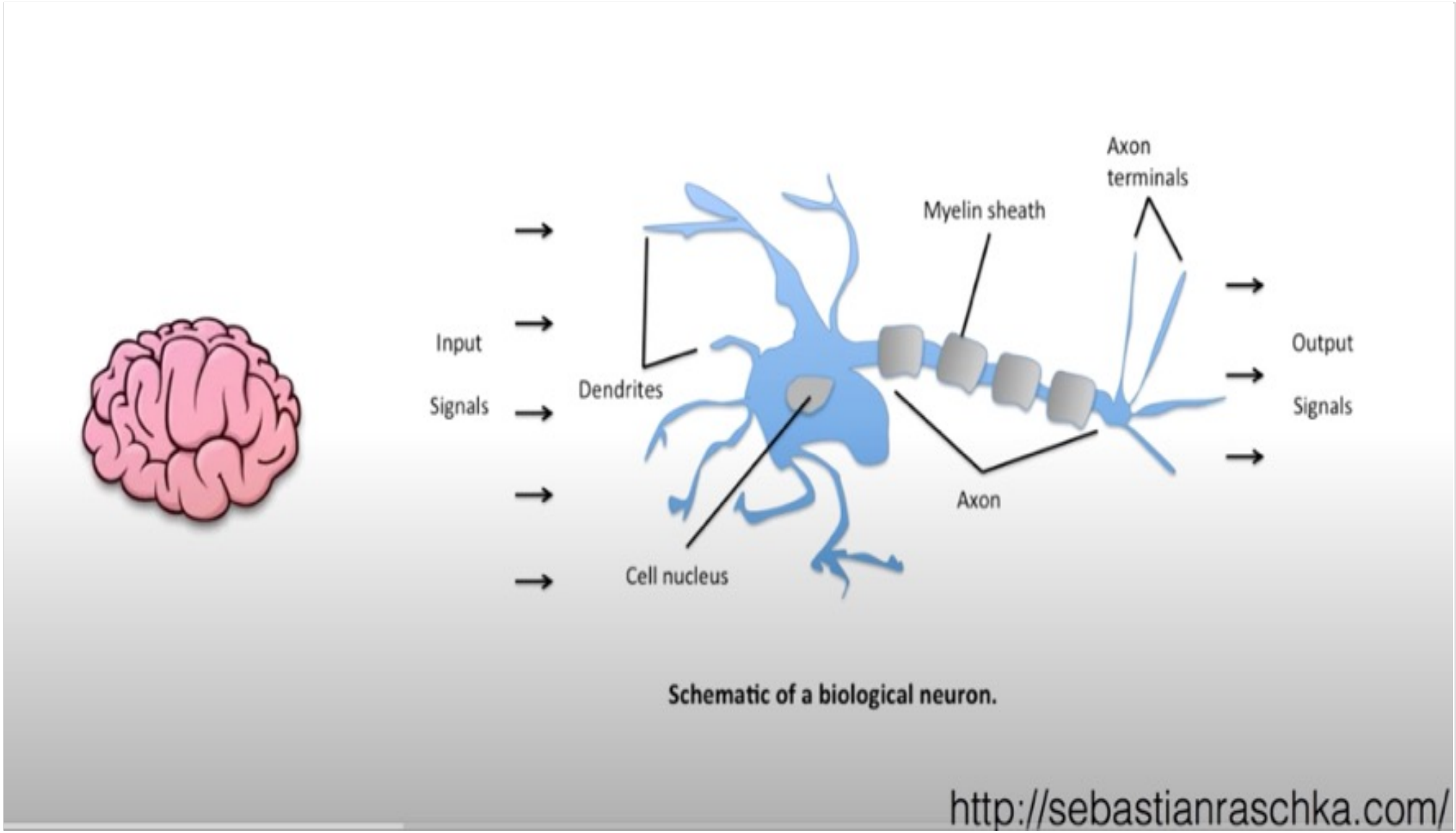
multicampus

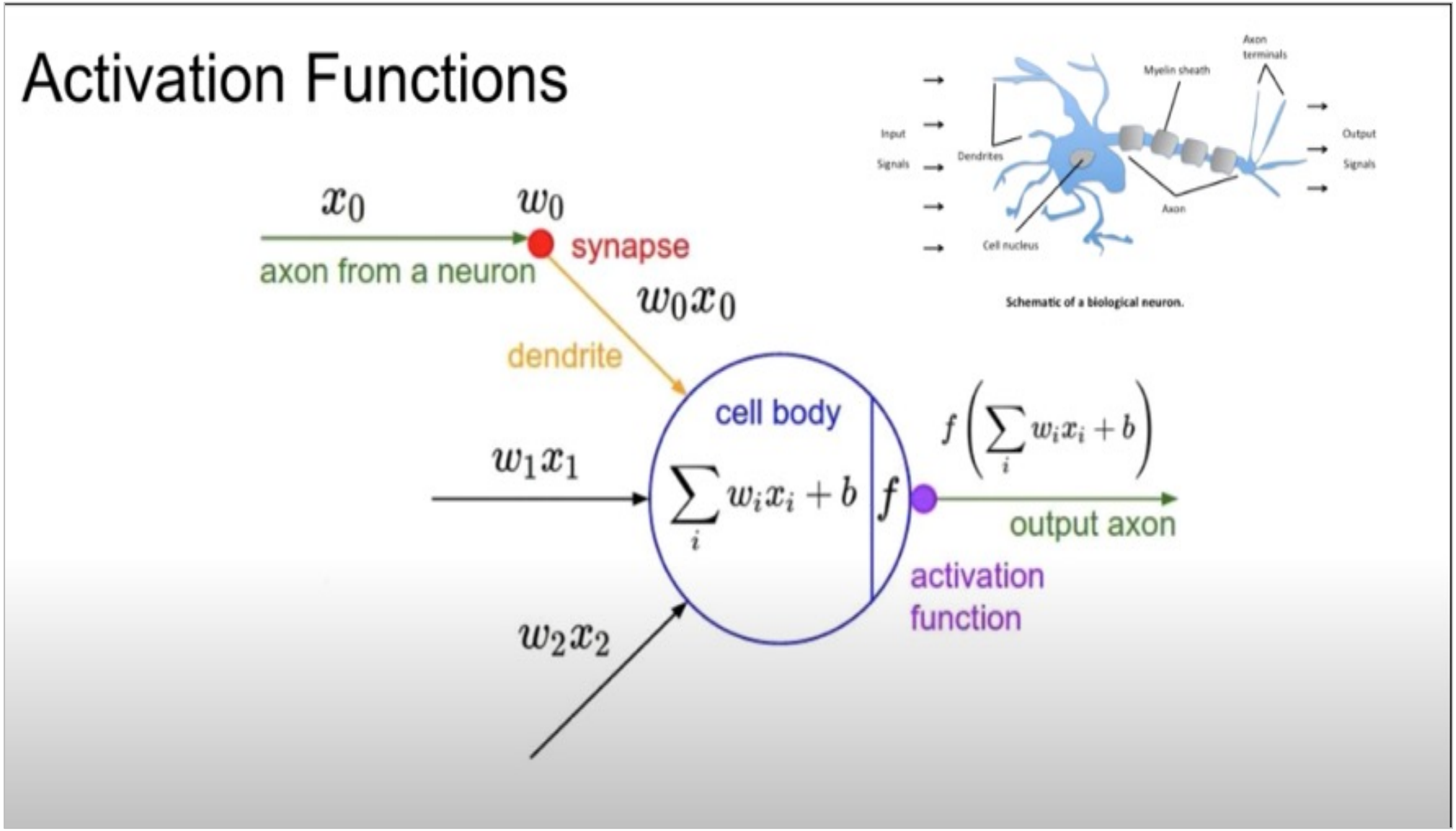

# 신경망의 역사
## (1950 ~ 2006)

Ultimate dream: thinking machine

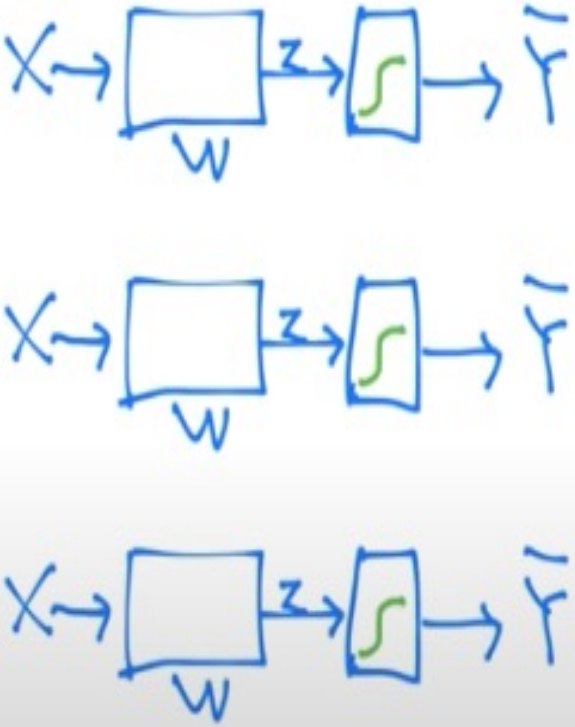
# Ultimate dream: thinking machine

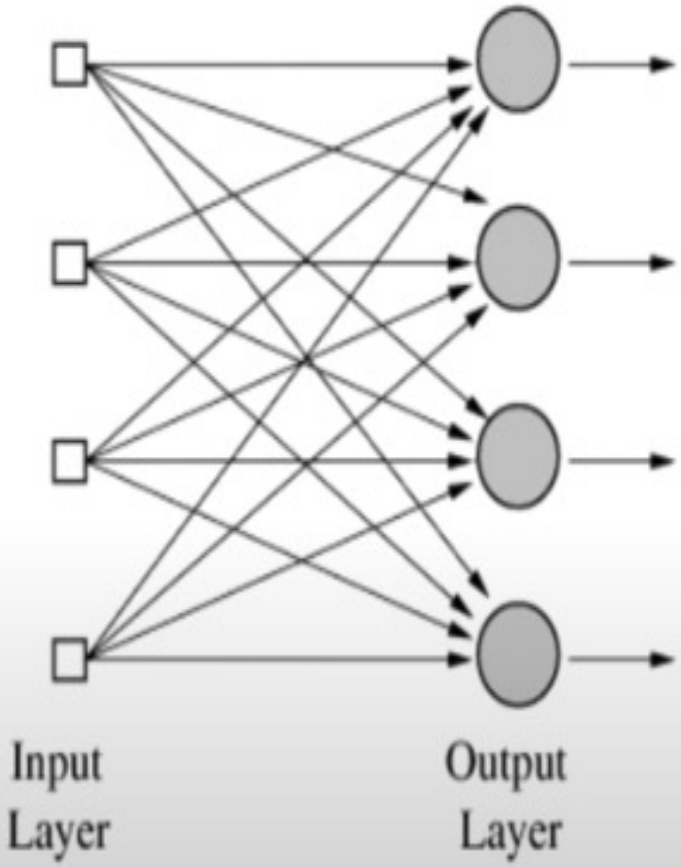


# 활성함수

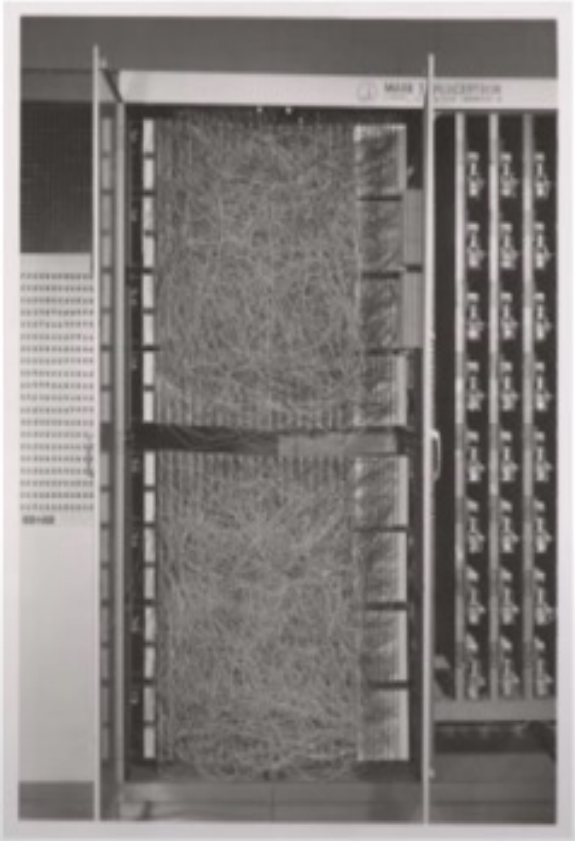

Activation Functions
$x_0$
$w_0$
synapse
axon from a neuron
$w_0x_0$
dendrite
cell body
$w_1x_1$
$\sum_i w_ix_i + b$
$f$
$f\left(\sum_i w_ix_i + b\right)$
output axon
activation function
$w_2x_2$
Axon terminals
Myelin sheath
Input Signals
Dendrites
Output Signals
Axon
Cell nucleus
Schematic of a biological neuron.

