



Lecture 08

Deep Neural Nets

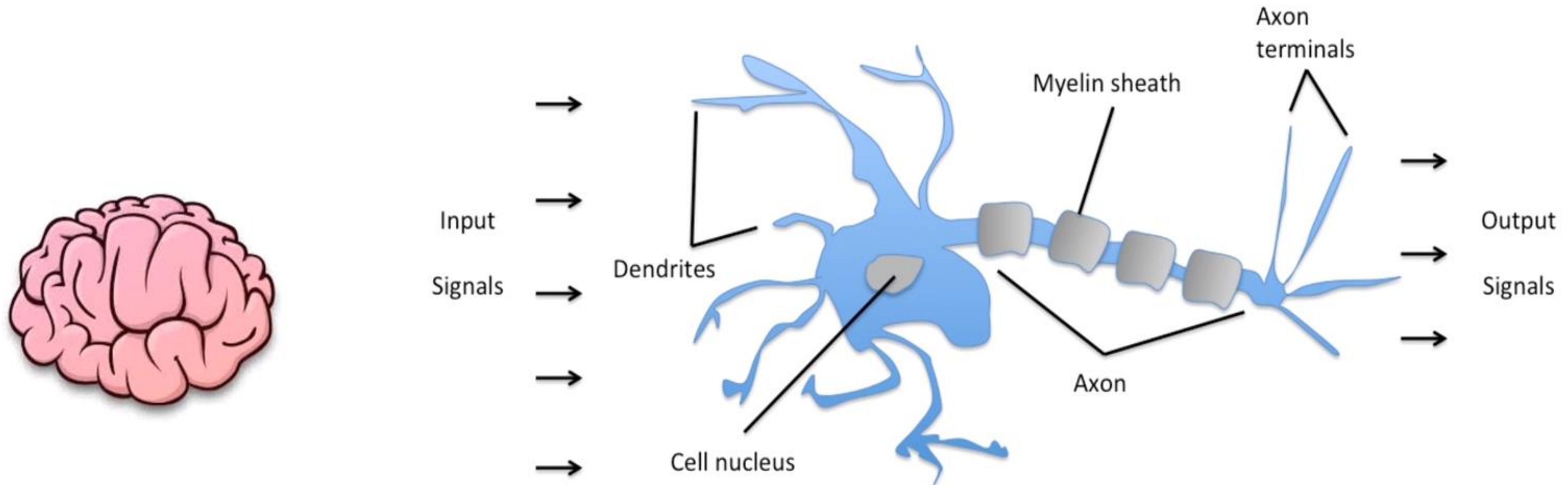
Ultimate dream: thinking machine

- The ultimate dream of mankind is a thinking machine!



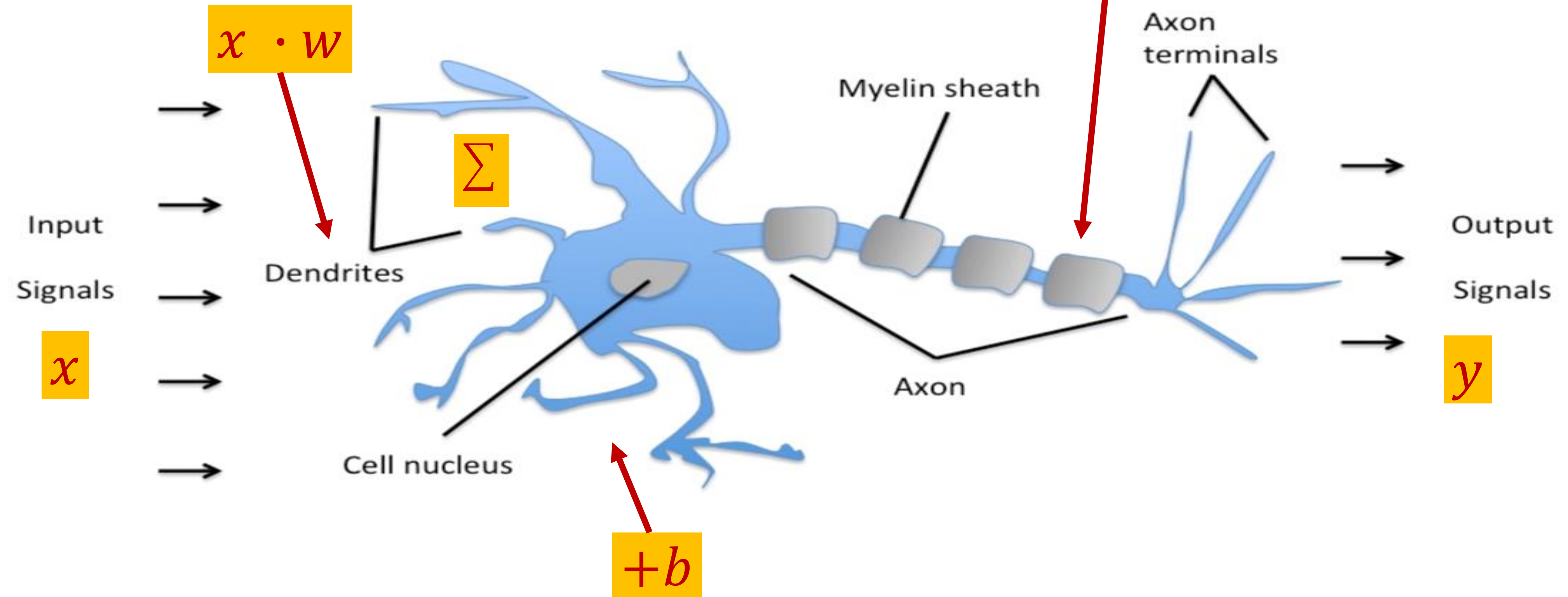
Ultimate dream: thinking machine

Schematic of a biological neuron

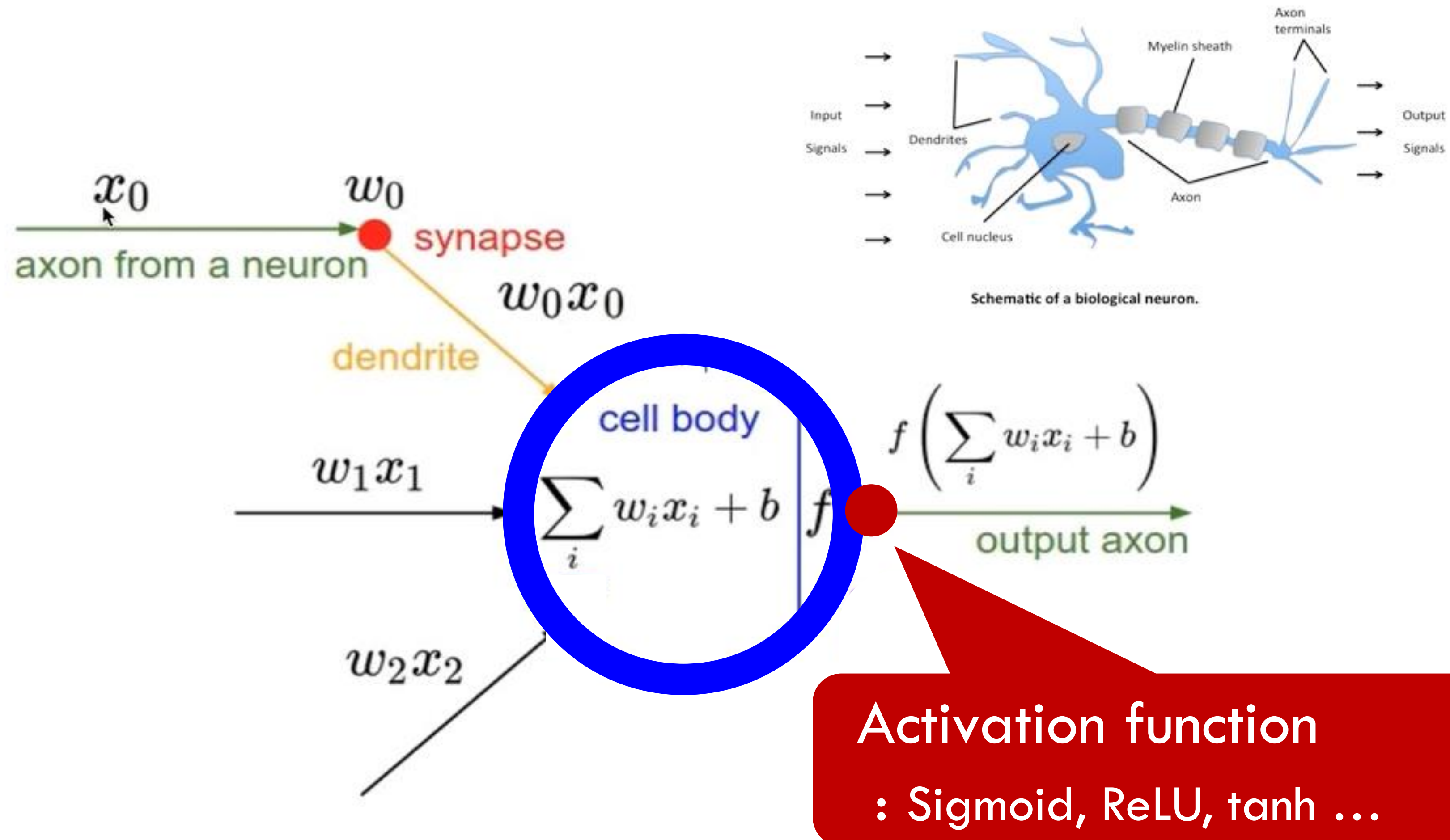


Ultimate dream: thinking machine

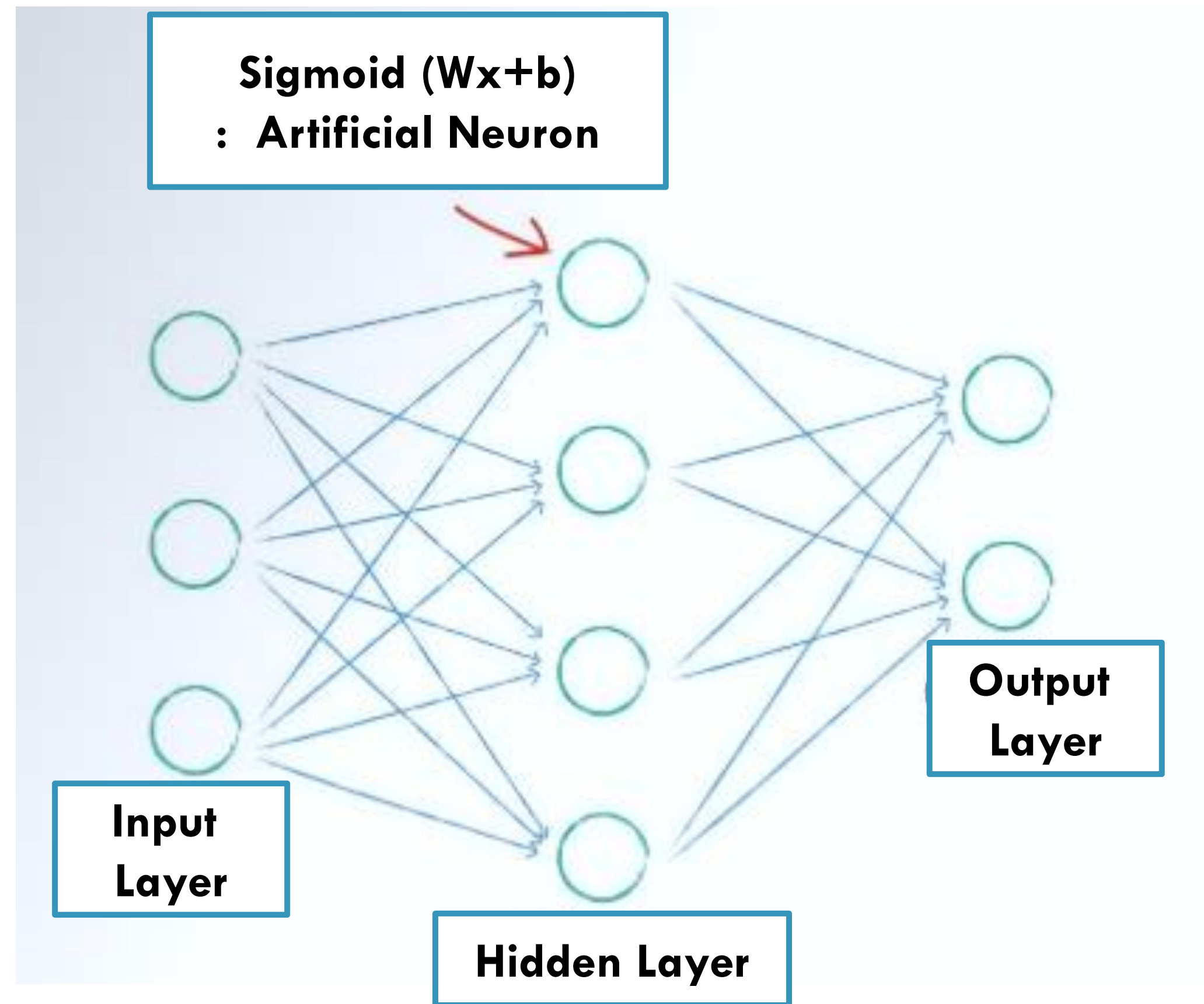
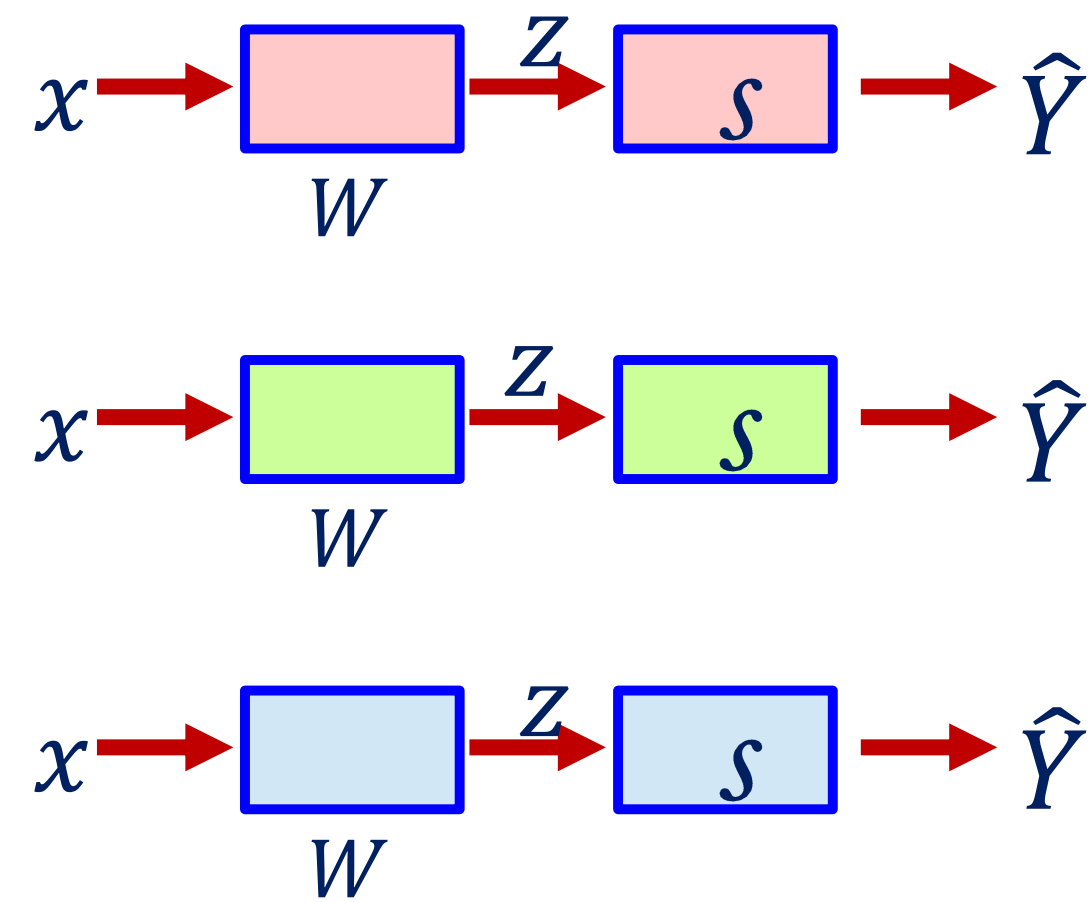
Schematic of a biological neuron



