Artificial Intelligence, Neurotechnologies and Human Augmentation

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YUFE Academy, 6.12.2022

Toruń


Rockall (U.K.)
ORKNEY ISLANDS
HEBRIDES
North Atlantic Ocean
Bergen
Oslo
Stockholm
ALAND ISLANDS
Tallinn
ESTONIA
RUSSIA
Moscow
Stavanger
Aberdeen
Göteborg
Gotland
Riga
LATVIA
Glasgow
Edinburgh
UNITED
North Sea
Skagerrak
Kattegat
Baltic Sea
Öland
DENMARK
Copenhagen
Malmö
LITHUANIA
Vilnius
Vitsyebsk
Smolensk
Mahilyow
Minsk
Kaliningrad
RUSSIA
Bornholm
BELARUS
Belfast
Isle of Man (U.K.)
Irish Sea
Dublin
IRELAND
Leeds
Manchester
Liverpool
KINGDOM
Gdańsk
Hrodna
Homyel'
Hamburg
Bremen
Berlin
Poznań
Warsaw
Brest
Cardiff
Birmingham
Amsterdam
NETH.
Rotterdam
POLAND
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Kiev
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Celtic Sea
London
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Cologne
Wrocław
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BEL.
Bonn
GERMANY
Prague
Kraków
UKRAINE
English Channel
Guernsey (U.K.)
Jersey (U.K.)
Frankfurt am Main
CZECH REPUBLIC
Brno
SLOVAKIA
L'viv
Chernivtsi
Mykolayiv
Luxembourg
LUX.
Paris
Stuttgart
Bratislava
Chişinău
Strasbourg
Munich
Vienna
Budapest
Cluj-Napoca
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MOLDOVA
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Nantes
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AUSTRIA
HUNGARY
Zürich
Bern
SWITZ.
Vaduz
Geneva
FRANCE
ROMANIA
Bay of Biscay
Ljubljana
Zagreb
Bucharest
Constanța
SLOVENIA
MASSIF CENTRAL
Lyon
Milan
Venice
Turin
Bordeaux
BOSNIA AND HERZEGOVINA
Belgrade
Varna
Black Sea
Genoa
CROATIA
Bilbao
Toulouse
SAN MARINO
Sarajevo
Serbia
BULGARIA
MONACO
Andorra la Vella
Marseille
Ligurian Sea
Florence
Sofia
Porto
PYRENEES
ANDORRA
ITALY
Adriatic Sea
Podgorica
Skopje
İstanbul
Zaragoza
Corsica
Rome
F.Y.R.O.M.
Madrid
Barcelona
VATICAN CITY
Tirana
Thessaloniki
Bursa
ALB.

Toruń

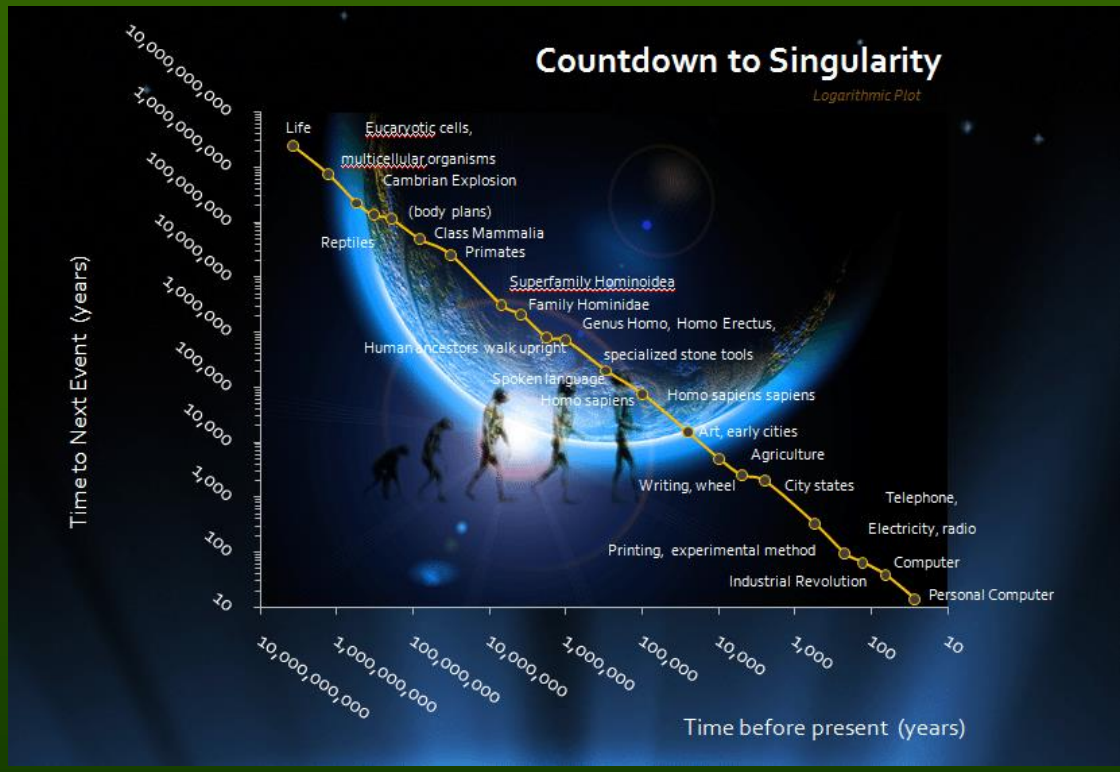
Nicolaus Copernicus, born in 1473 in Toruń (550 years ago).
Studied in Krakow, Bologna, Padova and Ferrara

Are we close to the Singularity?

1. Autonomous Artificial Intelligence.
2. Superhuman level.
3. Brain-computer interfaces for human augmentation.
4. Neurotechnologies to restructure our brains.

Are we on the threshold of a pleasant dream, or of a nightmare?

Is transhuman society around the corner?



Each new technological revolution comes faster than the previous one.

Development of civilization

We are in extraordinary moment in the history of the world!

Growing understanding of the world, since antiquity:

1. **Magical thinking**: the whims of the gods, fatalism.
2. **Protoscience**: empirical observations, causality, descriptive knowledge.
3. **Classical science**: theories, empirical verification, math and statistics.
4. **Computer simulations**: complex systems, “new kind of science” (Wolfram).
5. **Big data**: knowledge from large amount of data (KDD).
6. **Artificial intelligence**: support for thinking, autonomous AI.
7. **Superhuman augmentation**: coupling AI with brains, in near future?

Science in the new era

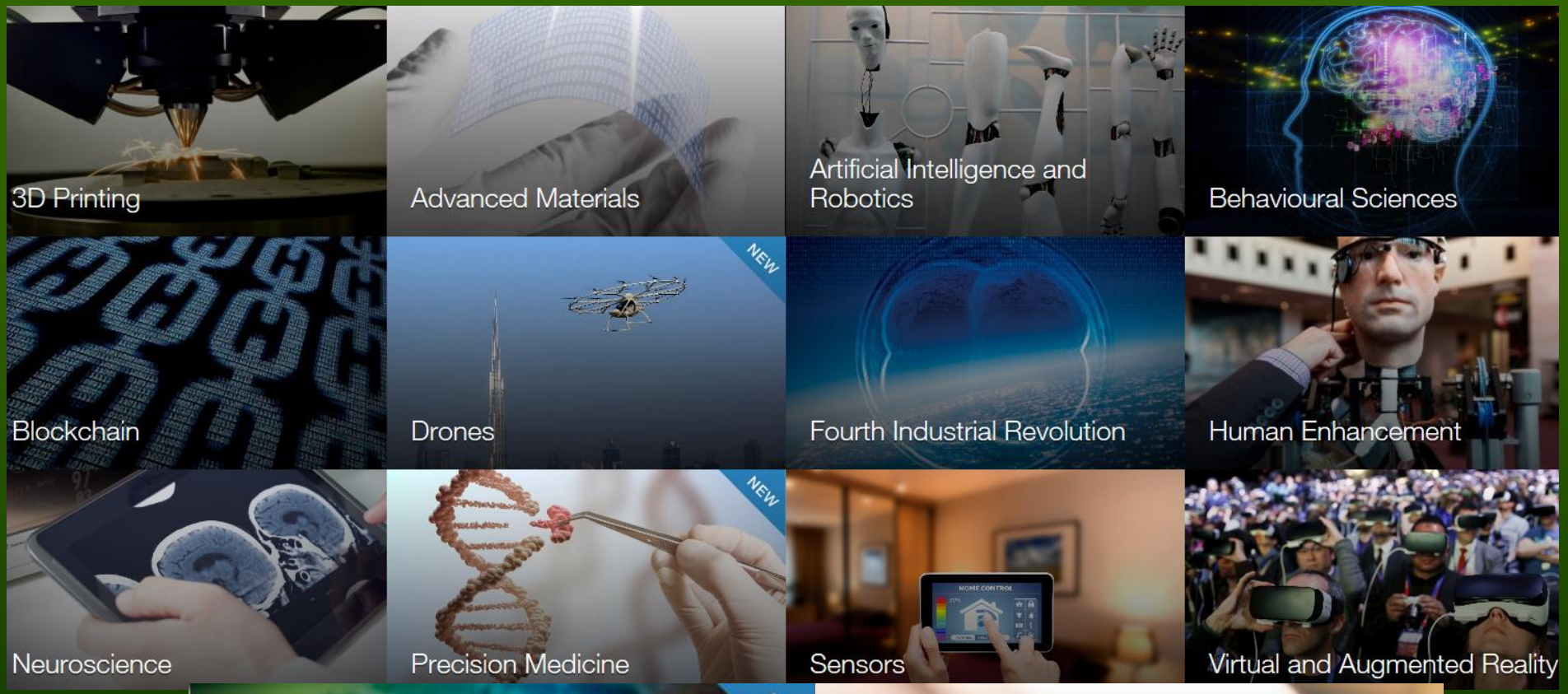
1st paradigm	2nd paradigm	3rd paradigm	4th paradigm	
Empirical science	**Theoretical science**	**Computational science**	**Big data-driven science**	**Accelerated discovery**
Observations Experimentation	Scientific laws Physics Biology Chemistry	Simulations Molecular dynamics Mechanistic models	Big data Machine learning Patterns Anomalies Visualzation	Scientific knowledge at scale AI-generated hypotheses Autonomous testing
Pre-Renaissance	**~1600s**	**~1950**	**~2000**	**~2020**

Increasing speed, automation, and scale

IBM Science and Technology Outlook 2021.

Increasingly complex data models: CyC, IBM Watson, GPT-3, Google Mixture of Experts (MoE), WuDao, models with more than trillion parameters ...

WEF: 4th Industrial Revolution driven by AI/neuro



Cogni
Cognitive sciences

Biohybrids

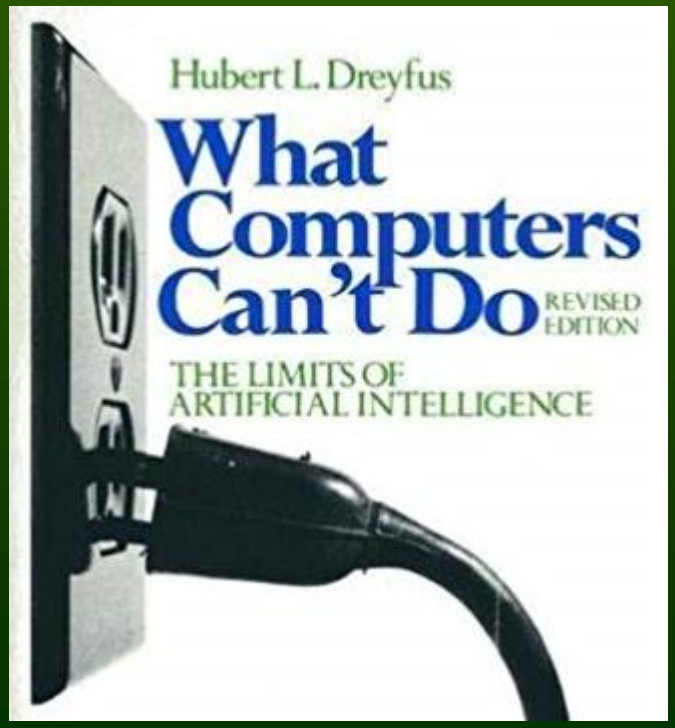
Bio
Neuroscience

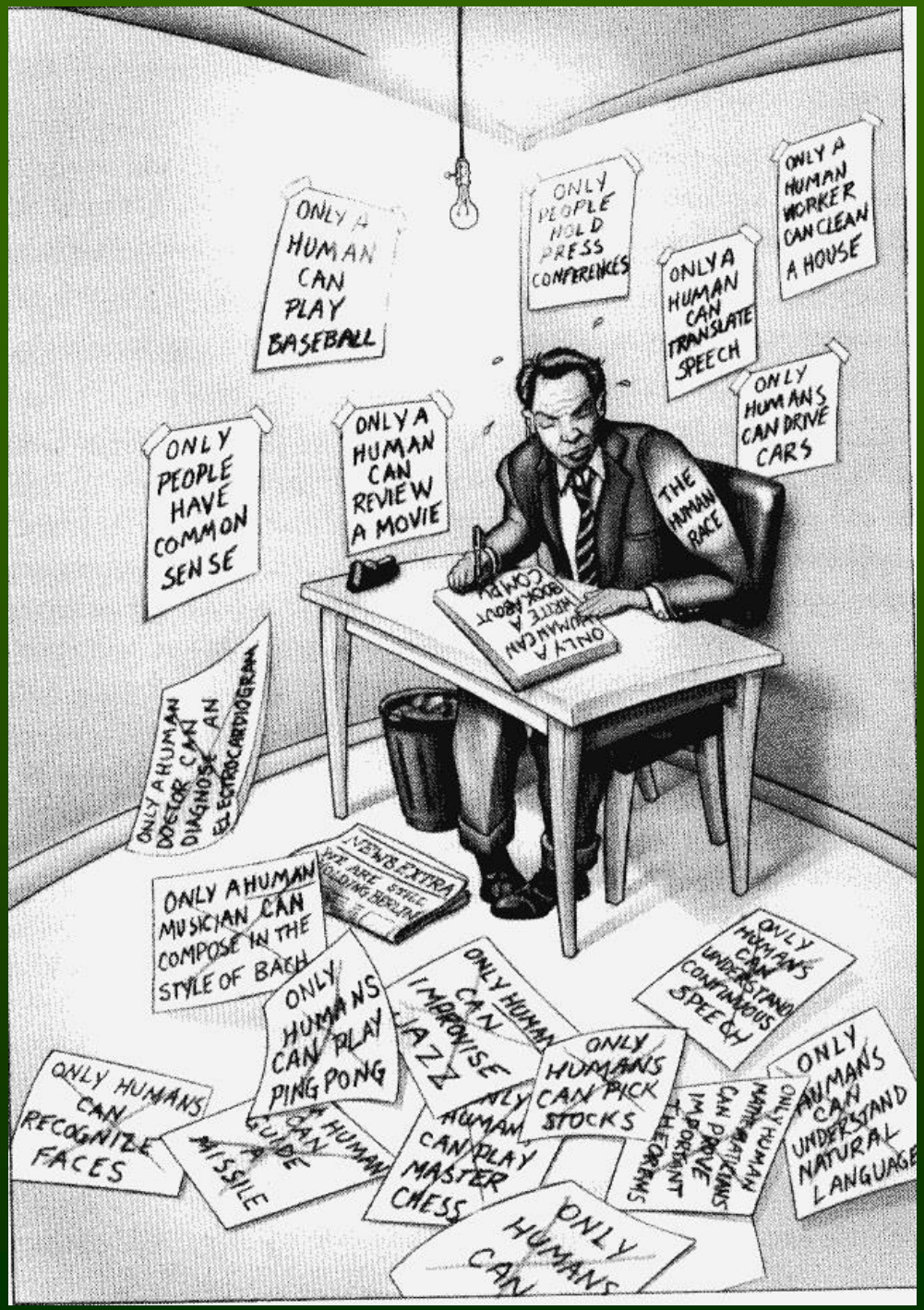
Nano
Quantum
Technologies

Neurocognitive
Informatics

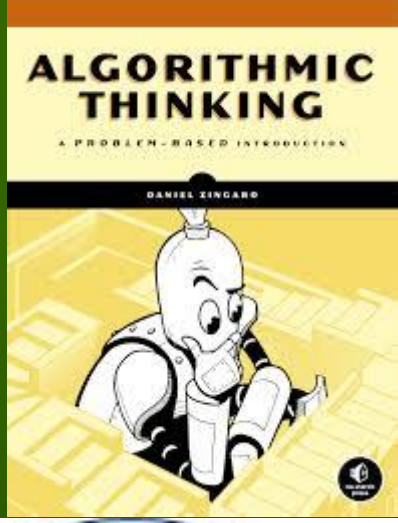
Info
Artificial/Computational Intelligence,
Machine Learning, Neural Networks

Intelligence is everything that artificial intelligence systems could not do …
Dreyfus (1972, 1992) critique was true, but only for the symbolic approach to AI, called now the GOFAI.



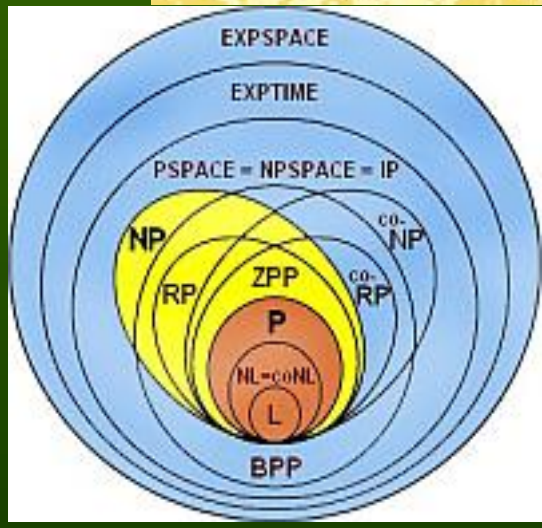


AI: computer science definition



Artificial Intelligence (AI) is a branch of computer science solving problems for which there are **no effective algorithms**.

Initially: AI was based on modeling knowledge, presented in symbolic, understandable way, dealing mainly with reasoning at the conceptual level.

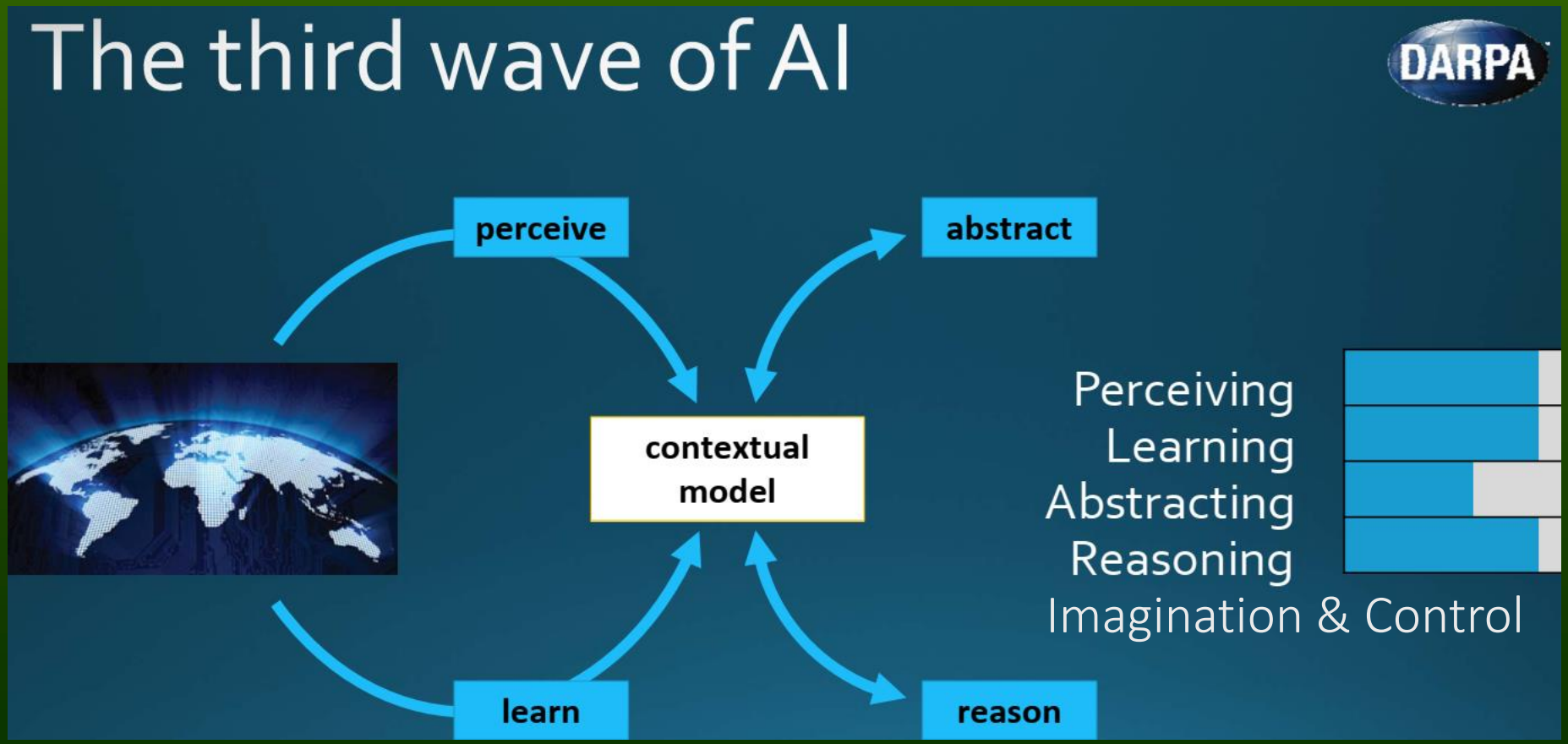


21 century: AI ≅ machine learning, functions that are performed intuitively by animals, like visual recognition, discovering structures in complex data + reasoning.
Most important technique: multilayer neural networks.
Neurocognitive technologies: neuro + cogito.

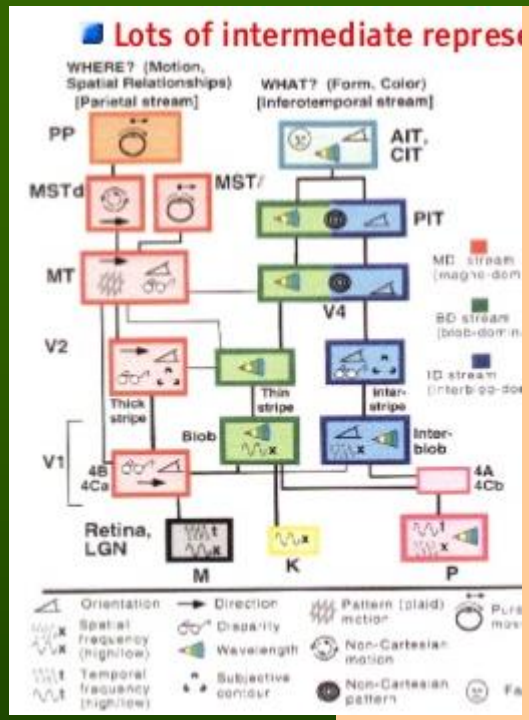
Governments want to regulate AI? Science is not an application.
Can we regulate algorithms or math equations?
All real-world applications (AI, software or any others) should be regulated.

