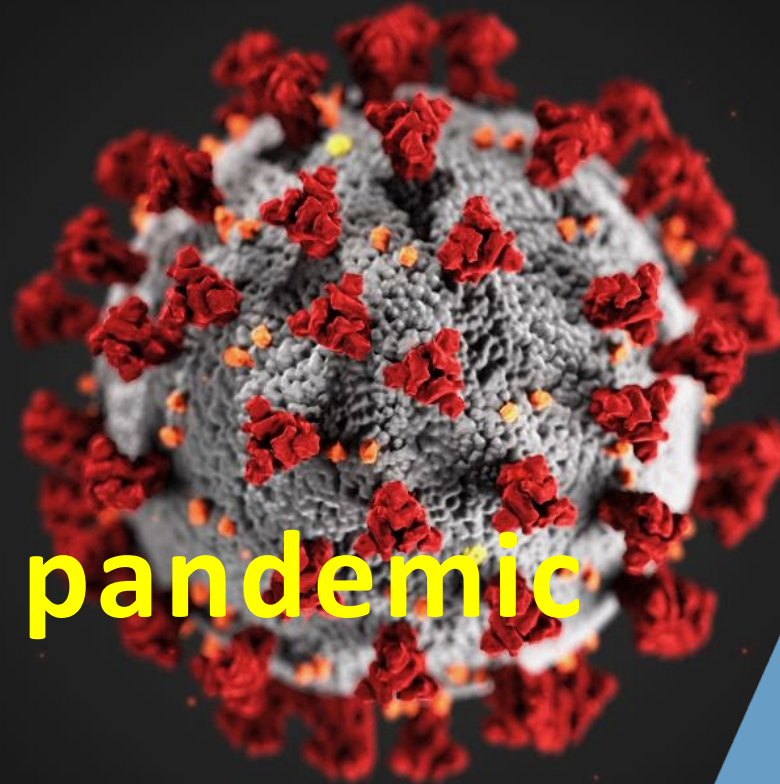


AI in the Covid-19 pandemic



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VANJ Webminar, 30/05/2020



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letdataspeak.blogspot.com



goo.gl/3jJ100

AI ... in movies

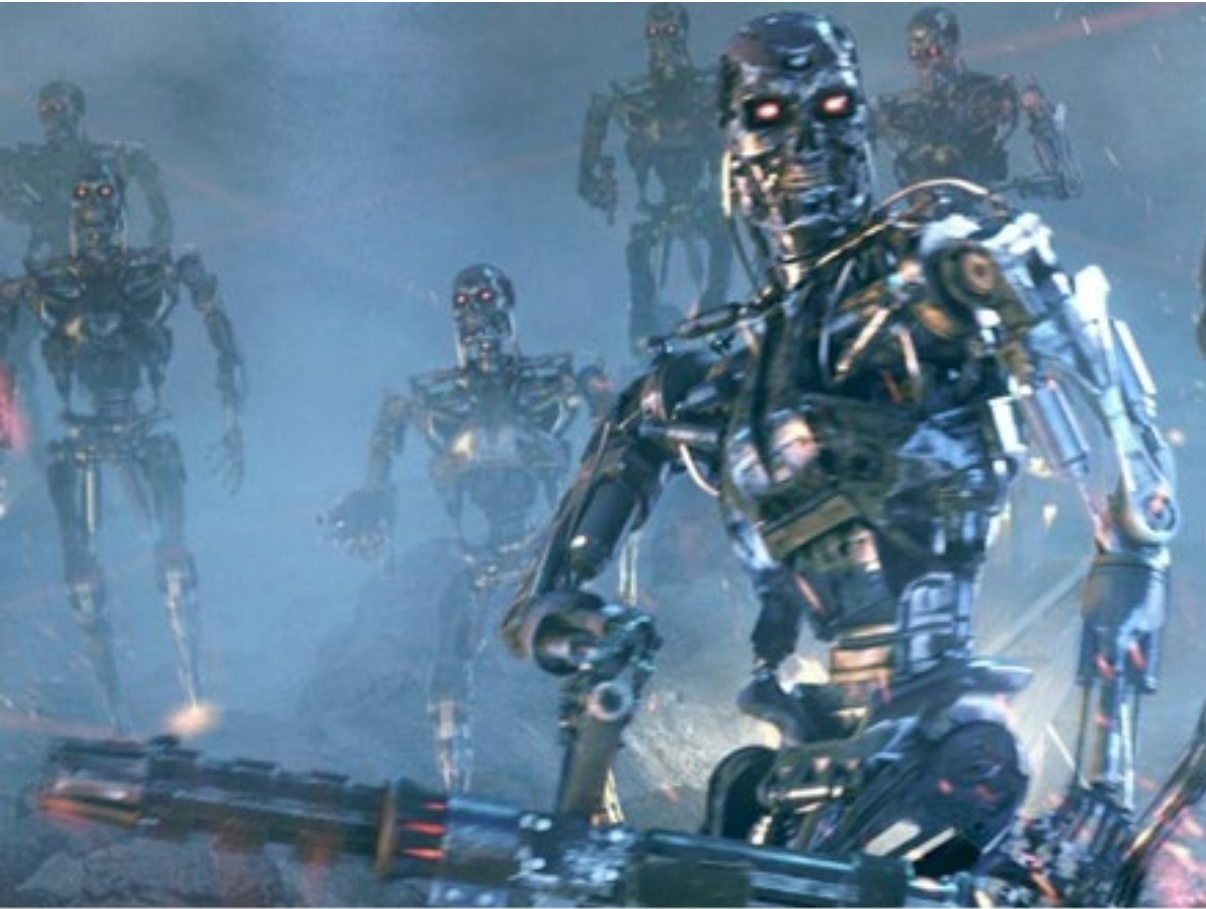


Image: © EPA PHOTO/EFE/Columbia TriStar/Robert Zucker

Mankind hater



Source: opgal

Love for the Earth

AI: Past, Present and Future

Narrow AI (rule-based, speech)

Personalization:
76,897 Micro-genres



Rule-based decisions



Industrial robots



Narrow AI – with big data (B-2-C, search, ecommerce)