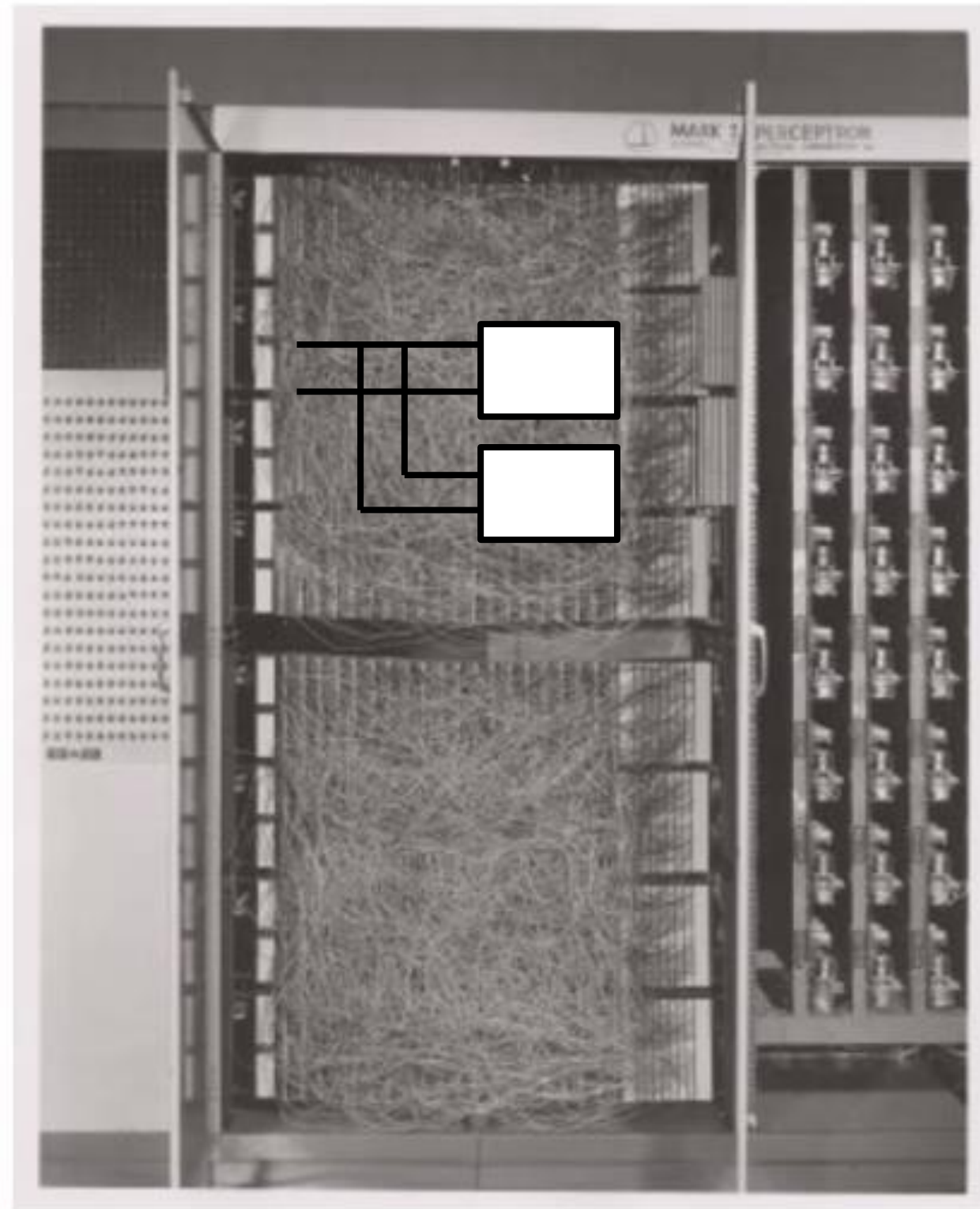
Activation Functions



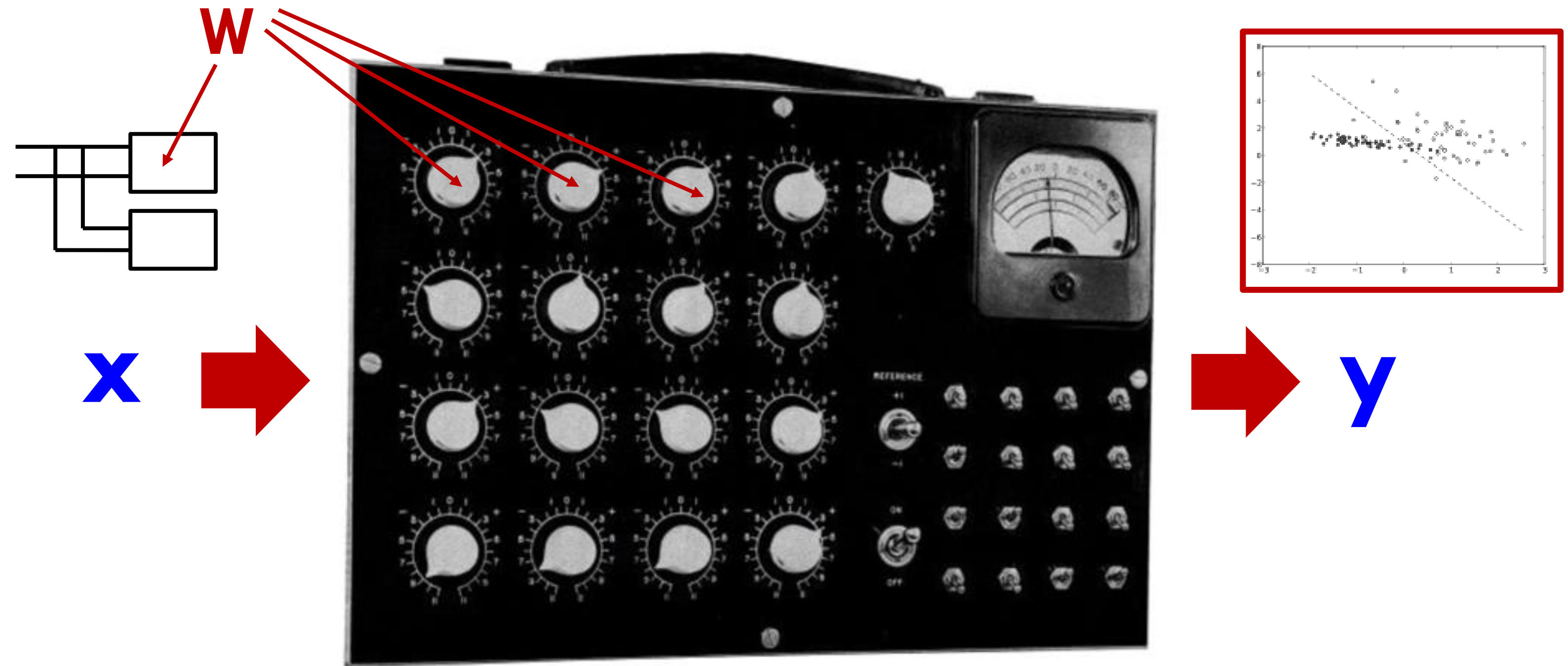
Logistic regression units



Hardware implementations



Frank Rosenblatt, ~1957: Perceptron



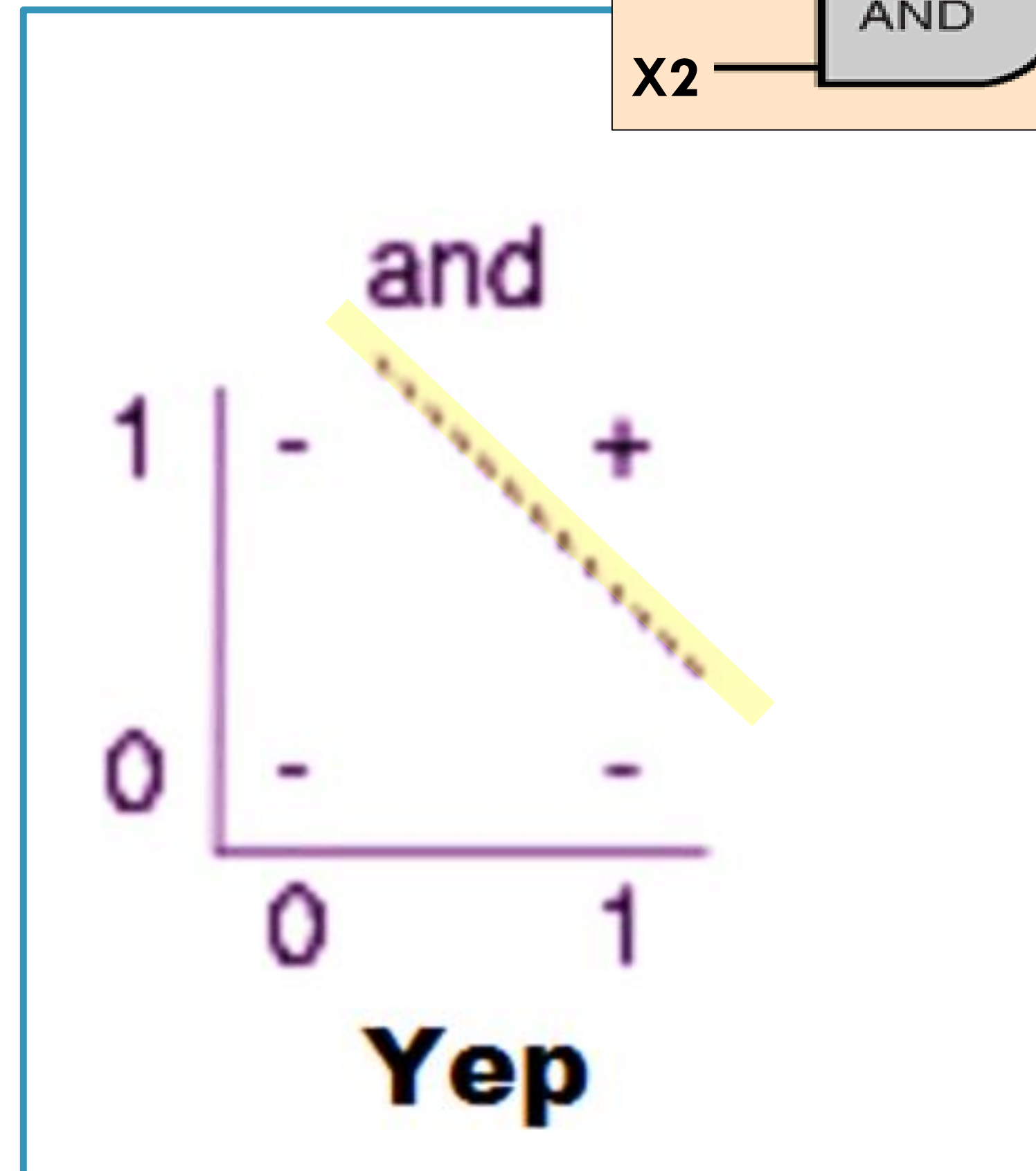
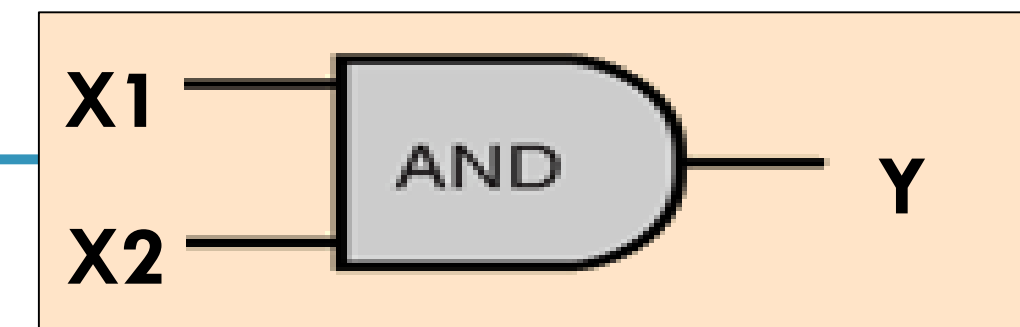
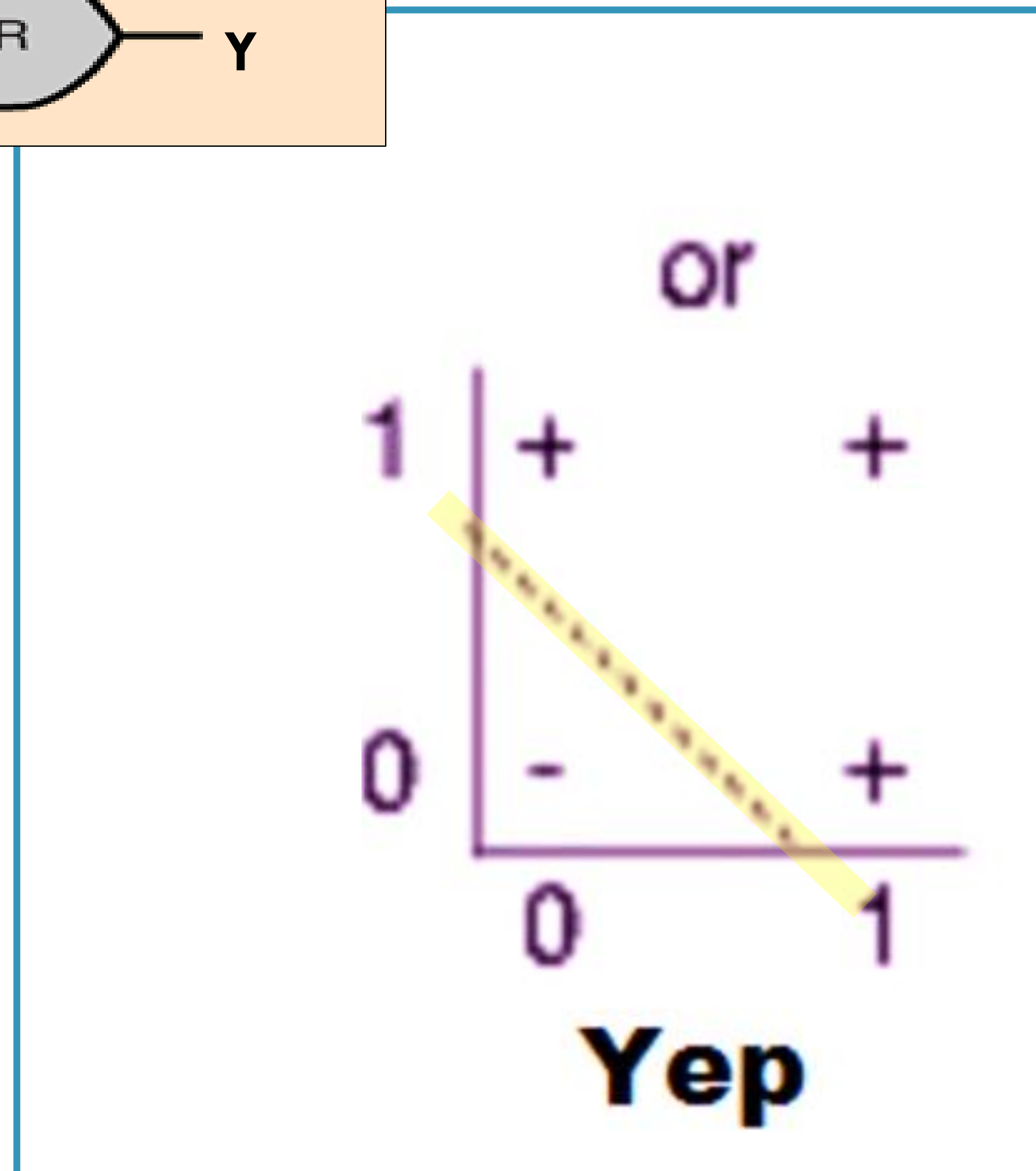
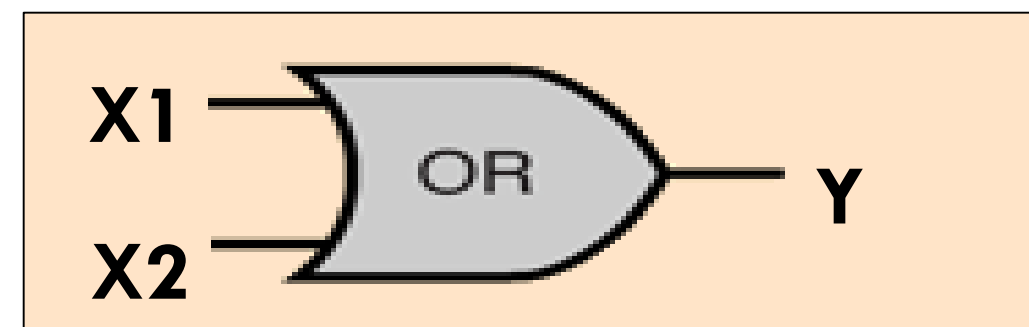
Widrow and Hoff, ~1960: Adaline/Madaline

