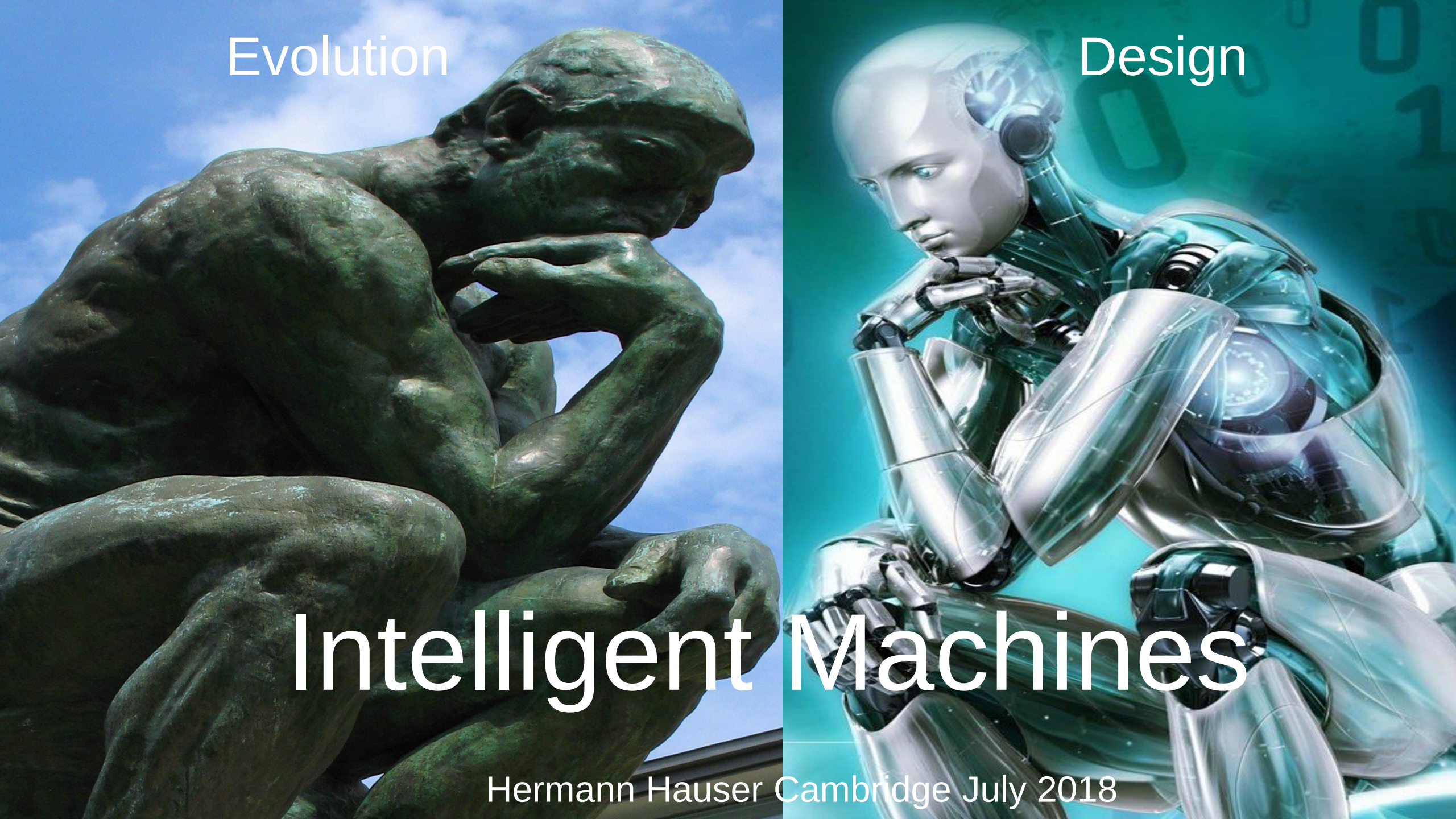


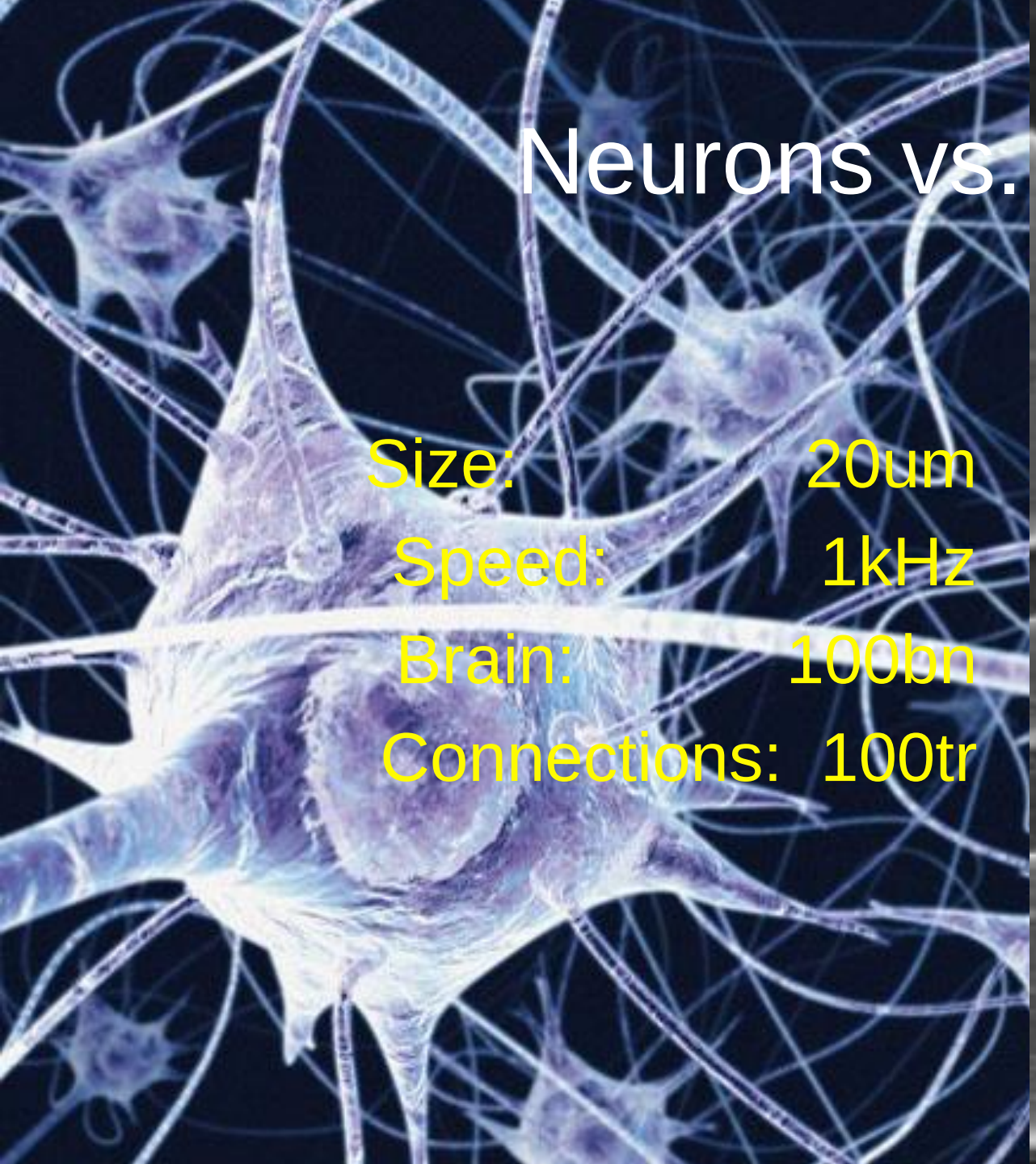

# Intelligent Machines

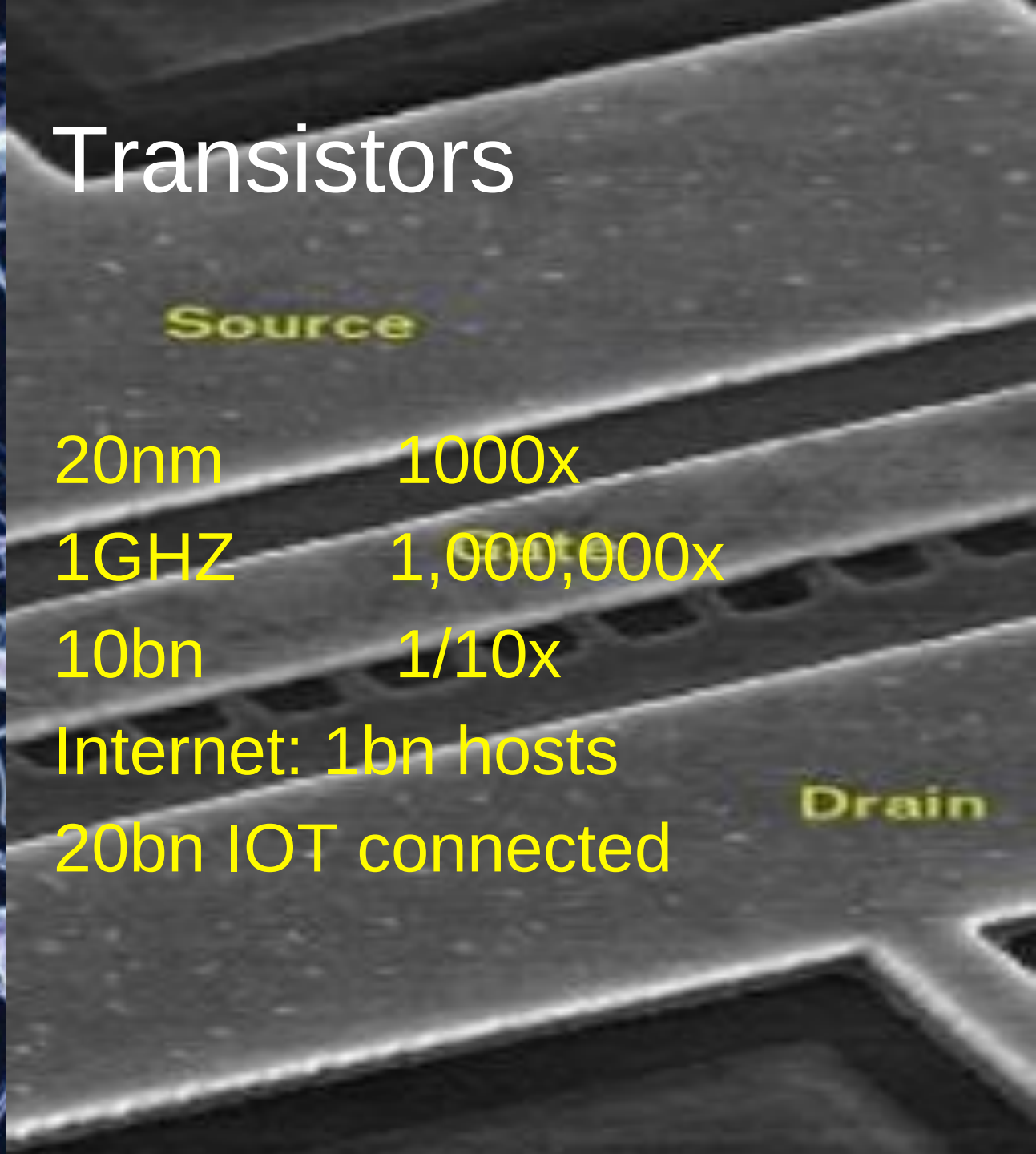
Hermann Hauser Cambridge July 2018

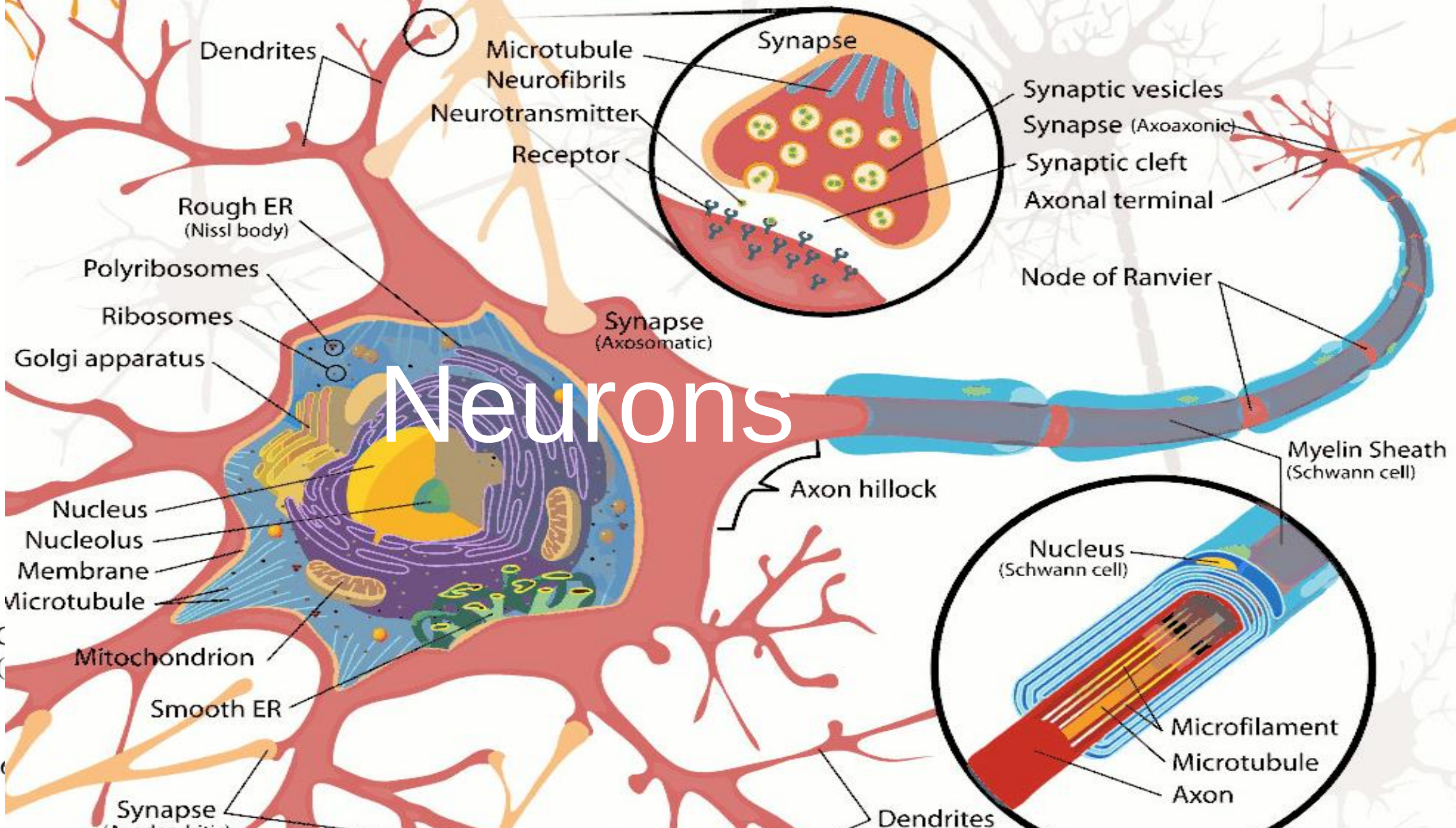
# Contents

# Neurons vs. Transistors

| | | | |
|---|---|---|---|
| Size: | 20um | 20nm | 1000x |
| Speed: | 1kHz | 1GHZ | 1,000,000x |
| Brain: | 100bn | 10bn | 1/10x |
| Connections: | 100tr | Internet: 1bn hosts<br>20bn IOT connected | |

