AI and Deep Learning

Artificial Intelligence and Brain

Jeju National University

Yung-Cheol Byun

Materials are here:

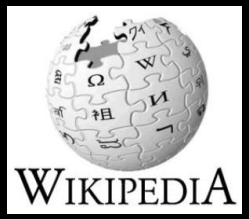
https://github.com/yungbyun/uae

git clone *link*

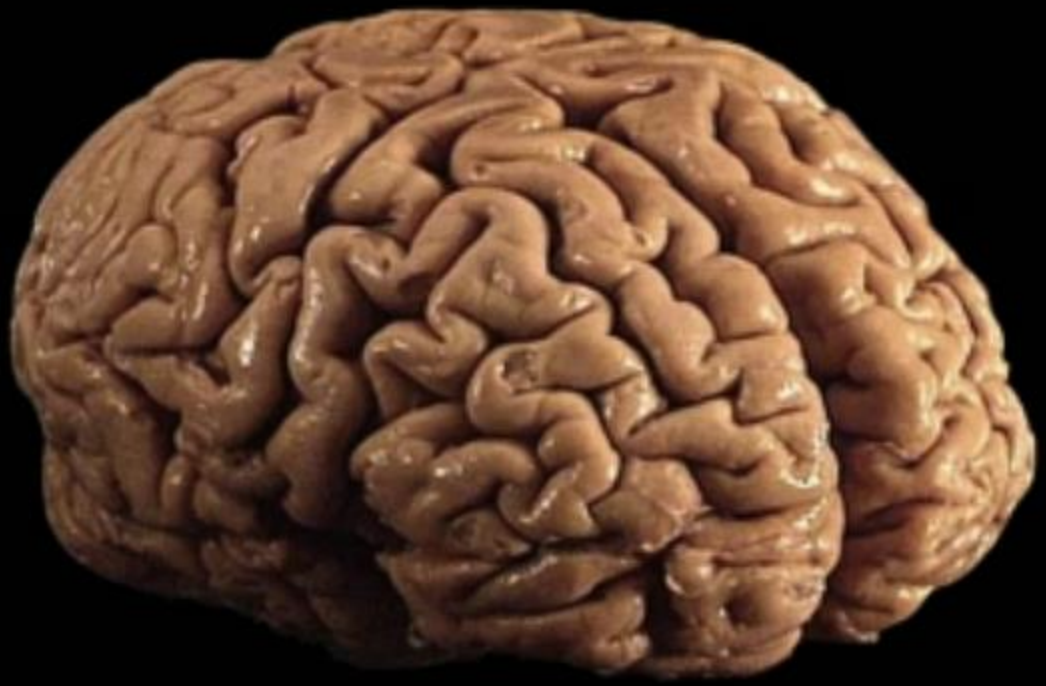
Agenda

- Artificial Intelligence
- Brain and Neuron
- Synapse: the connection between neurons
- Learning and Synapse

Intelligence



- One's capability for logic, understanding, self-awareness, learning, planning, creativity, and problem solving
- The ability to perceive information, and to retain it as knowledge to be applied towards adaptive behaviors within an environment
- Human Intelligence = Natural Intelligence



Aritificial Intelligence

- Intelligence exhibited by machines
- A computerized version of the human intelligence
- Theory and development of computer systems able to perform tasks such as visual perception, voice recognition, decision-making, and translation between languages

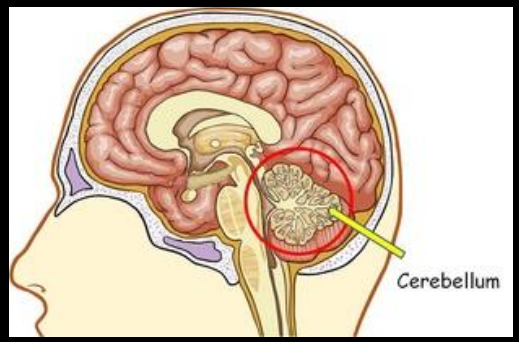
How can machines get AI?

What happens inside the human brain?