Deep learning – image processing



Handwriting & voice recognition

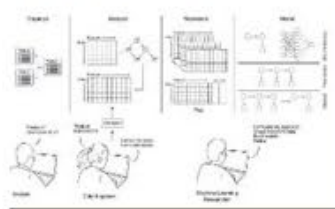


NLP & big data statistical learning



Democratisation & embodied AI

Data scientist in a box



Home & service robots



Self-driving vehicles

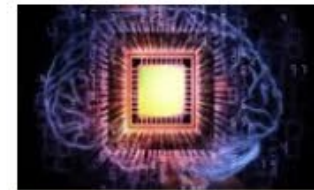


Collaborative AI on new AI hardware

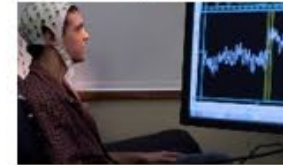
Man-machine collaboration



Neuromorphic computing

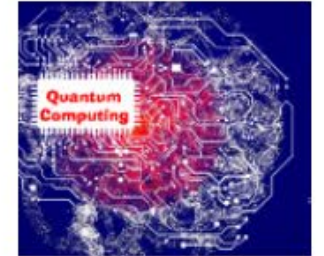


Brain-computer interfaces



Artificial general intelligence

Quantum computing



Emotional robots



Past

90's

00's

Now

Next 5 years

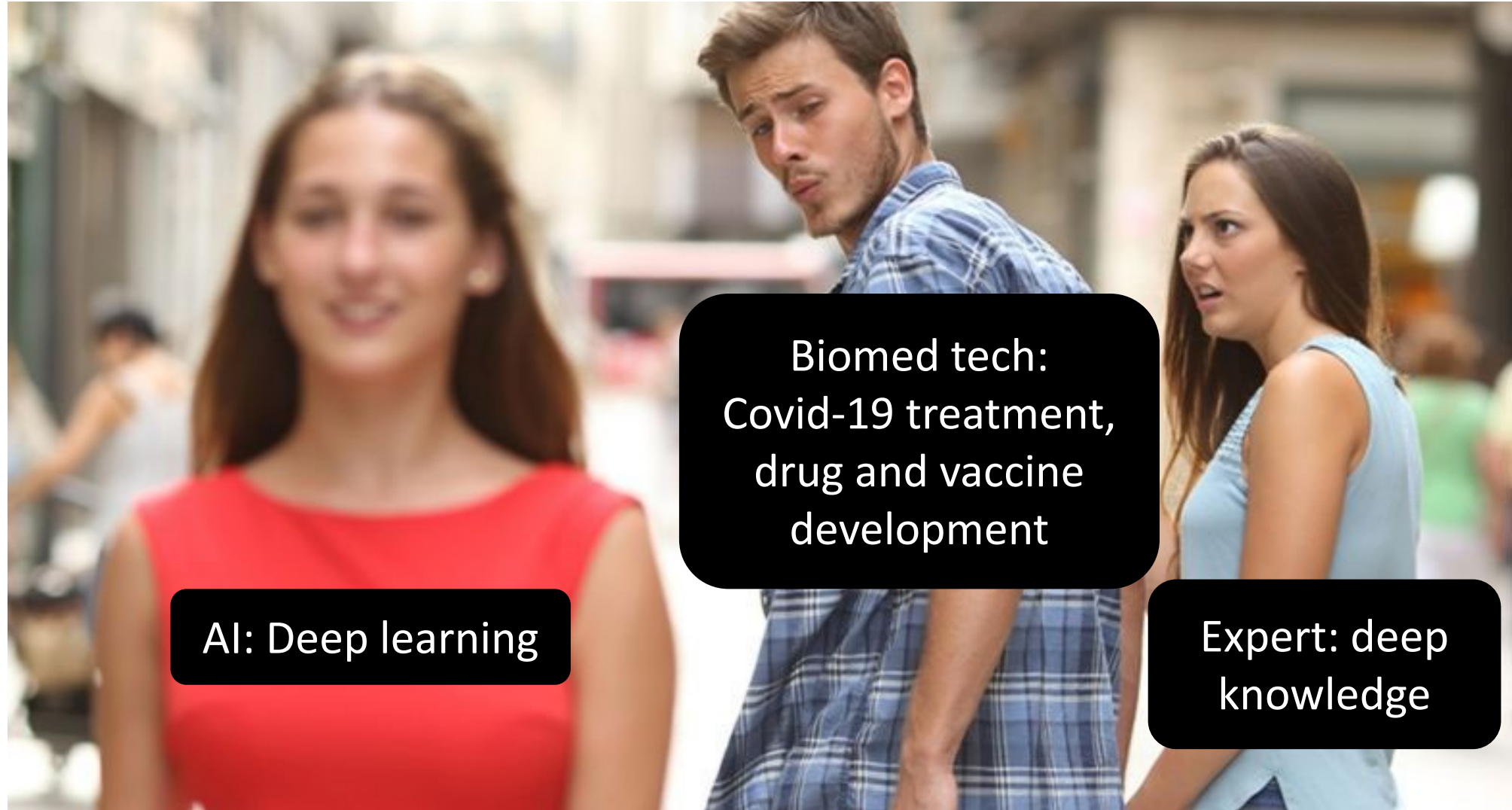
Next 20 years

Future

What AI can do, as a general purpose technology?

- Predict – filling the missing slots
- Optimize (arrangements, configurations, processes)
- Discover hidden patterns, phenotyping
- Discover complex relationships
- Imitate human and the world
- Plan action sequence for long-term rewards
