Artificial intelligence as a tool to conduct medical research: where are we heading to?

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No Disclosures

What shall we talk about TodAI?

- ❑ AI : reality and science fiction
- ❑ How AI was developed?
- ❑ Types of AI and how they work?
- ❑ AI in surgery
- ❑ Challenges AI
- ❑ Key consideration before planning any AI project
- ❑ Examples to illustrate these key considerations in AI projects
- ❑ OSRC, what is it, how it works and why we need it?
- ❑ What OSRC can help you with if you are planning AI-related project?

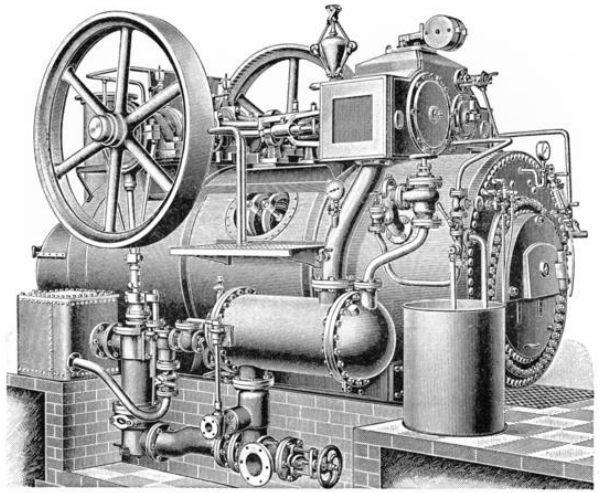
The **aim** is to move forward in a way that encourages innovation while avoiding hype, diminishing research waste, and protecting patients.

The hype around new technology, often commercially-driven, may promise more than it can deliver, and tends to underplay difficulties.

Some media headlines that claim superior performance to doctors have fuelled hype among the public and press for accelerated implementation.

Better study design and more transparent reporting will facilitate the innovation, validation, and translation process. It could also help avoid hype.

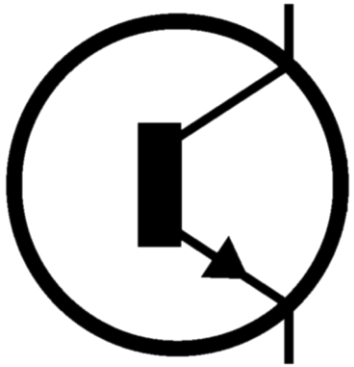
Lovejoy 2022, Matthiesen 2021, Nagendran 2020, Hashimoto 2020, European Society of Radiology (ESR) 2019, Chen 2017



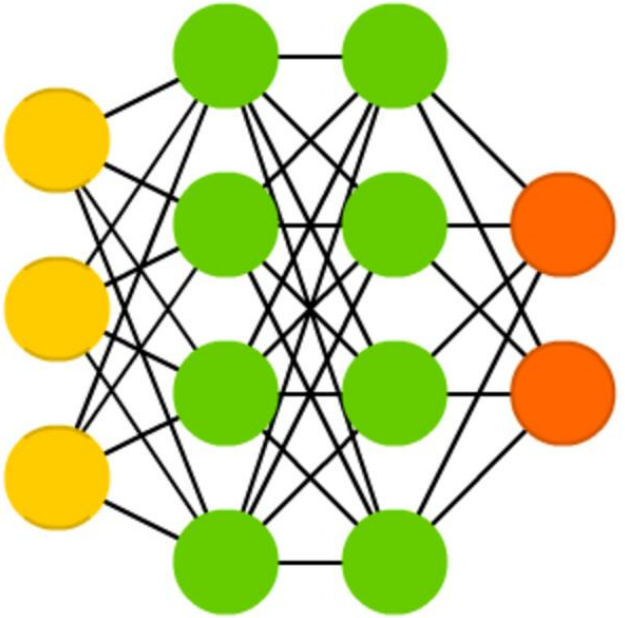
Artificial human-engineered objects, such as the steam engine.

Thermodynamics: a system consisting of many many particles and perhaps the original black box.

Statistical mechanics explains how the macroscopic laws of thermodynamics could arise statistically from the deterministic dynamics of many microscopic elementary constituents.

