



The Digital Brain

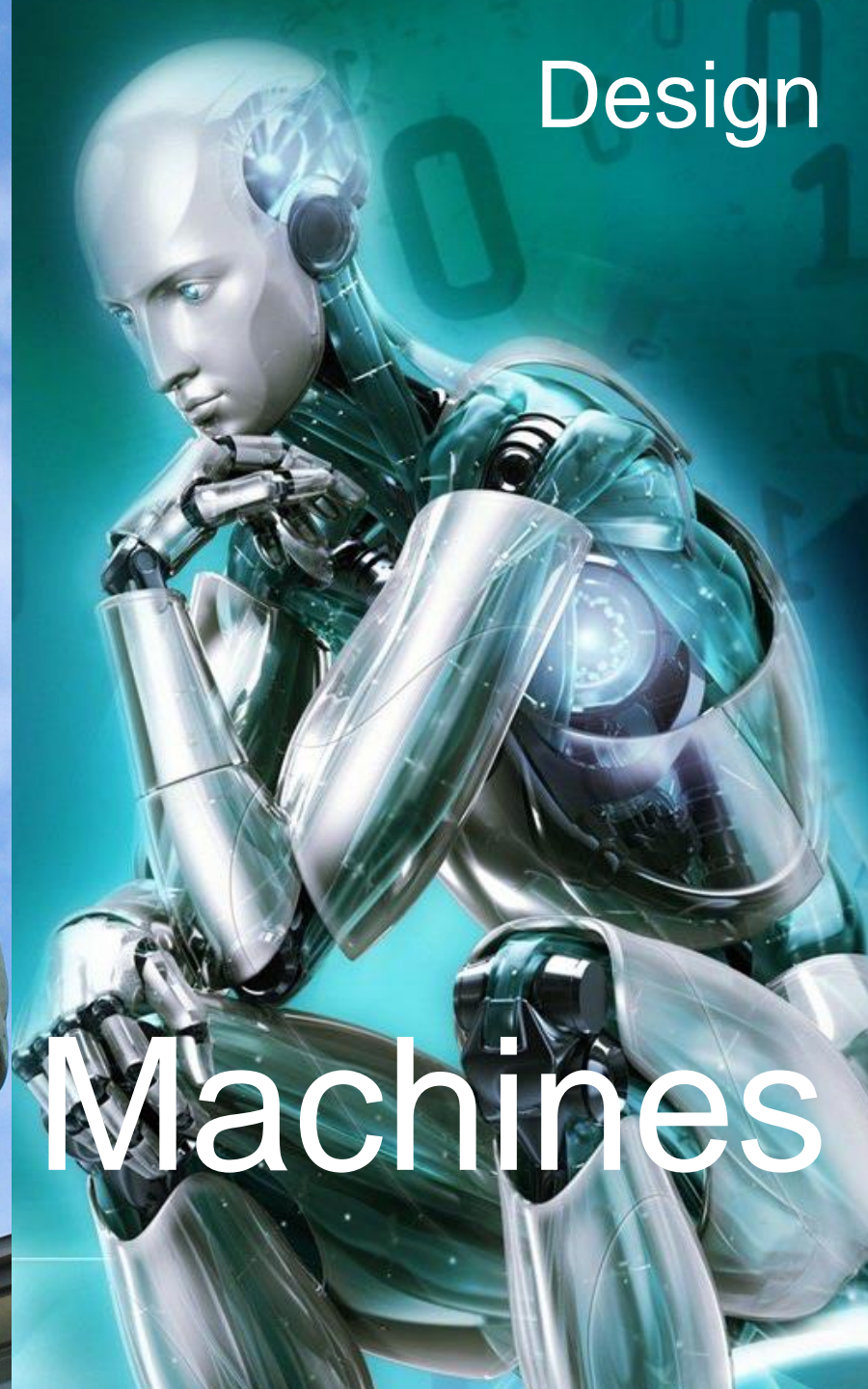
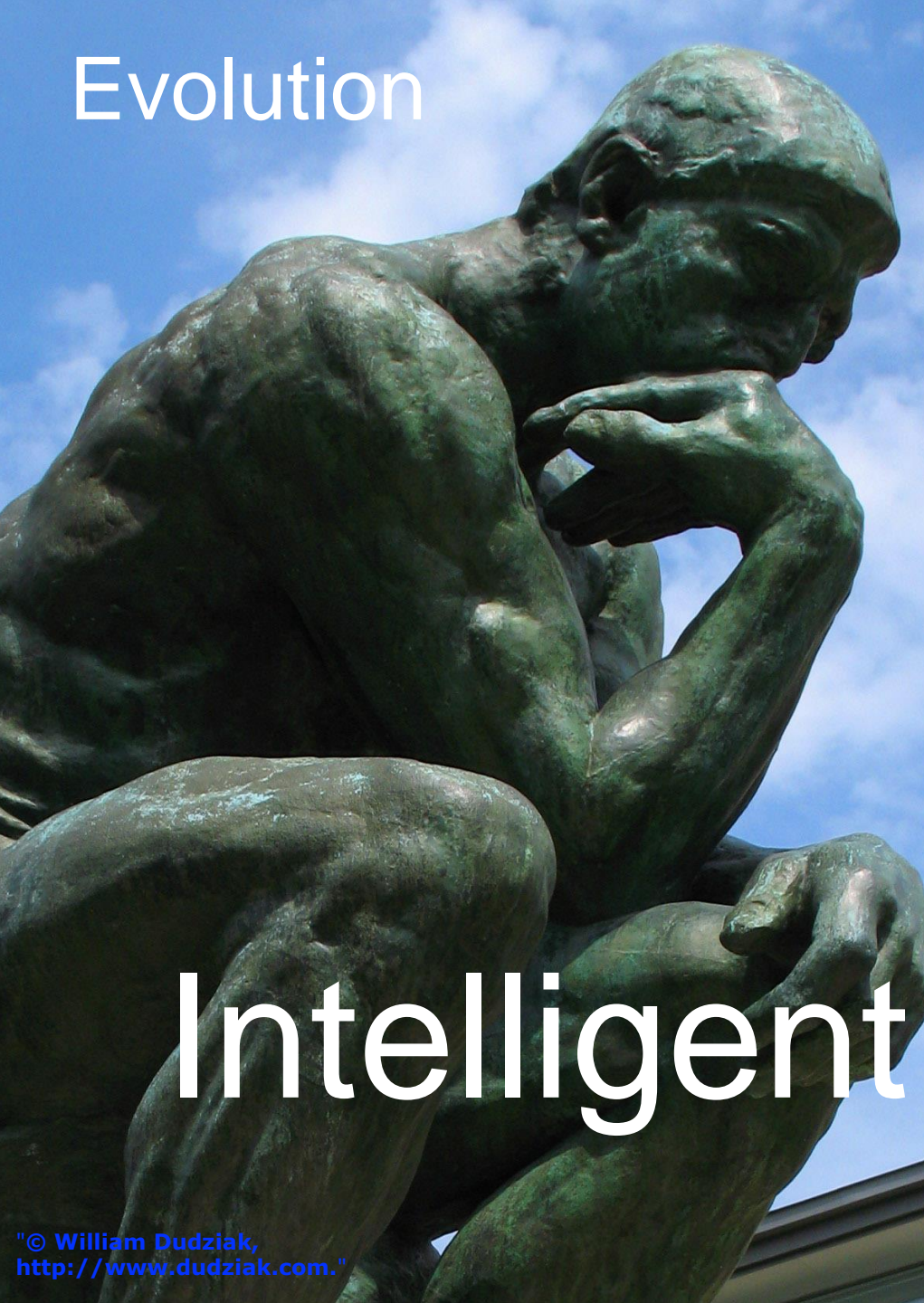
Knowing what to do Next