False Promises

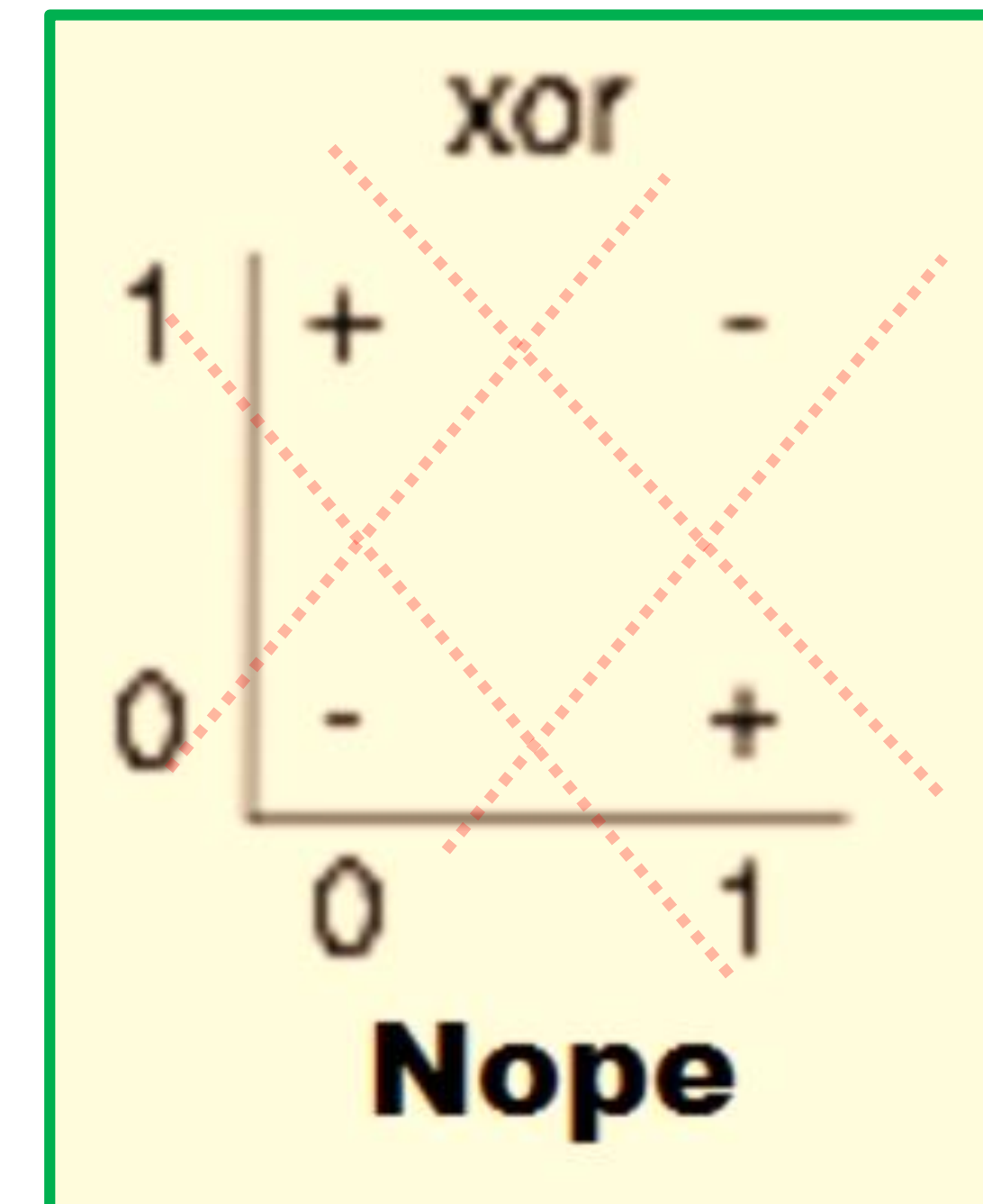
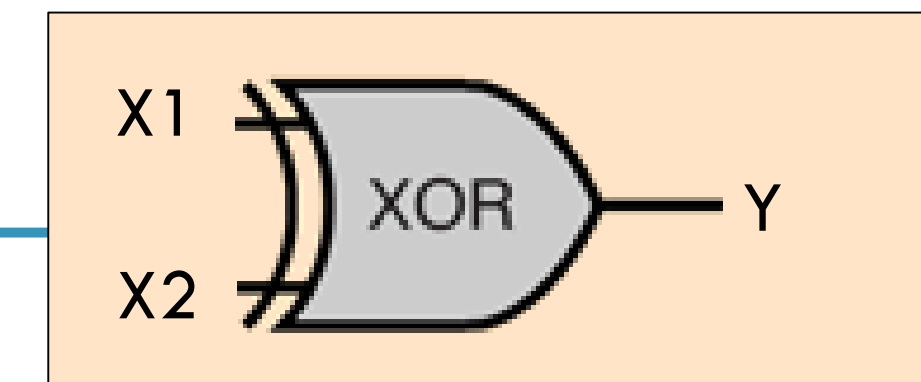
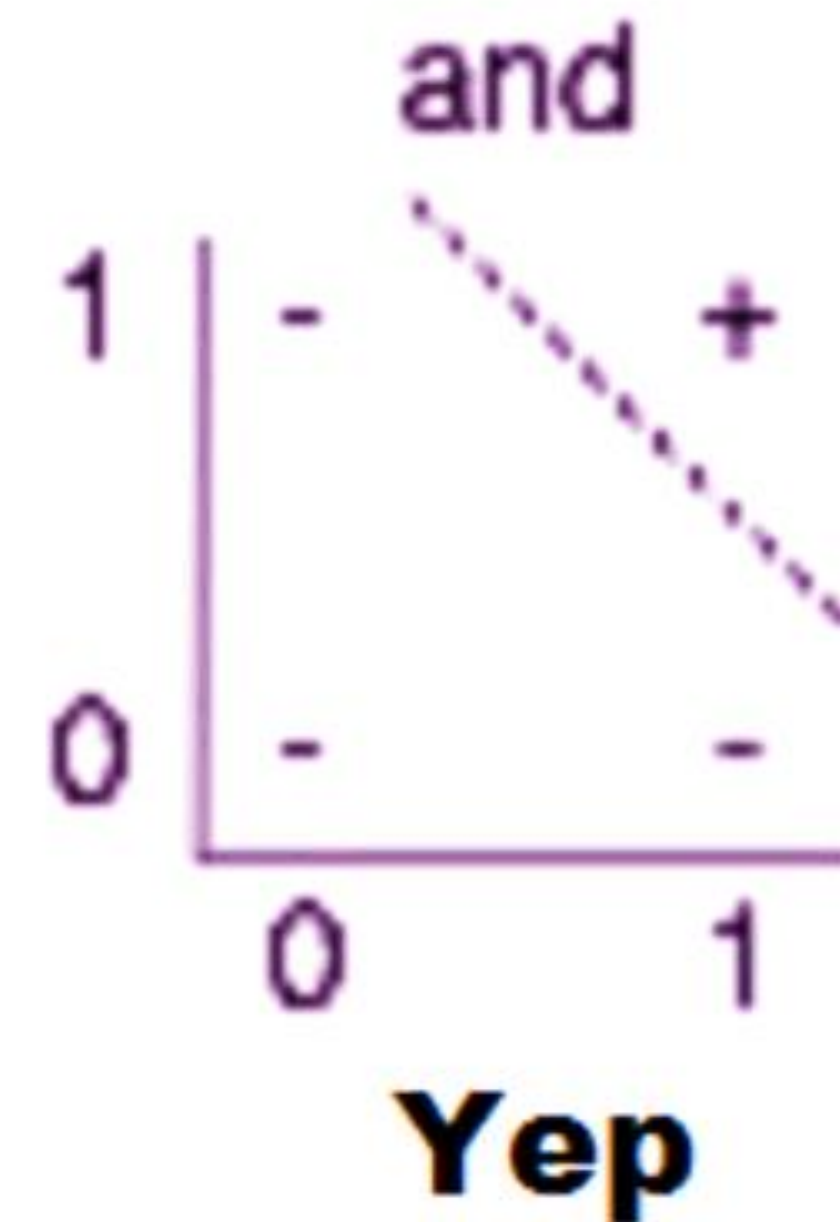
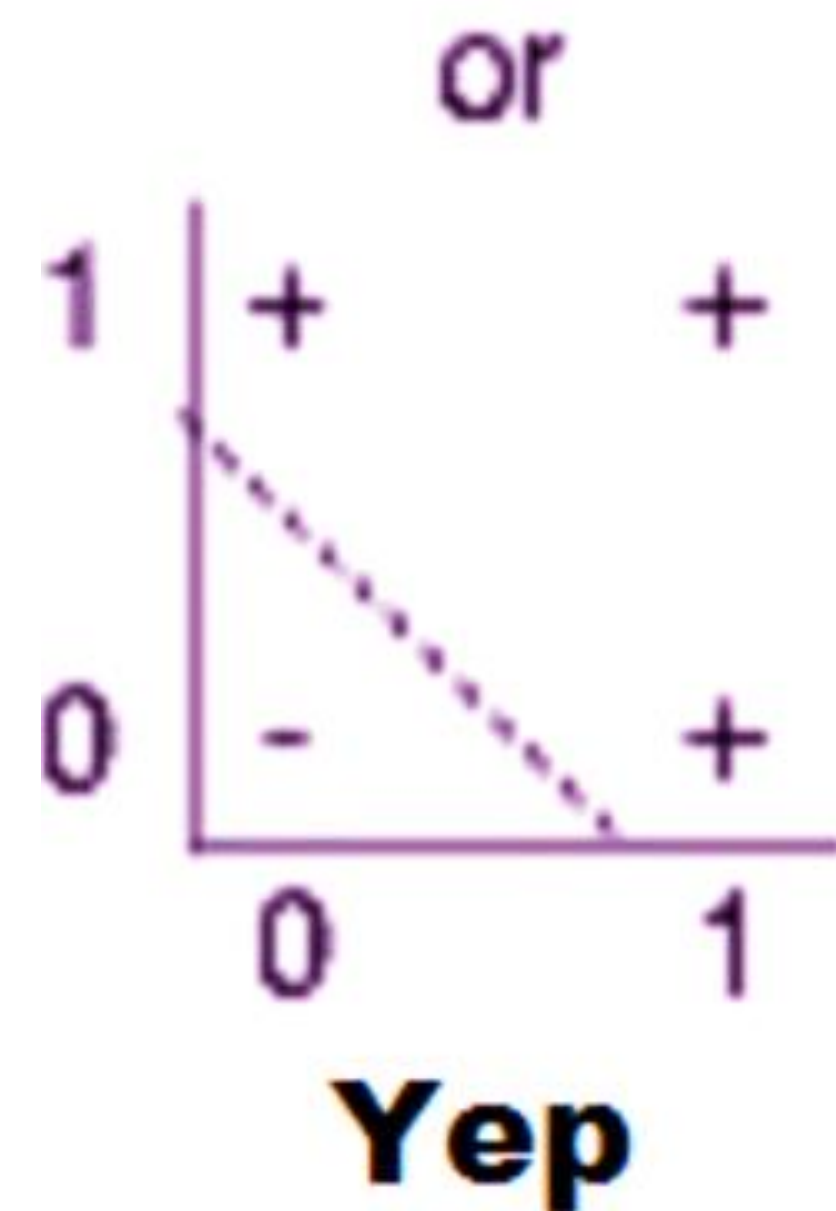
- “The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence ... **Dr. Frank Rosenblatt**, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired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