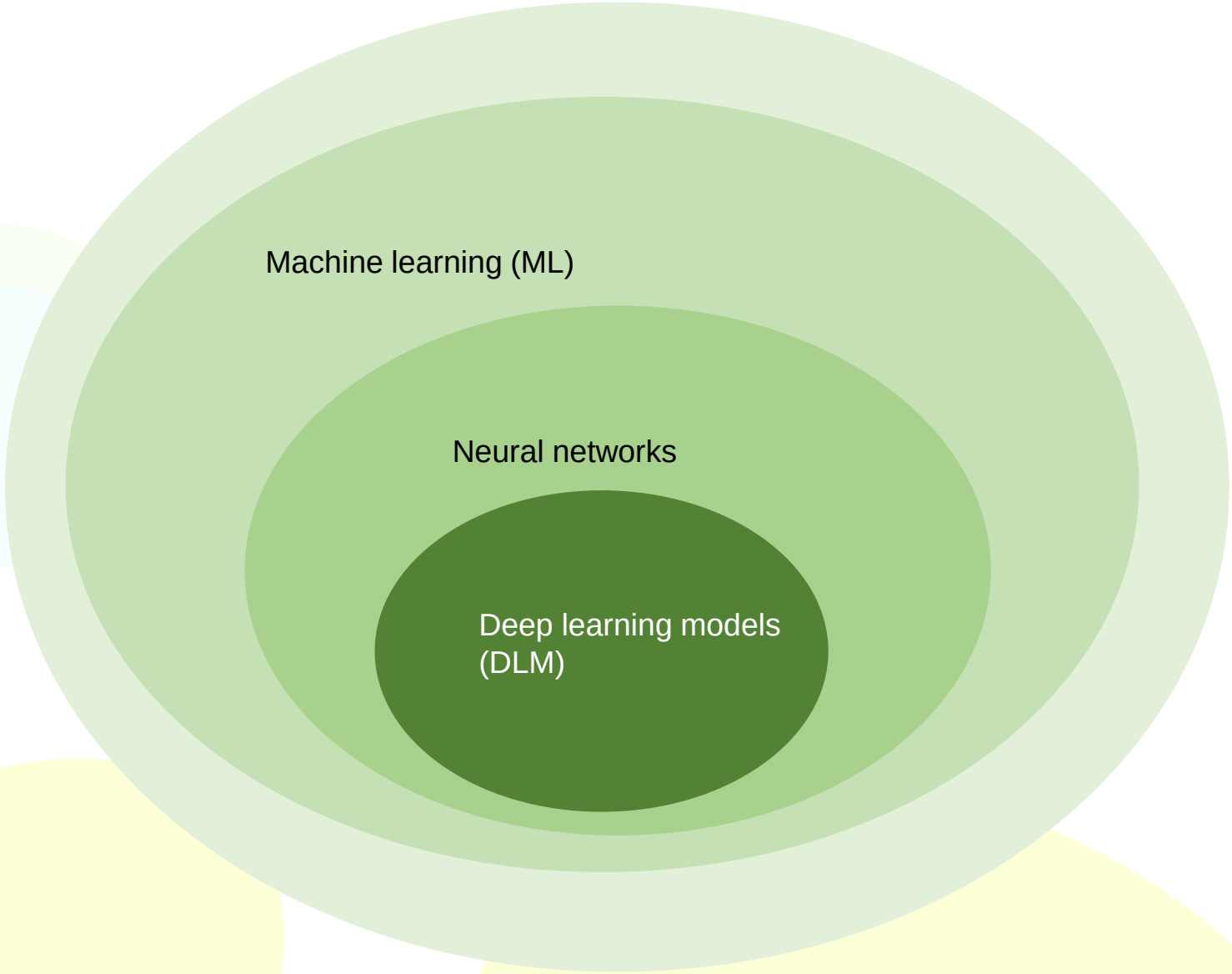


Application of statistical mechanics led to the discovery of quantum mechanics, which is a precursor to the invention of the transistor that powers the Information Age



Neural network is a recipe for computing a function built out of many computational units called neurons.

Each neuron is itself a very simple function that considers a weighted sum of incoming signals and then fires in a characteristic way by comparing the value of that sum against some threshold.



