Deep Neural Nets
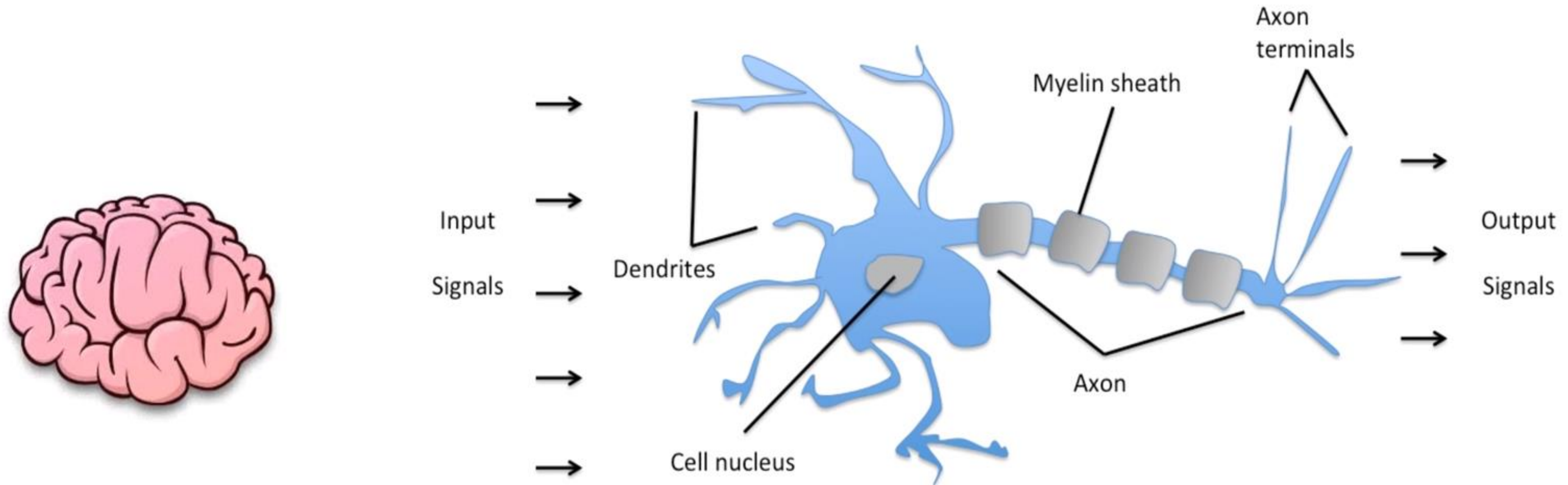
Ultimate dream: thinking machine
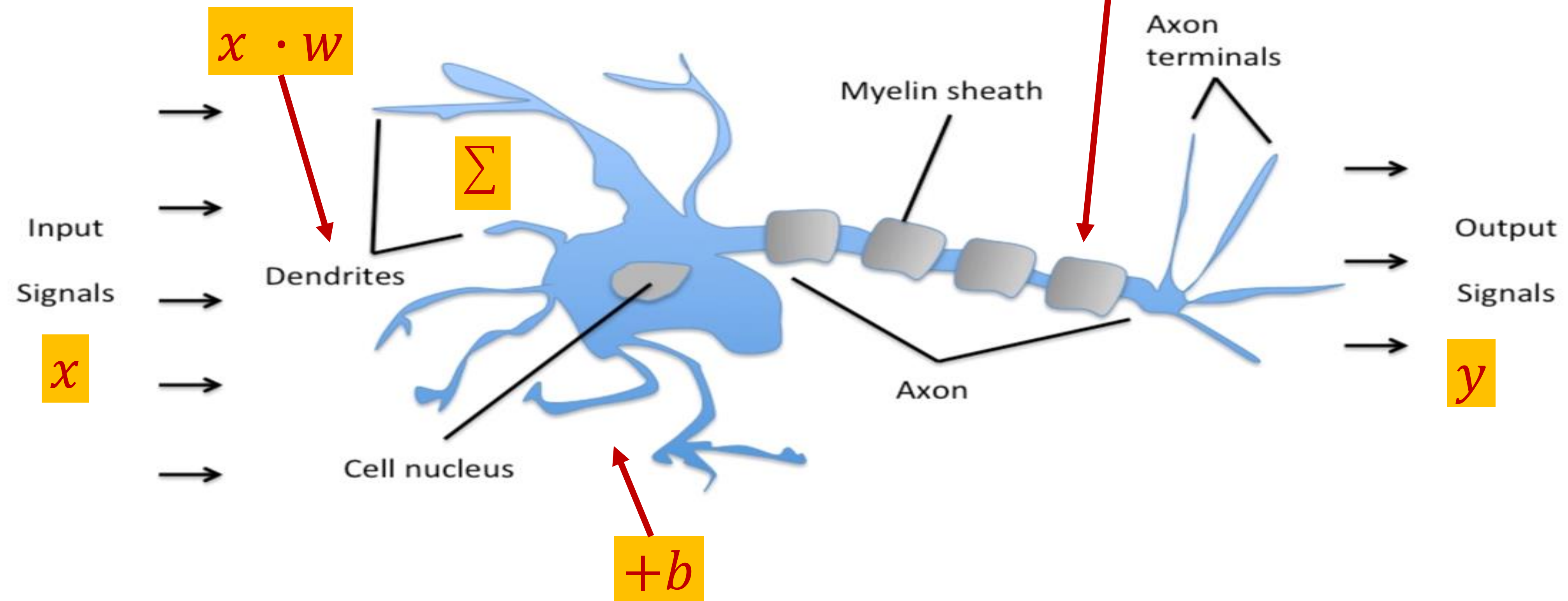
- The ultimate dream of mankind is a thinking machine!

Ultimate dream: thinking machine

Schematic of a biological neuron
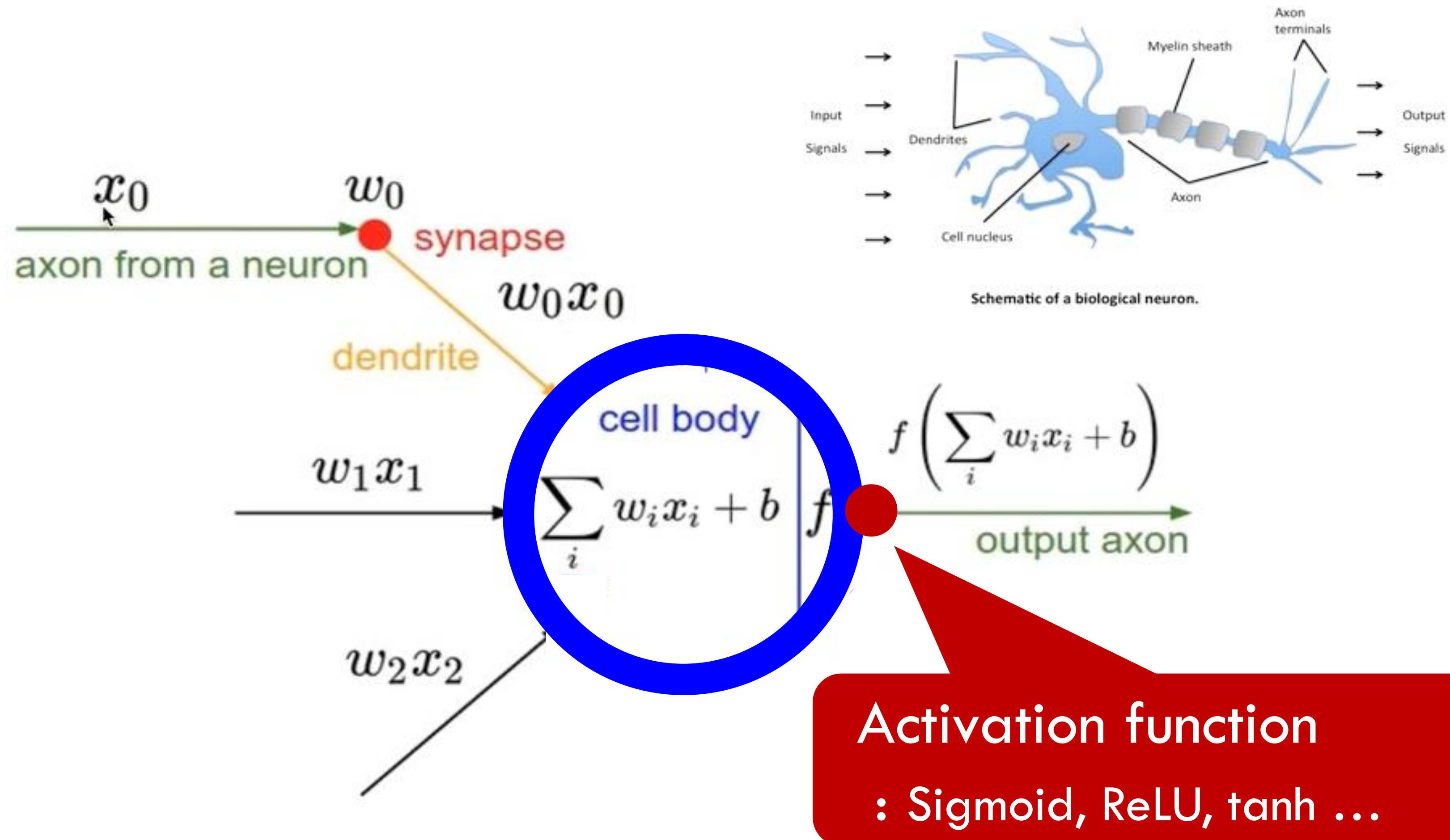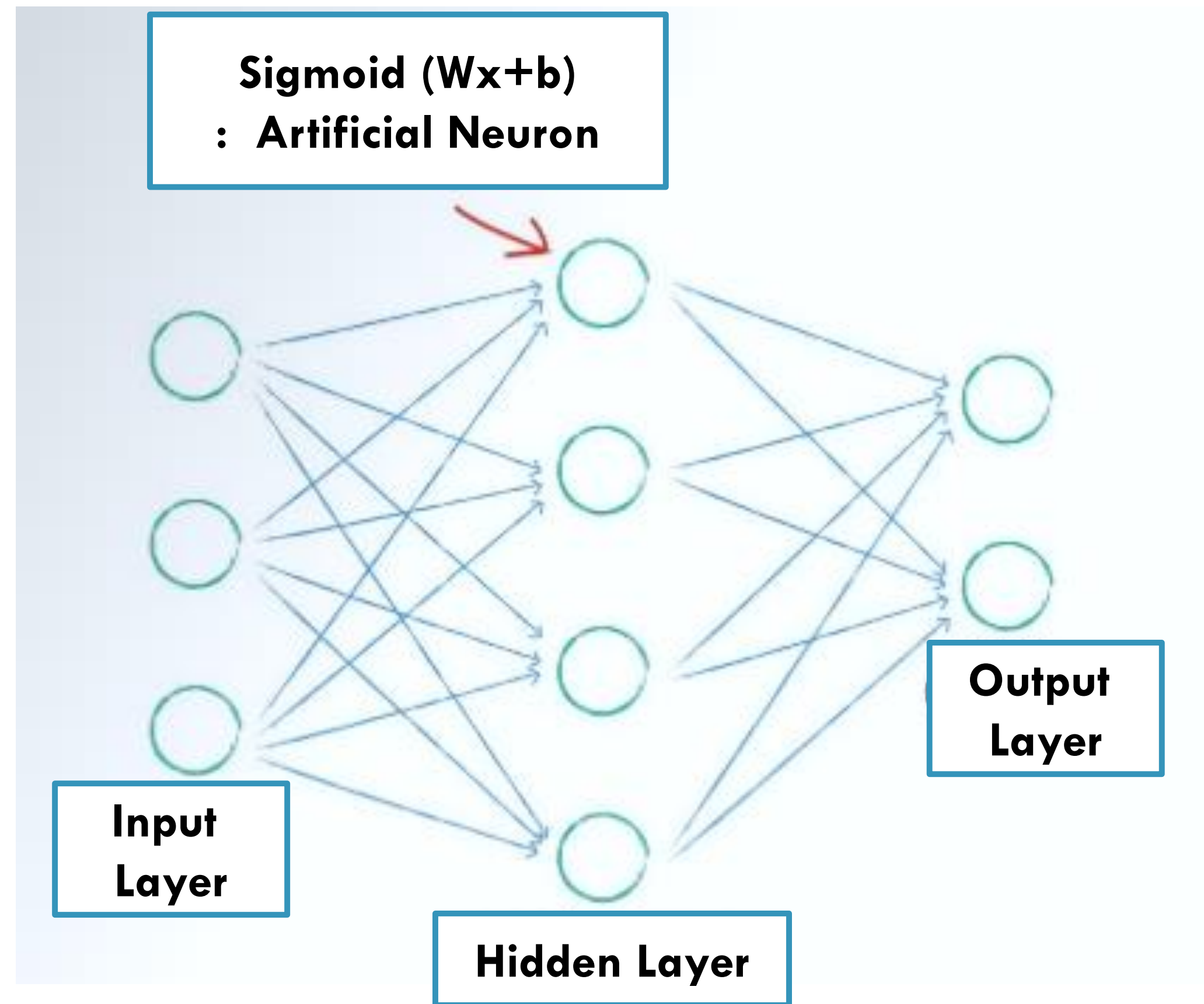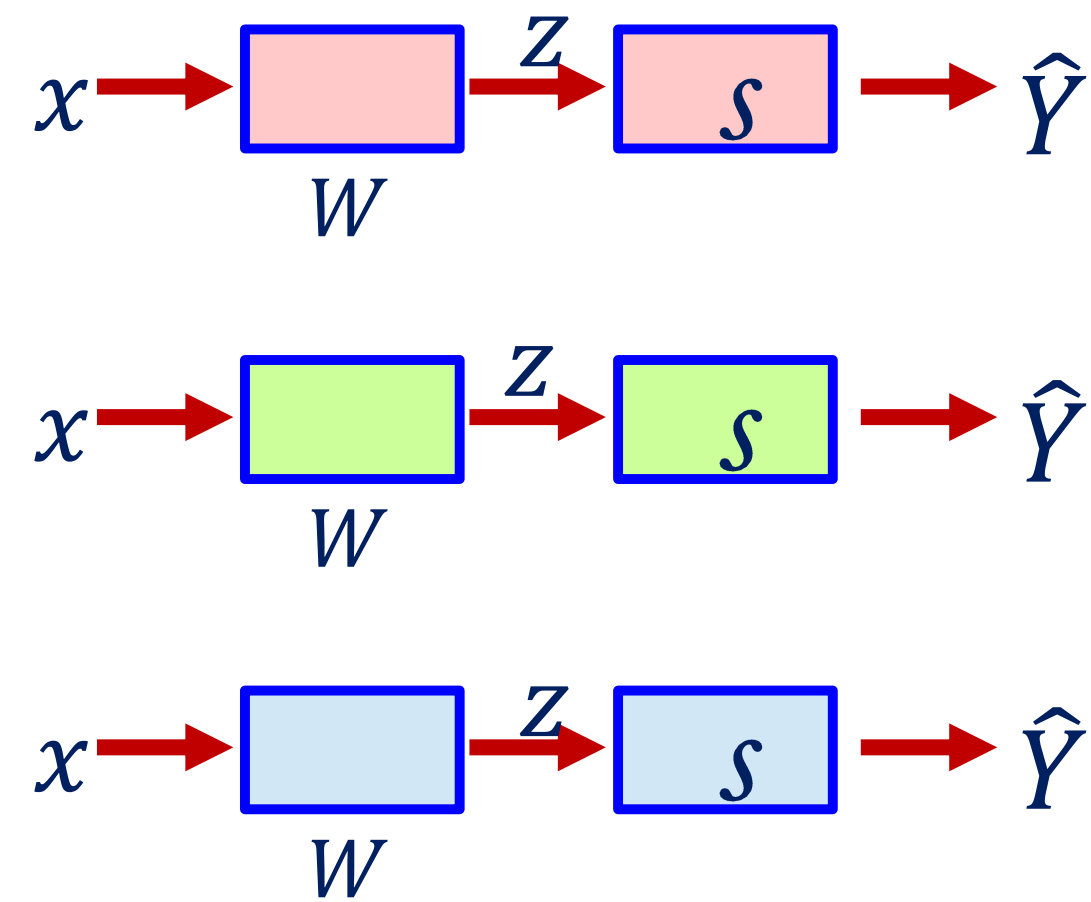
Ultimate dream: thinking machine
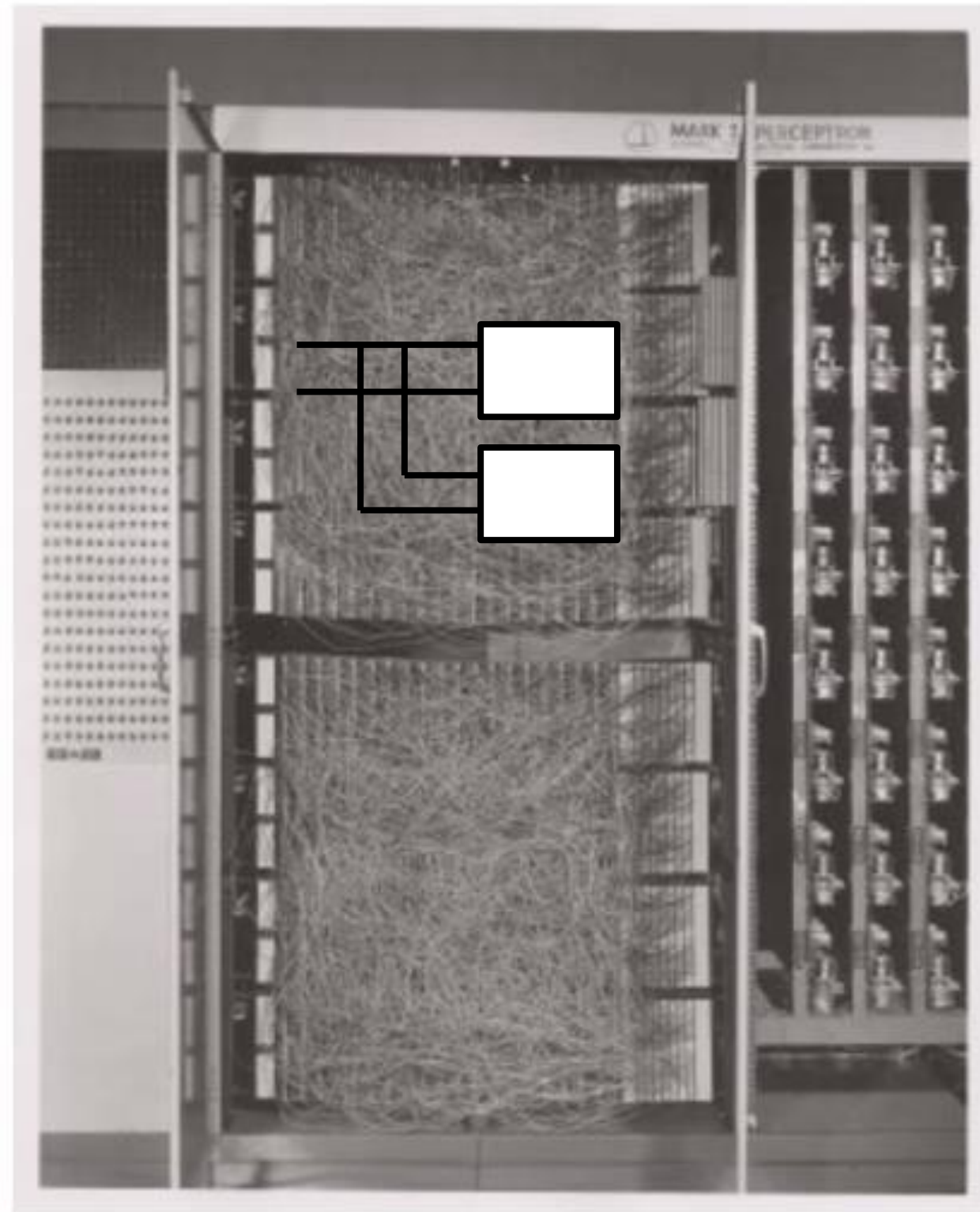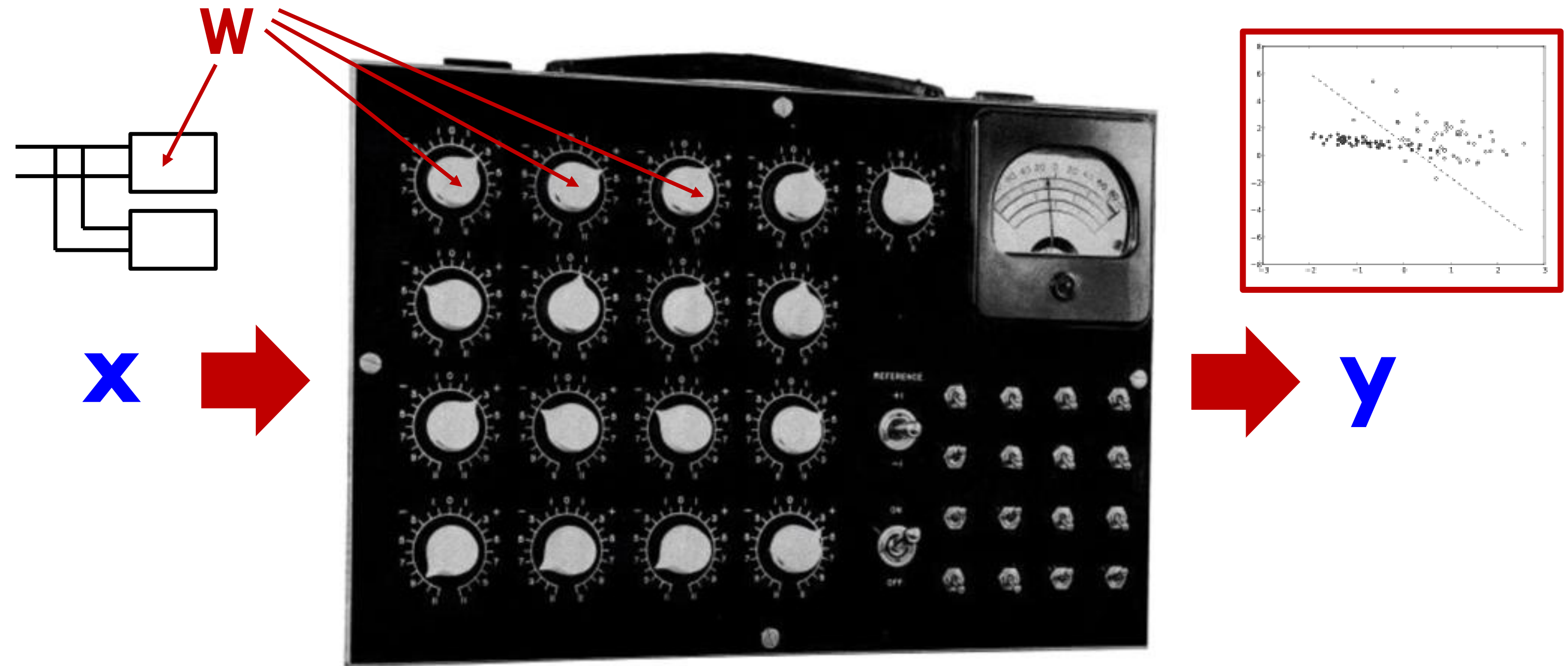
Schematic of a biological neuron