New York Times July 08, 1958

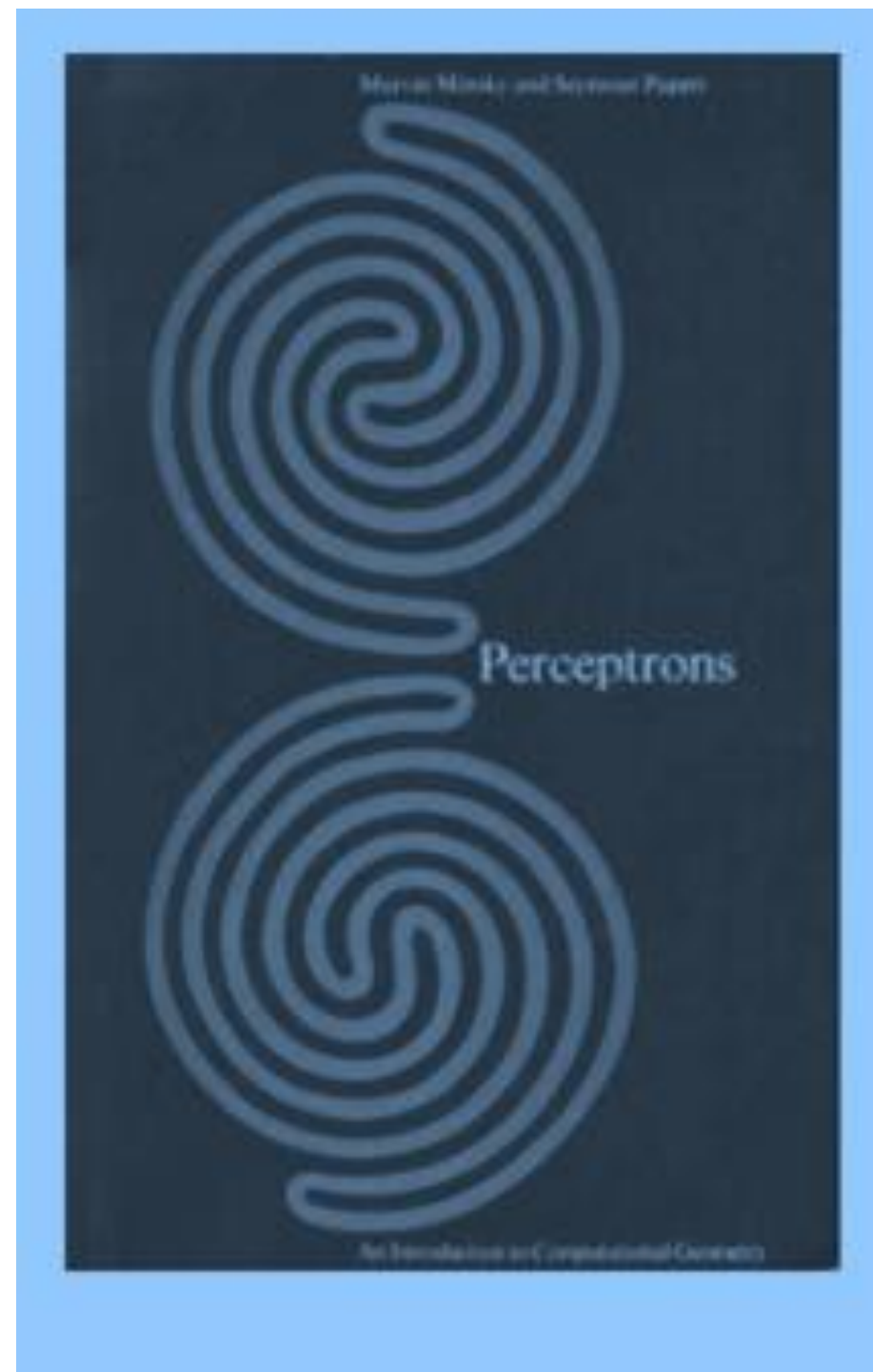
(Simple) AND/OR problem: linearly separable?



(Simple) XOR problem: linearly separable?

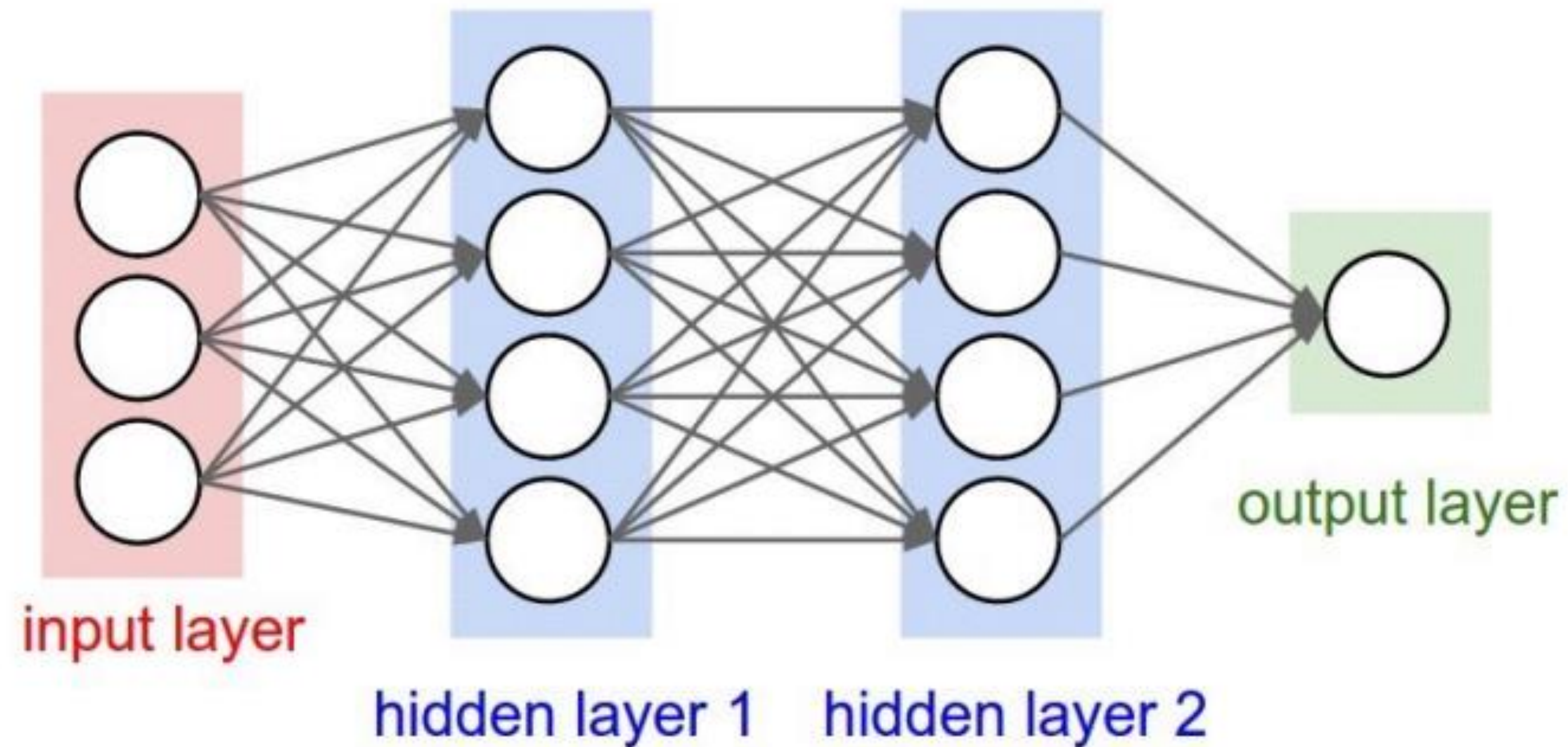


Perceptrons (1969) : by Marvin Minsky, founder of the MIT AI Lab



- 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

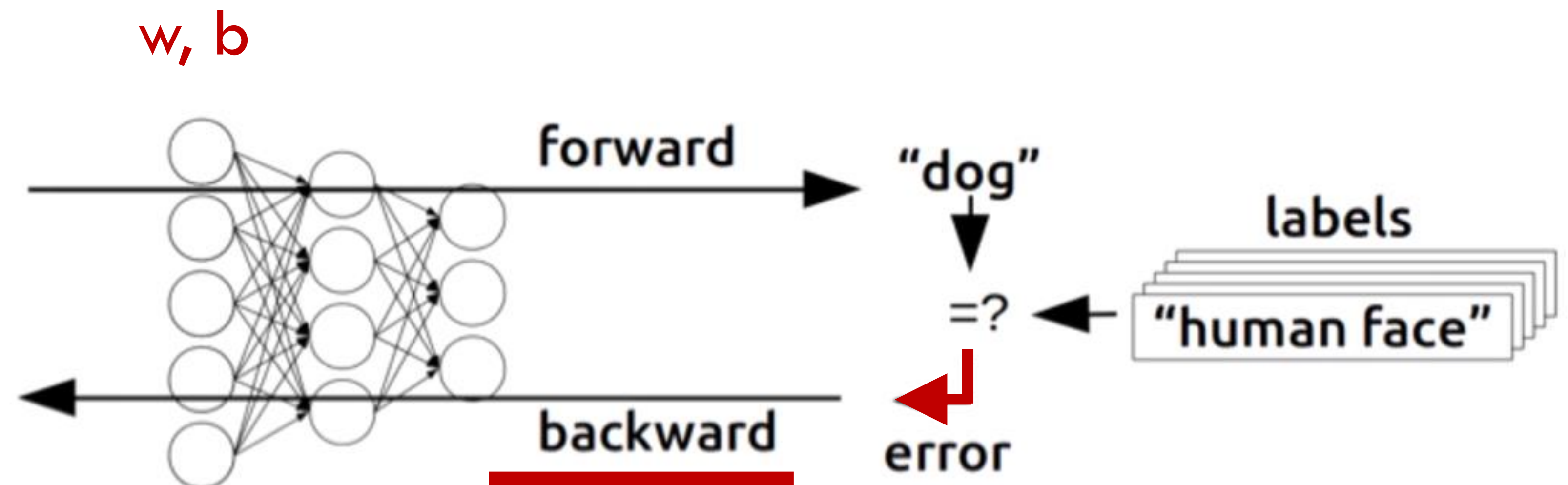
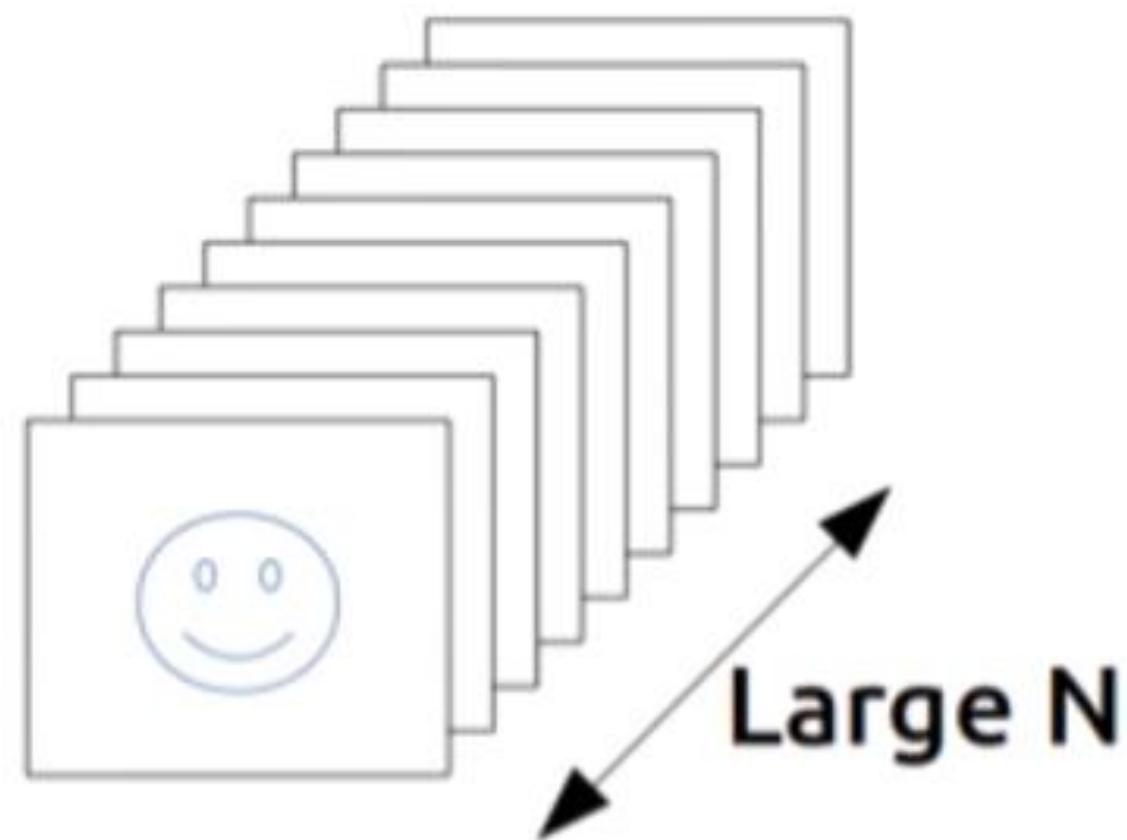


