Artificial Intelligence in Medicine and Life Sciences - Introduction (NTF012F)

Sonja Aits

Lund University
2023-12-12

We are filming!

Teachers

Sonja Aits
Faculty of Medicine

Mattias Ohlsson
Faculty of Science &
Halmstad University

Teaching assistants

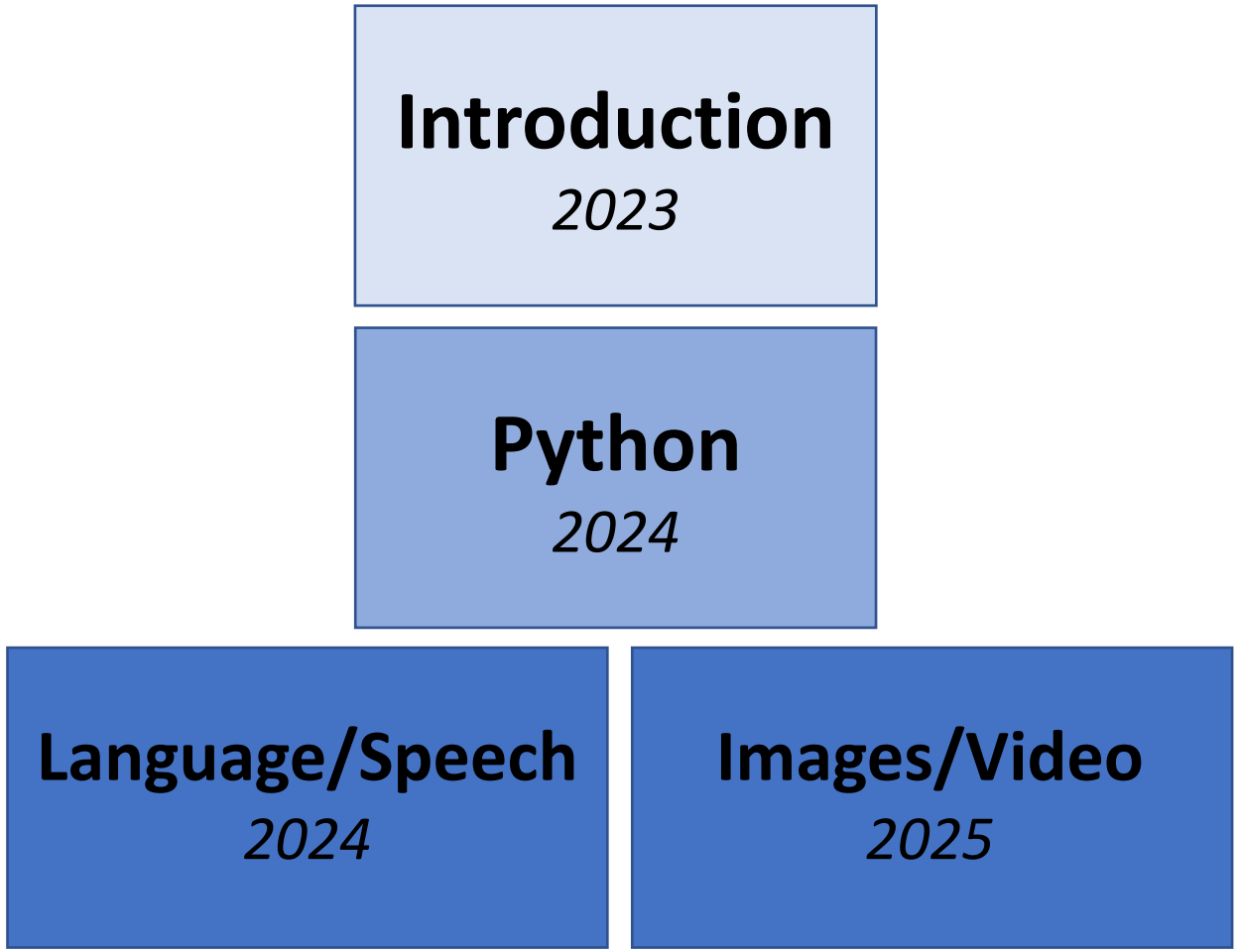
Salma Kazemi Rashed
Rafsan Ahmed

Course website

https://github.com/COMPUTE-LU/AI4MedLife_intro_2023

AI in Medicine and Life Sciences Courses

https://www.compute.lu.se



Tuesday Dec 12

09:00-10:00	Welcome and introduction round	Sonja Aits	I1345
10:00-11:30	Introduction: what is AI and how can it be used in medicine and life sciences?	Sonja Aits	I1345
11:30-12:00	Data types and sources	Sonja Aits	I1345
12:00-13:00	*Lunch break*		
13:00-16:00	General AI Concepts and Tasks	Mattias Ohlsson	I1345

Wednesday Dec 13

10:30-12:00	Computer vision in medicine and life science	Sonja Aits	I1345
12:00-13:00	*Lunch break*		
13:00-16:00	General AI Concepts and Tasks Ii	Mattias Ohlsson	I1345

Thursday Dec 14

09:00-11:30	Natural language processing in medicine and life science	Sonja Aits	I1345
11:30-12:00	Developing your AI project	Sonja Aits	I1345
Afternoon	Independent project work		

Friday Dec 15

09:00-10:30	Societal, ethical and legal implications of AI	Sonja Aits , teaching assistants	I1345
10:30-12:00	AI research in practice	Sonja Aits	I1345
Afternoon	Independent project work		