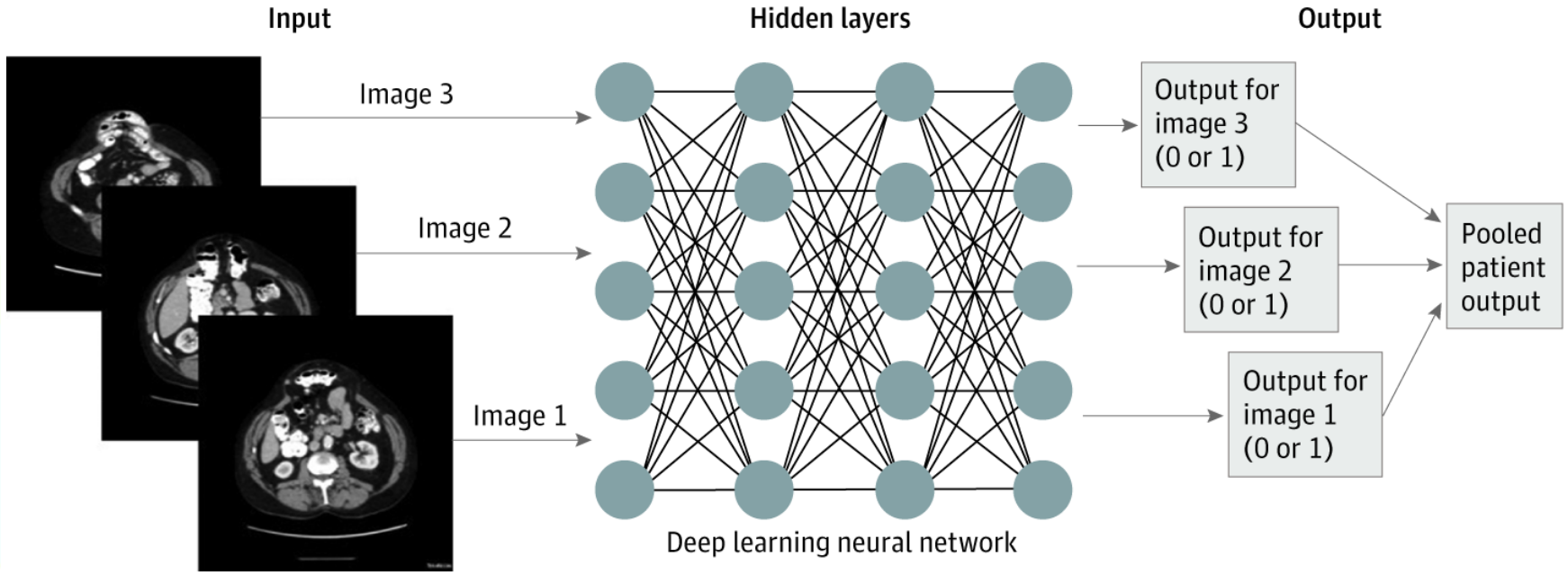
Artificial Intelligence (AI) represents the capacity of machines to mimic the cognitive functions of humans (in this context, learning and problem solving

Machine learning: situation in which an agent is learning if it improves its performance on future tasks after making observations about the world.

Machine learning can be unsupervised, reinforced, supervised, and semi-supervisedsituation.

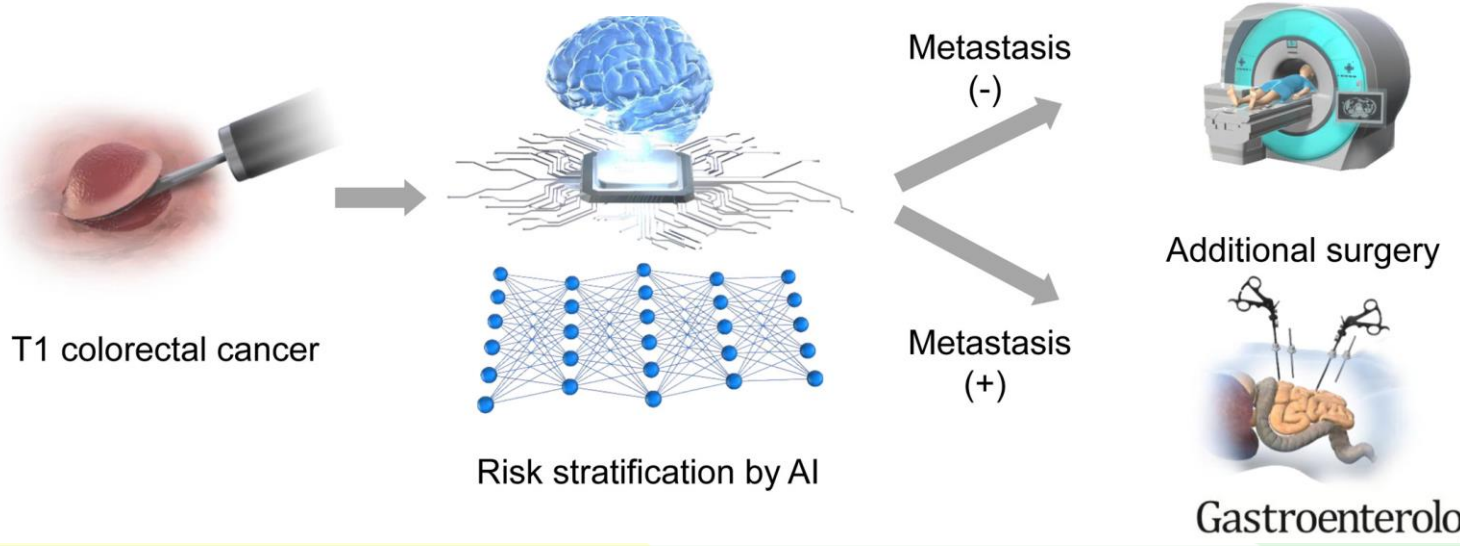
Unsupervised learning: no explicit feedback
Reinforced: rewards or punishments
Supervised: with a teacher's output
Semi-supervised: fewer teacher's outputs