*Marvin Minsky, 1969

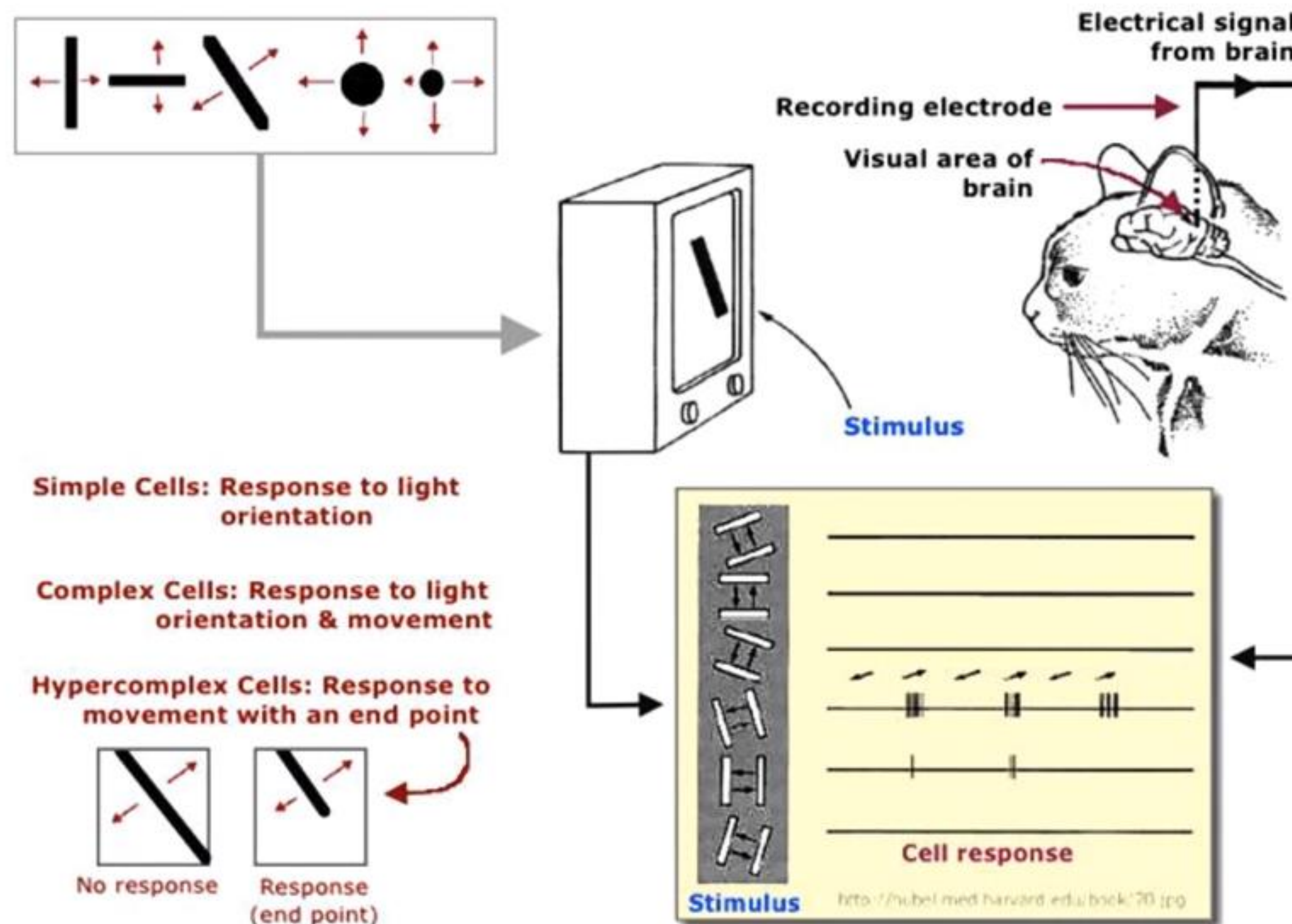
Backpropagation : (1974, 1982 by Paul Werbos, 1986 by Hinton)



Training

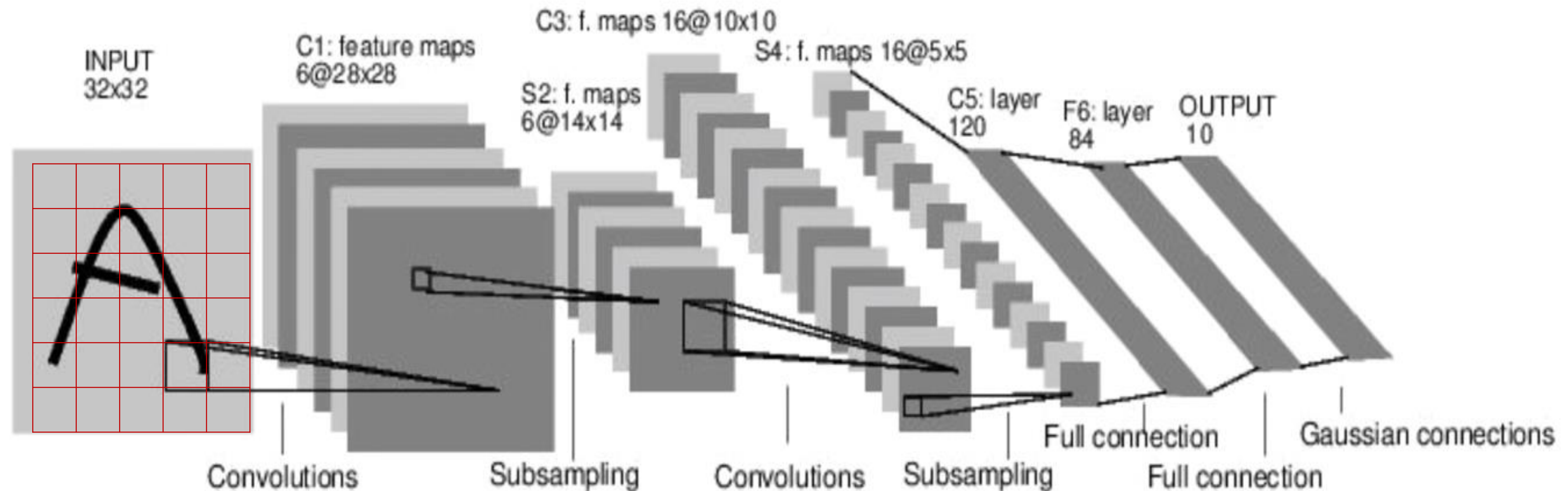


Visual neurophysiology



Hubel & Wiesel, 1959

CNN : Convolutional Neural Networks

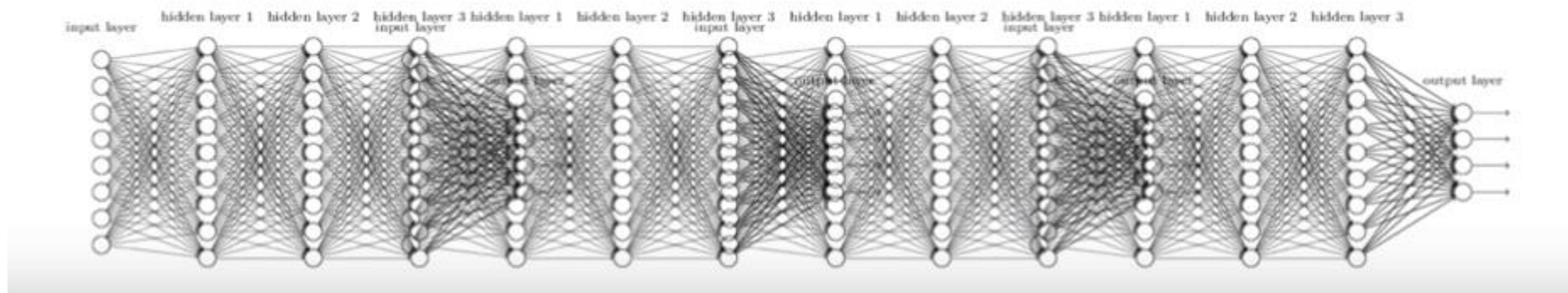


“At some point in the late 1990s, one of these systems was reading 10 to 20% of all the checks in the US.”

[LeNet-5, LeCun 1980]