AI history

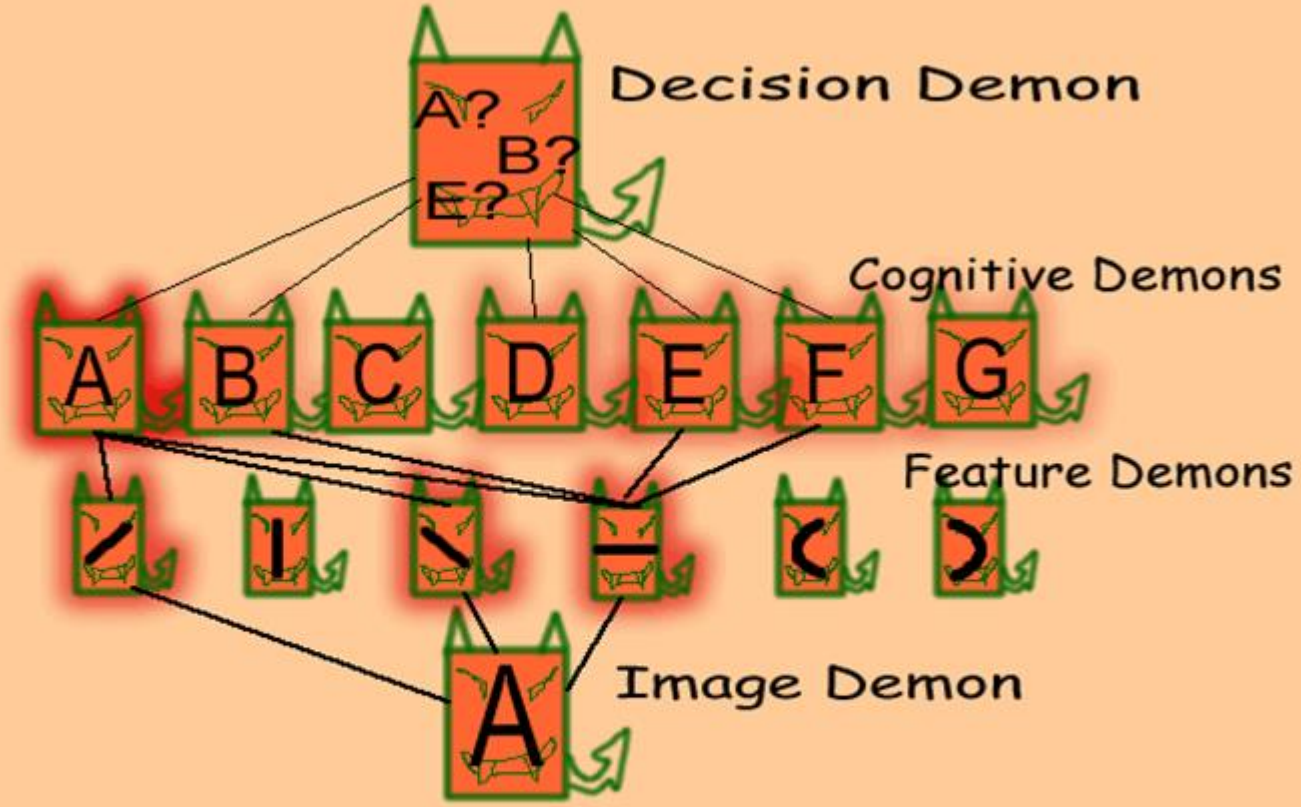
The First AI Wave (1980): rule-based, expert systems, classic GOFAI systems.
The Second AI Wave (2000): statistical, data-driven approaches, KDD.
Since 2014: GAN, Generative Adversarial Networks, artificial imagination!



Selfridge NN Model (1959)

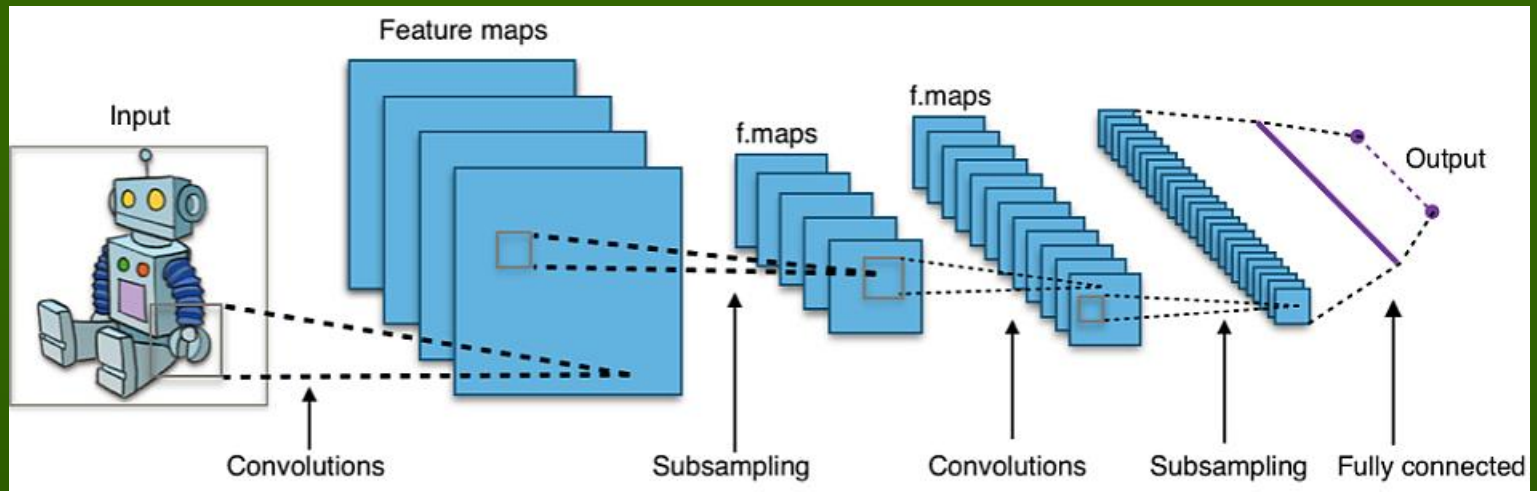


32 visual cortical areas were known in 1991!



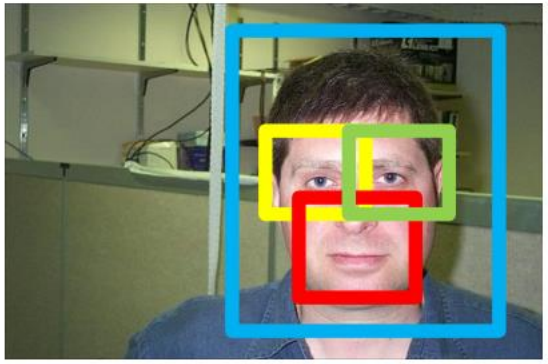
Based on:

Selfridge, O. G. (1959). *Pandemonium: A paradigm for learning.* In *Symposium on the mechanization of thought processes* (pp. 513-526). London: HM Stationery Office.



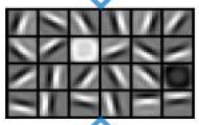
Feature representation

Input data



3rd layer
"Objects"

2nd layer
"Object parts"

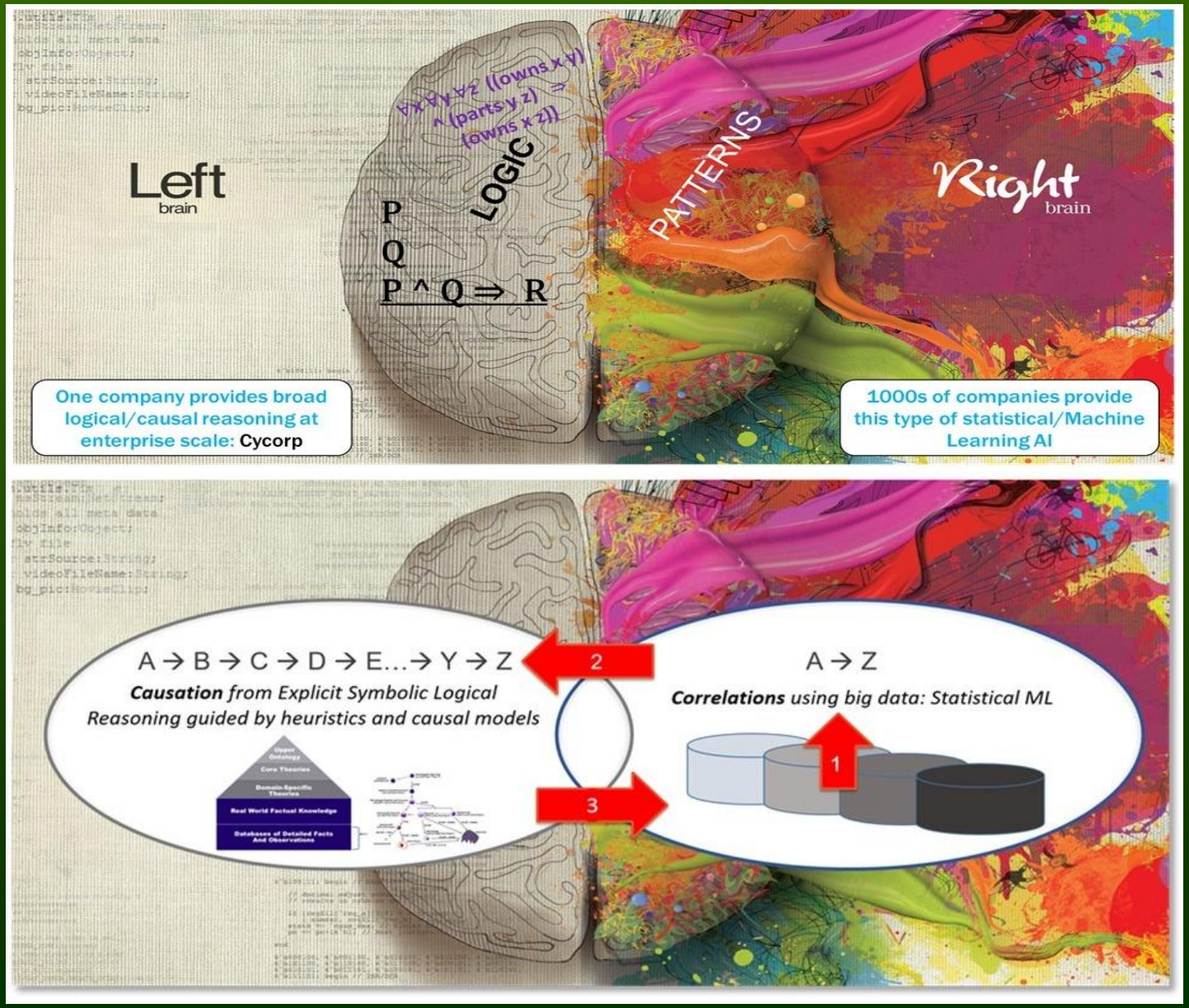


1st layer
"Edges"

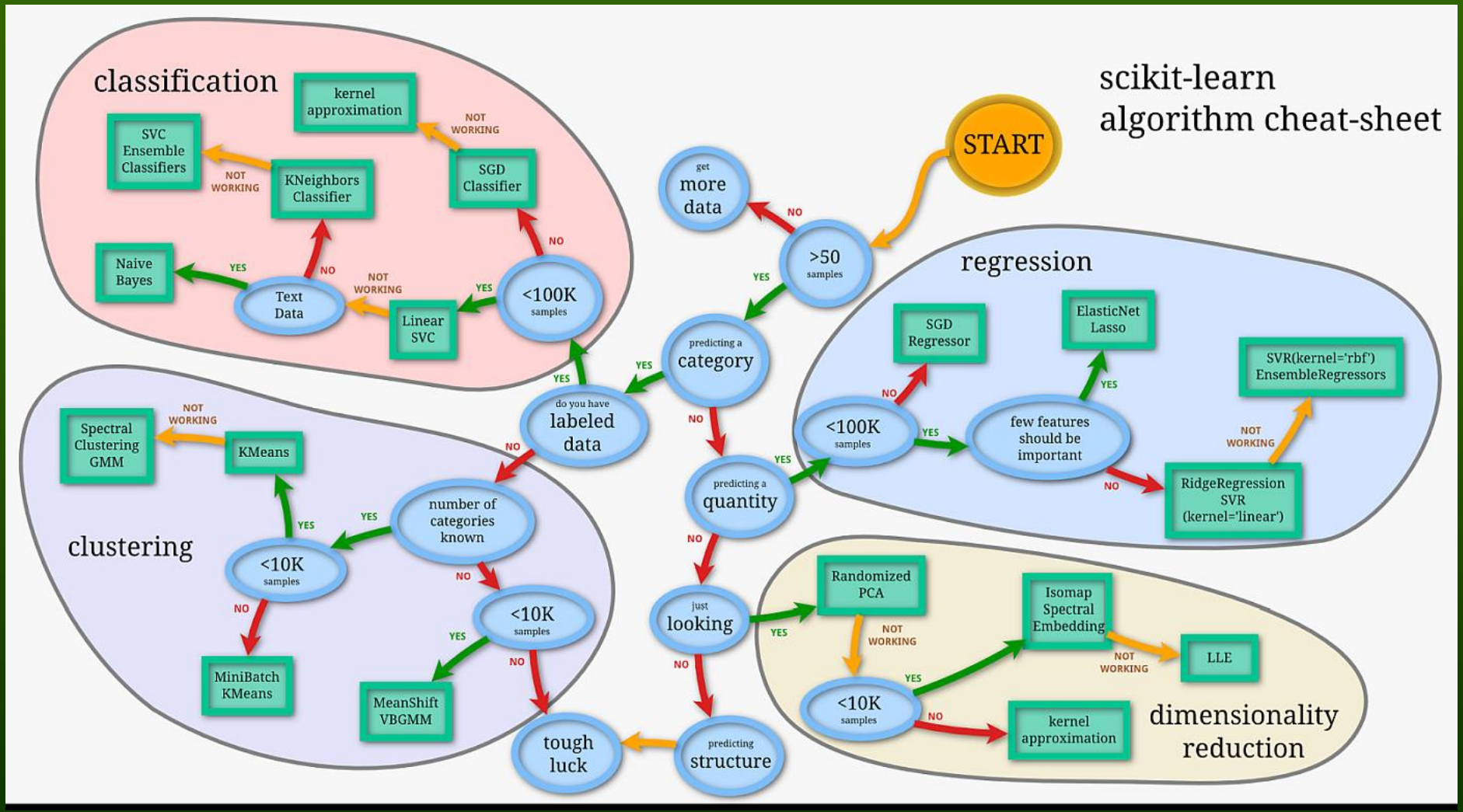
Pixels

Lee et al., ICML 2009;
CACM 2011

Third AI wave and brains

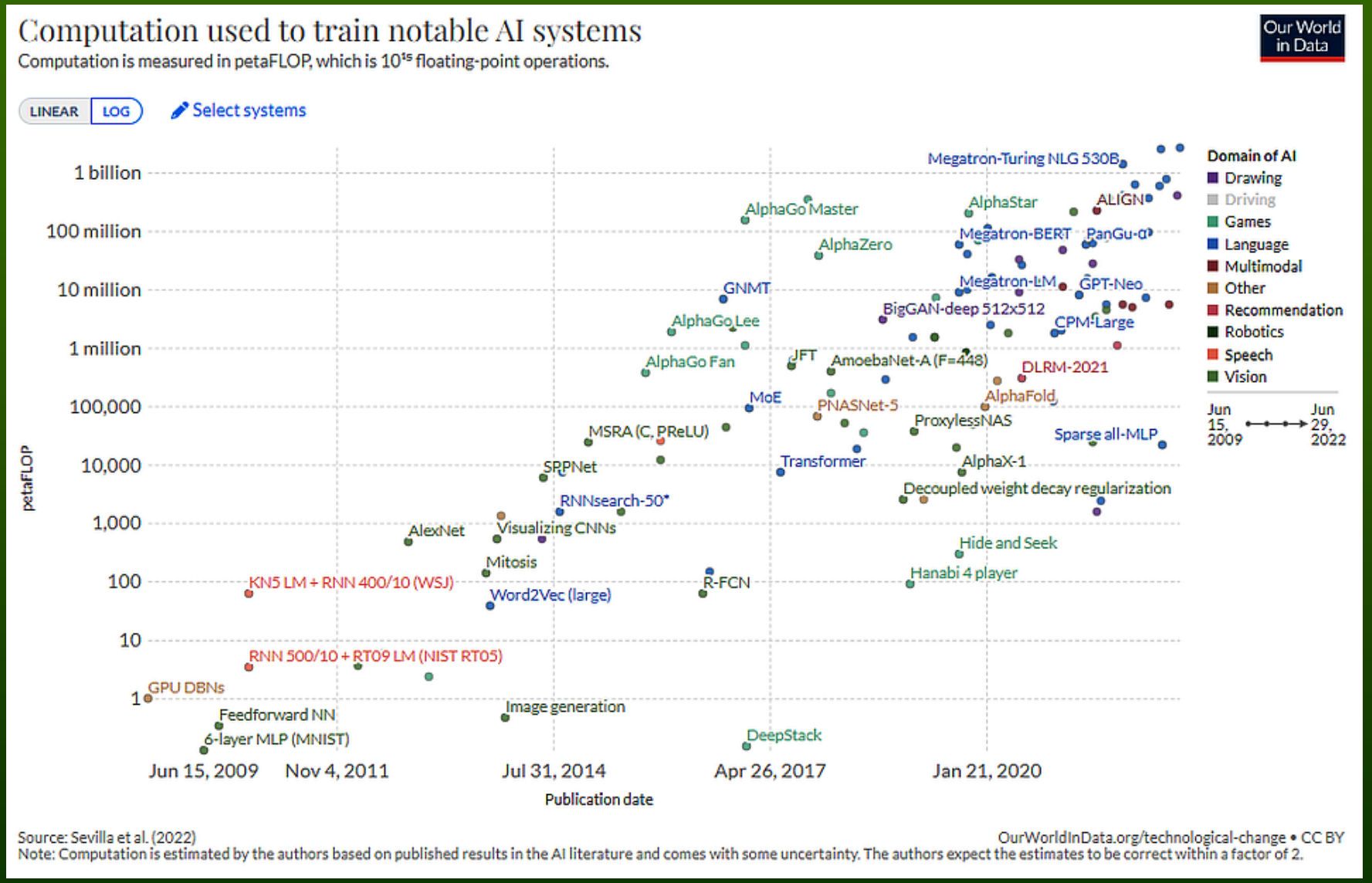


ML is easy - just pick up your method ...



Thousands of applications of machine learning are enabled by free powerful large systems, such as TensorFlow, Scikit-learn, Keras, MS Cognitive services …

Acceleration... speed and memory



Nanotechnologies for ML training: in 10 years from 1 Pflop to 1 billion Petaflops!

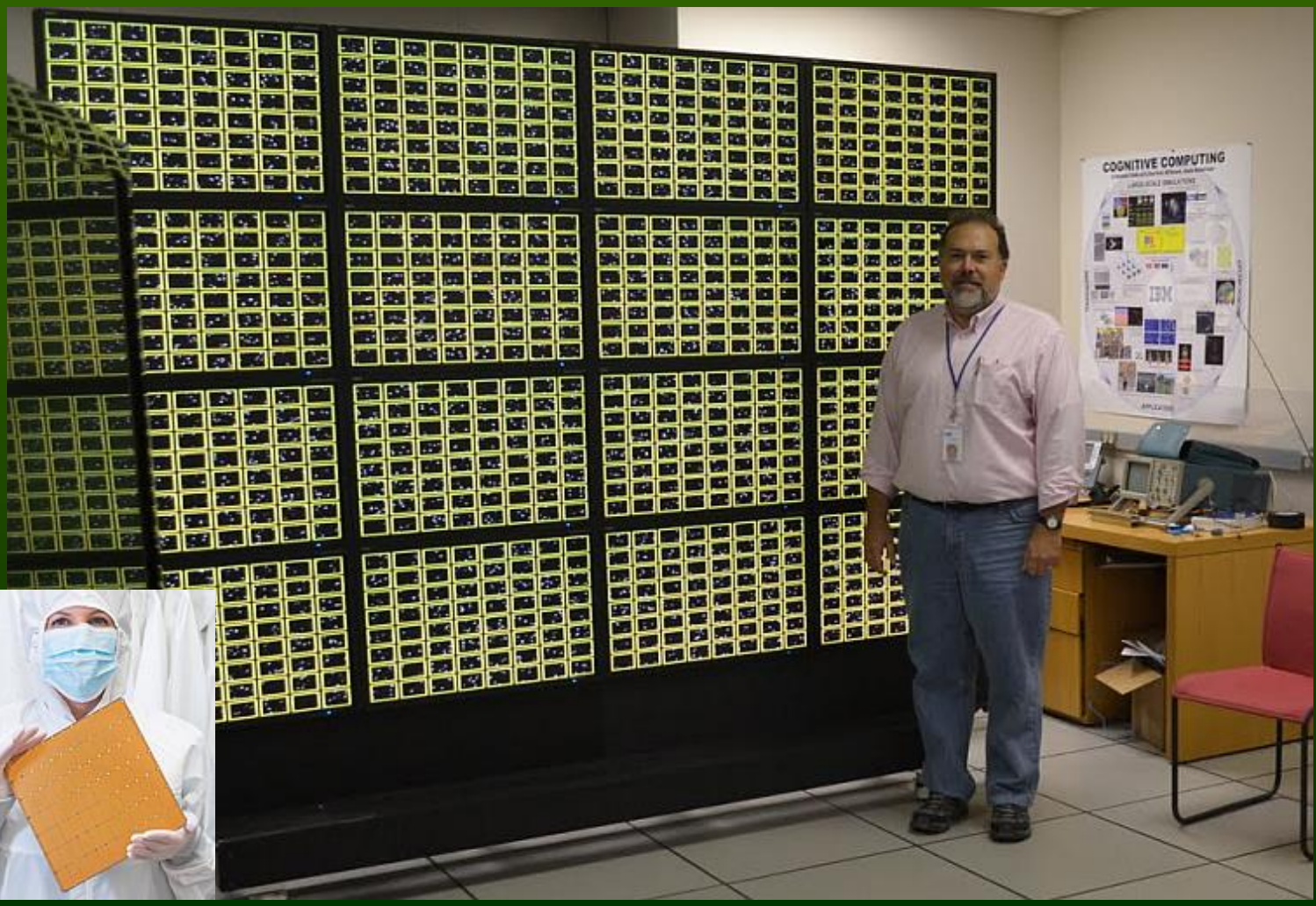
Neuromorphic future

Wall with 1024 TrueNorth chips, equivalent of 1 Billion neurons, 256 B synapses. 1/6 of chimp brain. Cerebras CS-2 chip has 2600 B transistors, almost 1M cores!

Integration:

Nano +
Neuro +
Info +
Kogni

Neural AI accelerators AD 2022. Cerebras CS-2 Andromeda system, 10^{18} op/sec!



Superhuman AI

Reasoning: 1997–Deep Blue wins in chess;
2016 –AlphaGo wins in Go; 2017 Alpha GoZero 100:0.

Open Games: 2017–Poker, Dota 2; 2019-Starcraft II,
2022 Stratego, Diplomacy – what is left?

Perception: speech, vision, recognition of faces, images, personality traits, political and other preferences ...

Robotics: 2020 Atlas robot (Boston Dynamics) backflip and parcour, autonomous vehicles on the roads.