# Logistic regression units

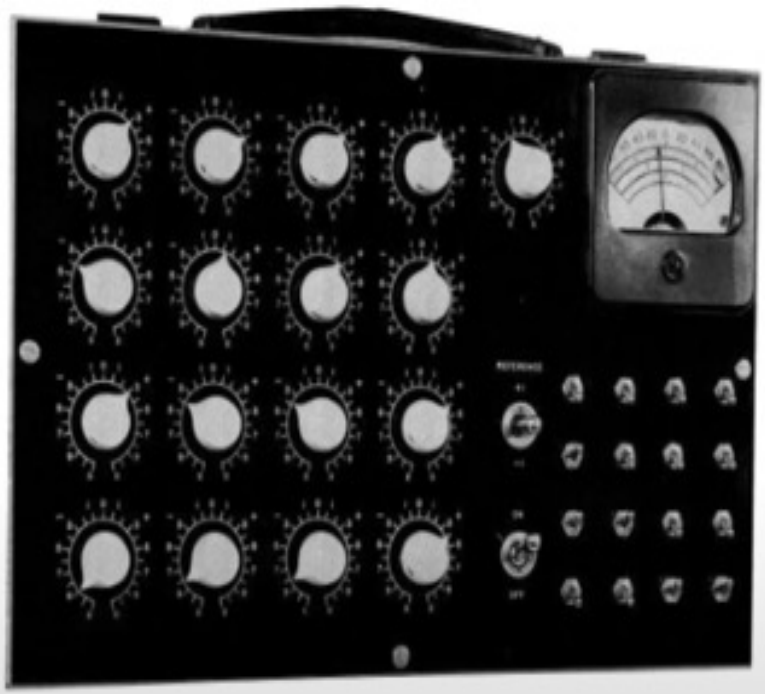


# Hardware implementations



*Frank Rosenblatt, ~1957: Perceptron*

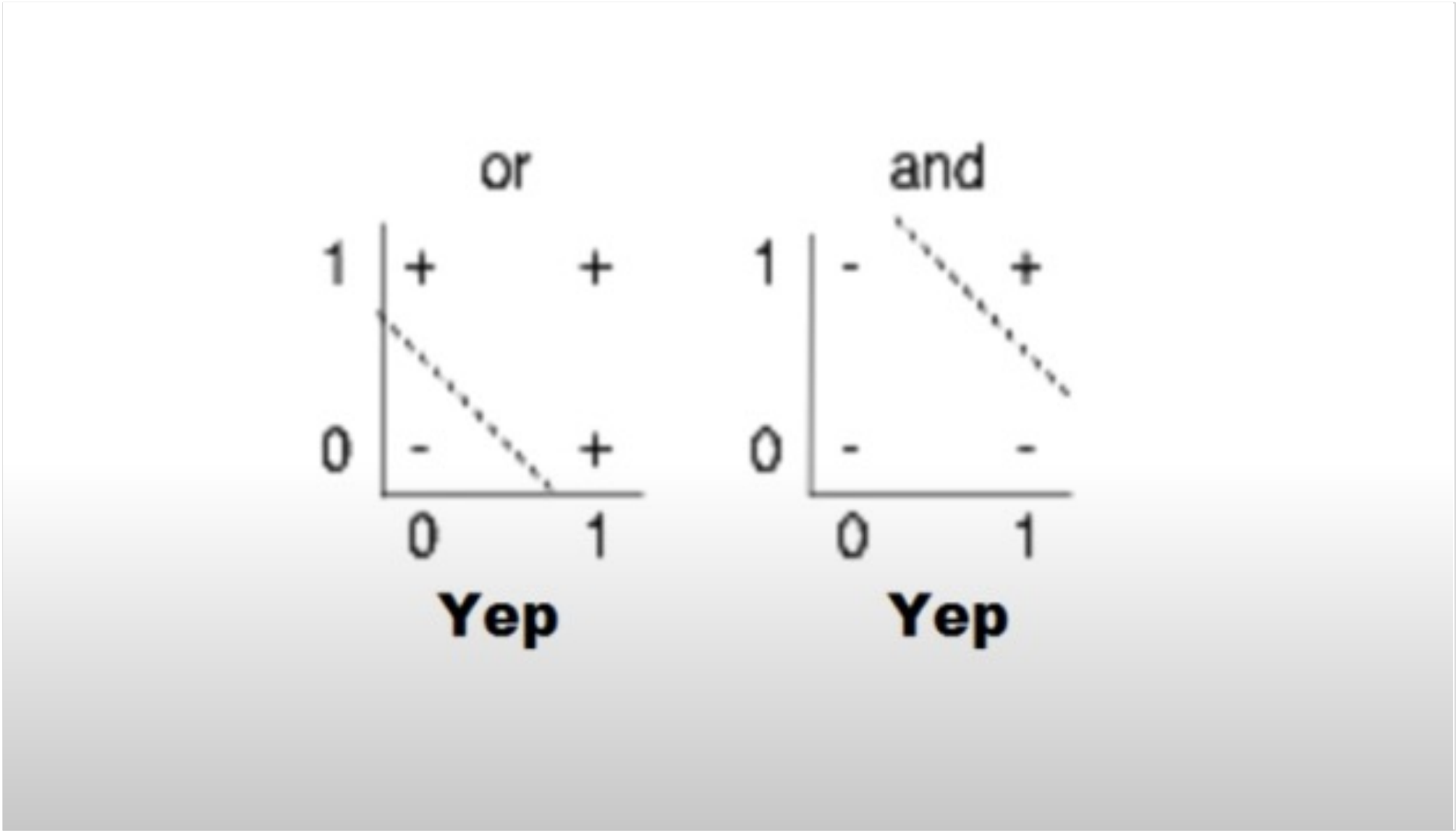


*Widrow and Hoff, ~1960: Adaline/Madaline*

# False Promises

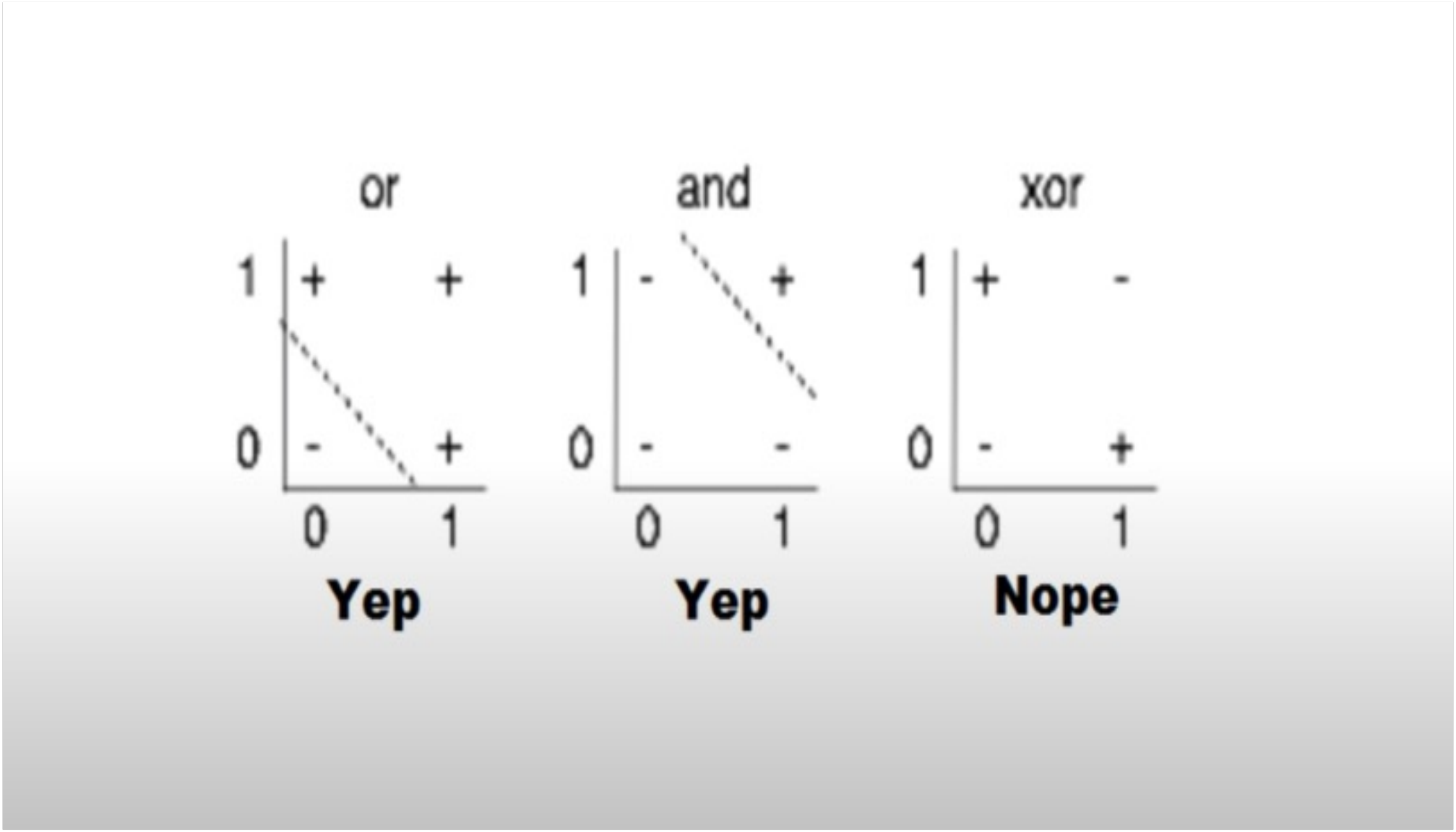
"The Navy revealed the embryo of an electronic computer today that *it