Jan 22/23

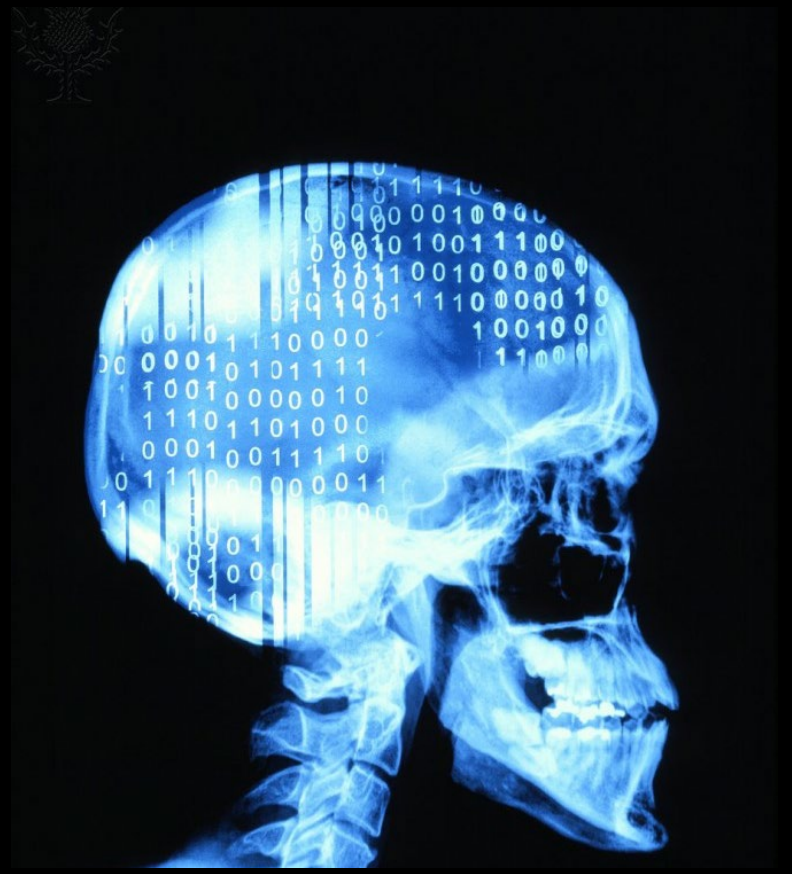
09:00-16:00	Student presentations and discussion	Sonja Aits, teaching assistants	I1345 (Jan 22) BMC A, Segerfalksalen (Jan 23)

Individual projects (examination)

- Choose a research task
- Evaluate related research
- Design project
- Present project – Jan 22/23, 2024
- Review another project

What is AI?

And how can it be used in medicine and life sciences?



Big data
Artificial intelligence
Machine learning
Deep learning

What is artificial intelligence?

Artificial intelligence

Imitation of natural intelligence in computers

What is artificial intelligence?

Artificial intelligence

Imitation of natural intelligence in computers

Machine learning

Computers learn decision rules from examples

Height	Movement	Decision
50 m	no	Plant
7 m	yes	Animal
10 cm	no	Plant
2 mm	yes	Animal
30 cm	yes	???

What is artificial intelligence?

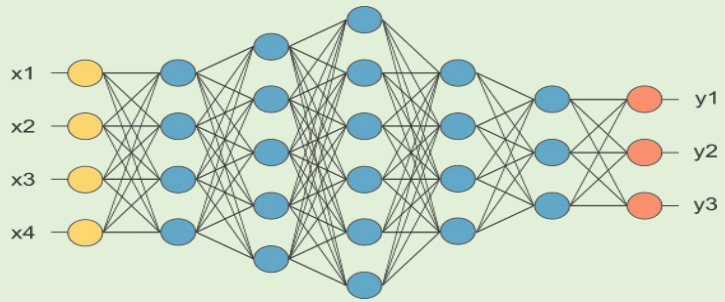
Artificial intelligence

Imitation of human intelligence in computers

Machine learning

Computers learn decision rules from examples

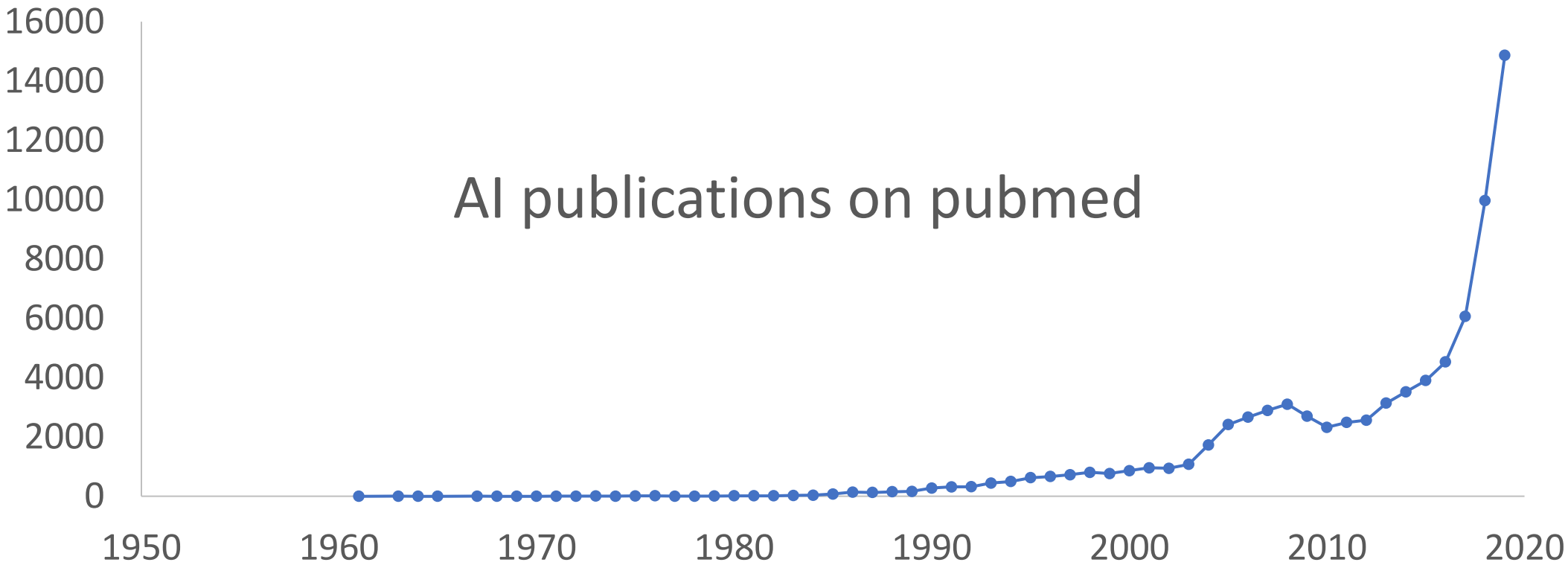
Deep learning



What is AI?