Hermann Hauser Cambridge 3rd April 2019

Evolution

Design

Intelligent Machines



Contents



Neurons vs. Transistors

Size: 20um

Speed: 1kHz

Brain: 100bn

Connections: 100tr

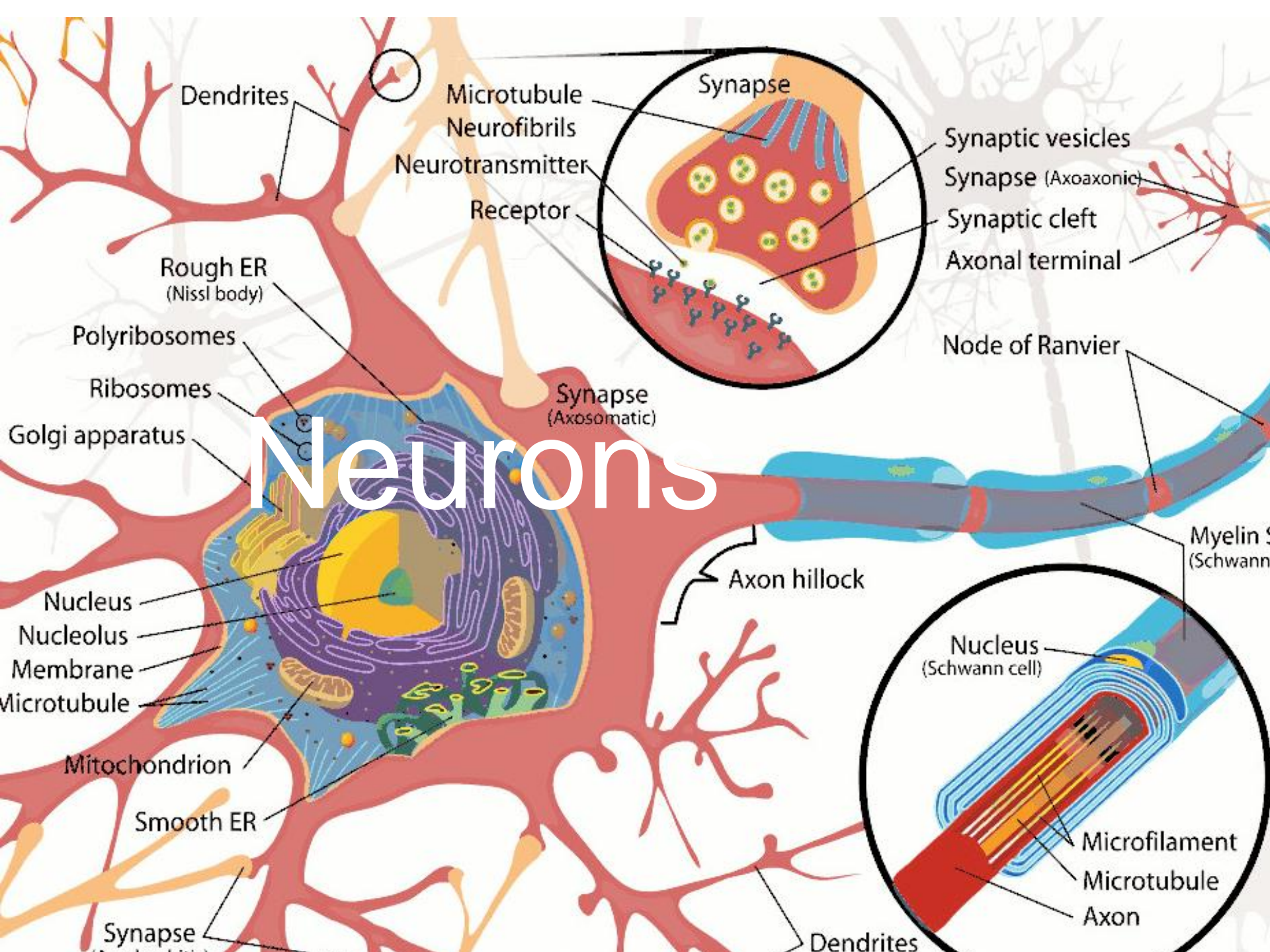
20nm 1000x

1GHZ 1,000,000x

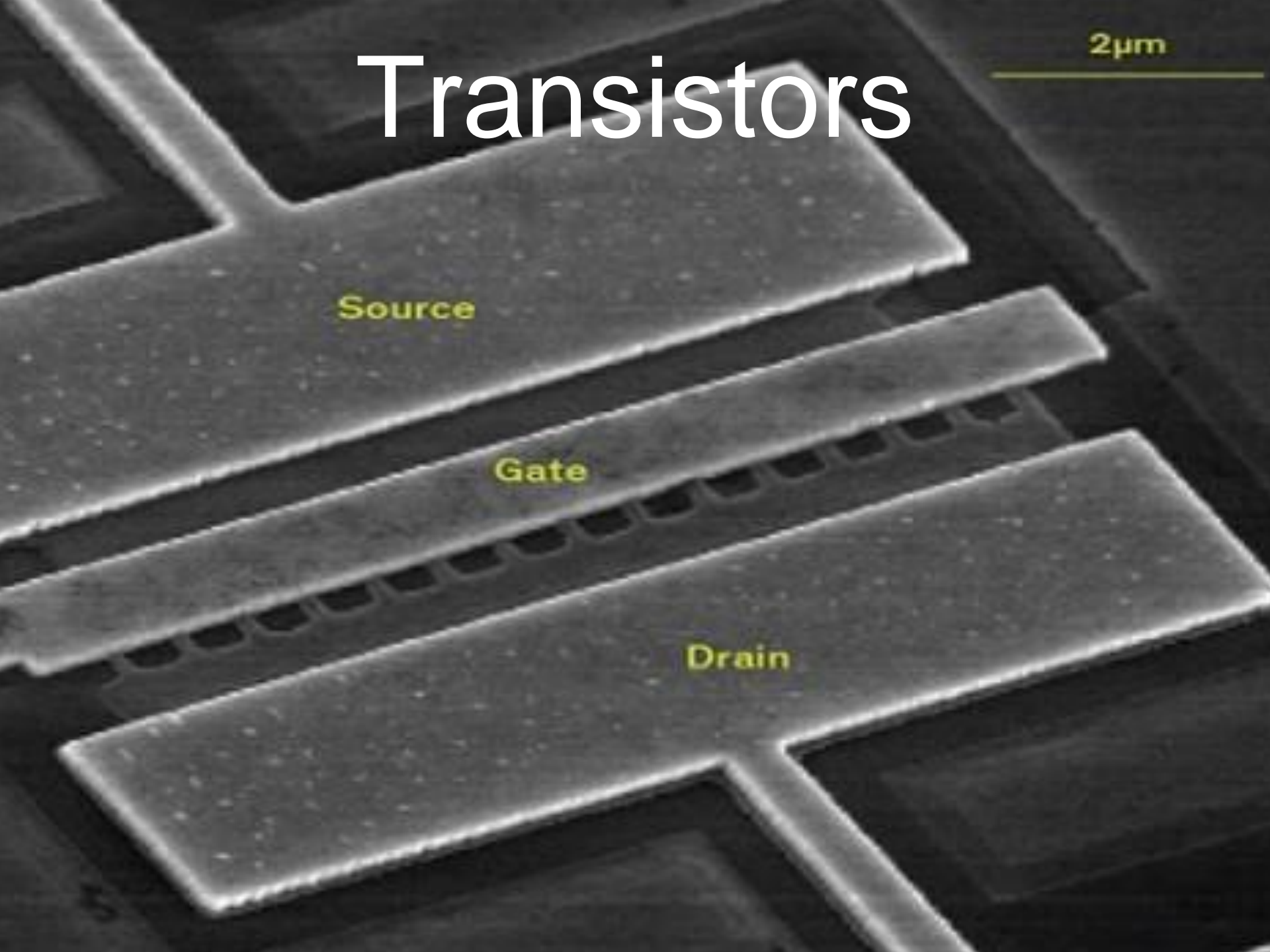
10bn 1/10x

Internet: 1bn hosts

20bn IOT connected



Transistors





Think

Brains vs.

Computers

Capacity:

10 to 100TB

Processing power:

10Peta-1ExaFLOPS

Power consumption:

20W

Connections: 100tr

Memory 512GB

1g

500TB

5x

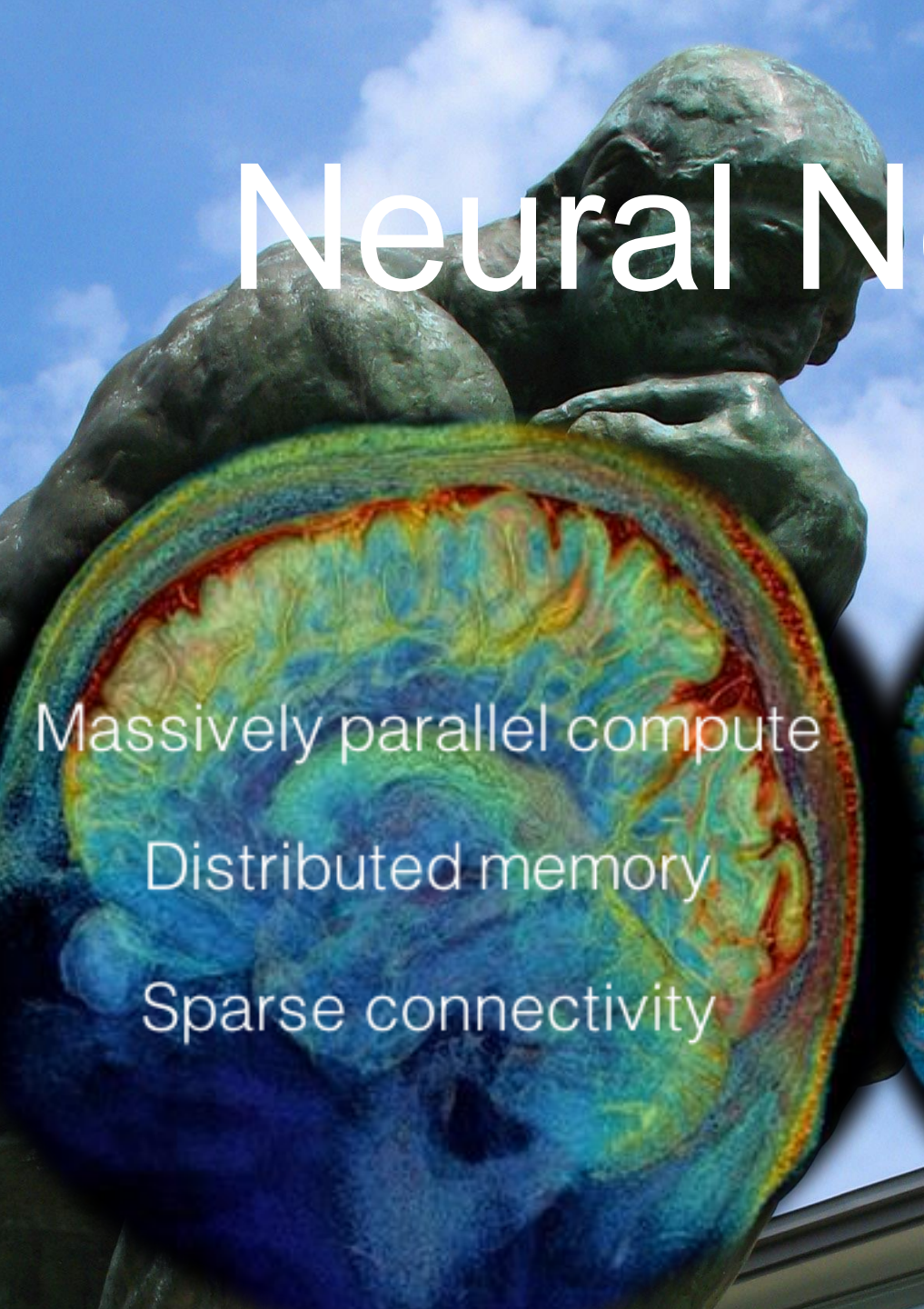
125TeraFLOPS: 1000x

200kW

10,000x

IPU Intelligent Processing Unit

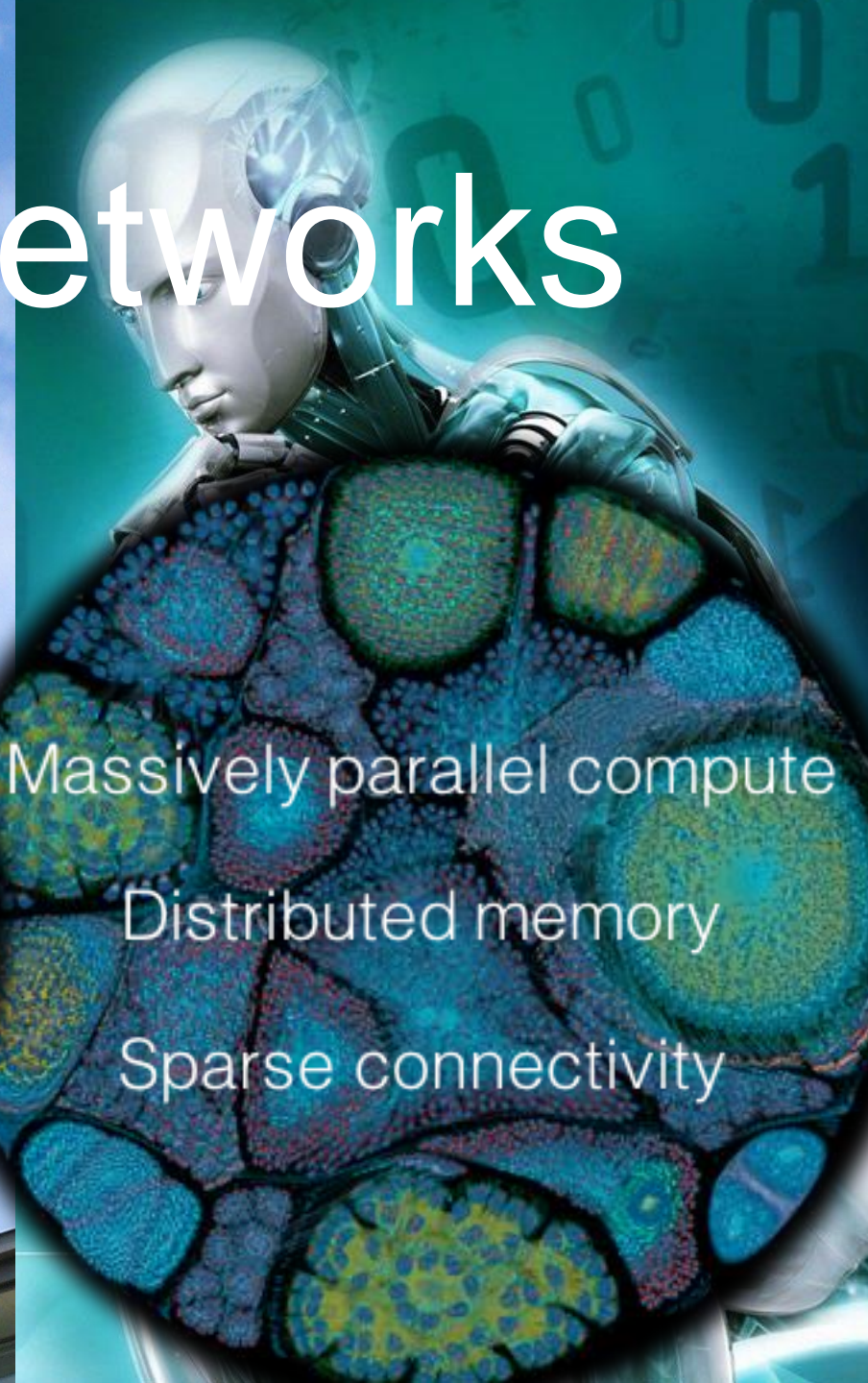
Neural Networks



Massively parallel compute

Distributed memory