expects will be able to walk, talk, see, write, reproduce itself* an be conscious of its existence … Dr. Frank Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers" The New York Times July 08, 1958

(Simple) AND/OR problem: linearly separable?

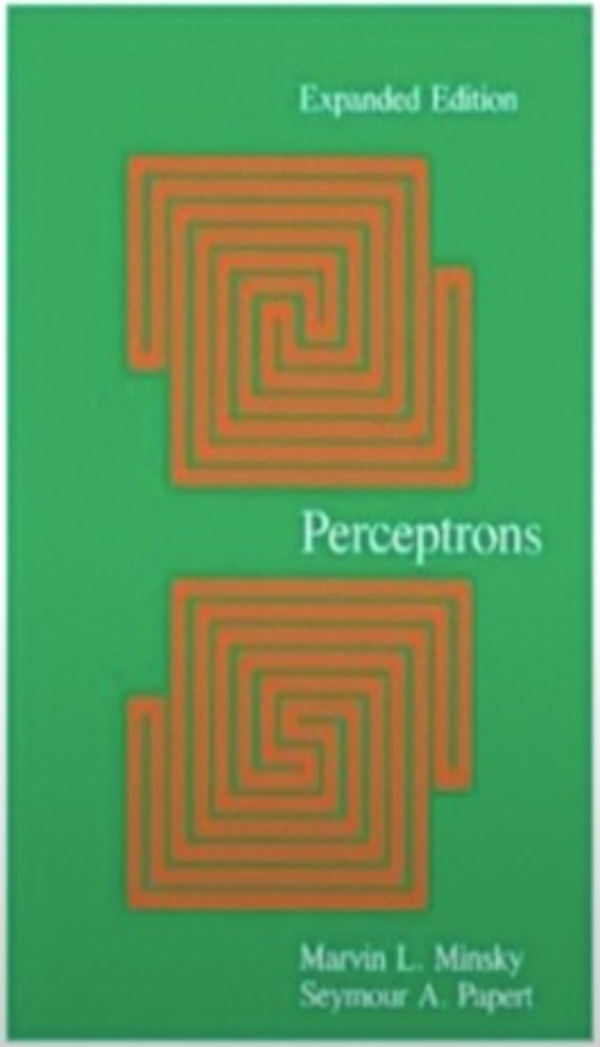



Go back in time
1950s

(Simple) XOR problem: linearly separable?