- Reason about the world
- Be self-aware of its own limitations
- Honour and align with human values.

AI ... in the eyes of biomed tech





“It's quite obvious that we should stop training radiologists”

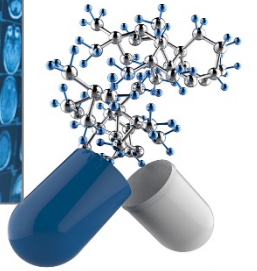
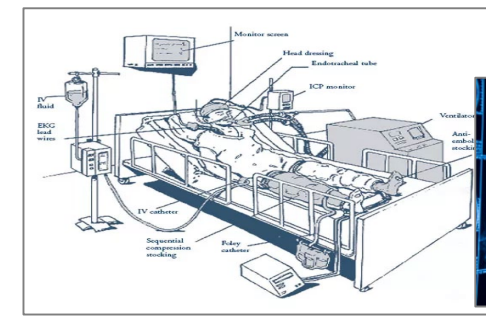
Geoff Hinton, “godfather” of modern AI, Turing Award 2019, stated in Nov 2016.

AI in Biomedicine

Deep learning has matured, esp. in image processing
→ image-based diagnosis.

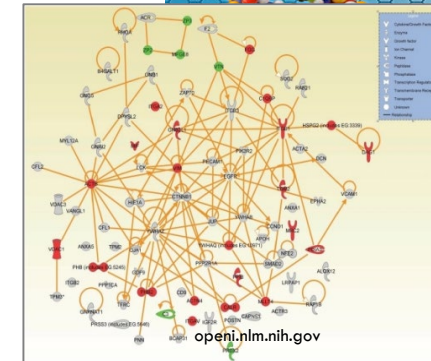
Challenges and opportunities:

- Huge data but isolated in silos, non-uniform, difficult to share due to privacy concerns
- Multiple modalities: 1D-4D, image, sound, text, language, social networks, biomed networks.
- Multiple scales: nano (atom) to meter (body and brain).
- Unseen complexity (brain, DNA, cell network).
- Touching deepest topics of science and philosophy (life, brain, cognition and consciousness).