Maths

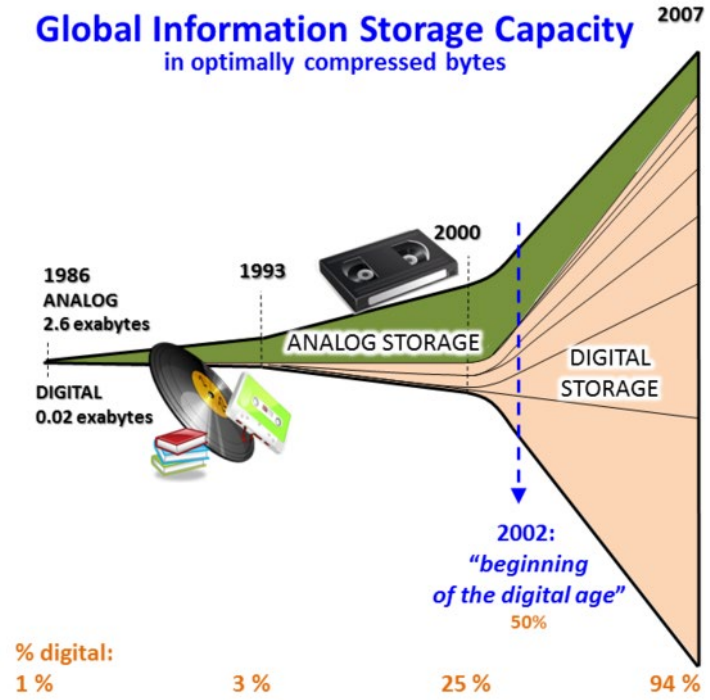
AI revolution



Why now?

Potent hardware

Big data



Source: Hilbert, M., & López, P. (2011). The World's Technological Capacity to Store, Communicate, and Compute Information. *Science*, 332(6025), 60 –65. http://www.martinhilbert.net/WorldInfoCapacity.html

Methodological advances

ImageNet Classification with Deep Convolutional Neural Networks

Alex Krizhevsky
University of Toronto
kriz@cs.utoronto.ca

Ilya Sutskever
University of Toronto
ilya@cs.utoronto.ca

Geoffrey E. Hinton
University of Toronto
hinton@cs.utoronto.ca

Article | Published: 27 January 2016

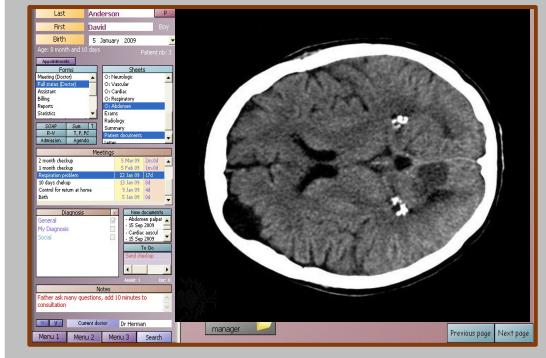
Mastering the game of Go with deep neural networks and tree search

David Silver, Aja Huang, Chris J. Maddison, Arthur Guez, Laurent Sifre, George van den Driessche, Julian Schrittwieser, Ioannis Antonoglou, Veda Panneershelvam, Marc Lanctot, Sander Dieleman, Dominik Grewe, John Nham, Nal Kalchbrenner, Ilya Sutskever, Timothy Lillicrap, Madeleine Leach, Koray Kavukcuoglu, Thore Graepel & Demis Hassabis

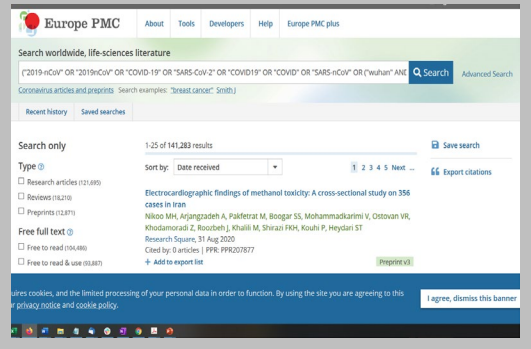
Nature **529**, 484–489(2016) | Cite this article