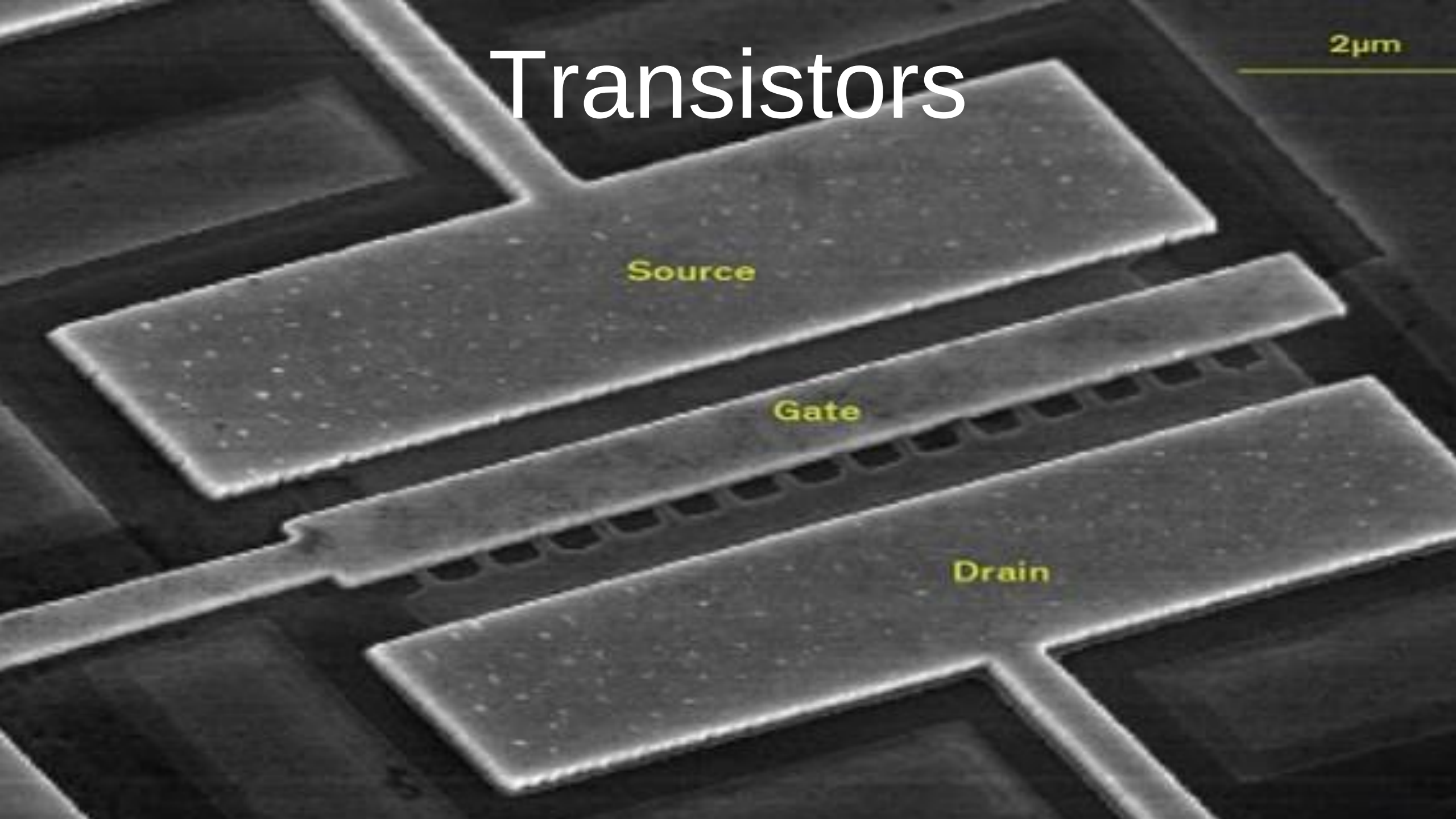


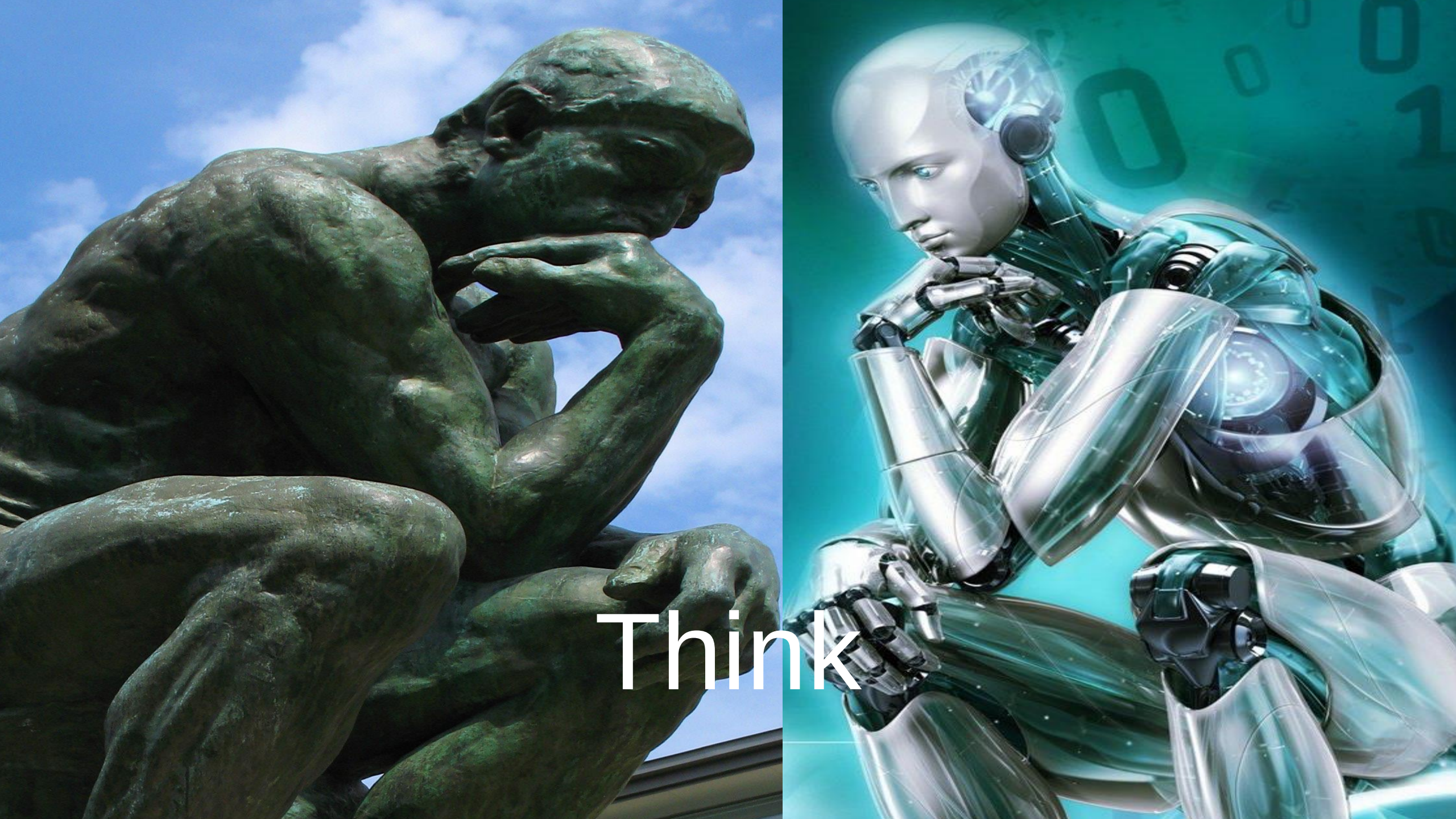



Dendrites
Microtubule
Neurofibrils
Neurotransmitter
Receptor
Synapse
Synaptic vesicles
Synapse (Axoaxonic)
Synaptic cleft
Axonal terminal
Rough ER
(Nissl body)
Polyribosomes
Ribosomes
Golgi apparatus
Synapse
(Axosomatic)
Node of Ranvier
Myelin Sheath
(Schwann cell)
Axon hillock
Nucleus
Nucleolus
Membrane
Microtubule
Mitochondrion
Smooth ER
Synapse
Nucleus
(Schwann cell)
Microfilament
Microtubule
Axon
Dendrites

# Neurons

# Transistors




Think

# Brains vs. Computers

Capacity:

10 to 100TB

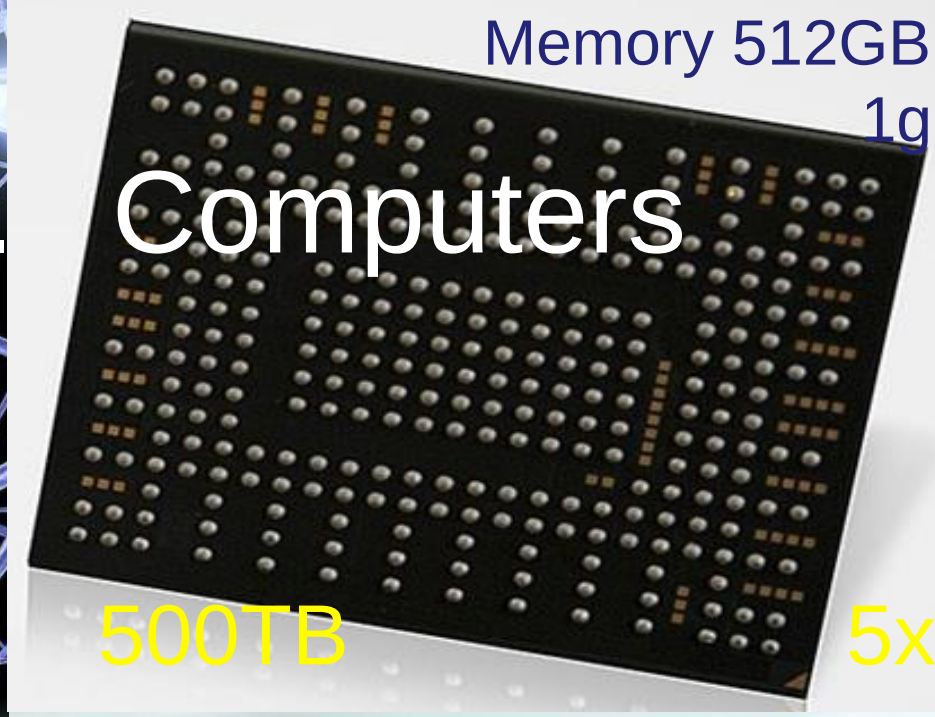
Processing power:

10Peta-1ExaFLOPS

Power consumption:

20W

Connections: 100tr



Memory 512GB

1g

500TB

5x

10TeraFLOPS:

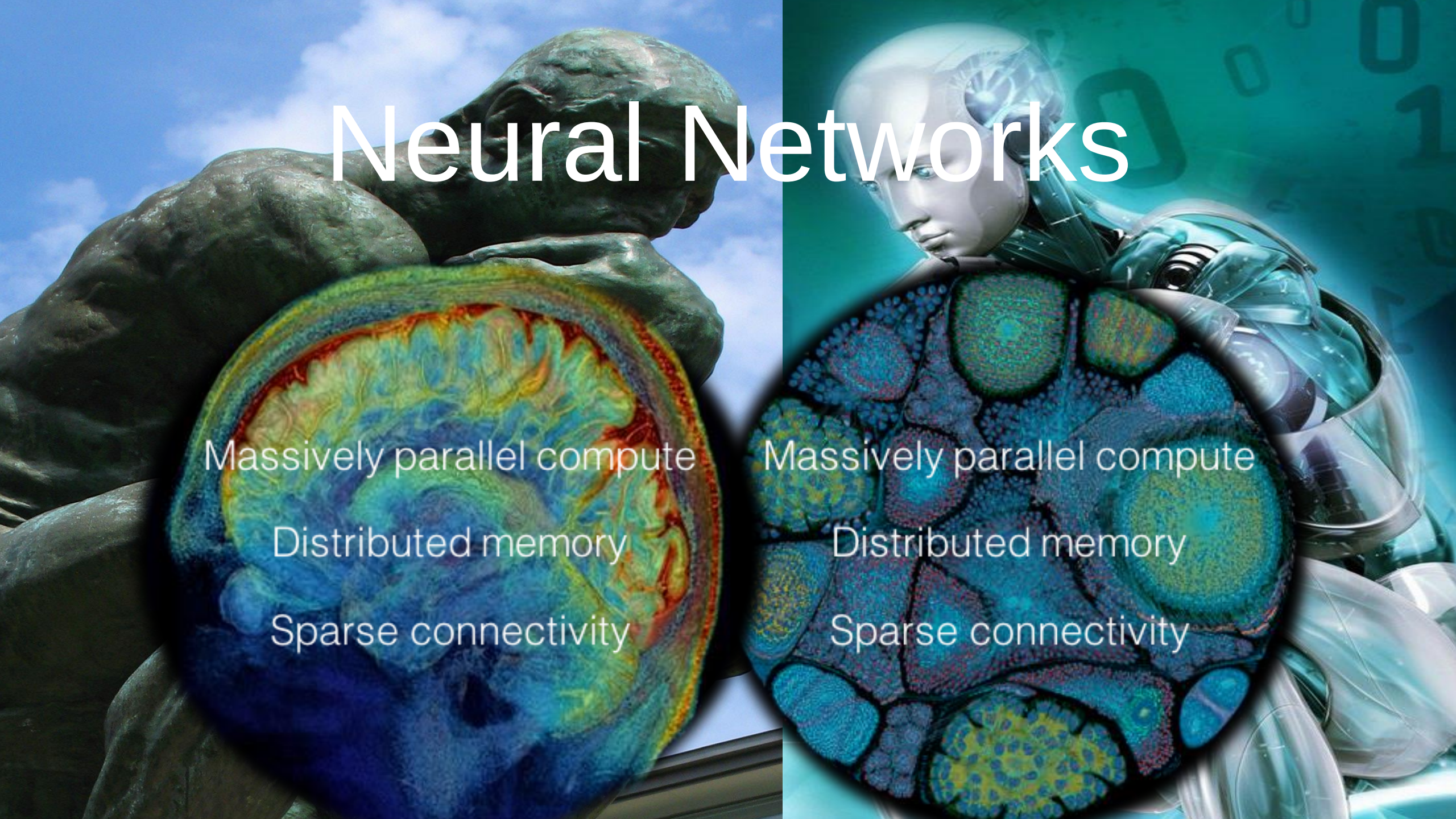
1000x

200kW

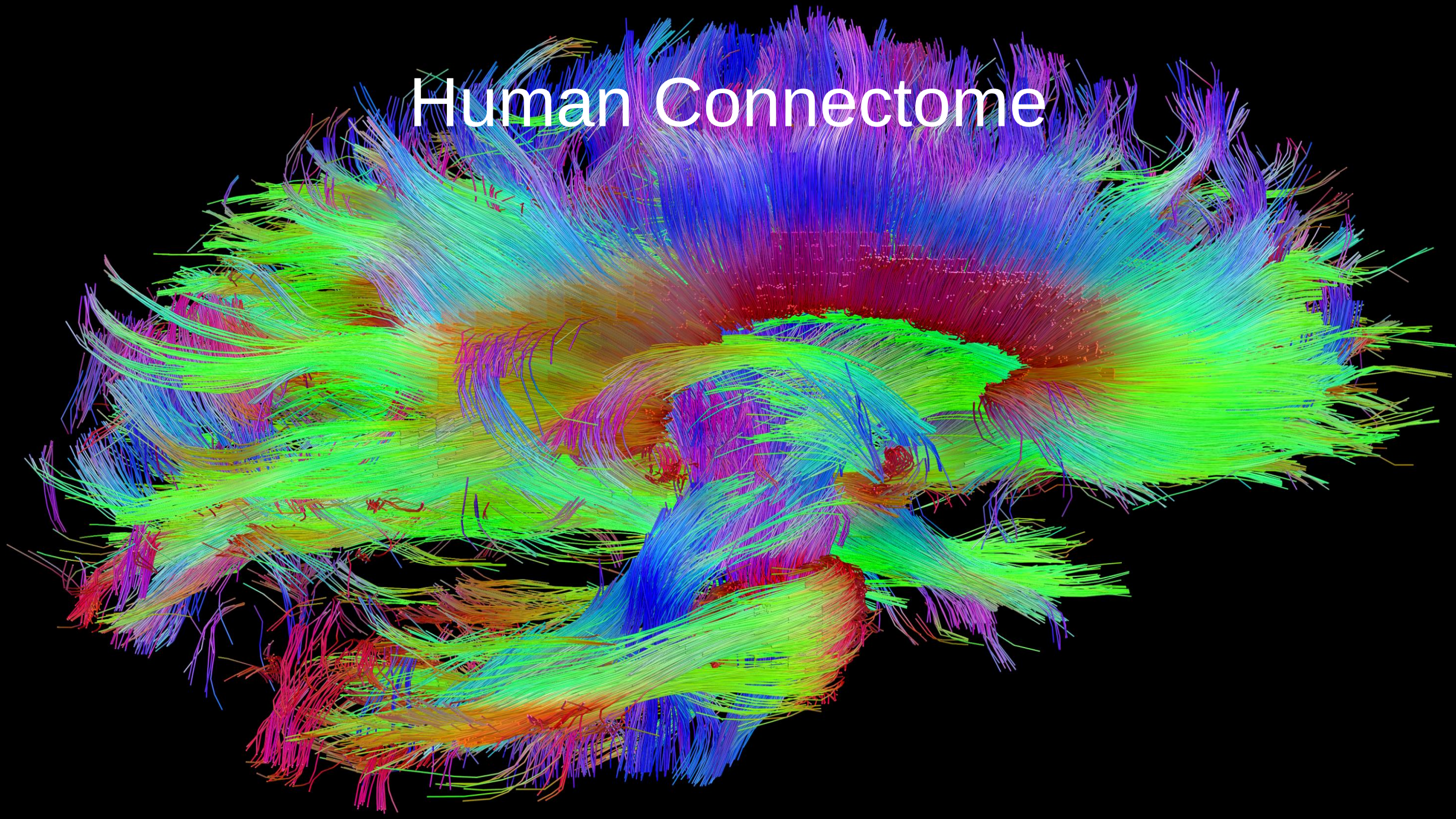
10,000x

GPU Graphical Processing Unit

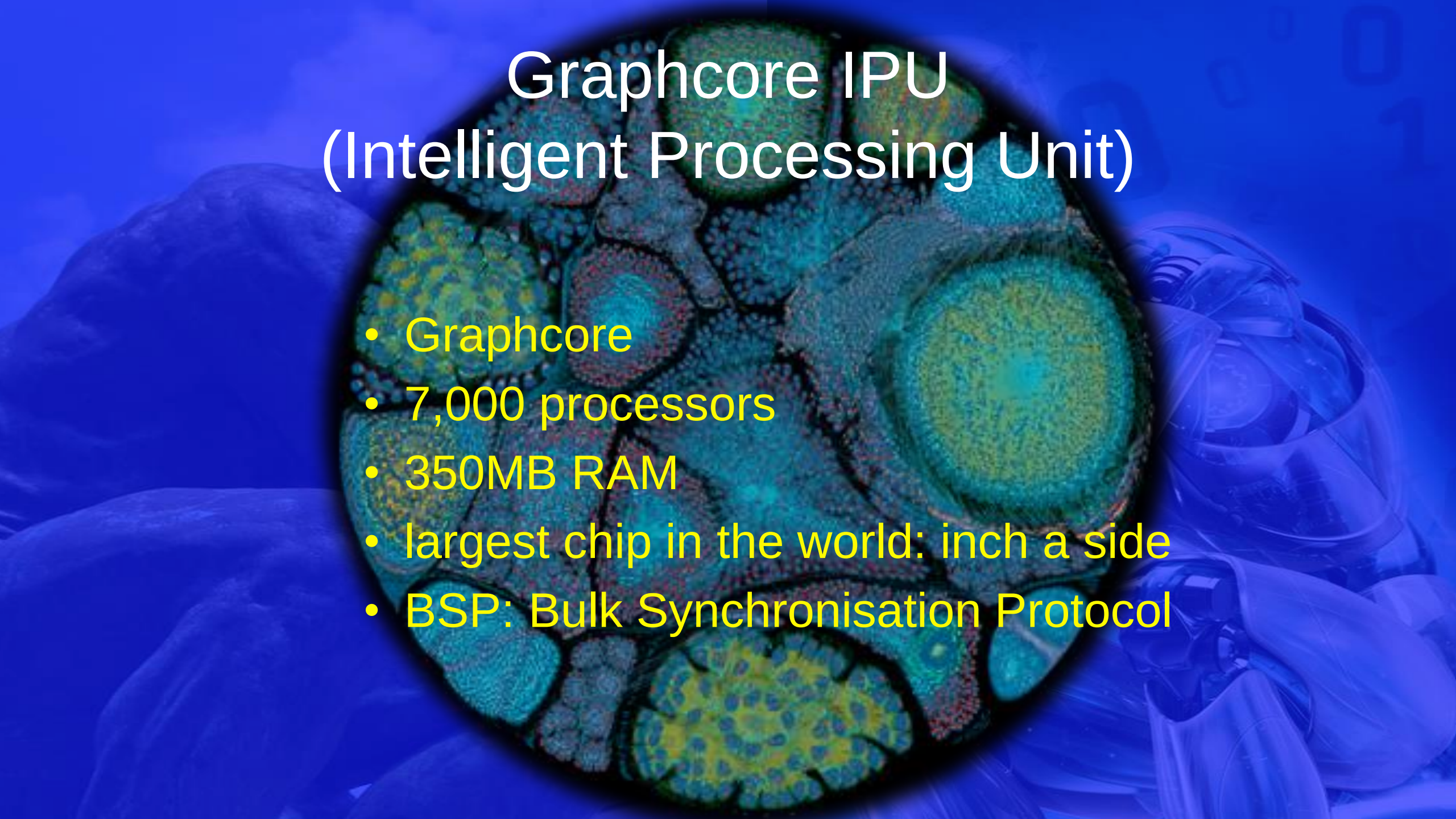
# Neural Networks



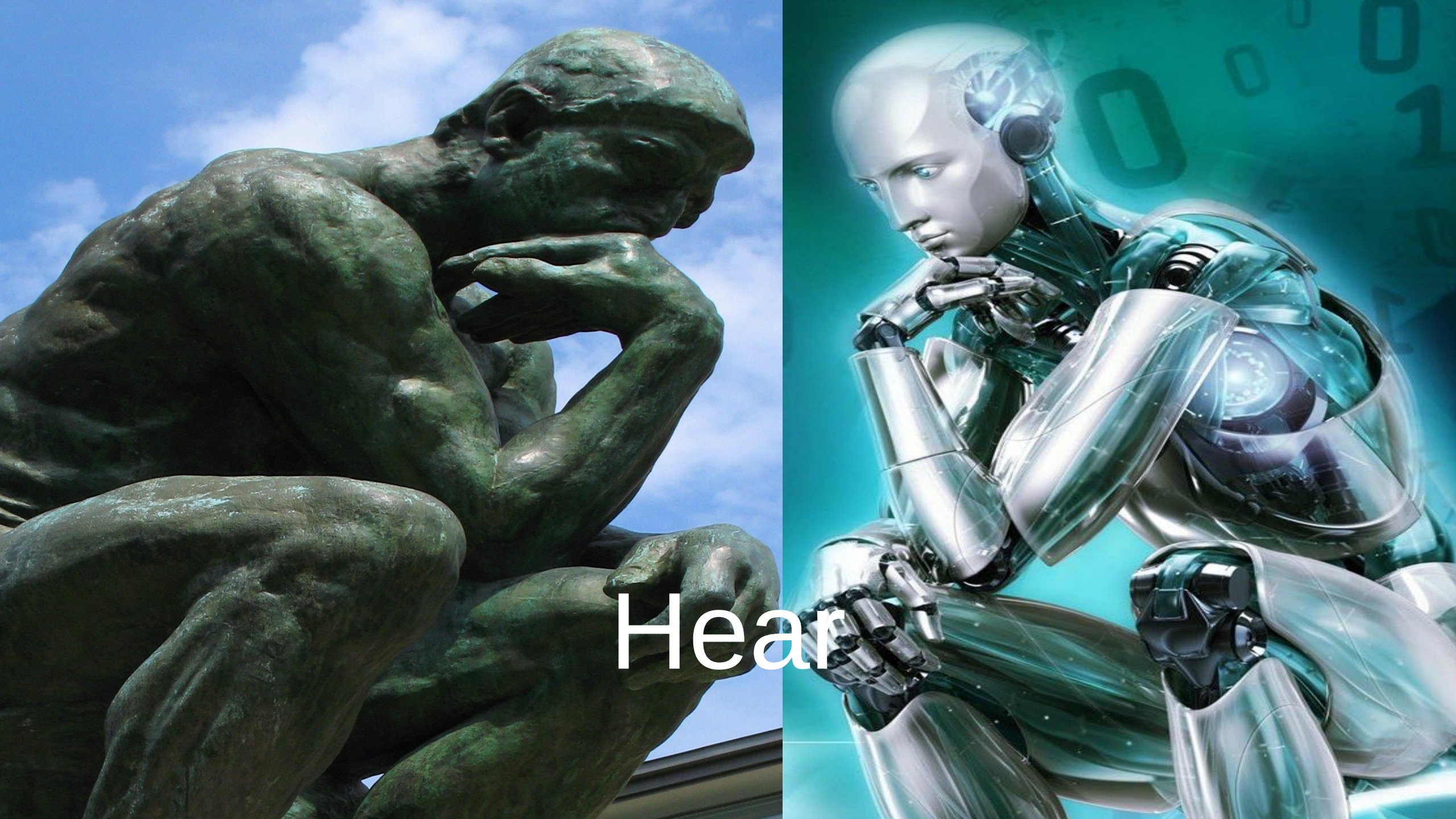