engineering.case.edu

pharmacy.umaryland.edu



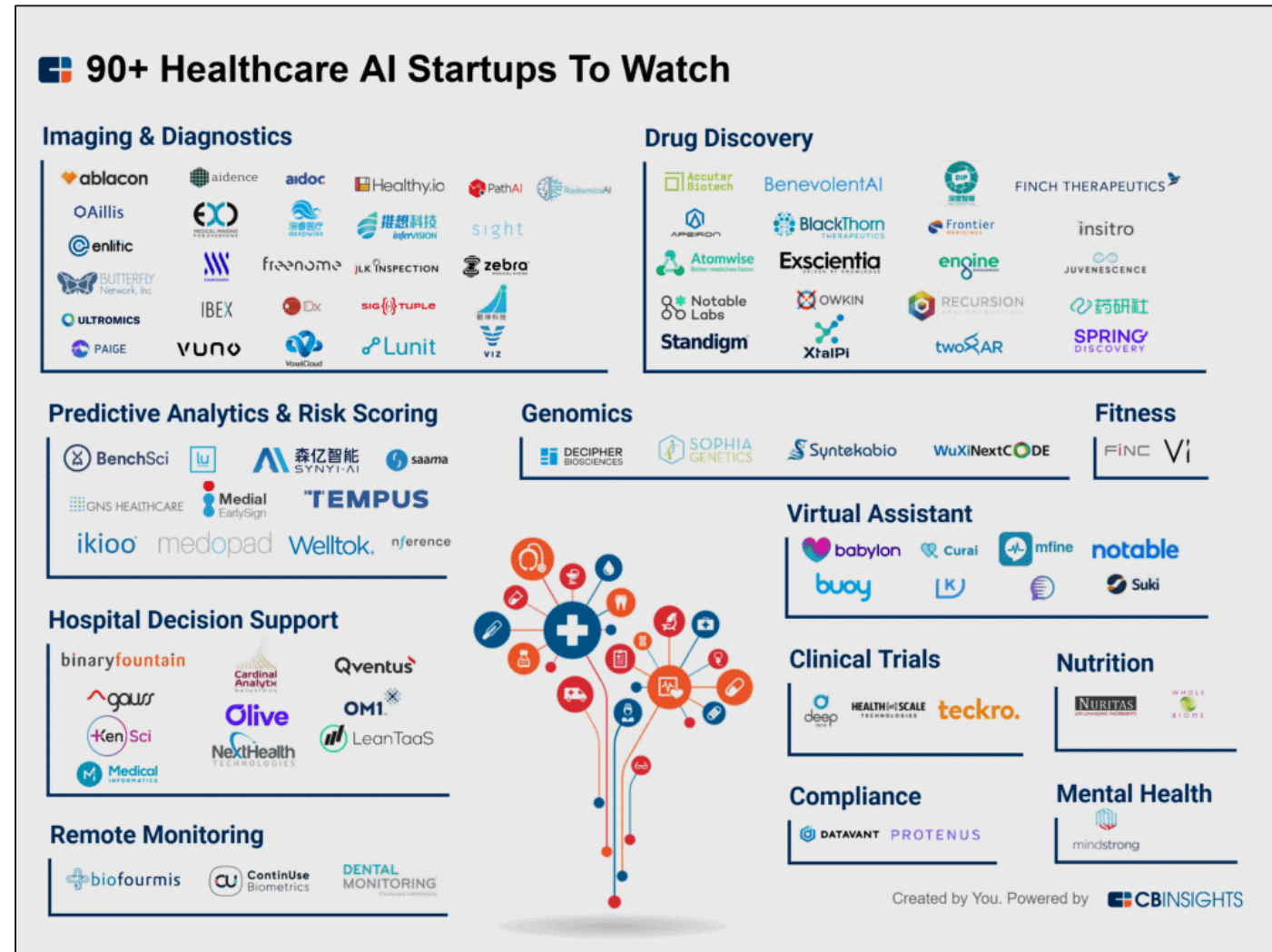
marketingland.com

PubMed

Need new collaboration of policy makers, tech experts, biomed experts and physical scientists.

Global AI for health

- Health data doubles every 2-3 months.
- The market grows by 41.9% annually, reaching \$13B in 2025.



The Covid-19 pandemic raises new challenges

- The healthcare system needs to respond fast and effectively but cannot collapse from overloading.
- Accelerating scientific discovery on virus, treatment and vaccine, in *months*, not years.
- Enforcement of social distancing.
- Forecast and modelling for planning (cases, inpatients, deaths, ventilators and other health resources).
- Early warning of new outbreak regions.
- Assurance of ethical concerns and privacy.

What can AI do in a pandemic?

Accelerating biomed sciences (molecular, clinical, epidemic, information, public health)

- Data-driven models (e.g., CT-based diagnosis)
- Process-driven models (e.g., differential equations)
- Hybrid models
- Organising the scientific literature

Mitigation of risks

- Enforcing mask wearing in public
- Assisting families in isolation and quarantine
- Public surveillance, case tracing
- Enforcing social distancing
- Optimizing ventilators, and its distribution
- Optimizing business supports.

Adaptation

- Localizing global solutions.
- Assisting online learning and communication.
- Reduction of physical contacts.
- Promoting new income sources and jobs.

End-game solutions

- Discovering and repurposing drugs.
- Vaccine development.
- Simulation, early warning of future pandemics.
- Optimizing preventive and public health.
- New rapid process to effectively respond in weeks.