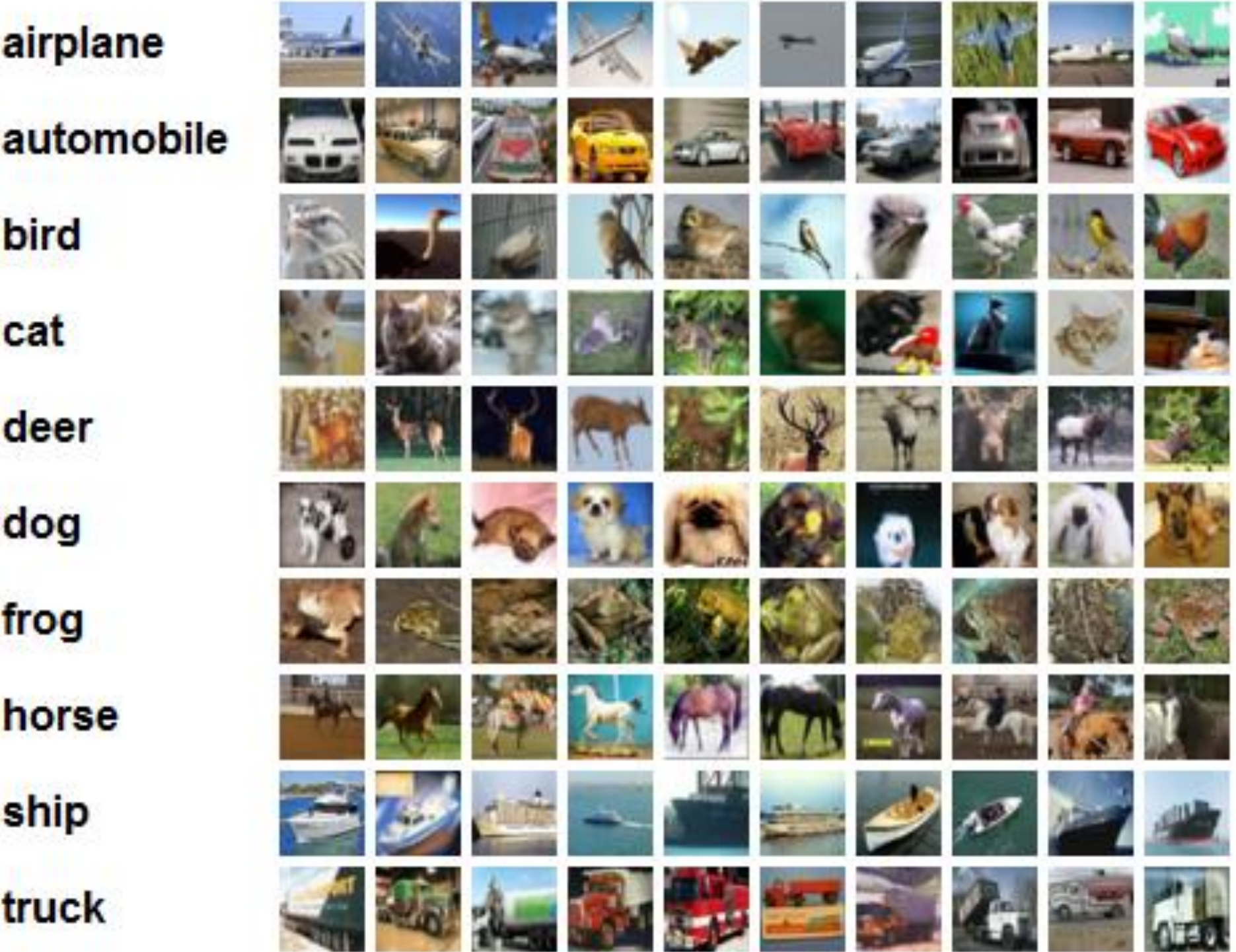
A Big Problem

- 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



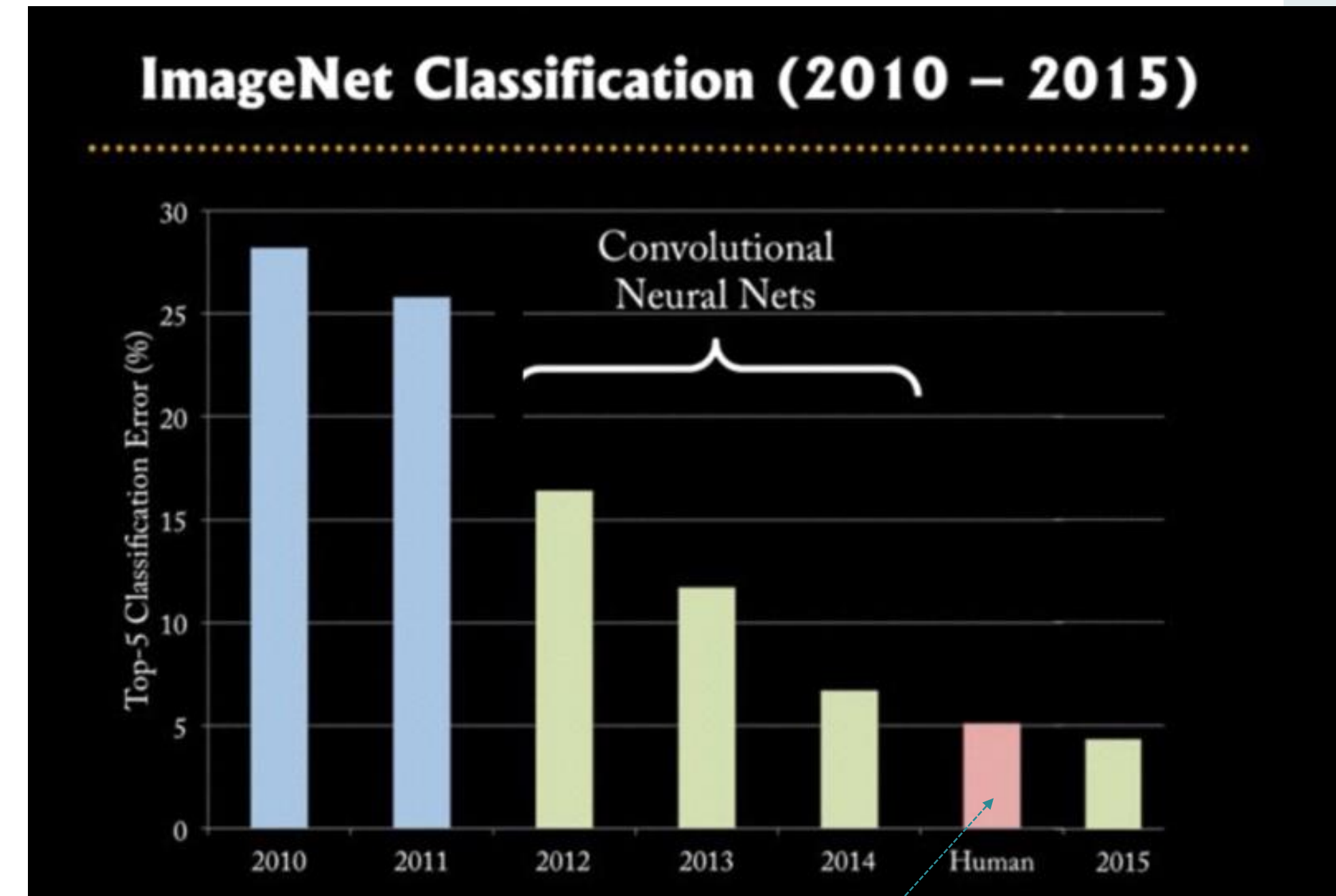
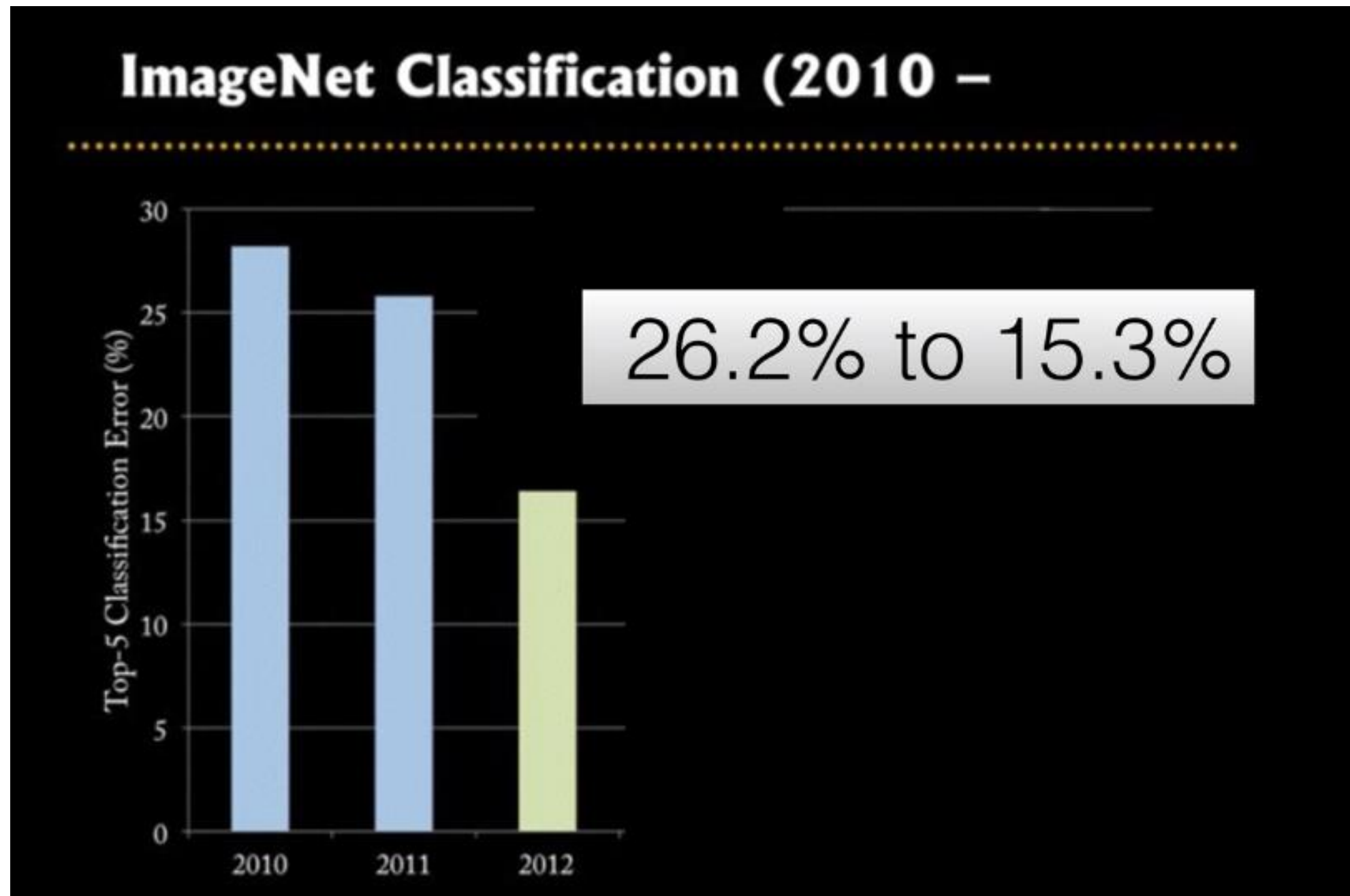
CIFAR

CANADIAN INSTITUTE
for ADVANCED RESEARCH

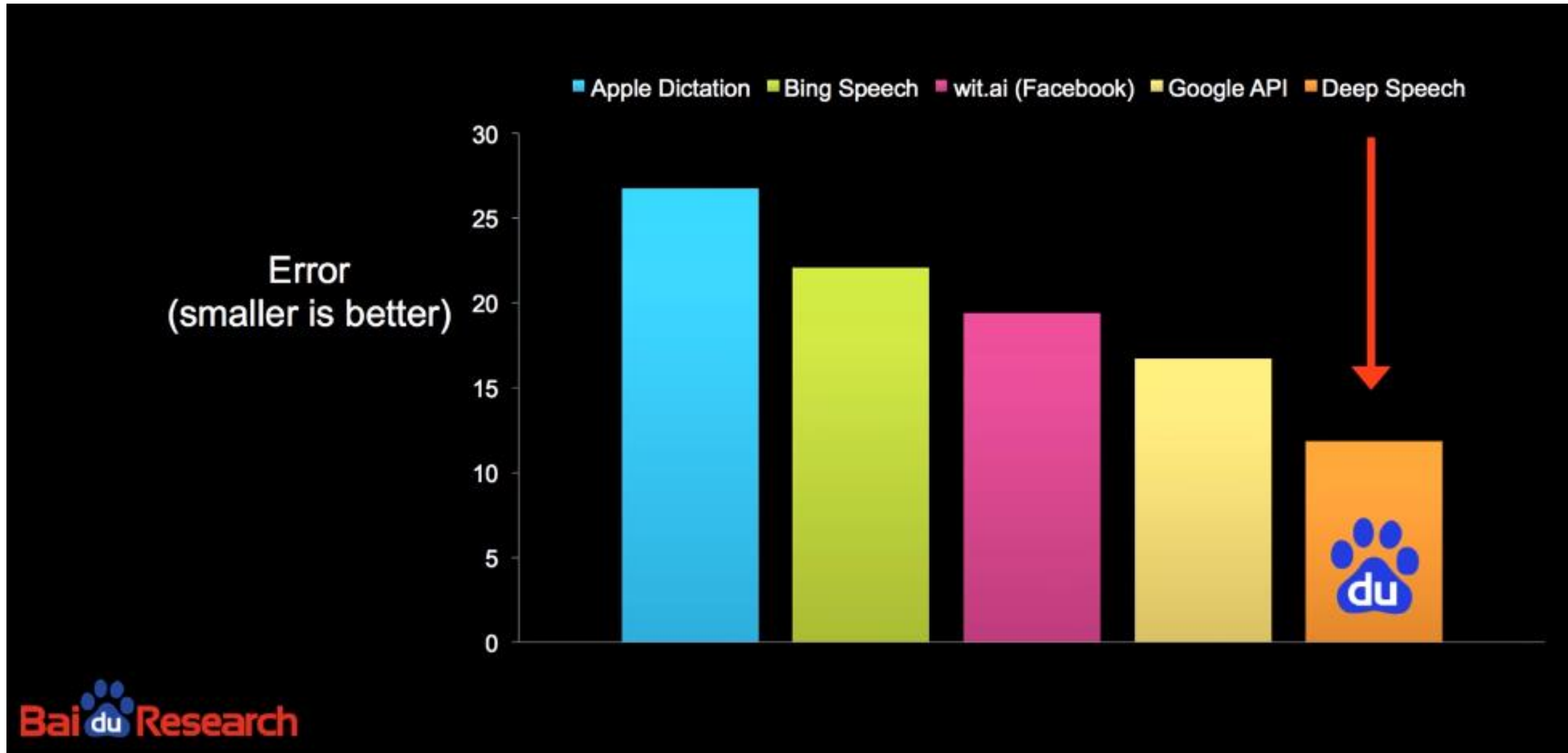
Breakthrough in 2006 and 2007 by Hinton and Bengio