Activation function
: Sigmoid, ReLU, tanh …

$x \cdot w$

Σ

x

$+b$

y

Activation Functions

Schematic of a biological neuron.

Activation function
: Sigmoid, ReLU, tanh …

Logistic regression units

$x \rightarrow$ [ ] $\xrightarrow{z}$ [s] $\rightarrow \hat{Y}$
W

$x \rightarrow$ [ ] $\xrightarrow{z}$ [s] $\rightarrow \hat{Y}$
W

$x \rightarrow$ [ ] $\xrightarrow{z}$ [s] $\rightarrow \hat{Y}$
W

Sigmoid (Wx+b)
: Artificial Neuron

Input Layer

Hidden Layer

Output Layer

# Hardware implementations


W

x ➡

y

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** an 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"
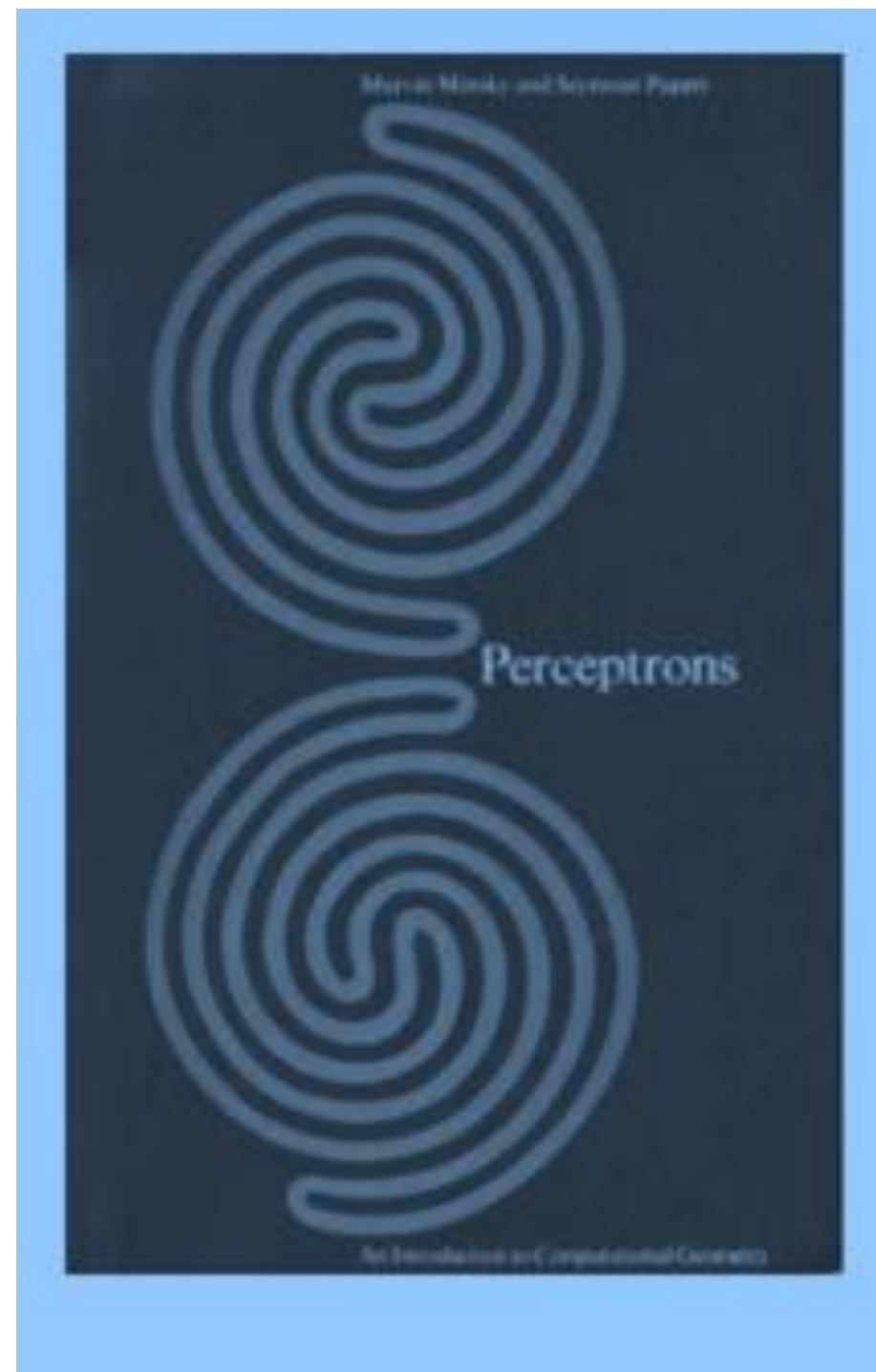
NewYork Times   July 08, 1958