Sparse connectivity

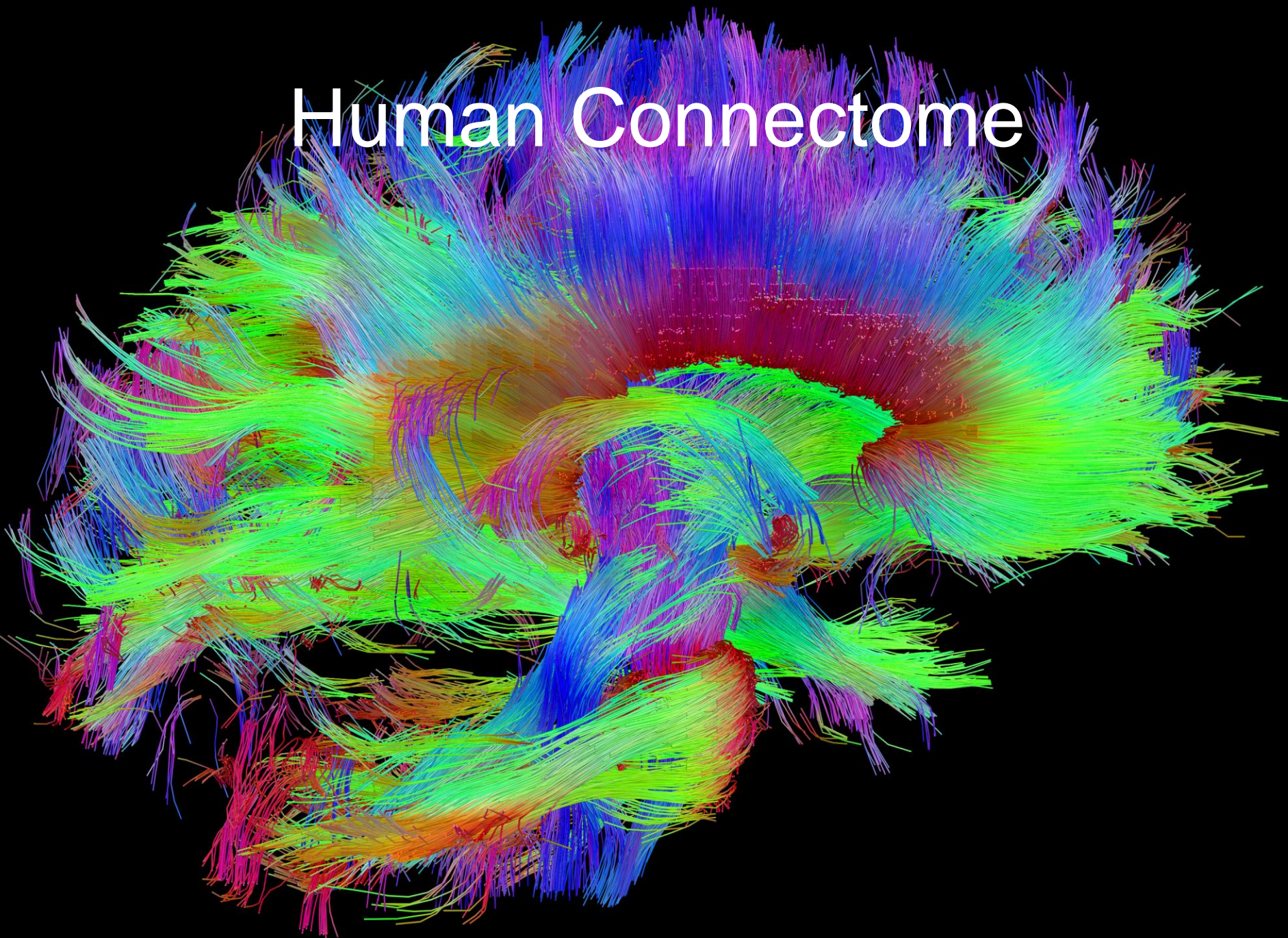


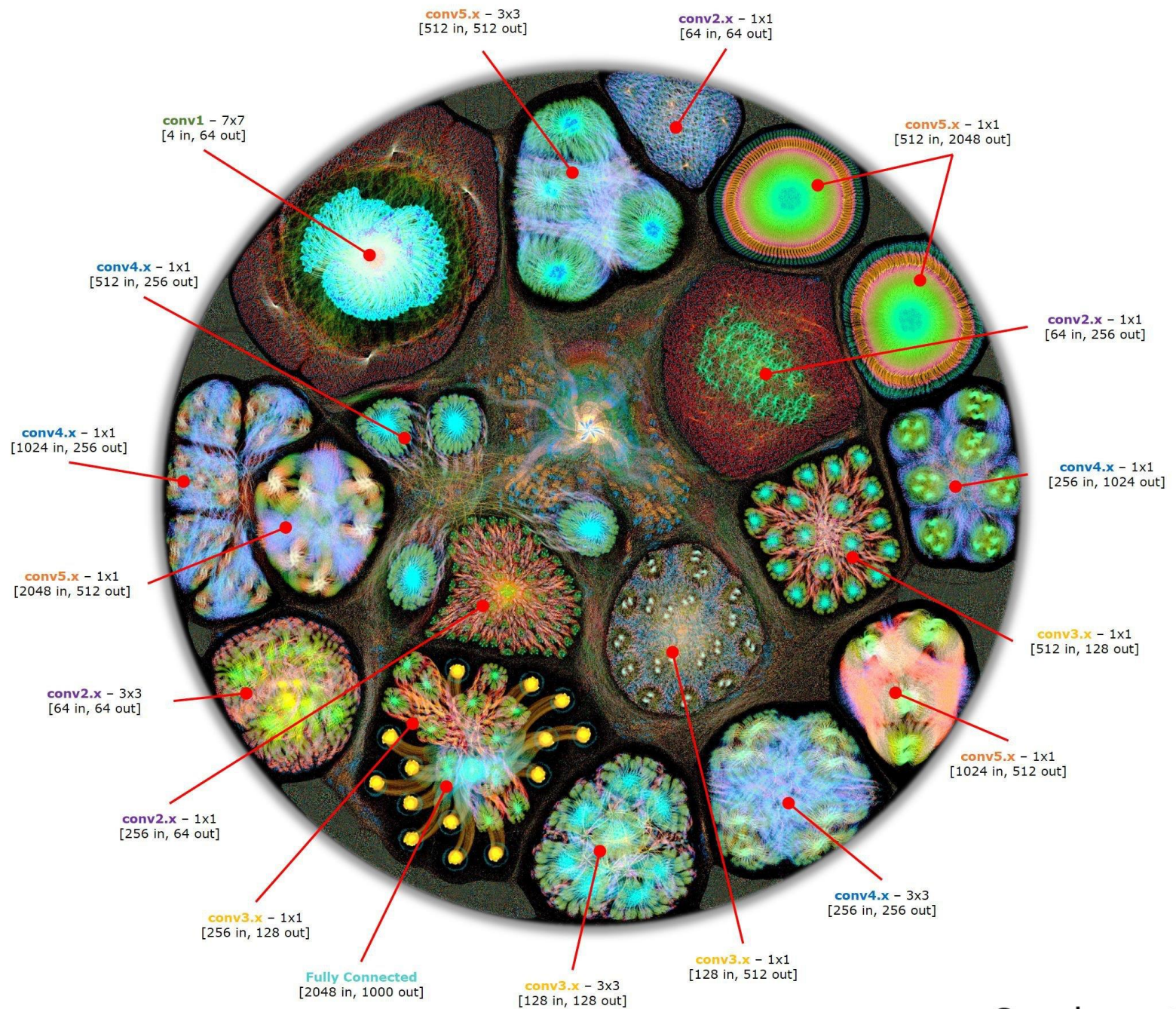
Massively parallel compute

Distributed memory

Sparse connectivity

Human Connectome

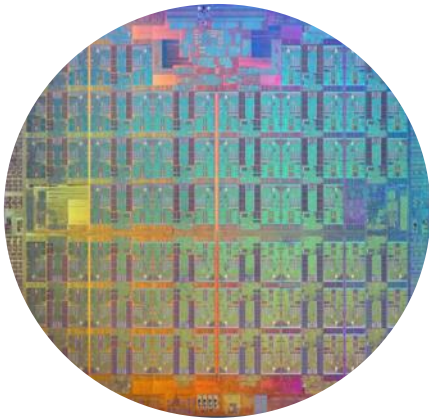




IPU (Intelligent Processing Unit)