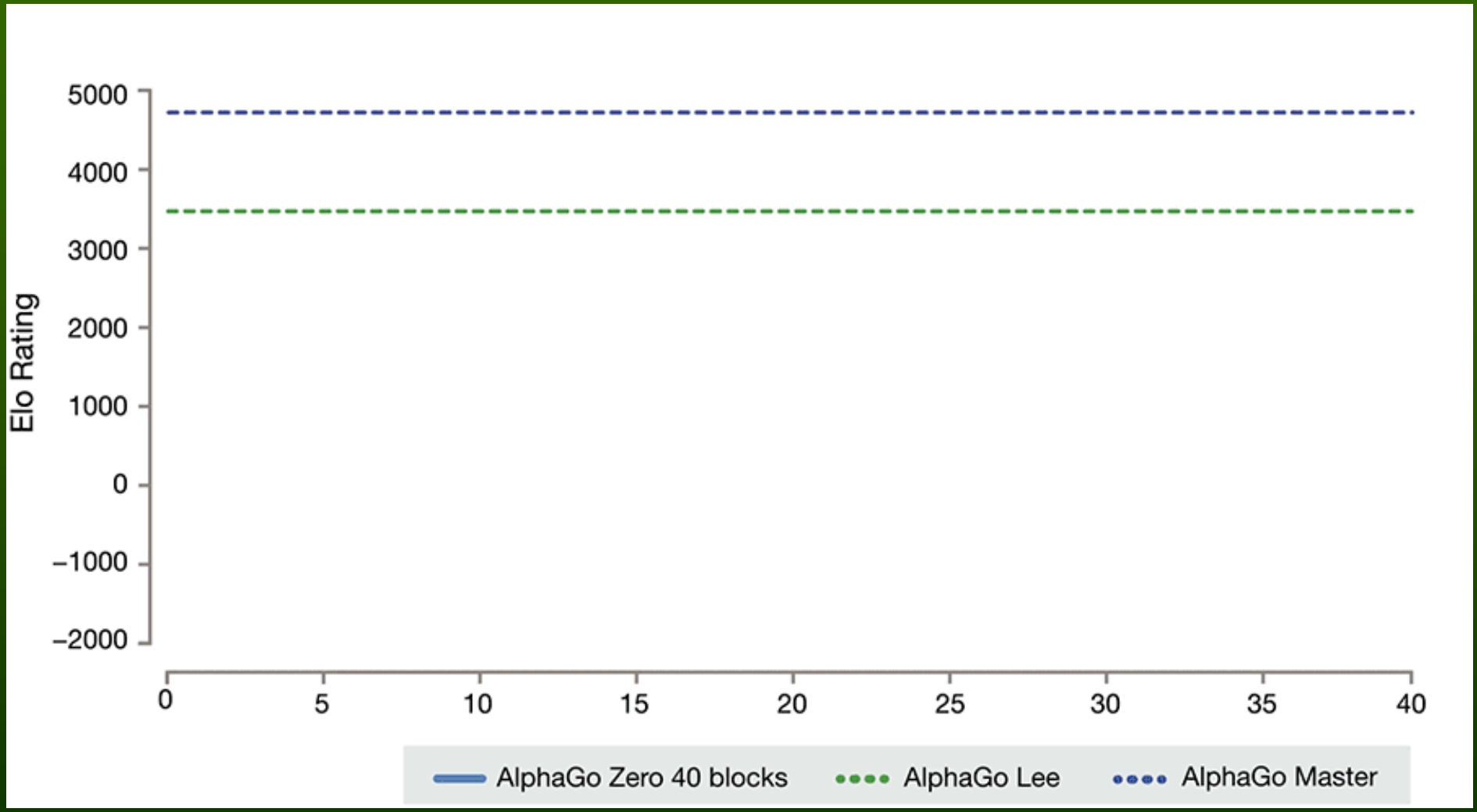
Automation of science: 2015-AI uncovers genetic and signaling pathways of flatworm regeneration.
2020 AlphaFold 2, now 600 mln protein structures.

Creativity and imagination: DeepArt, Midjourney, Dall-E, AIVA and music composers, GAN revolution.

Language: 2011–IBM Watson wins in Jeopardy;
2018–Watson Debater beats professionals
2020: BERT answers questions from SQuAD database.

Cyborgization: BCI, brain optimization, coming?

AlphaGo Zero learns Go from 0!



Superhuman level in the strategic game of Go. Human experience surpassed by software playing against its own copy. Search + NN as heuristics.

Protein folding

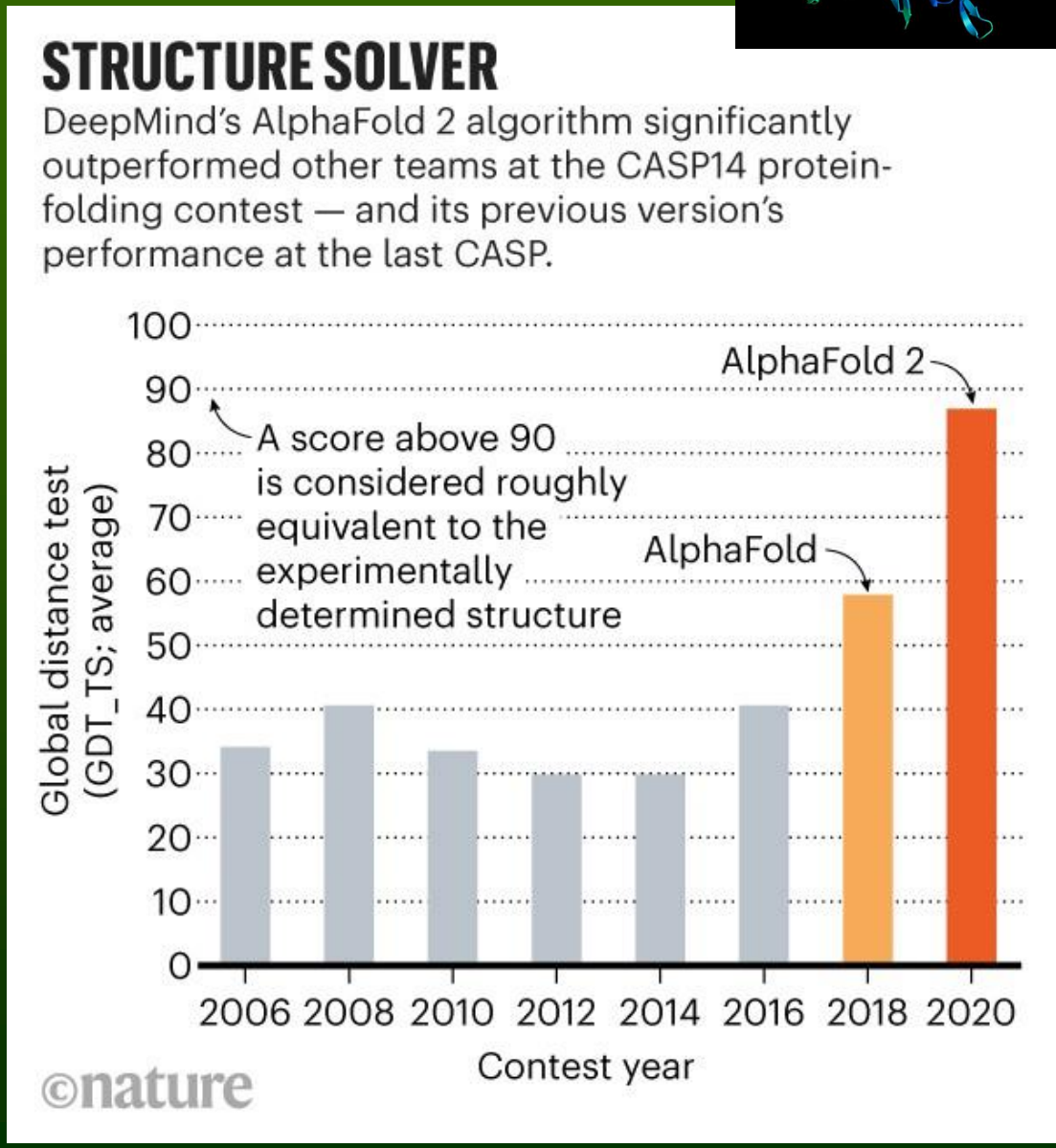
AlphaFold 2 using deep learning predicted more than 2/3 of all protein structures with an accuracy equivalent to experimental!

Nature, 30.11.2020

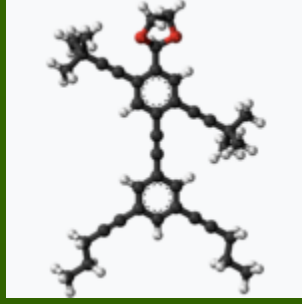
Structure recognition + learning + inference.

Predicting protein structures based on amino acid sequences is the basis for the search for proteins and the design of drugs with the desired properties.

Prediction of 600 mln protein structures (DM+EMBL-EBI).



Material design

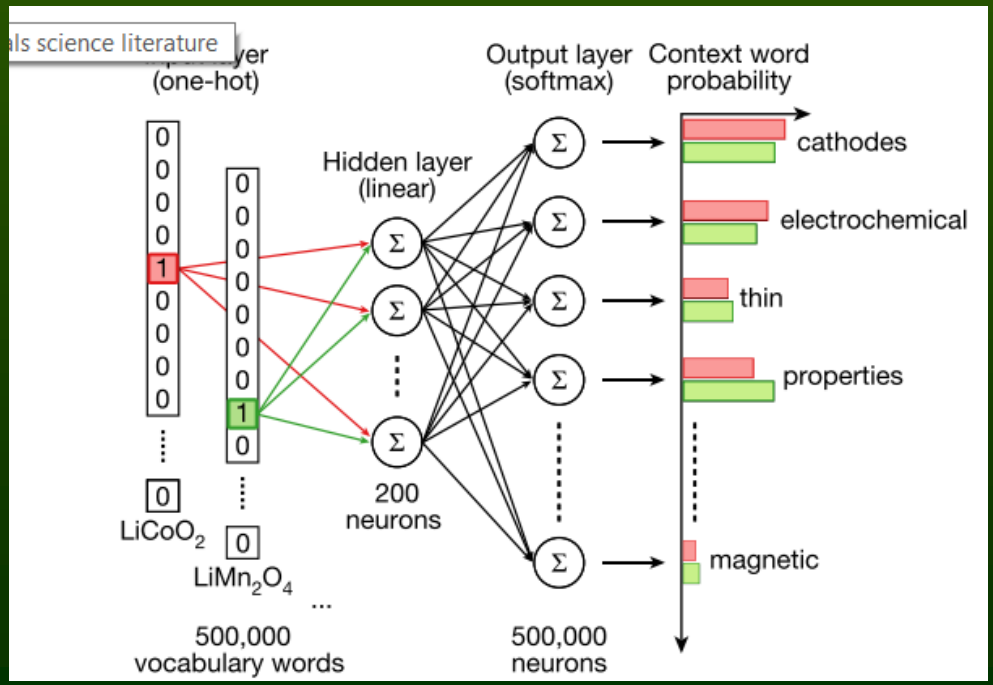


Materials science knowledge present in the published literature can be effectively encoded as a dense informative representation of chemical knowledge, complex concepts, periodic table and the relationships between the structure and properties of materials.

Tshitoyan, V. … Jain, A. (2019). Unsupervised word embeddings capture latent knowledge from materials science literature. Nature, 571(7763), 95.

Based on previous publications unsupervised ML methods could recommend materials for functional applications a few years before they were discovered.

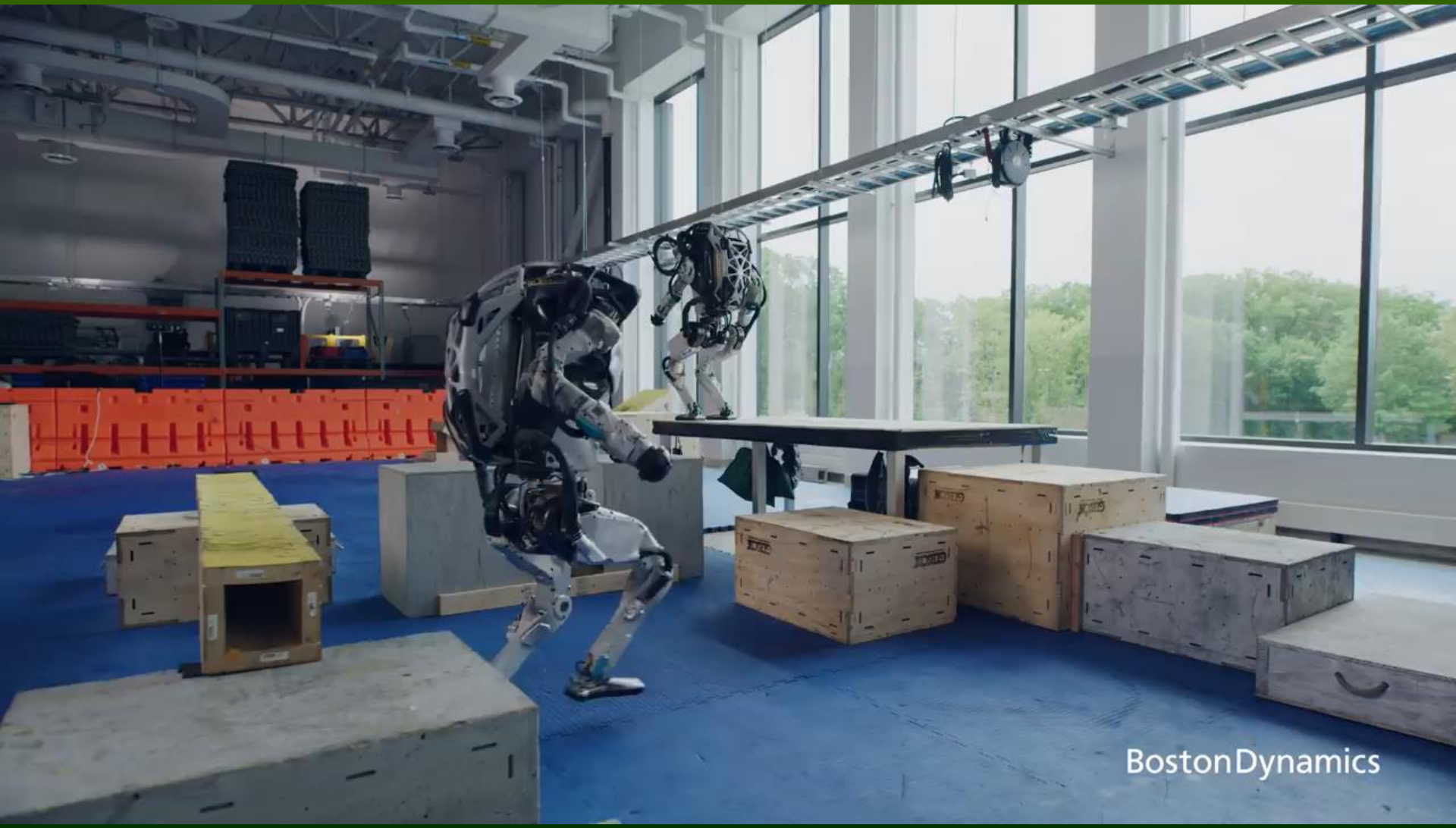
GPT-3 Crush: 100 applications in design, business education, philosophy, research, creative writing and many other fields.



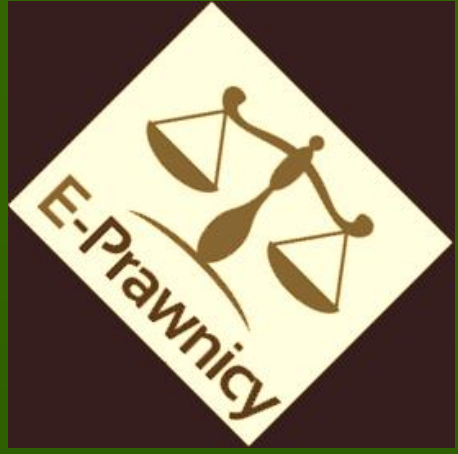
Control: robots

Behavioral intelligence: training a robot from “infancy”.

Cog Project, MIT Brooks lab, 1994-2003. iCube (EU). Now we have **Atlas**.



Lawyers



Lawyers: EMERJ.com predicts automation in 6 categories:

1. Information collection, contract review, legal research and electronic detection of inaccuracies.
2. Forecasting the outcome of court proceedings.
3. Legal analysis – finding previous cases, win/lose ratios, trends and patterns.
4. Automate the filling out of documents based on data.
5. Intellectual property, analysis of large intellectual property portfolios ...
6. Electronic invoicing.

WhatSun Exterro – out of 100 lawyers, 5 remained thanks to e-Discovery.

JP Morgan – COIN (Contract Intelligence) handles 12,000 loan agreements or contracts in a few seconds, equivalent to about 36,000 hours of work. Annually makes 12,000 less errors in the analyzed contracts than humans.

eBrevia – summary and analysis of documents, writing reports.
50 long contracts in less than 1 minute, 10% fewer errors.

Deep Knowledge Ventures (DKV) appointed AI robot to the board of directors.

Vanishing professions

World Economic Forum: 85 million jobs lost by 2025 due to automation.
Among "dying professions":

- Telemarketers, 200,000 in call/contact center of Poland.
- Travel agents, postal officials, sellers, cashiers ...
- Mechanics, machine operators, equipment repairs ...
- Mortgage brokers, bank officials, accounting ...
- Truck and taxi drivers, farmers ...
- Lawyers, middle managers ...
- Journalists, reporters, booksellers …
- Architects, photographers, artists ...

Superhuman perception

Automatic analysis of facial features determines: gender, age, race, health, BMI.

Surprise! Emotions, character traits, criminal tendencies, religious, political, and sexual preferences can be read from faces with greater accuracy than people are able to recognize.

Using 5 photos/person recognition of homo or hetero men with 91% accuracy, women 83%. Humans: only 61 and 54% correct.

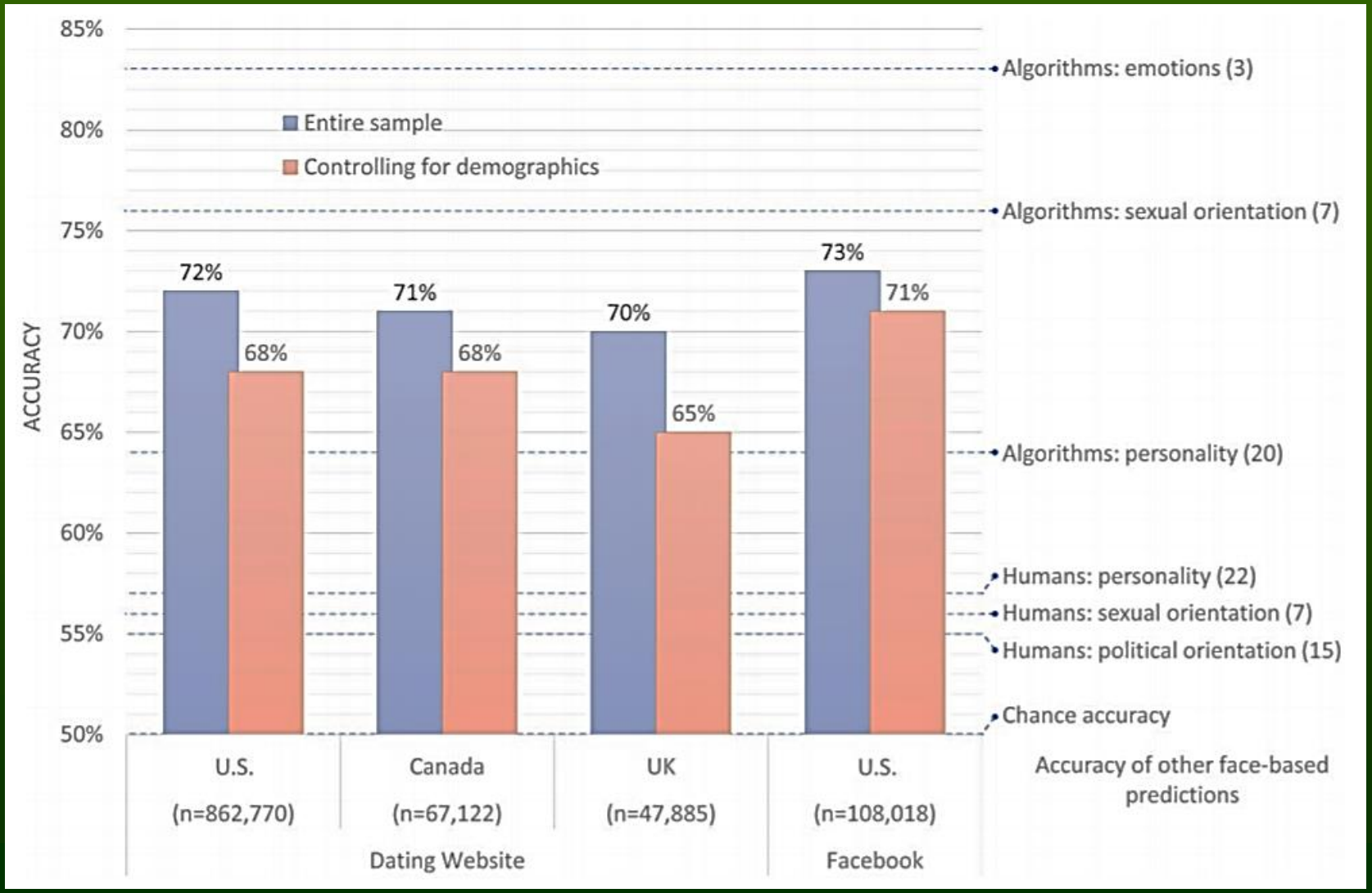
(a) Three samples in criminal ID photo set S_c.

(b) Three samples in non-criminal ID photo set S_n

Criminal tendencies: for 5,000 prisoners and the same number of control photos, CNN gave 97% accuracy (this work was withdrawn by ethics committee).

AI will give us …

Analysis of facial images of >1M people allowed to recognize **conservative vs liberal** orientation in 72%; human judges 55% (M. Kosiński, Sci. Rep. 2021).



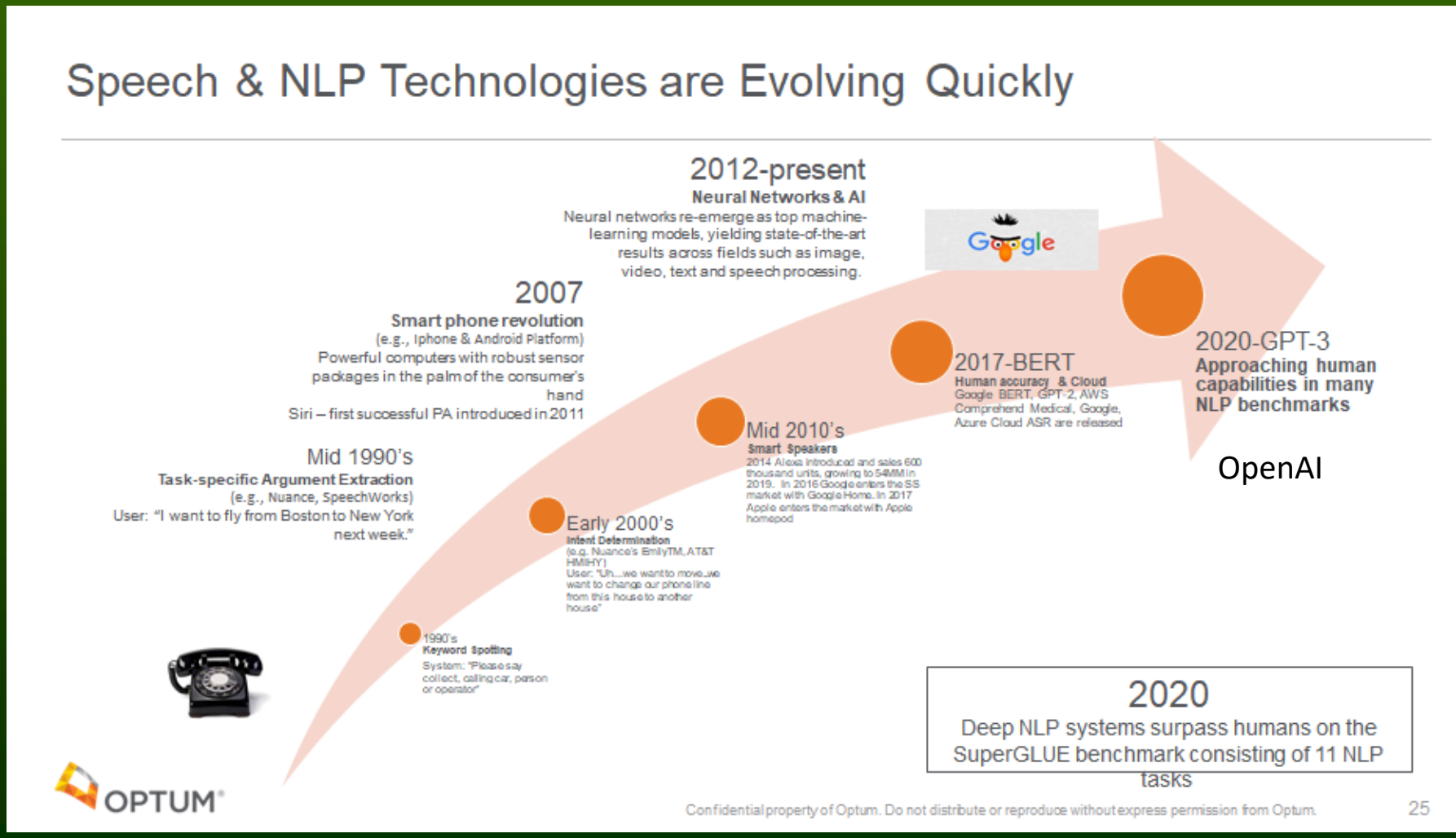
Language algorithms

Language models: relation of words in complex network structures.
In 2018, to gain a general-purpose “language understanding”,
Google created BERT, model pre-trained on a very large text corpus.