(Simple) AND/OR problem: linearly separable?
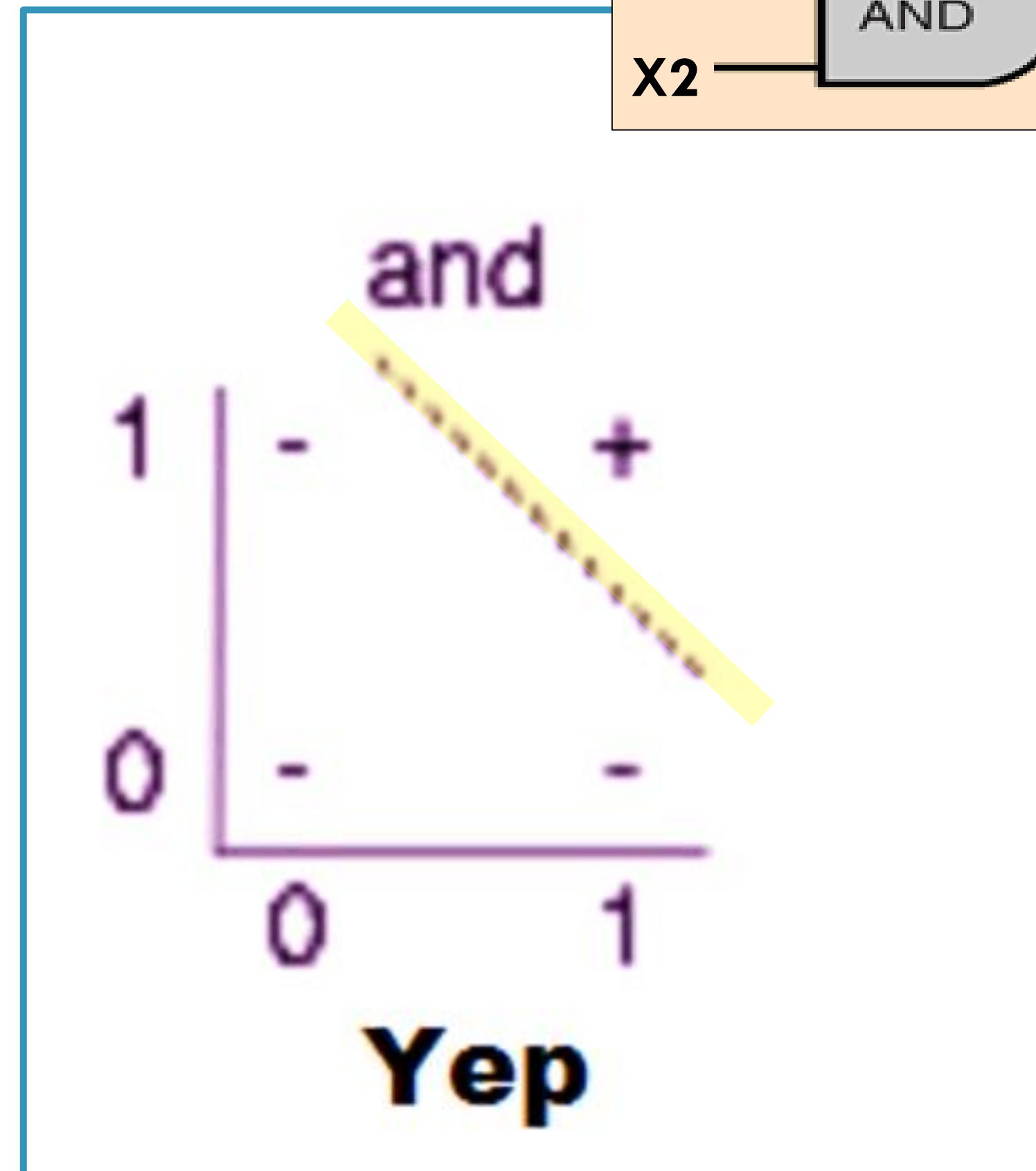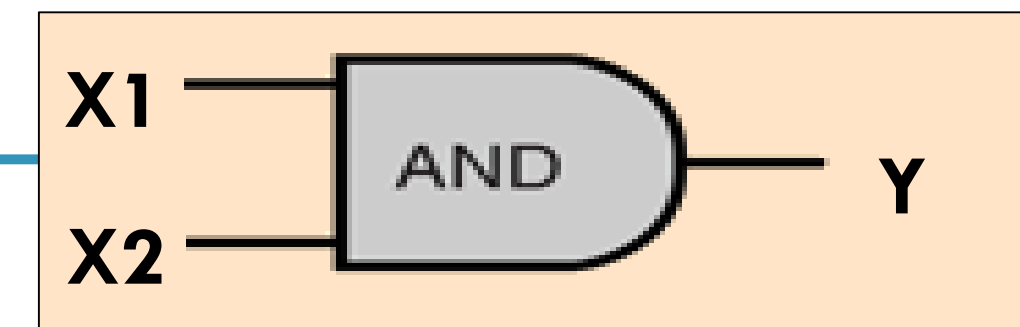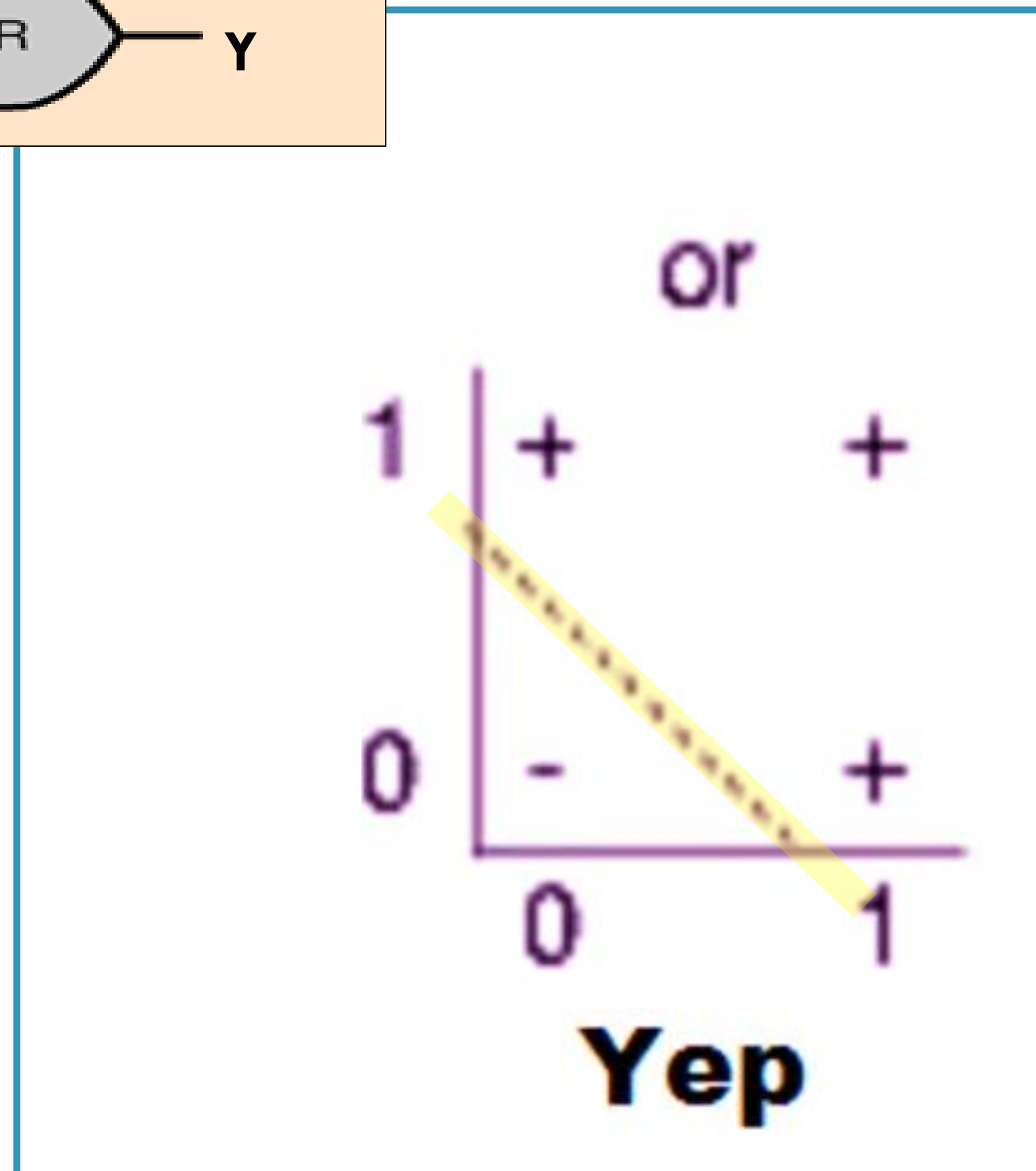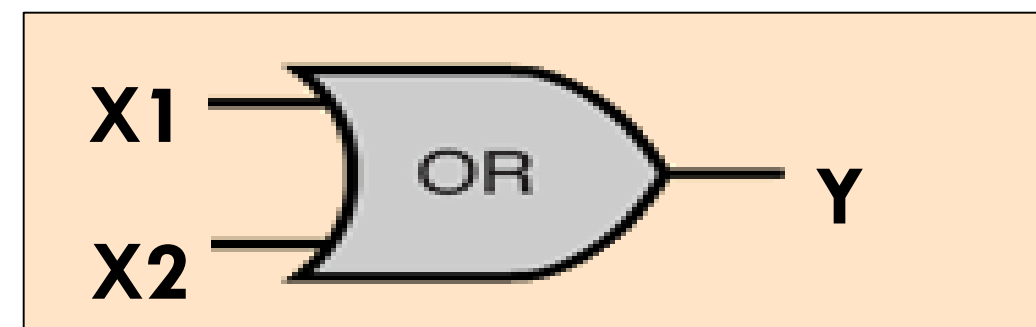
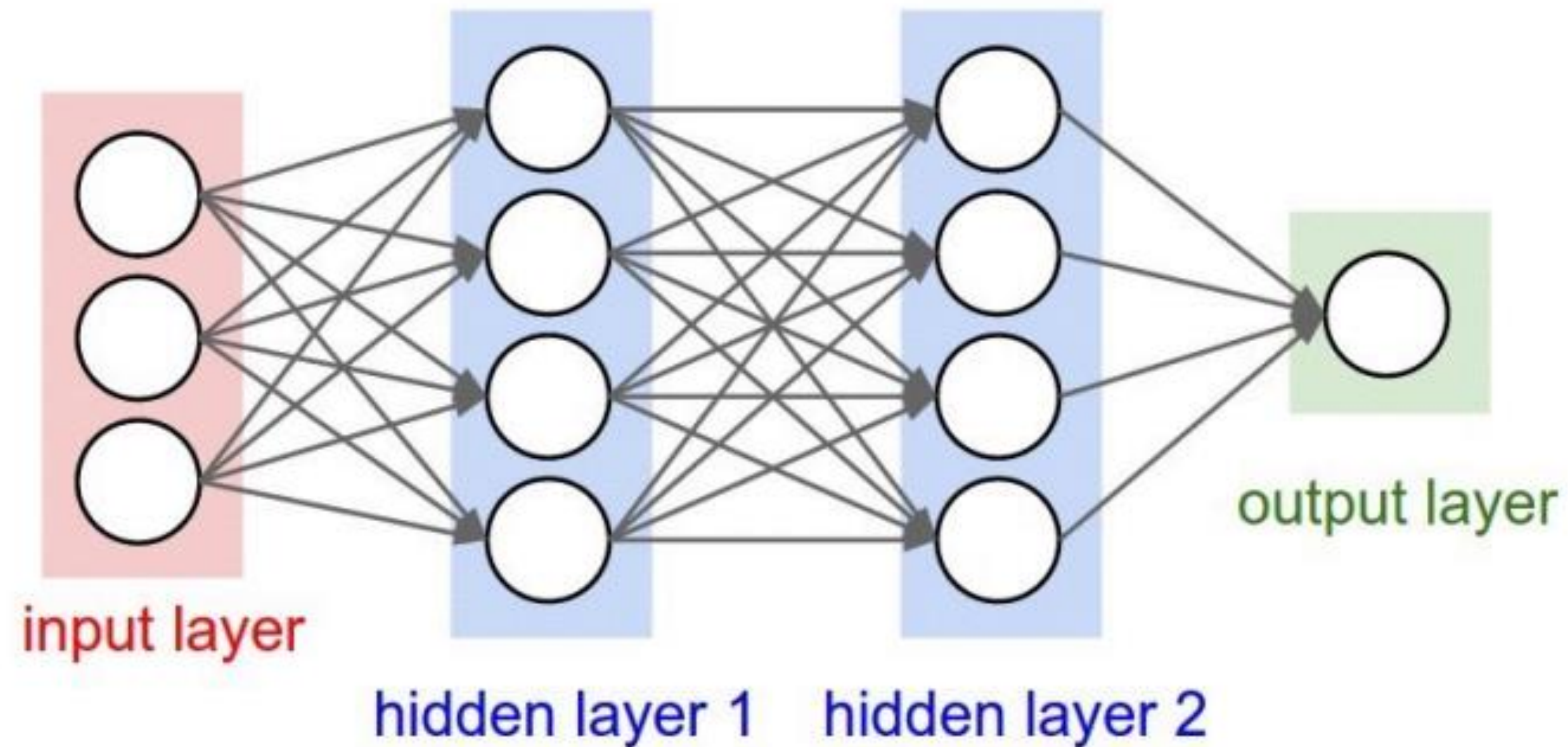# (Simple) XOR problem: linearly separable?
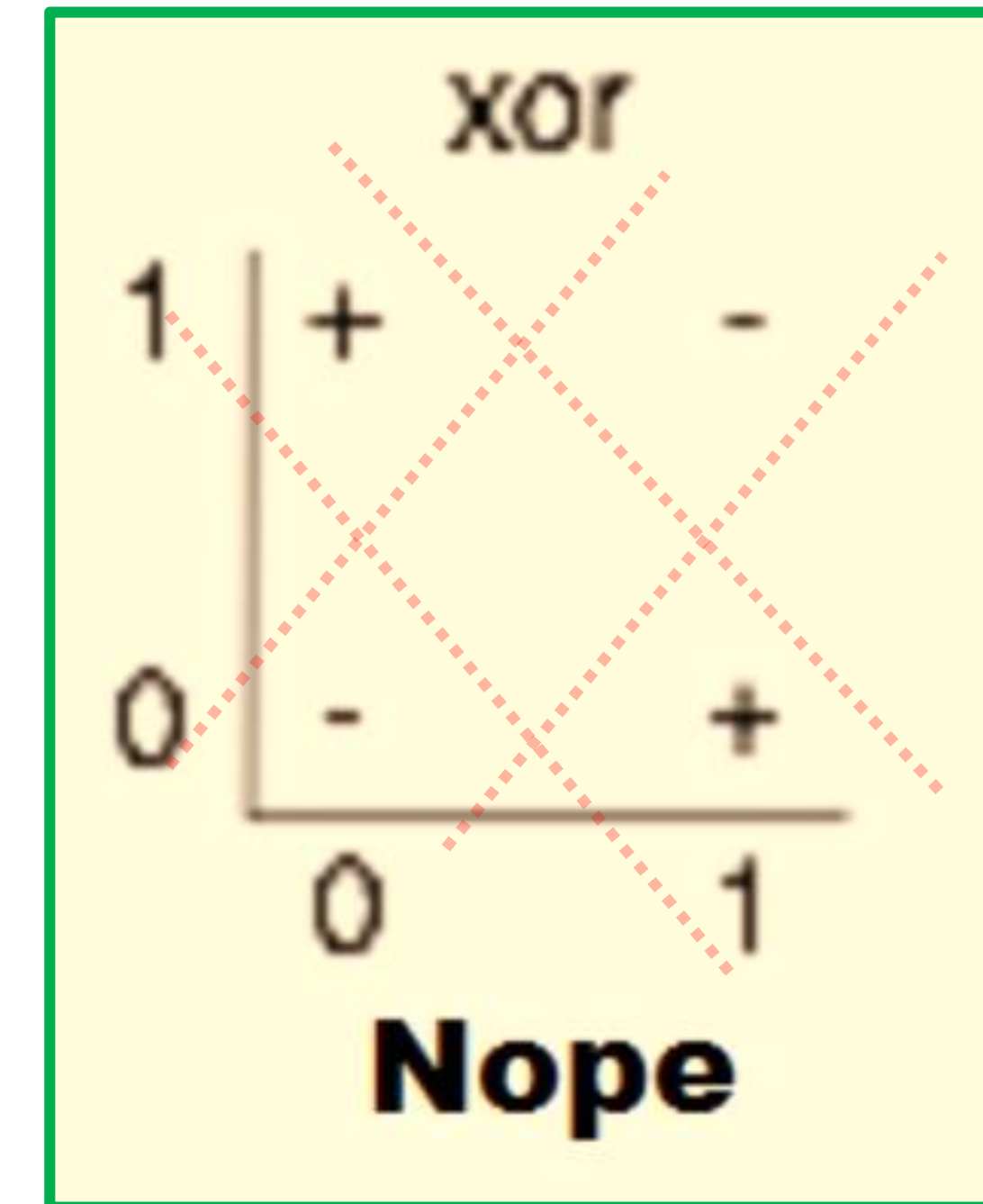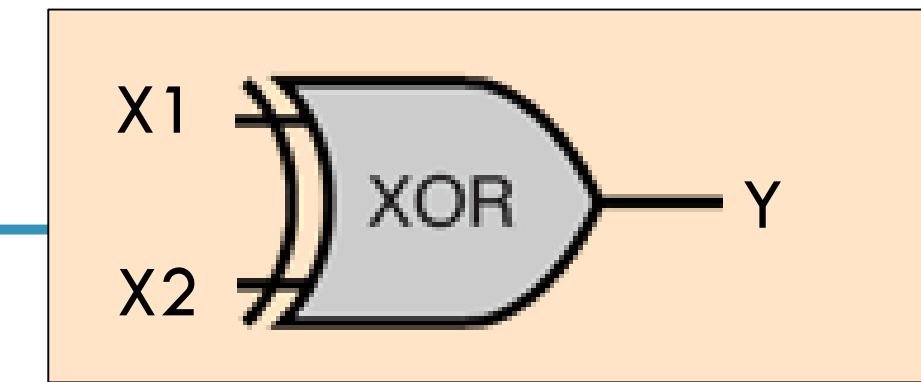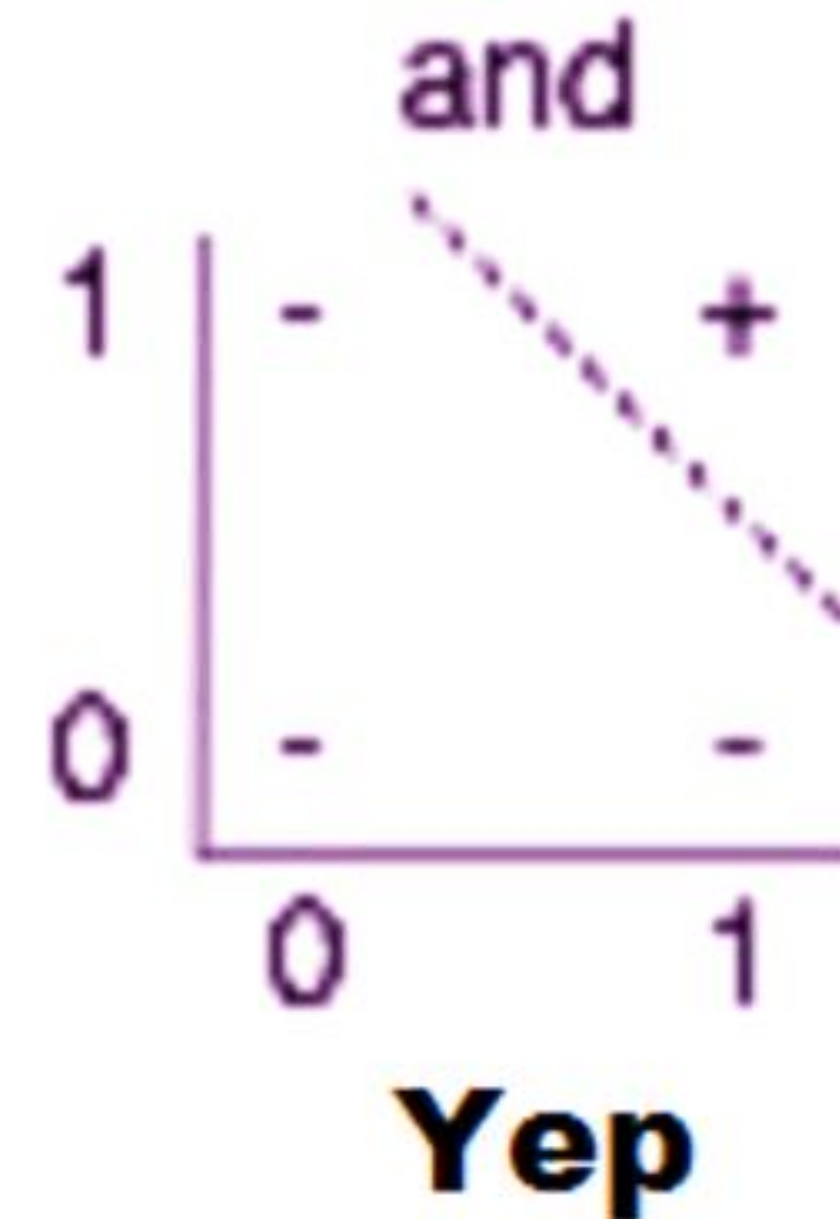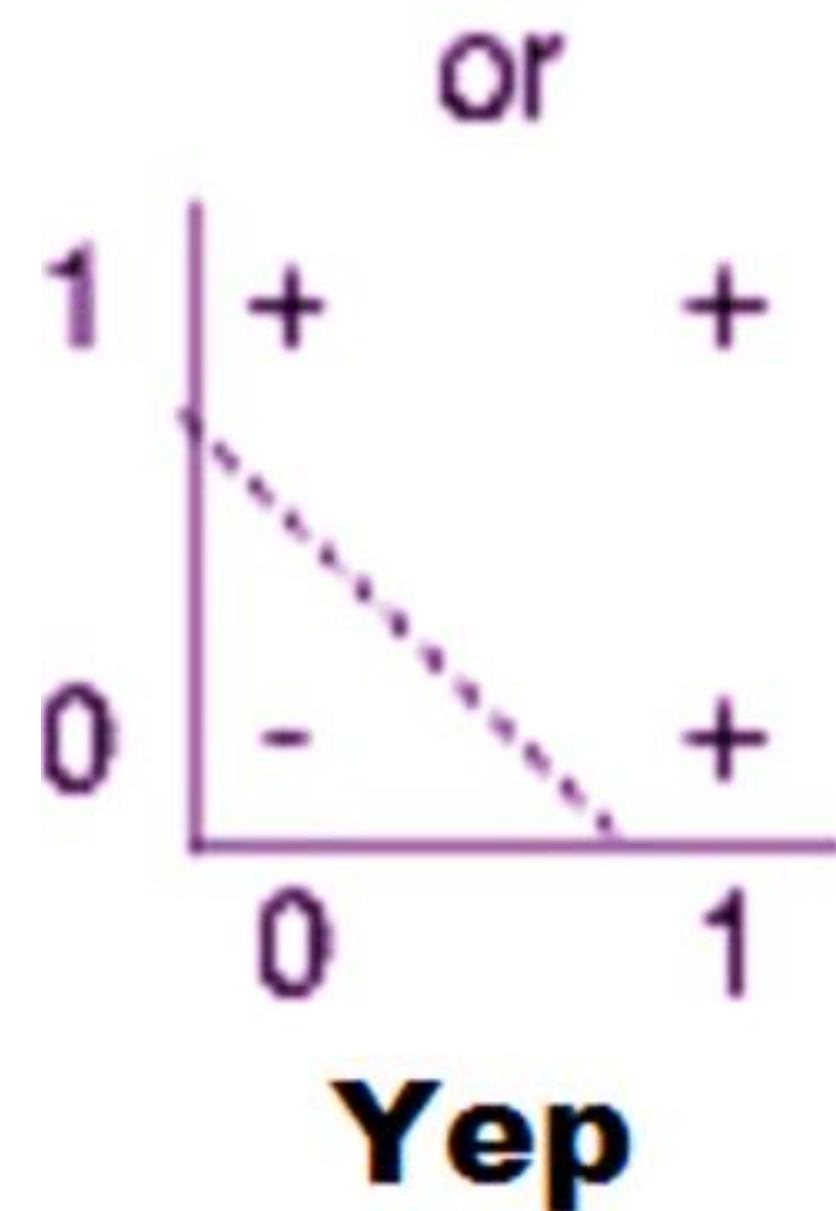
Perceptrons (1969) : by Marvin Minsky, founder of the MIT AI Lab