Deep neural networks are, effectively, neural networks with more than 3 layers, allowing for learning of more complex patterns than those that are discernible from simple 1-layer or 2-layer networks.



DLM prediction of surgical complexity using need for component separation techniques as a surrogate and prediction of postoperative surgical site infection and pulmonary failure.

The predictive model was developed using the following 8 factors: patients' age, sex, tumor size, location, morphology, lymphatic invasion, vascular invasion, and histologic grade.



Development and Validation of Image-Based Deep Learning Models to Predict Surgical Complexity and Complications in Abdominal Wall Reconstruction Elhage ***JAMA Surgery*** 2021

Artificial Intelligence System to Determine Risk of T1 Colorectal Cancer Metastasis to Lymph Node. Kudo ***Gastroentrology*** 2021

Artificial intelligence in Surgery

Prediction modules using machine learning

e.g. Utilizing Machine Learning Methods for Preoperative Prediction of Postsurgical Mortality and Intensive Care Unit Admission
Chiew, Ann Surg 2020;272:1133–1139

Surgical phase recognition using computer vision

e.g. Automated laparoscopic colorectal surgery workflow recognition using artificial intelligence
Kitaguchi, International Journal of Surgery 79 (2020) 88–94

Aided surgical-decision making

Development and Validation of Image-Based Deep Learning Models to Predict Surgical Complexity and Complications in Abdominal Wall Reconstruction
Elhage JAMA Surg. 2021;156(10):933-940.