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

A new type of processor is required



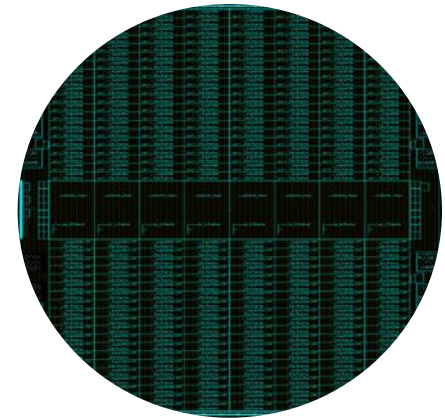
CPU = Scalar

Designed for office apps
Evolved for the web



GPU = Vector

Designed for graphics
Evolved for HPC



IPU = Graph

Designed for intelligence
The future of all computing



Hear



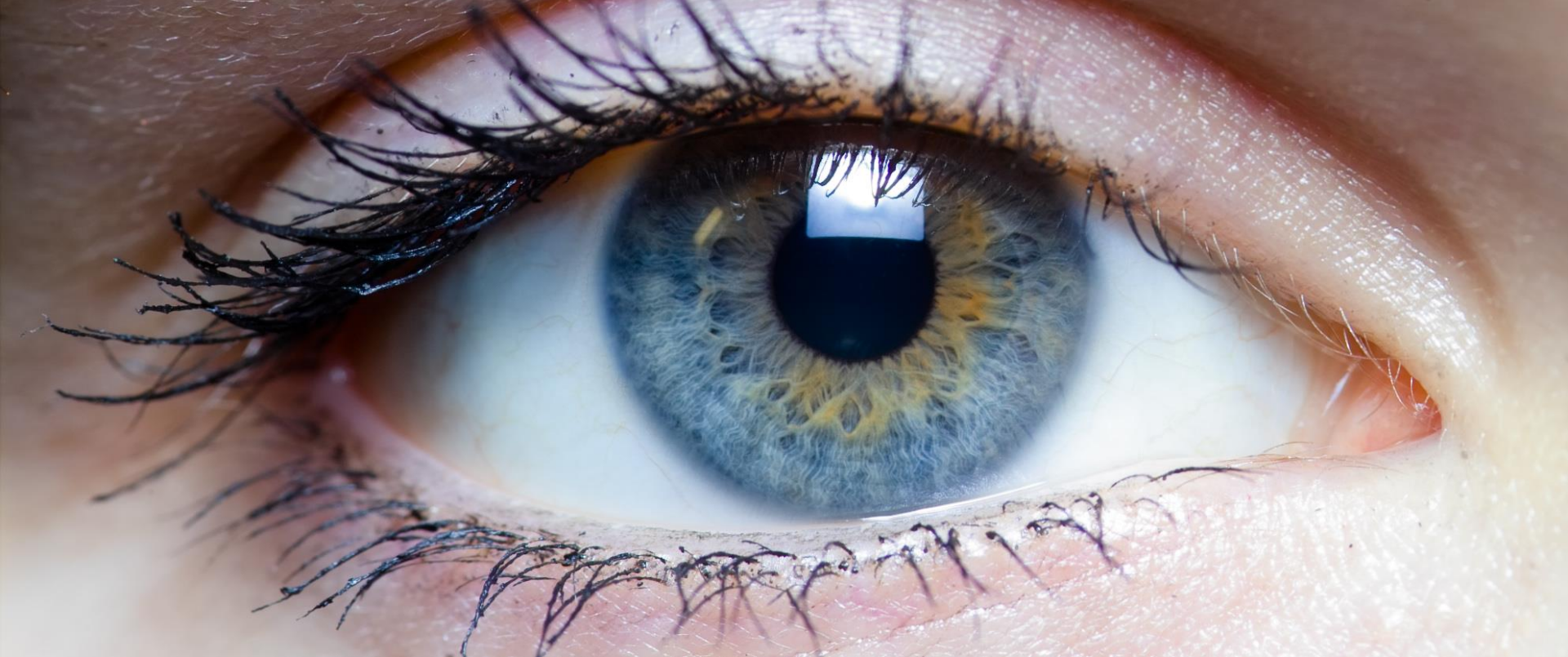
He
Ears vs



Microphones

Beam forming Microphone