# Human Connectome



# Graphcore IPU (Intelligent Processing Unit)



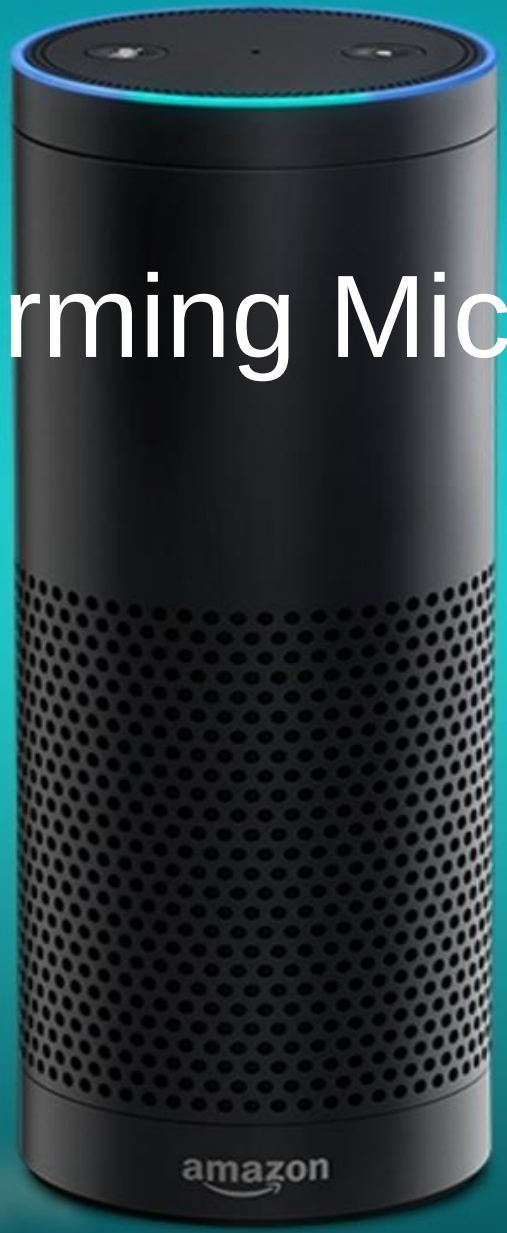
- Graphcore
- 7,000 processors
- 350MB RAM
- largest chip in the world: inch a side
- BSP: Bulk Synchronisation Protocol