Education

- Providing and filtering information.
- Enabling individual actions

Robot deployment

Rapid treatment

Vaccine development

Early warning

Social distancing

Home isolation

Quarantine

Mental health

Information

Personal actions

Collective decisions

Education

Finance

Action areas



AI areas

Computer vision

NLP

Reinforcement learning

Time-series

Interpretable learning

Reasoning, causality

Transfer, continual and
lifelong learning

Uncertainty quantification

Unsupervised learning

Structured data

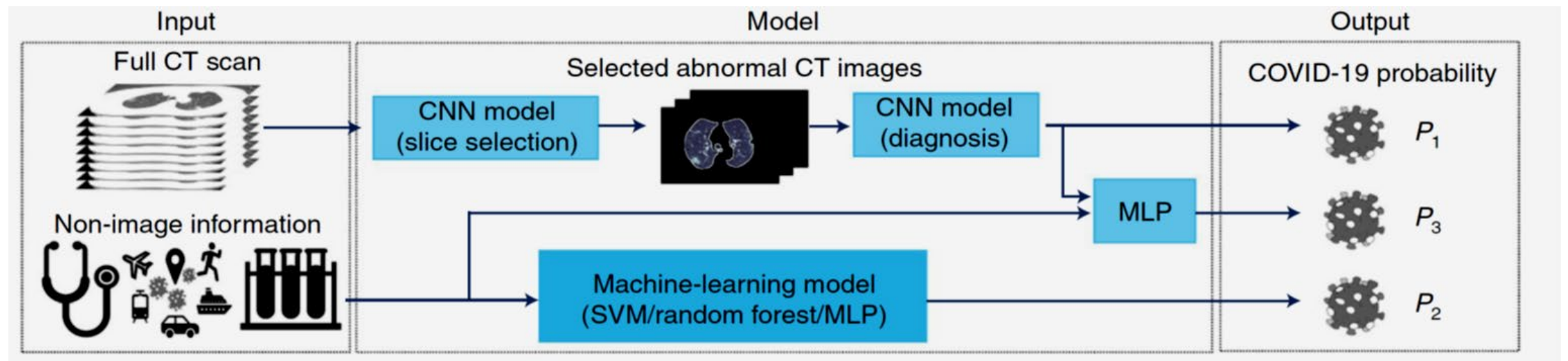
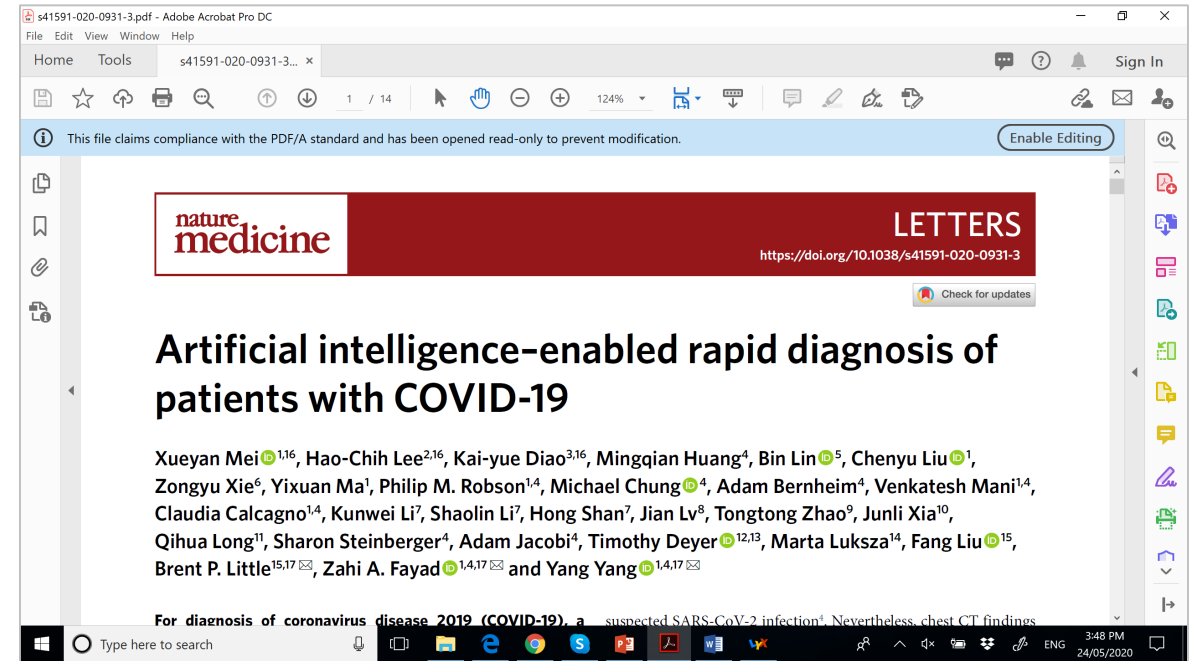
Knowledge-driven ML

Some applications of AI in the Covid-19 pandemic

- BlueDot – early warning at the end of 2019
- Chatbot, patient triaging, medical record analysis
- Optimizing clinical trials
- Alerting of close physical contacts
- Fast image-based diagnosis
- Robots to deliver (foods, medicines, and essential goods) to patients and isolated families.
- Drug discovery (protein folding, drug repurposing, new drug search)
- Distance monitoring (e.g., for aged care residents).
- Information filtering: detecting fake news, unsupported claims, ads of masks and essential items.
- Enforcement of safety rules compliance (e.g., washing hands for more than 20s).

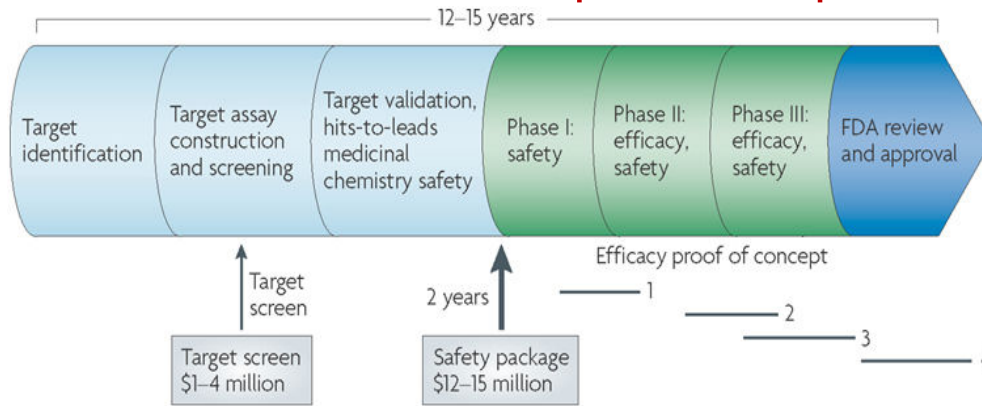
Diagnosis using lung CT scan in China

- Training set: 534 (242+).
- Validation set: 92 (43+)
- Evaluation set: 279 (134+)
- Result: **AUC = 92%, Sensitivity ~ experienced radiologist.**



Knowledge-driven

\$500M - \$2B



→ Screening thousands of potential molecules → Selecting dozens of drug-like molecules → One out of ten has positive response in clinical trials.