- **Bidirectional Encoder Representations from Transformers** (**BERT**).
  Transformer-based machine learning technique for (NLP) pre-training.
- English-language BERT: two networks, smaller 110M parameters,
  larger model with 340M parameters in 24-layers; trained on the
  BooksCorpus with 800M words, and Wikipedia with 2,500M words.
  In 2019 BERT worked already in 70 languages.
- BERT model was then fine-tuned for specific NLP tasks such as question answering or semantic information retrieval. Many smaller pre-trained open software models were published in GitHub repository.
- The network learns to predict masked words (images, signals):
  Input: the man went to the [MASK1]. He bought a [MASK2] of milk.
  Labels: [MASK1] = store; [MASK2] = gallon.

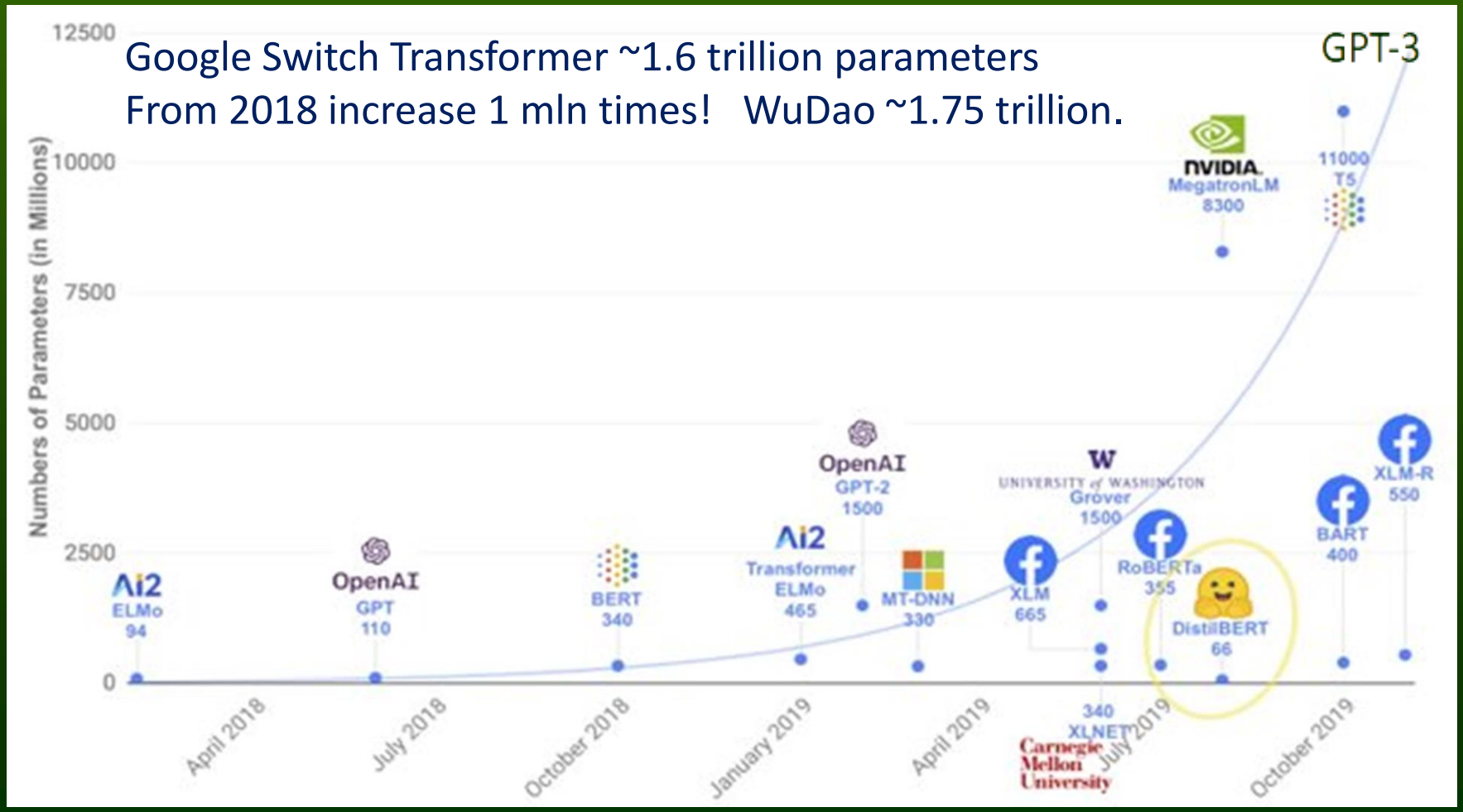
Q/A state of the art

Results for 100,000 questions from the database Stanford Question Answering Dataset (SquAD) are better than the results achieved by humans.



NLP supermodels

OpenAI GPT-3 model has 175 B parameters! One can use it on OpenAI server. First-of-its-kind API can be applied to any language task, and serves millions of production requests each day.

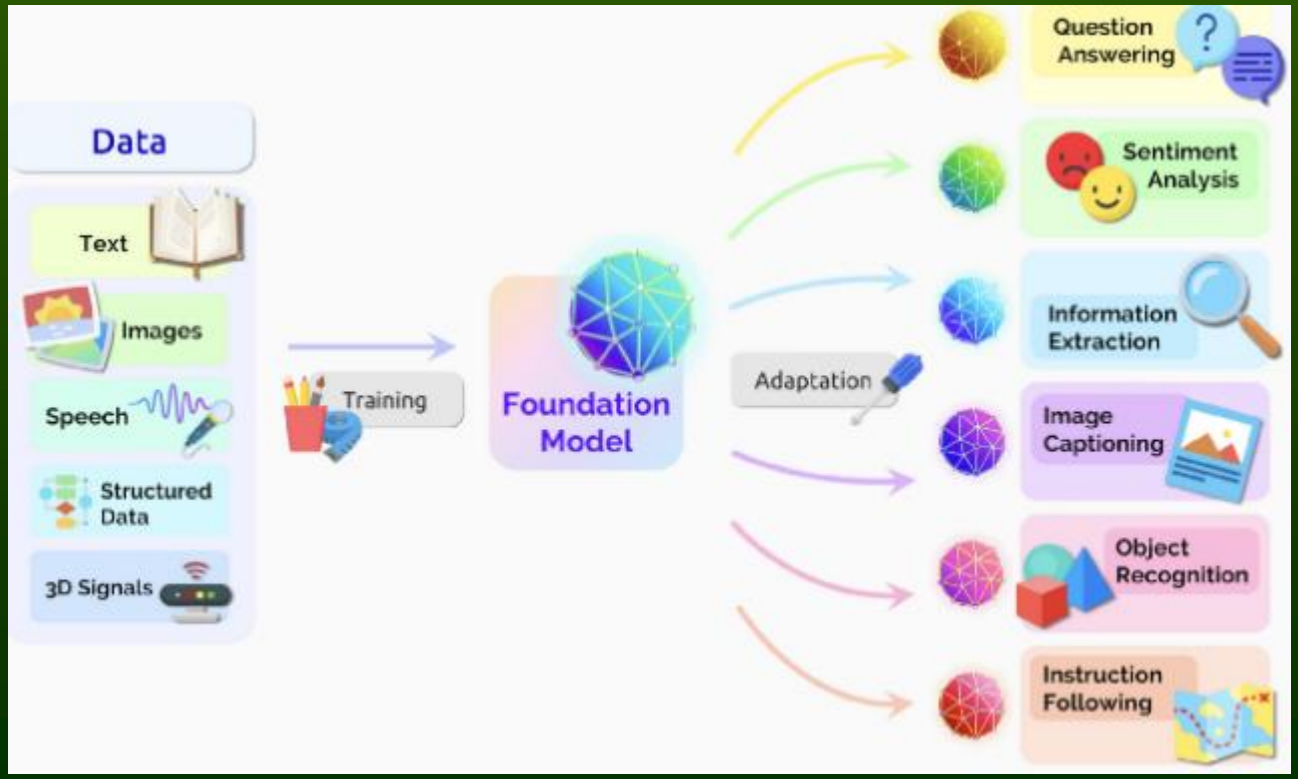


Multimodal models

Multimodal learning – different types of modalities with different statistical properties, embedded in **the same model**.

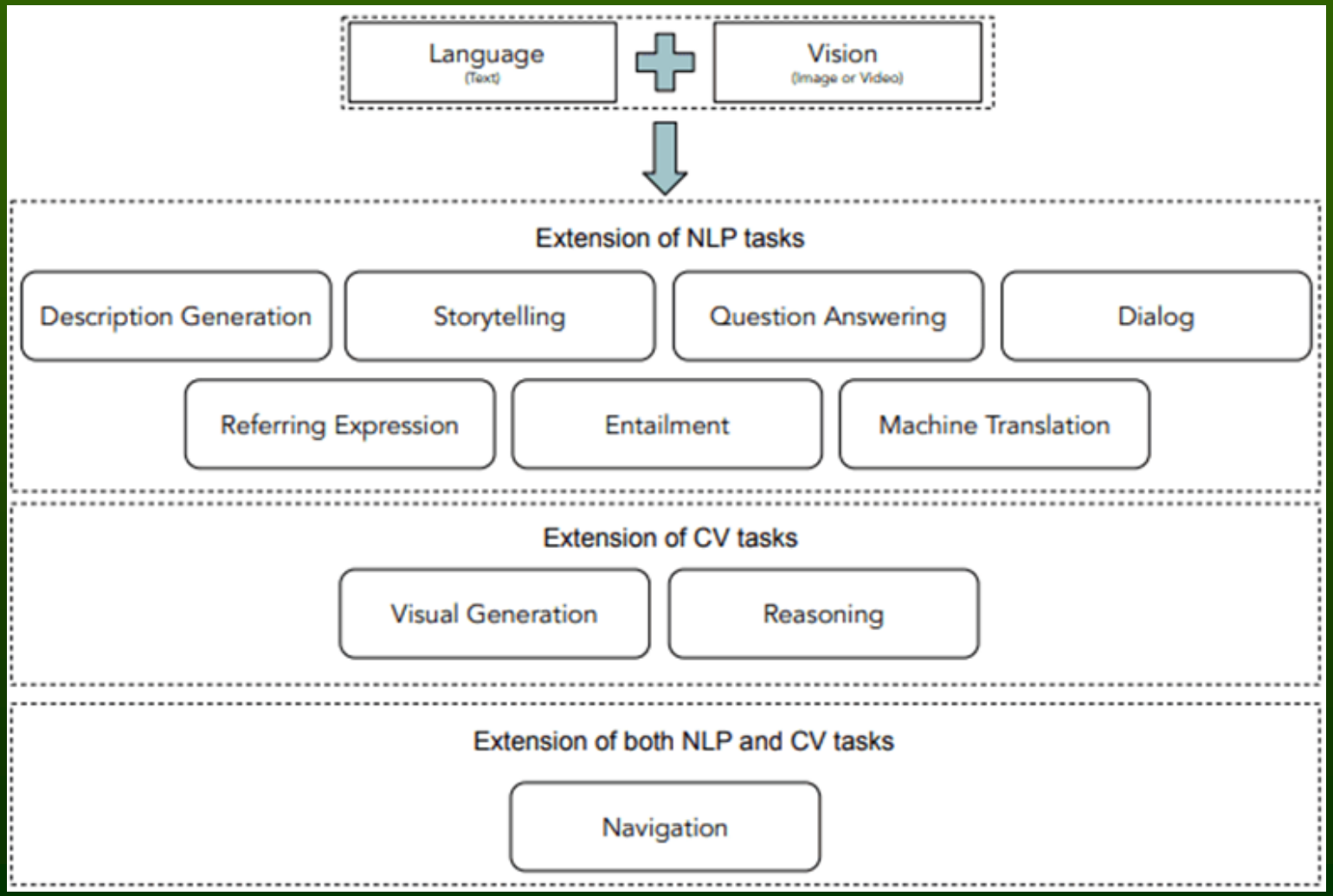
- **Multimodal Affective Computing (MAC)**, sentiment analysis.
- **Natural Language for Visual Reasoning (NLVR)**.
- **Multimodal Machine Translation (MMT)**.
- **Visual Retrieval (VR)** and **Vision-Language Navigation (VLN)**.

Image: Center for Research on Foundation Models (CRFM), Stanford Institute for Human-Centered Artificial Intelligence (HAI)



Vision-language models

Vision-Language Pre-Trained Models (VL-PTMs): convergence of language, vision, and multimodal pretraining. General-purpose foundation models can be easily adapted to multiple diverse tasks with minimal training.

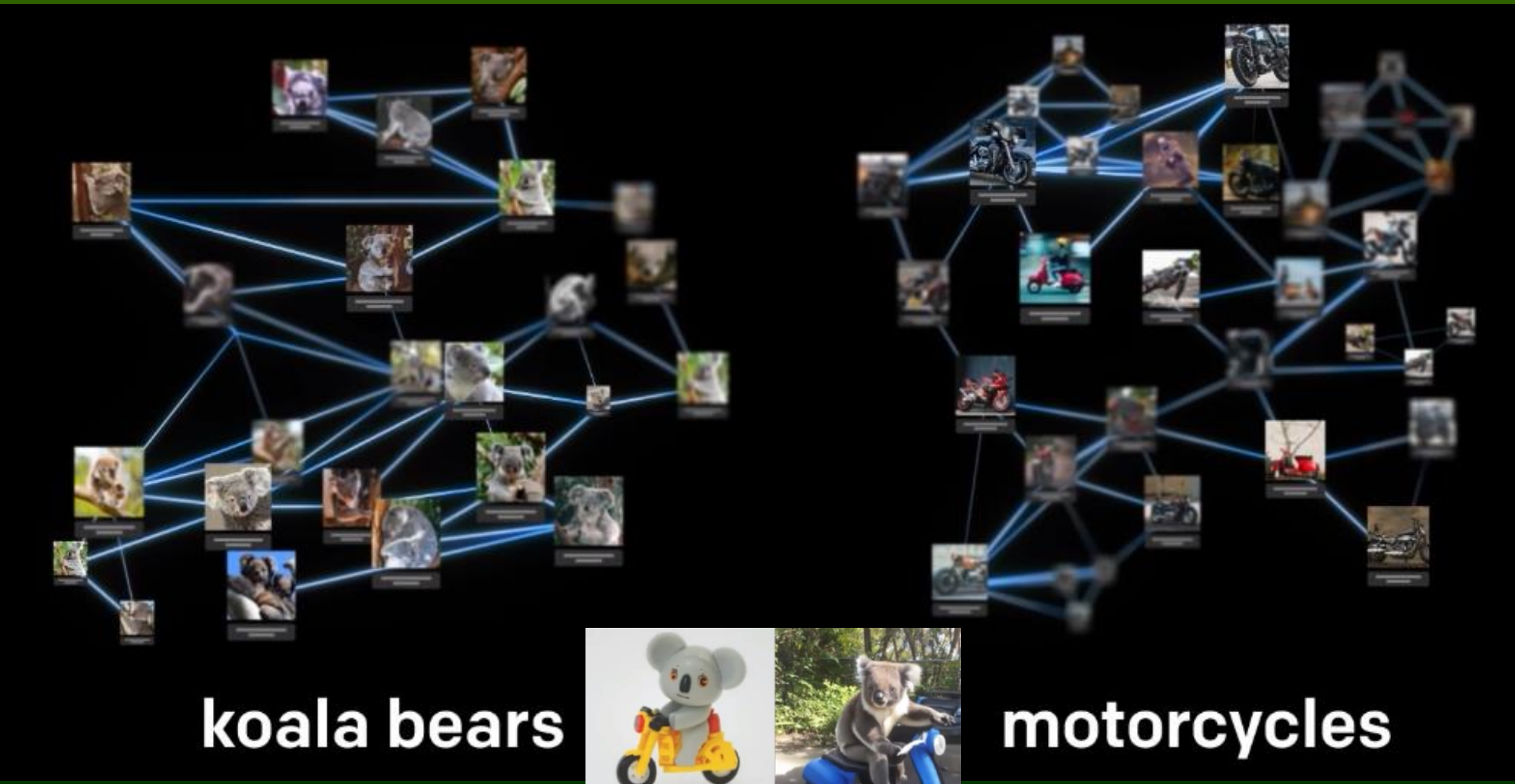


GAN, Generative Adversarial Networks

Idea (2014): one network generates false examples by distorting training data, the other evaluates whether it is real data. To see is to believe! Not anymore!

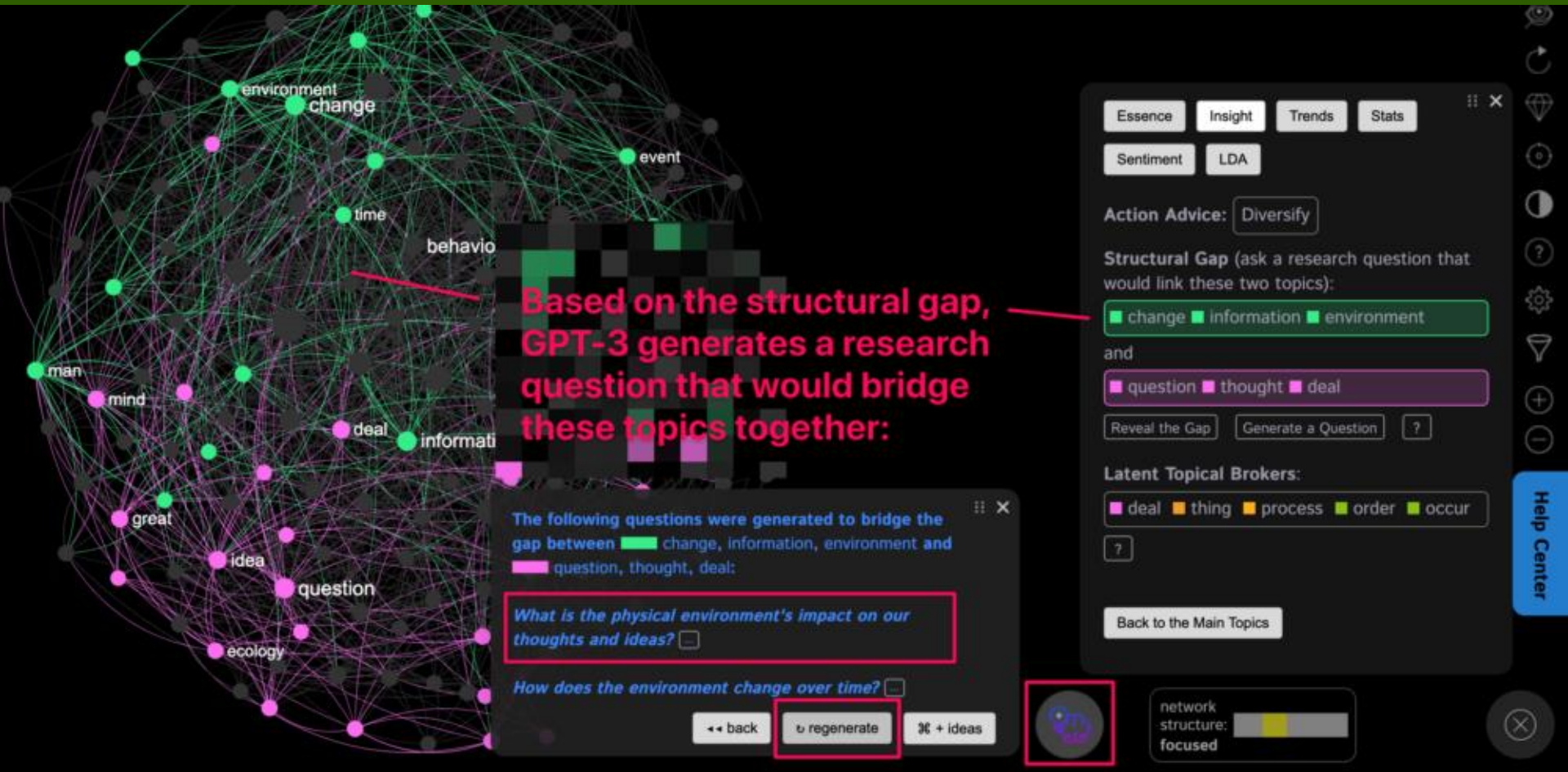
Vision-language models

Vision-Language Pre-Trained Models (VL-PTMs), convergence of language, vision, and multimodal pretraining => general-purpose foundation models can handle be easily adapted to multiple diverse tasks with zero-shot learning.



Vision-language generative models

Dall-E2, Craiyon, Imagen, Midjourney, Nightcafe, Artbreeder, Hotpot AI, Deep Dream Generator, Deep AI Text to Image, Generative Engine, Starry AI, My Hertitage … PromptBase is at the center of the new trade in prompts for generating specific imagery by image generators, a kind of meta-art market.



AI imagery

The neural network has billions of parameters, it can combine textual description with images.

These images were created from prompt:

The painting American Ghotic, with two dogs holding pepperoni pizza instead of the farmers holding a pitchfork.

Each time program is run another version is created. This technique can create 3D images and video.

Vision-language models

MS BEiT-3 (BERT Pretraining of Image Transformers), a general-purpose state-of-the-art multimodal foundation model for vision-language tasks.