Hear

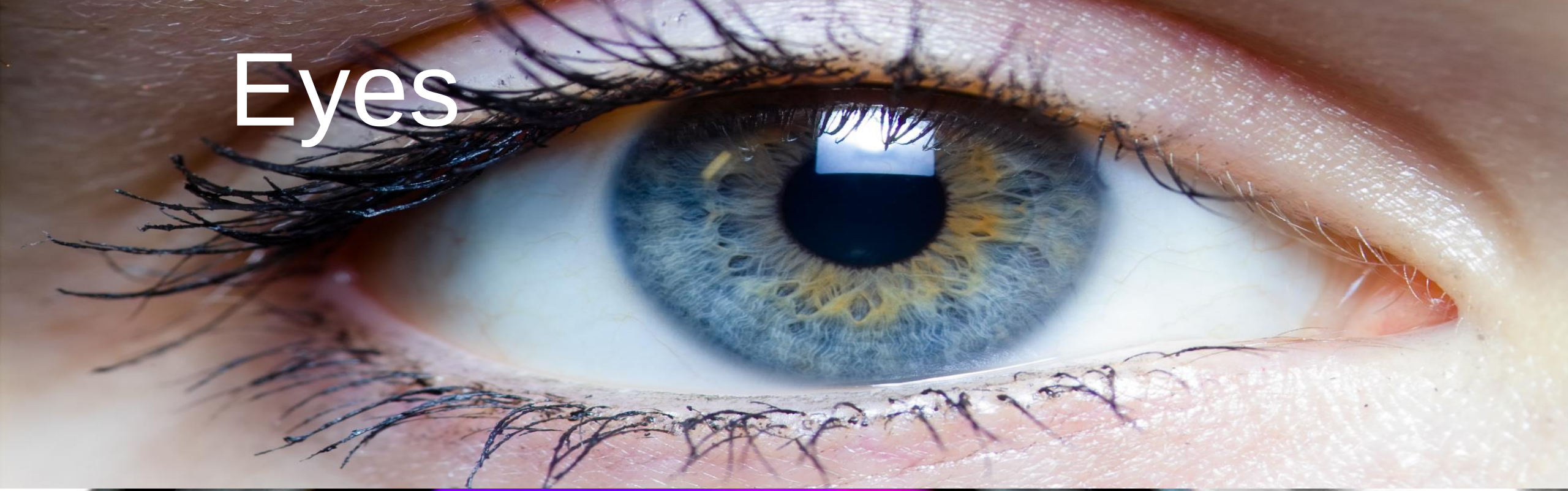
Hea r

Ears vs Microphones

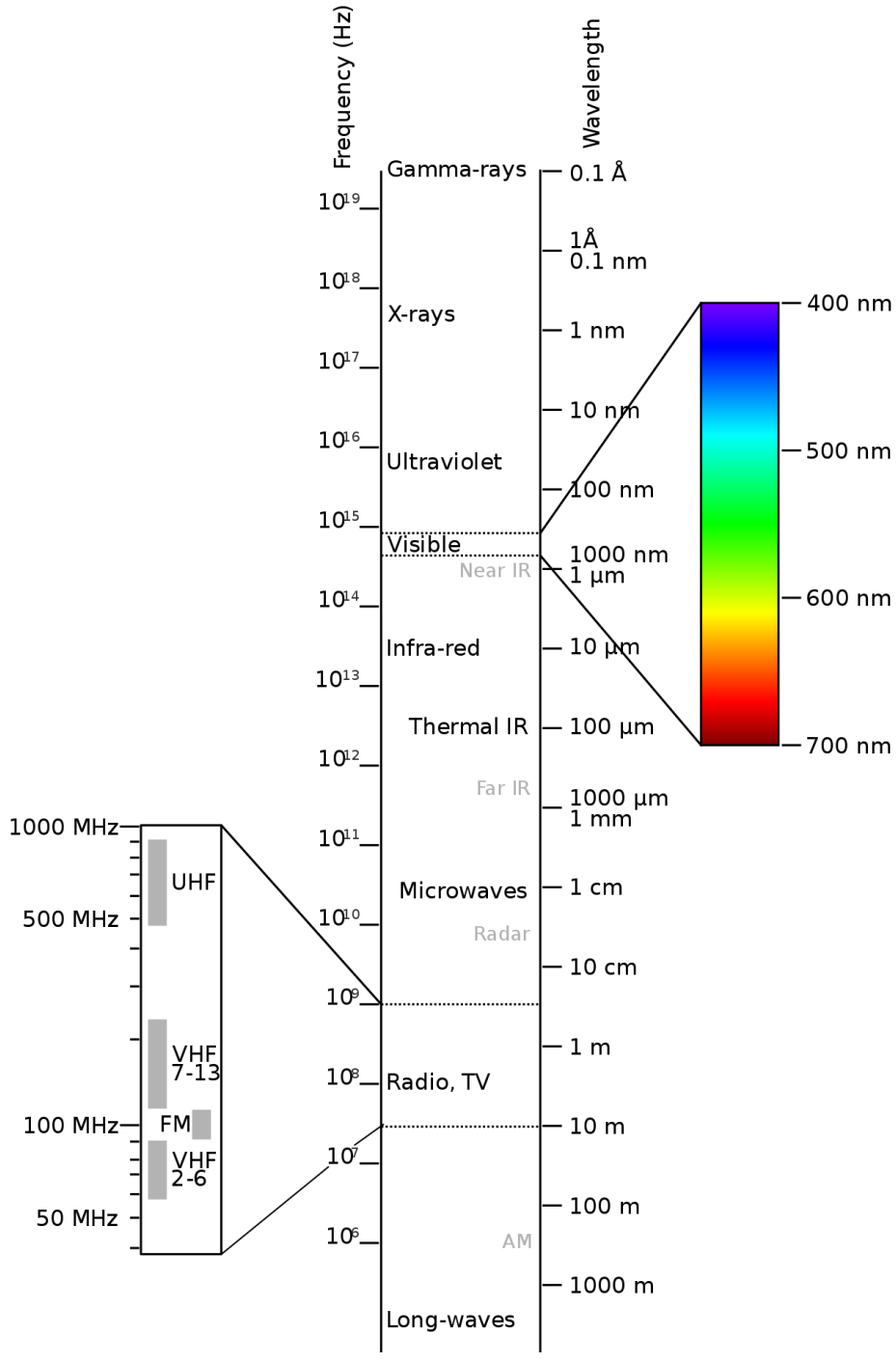
# Beam forming Microphone




See

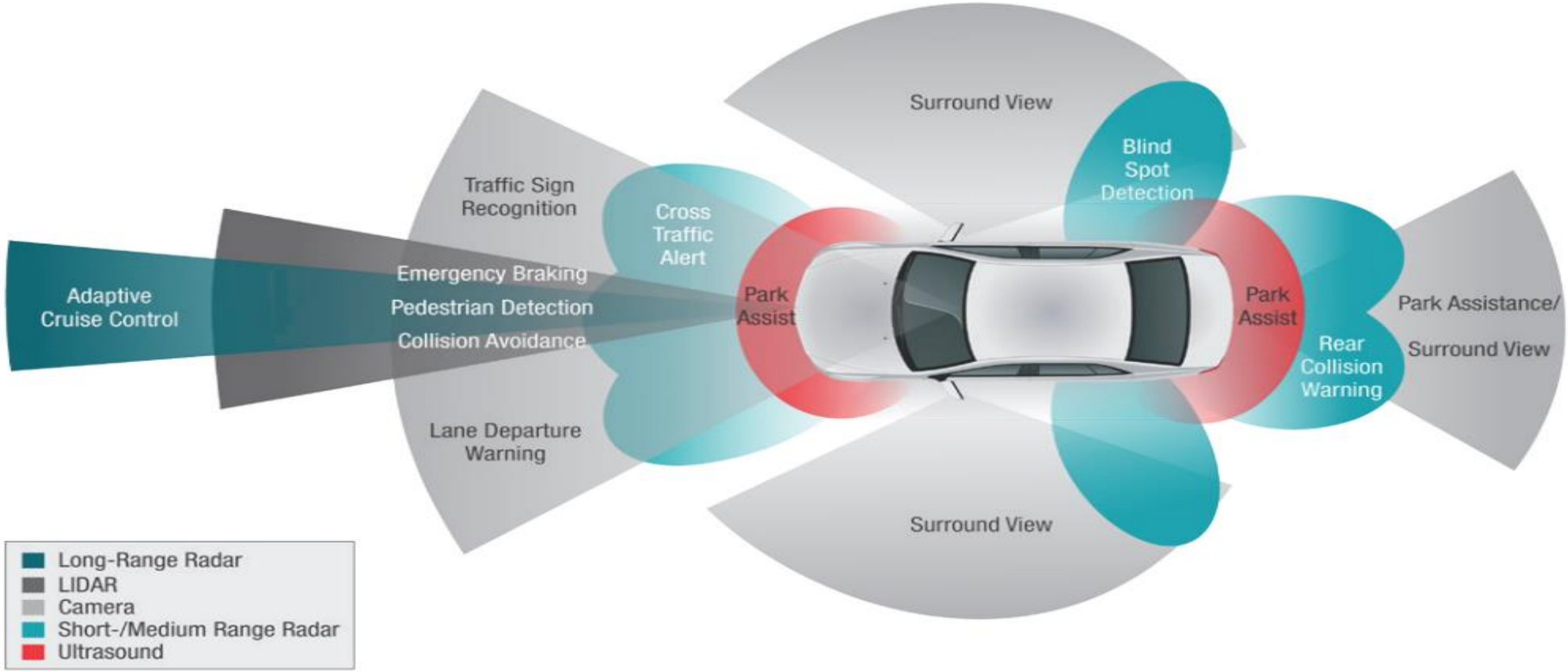

Eyes


Camera

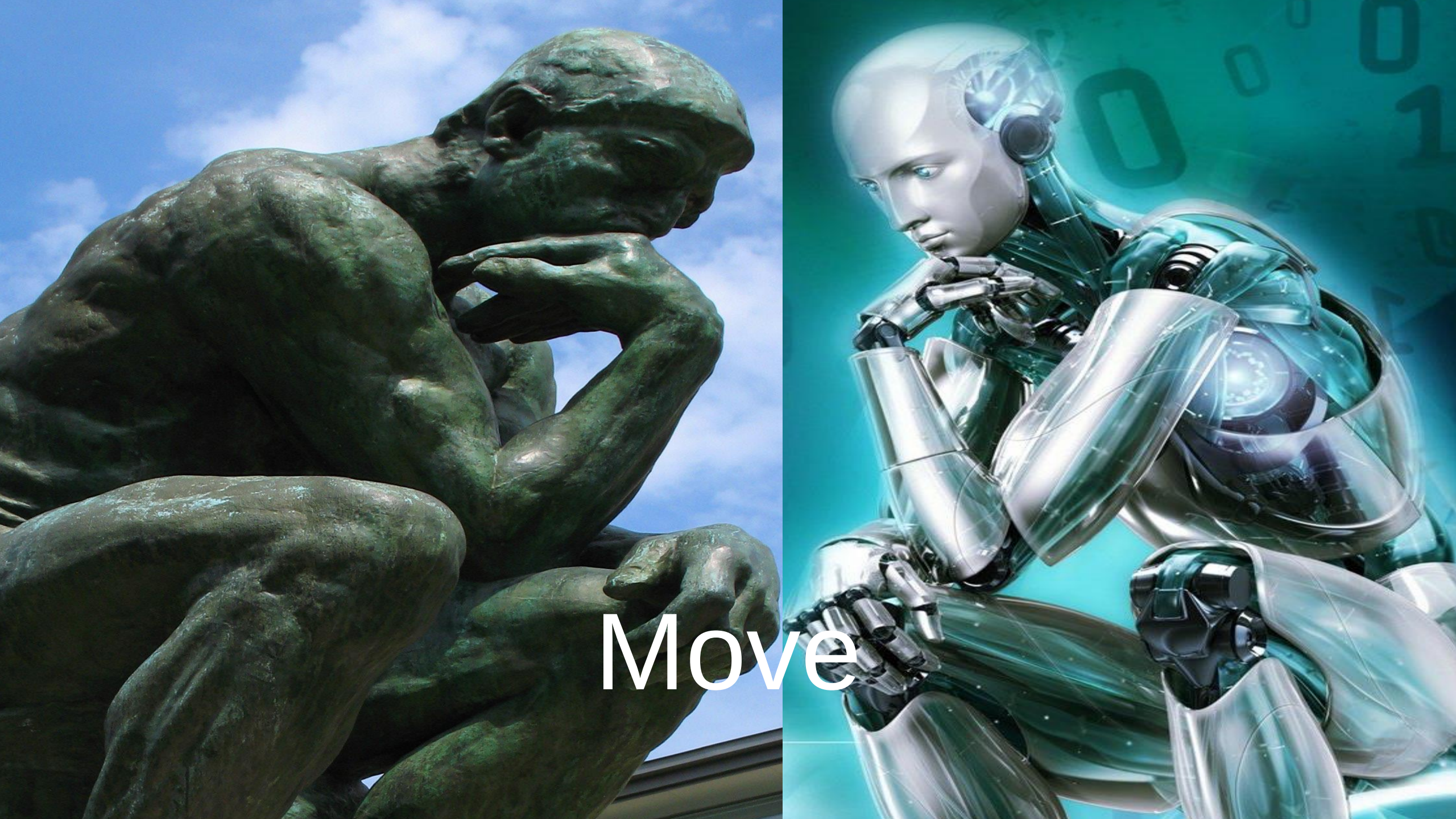

Frequency (Hz)
Wavelength
Gamma-rays
X-rays
Ultraviolet
Visible
Near IR
Infra-red
Thermal IR
Far IR
Microwaves
Radar
Radio, TV
AM
Long-waves
$10^{19}$
$10^{18}$
$10^{17}$
$10^{16}$
$10^{15}$
$10^{14}$
$10^{13}$
$10^{12}$
$10^{11}$
$10^{10}$
$10^{9}$
$10^{8}$
$10^{7}$
$10^{6}$
0.1 Å
1Å
0.1 nm
1 nm
10 nm
100 nm
1000 nm
1 µm
10 µm
100 µm
1000 µm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1000 m
400 nm
500 nm
600 nm
700 nm
1000 MHz
500 MHz
100 MHz
50 MHz
UHF
VHF
7-13
FM
VHF
2-6