- 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.

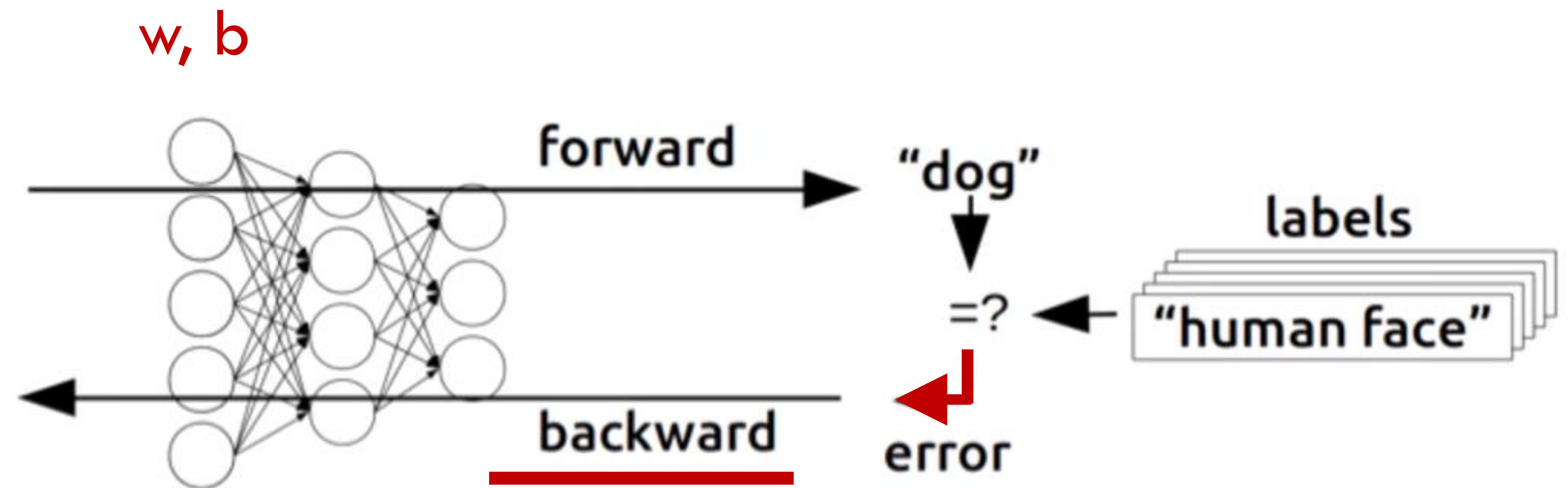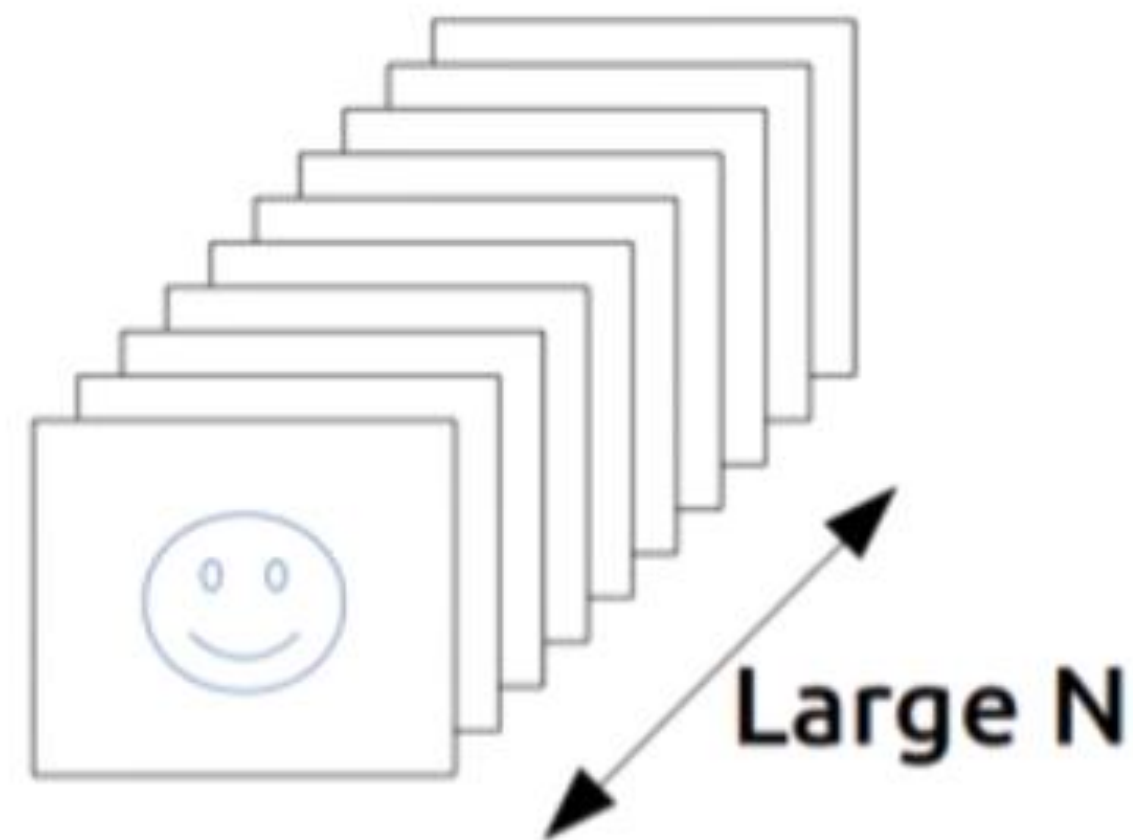# No one on earth had found a viable way to train

input layer

hidden layer 1   hidden layer 2

output layer

*Marvin Minsky, 1969

Training

Large N

w, b

forward

"dog"

labels

=?

"human face"