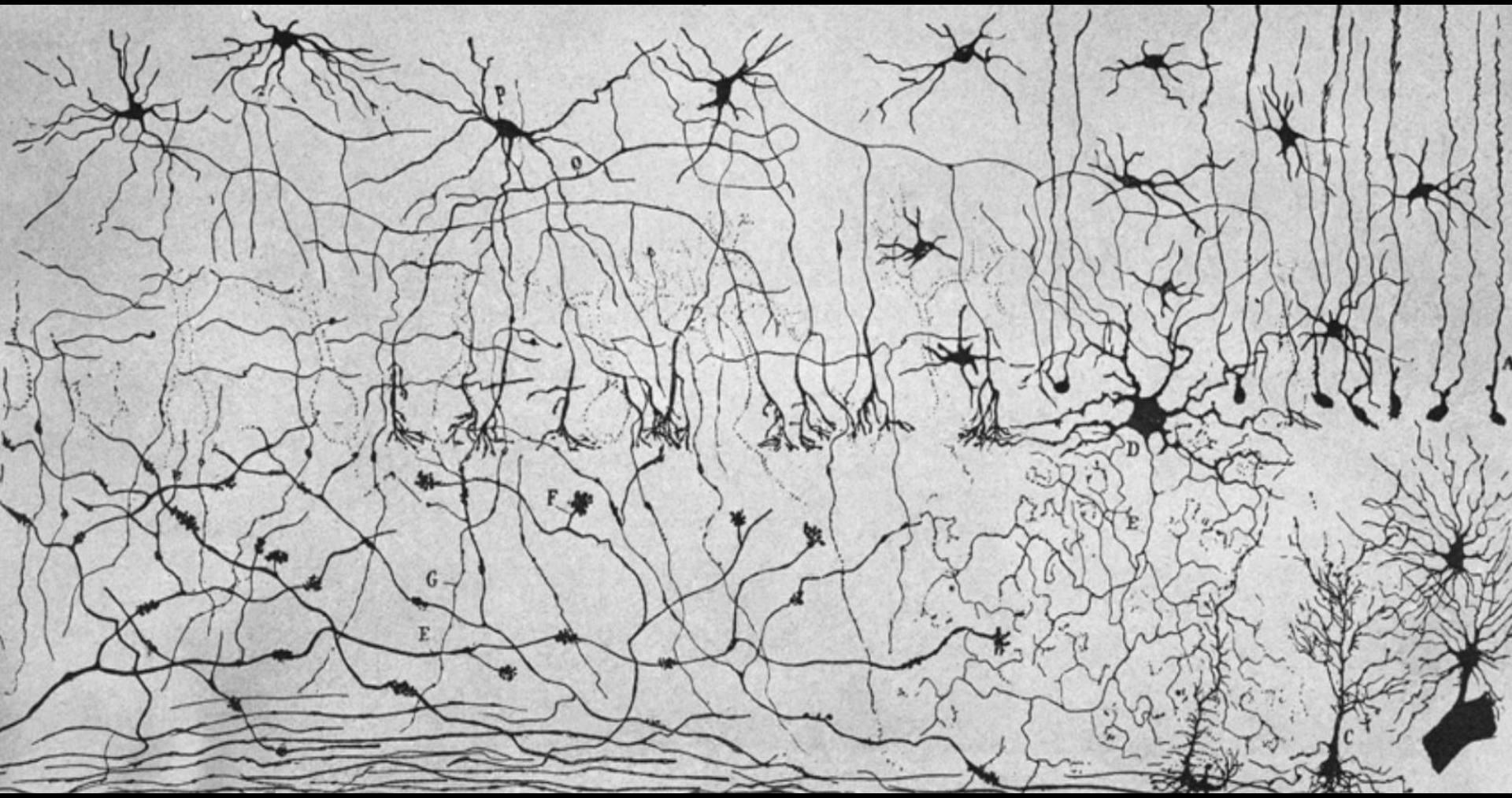
Neuroanatomist

Santiago Ramón y Cajal, 1852-1934

Cerebellum(소뇌) : controls muscles



Neurons in a bird's brain



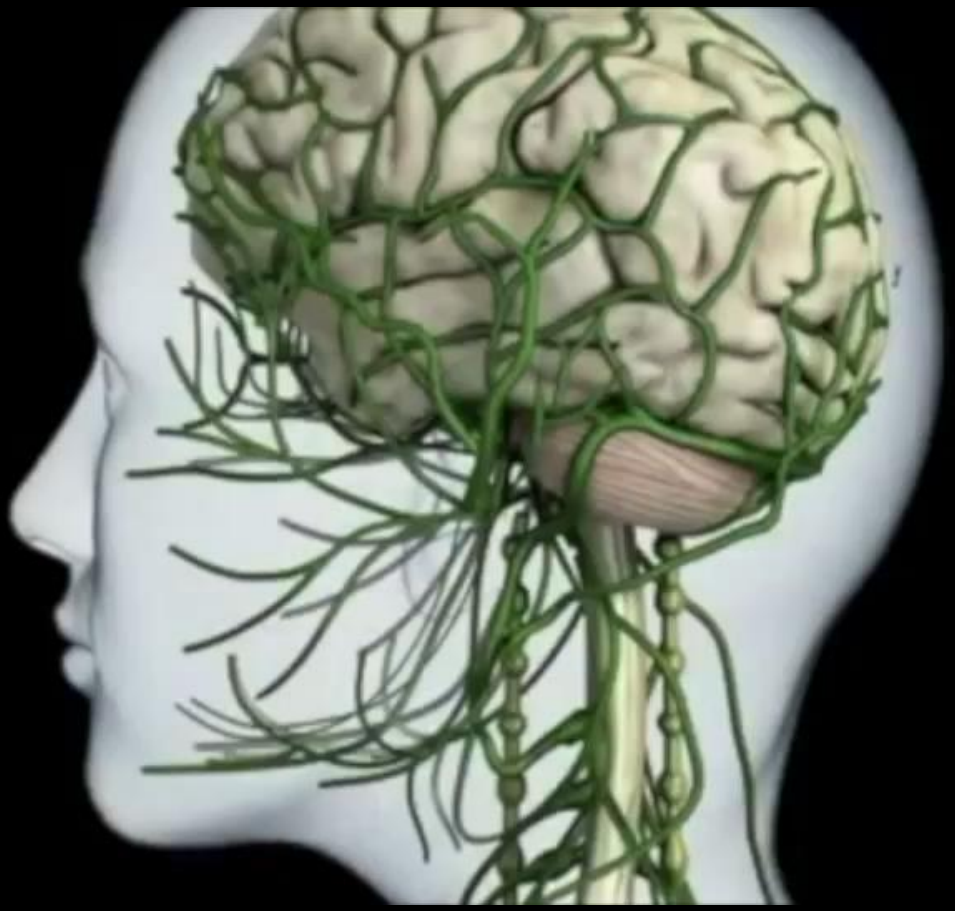
Ramón y Cajal's drawing of the neurons in a bird's cerebellum – a part of the brain.

Brain of Human


1
2
3
6
5

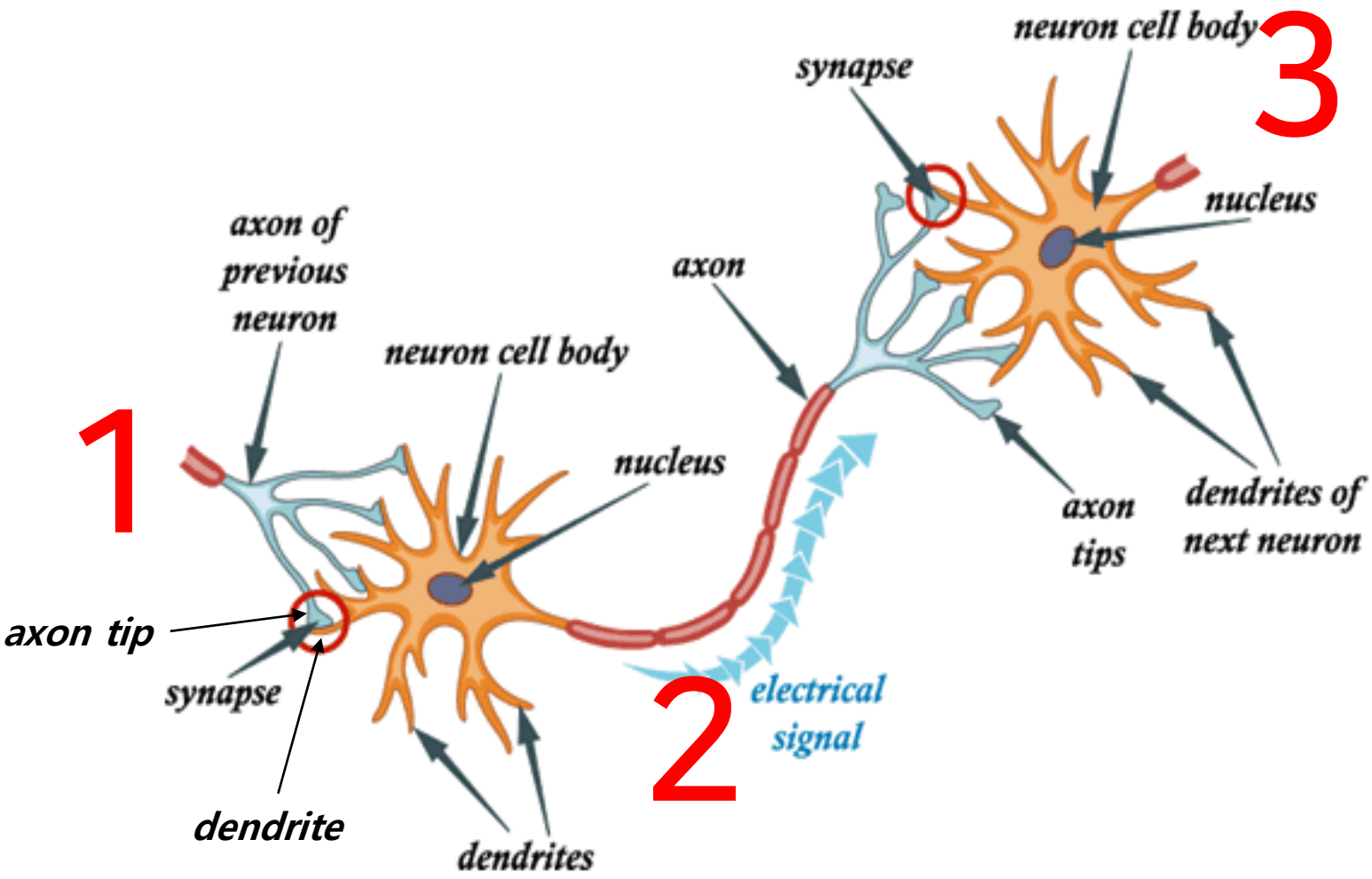
100 billion neurons
more than
the number of stars
in the universe

So, what happens inside?

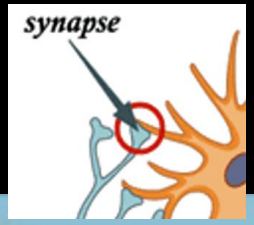


From a DVD that comes with the illustrated medical atlas, The Human Brain, DK Publishing UK.