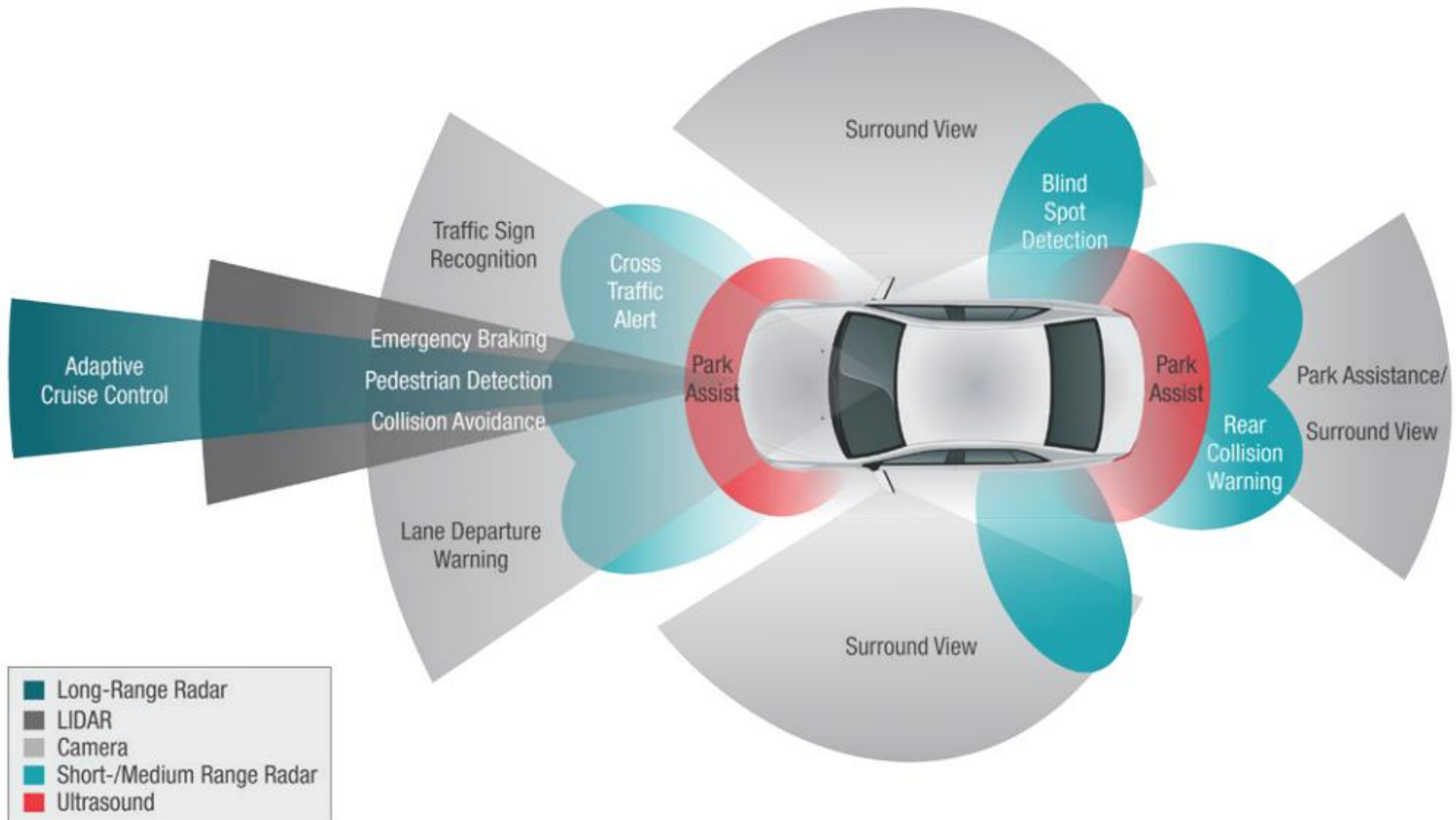




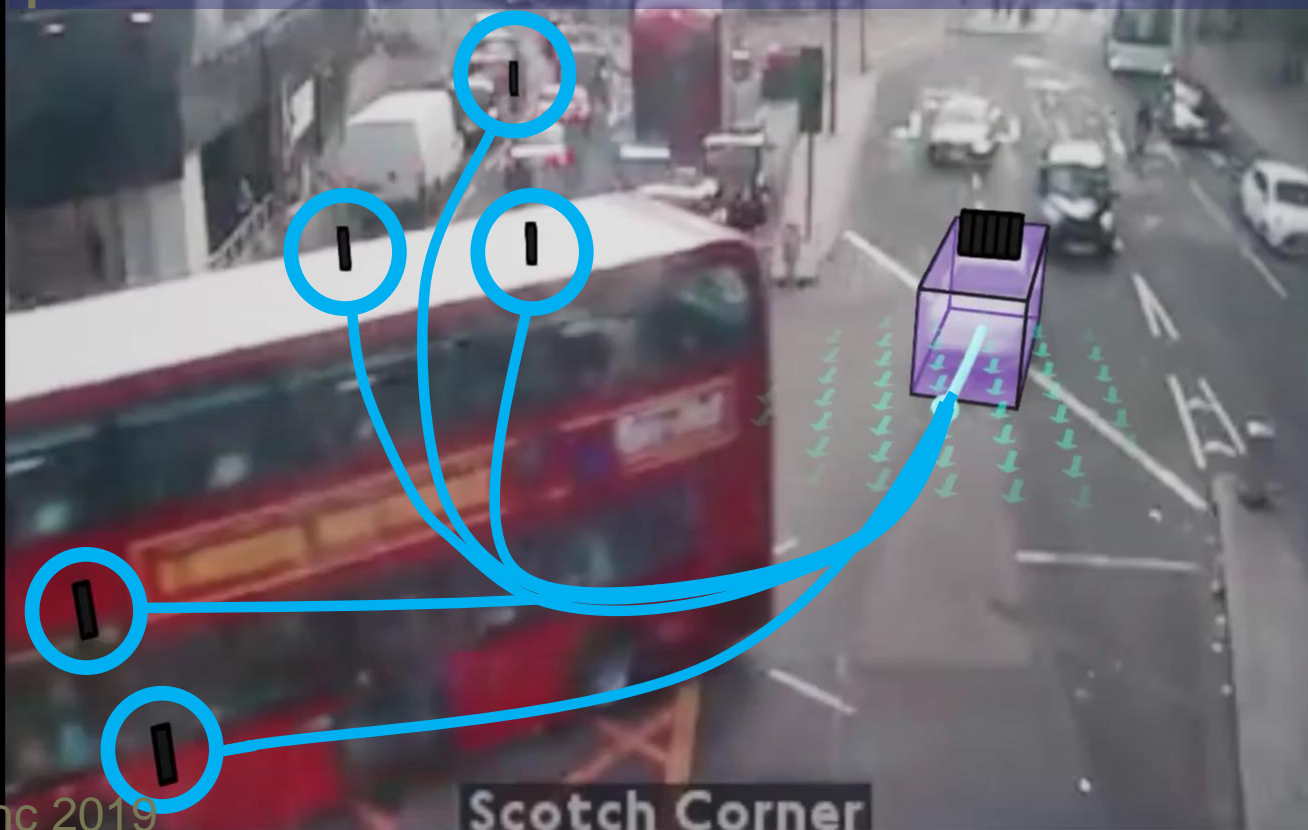
Many Cameras

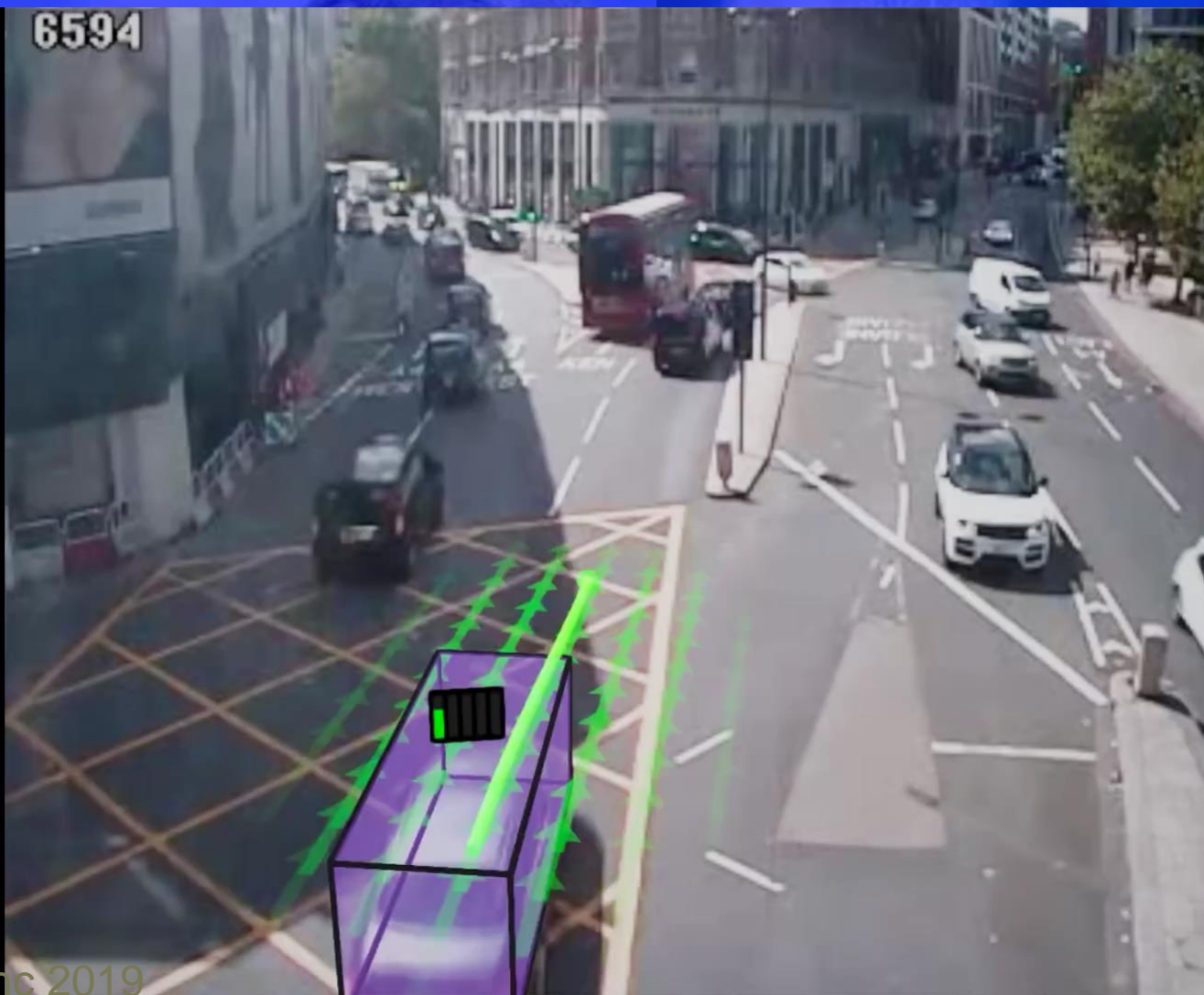


Self-driving car

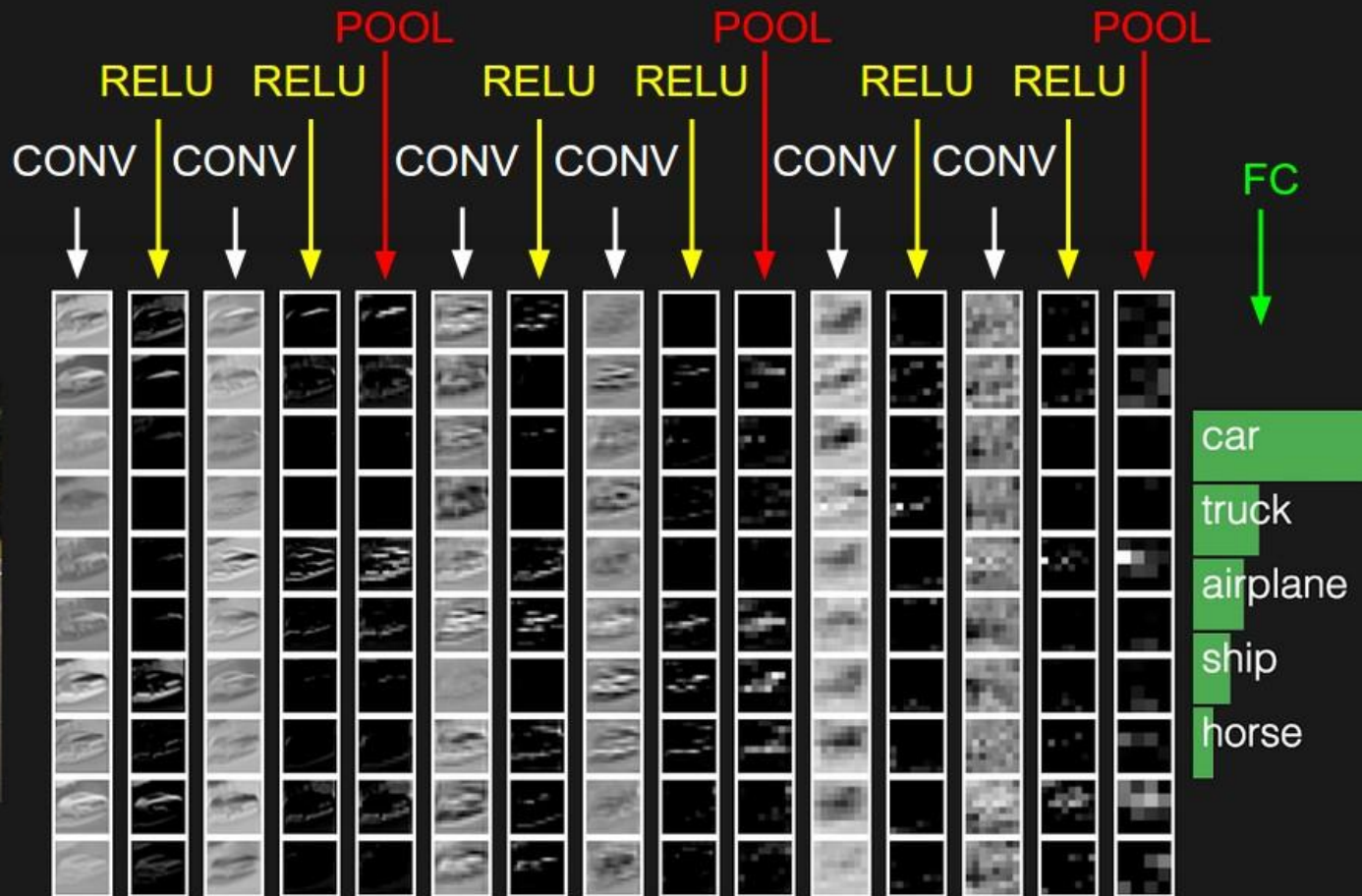


And use inverse planning to maintain beliefs around possible paths





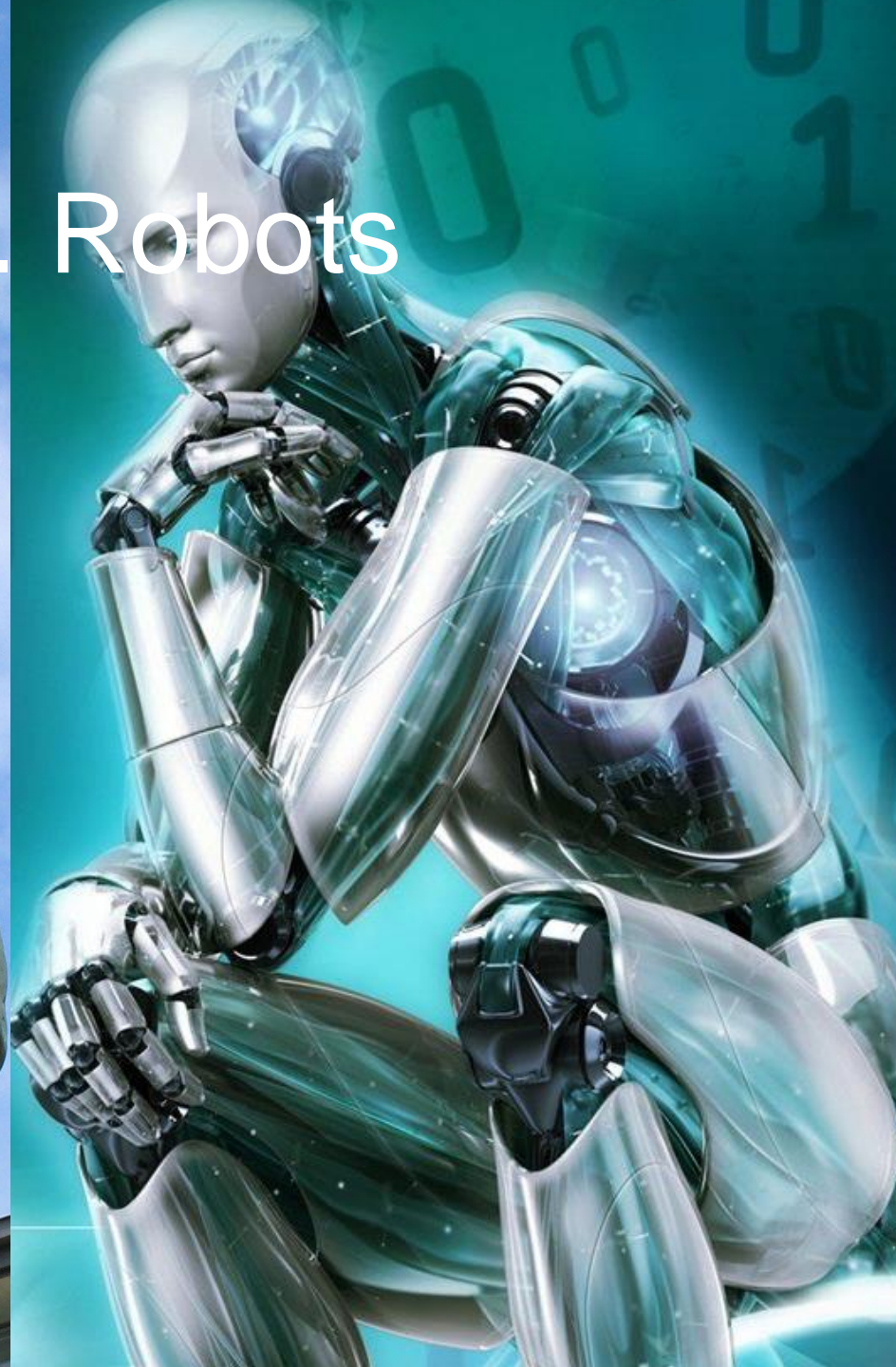
Convolutional Neural Networks





Move

Legs vs. Robots



Artificial Intelligence