backward
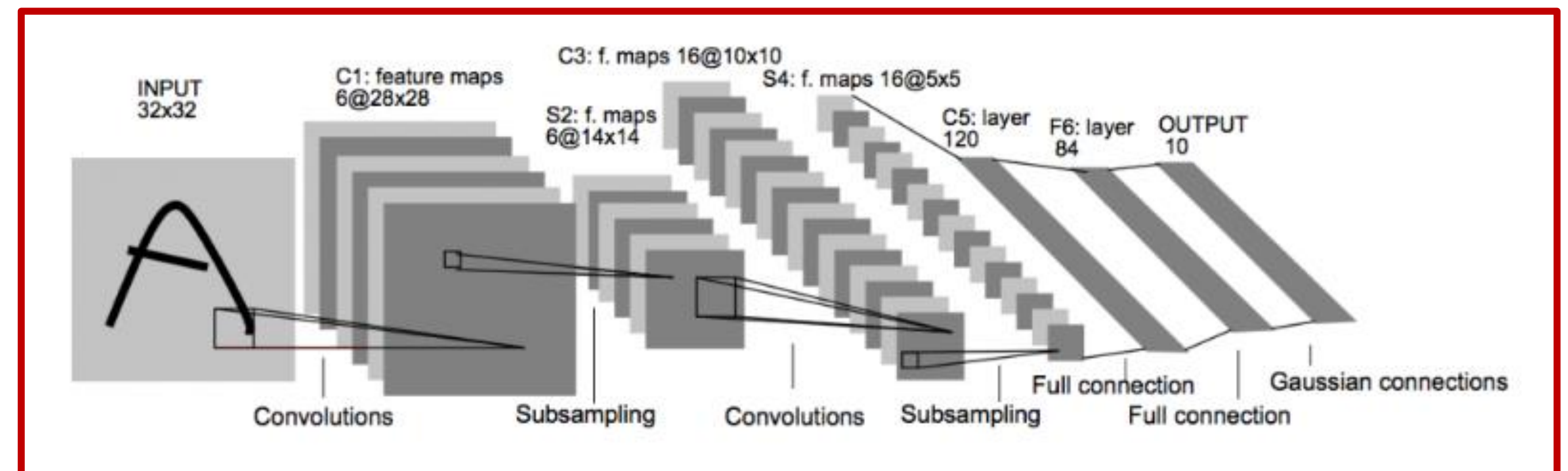
error

Visual neurophysiology
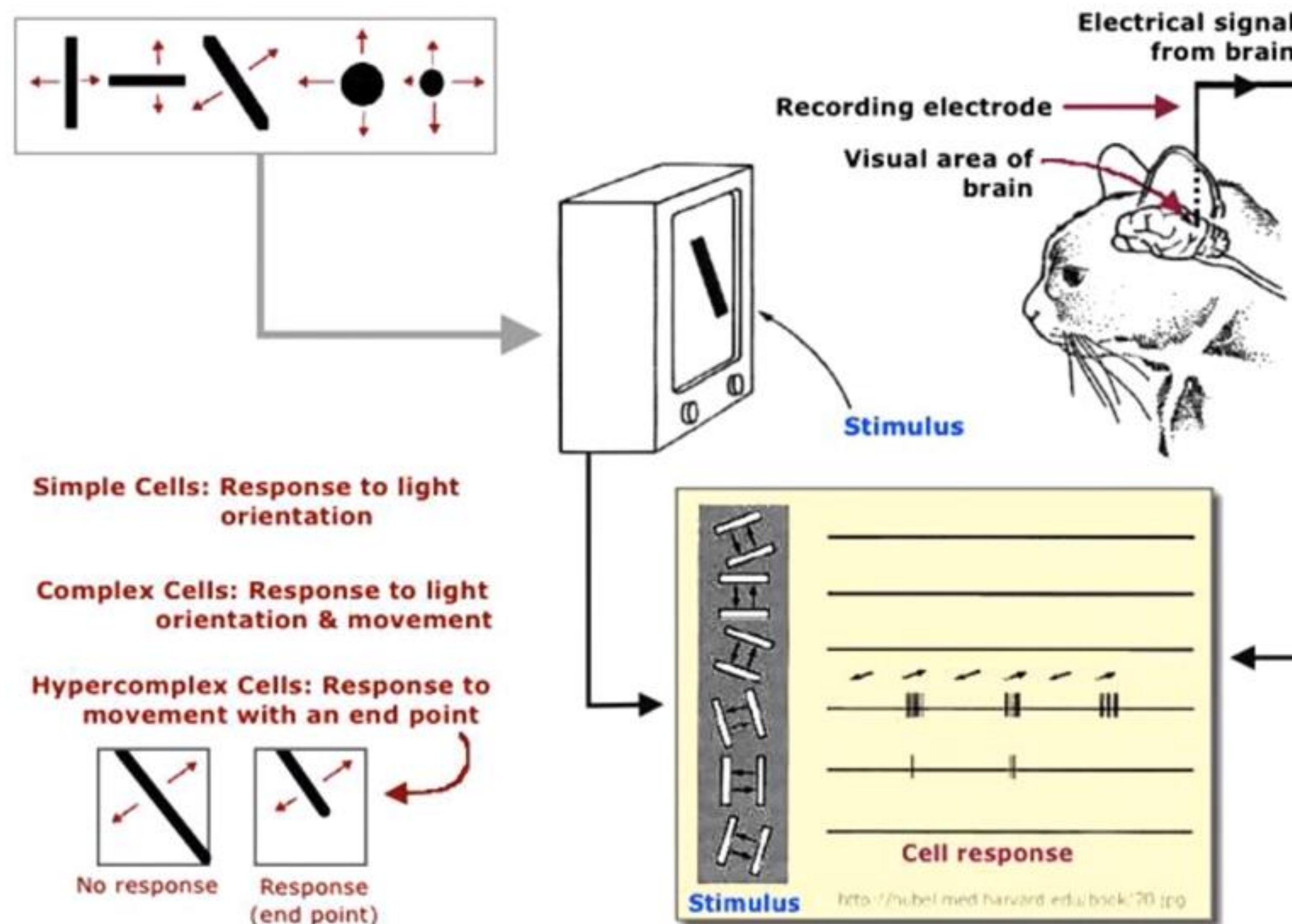
Hubel & Wiesel, 1959
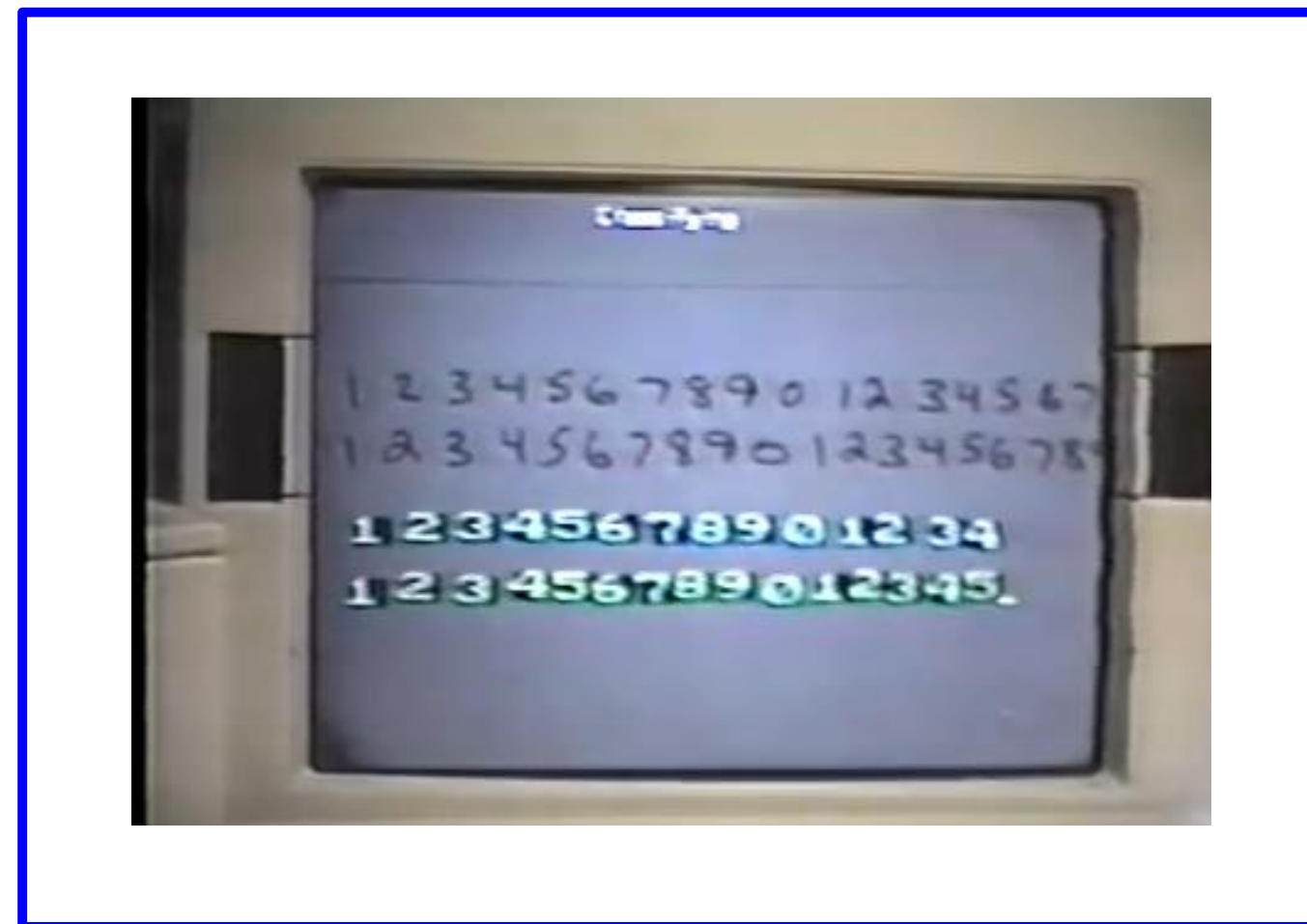
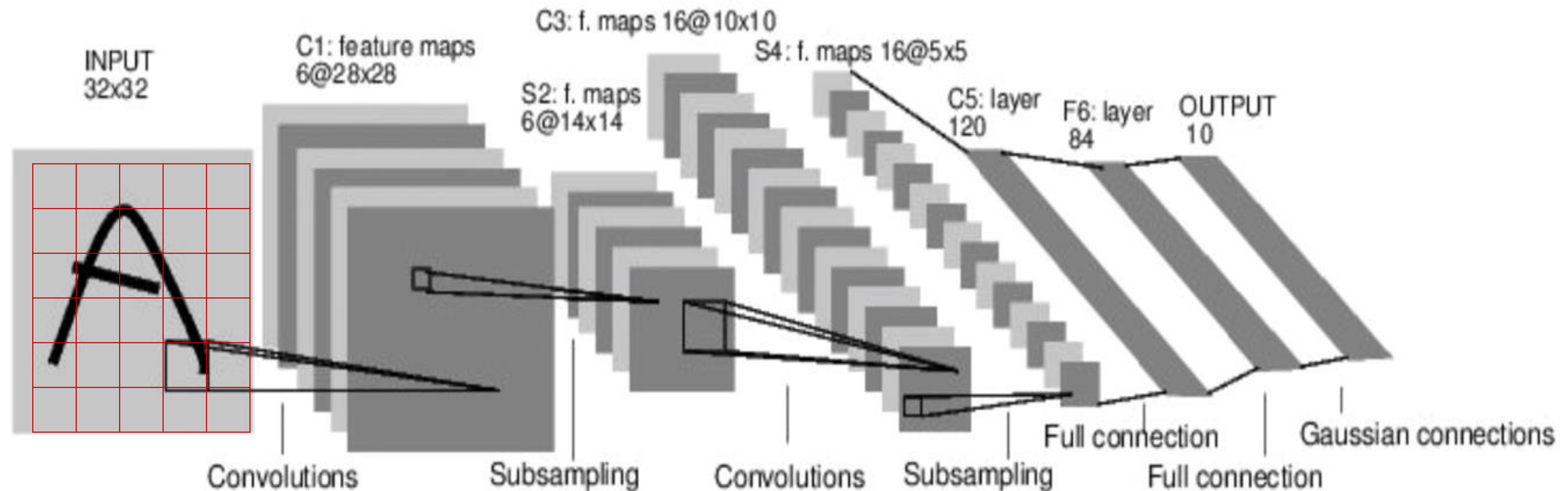# CNN : Convolutional Neural Networks (by Yann Lecun)

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."
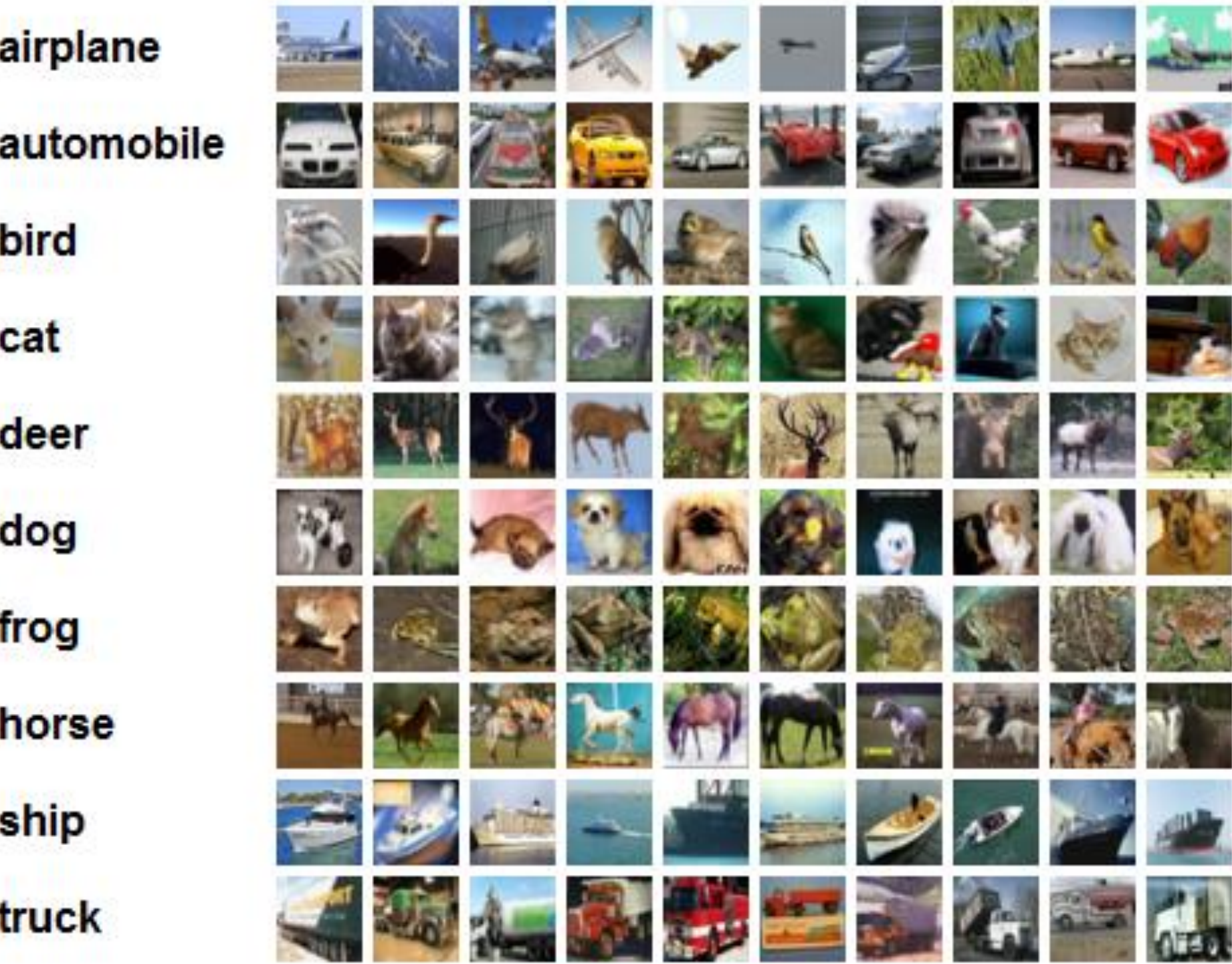
[LeNet-5, LeCun 1980]

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
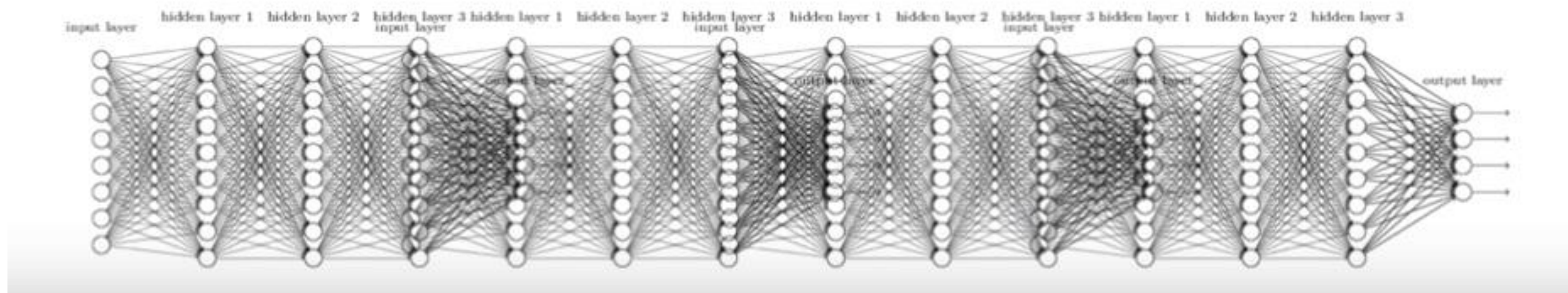
CIFAR