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

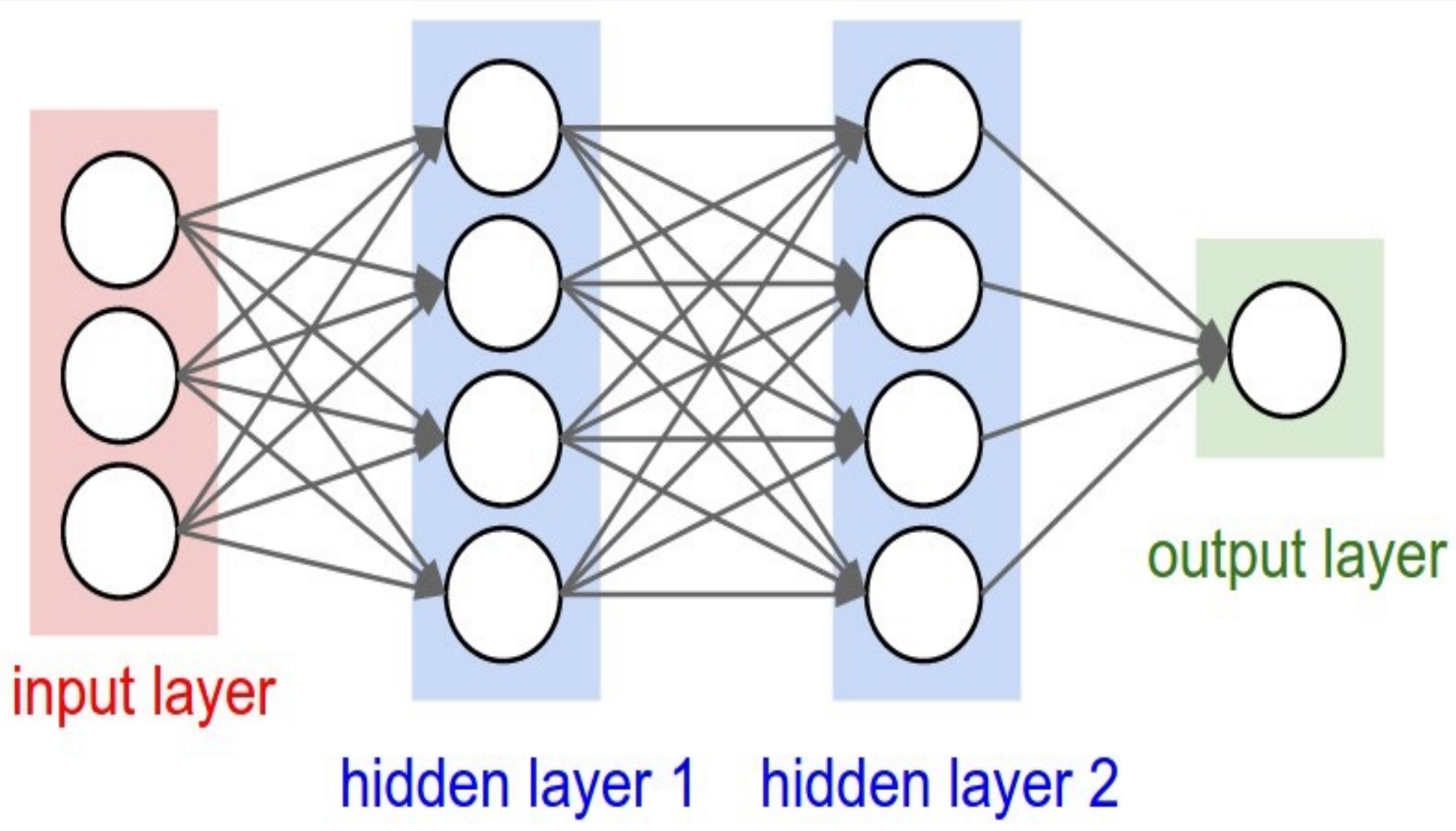



- We need to use MLP, multilayer perceptrons (multilayer neural nets)
- No one on earth had found a viable way to train MLPs good enough to learn such simple functions.

결국 XOR 문제를 풀었는데?

# 문제는?

”No one on earth had found a viable way to train"