Life science data is abundant…

Patient journals

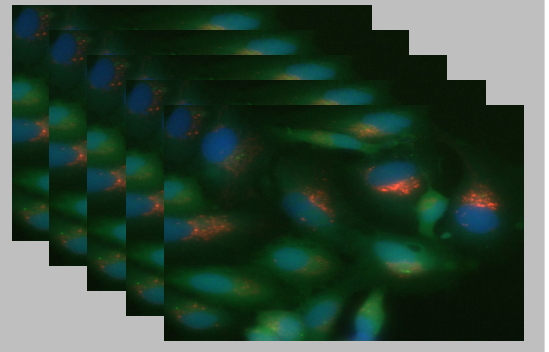


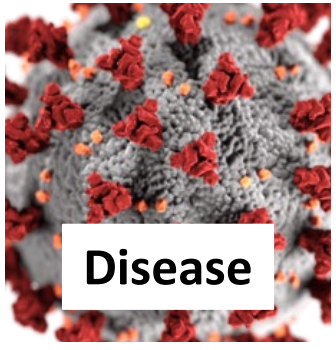
Scientific literature and other texts

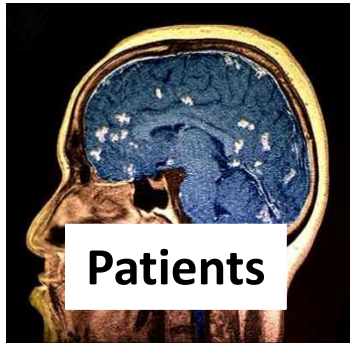


Bioinformatics databases

Large unstructured research datasets

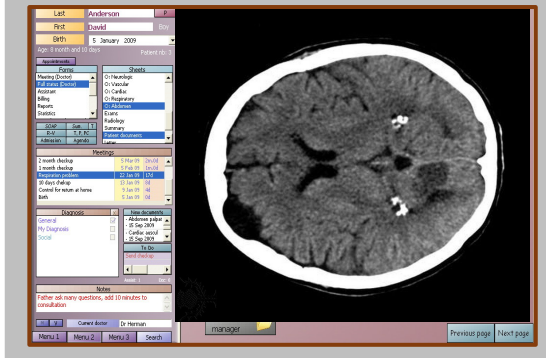




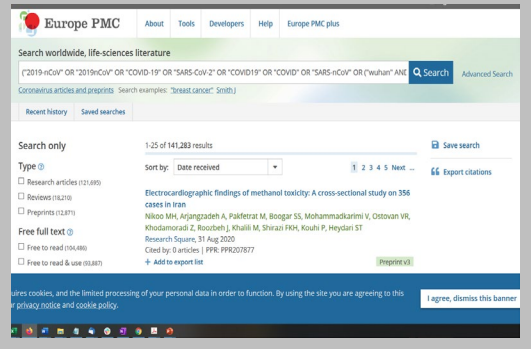


…but scattered and very complex

Patient journals



Scientific literature and other texts



Bioinformatics databases

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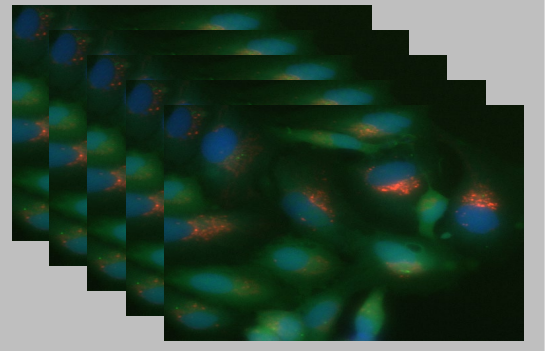
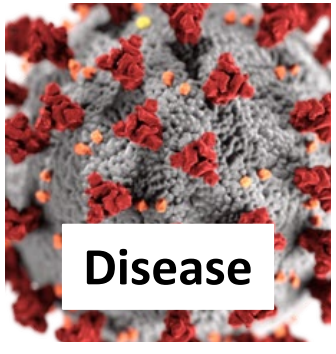
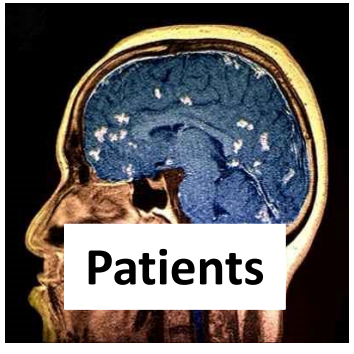