#REF: Roses, Allen D. "Pharmacogenetics in drug discovery and development: a translational perspective." *Nature reviews Drug discovery* 7.10 (2008): 807-817.

Drug discovery process

Nature Reviews | Drug Discovery

AI-driven

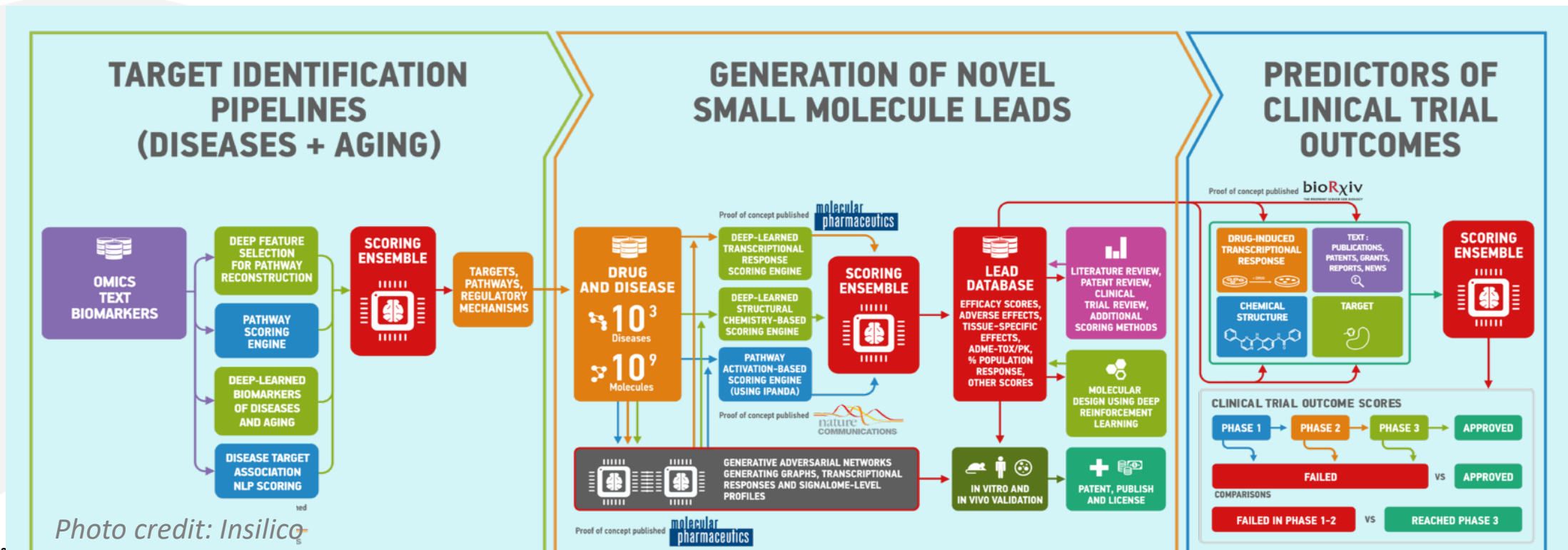
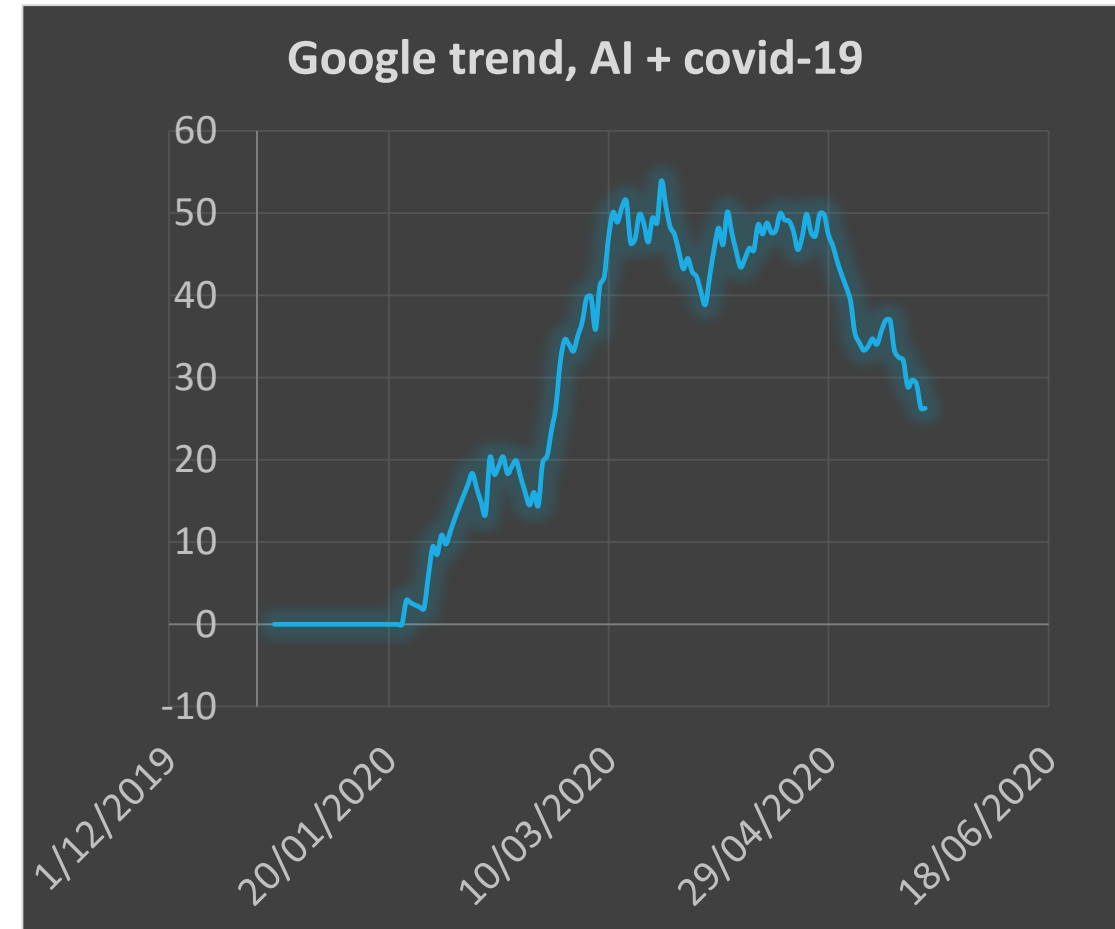