Connection between neurons

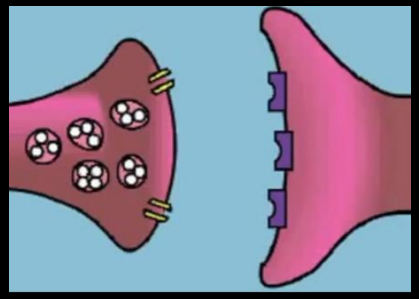


Synapse

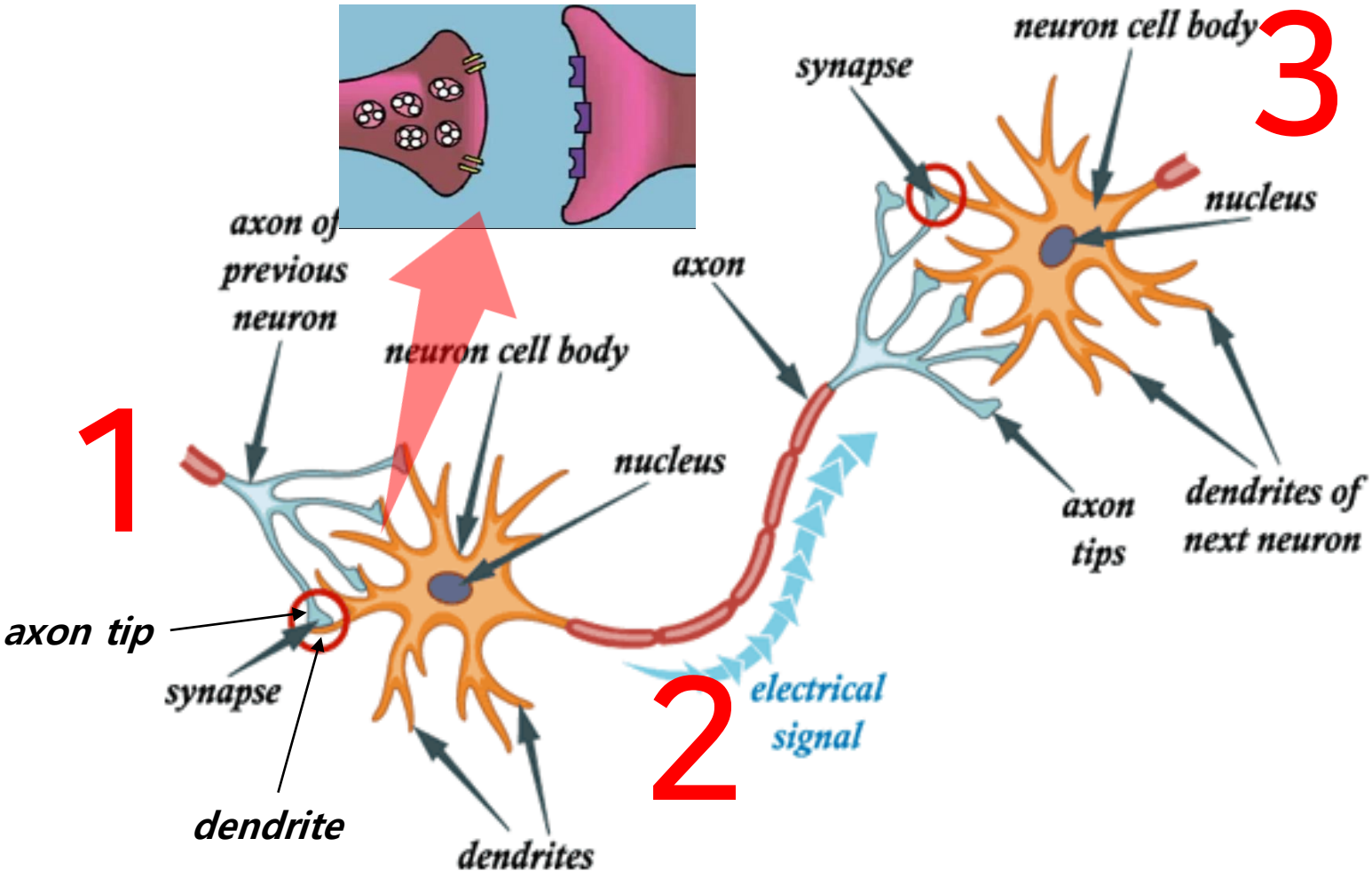


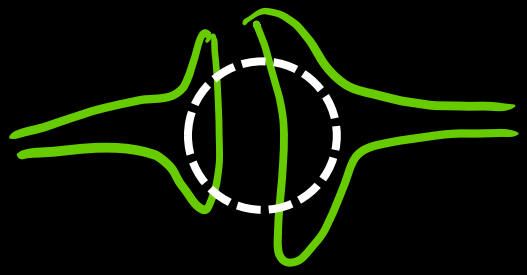
Neurotransmitter in synapse

Various amount of neurotransmitter in each synapse

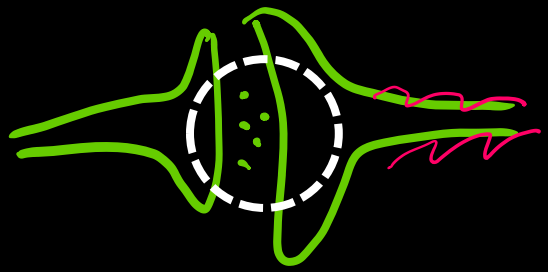


Connection between neurons

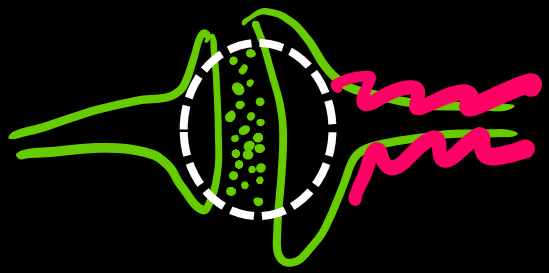




No neurotransmitter and no signal to the nucleus



Small amount and week signal to the nucleus



Strong connection and strong signal to the nucleus

Our memory, thinking, moving, emotion, and everything

Alzheimer's, Paralysis

Simulation(signaling)

A brain in a supercomputer | Henry Markram

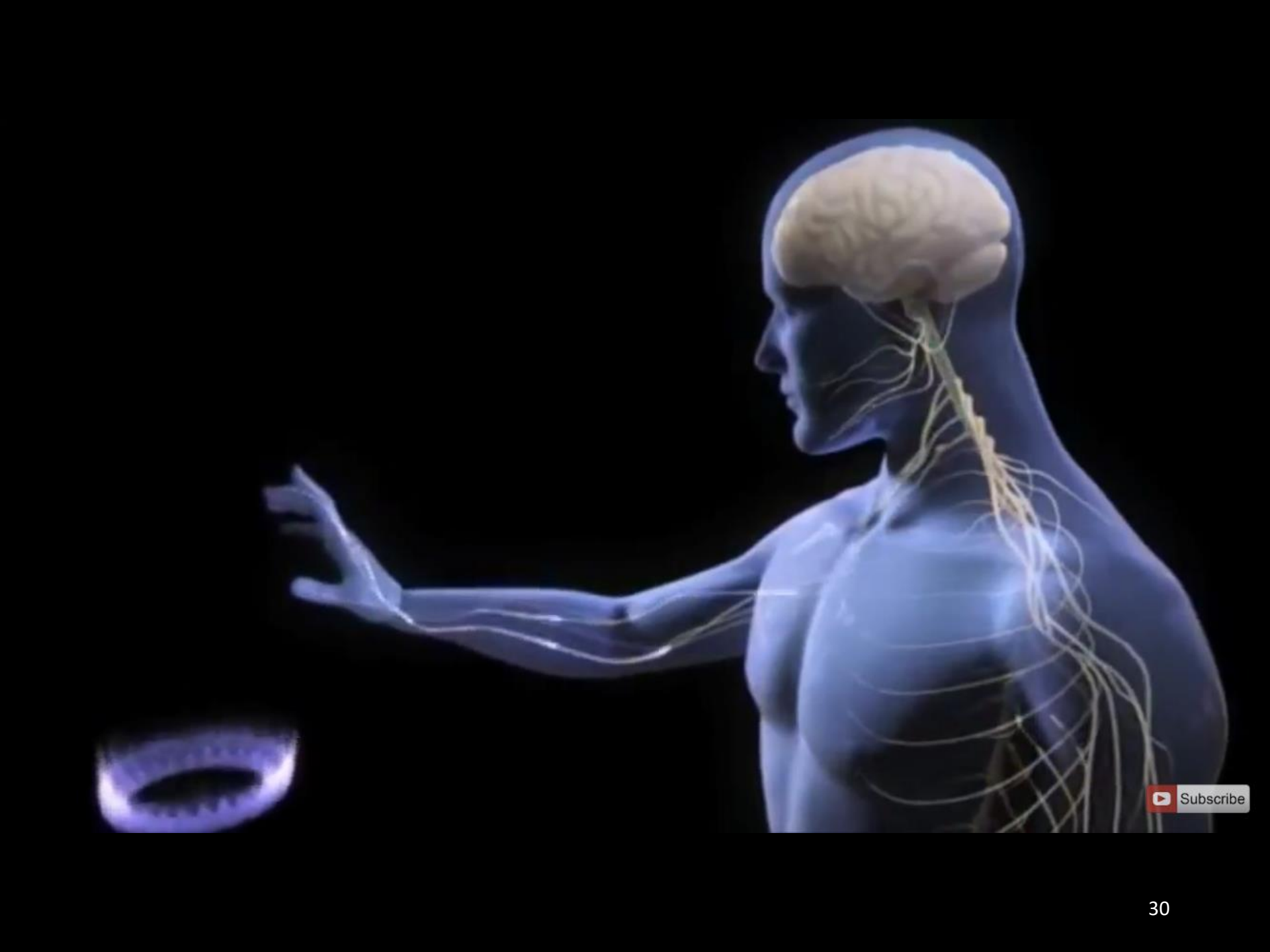
A neuron
has a so simple function,

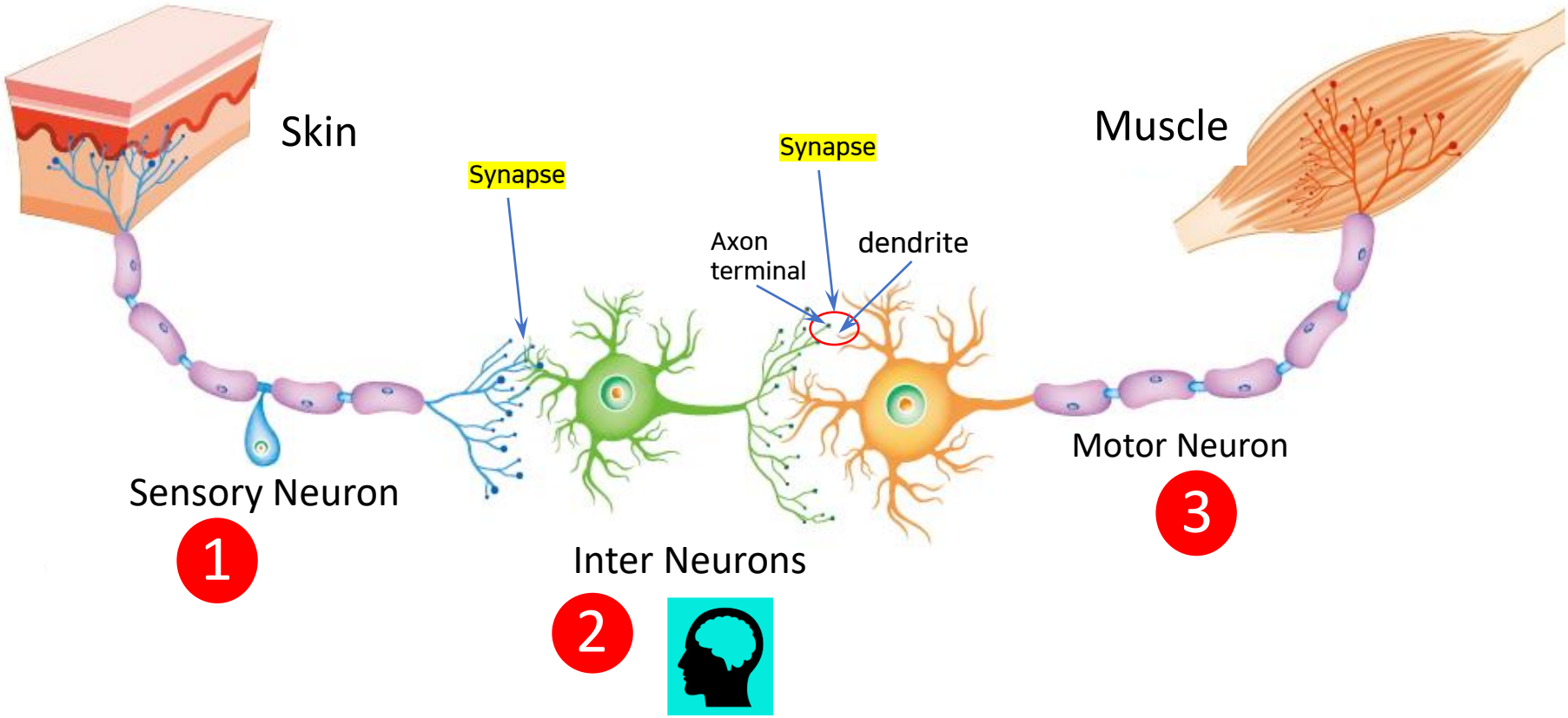
ON or OFF
(two states)