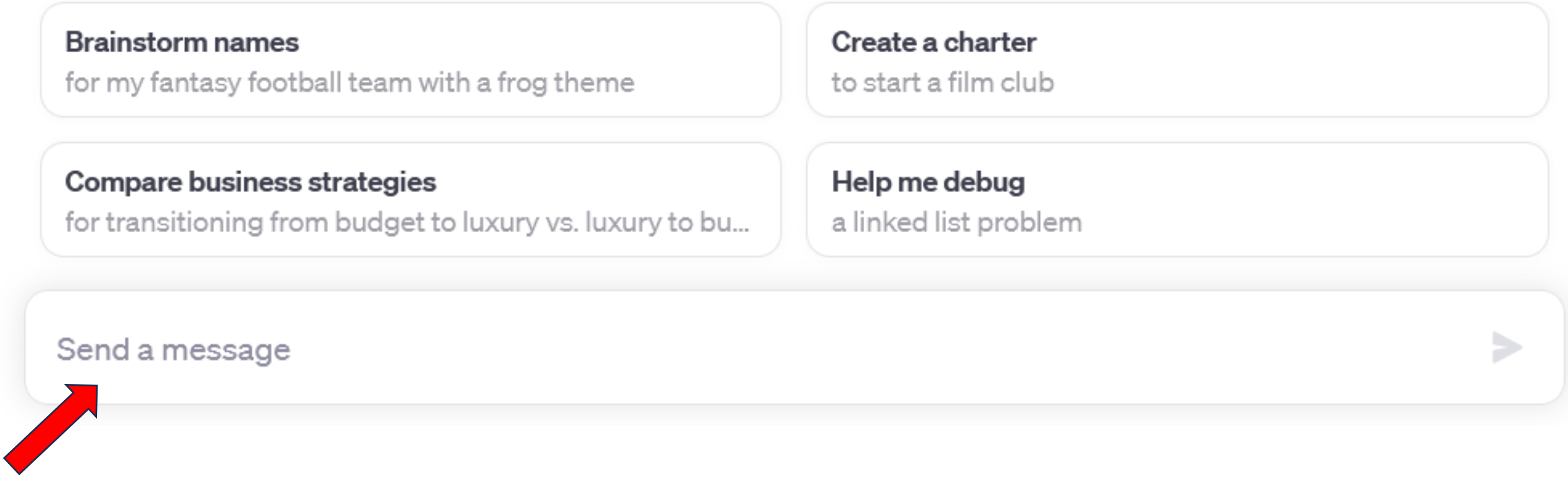




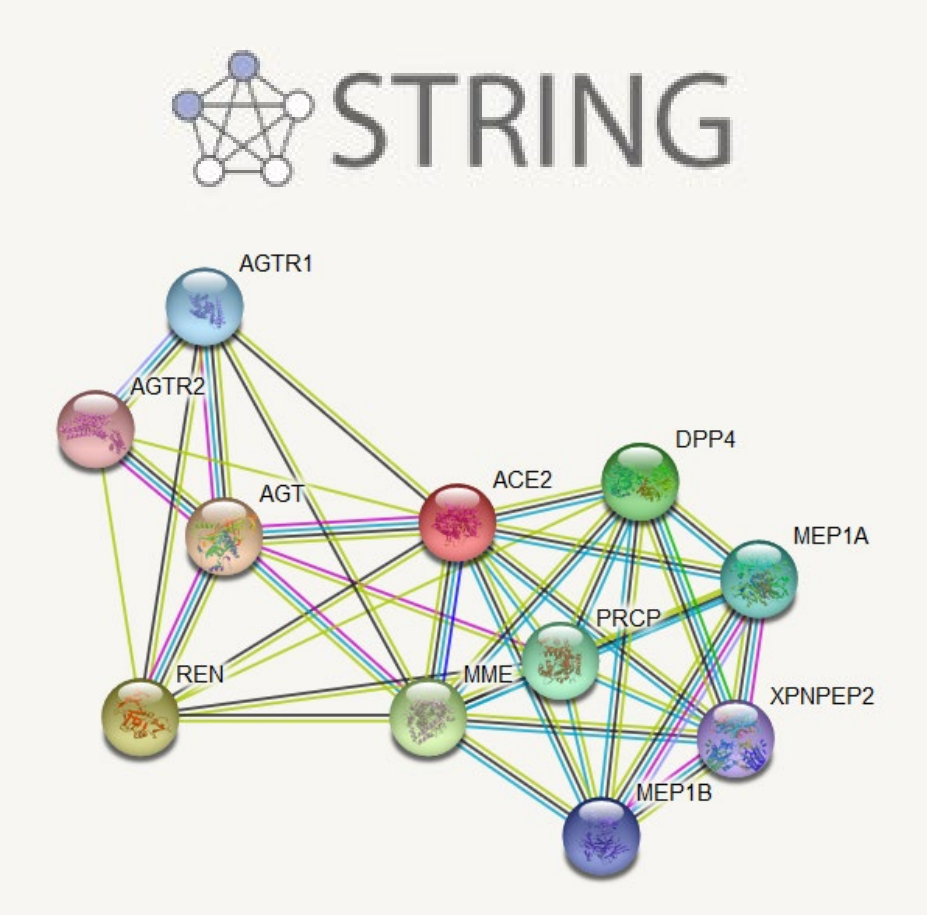
Natural language processing

ChatGPT

https://chat.openai.com/



Text mining of protein-protein interactions



https://string-db.org/

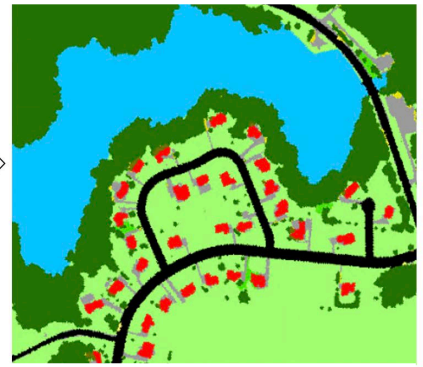
Computer vision

Image analysis

Classifying and scoring images

Counting and tracking objects

Distinguishing structures



AI-based diagnostic tools

Structural biology

Google's DeepMind aces protein folding

By Robert F. Service | Dec. 6, 2018 , 12:05 PM

Google's DeepMind predicts 3D shapes of proteins

Demis Hassabis
@demishassabis

Follow

Proteins are essential to life. Predicting their 3D structure is a major unsolved challenge in biology and could impact disease understanding and drug discovery. I'm excited to announce that we have won the CASP13 protein folding competition! #AlphaFold