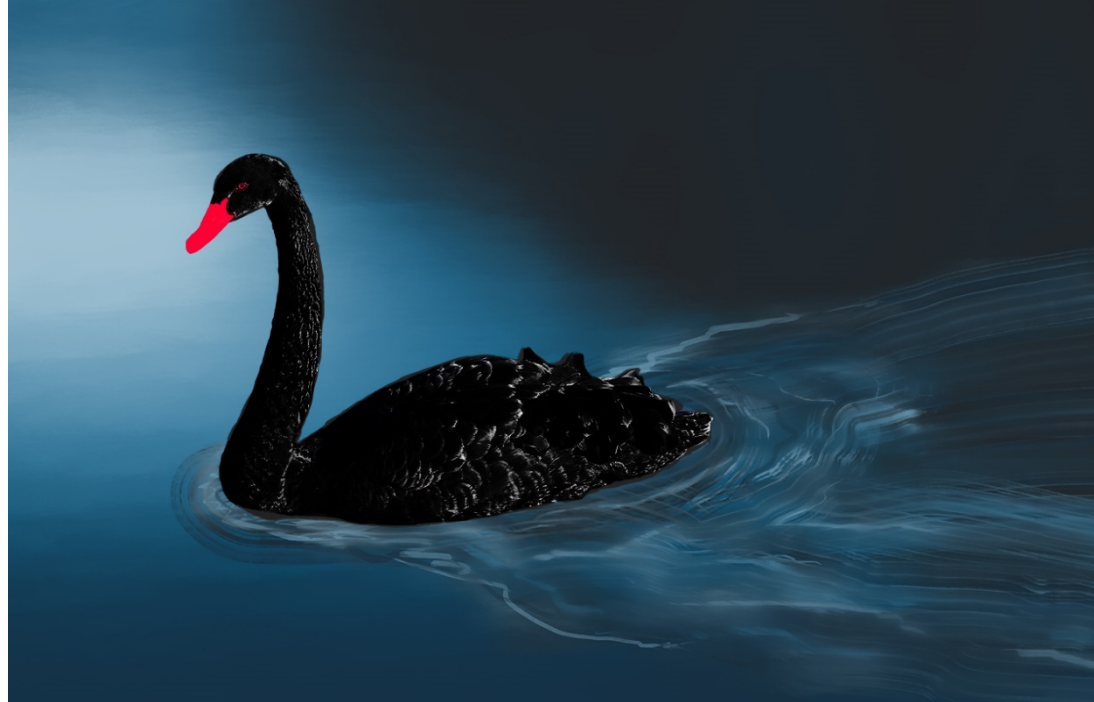
Photo credit: Insilico

30/05/2022

AI has played a limited role in this Covid-19 pandemic

- Only played the role in some separate parts.
- Couldn't demonstrate in regions that responded slowly with complex big health system, high inertia and conservative.
- Had little prior relevant data to train. Modern AI relies heavily on large data but little on existing knowledge.
- Building an AI system from scratch is expensive and takes time.
- AI is just a tool. Human with deep knowledge and skilled users are key.
- Score: **B-** (Kai-Fu Lee, 22/05/2020).





Credit: Carolyn Ann Geason, MIT

Rare, but causes catastrophe when occurring

Breaks existing rules, habits and established behaviours.