CIFAR-10 data set

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
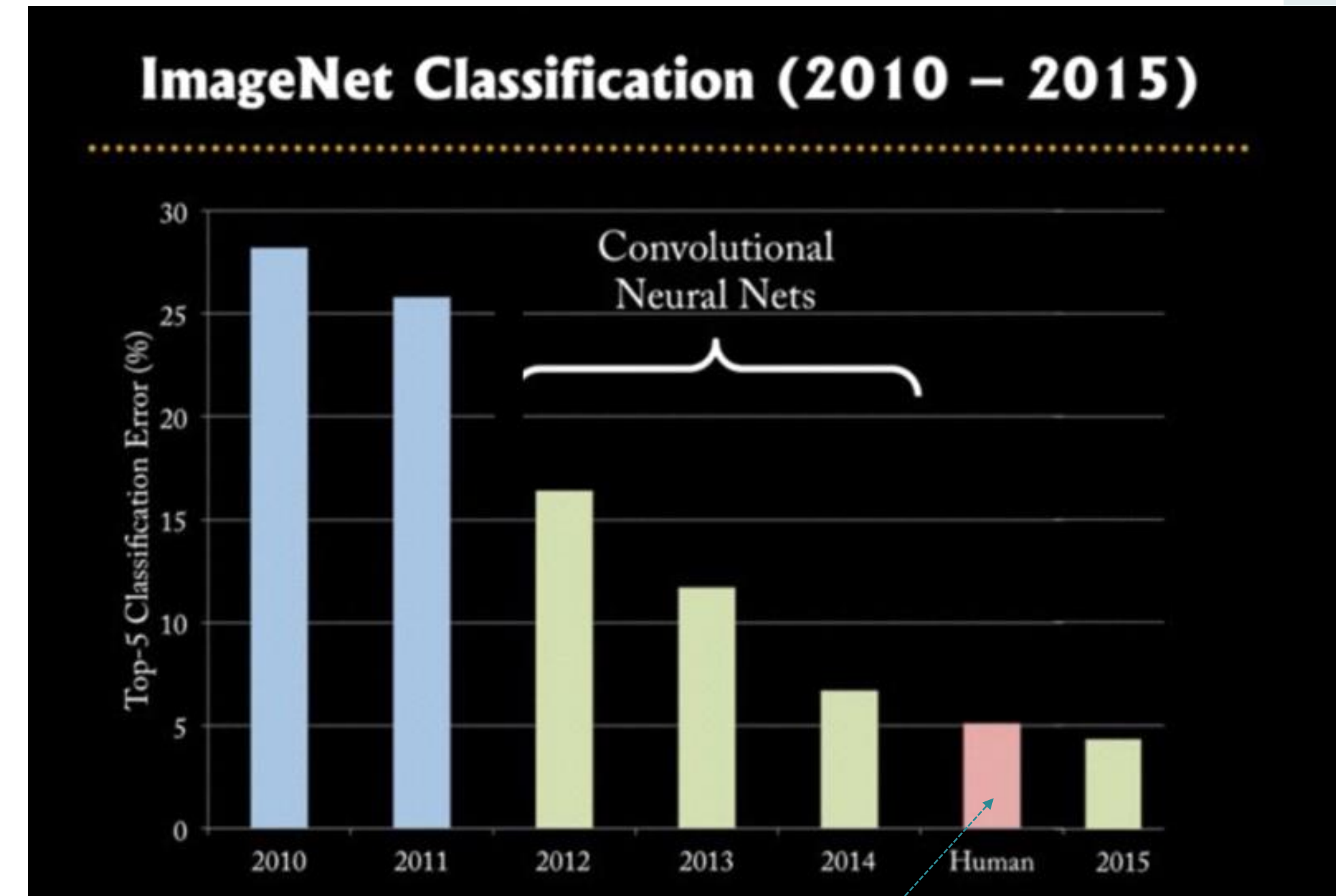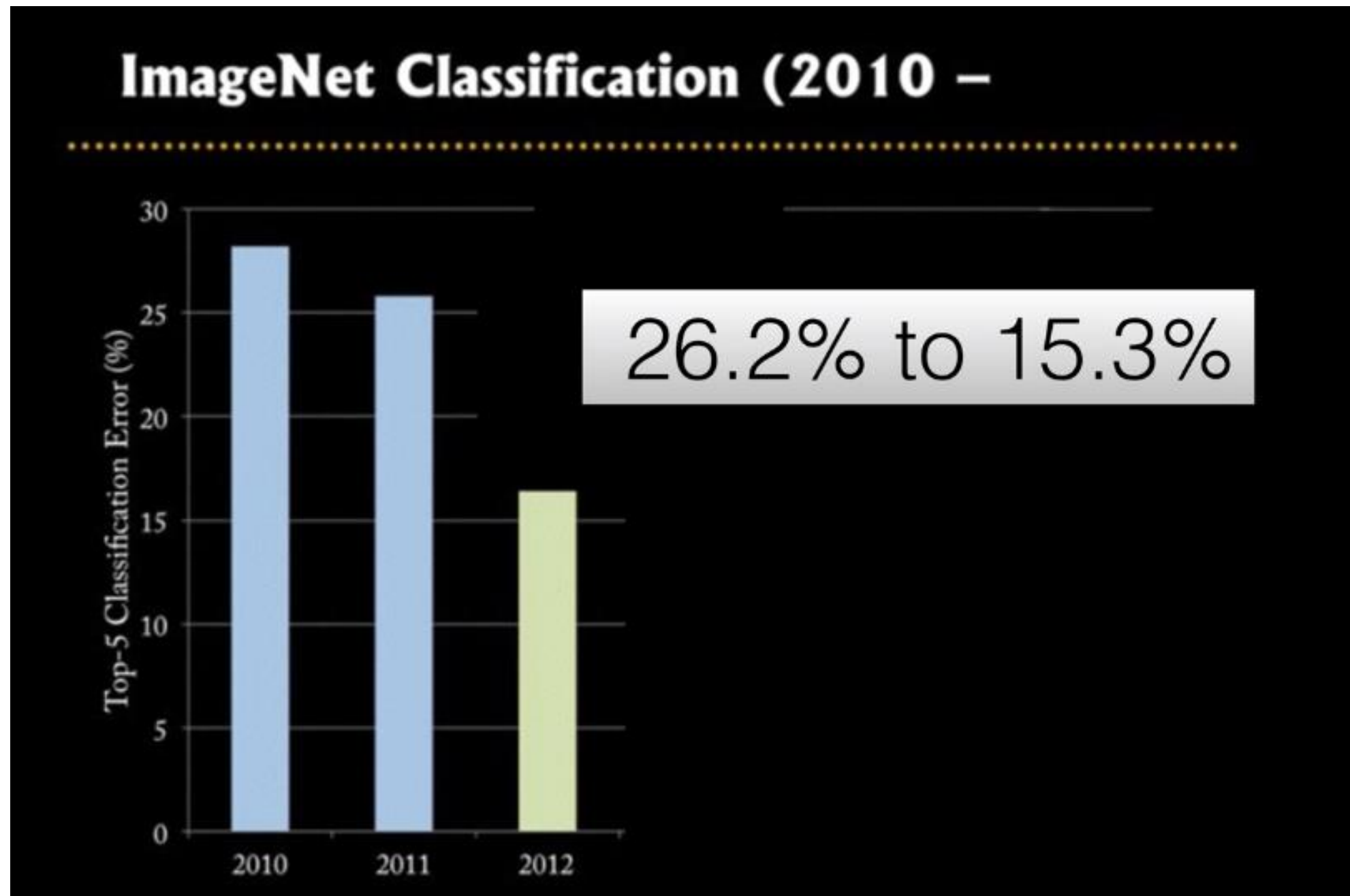
Speech recognition errors
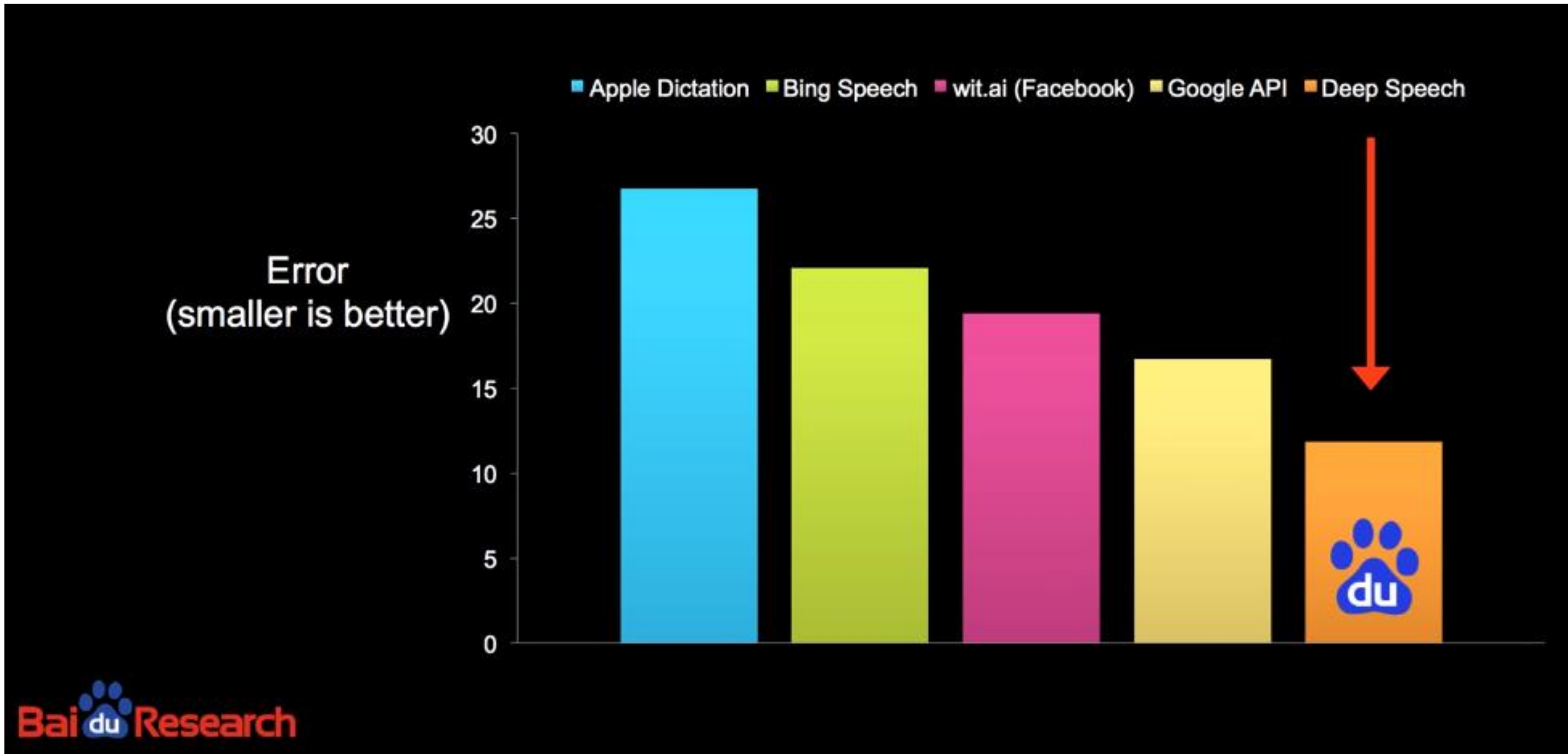
AlphaGo

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.