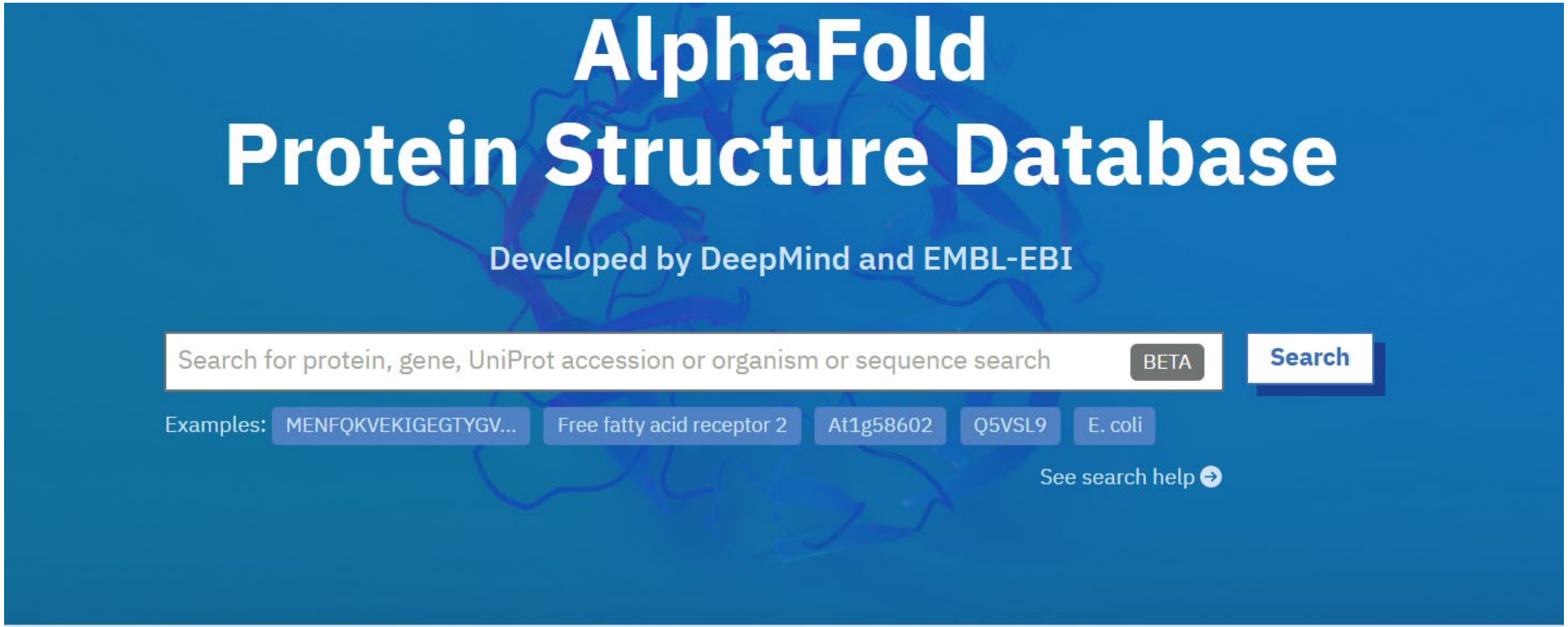
INTELLIGENCE ARTIFICIELLE SCIENCE

DeepMind a développé une IA pour modéliser des protéines

Une avancée majeure dans le monde scientifique, qui devrait notamment permettre de d'améliorer considérablement le traitement des maladies.

Technology

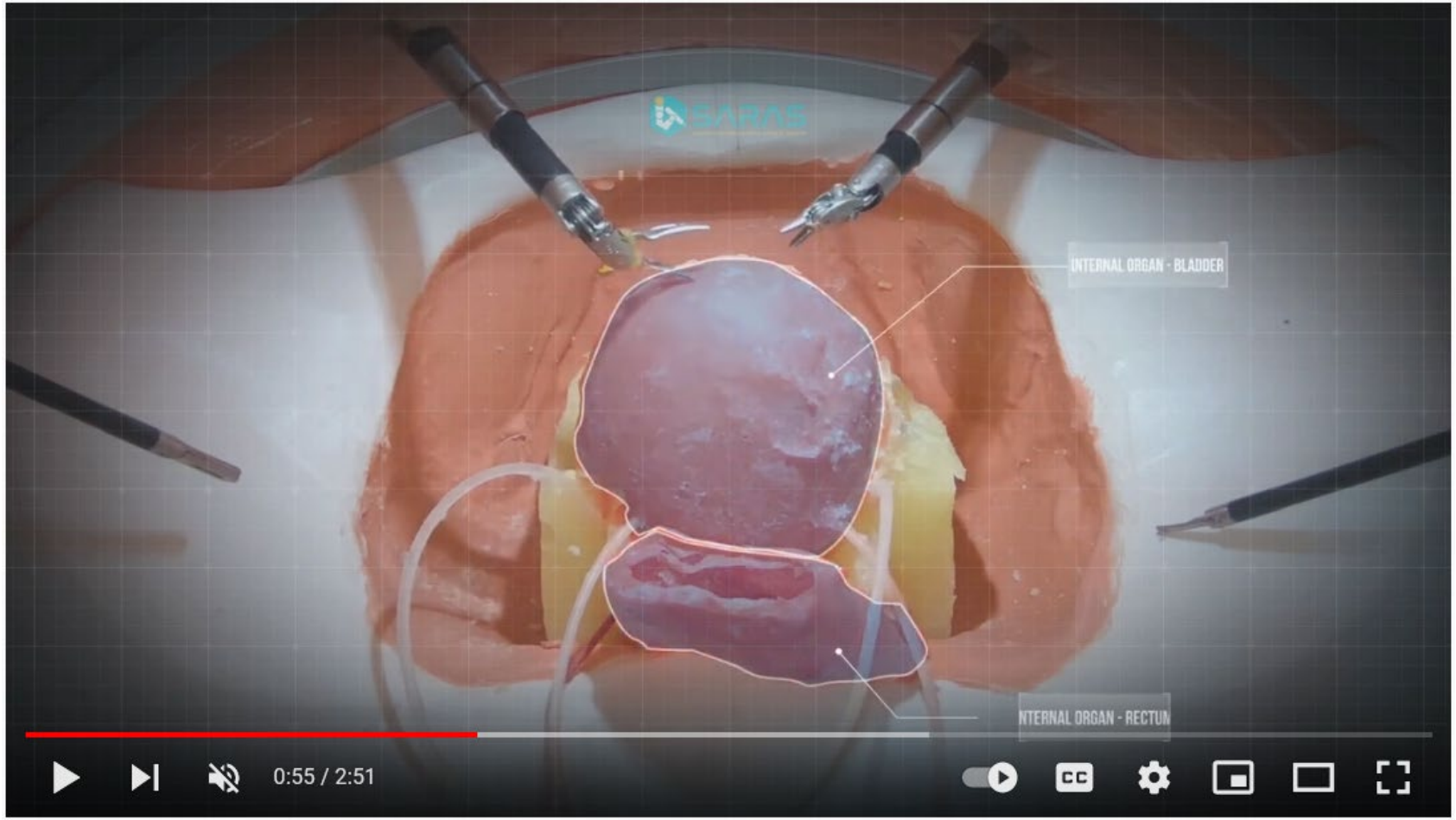
Alphabet's DeepMind AI Algorithm Wins Protein-Folding Contest



AlphaFold DB provides open access to over 200 million protein structure predictions to accelerate scientific research.