그래서

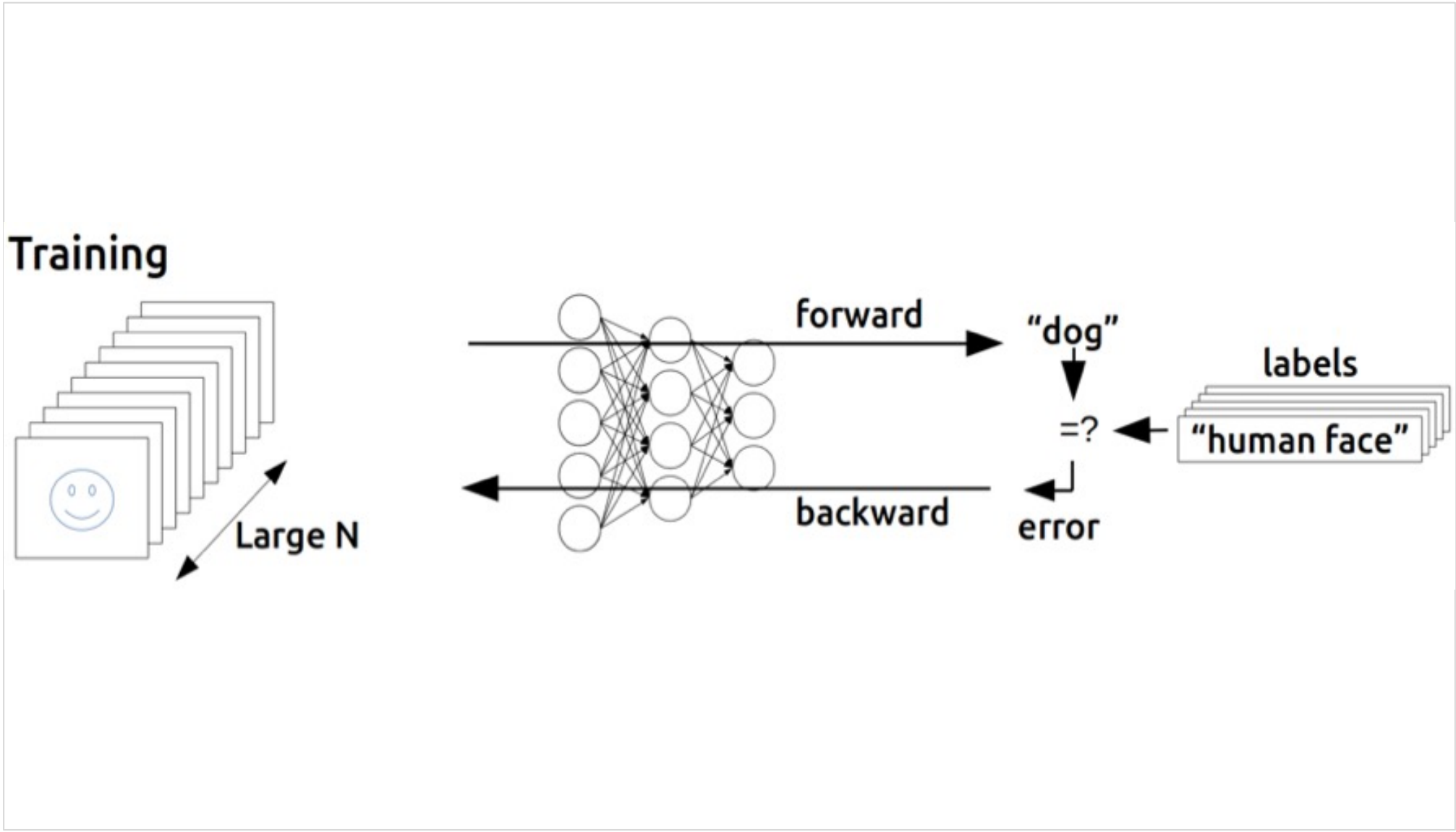
# Back Propagation

*1974, 1982 Backpropagation by Paul Werbos*

*1986 by Hinton*

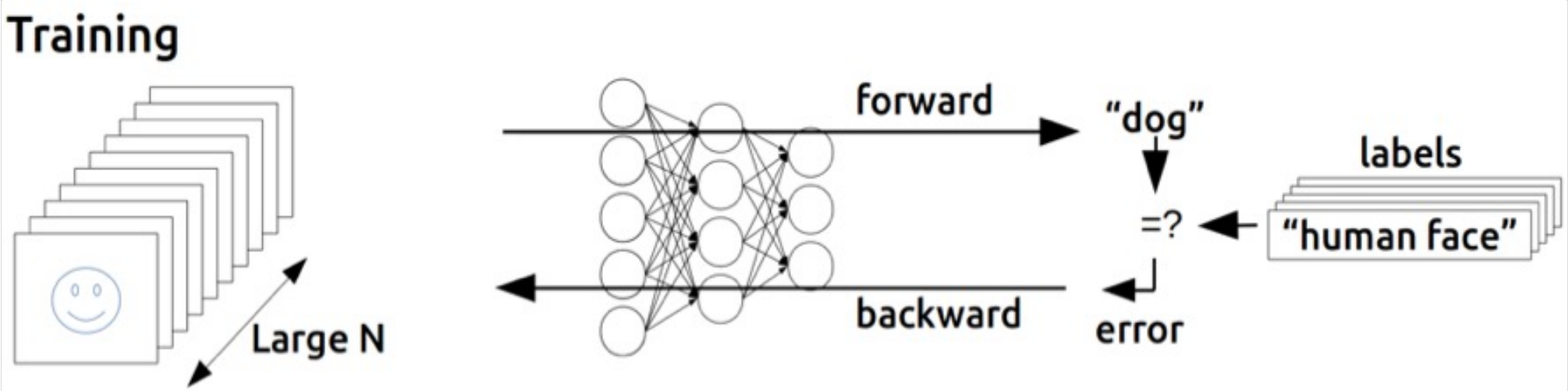

Go back in time
1980s

# Backpropagation



# Back propagation

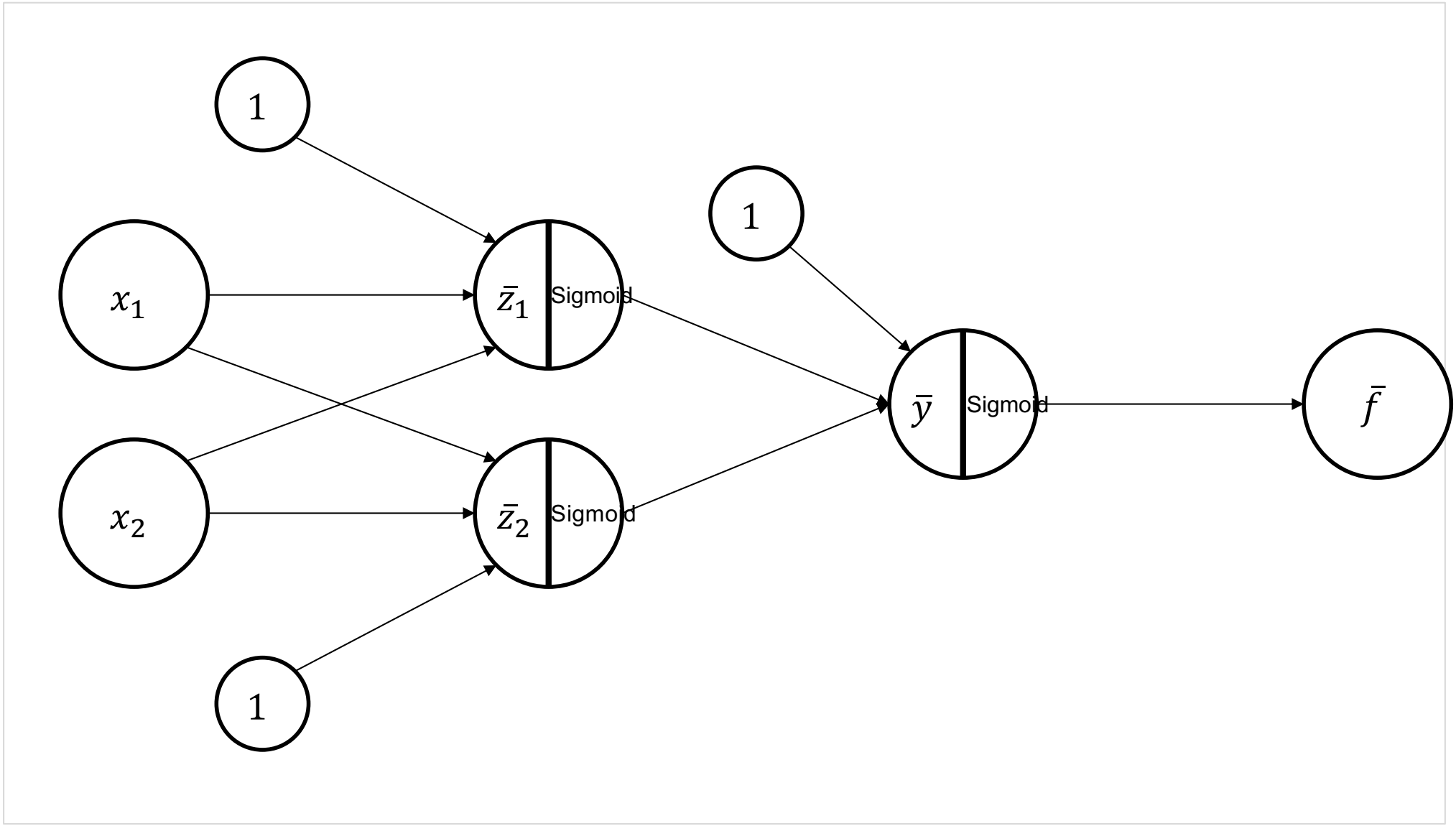
- How can we learn W1, W2, B1, B2 from training data?