but huge amounts of neurons & connections among them,

High-level functions from the connection

Everything we do is enabled by electrical signals running through our neural networks.


Subscribe

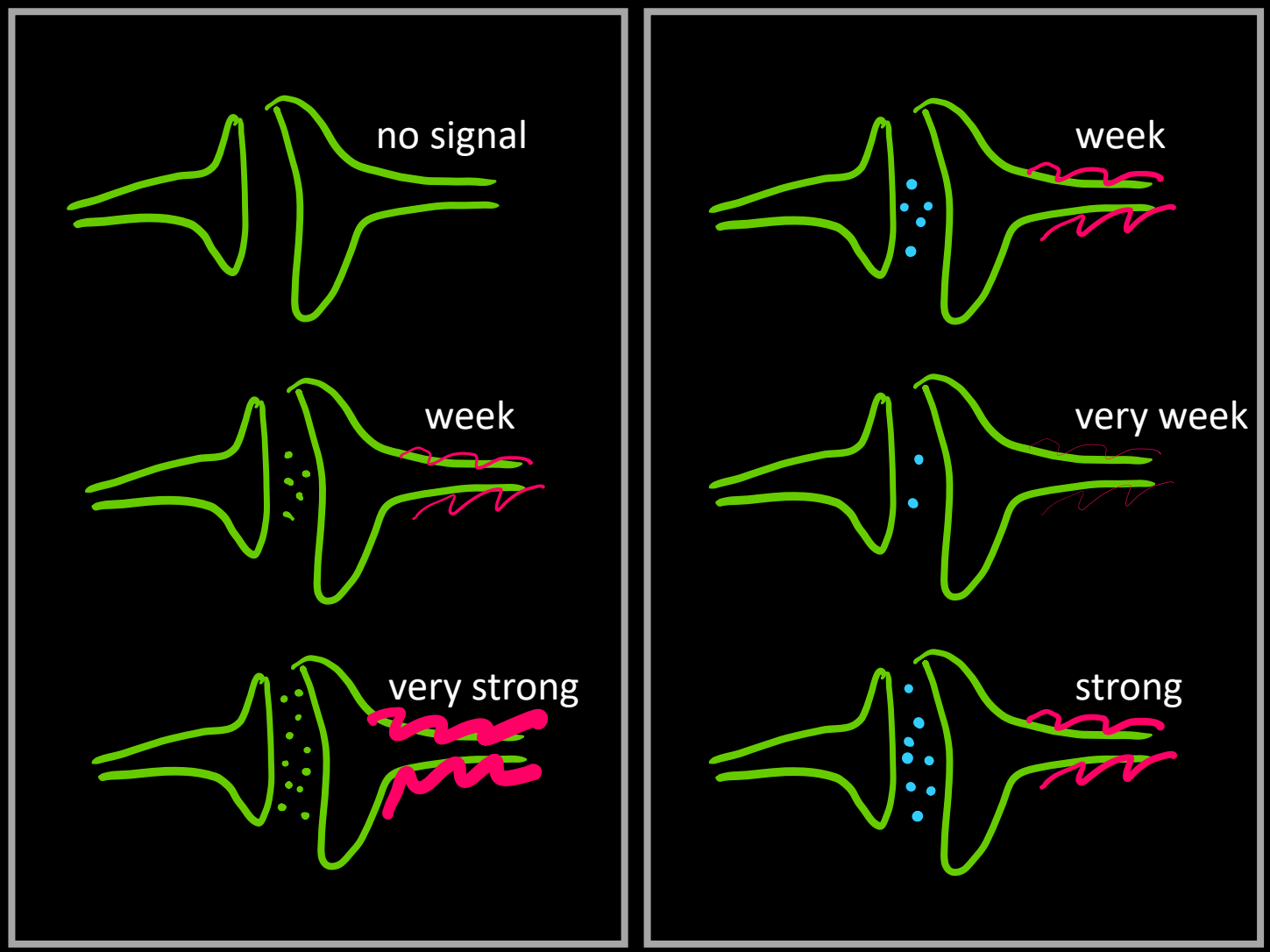

Skin
Synapse
Synapse
Muscle
Axon terminal
dendrite
Sensory Neuron
1
Inter Neurons
2
Motor Neuron
3

Is just the connection enough?

Huge amounts of neurons &
the initialized connections
among them

Updating connections

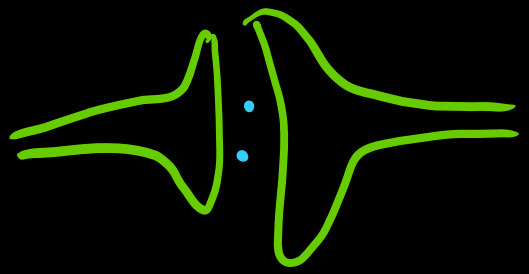
while experiencing


Old connection (yesterday)
New connection (today)
no signal
week
very strong
week
very week
strong