- 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



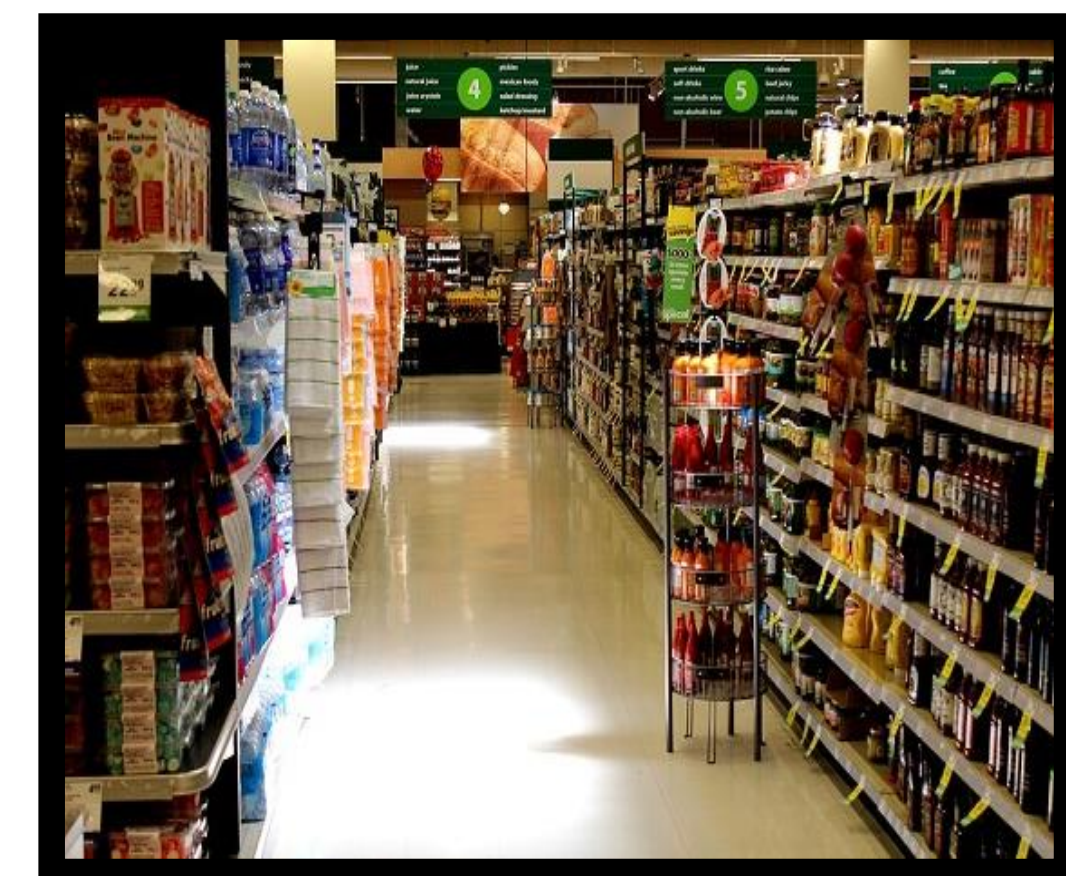
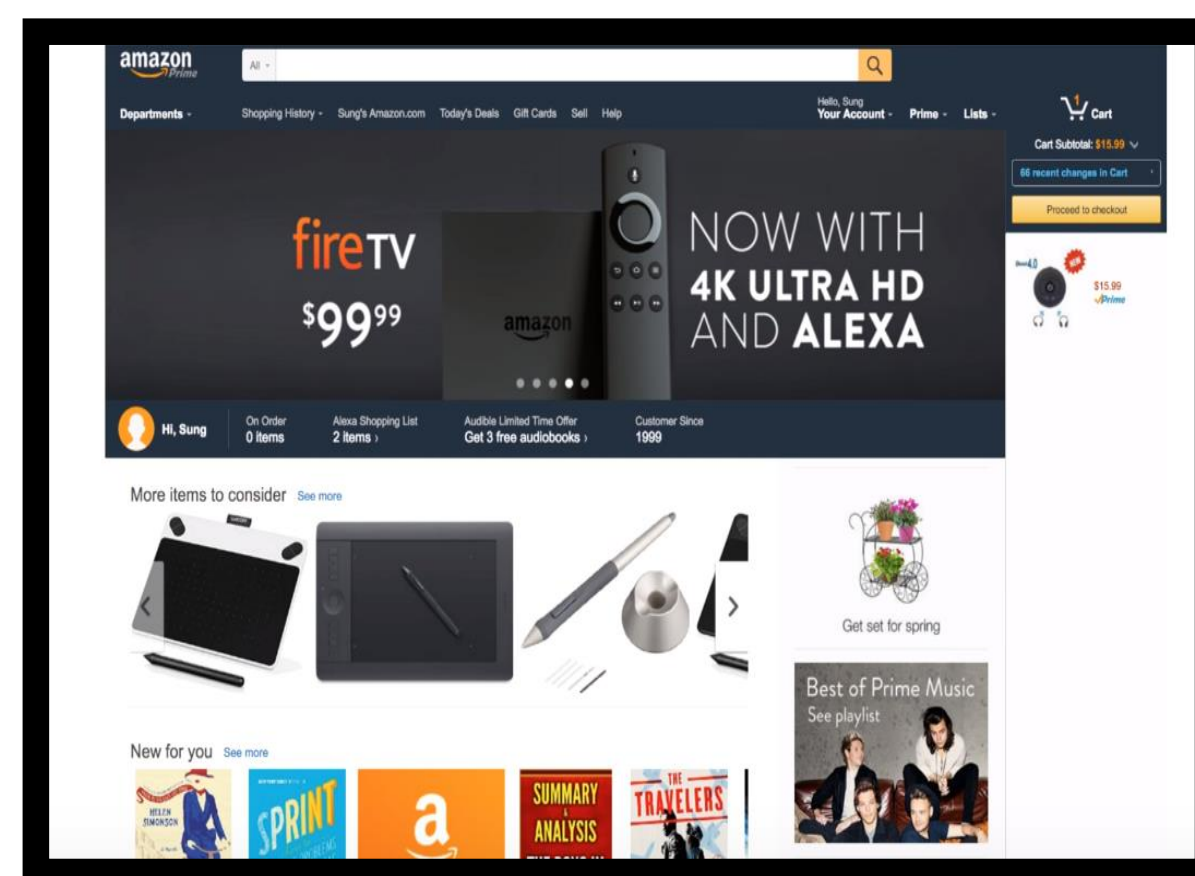
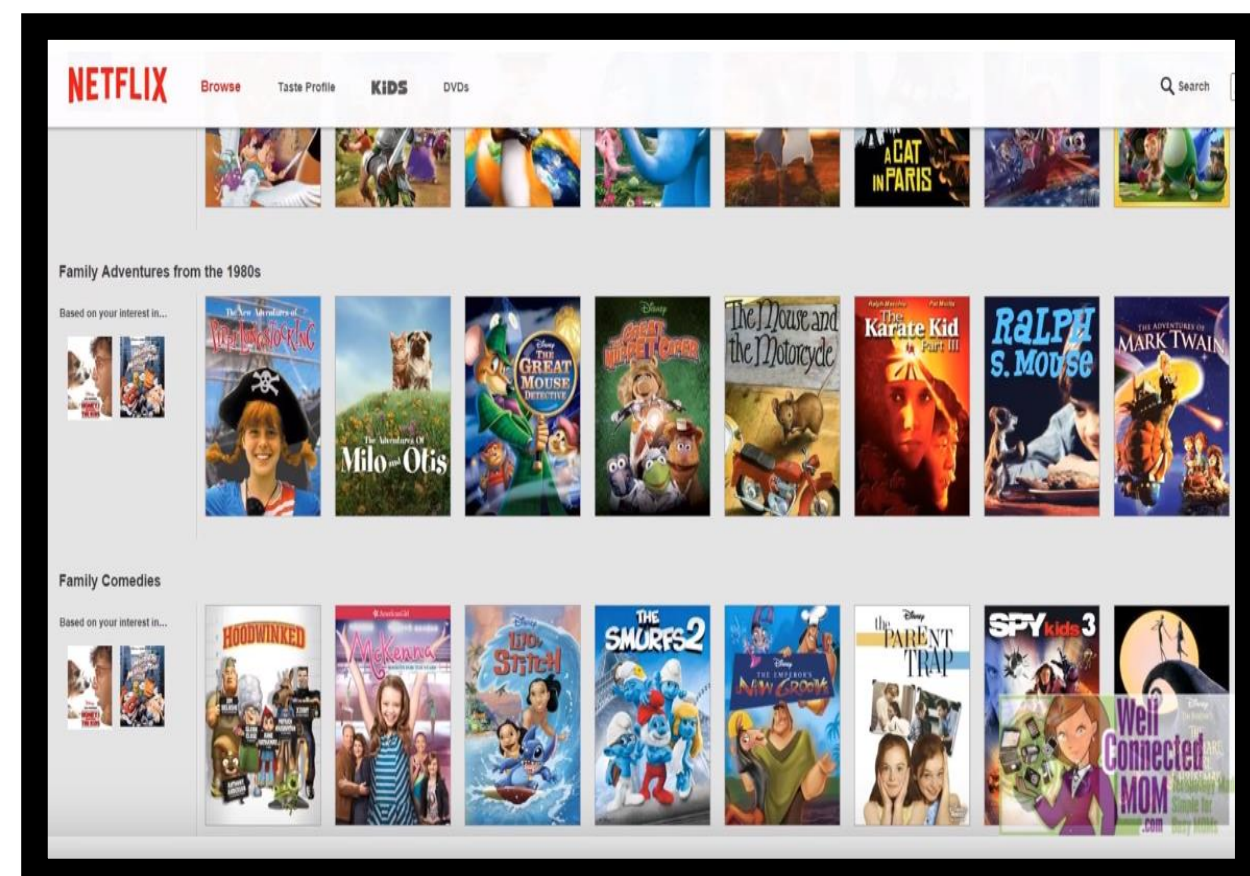
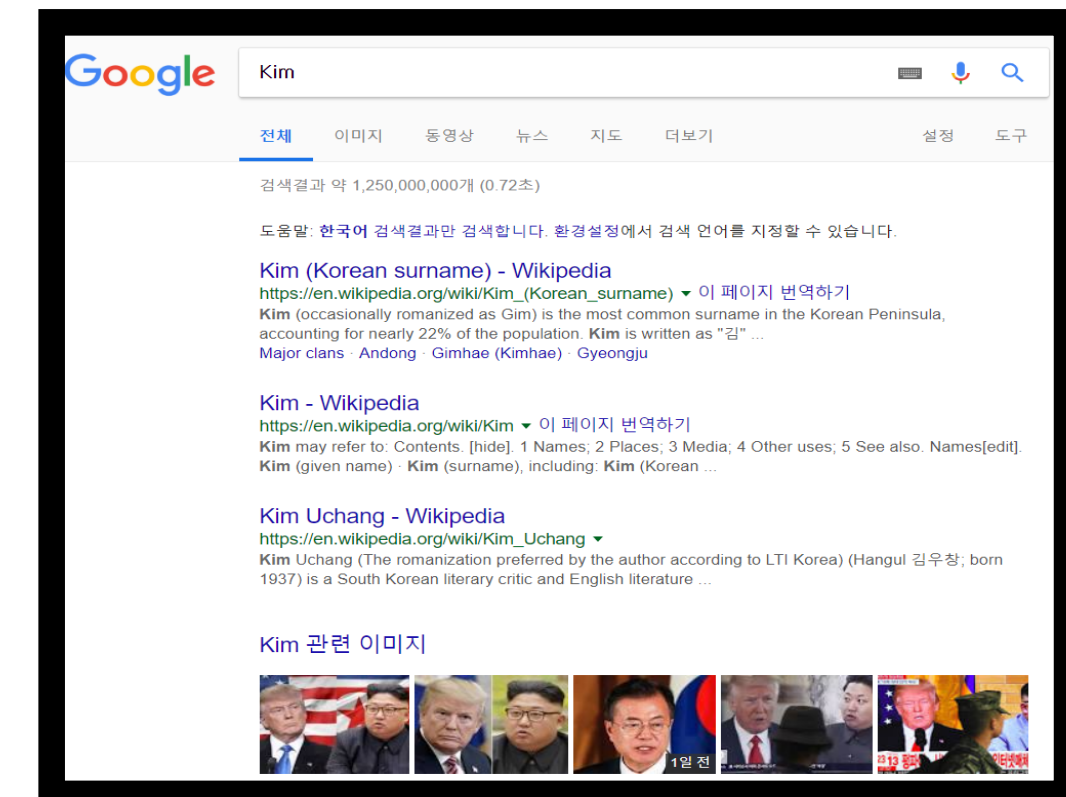
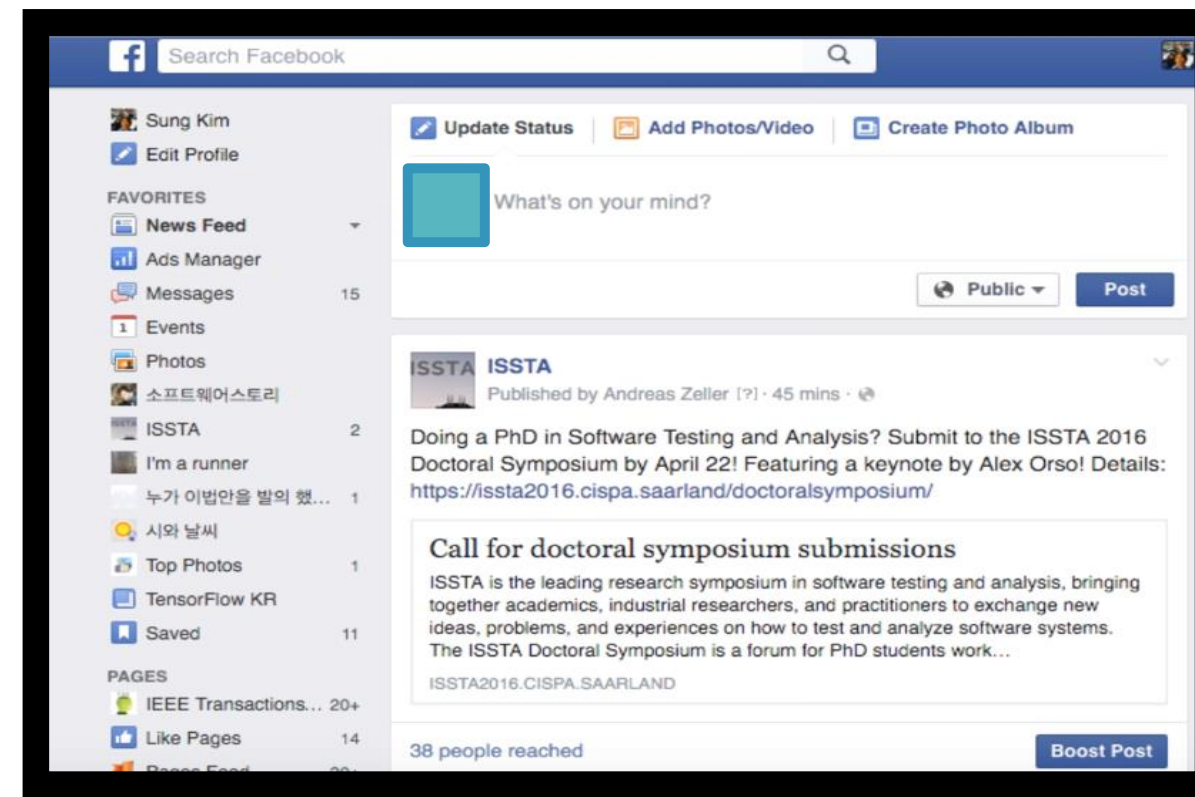
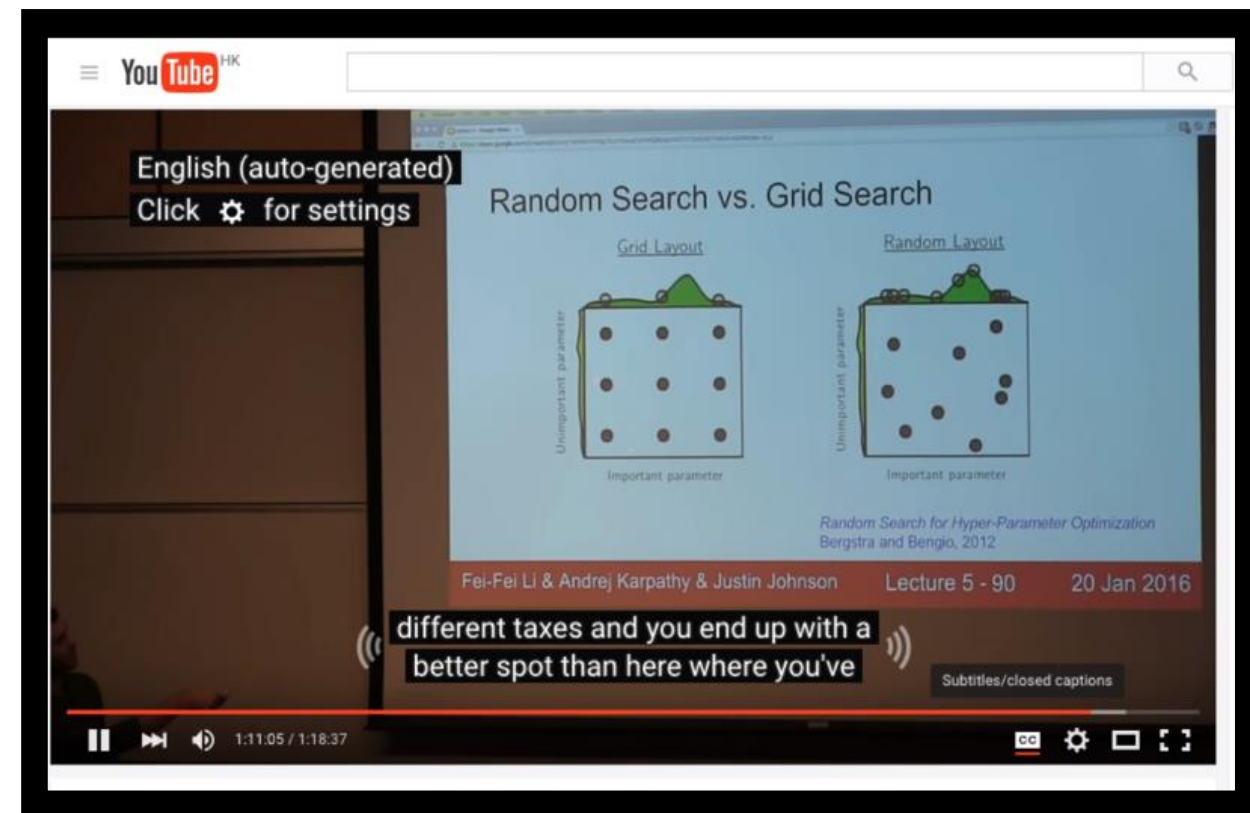
AlphaGo