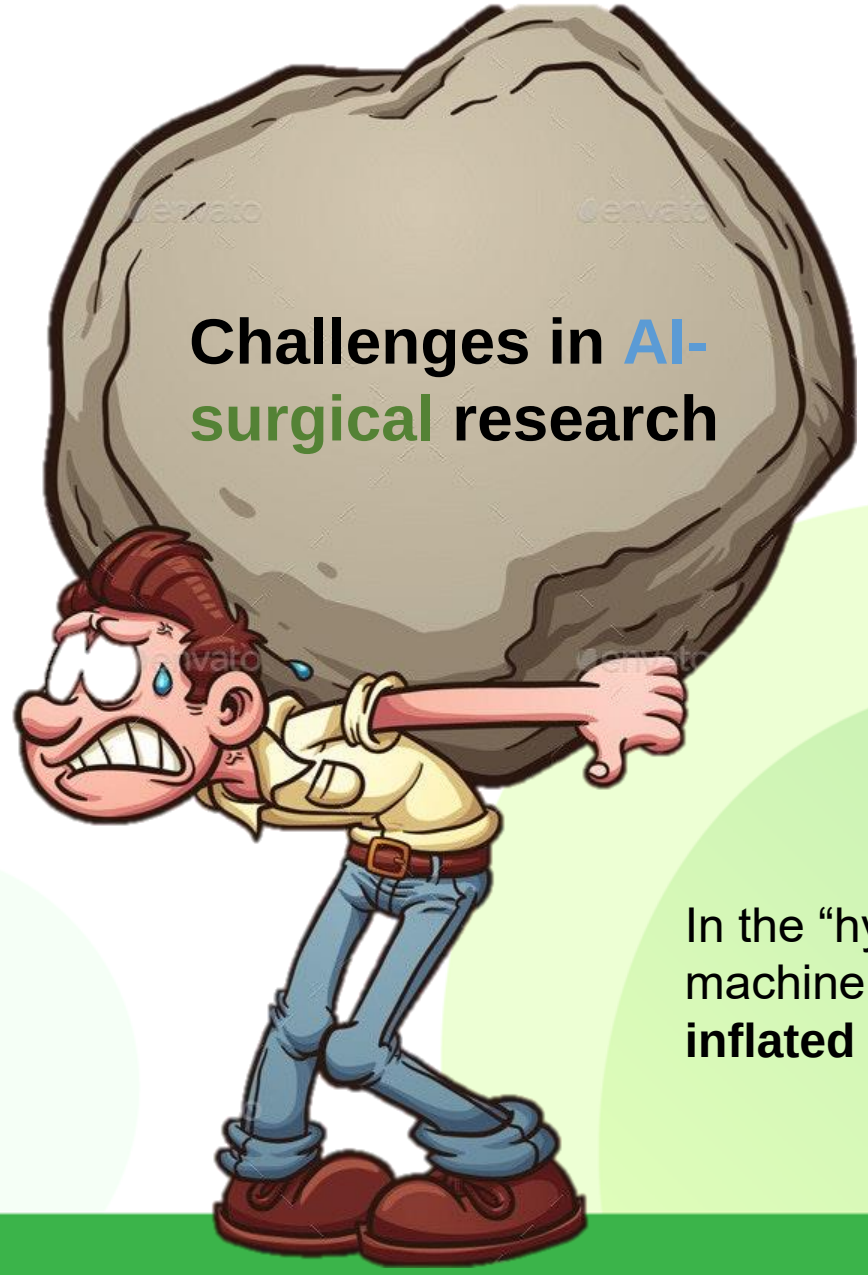
Classification of disease

A Novel Classification of Intrahepatic Cholangiocarcinoma Phenotypes Using Machine Learning Techniques
Tsilimigras, Ann Surg Oncol (2020) 27:5224–5232

Natural language processing

e.g. Research and Application of Artificial Intelligence Based on Electronic Health Records of Patients With Cancer
Yang JMIR Med Inform 2022;10(4):e33799

Challenges in AI-surgical research



In the “hype cycle” of emerging technologies, machine learning now rides atop the “**peak of inflated expectations**”

LMICs?

Commercialization?

Deploying the model

- Generalisability
- Regulation
- Deployment

Engineering the model

- Collection and preparation of data: How much data is needed? How to obtain the dataset
- Defining the ground truth
- The multidisciplinary team

Identifying appropriate research questions

'Would AI really be appropriate for the research question at hand?

Key considerations for the use of artificial intelligence in healthcare and clinical research
Lovejoy, Future Healthcare Journal 2022 Vol 9, No 1: 75–8

Not all problems need an AI-based solution

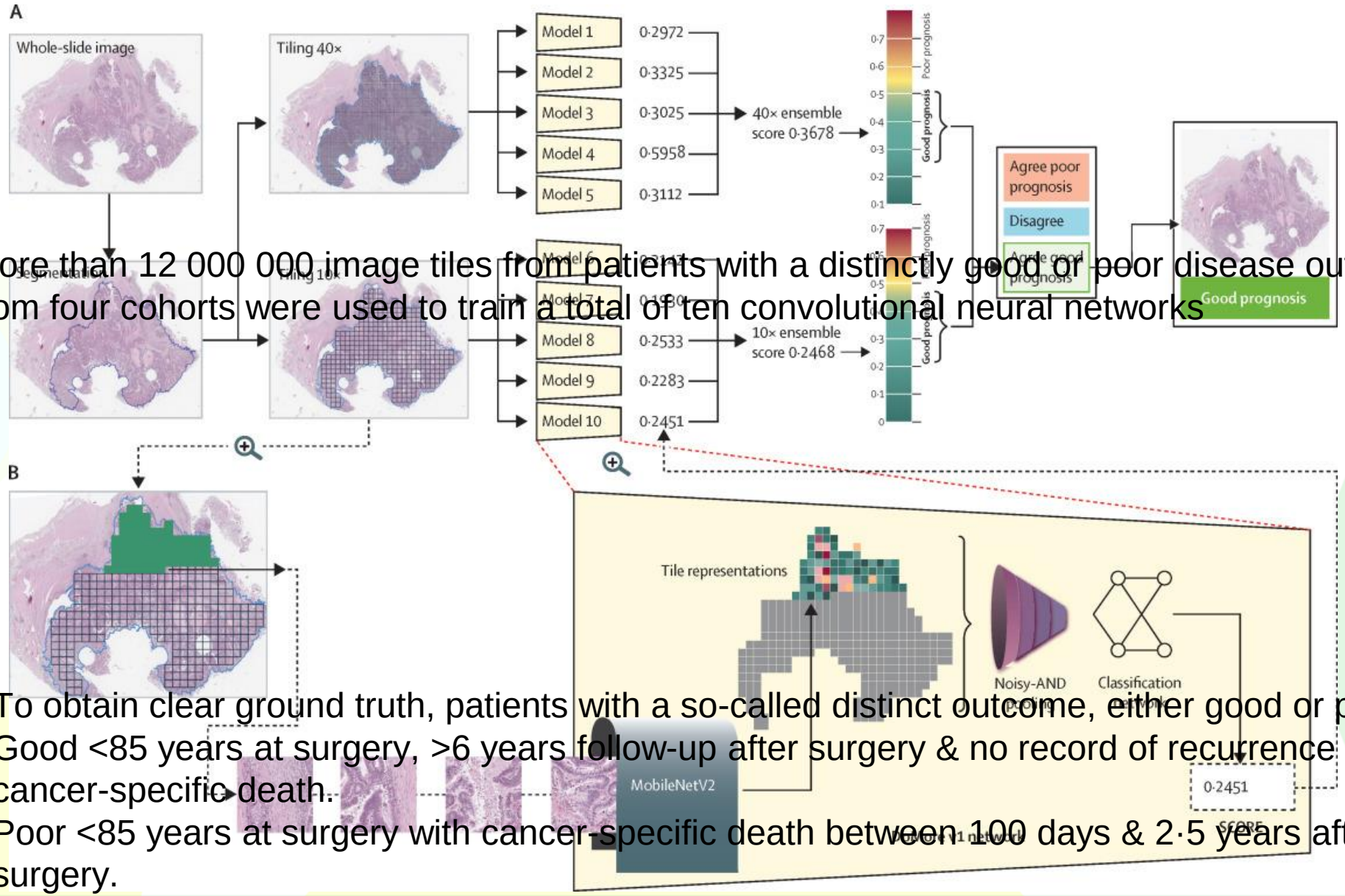
A common pitfall in industry is to search for solutions which utilise AI rather than focusing on existing problems