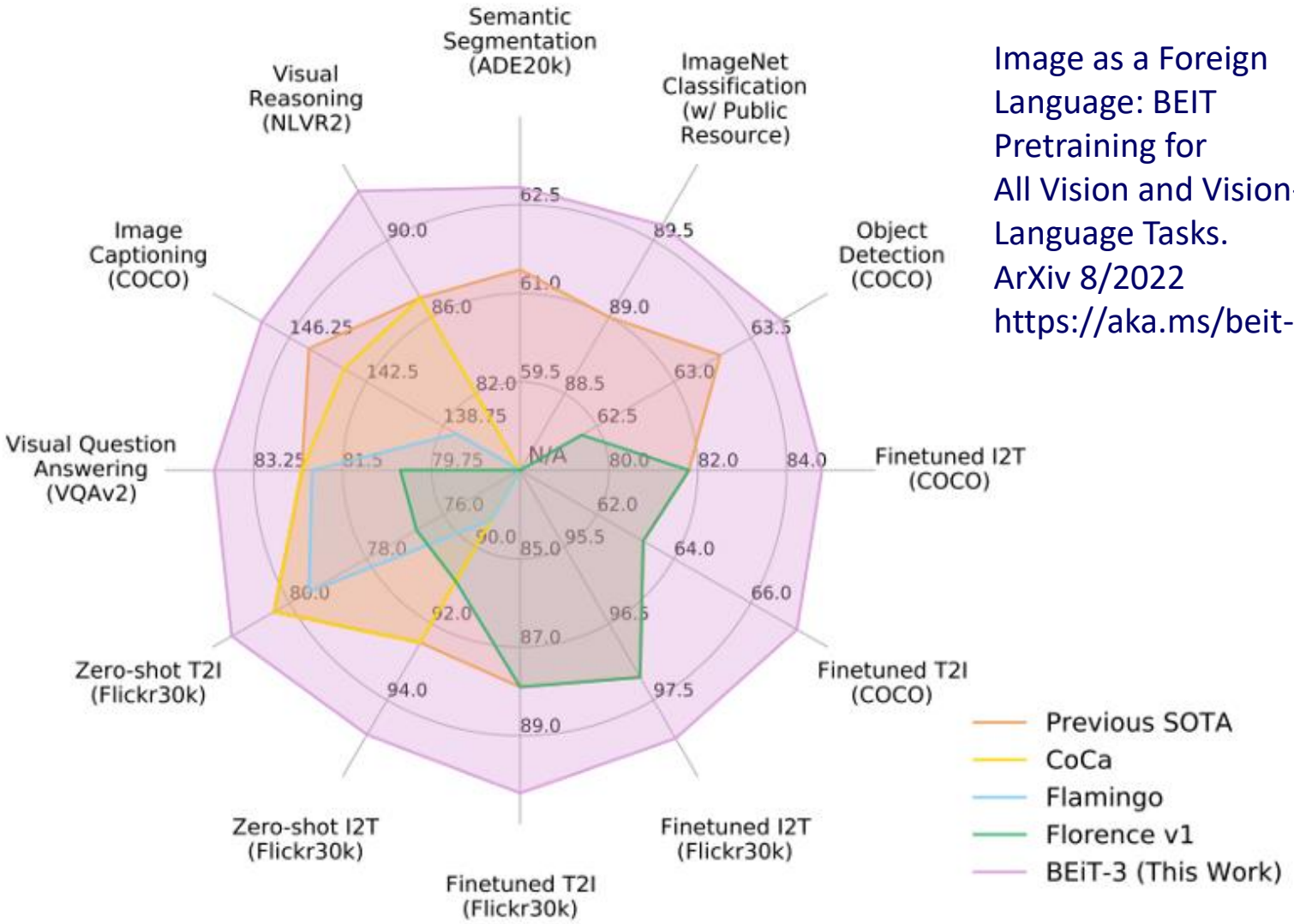


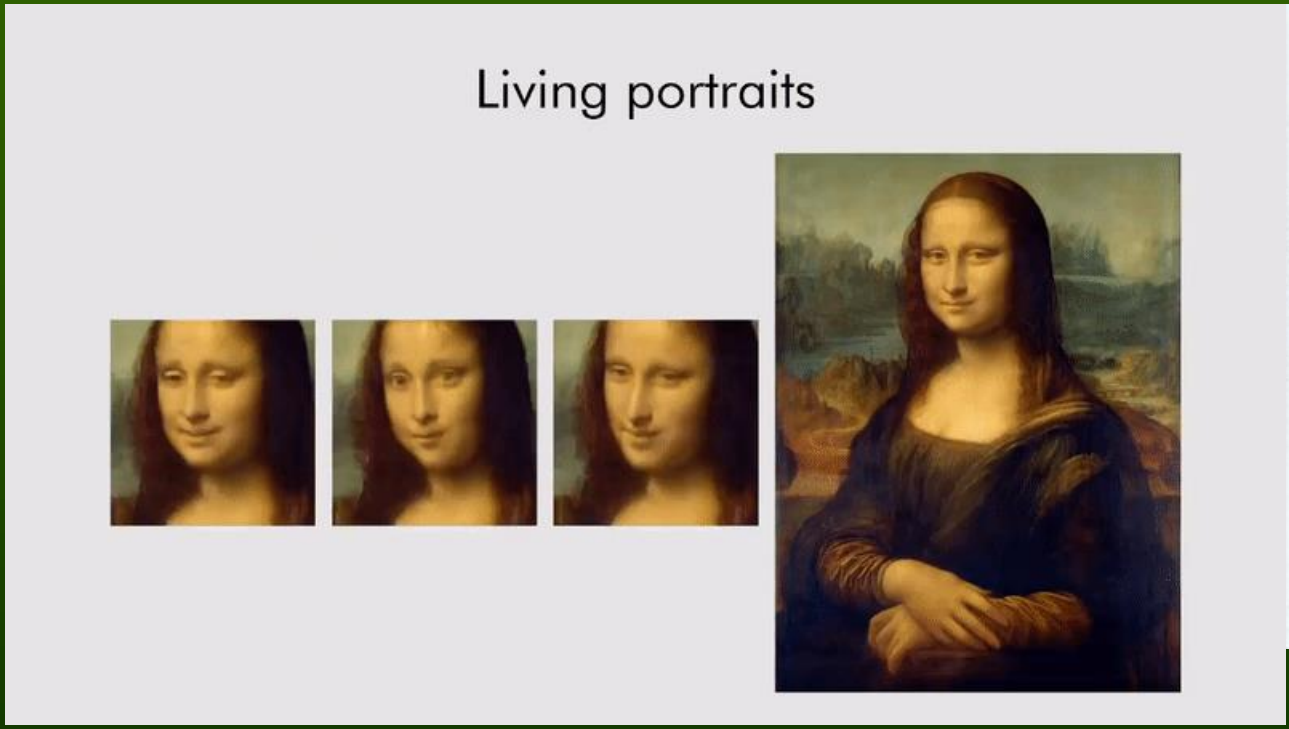
Image as a Foreign Language: BEIT Pretraining for All Vision and Vision-Language Tasks. ArXiv 8/2022 https://aka.ms/beit-3

Deep Dream

Artificial imagery: Google Deep Dream/Deep Style & Generator, Gallery
LA Gatys, AS Ecker, M Bethge, A Neural Algorithm of Artistic Style (2015)

GAN-animation

Images are revived or automatically turned into caricatures.
A realistic model requires several photos or images.
You can also add different expressions imitating personality and voice.



Gender swap of composers, AI can change your gender!
No pills secretly thrown into children's satchels are needed to do it!

Deep fake video

Anyone can create „deep fake”.
You can also add different expressions imitating personality and voice.

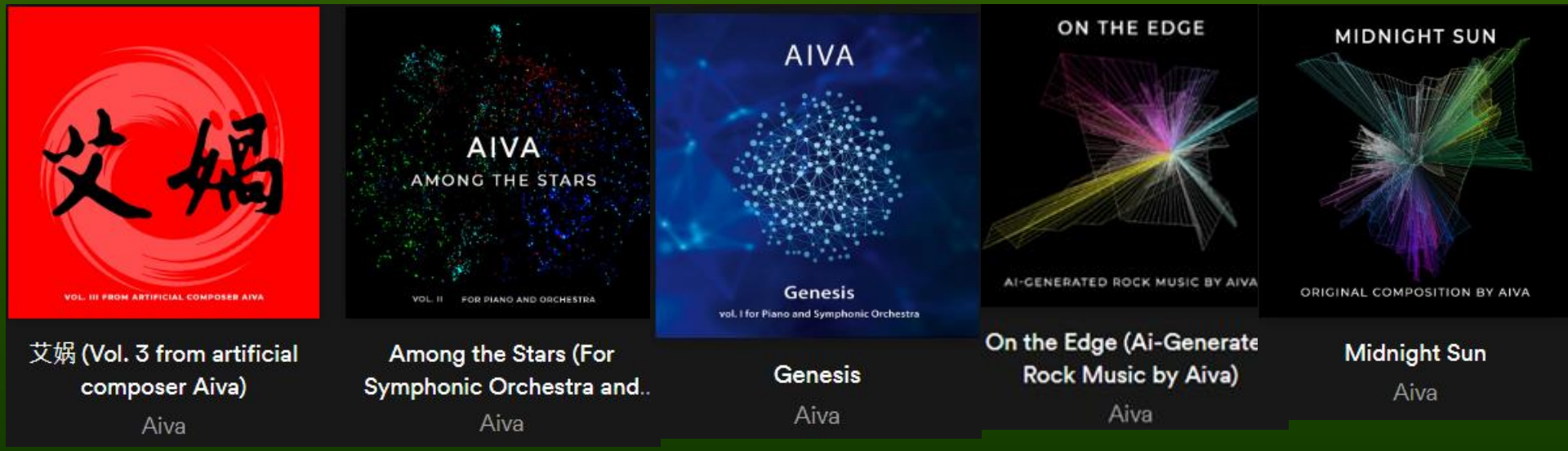
Deepfake Videos Are Getting Real, Gender swap of composers
Google Deep Dream, or androids really dream of electric sheep!

Music: AI Virtual Artist

AIVA – AI Virtual Artist, admitted to SACEM (Association of Authors, Composers and Music Publishers of France), 1882 compositions (11/2022).

AIVA YouTube channel, Youtube „Letz make it happen", Op. 23

SoundCloud channel Spotify i Apple channel



Duch W, *Intuition, Insight, Imagination and Creativity*.
IEEE Computational Intelligence Magazine 2(3), August 2007, pp. 40-52

AGI & BICA

From an engineer's perspective, to understand the brain is to build a working model that exhibits the same functions. Needed: spatial models of phenomena, actions and their causes, real world imagery.

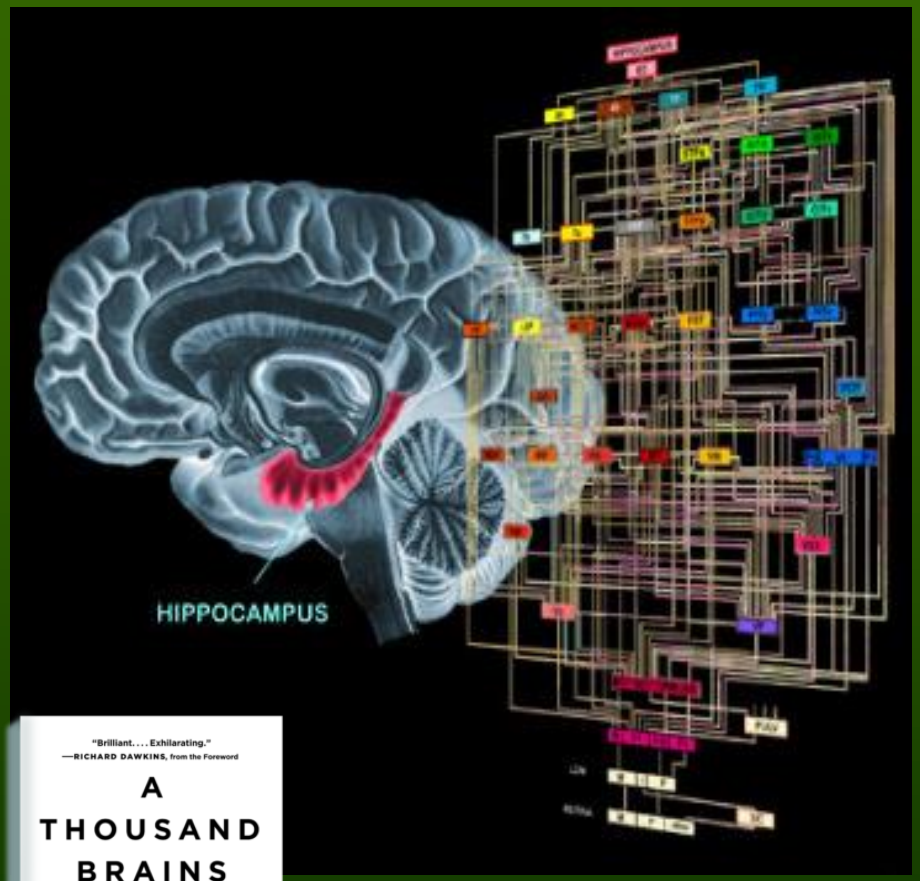
AGI = Artificial General Intelligence, learn many different things.

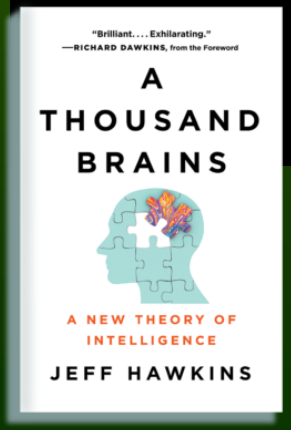
BICA (Brain-Inspired Cognitive Architecture) brain-like intelligence.

Duch, Oentaryo, Pasquier, Cognitive architectures: where do we go from here?

"We'll never have true AI without first understanding the brain"

Jeff Hawkins (2020).

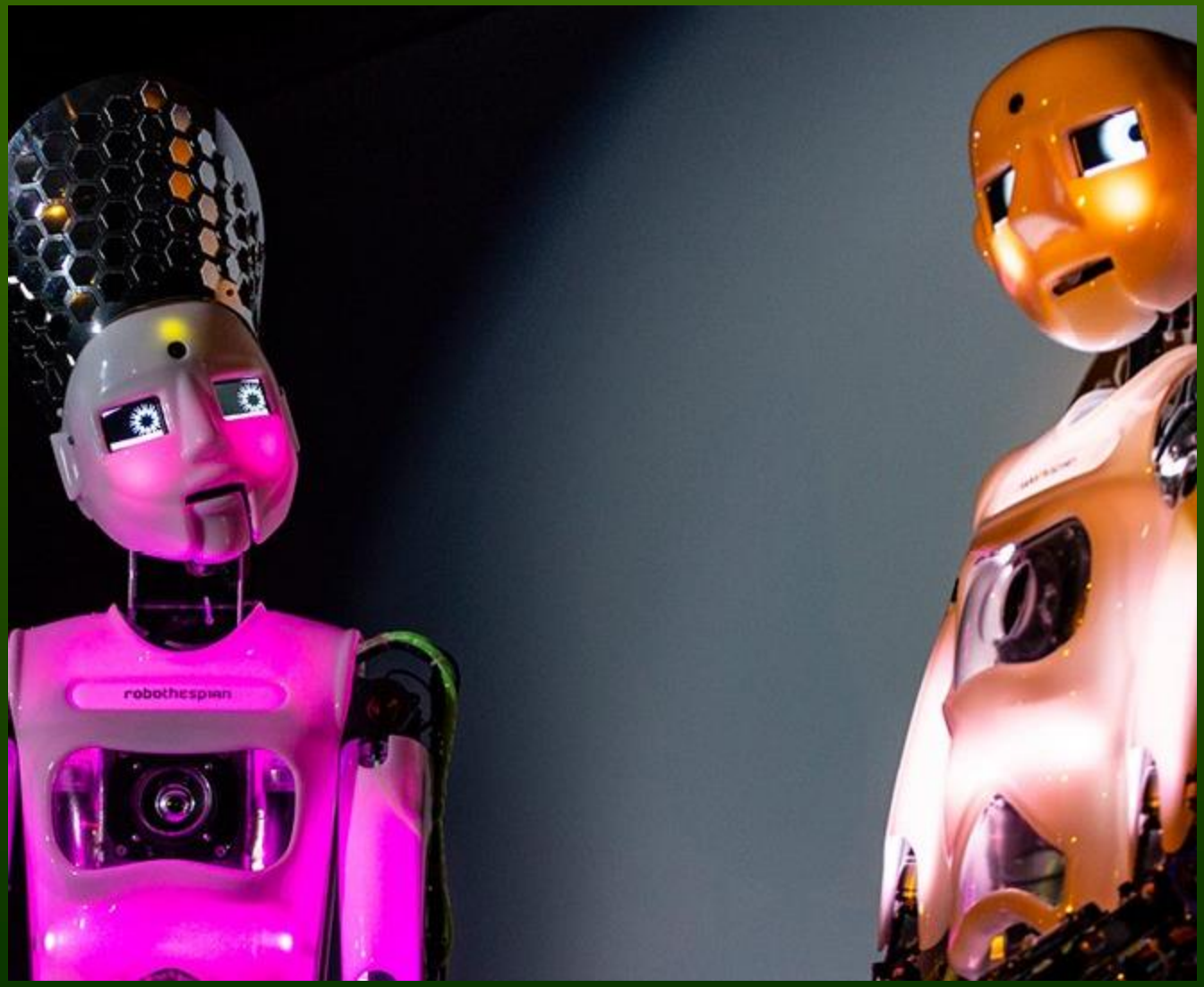




Artificial General Intelligence (AGI), Memphis 2008

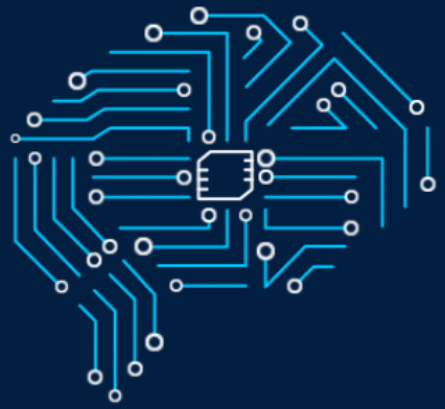
2022: DeepMind Gato is a relatively small model, with 1.2 billion parameters. Multi-modal, multi-task, multi-embodiment, learned simultaneously over 600 tasks, games to controlling robots. Small working memory capacity.

Stanislaw Lem: About prince Ferrycy and princess Crystala. Intelligent Palefaces? Is it possible?



Neuro-inspirations

BRAIN INITIATIVE



Advance Neurotechnologies

Accelerate the development and application of new neurotechnologies.

Support multi-disciplinary teams and stimulate research to rapidly enhance current neuroscience technologies and catalyze innovative scientific breakthroughs.

IEEE brain

IEEE brain

Join the IEEE Brain Community

JOIN FREE

Human Brain Project, EU Flagship (2013), and Obama BRAIN Initiative (2013): BRAIN=**B**rain **R**esearch through **A**dvancing **I**nnovative **N**eurotechnologies.

Neuroscience ⇔ AI

Hassabis, D., Kumaran, D., Summerfield, C., Botvinick, M. (2017). **Neuroscience-Inspired Artificial Intelligence**. *Neuron*, *95*(2), 245

Affiliations: **Google DeepMind**, Gatsby, ICN, UCL, Oxford.

Attention, awareness models, consciousness, complementary learning systems, various types of memory, reinforcement learning are used in machine learning.

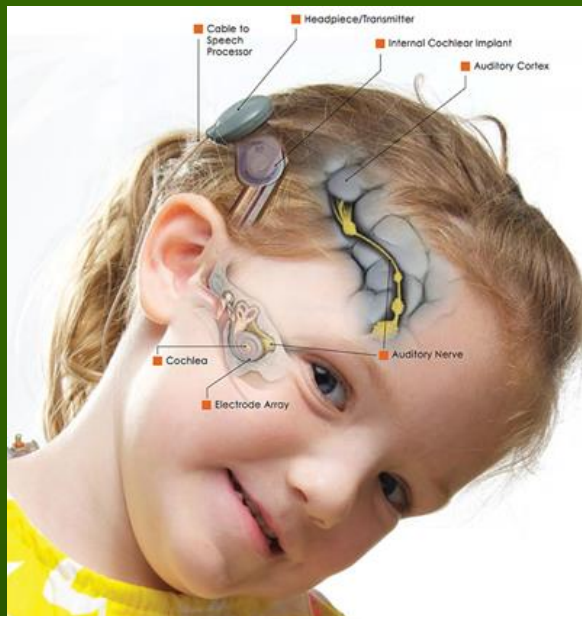
Key concepts from RL inform neuroscience and ML techniques are basic tools for analysis and interpretation of brain neuroimaging data. Ex:

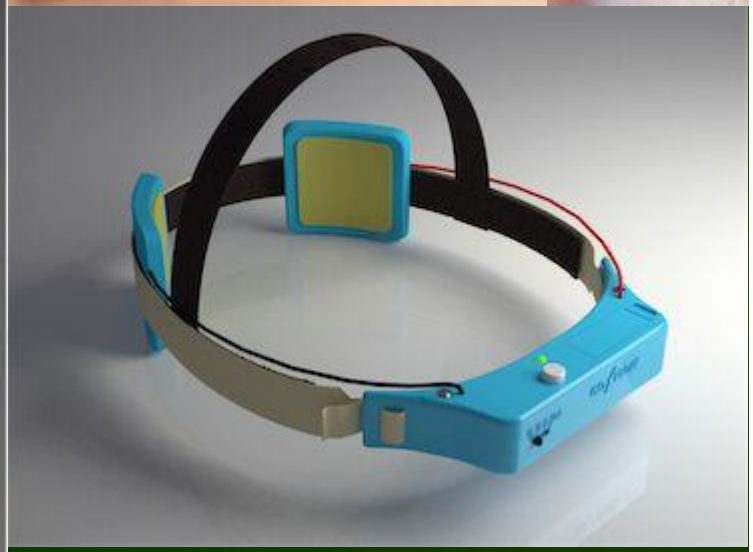
CNN ⇔ interpret neural representations in high-level ventral visual stream of humans and monkeys, finding evidence for deep supervised networks.

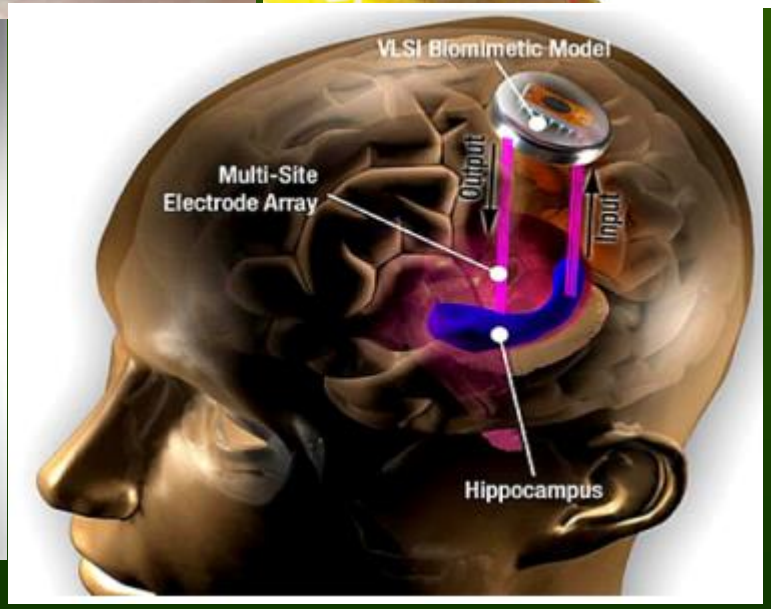
LSTM architecture provides key insights for development of working memory, gating-based maintenance of task-relevant information in the prefrontal cortex.

All this will help in development of **neurocognitive technologies**.

Amplification







Improvement of our senses: sight, hearing, touch, memory, attention ...
Improving brains by adding new senses (Eagleman, Livewired 2020).

On the threshold of a dream …

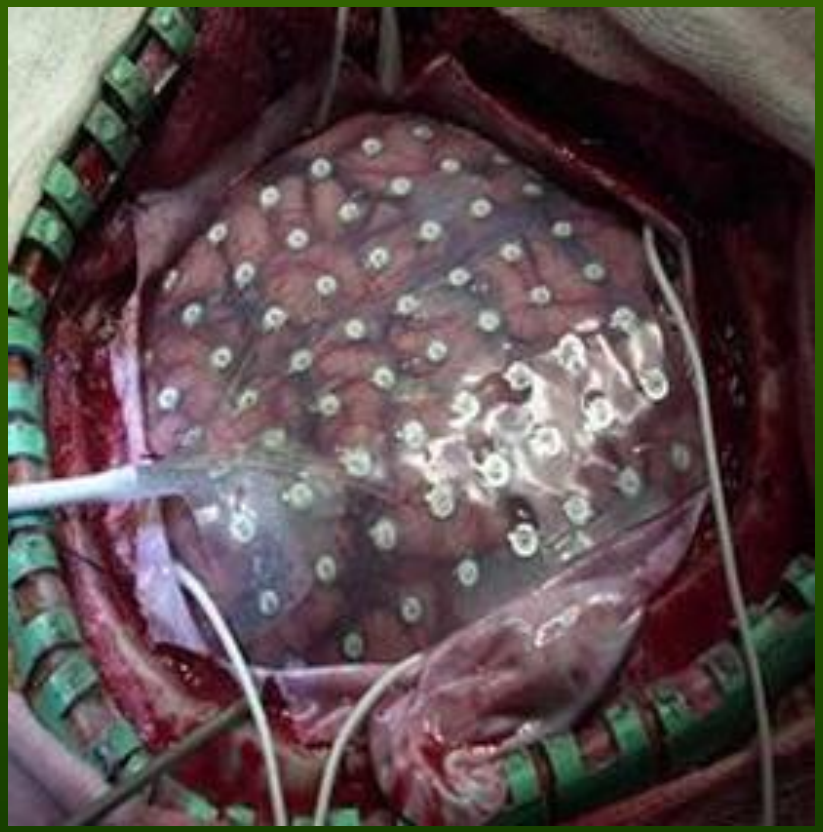
Final goal: optimize brain processes!