# Many Cameras

# Self-driving car

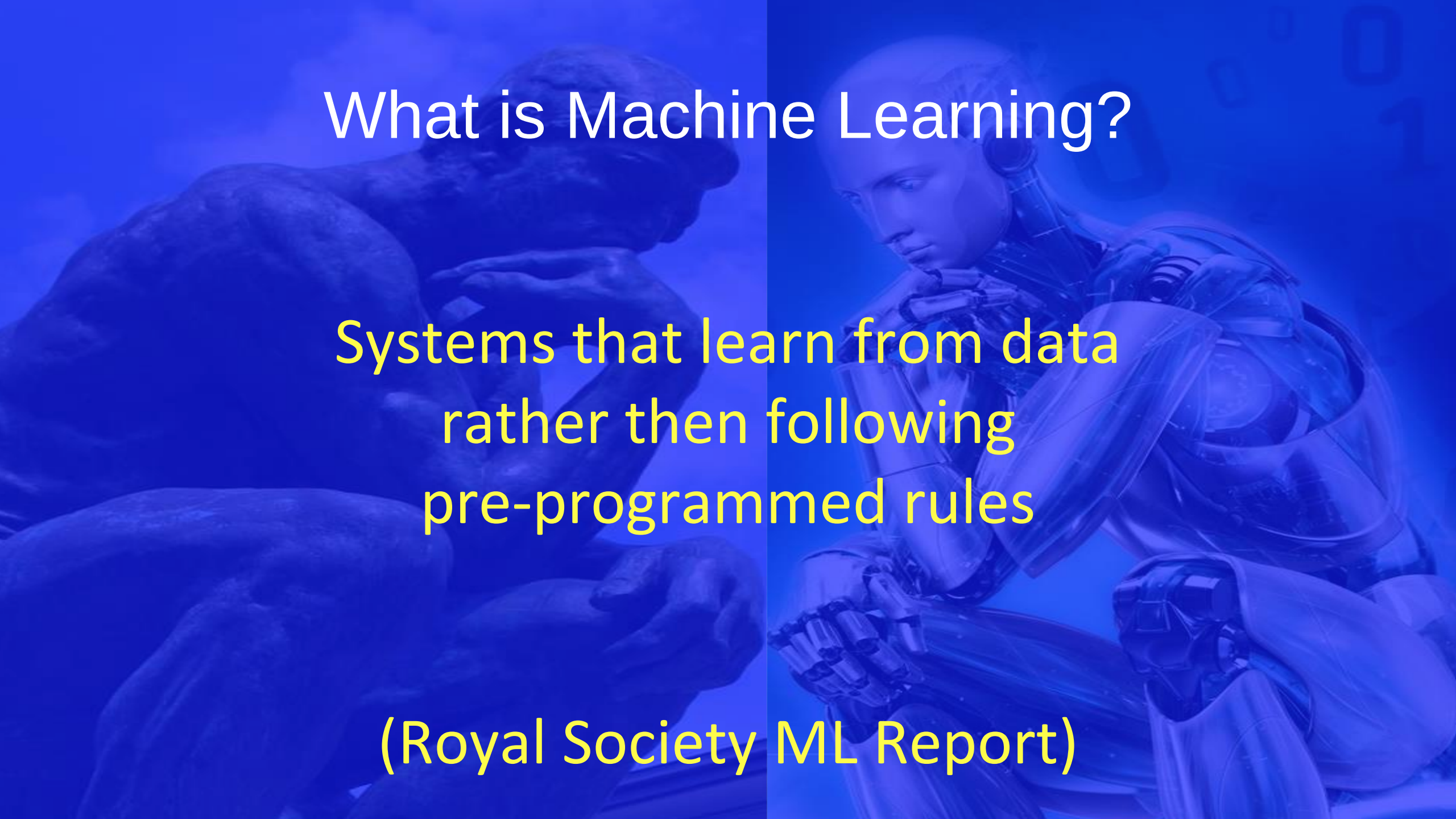



ausgen.
W 80 426 I
Ende


Move

# Legs vs. Robots


Learn



# What is Machine Learning?

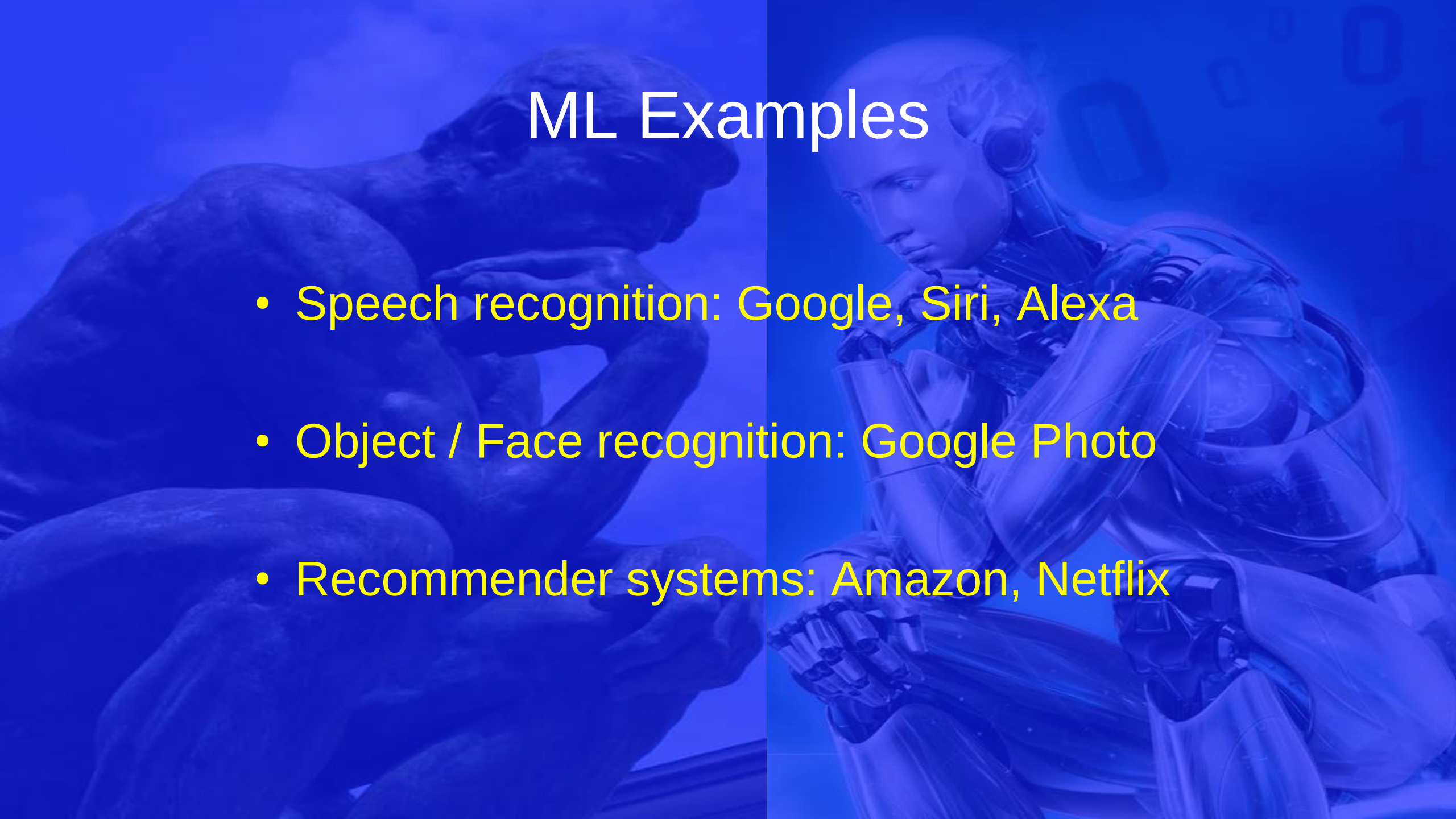
Systems that learn from data
rather then following
pre-programmed rules

(Royal Society ML Report)

# Branches of ML

- SUPERVISED ML: trained on LABELED DATA
- UNSUPERVISED ML: without labels
-
- REINFORCEMENT ML: learning from experience, reward function (winning game)
