap승 위치 설정

Uber

이동중

샌프란시스코 국제공항

UberX uberXL UberBLACK SUV ACCESS

REDZEP 4.8 ★

Hotel Industry Market Value

- Air B&B \$25.5B (2015.6), \$10B (2014.3)
- Hilton \$24.0B (2015.6, 627,000 Rooms)
- Marriott \$21B (2015)
- Hyatt \$8.3B (2015.6)

한계 비용 제로 사회 – Jeremy Rifkin

+ = ?

Why should I care?



Why should I care?

10년 전에 존재하지 않았던 현재의 유망 직업



미래부, '10년 후 대한민국 미래 일자리의 길을 찾다' 보고서 중에서...

Why Now?

- Students / Researchers
 - Not too late to be a world expert.
 - Not too complicated (mathematically).
- Practitioner
 - Accurate enough to be used in practice
 - Many ready-to-use tools such as TensorFlow
 - Many easy/simple programming languages such as Python
- After all, it is fun!