Although whole brain is always active we are far from achieving full human potential. To repair damaged brains and increase efficiency of healthy brains we need to understand brain processes:

1. Find fingerprints of specific activity of brain structures using new neurotechnologies.
2. Create models of cognitive architectures that help to understand information processing in the brain.
3. Create new diagnostic and therapeutic procedures.
4. Use neurofeedback based on decoding and changes in connectivity to stimulate the brain.
5. Stimulate neuroplasticity by monitoring brain activity and directly stimulating it (TMS, DCS, EM).

G-tec wireless NIRS/EEG on my head.

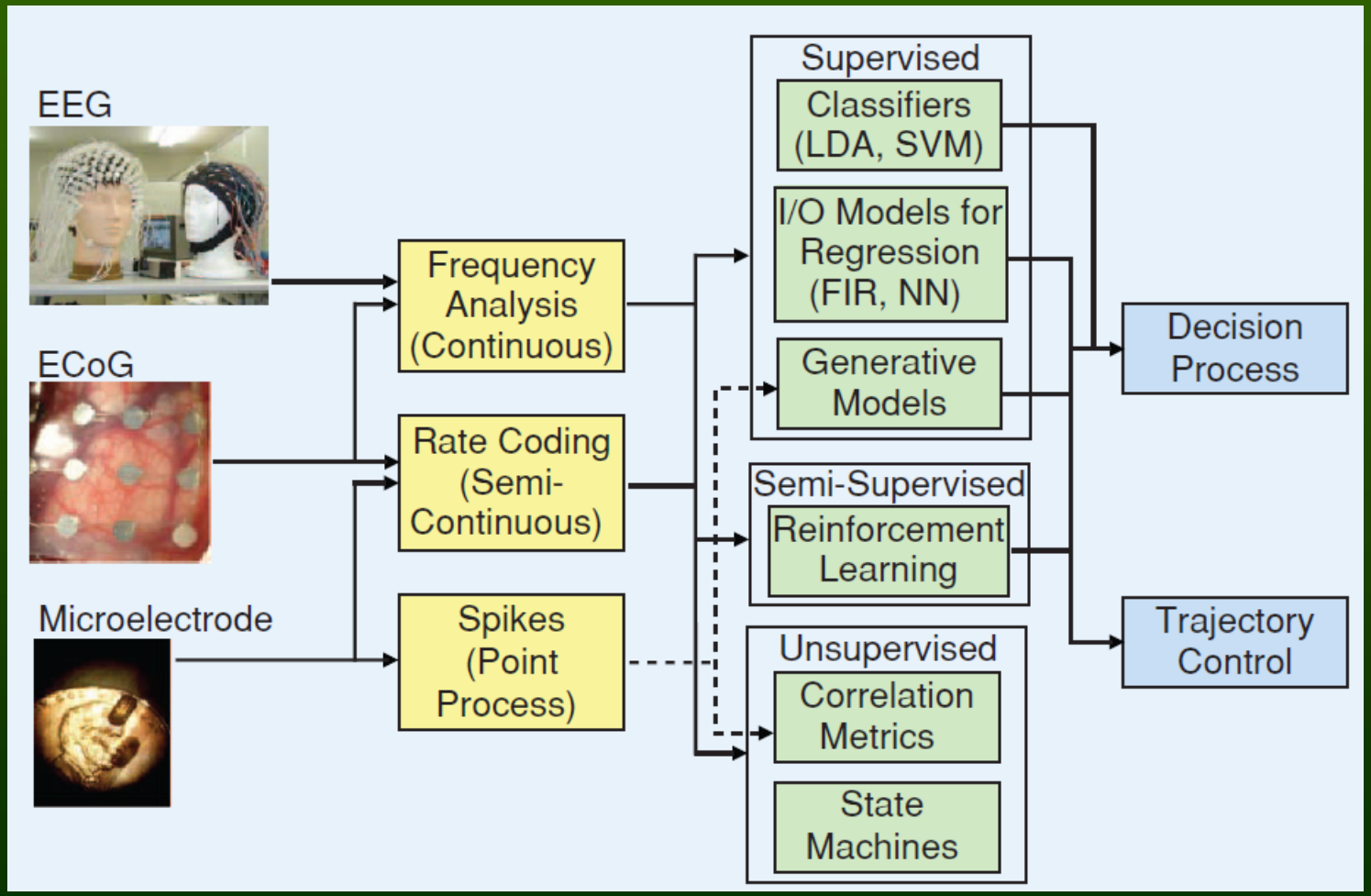
Brain computer interfaces



People with Parkinson's disease or compulsive-obsessive disorder who have pacemakers implanted in their brain can regulate their behavior with an external controller.

BCI: time to connect our brains …

Non-invasive, partially invasive and invasive methods carry increasing amount of information, but are more difficult to implement.
EEG+ML still reigns supreme!

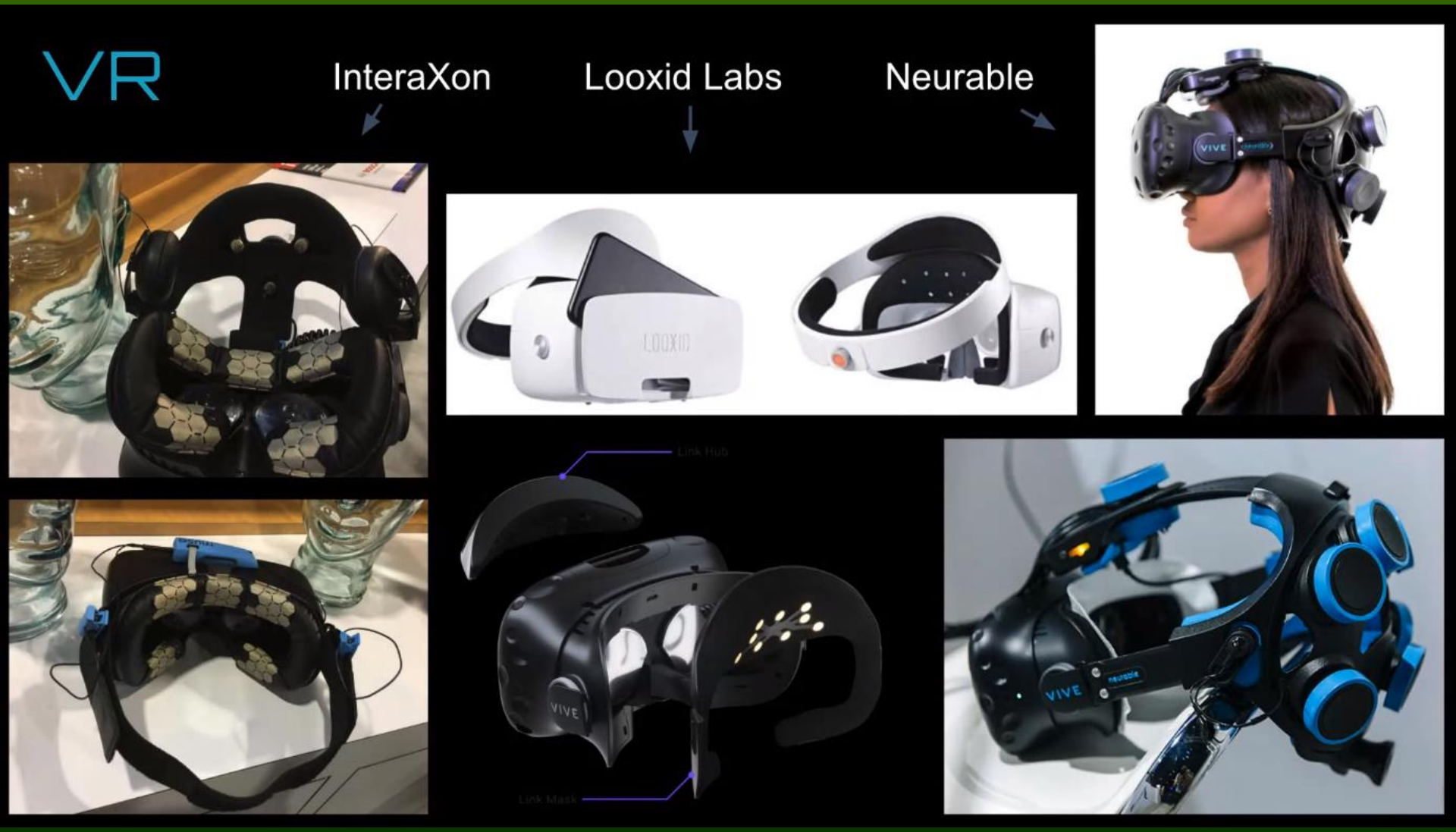


BCI tools

Many inexpensive EEG solutions, but analysis of brain signals is always hard.

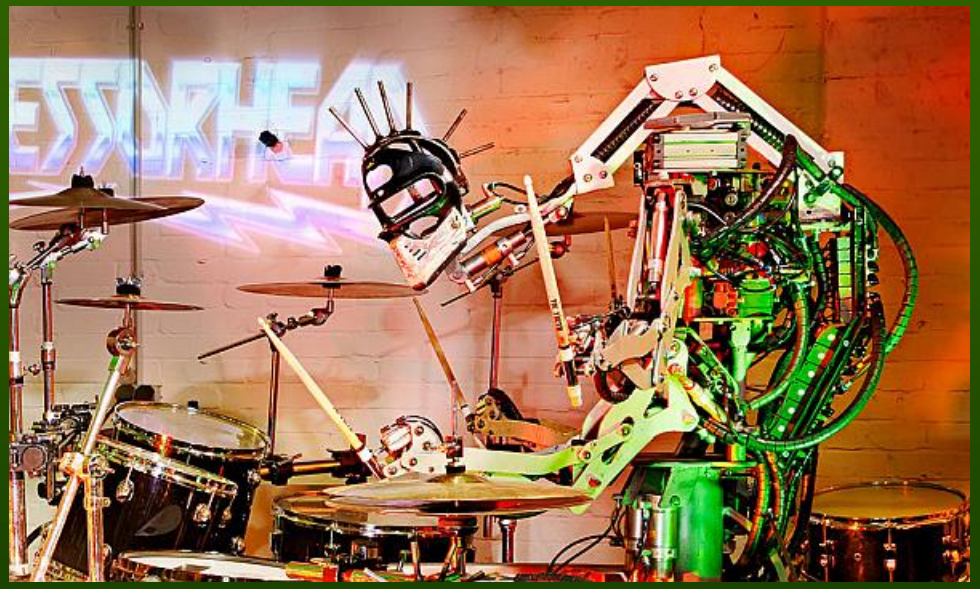
BCI tools

Combination of Virtual Reality with BCI has great potential.



What can I do with additional hand?

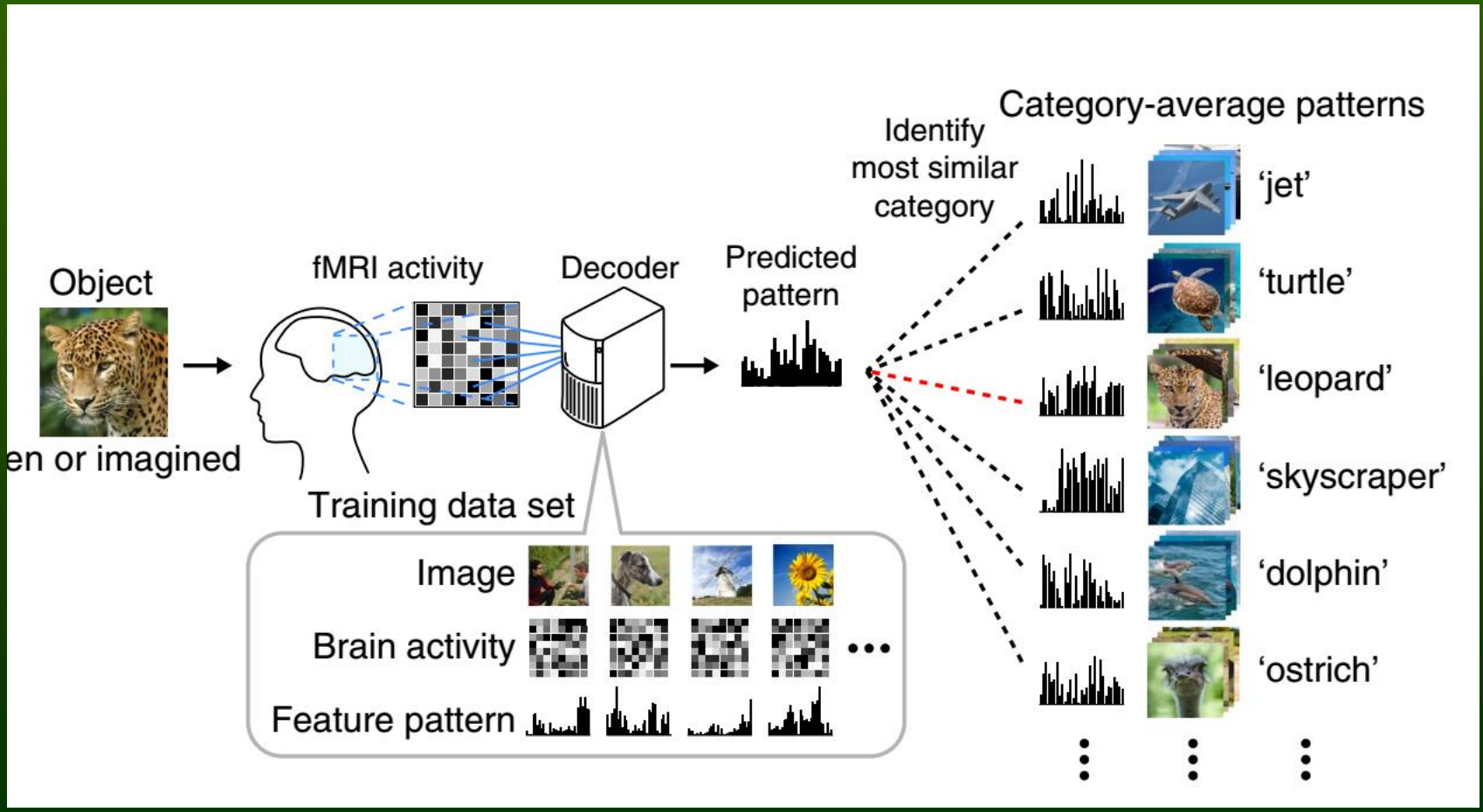
If I were an octopus ... then I would play the drums!



And if I were a robot, I would just play with 4 hands...
Robot group Compressorhead goes on a tour around the world.

Brain activations ⇔ Mental images

fMRI activity can be correlated with deep CNN network features; using these features most similar image from a large database is selected.
Horikawa, Kamitani, Generic decoding of seen and imagined objects using hierarchical visual features. Nature Communications, 2017.



Neural screen

Features of the face image are analyzed and their combination remembered.

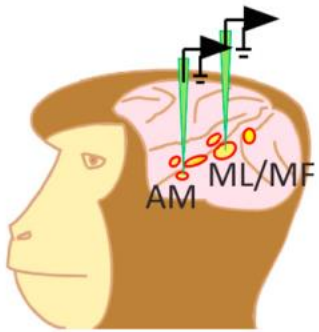
This can be decoded from brain signals if we have access to neural spikes.

It took only 205 neurons in several visual cortex areas to reproduce images of the faces from spikes.

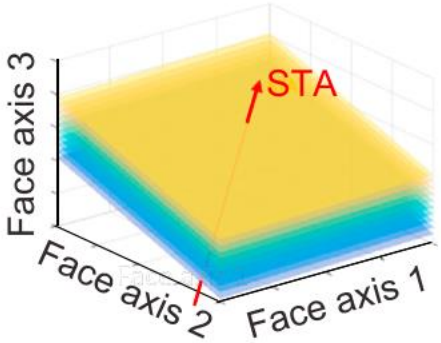
L. Chang and D.Y. Tsao, "**The code for facial identity in the primate brain**" *Cell* 2017

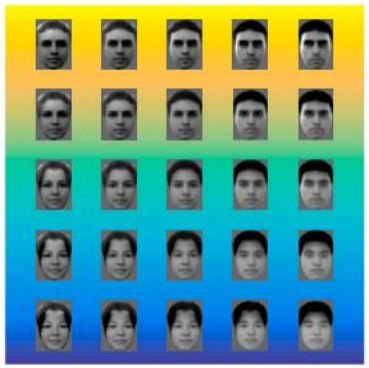
Voice, and even thoughts can be read in a similar way.

1. We recorded responses to parameterized faces from macaque face patches

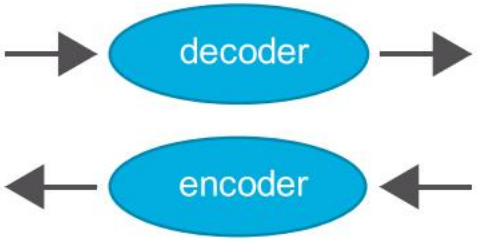


2. We found that single cells are tuned to single face axes, and are blind to changes orthogonal to this axis



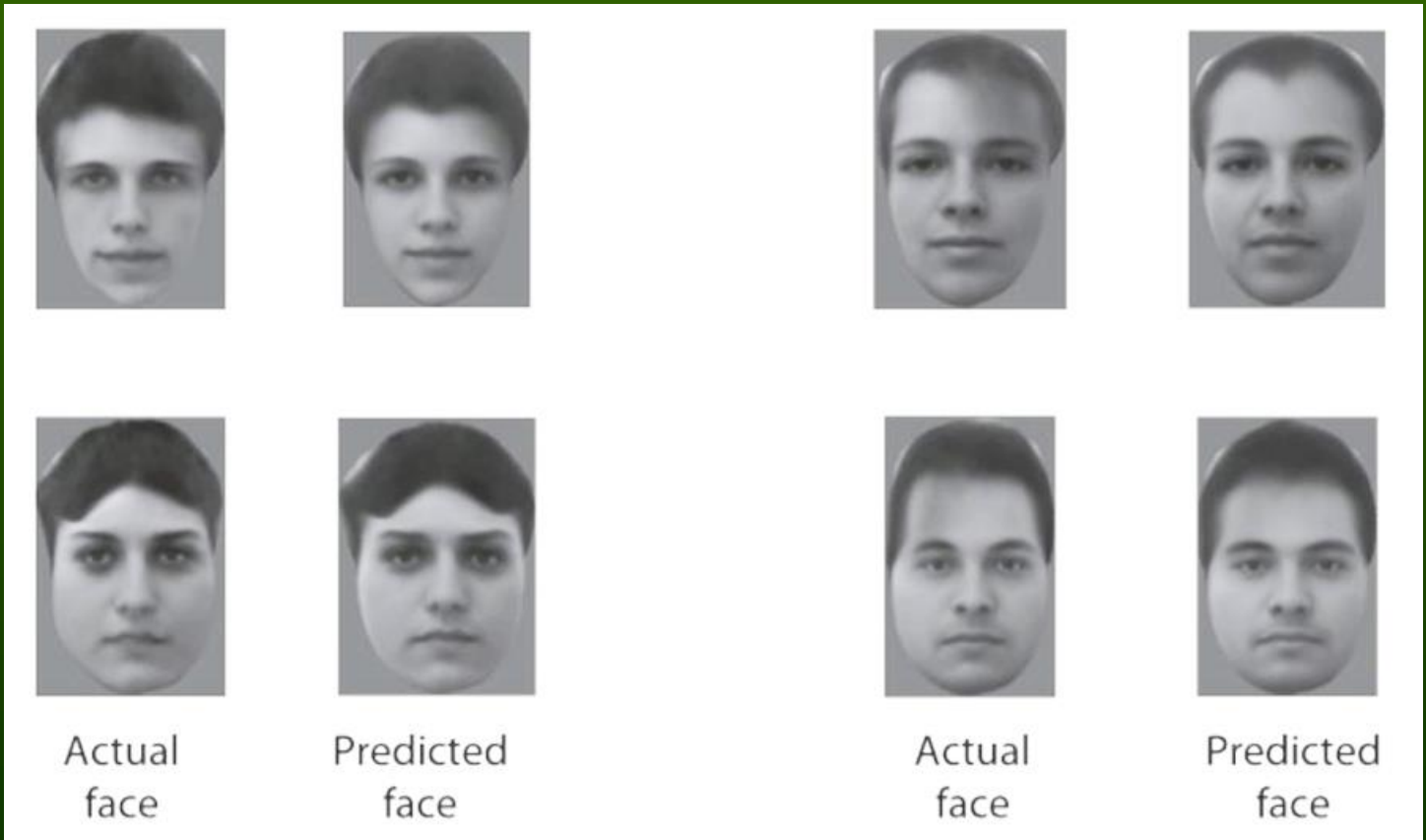


3. We found that an axis model allows precise encoding and decoding of neural responses



Mental images

The image of the face is encoded using a simple neural code that is based on the ability of neurons to distinguish facial features along specific axes in the facial features space.