The three-point belt was invented by Volvo Cars in 1959 & listed as the 8th most important invention of century.
With more than 60 years of use, it saved about **1 million** people & reduced the risk of death in accidents by **45%**

Nils Bohlin

Identifying appropriate research questions

'Would AI really be appropriate for the research question at hand?



More than 12 000 000 image tiles from patients with a distinctly good or poor disease outcome from four cohorts were used to train a total of ten convolutional neural networks

To obtain clear ground truth, patients with a so-called distinct outcome, either good or poor.
Good <85 years at surgery, >6 years follow-up after surgery & no record of recurrence or cancer-specific death.
Poor <85 years at surgery with cancer-specific death between 100 days & 2·5 years after surgery.

Deep learning for prediction of colorectal cancer outcome: a discovery and validation study/Norway
Skrede Lancet 2020; 395: 350–60

Key considerations for the use of artificial intelligence in healthcare and clinical research
Lovejoy, Future Healthcare Journal 2022 Vol 9, No 1: 75–8

A model is only as useful as its ability to perform on novel data

The training data must be at least as diverse as the population that the algorithm intends to serve

Deploying the model

- Generalisability
- Regulation
- Deployment

External validation on independently derived data is required in order to ensure that the systems perform effectively when exposed to novel data

Unlike traditional medical devices, which would not change after development, AI algorithms can be updated & improved as new data are collected. Good performance at the time of deployment does not guarantee (regulate throughout the lifetime of an algorithm)

It is important to consider how a model will be incorporated into existing clinical workflows, with disruption kept to a minimum.

Commercialization is an incentive to more R & D spending

Good ideas are not the same thing as a good business

Commercialization?

America's five tech behemoths have spent billions on various healthcare bets

What matters to the economy are not scientific discoveries or the innovations at technology's cutting edge, not papers in peer-reviewed journals or even cool lab creations,
but
things which pervasively improve the everyday and generate economic activity in doing so

Although the production of scientific knowledge and the desire to solve real-world problems are closely entwined, corporate science has gone into decline, with big firms increasingly choosing to license research from universities rather than do it themselves.

Further removed from production, the universities are not so focused on useful invention

The Economist January 2021, The case for more spending on R&D

LMICs?

LMICs face challenges, including acute health workforce shortages and weak public health surveillance systems