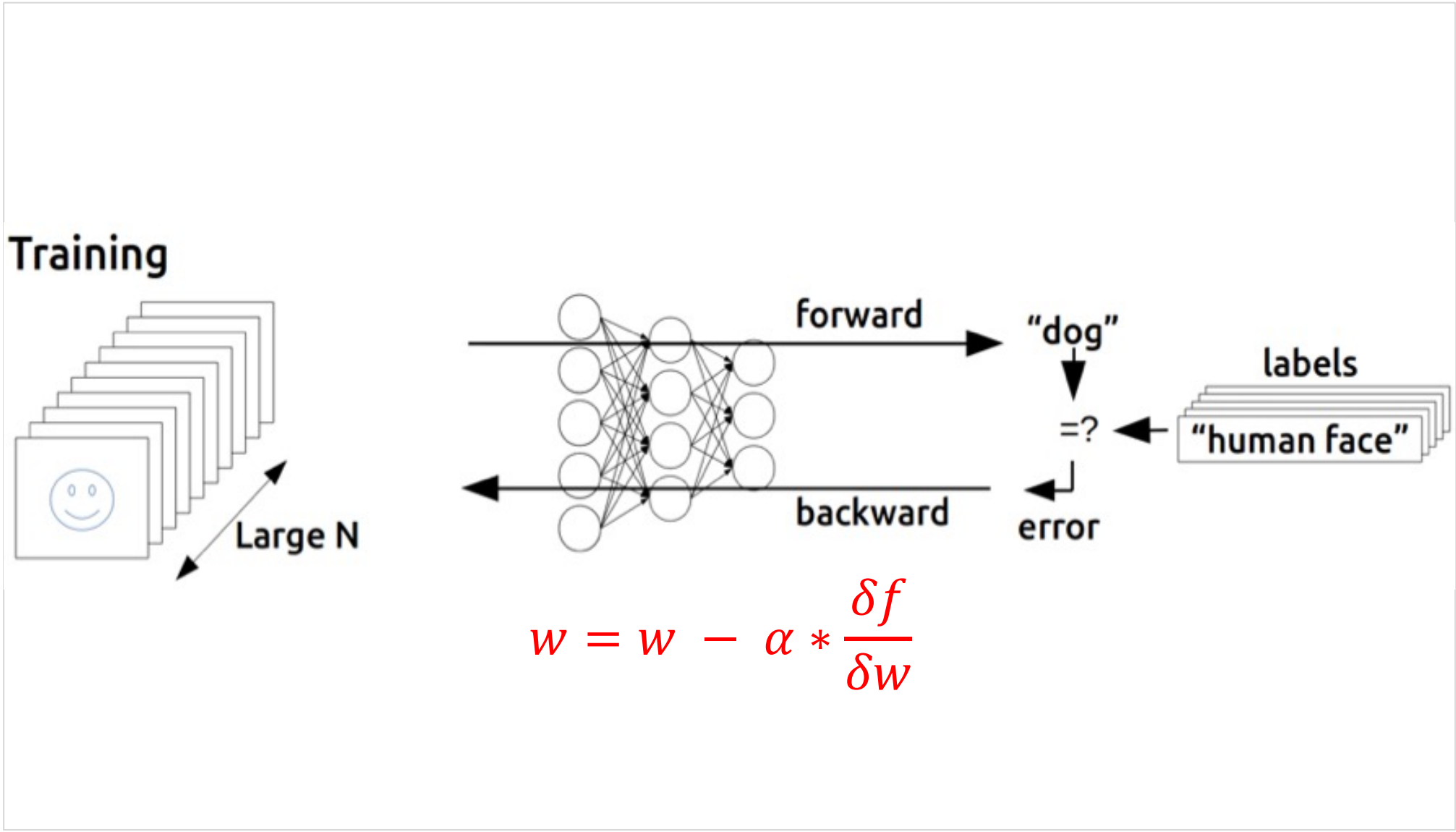
# Basic derivative

- $\frac{df(x)}{dx} = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}$
- $f(x) = 3$
  - $\frac{df(x)}{dx} = 0$
- $f(x) = x$
  - $\frac{df(x)}{dx} = 1$
- $f(x) = 2x$
  - $\frac{df(x)}{dx} = 2$
- $f(x) = x + 3$
  - $\frac{df(x)}{dx} = 1$
- $f(x, y) = xy$
  - $\frac{df(x,y)}{dx} = y$
- $f(x, y) = x + y$
  - $\frac{df(x,y)}{dy} = x$

# Back propagation



”No one on earth had found a viable way to train"




$$w = w - \alpha * \frac{\delta f}{\delta w}$$

터미네이터 2 (1991) 영화

# Terminator 2 (1991)


JOHN: Can you learn? So you can be... you know. More human. Not such a dork all the time.

**TERMINATOR:** My CPU is a neural-net processor... a learning computer. But **Skynet** presets the switch to "read-only" when we are sent out alone.

...

We'll learn how to **set** the neural net

**TERMINATOR** Basically. (starting the engine, backing out) The **Skynet** funding bill is passed. The system goes on-line August 4th, 1997. Human decisions are removed from strategic defense. **Skynet** begins to learn, at a geometric rate. It becomes **self-aware** at 2:14 a.m. eastern time, August 29. In a panic, they try to pull the plug.

SARAH: And **Skynet** fights back.