Happiness
Stress

“

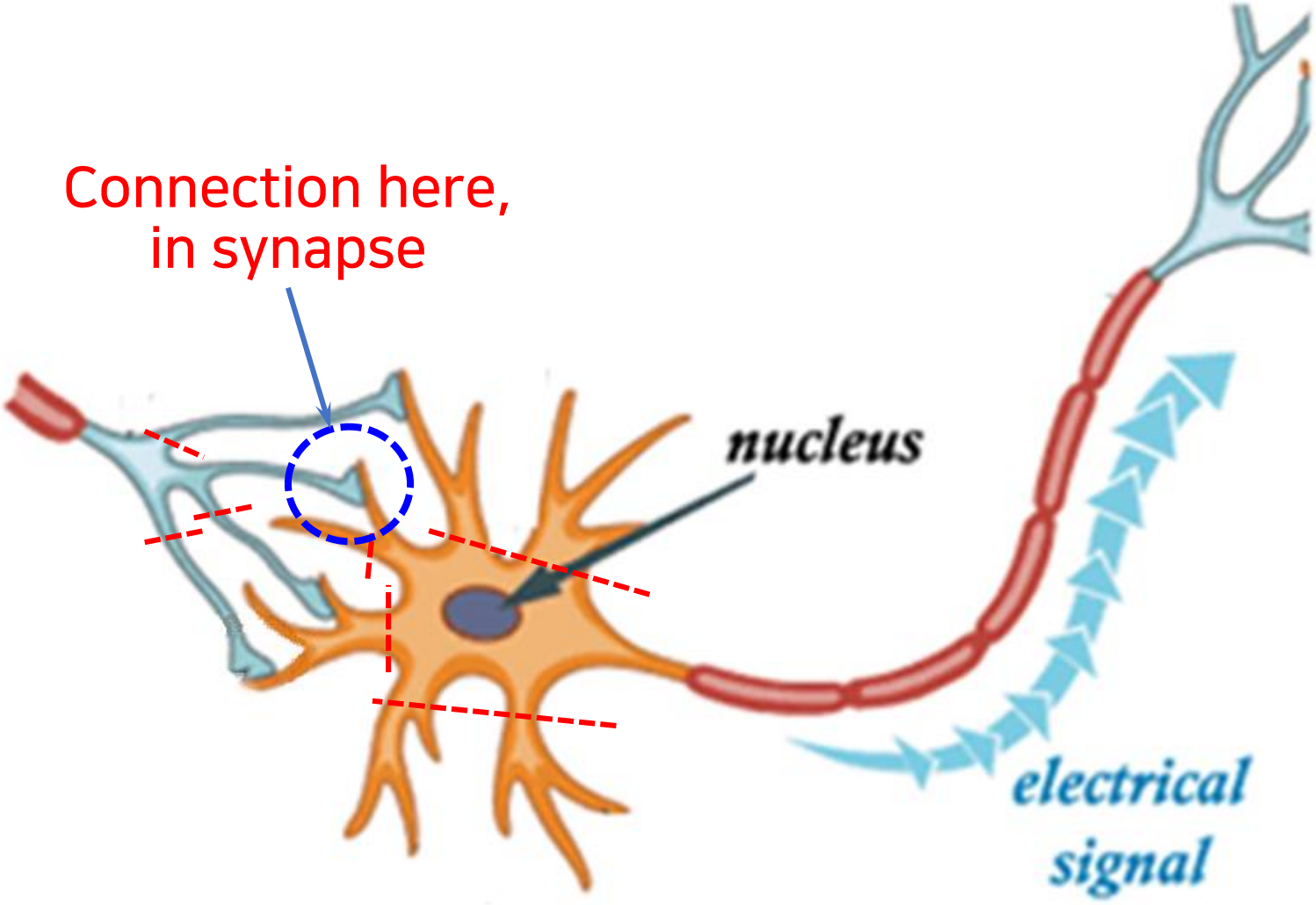
Learning



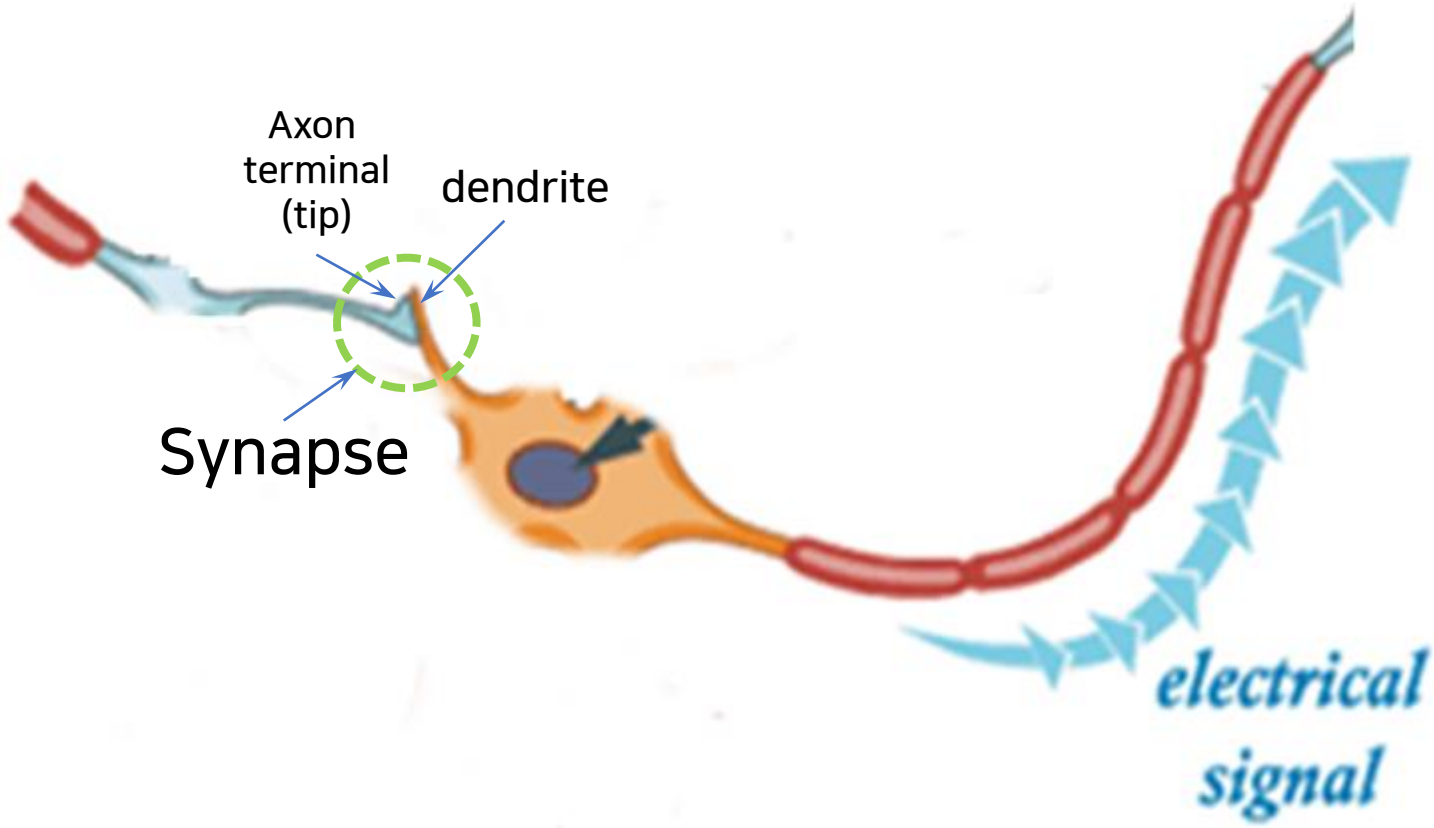
Adjusting the amount of neurotransmitter

S/W implementation
→Artificial Intelligence

The connections

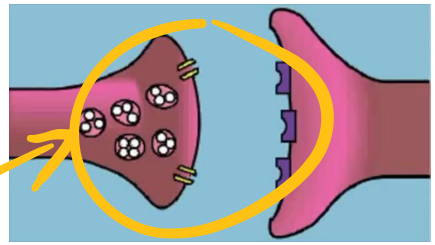


A Neuron with 1 Input



Action of a neuron

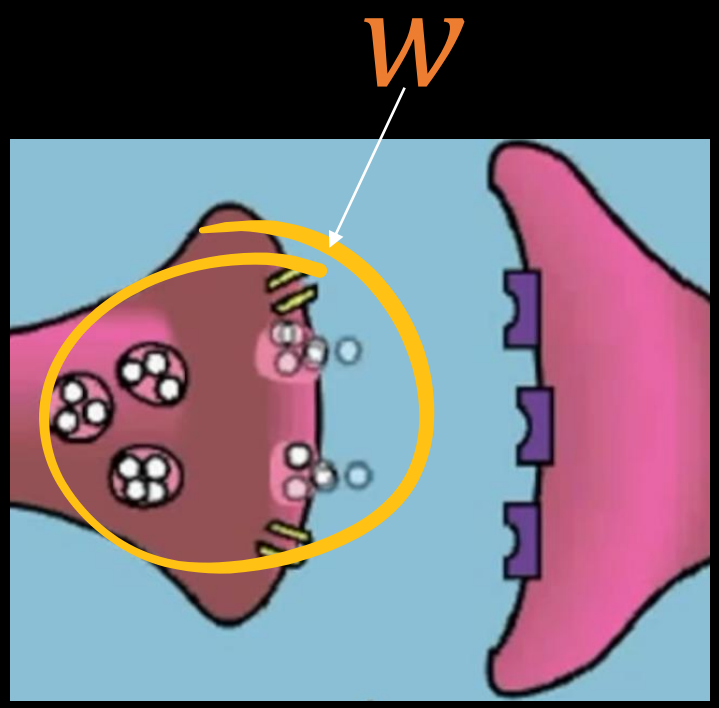
- The amount of neurotransmitter
- The strength of connection



$$h = wx$$

Strength of a connection (w)