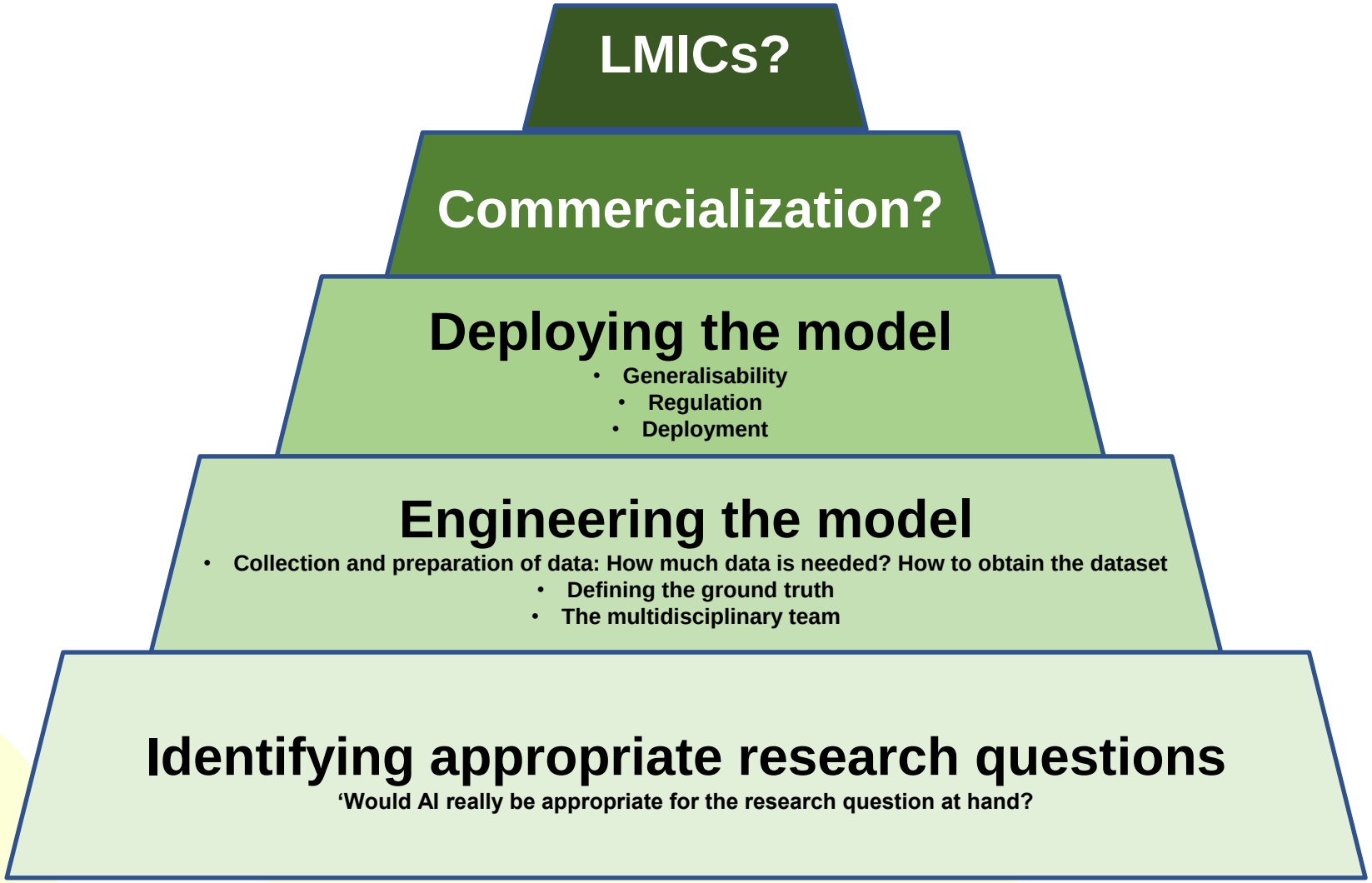
Advances in IT and mobile computing power in many LMICs have raised hopes that AI might help to address challenges unique to the field of global health and accelerate achievement of the health-related sustainable development goals.

AI-driven health interventions:

1. diagnosis,
2. patient morbidity or mortality risk assessment,
3. disease outbreak prediction and surveillance, and
4. health policy and planning

Examples: detection of cervical cancer, detecting high-risk births, estimate gestational age using data from ultrasound images, quantify the risk of dengue fever severity, transmission patterns of Zika virus globally, identify tuberculosis cases

Artificial intelligence and the future of global health. Schwalbe Lancet 2020; 395: 1579–86



Key considerations for the use of artificial intelligence in healthcare and clinical research
Lovejoy, Future Healthcare Journal 2022 Vol 9, No 1: 75–8

Limitations of need AI

Large datasets often lack diversity and studies based on these datasets may not reflect the target population

Common AI models, such as deep neural networks, have internal logic which is inherently difficult to interpret. This ‘black-box’ problem makes models more difficult to explain when clinical intuition contradicts them

When clinical decisions are entrusted to healthcare professionals and use of AI may be inappropriate e.g. decisions relating to withdrawing life-supporting treatment

While one strength of AI models is their ability to fit to complex nuances within a dataset, this places them at greater risk of finding artefactual idiosyncrasies in the dataset that are not reflective of a wider reality (Overfitting)