AlphaGo



Google DeepMind Challenge Match 8 - 15 March 2016



Move 37 in game 2



Move 78 in game 4



Probability and ML

- NOT
- NOT deterministic
- NOT program
- Needs Big Data
- Needs (Human) S
- Genie Problem



Disruption

ARM Business model

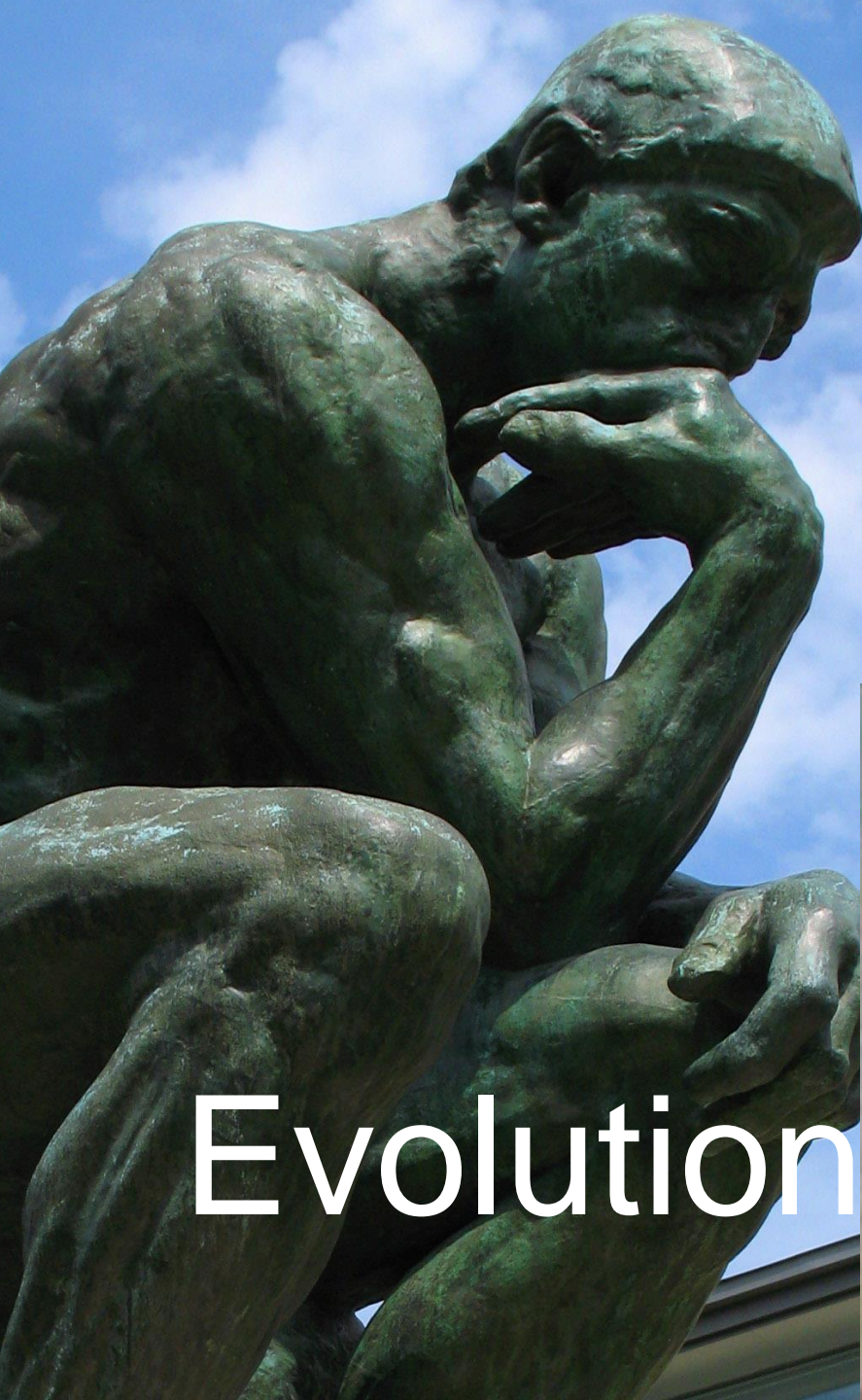
	Intel	ARM
Customer	Dell,HP	Samsung,Apple
Chipfab	Intel	TSMC+450
Design	Intel	ARM
Intellectual Property	Intel	ARM