Amount of neurotransmitter & the strength of a signal



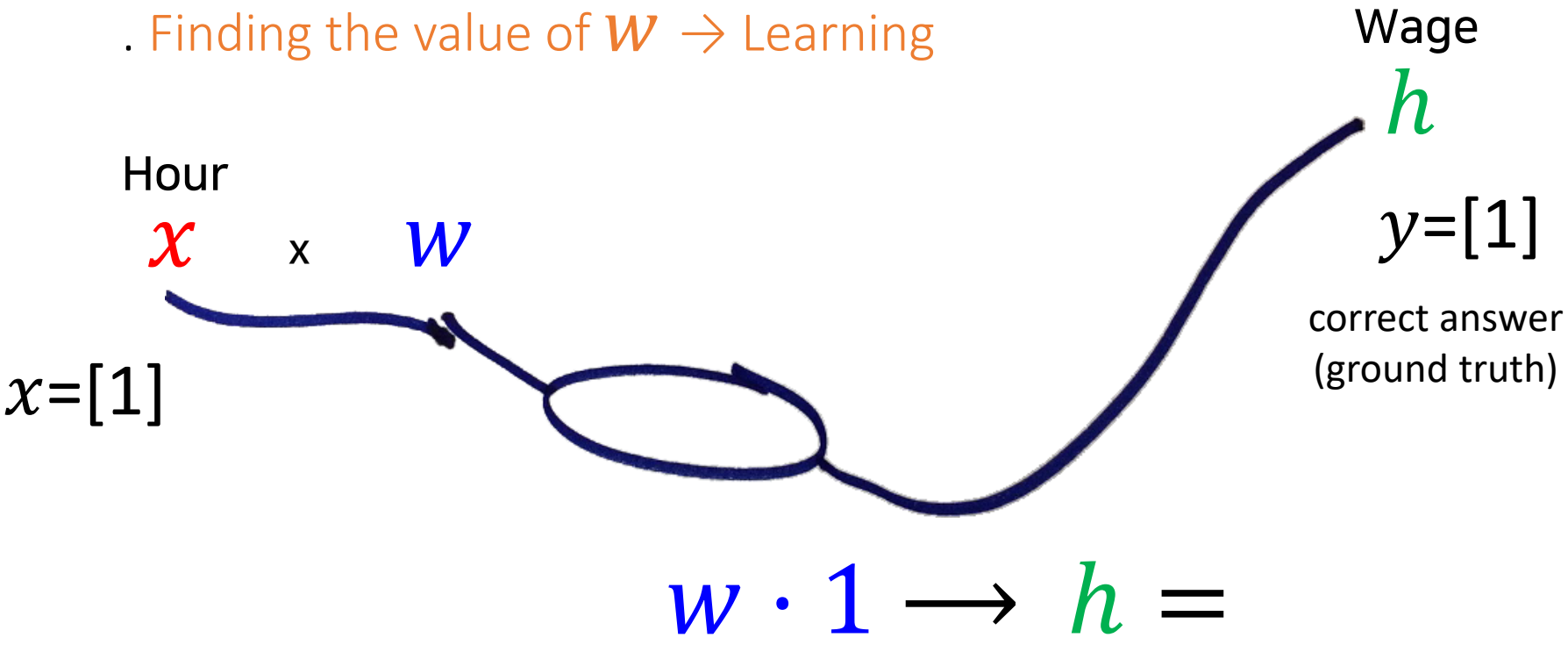
if w is large,
if small,
if not exist,

Application: Wage Calculator

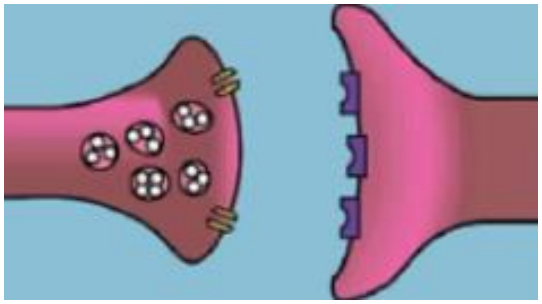
. Knowledge: 1 hour working(x) → 1USD(y) pay

. How much you get if work 4 hours? (prediction)

. Finding the value of W → Learning



x (hour)	w	output of a neuron	y (wage)	error	Reaction
1	4(random)	4	1	4-1	scolding seriously
1	2	2	1	2-1	ordinarily
1	1.5	1.5	1	1.5-1	not bed
1	1.3	1.3	1	1.3-1	good but not enough
1	1.1	1.1	1	1.1-1	acceptable



Scolding a dog/dolphin/child automatically updates the connection strength(w)

to make the error smaller in the next step.

Learning

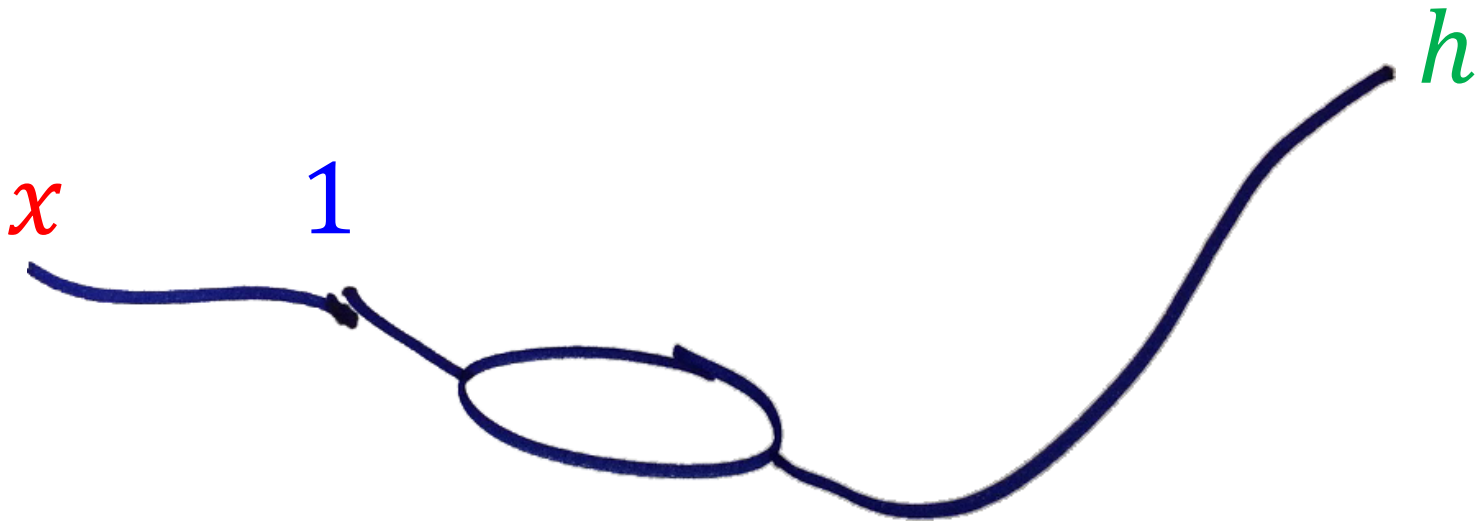
is to find the optimal value of parameter (w) to predict correctly.

the amount of neurotransmitter

Drawing a neuron

Representing the below equation:

$$h = 1x$$

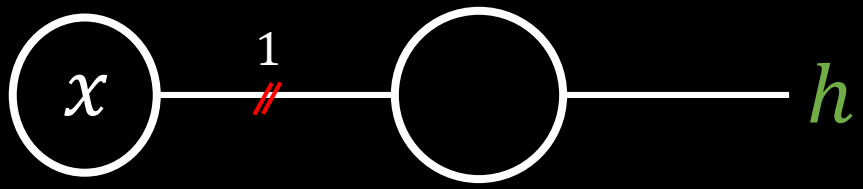


$$h = 1x$$

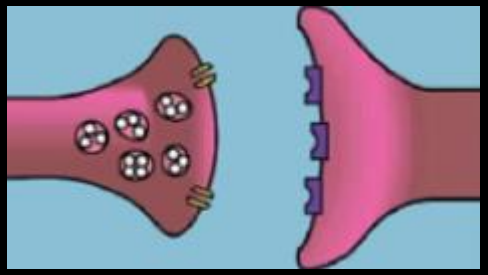
Matrix notation

$(x)(1) \longrightarrow (h)$

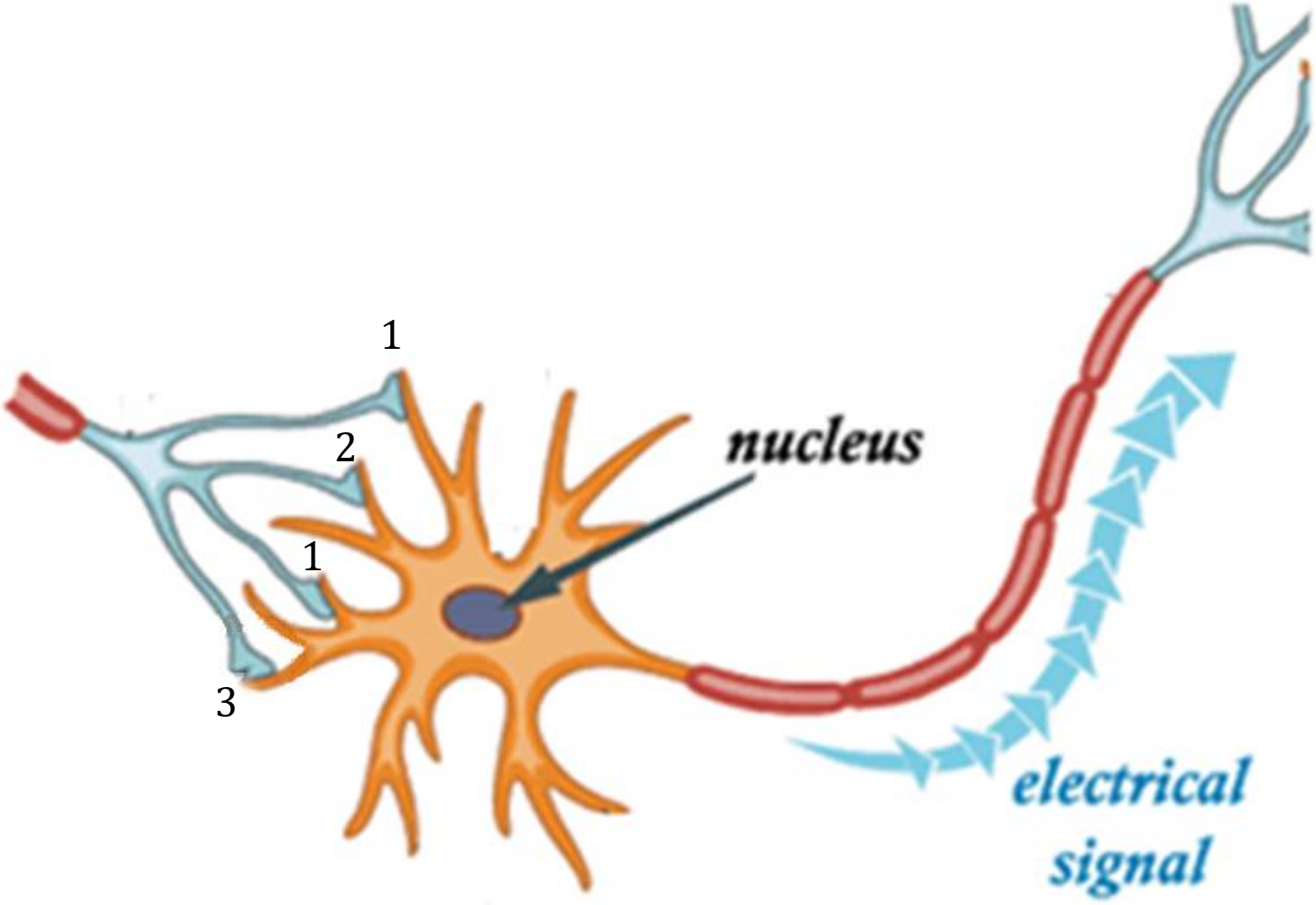
Simplified version

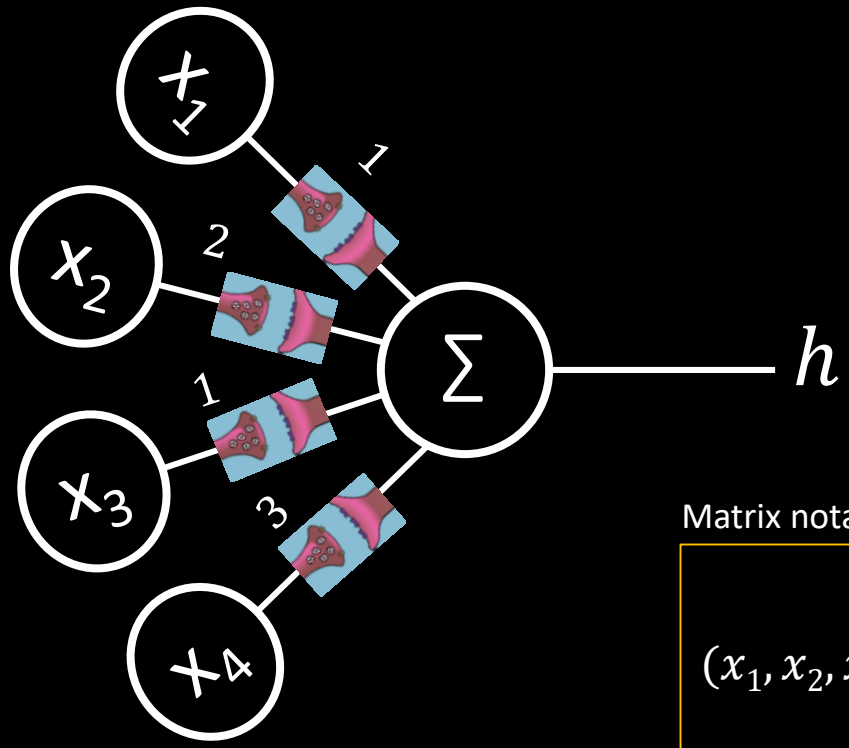


Where is the synapse/connection?



Neuron with many inputs





Matrix notation

$$(x_1, x_2, x_3, x_4)\begin{pmatrix}1\\2\\1\\3\end{pmatrix} \longrightarrow (h)$$

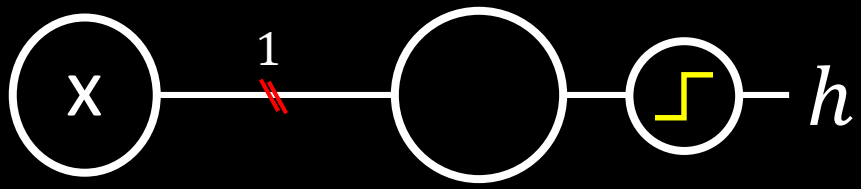
Weighted Sum

$$h = w1 \cdot x1 + w2 \cdot x2 + w3 \cdot x3 + w4 \cdot x4$$

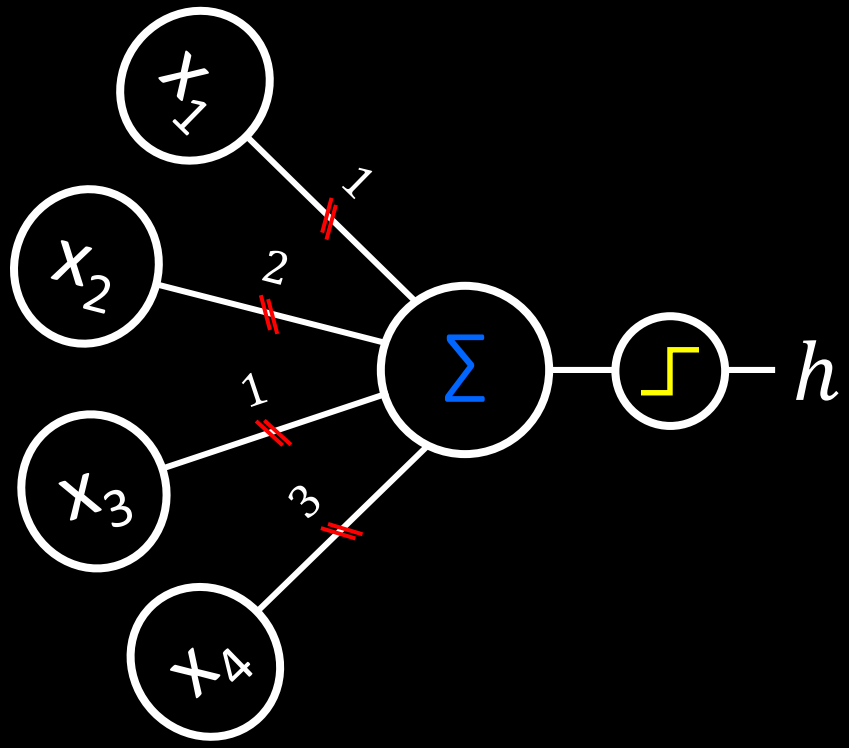
if the inputs are $(1,1,1,1)$, then h is ..

Real operation of a neuron

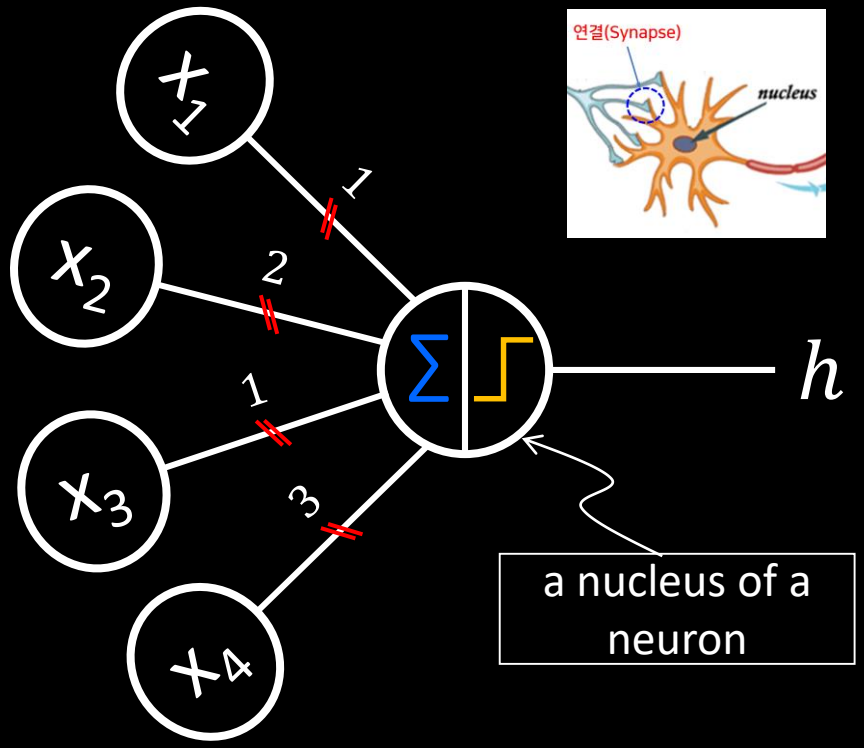
- signal ON if the weighted sum is greater than T
- otherwise signal OFF