Robotics

Robotic surgery

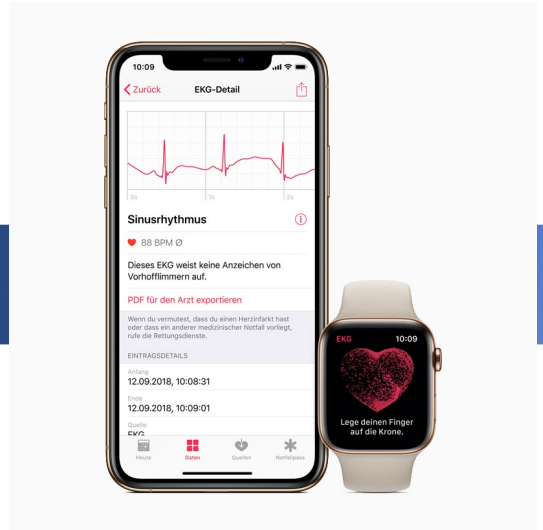


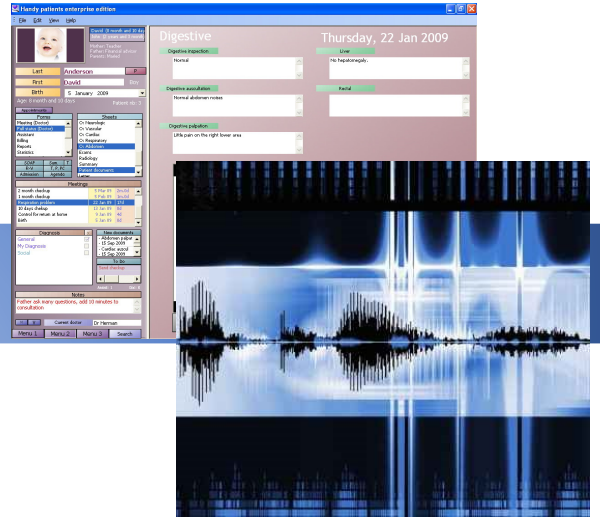
https://www.youtube.com/watch?v=XeYeAzsQ1-U

AI-supported transport

Personalized health care

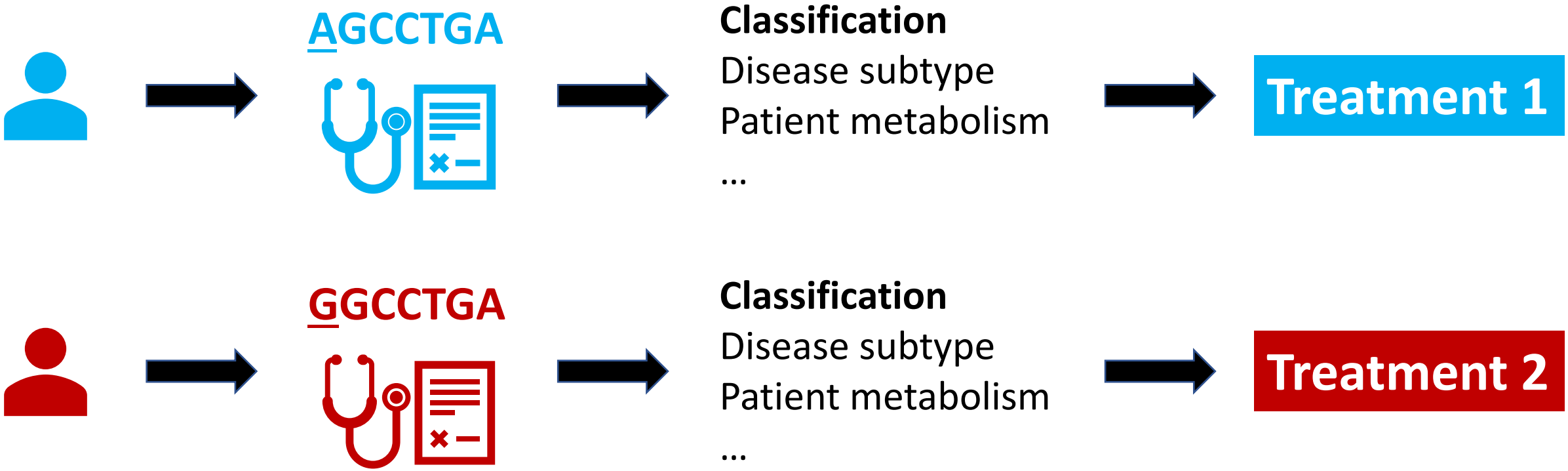
Health apps and speech recognition for collection of patient history





Structured and comprehensive patient history

AI-based predictions for personalized medicine



Custom-made implants

Other applications

AI for omics analysis

- Denoising
- Peak calling
- Variant calling
- Clustering
- Outlier detection
- Spatial omics analysis
- Multi-omics integration
- …

AI for drug development

Drug discovery
Gene-disease mapping
Biomarker discovery
Drug repurposing
Drug target identification
Lead ranking
Adverse event prediction

Clinical trials
Patient identification
Patient monitoring
Pharmacogenomics
Regulatory document preparation

Pharmacovigilance
Adverse event detection
Drug-drug interaction mapping
Patient data anonymization

AI for public health monitoring

Research Article | Open Access | Open Peer Review | Published: 08 November 2019

Deep learning for pollen allergy surveillance from twitter in Australia

Jia Rong, Sandra Michalska

BMC Medical Informatics and

243 Accesses | 11 Altmetric

Forecasting influenza activity using self-adaptive AI model and multi-source data in Chongqing, China

Kun Su[a,b,1], Liang Xu[c,1], Guanqiao Li[d,1], Xiaowen Ruan[c], Xiong[b], Shaofeng Lu[c], Li Qi[b], Chaobo Shen[c], Wenge Tang Xu[c], Xuanling Shi[d], Zhihong Yang[c], Qi Zhang[d], Ziqi Zhuan [2],

Open Access PlumX Metrics

DOI: https://doi.org/10.1016/j.ebiom.2019.08.024

Article | Open Access | Published: 18 April 2019

Measuring social, environmental and health inequalities using deep learning and street imagery

Esra Suel, John W. Polak, James E. Bennett & Majid Ezzati

Scientific Reports **9**, Article number: 6229 (2019) | Cite this article

5986 Accesses | **1** Citations | **141** Altmetric | Metrics

Other applications of AI

- Forecasting/Modelling
- Outlier detection
- Data clustering
- Recommender systems
- Generation of artificial data

…

A bright future?