ML effect on Pharma

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

Trillion \$ Opportunity

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



Evolution vs. D

USA

Google



China



Europe



World's Largest Companies by Market Capitalization

2007

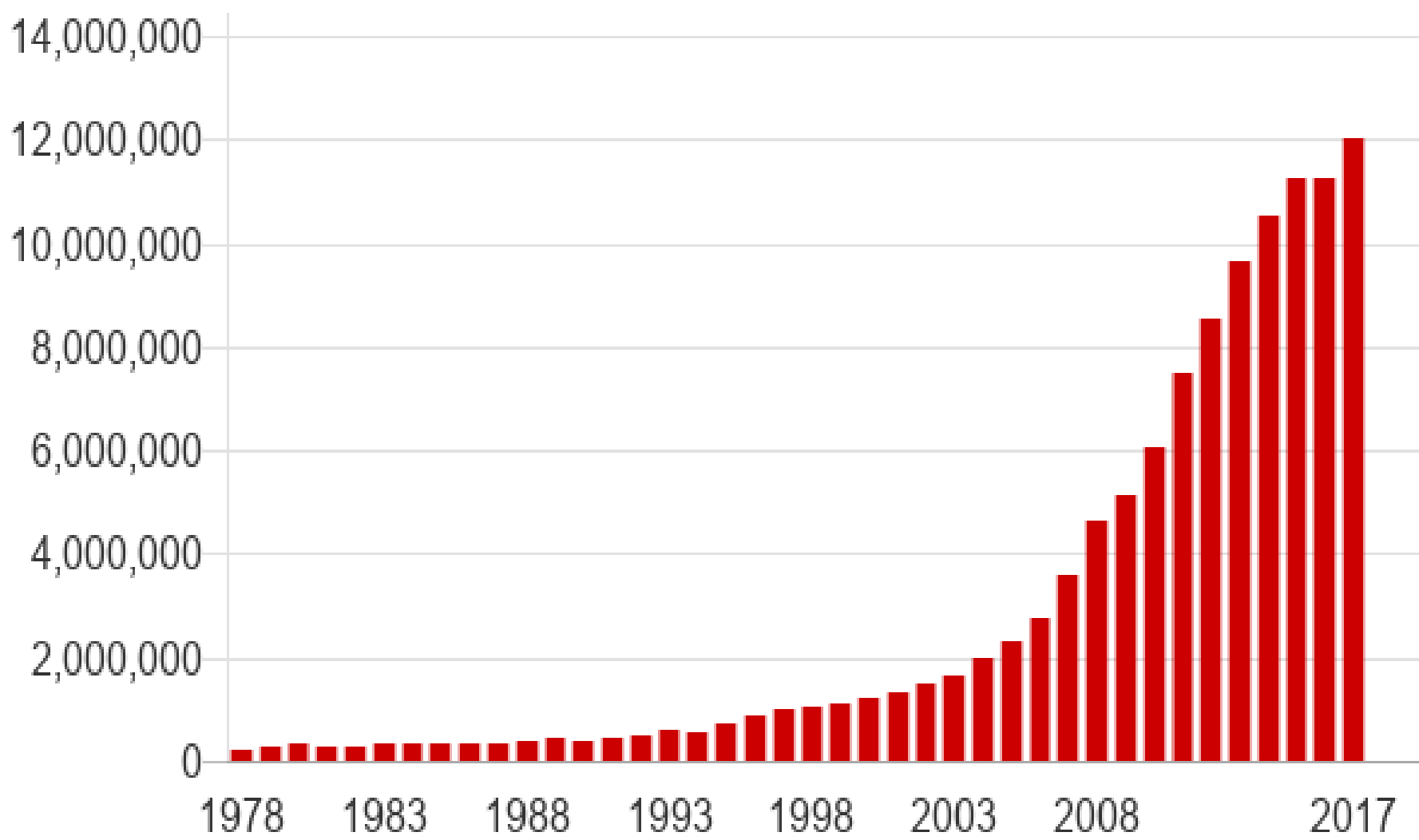
Exxon Mobil	467
General Electric	394
Microsoft	265
ICBC	259
Citigroup	243
AT&T	238
Royal Dutch Shell	232
Bank of America	230
PetroChina	225
China Mobile	207

2017

Apple	815
Alphabet	637
Microsoft	558
Facebook	485
Amazon	461
Berkshire Hathaway	438
Alibaba	415
Tencent	394
Johnson & Johnson	357
Exxon Mobil	323

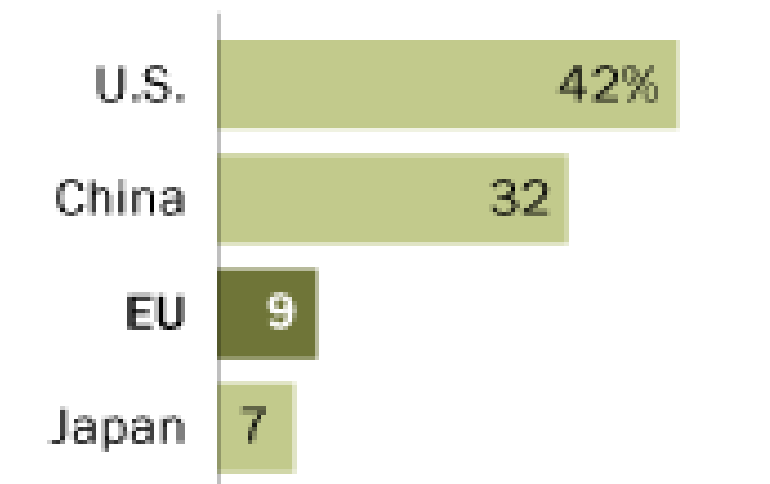
China's GDP

(billion US\$ at 2010 prices)

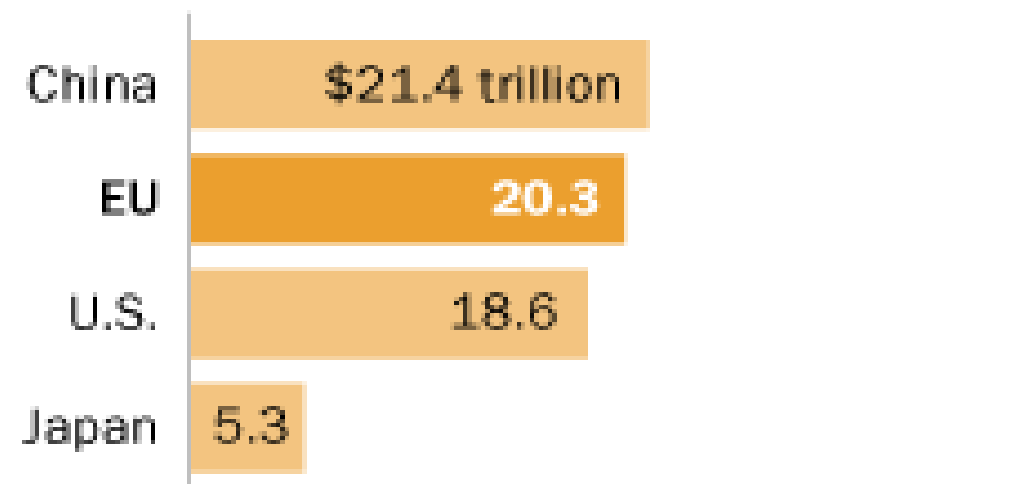


Despite EU's large economy, few see it as world's top economic power

% who say __ is the world's leading economic power



2016 GDP (current intl. dollars, based on purchasing power parity)



Note: Percentages are global medians based on 38 countries. Volunteered categories "Other" and "None/There is no leading economic power" not shown.
Source: Spring 2017 Global Attitudes Survey; World Bank, accessed Aug. 4, 2017.

4 Key Innovations

- AI & ML
- Blockchain + Smart Contracts
- Synthetic Biology
- Quantum Computing

EUROPEAN INNOVATION COUNCIL eic



Nicklas Bergman



Martin Bruncko



Paddy Cosgrave



Gráinne Dwyer



Hermann Hauser



Marjolein Helder



Taavet Hinrikus



Ingmar Hoerr



Bindi Karia



Jana Kolar



Carlos Oliveira



Jim Hagemann Snabe



Kinga Stanislawska



Constantijn
van Oranje



Roxanne Varza

Funding (1)

Empower the Innovator, Simplify, Incentivise Private Investment

- 1) Simplify current schemes into a small set of “EIC Awards” (grants and other forms of funding) supporting the emergence and the scaling up of breakthrough market-creating innovation
- 2) Enable grants, loans and equity investments to be awarded in combination



USA



China



Europe

Conclusion