- INVERSE REINFORCEMENT ML: system has to deduce reward function buy observation (driving a car)

# ML Examples

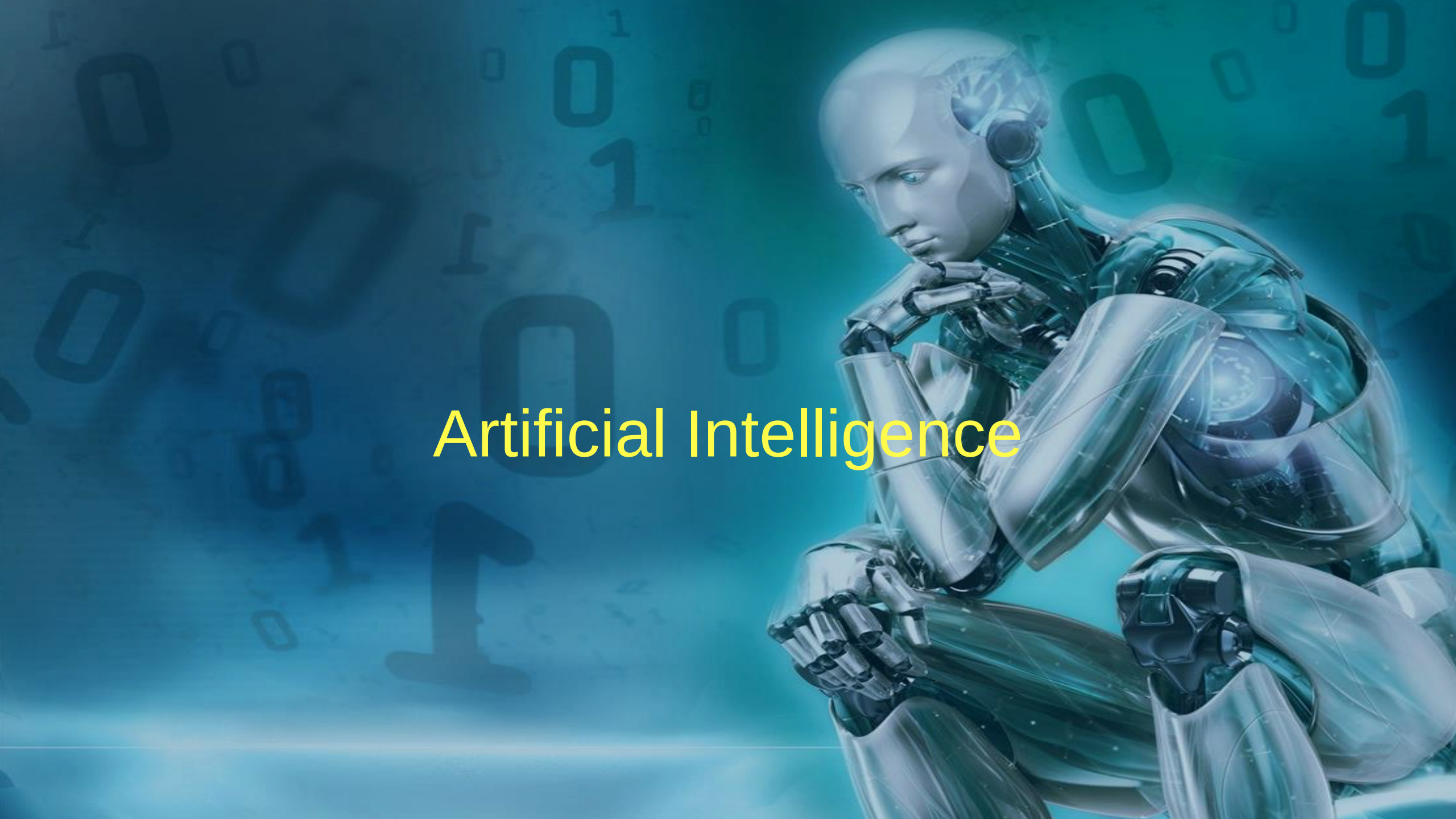


- Speech recognition: Google, Siri, Alexa
- Object / Face recognition: Google Photo
- Recommender systems: Amazon, Netflix

# Probability and ML

- NO
- NOT dete
- NOT progr
- Needs Big D
- Needs (Human)
- Genie Problem

# Artificial Intelligence



# AI Risks

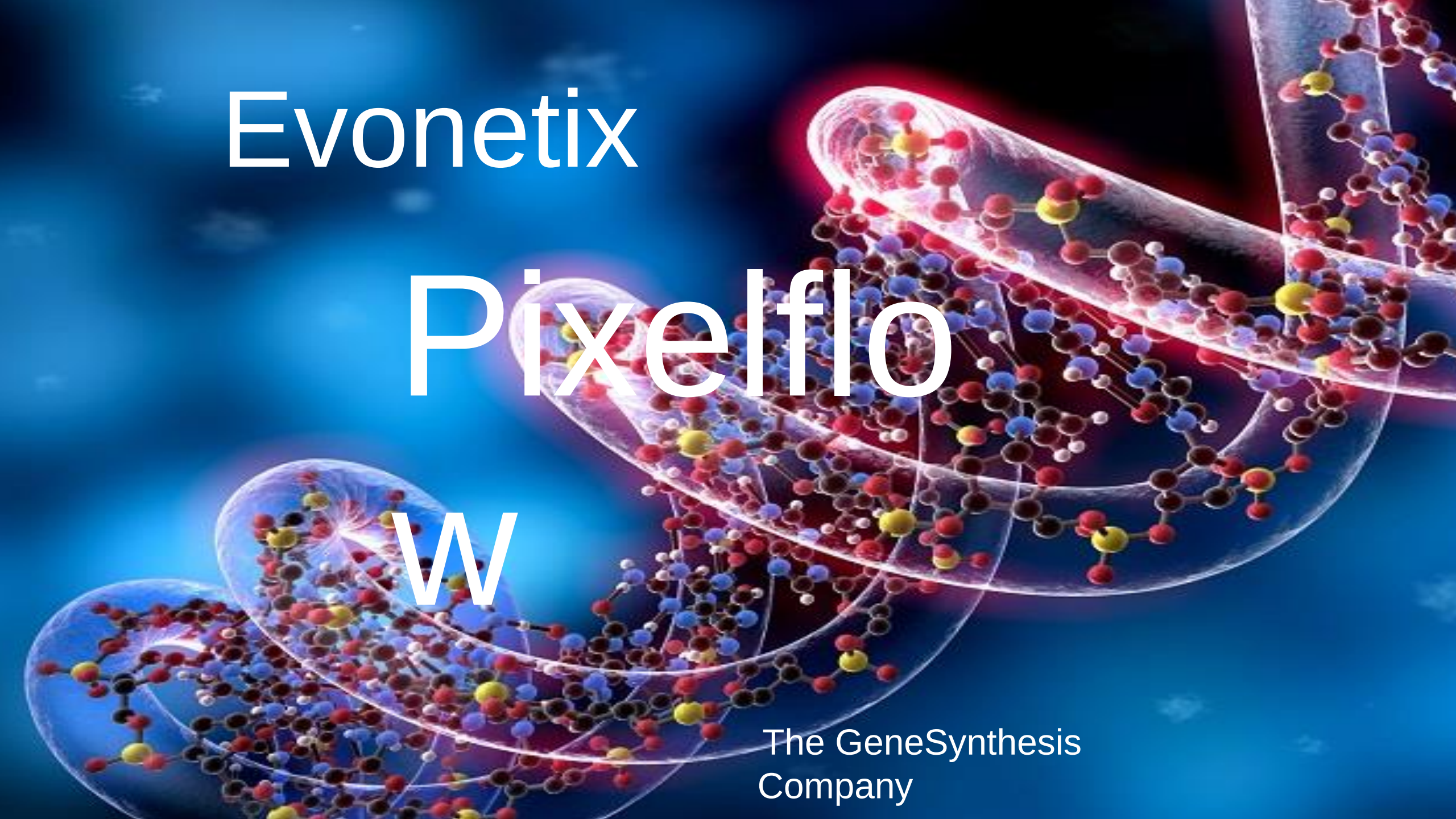
"Success in creating AI would be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks."