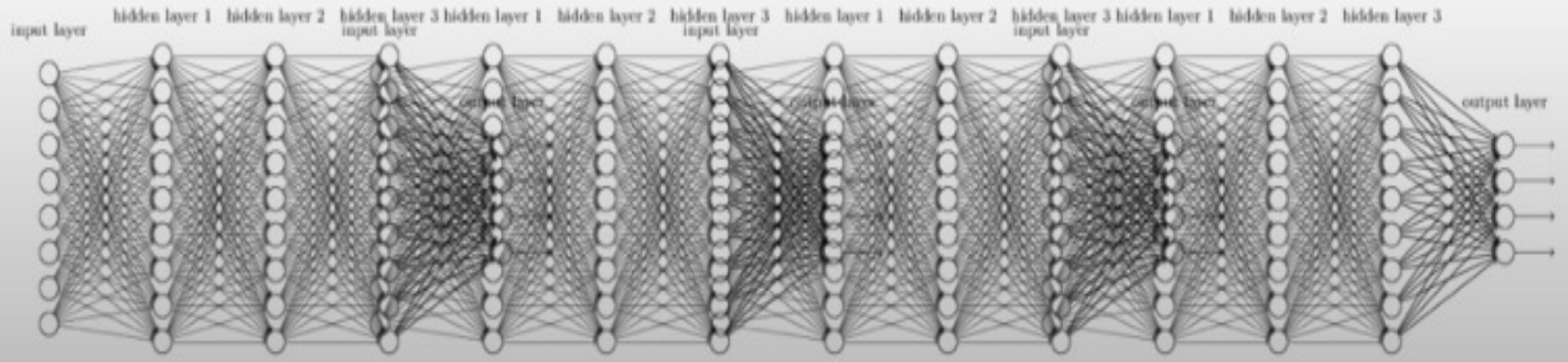
**TERMINATOR:** Yes. It launches its ICBMs against their targets in Russia.

SARAH: Why attack Russia?

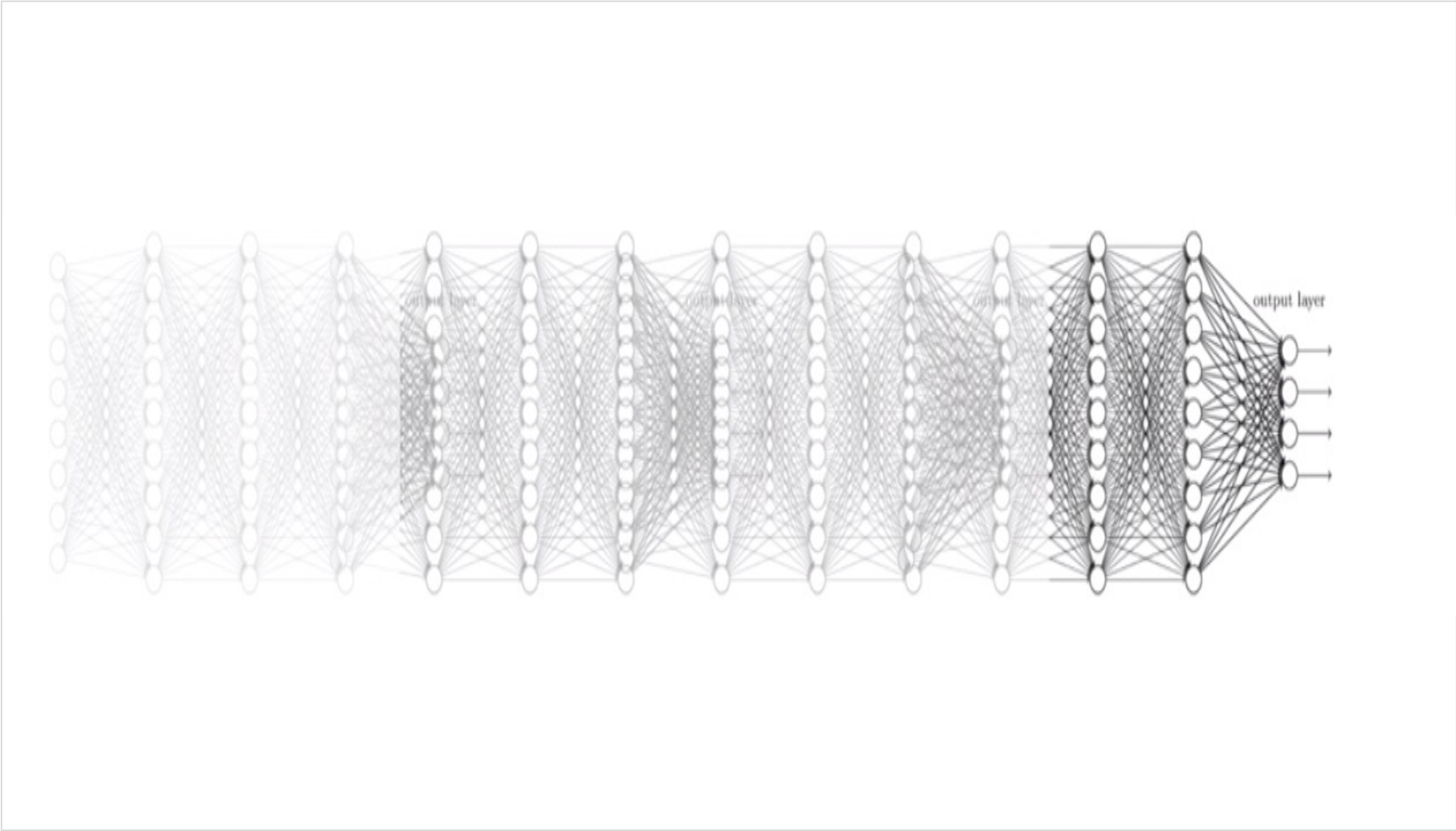
**TERMINATOR:** Because **Skynet** knows the Russian counter-strike will remove its enemies here.

# 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



# Vanishing gradient (NN winter2: 1986-2006)



# CIFAR

- CIFAR encourages basic research without direct application, was what motivated Hinton to move to Canada in 19 87, and funded his work afterward.

CIFAR
CANADIAN INSTITUTE FOR ADVANCED RESEARCH

# "Everyone else was doing something different"

- *"It was the worst possible time," says Bengio, a professor at the Universite de Montreal and co-director of the CIFAR probram since it was renewed last year. "Everyone else was doing somet hing different. Somehow, Geoff convinced them."*
- *"We should give (CIFAF) a lot of credit for making that gamble."*
- *CIFAR "had a huge impact in forming a community around deep learning," adds LeCun*