Why should I care?
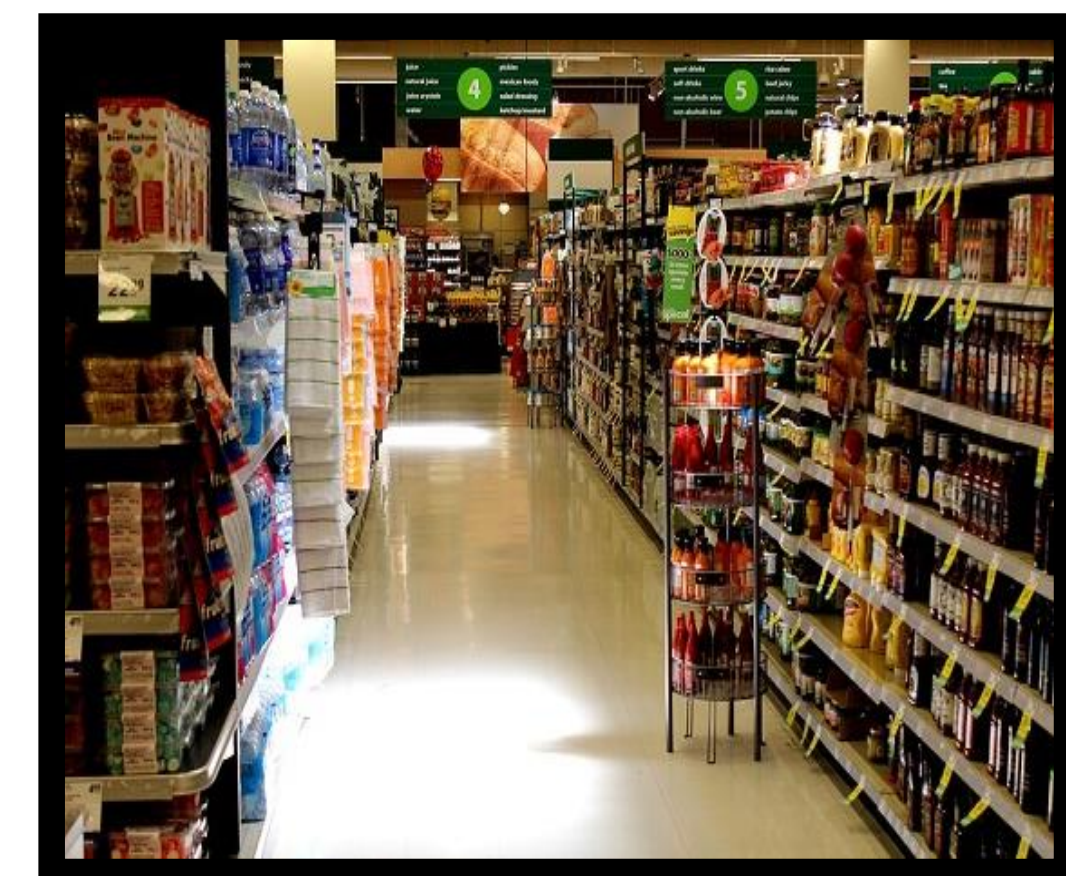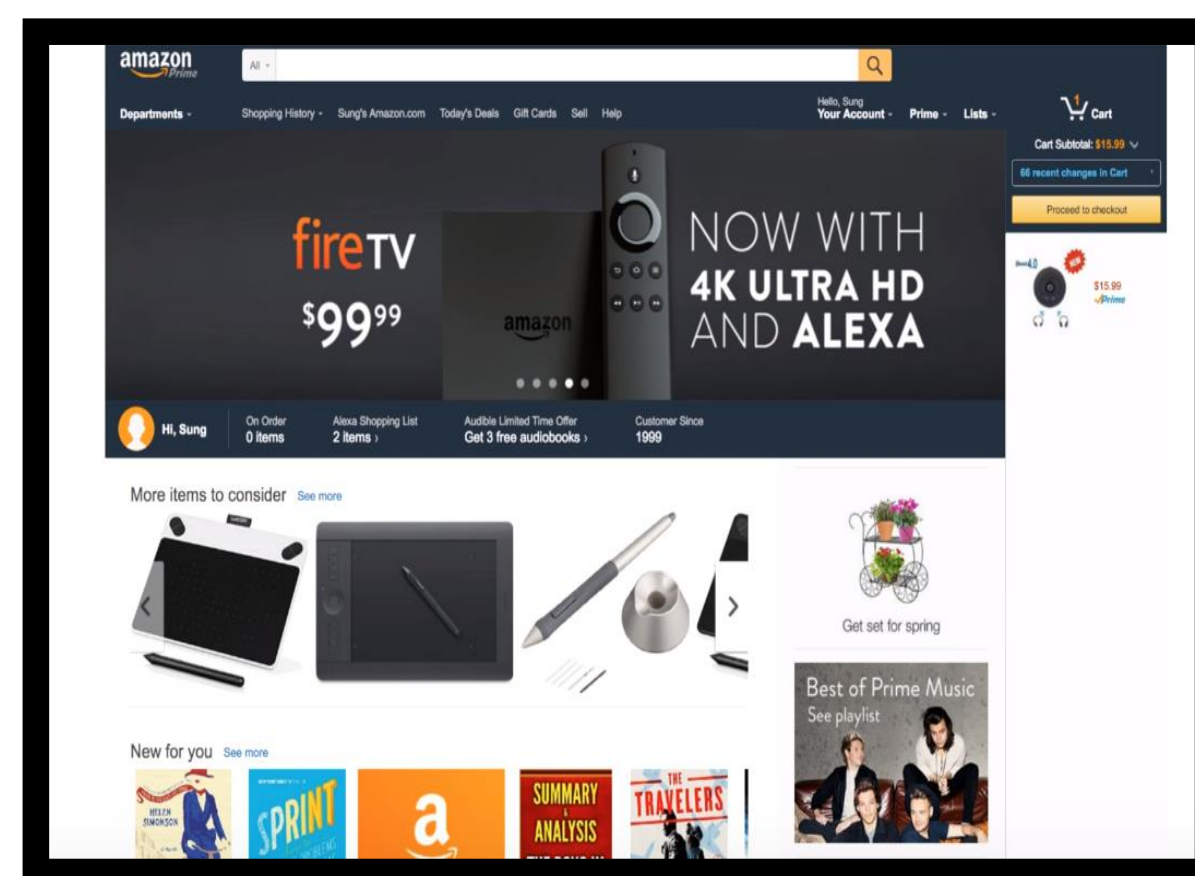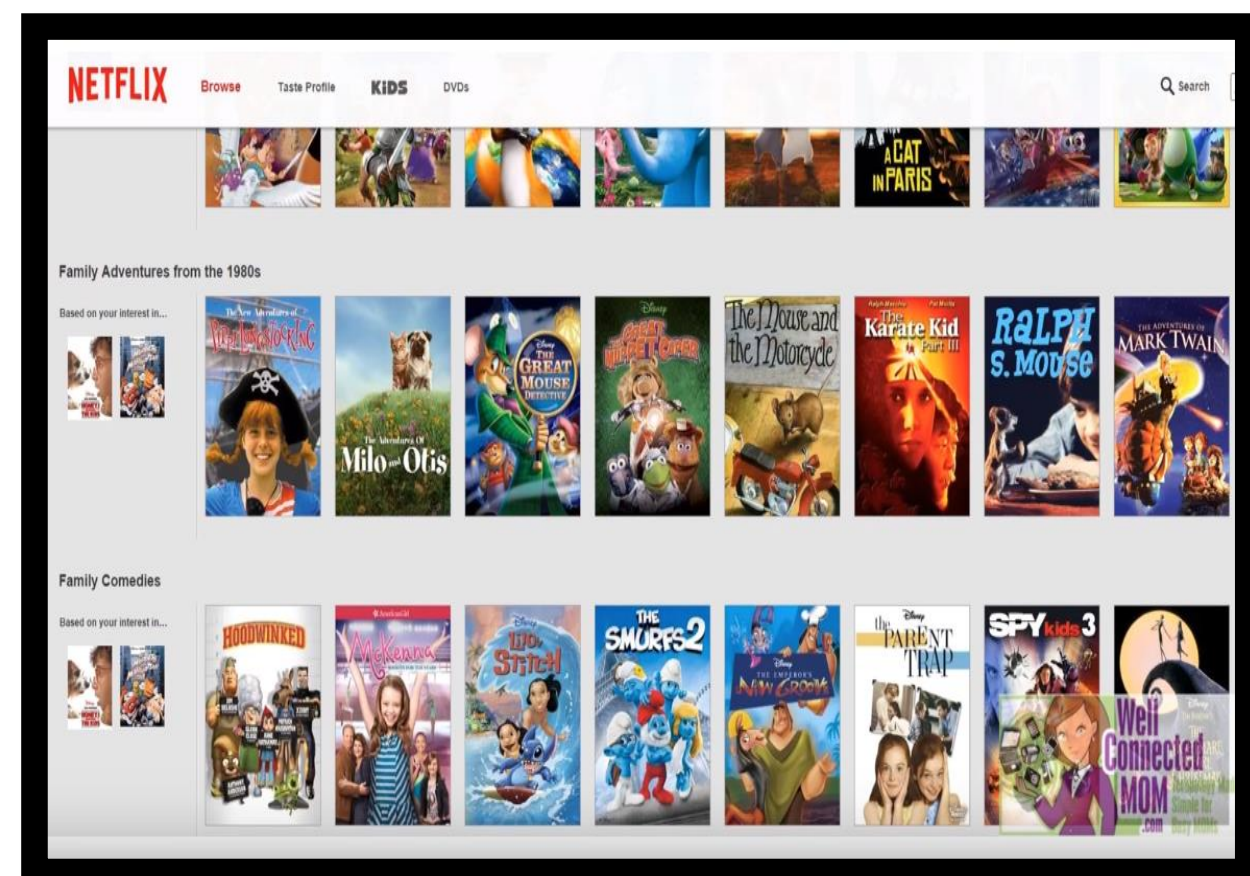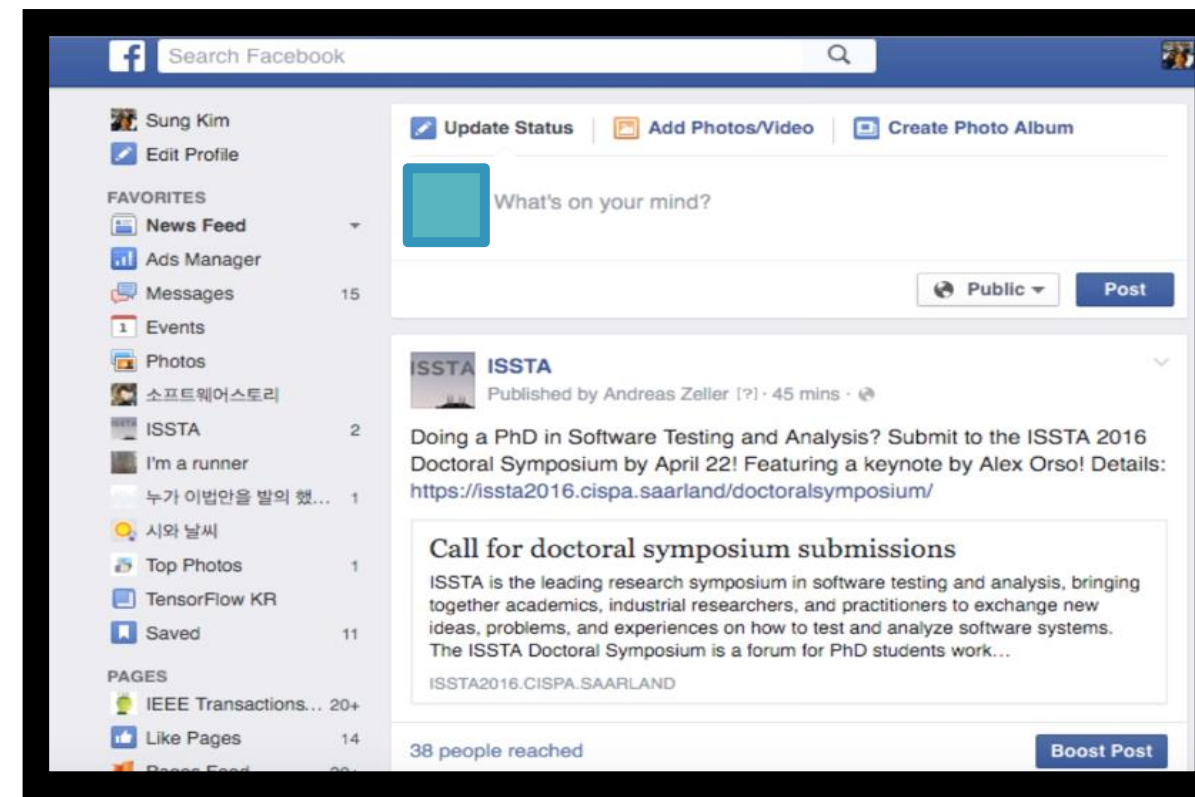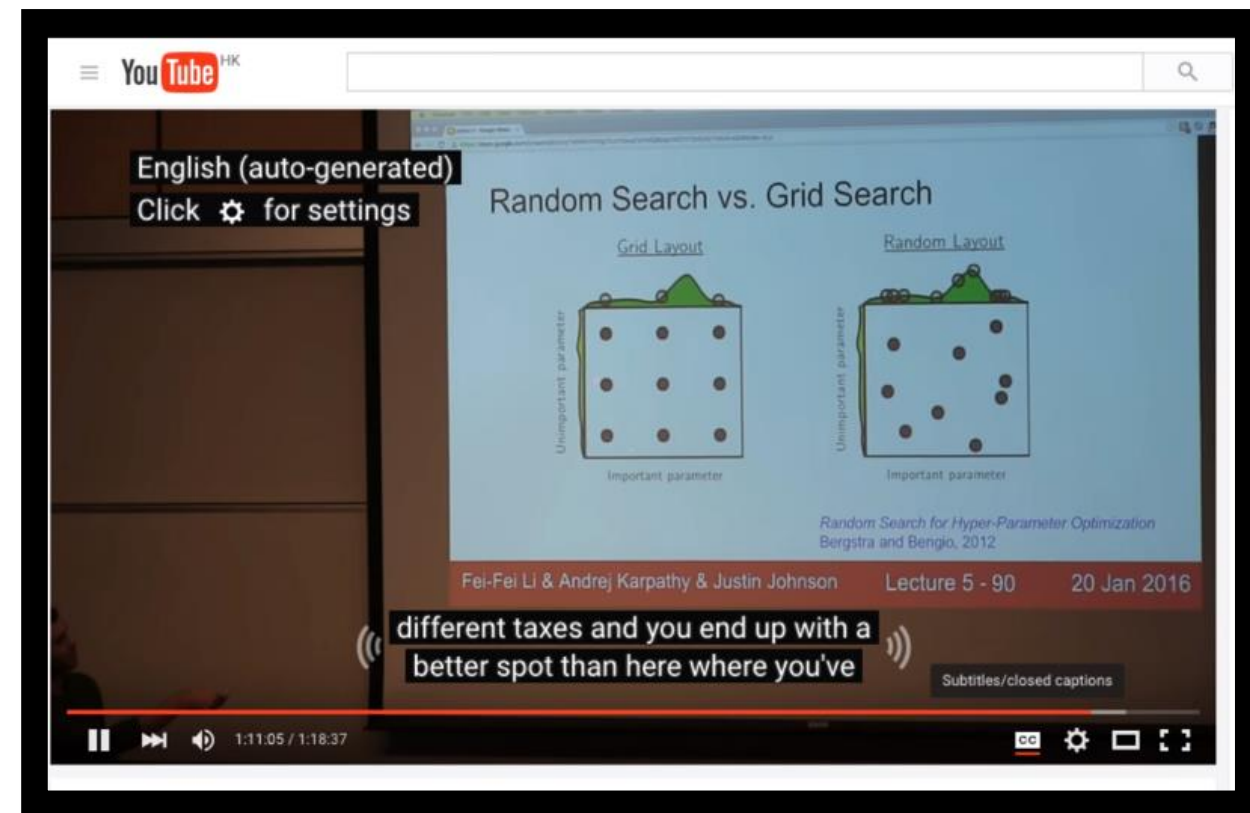
Why should I care?
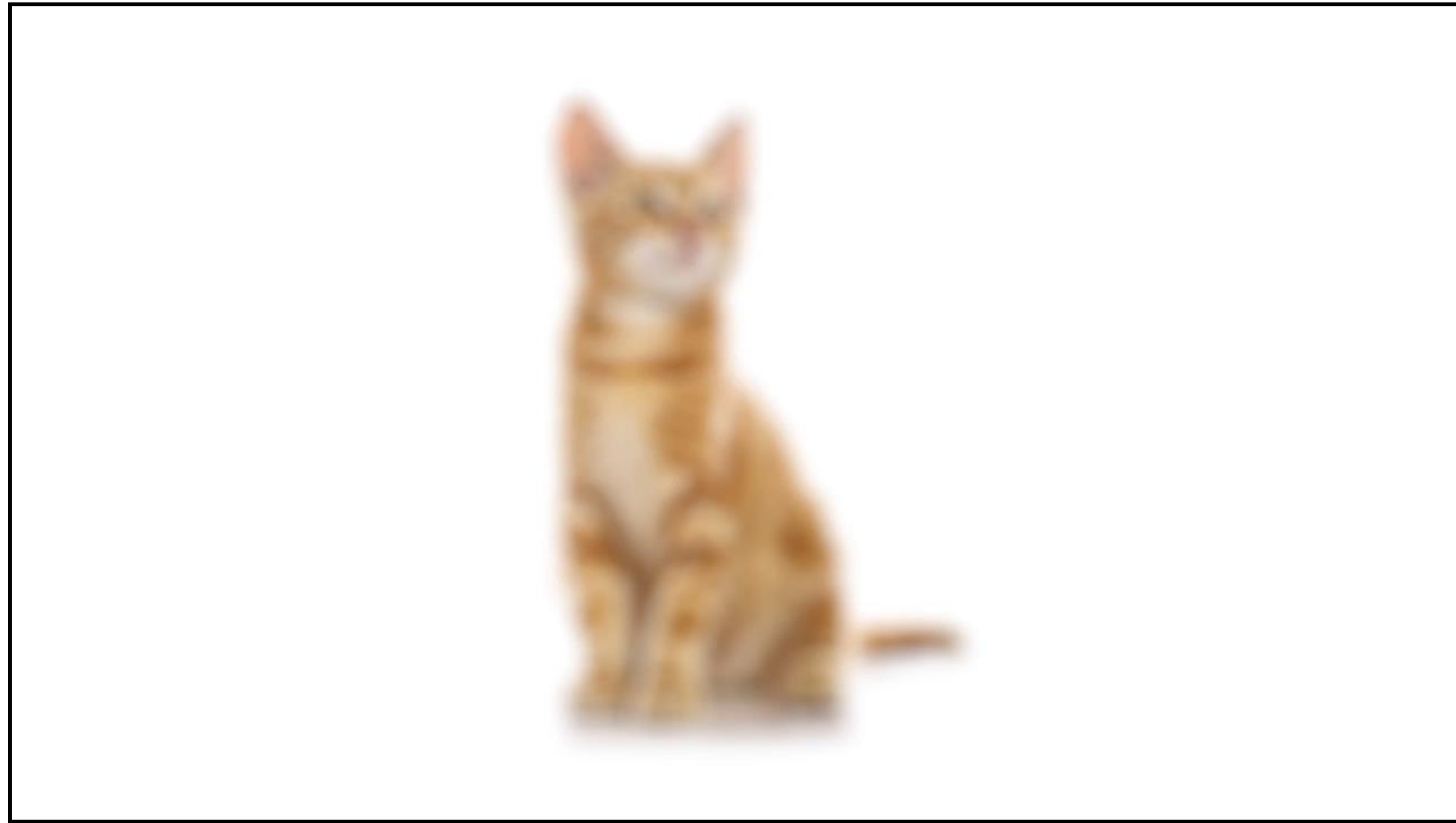
Why should I care?