"Hope we're not just the biological boot loader for digital superintelligence. Unfortunately, that is increasingly probable."

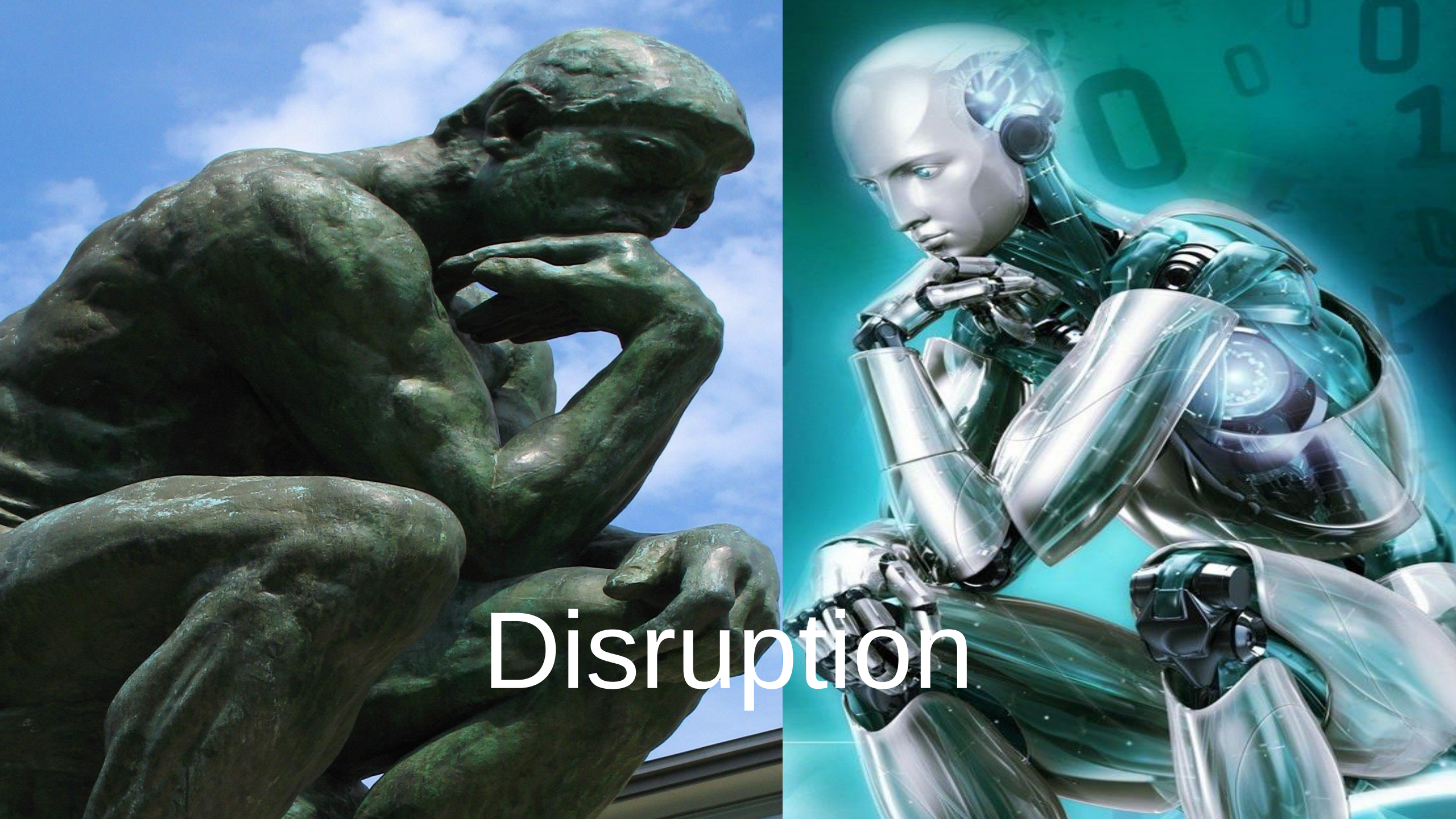
# Life 3.0

- Book by Max Tegmark

- Life 1.0: HW evolved. SW evolved
- Life 2.0: HW evolved. SW designed (culture)
- Life 3.0: HW designed. SW designed


Evonetix
Pixelflow
The GeneSynthesis Company


Google DeepMind
allenge Matc
8 - 15 March 20
Move 37
in game 2
Move 78
in game 4


Disruption

# ARM Business model

| | Intel | ARM |
|---|---|---|
| **Customer** | Dell,HP | Samsung,Apple |
| **Chipfab** | Intel | TSMC+450 |
| **Design** | Intel | ARM |
| **Intellectual Property** | Intel | ARM |

# ARM

# ML effect on Car industry

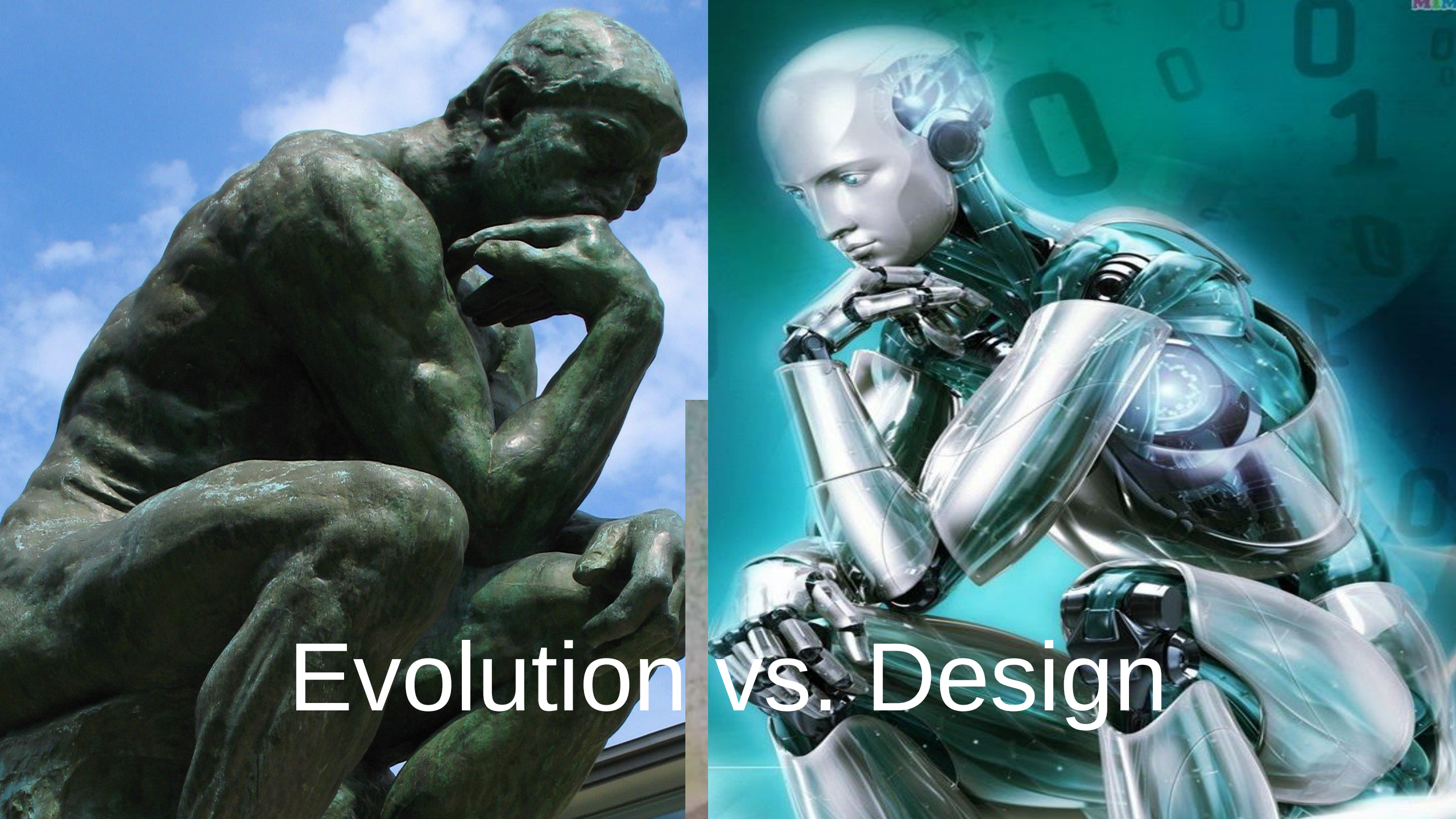
| | Today | With ML |
|---|---|---|
| **Customer** | Showroom | Uber |
| **Autonomous SW** | BMW, Tesla | Uber, FiveAI |
| **Car** | BMW,Tesla | BYD, KIA |
| **Components** | Bosch | China |

# Trillion $ Opportunity

- US spends $3tr on Healthcare
- Treating ill people: 70%
- Keeping them healthy: 30%
- Expected to change to 50:50 in 5 yrs

# ML effect on Pharma

| | Today | With ML |
|---|---|---|
| **Customer** | Patient | Healthy person |
| **Provider** | Doctor/hospital | e-Health |
| **Supplier** | Pharma | Personalised Advice |
| **Components** | Drugs | Data |


Evolution vs. Design

# Conclusion