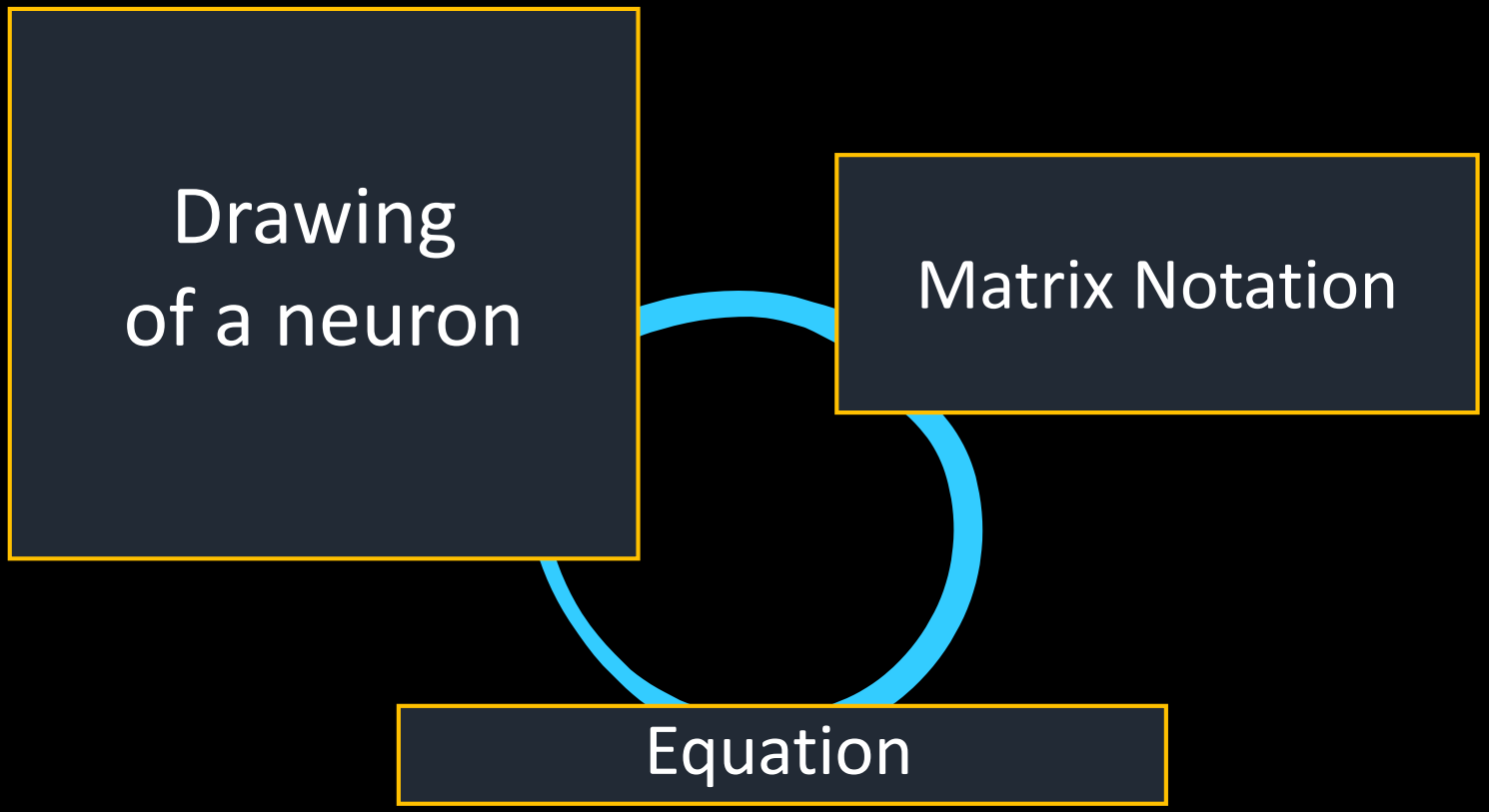
Thresholding



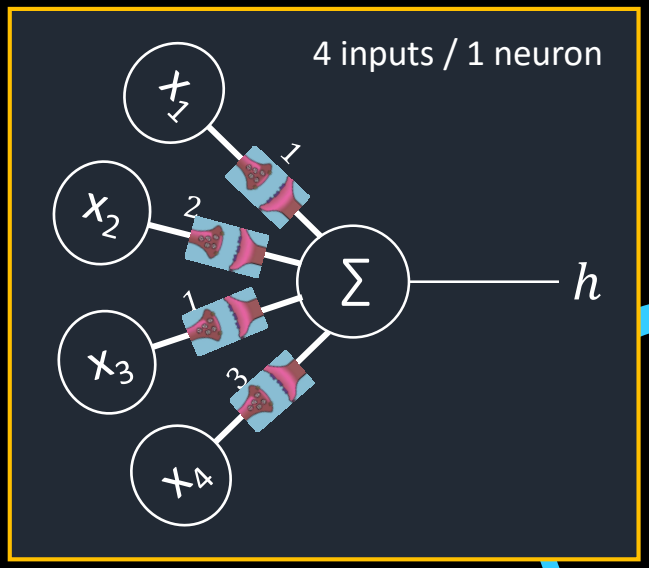
Weighted sum and thresholding



$$h = \begin{cases} 1 & if\ x_1 + 2x_2 + x_3 + 3x_4 > T \\ 0 & otherwise \end{cases}$$


Drawing
of a neuron
Matrix Notation
Equation

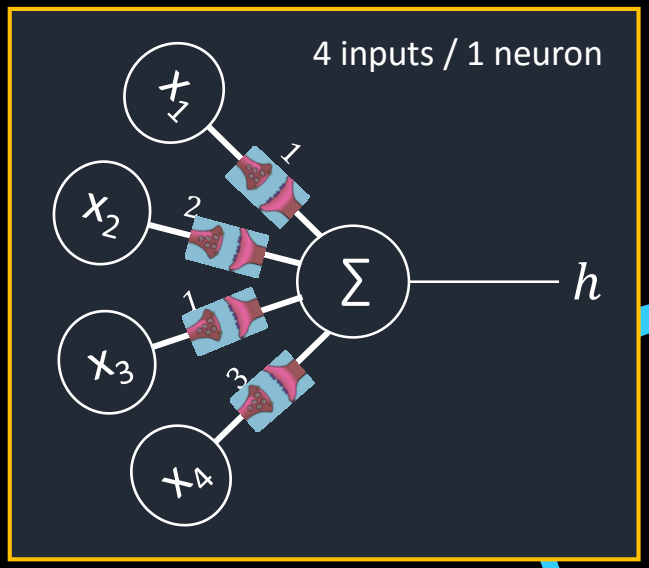
Drawing



Matrix notation

Equation

Drawing

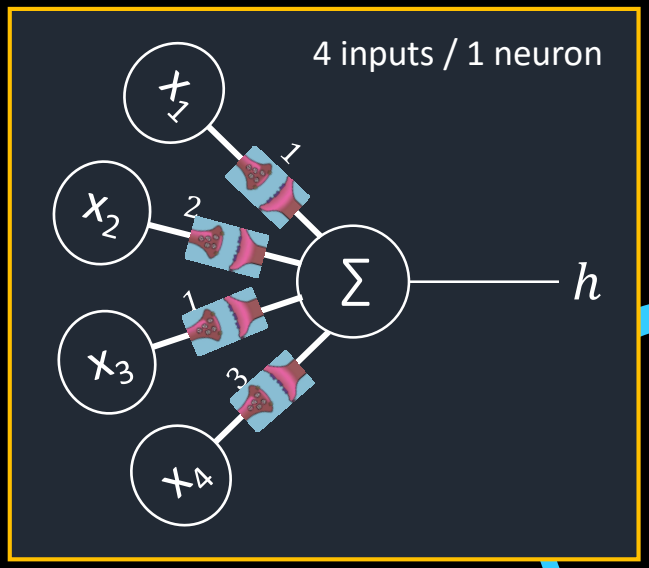


Matrix notation

Equation

$$h = 1 \cdot x1 + 2 \cdot 1 + 1 \cdot x3 + 3 \cdot x4$$

Drawing



Matrix notation

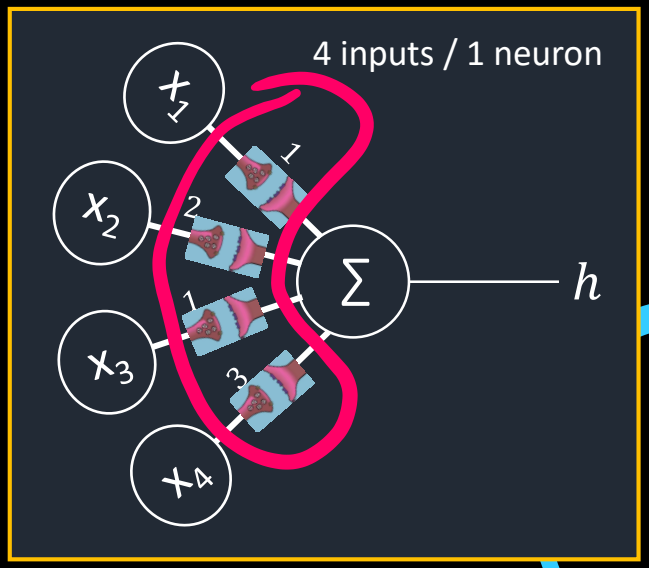
$$(x_1, x_2, x_3, x_4)\begin{pmatrix}1\\2\\1\\3\end{pmatrix} \rightarrow (h)$$

Equation

$$h = 1 \cdot x1 + 2 \cdot 1 + 1 \cdot x3 + 3 \cdot x4$$

What is learning?

Drawing



Matrix notation

$$(x_1, x_2, x_3, x_4) \begin{pmatrix} 1 \\ 2 \\ 1 \\ 3 \end{pmatrix} \rightarrow (h)$$

Equation

$$h = 1 \cdot x1 + 2 \cdot 1 + 1 \cdot x3 + 3 \cdot x4$$

How does it learn automatically?