A.I. Duet
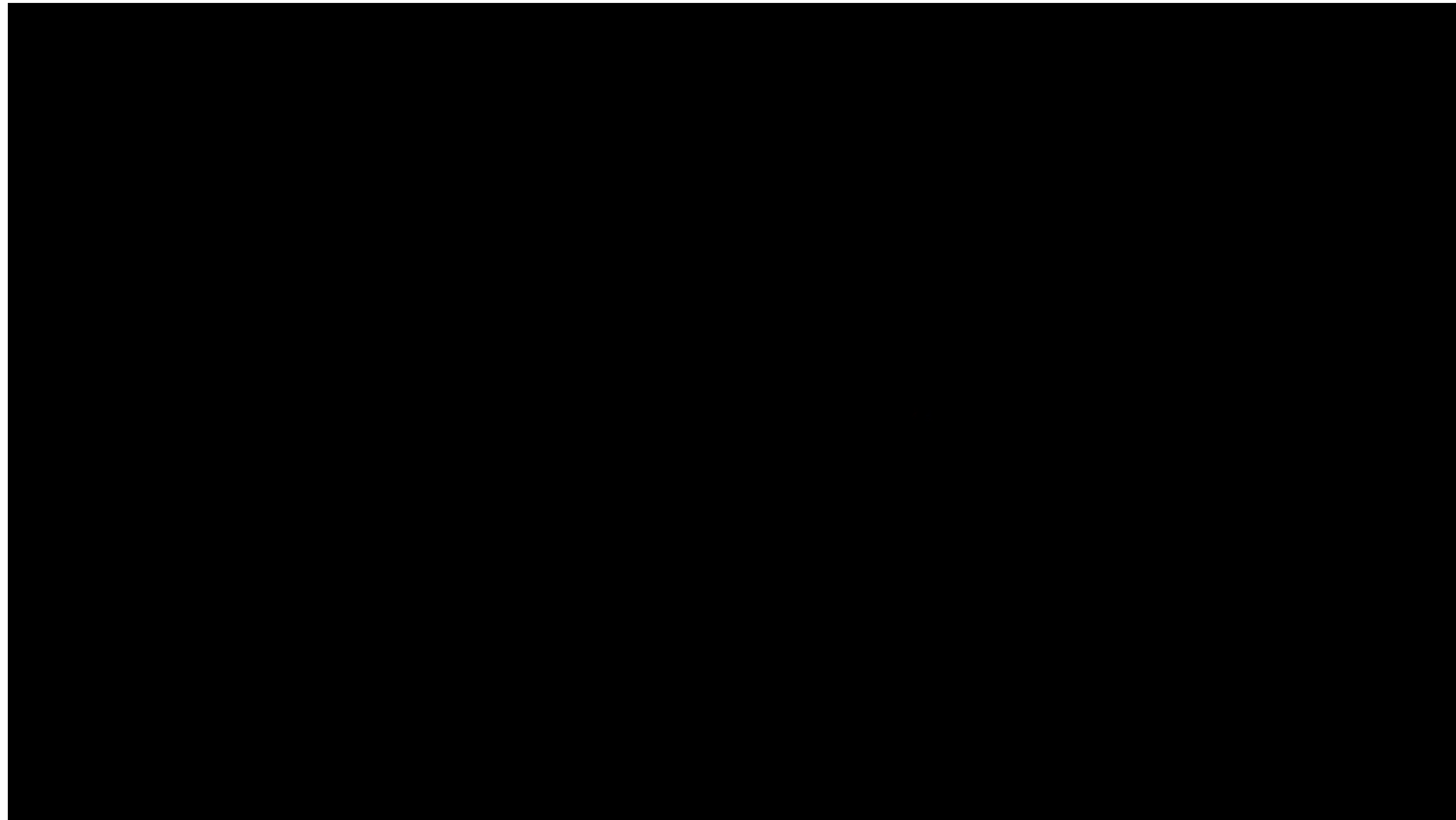
Why should I care?

- **IBM Watson :** 미국 주요 병원에서 암 진단 및 치료법 조언, 국내 주요 대학병원에도 도입

  → **2013**년 투입 전 : **60**만 건 진단서, **200**만 쪽 전문서적, **150**만 명의 환자 기록을 학습

  → 정확도 비교 : 폐암 진단에서 **Watson 90%** , 의사 **50 %**

I know my children will N E V E R have to say: "Mom died of Ovarian Cancer."
- Angelina Jolie
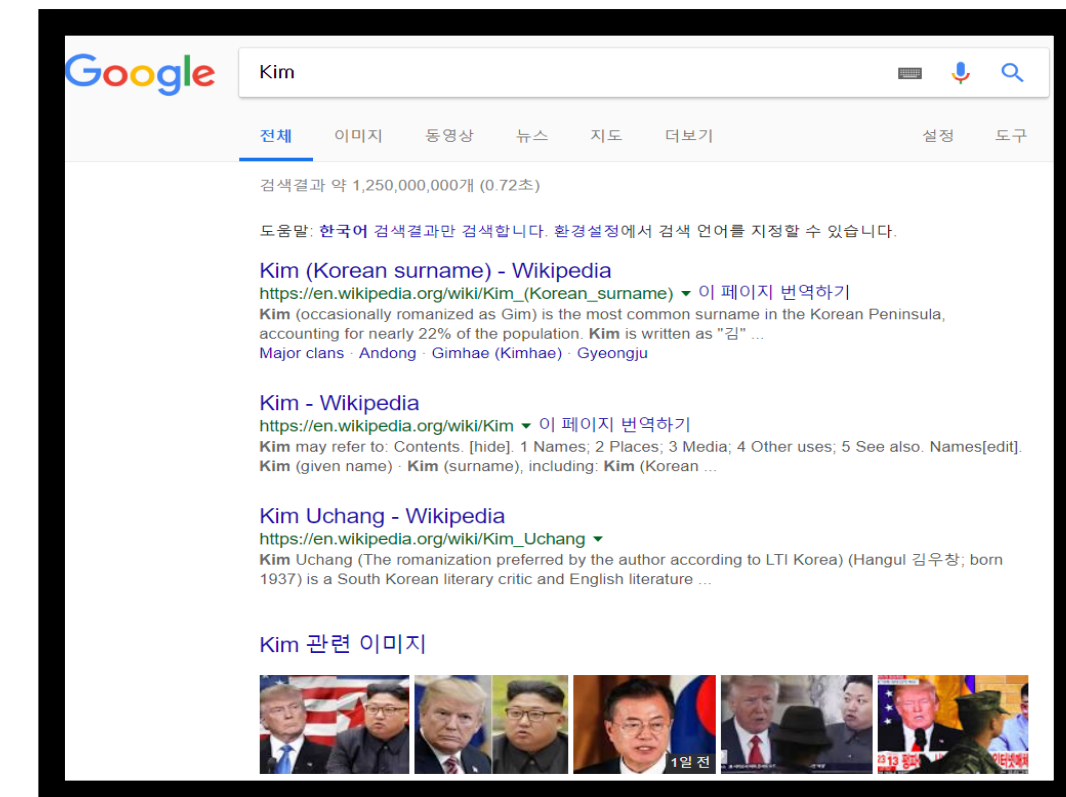

Long Life for Everybody not Somebody

% Survivors

Populations

Age →

생존곡선의 직각화
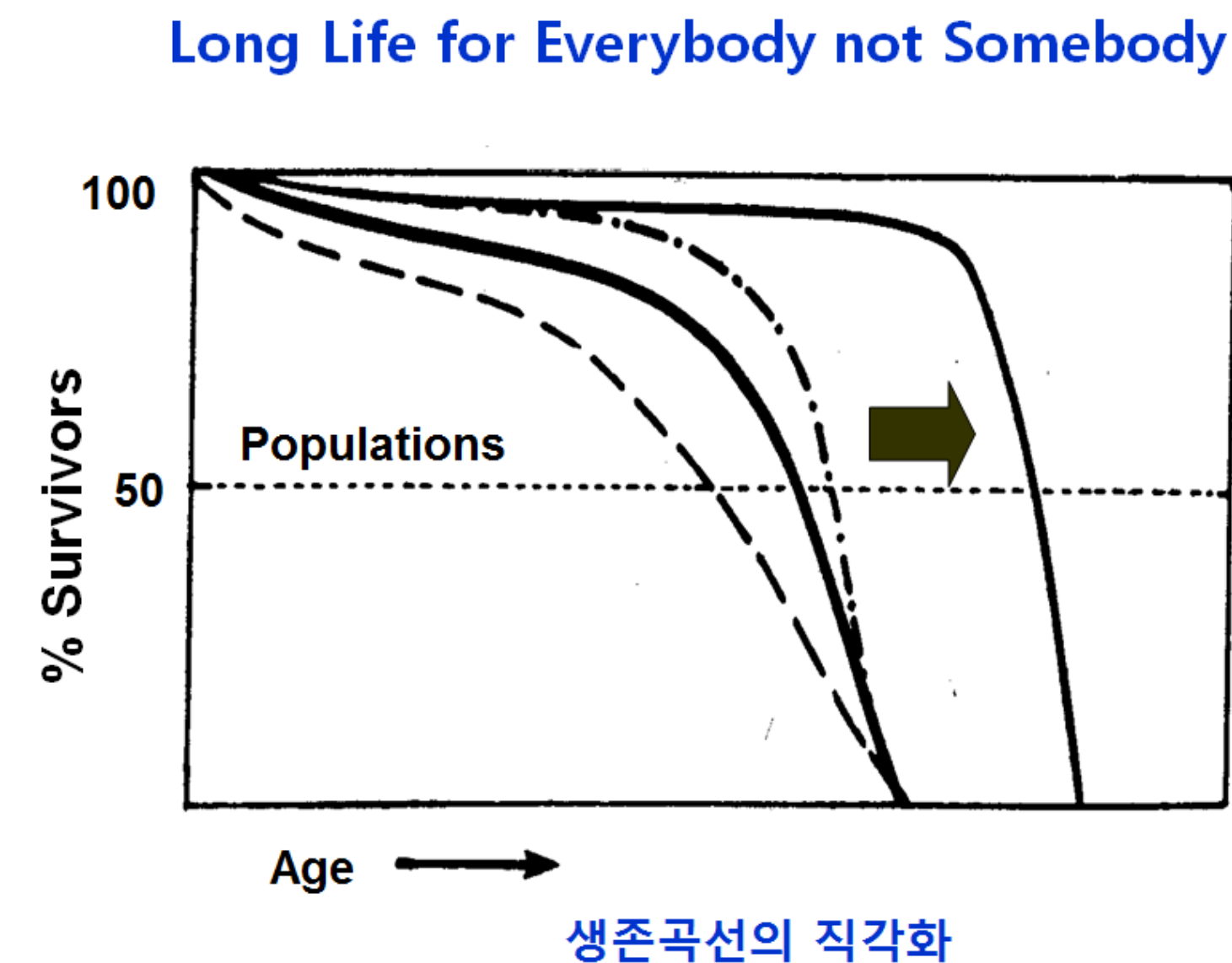
Why should I care?

- 컴퓨터가 스스로 사고 팔고를 결정 **– Algorithm Trading**

  → 주식 거래의 **70%**이상을 **SW**알고리즘으로 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.
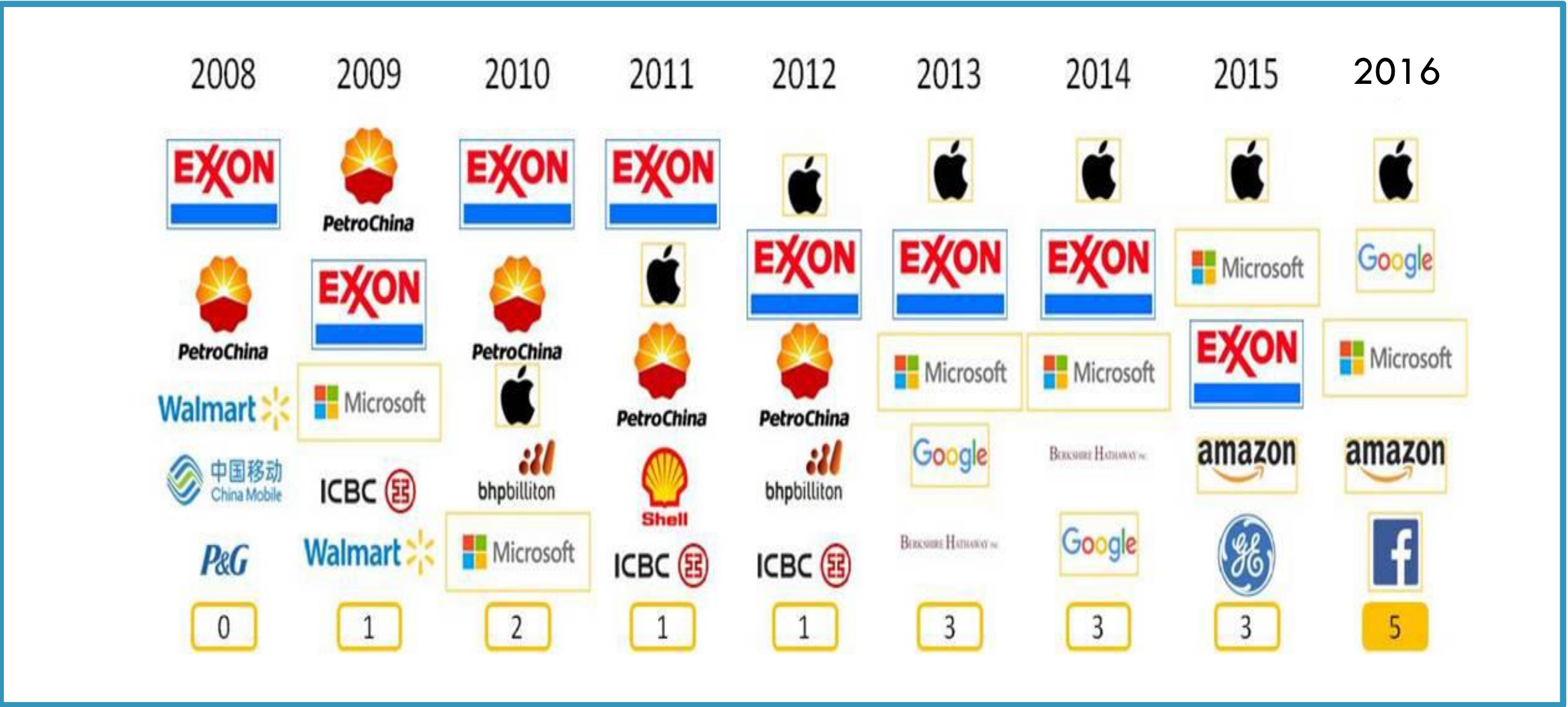
Why should I care?

20년 안에 사라질 직업들과 확률
(단위: %)

텔레마케터	회계사	소매점 계산원	속기사	부동산 중개인
99	94	92	89	86

단순제조업 종사자	파일럿 (상업비행기)	이코노미스트	배우	소방관
65	55	43	37	17

자료: 이코노미스트지

Why should I care?

10년 전에 존재하지 않았던 현재의 유망 직업

앱 개발자	드론 조종사	소셜 미디어 관리자	클라우드 컴퓨팅 스페셜리스트	우버 택시 운전자
지속 가능성 관리자	무인자동차 엔지니어	유튜브 콘텐츠 크리에이터	빅데이터 애널리스트 데이터 사이언티스트	밀레니얼 세대 전문가[1]

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!**