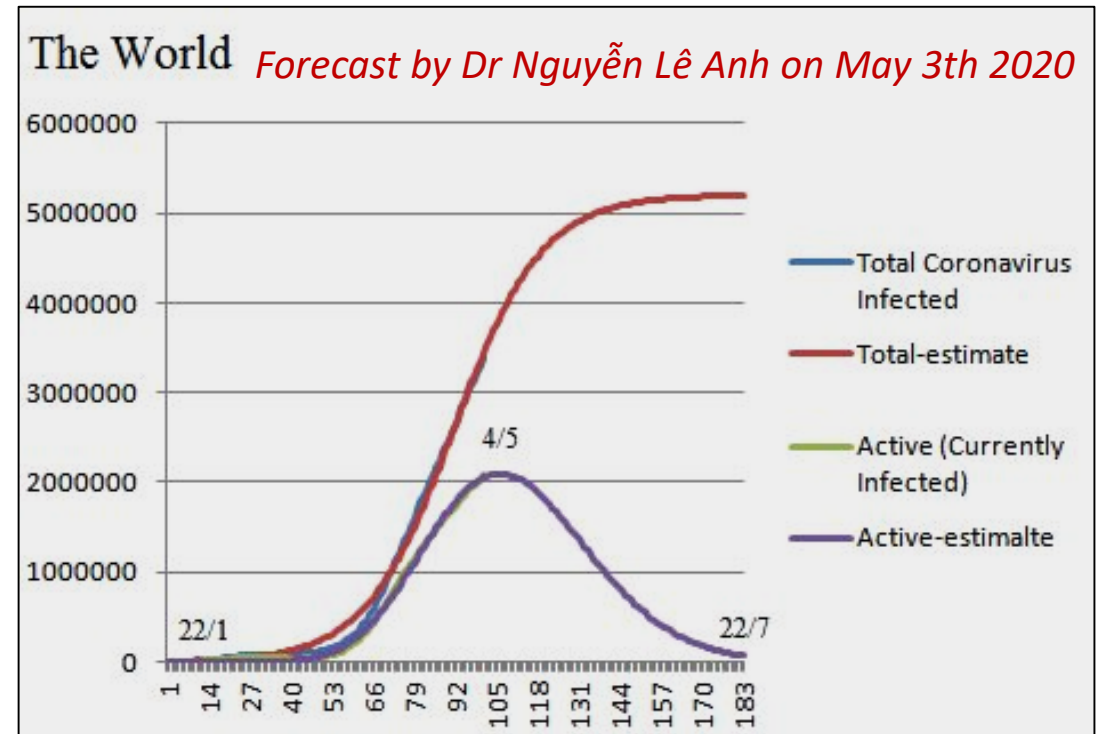
→ We can only rely on invariant, or slowly changing rules and processes (e.g., preventive health, bio-chem processes, values system, culture).

Covid-19 is a Black Swan event.

Prediction: AI after the pandemic

AI in Health will accelerate:

- Forecasts of needs of med resources and the response time.
- Optimizing logistics, warehousing of med supply.
- Accelerating vaccine and drug discovery.
- Detecting and warning early of future outbreaks.
- Care and support for mental health.
- Information and data sharing globally.



AI is changing:

- Better objectives, e.g., balancing between importance and urgency.
- New AI with less historical data.
- AI is self-aware of its own limitations.
- AI that respects privacy, fairness, and responsibility. AI that puts human first.
- Better interaction with human.
- Above all, AI that aligns its values with human.

To sum up

AI as a general purpose technology

- Said to be a new kind of electricity
- Play the roles whenever we can code knowledge, have training data, need decision making, automation.

Why AI is needed in pandemics like Covid-19?

- It helps automation, integrates data, information and knowledge.
- Supports well personal care, precision medicine.
- Assisting in decision making; support human-human interaction.
- Supports rational, objective and quantitative solutions.

Can AI fail?

- Yes. Our understanding of intelligence and computational power are limited.
- AI can be misused.
- There is a risk of going against human values.



AI for biomedicine @A2I2

Molecular biology and medicinal chemistry

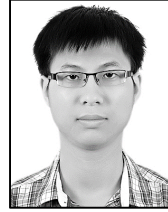
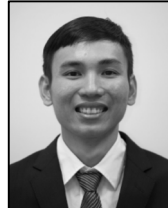
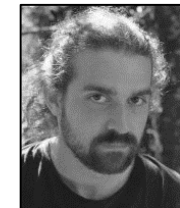
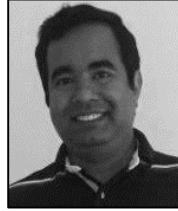
- Protein-drug binding → drug repurposing, drug screening.
- Protein folding prediction.
- Chemical reaction prediction.
- Discovery of gene-disease association.

Population health

- Social listening of outbreaks, medicine needs, vaccination, mental health.
- Social monitoring – tracking community mobility and social distance.

Pre-clinical and Clinical decision support

- Risk, mortality prediction. Early warning.
- Medical QA
- Prognosis, treatment recommendation.
- Analysis of electronic medical records.
- Optimizing choices. Supporting decision making.
- Assisting people with dementia.
- Early detection of cerebral palsy using mobile phone.
- Evaluation of autistic behaviours in gait video.



Thank you!

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truyentran.github.io



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goo.gl/3jJ100



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