$15.7 trillion

Increase in global GDP by 2030 due to AI (14%)

81%

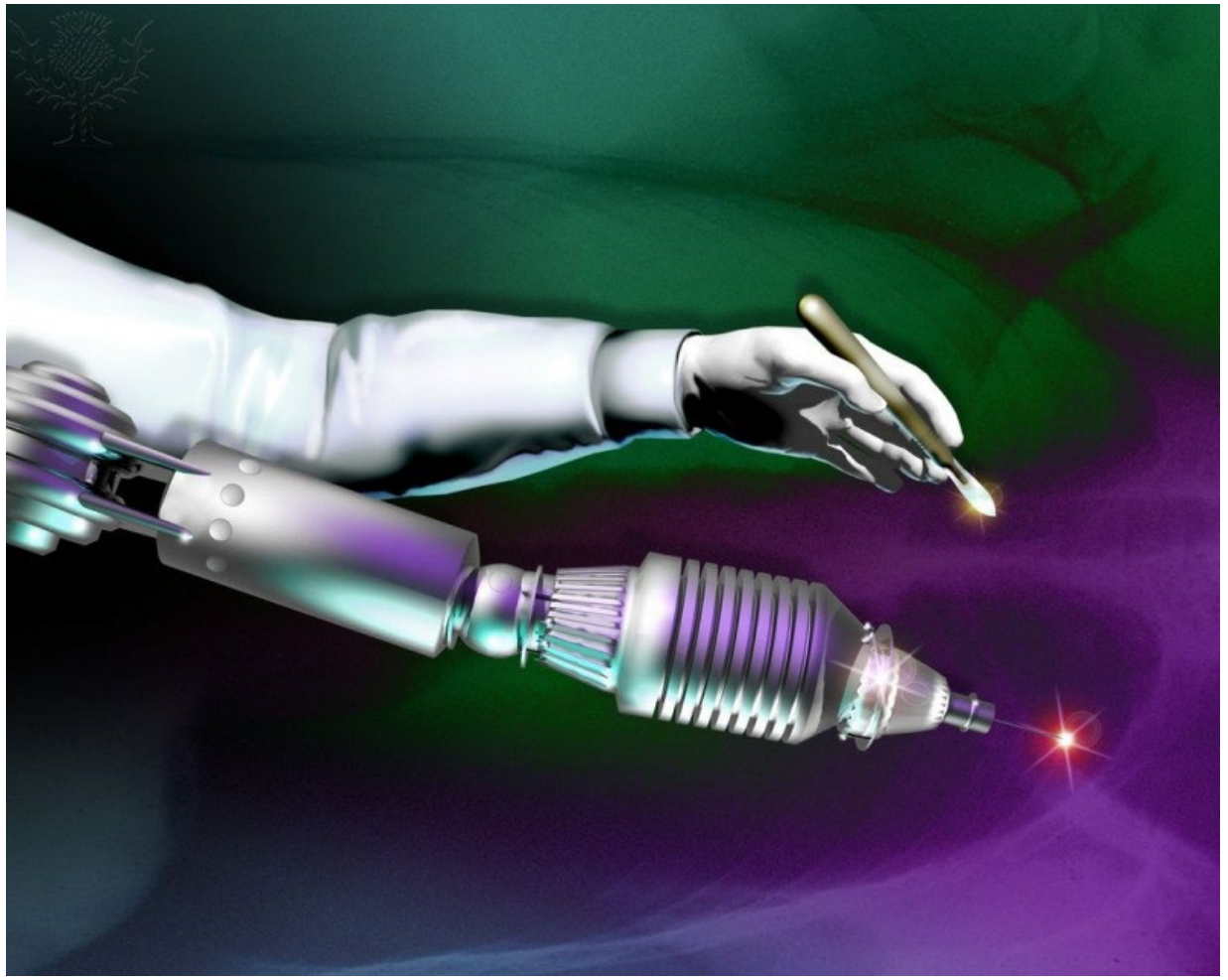
Health care CEOs who believe that AI will significantly change their business

PwC. Sizing the Price
PwC. Health care and pharmaceutical trends 2019

Company	FDA Approval	Indication
Apple	September 2018	Atrial fibrillation detection
Aidoc	August 2018	CT brain bleed diagnosis
iCAD	August 2018	Breast density via mammography
Zebra Medical	July 2018	Coronary calcium scoring
Bay Labs	June 2018	Echocardiogram EF determination
Neural Analytics	May 2018	Device for paramedic stroke diagnosis
IDx	April 2018	Diabetic retinopathy diagnosis
Icometrix	April 2018	MRI brain interpretation
Imagen	March 2018	X-ray wrist fracture diagnosis
Viz.ai	February 2018	CT stroke diagnosis
Arterys	February 2018	Liver and lung cancer (MRI, CT) diagnosis
MaxQ-AI	January 2018	CT brain bleed diagnosis
Alivecor	November 2017	Atrial fibrillation detection via Apple Watch
Arterys	January 2017	MRI heart interpretation

Topol EJ. Nature Medicine 2019, https://doi.org/10.1038/s41591-018-0300-7

Is AI the doctor and scientist of the future?



Using AI for medicine/life science is challenging

Report: IBM Watson delivered 'unsafe and inaccurate' cancer recommendations

JULY 25, 2018 BY FINK DENSFORD — LEAVE A COMMENT

Biased Data the Real Danger of AI

By Oliver Mitchell | March 19, 2018

REGULATION

There's No Such Thing as Anonymous Data

by Scott Berinato

FEBRUARY 09, 2015

Anonymous patient data may not be as private as previously thought

REUTERS By Linda Carroll, Reuters • December 21, 2018

Take home message

AI has a broad variety of applications in health care and life science research