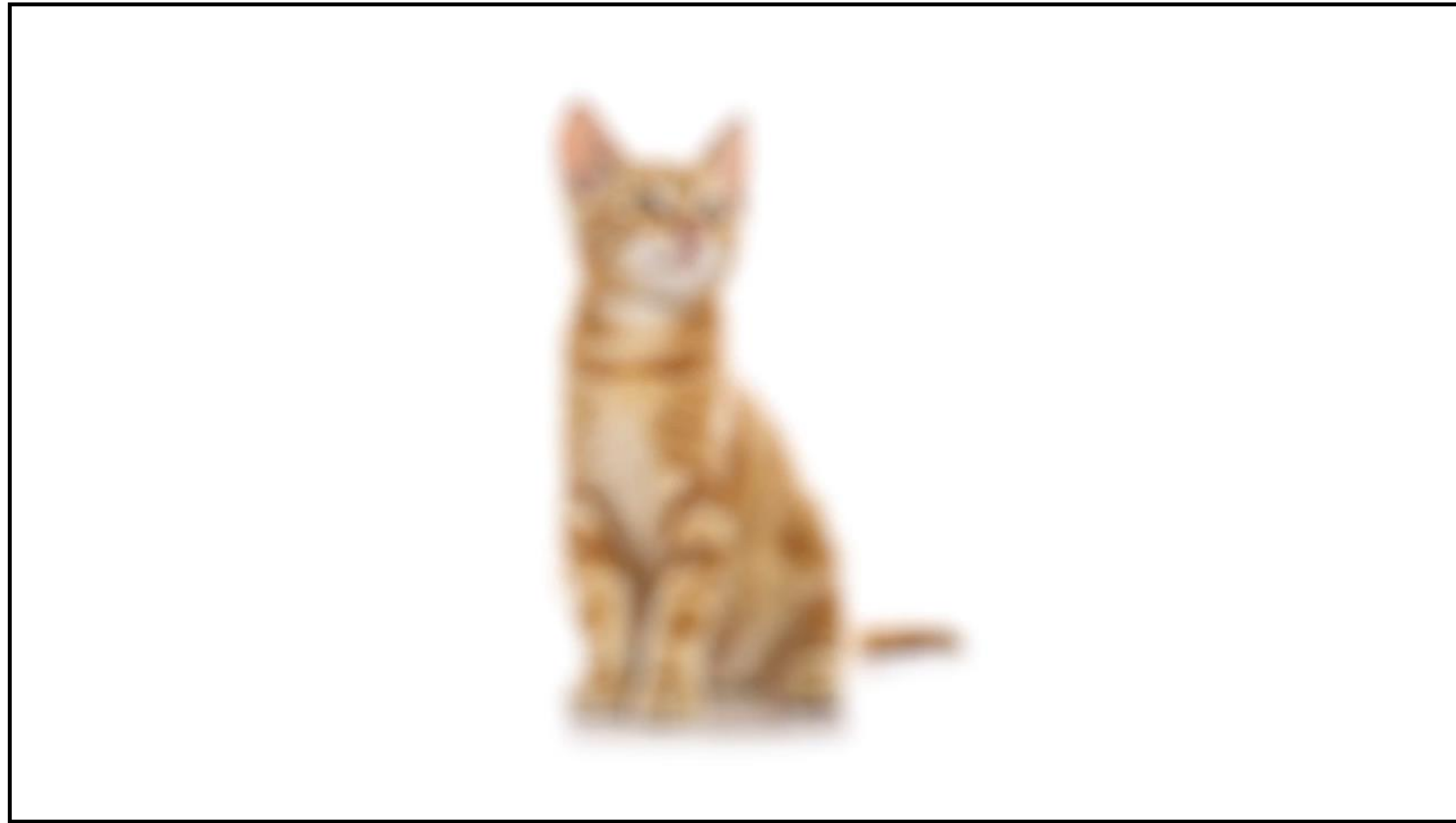
Geoffrey Hinton's summary of findings up to today

- 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?

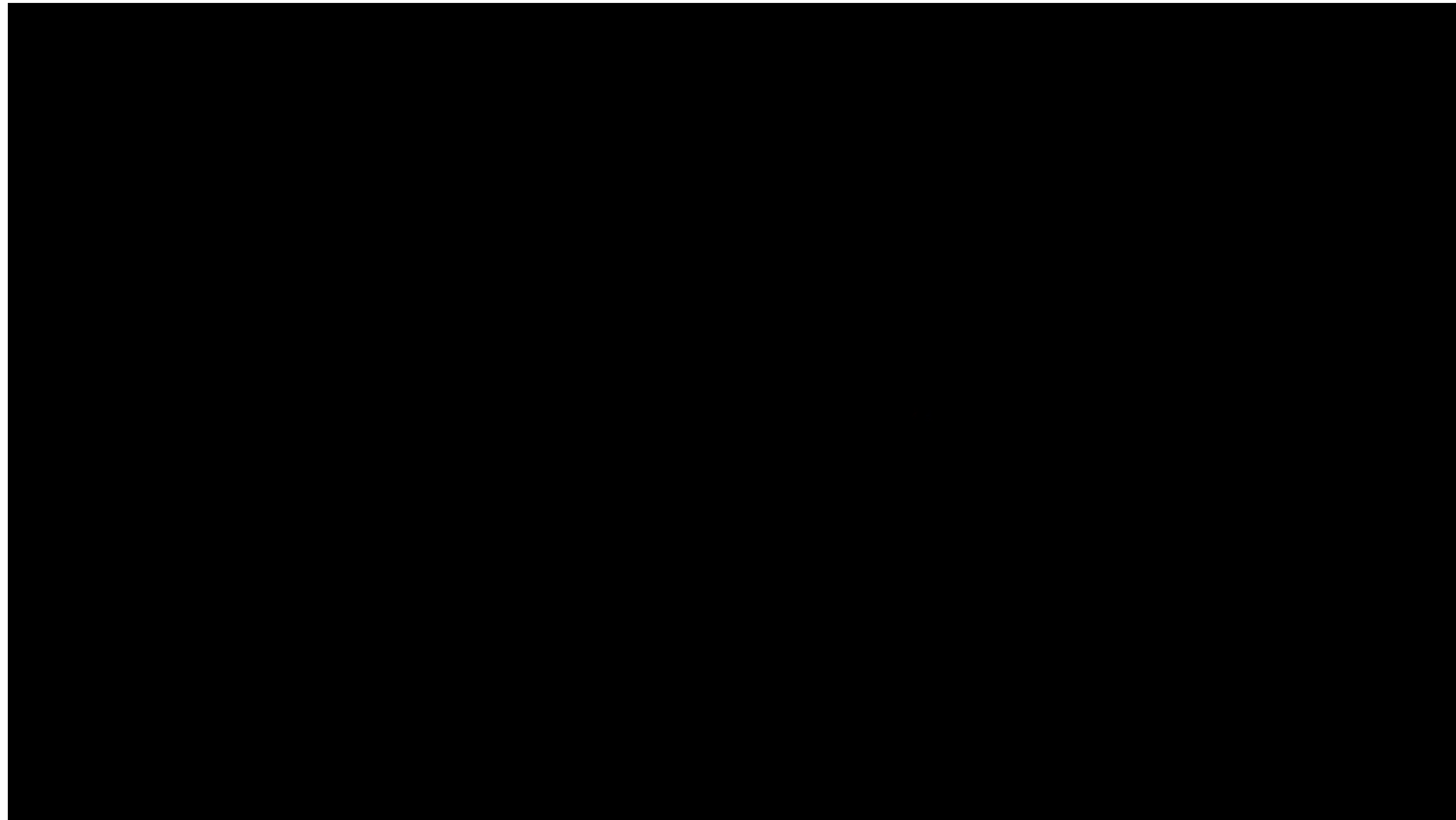


Why should I care?



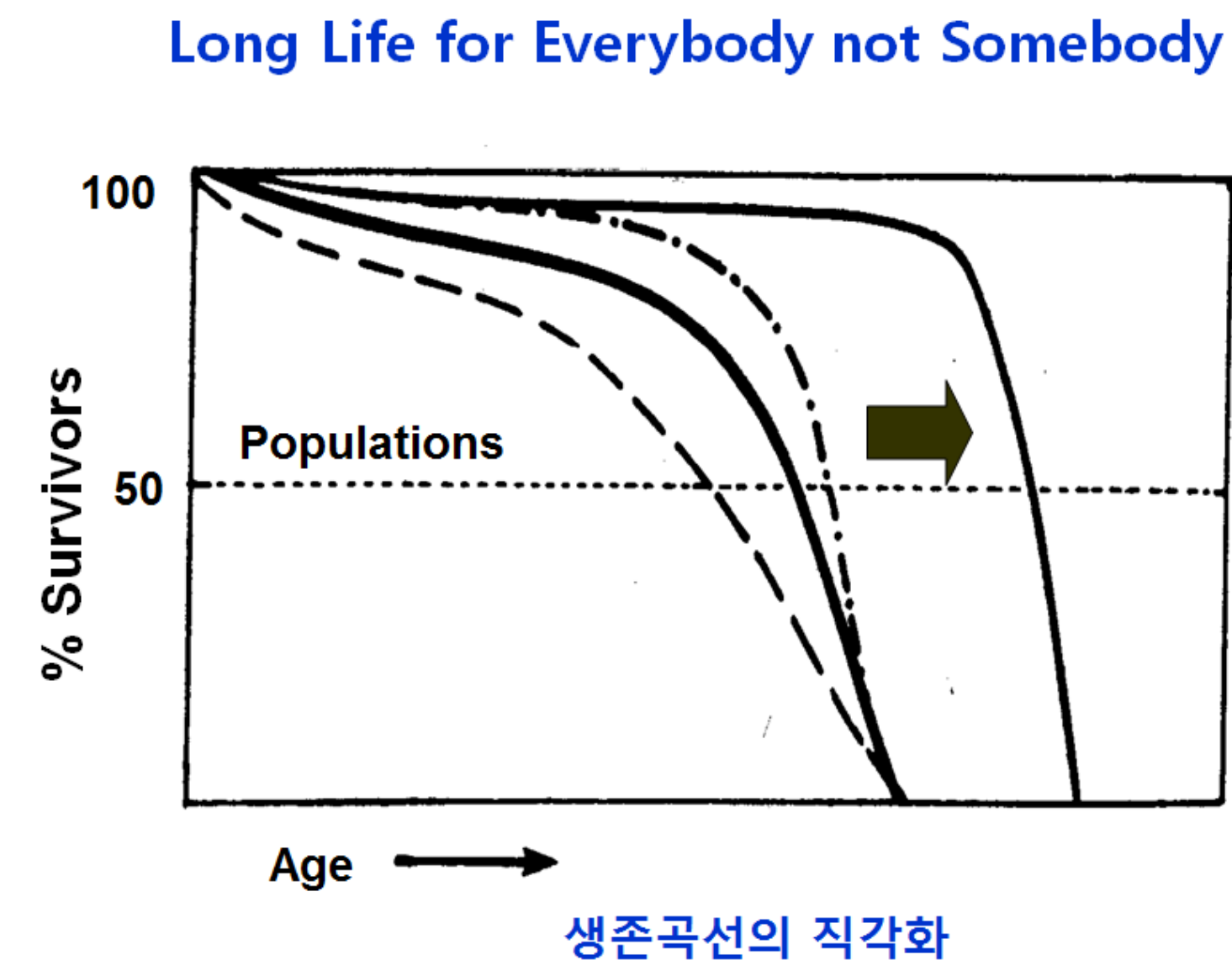
Why should I care?

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 %**



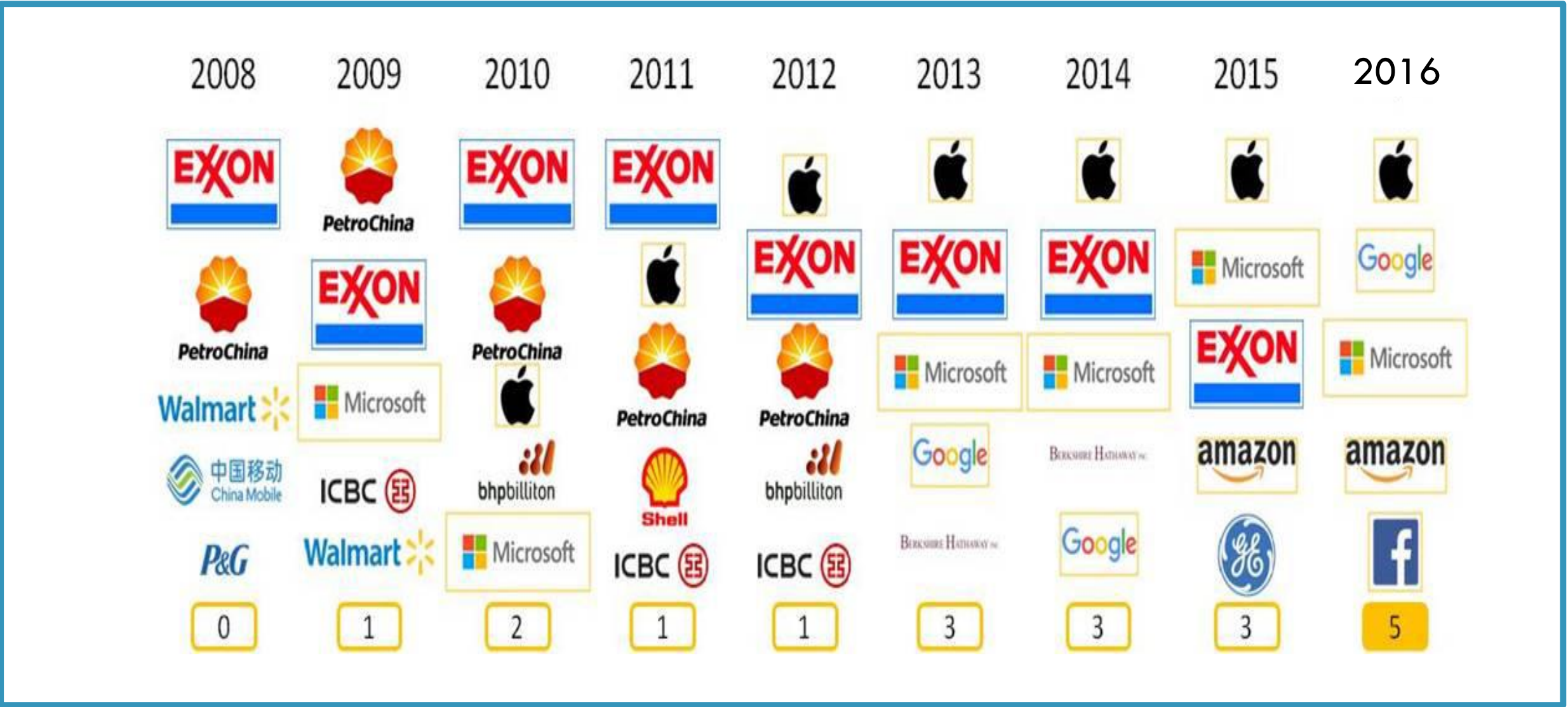
Why should I care?

- 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

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)

Uber

Uber Market Value \$50B (2015.5)

+
= ?

•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!**