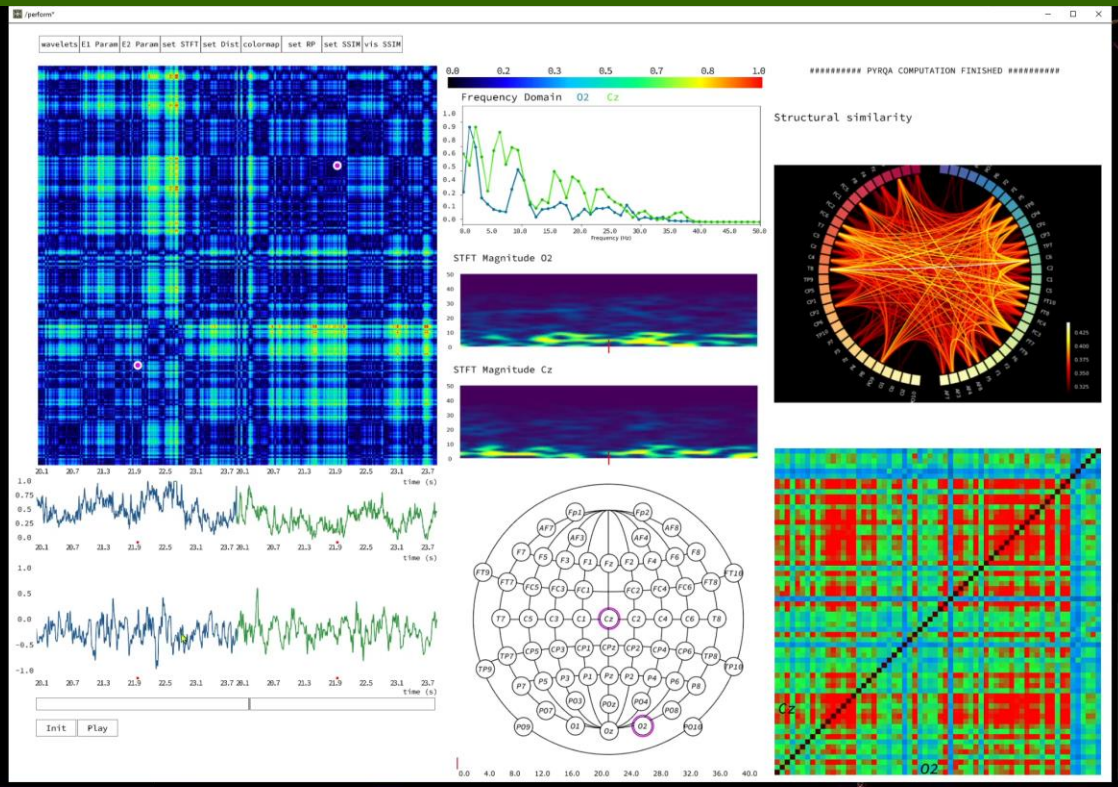


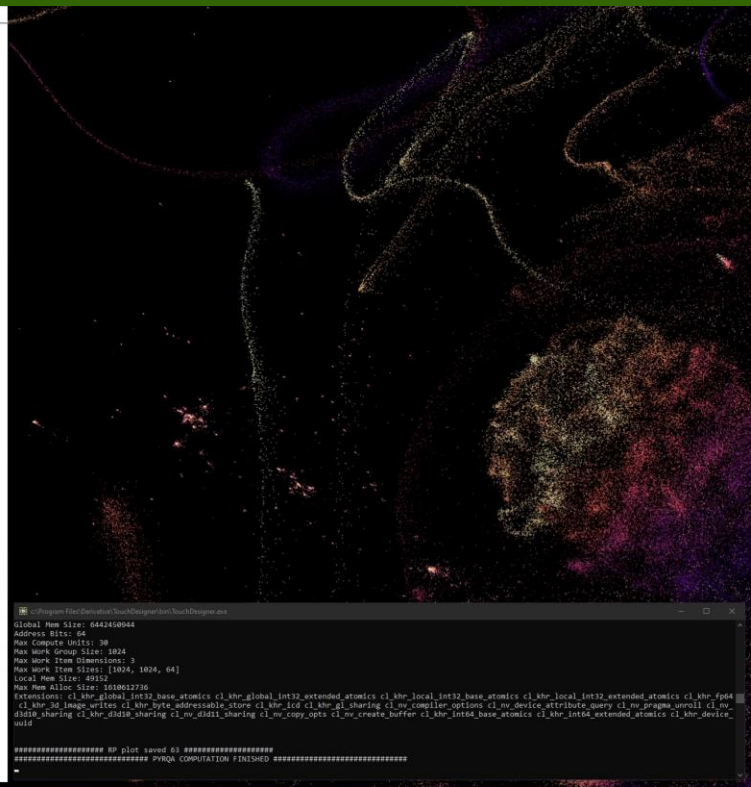
L. Chang and D.Y. Tsao, *Cell* 2017

Dreams

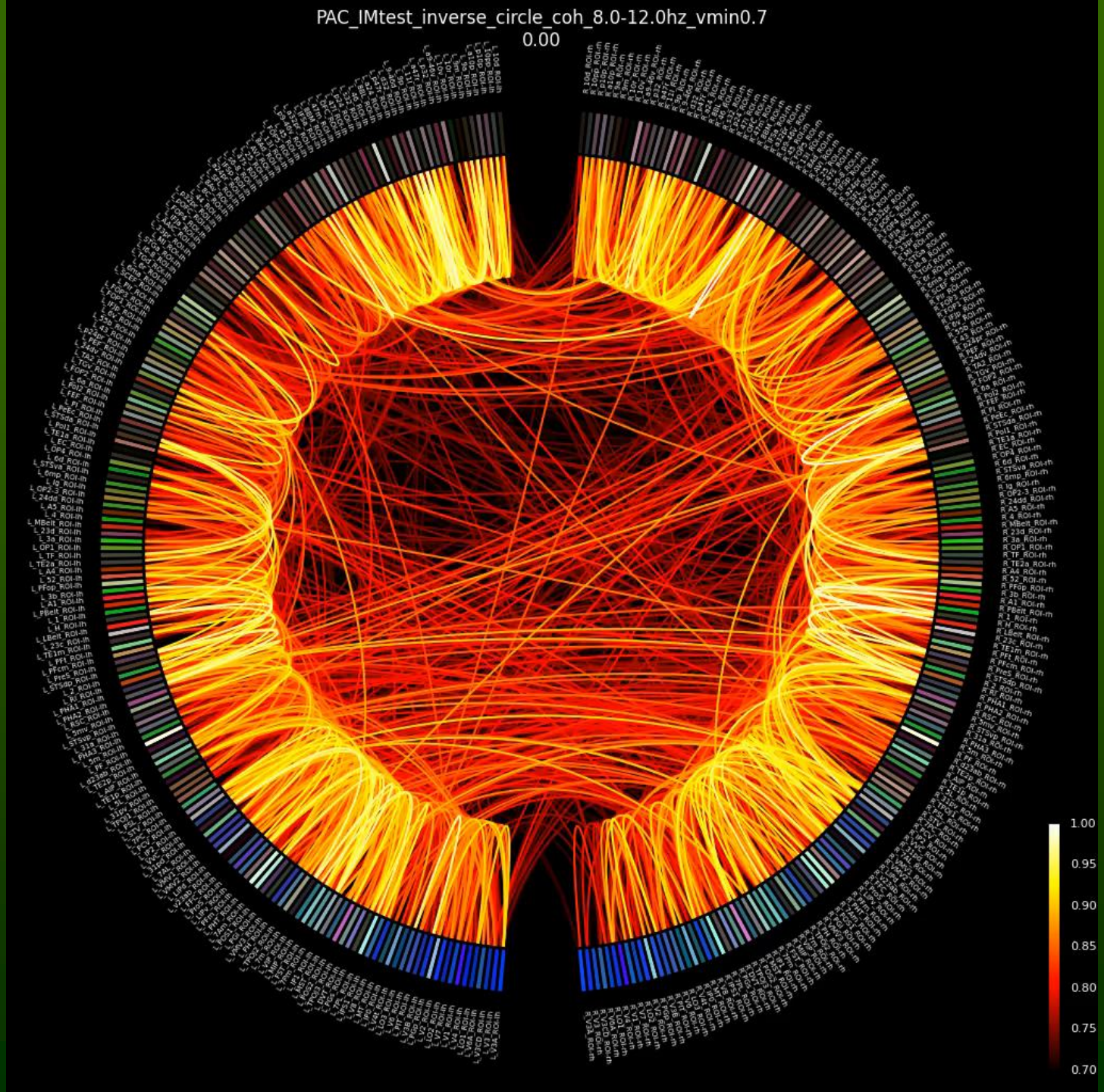
Decoding Dreams, ATR Kyoto, Kamitani Lab.
fMRI images analyzed during REM sleep or while falling asleep allow for the classification of dreams (~20 categories).
Dreams, thoughts... is it possible to hide what we have seen and experienced?

EEG analysis

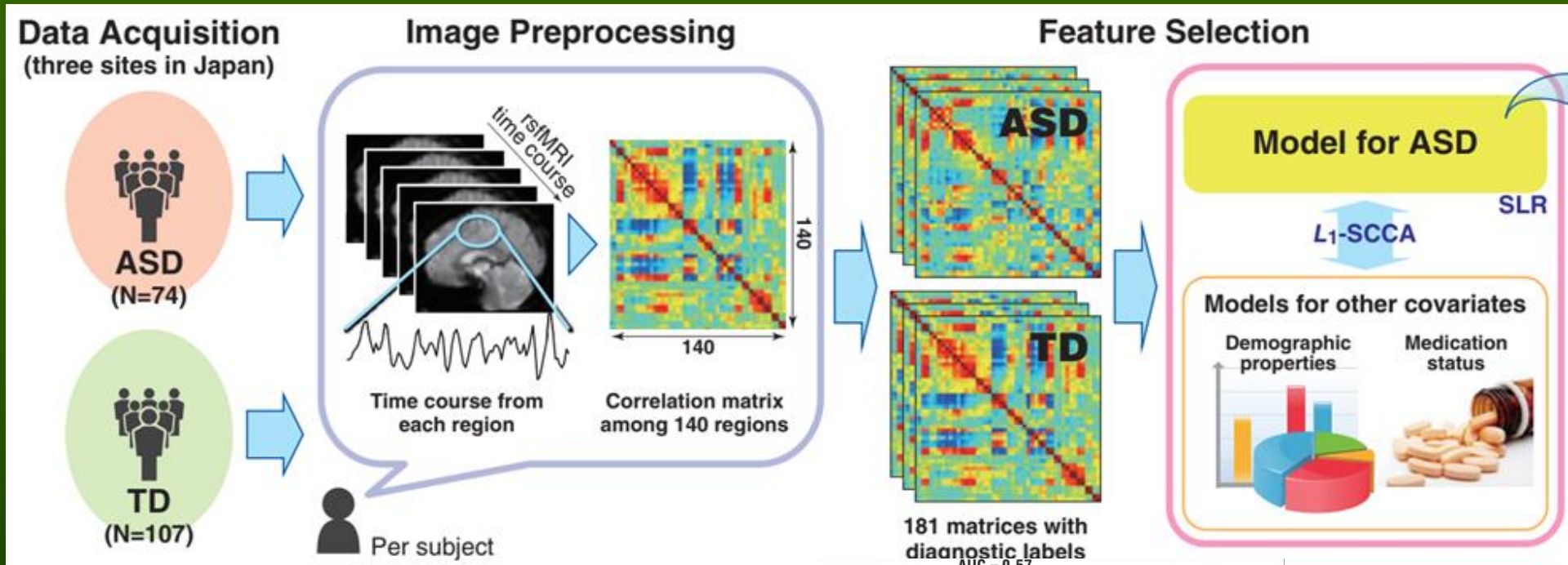


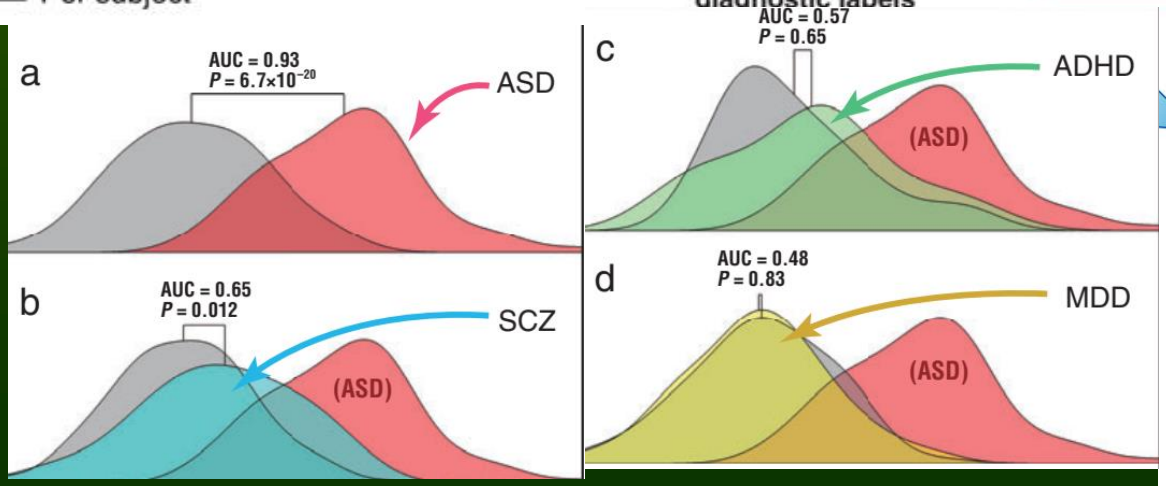


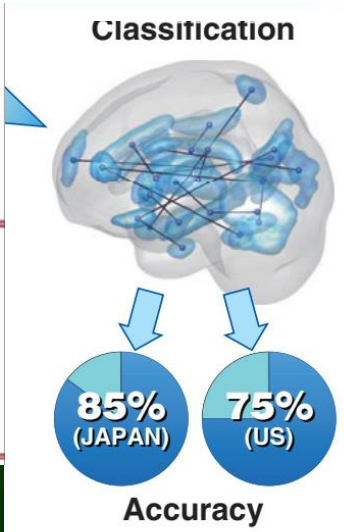
EEG data, 128 channels, recursion graphs, power spectrum for two electrodes, information flow and correlations between brain regions (Łukasz Furman).


PAC_IMtest_inverse_circle_coh_8.0-12.0hz_vmin0.7
0.00
1.00
0.95
0.90
0.85
0.80
0.75
0.70

Diagnostic biomarkers

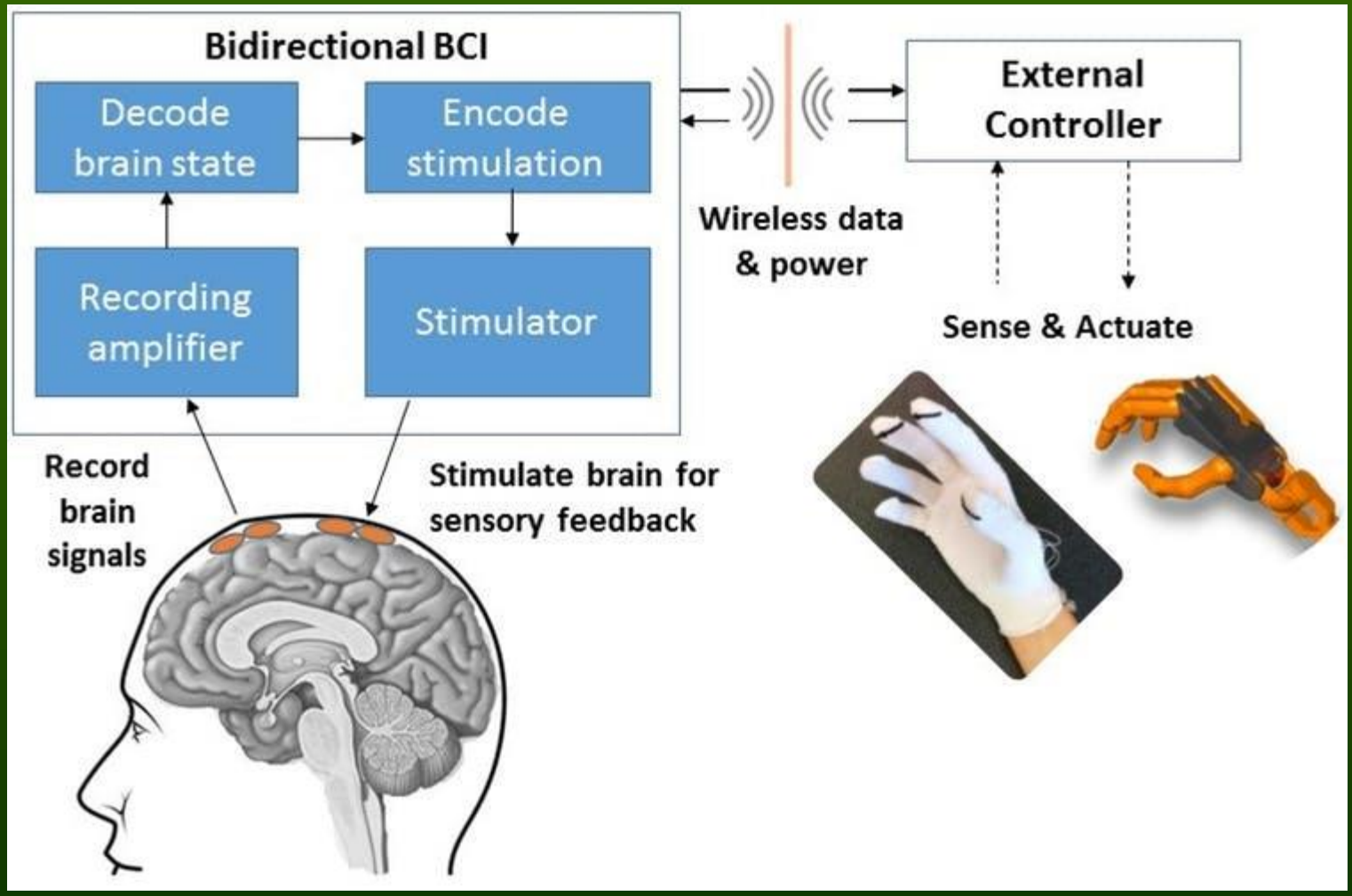






N. Yahata et al, *Psychiatry and Clinical Neurosciences* 2017: **71**

BCBI: Brain-Computer-Brain

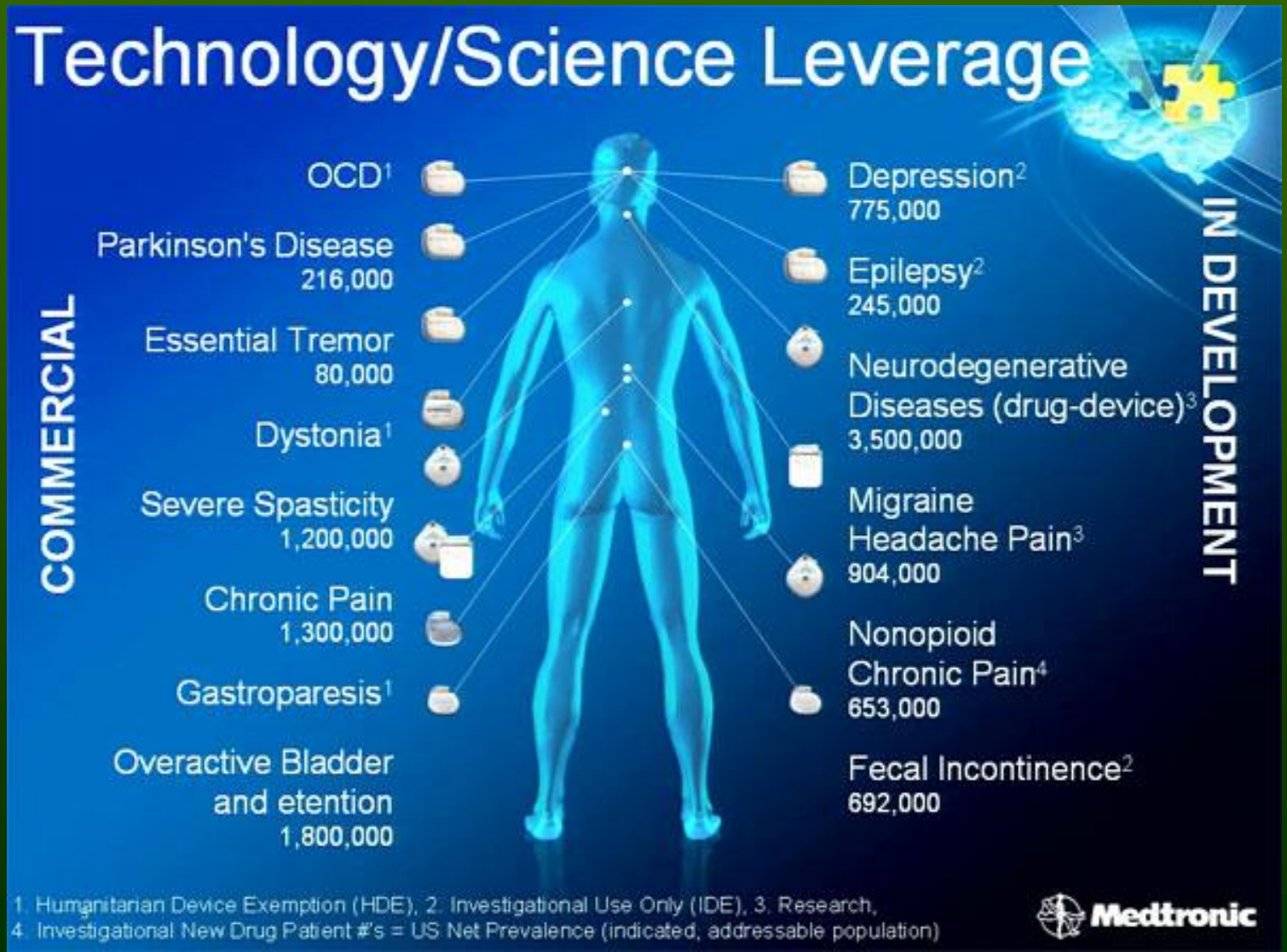


BCI + brain stimulation = BCBI – a closed loop through which the brain begins to restructure itself. The body can be replaced by signals in Virtual Reality.

Neuromodulation

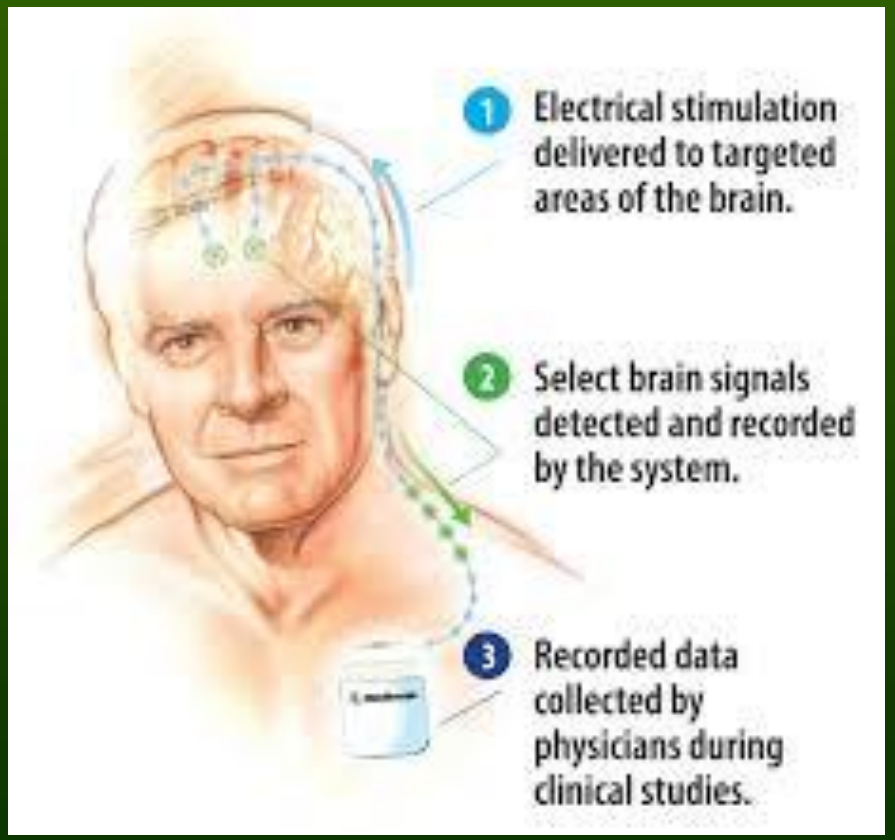
Cochlear implants are common, deep implants stimulate brain structures, not only for deficits of perception, but to regulate cortical neural processes.

Market:
10B$ (2021),
25B$ in 2027.

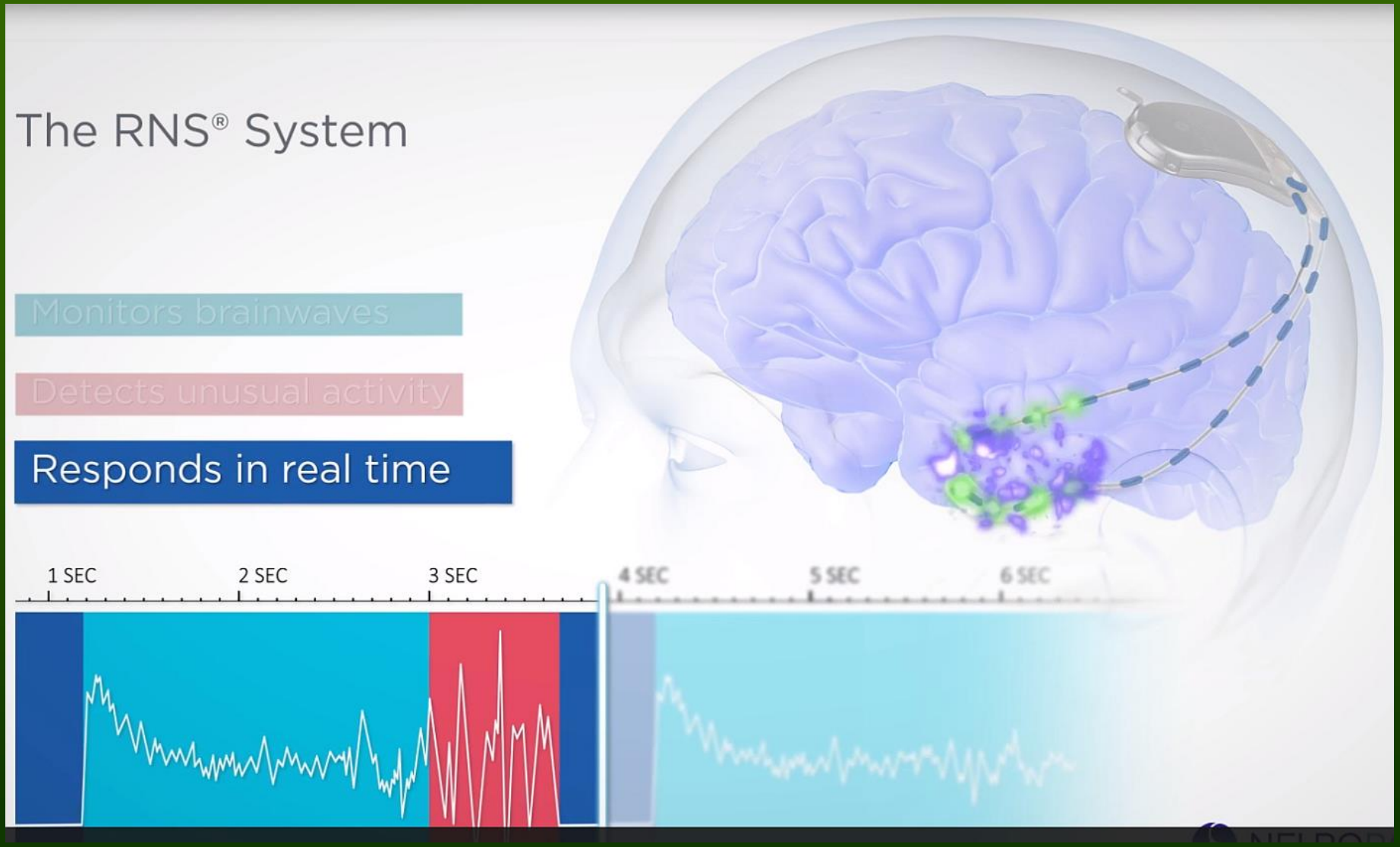


Deep brain stimulation

People suffering from Parkinson's disease or compulsive-obsessive disorder who have electrodes implanted deeply in their brain can regulate their behavior with an external controller.
Let's turn up our brains ... Can I program my brain?



Epilepsy



The neurostimulator and detector stops attacks of drug-resistant epilepsy before cramps occur. About 1% of people in the world have epilepsy.

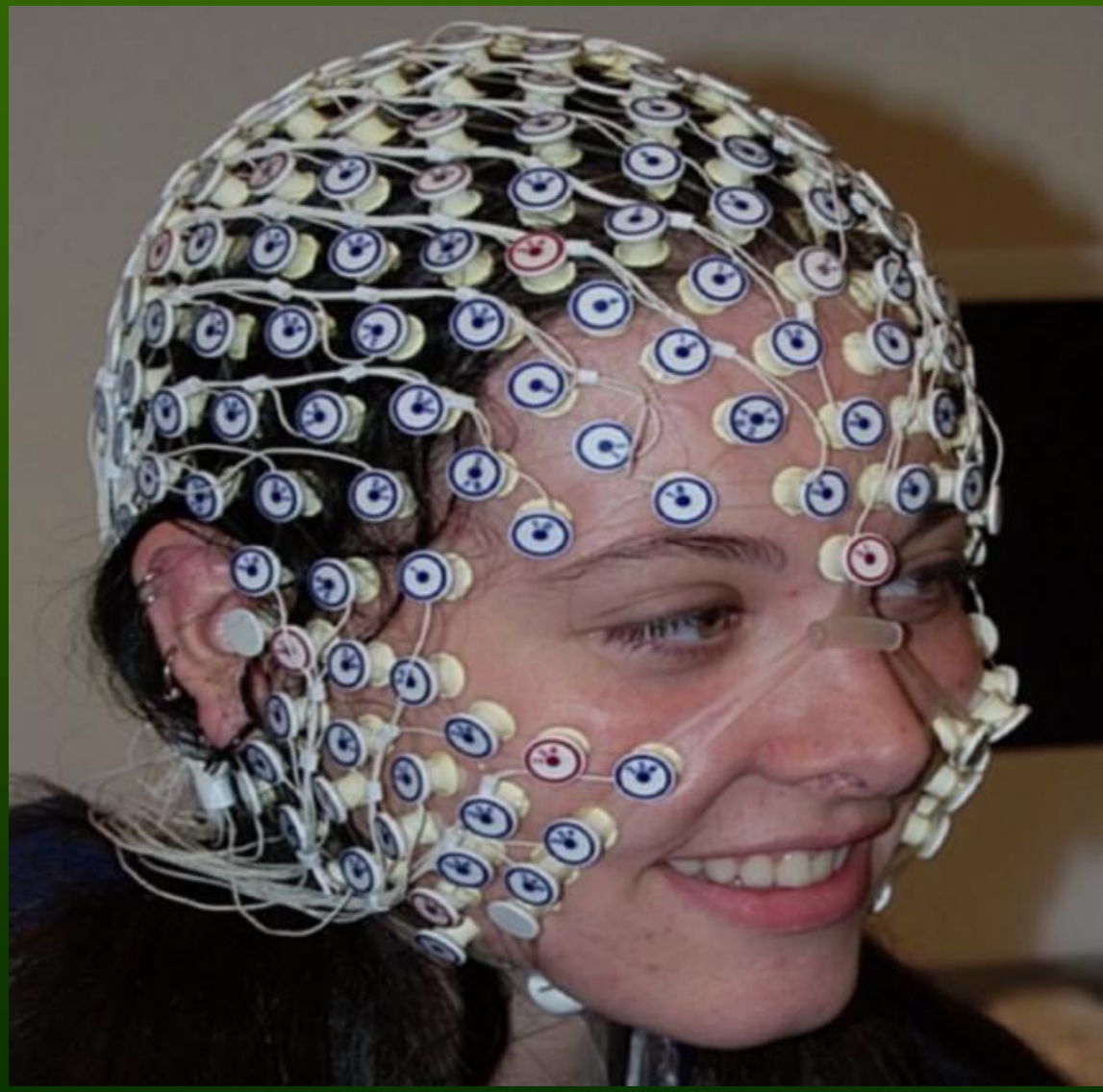
HD DCS for BCBI

Reading brain states => transforming to common space => duplicating in other brains …

Depression, neuro-plasticity, pain, psychosomatic disorders, teaching!

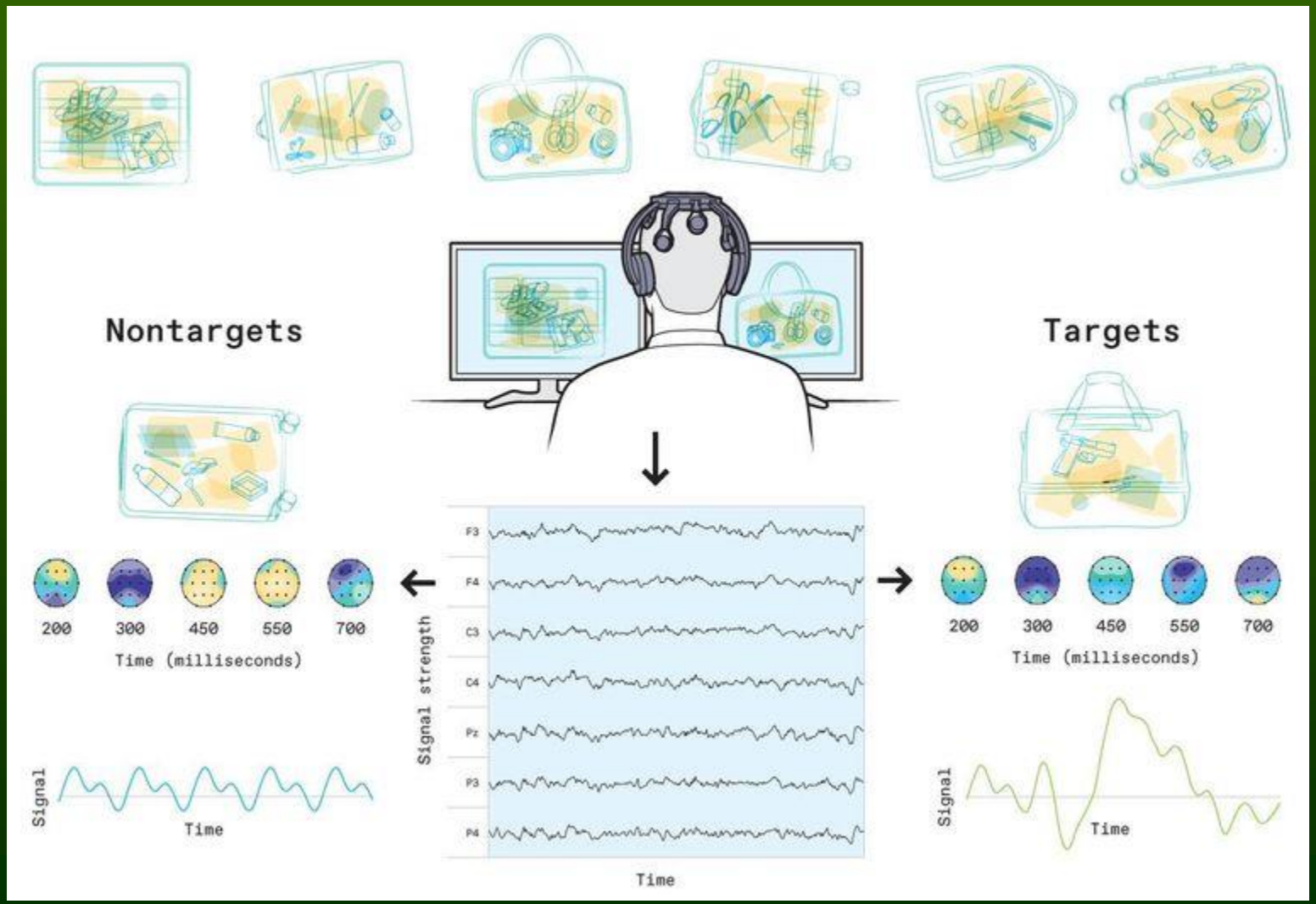
Multielectrode DCS stimulation with 256 electrodes induces changes in the brain increasing neuroplasticity.

But **no-one really knows** why it works …



InnerEye

Simple DCS will let you analyze 3-10 images per second for hours …
Your brain is smarter than you!



Brain to brain

Engagement Skills Trainer (EST), procedures for training American soldiers.

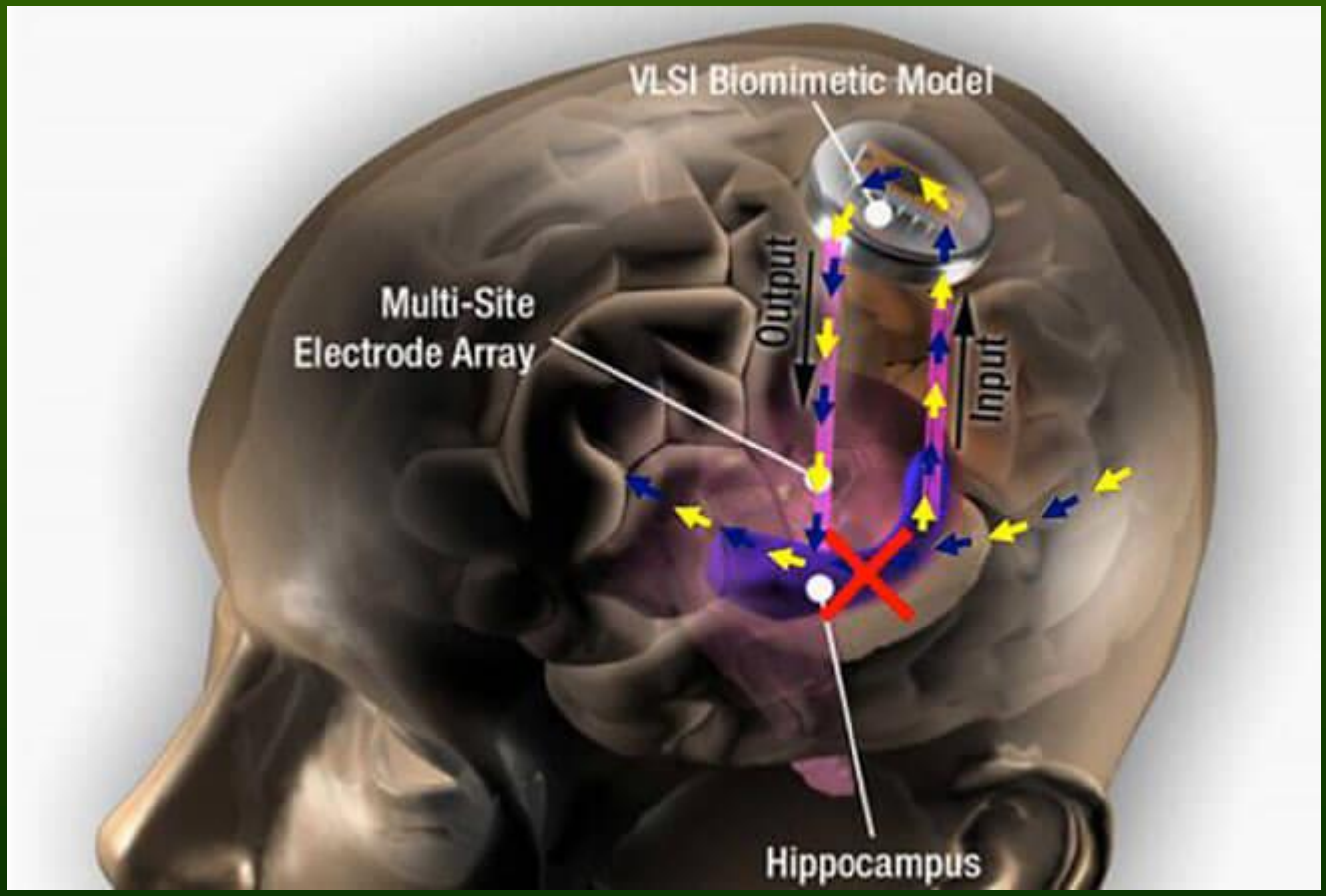
Intific Neuro-EST
a technology that uses EEG analysis and a multi-channel transcranial stimulator (MtCS) to transfer skills between master and student, brain-to-brain.

Memory implants

Tests on rats, monkeys, and in 2017 on 20 humans gave an improvement in memory by 30% (on rats by 35%). Ted Berger (USC, Kernel) : There are good reasons to believe that the integration of memory with electronics is possible.

DARPA: Restoring Active Memory (RAM) program, for people with brain damage (TBI), should be non-invasive.

Neurofeedback + closed-loop neurostimulation.



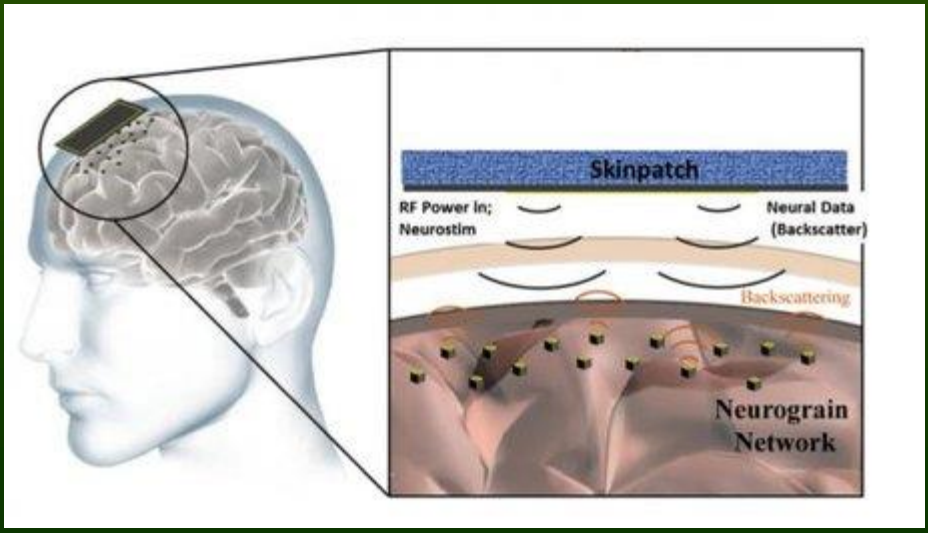
A million nanowires in the brain?

DARPA initiative: **Neural Engineering System Design (NESD)** and other projects.

An interface that reads the impulses of 10^6 neurons, stimulates 10^5 neurons, simultaneously reads and stimulates 10^3 neurons.

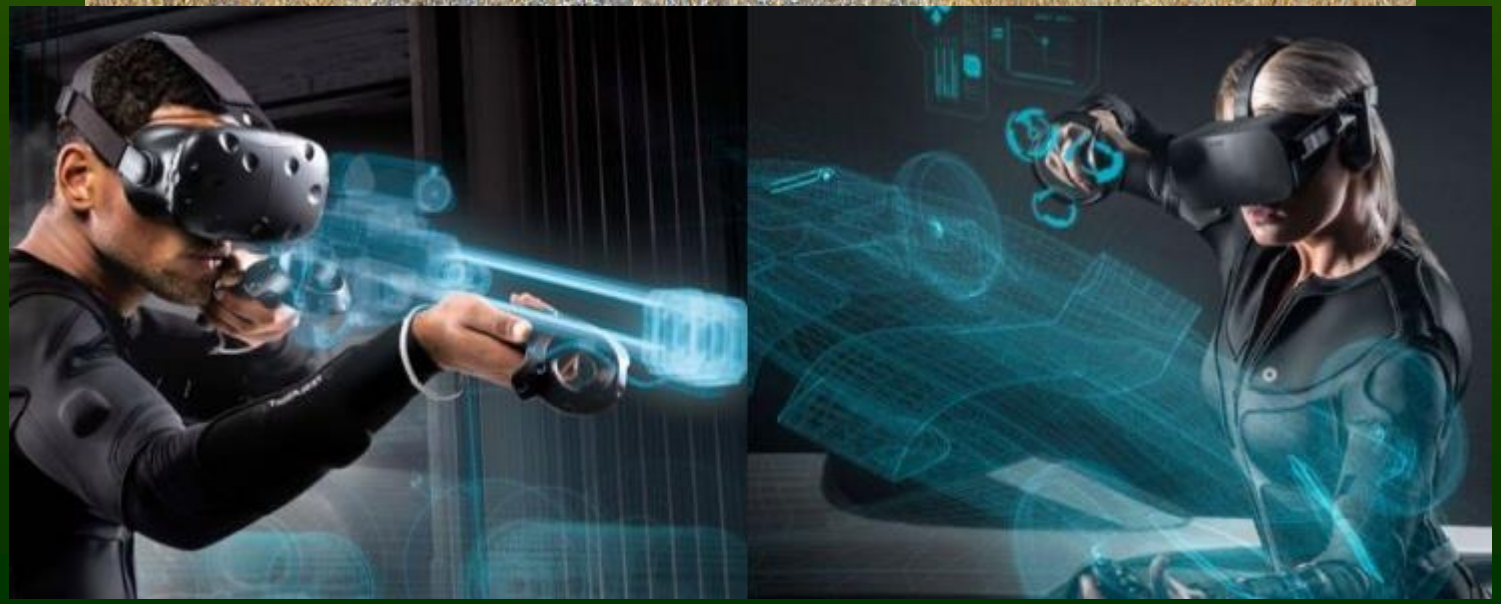
DARPA awarded grants to research groups for projects under the program Electrical Prescriptions (ElectRx), whose aim is to develop BCBI systems modulating the activity of peripheral nerves for therapeutic purposes.

Neural dust – microscopic wireless sensors in the brain.
Elon Musk and the much-heralded technology neuralink (neural lace).



A radical change is coming...

Our politicians still have not noticed that something had changed.



Towards Human-like Intelligence

IEEE Computational Intelligence Society Task Force (Mandziuk, Duch, M. Woźniak), **Towards Human-like Intelligence**

IEEE SSCI CIHLI 2022 Symposium on Computational Intelligence for Human-like Intelligence, Singapore.

AGI: conference, Journal of Artificial General Intelligence comments on Cognitive Architectures and Autonomy: A Comparative Review (eds. Tan, Franklin, Duch).

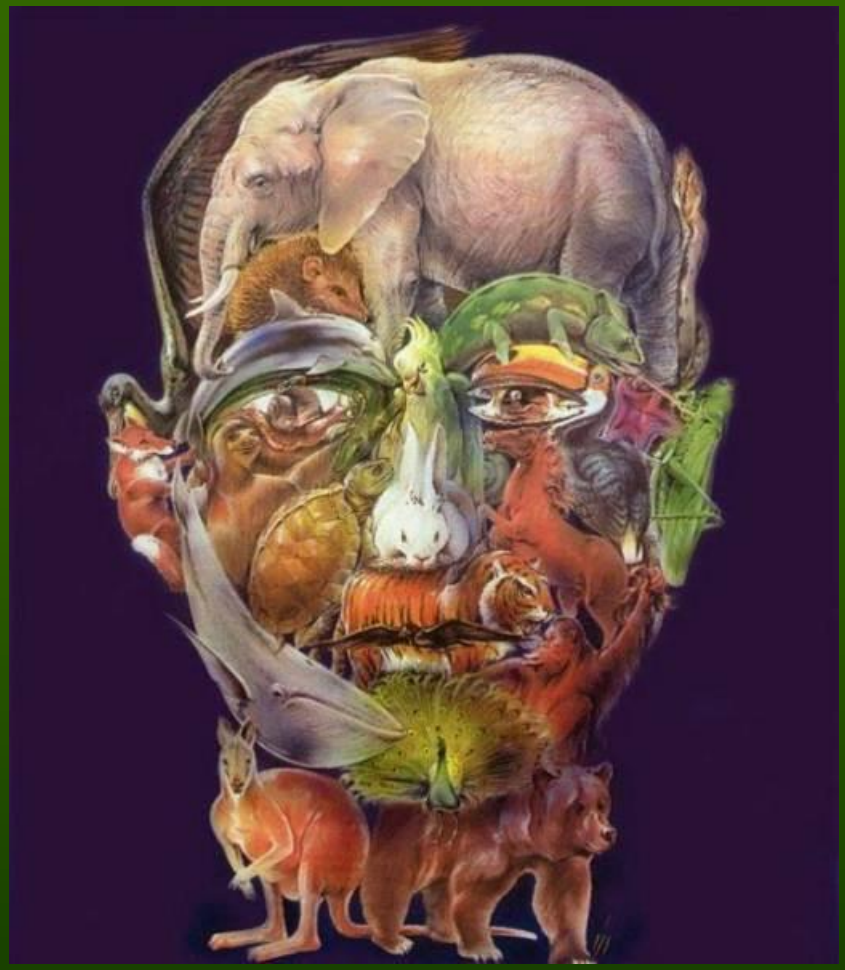
BICA: Annual International Conf. on Biologically Inspired Cognitive Architectures, 13th Annual Meeting of the BICA Society, Guadalajara, Mexico 2023.

Brain-Mind Institute Schools, International Conference on Brain-Mind (ICBM) and Brain-Mind Magazine (Juyang Weng, Michigan SU).

Perspectives

- AI is changing everything, including the way science is done.
  Large companies and global consortia are at the front of research.
- AI-based automation will lead to a great social changes.
- What was impossible yesterday tomorrow will be common.
  Growing understanding of perception and language leads to autonomous AI.
- The evolution of thought will move into multidimensional worlds beyond our comprehension. Robots/AI systems will quickly learn from each other.
- Machines will claim to be conscious, and most people will accept it;
  the legal status of the cyborgs is already being discussed.
- Neurocognitive technologies will profoundly change our selves.
  We are moving from animal life to our own virtual creation!
  Is this a brave new world or happiness for all?
- We are not becoming wiser, but
  the singularity may come faster than we think!

Intelligence?



Google: Wlodek Duch
=> talks, papers, lectures ...