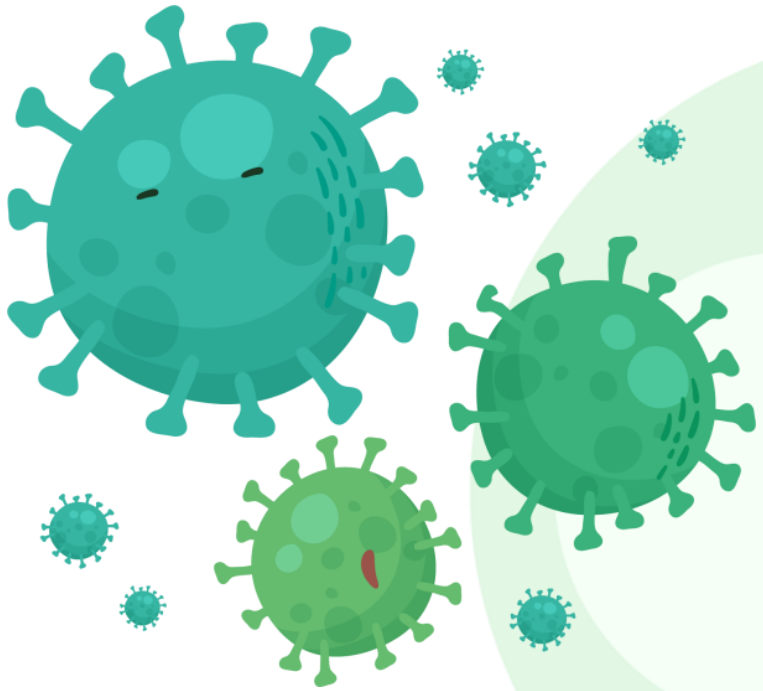
Key considerations for the use of artificial intelligence in healthcare and clinical research
Lovejoy, Future Healthcare Journal 2022 Vol 9, No 1: 75–8

OpenSourceResearch

Implementing information technologies
in medical research

Why we need OSRC?

- Traditional research methodology could NOT provide the badly needed evidence for policy makers e.g. Covid-19 pandemic
- There is a need to develop new research tools
- Information technologies revolutionized the world of banking, e-commerce and tourism. IT can also provide innovative research tools for medical research



Reference:
OpenSourceResearch Collaboration 2019. Biological Treatment and the Potential Risk of Adverse Postoperative Outcome in Patients With Inflammatory Bowel Disease. *Crohn's & Colitis 360*.

What is OSRC?

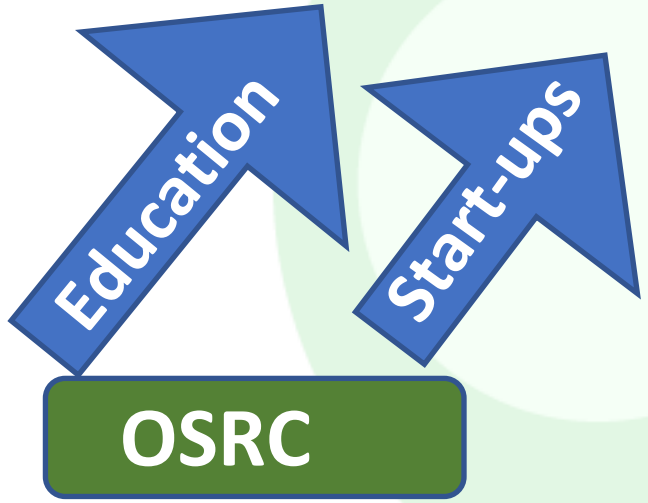
Platform to explore, develop, validate and disseminate new research tools such as:

- Computer simulation models
- Artificial intelligence
- Big data mining
- Synthetic and augmented data
- Crowd science
- Natural language processing

Reference:
OpenSourceResearch Collaboration 2021. Information Technologies to Support Research: Challenges and Action Plan. EC Gastroenterology and Digestive

How does OSRC work?

- **International research organisation embraces the use of open source products in multi-disciplinary team approach:**
  - Academic research
  - Boot camps, courses, workshops
  - International collaboration
  - Raise public awareness about challenges in medical research
  - …and more
- **Spin off StartUps based on academic research**



OSRC focuses on LMICs

Research skills workshop
Ankara-Turkey

Open intelligence in research
AlNajaf-Iraq

Coming workshop 2022: India- Kashmir

How can OSRC help researchers?

- **Using our vast network of experts:**
  - Consultation to design project
  - Connect to data scientists
  - International collaboration in collecting data
  - Dissemination through social media networks
  - Public relation…and more

- **Boot camps, courses, workshops about AI by leading experts**

How can OSRC help?

An example to show the case

English Proficiency Tests include IELTS, TOEFL, TOEIC, MTELP, DET, PTE, CPE, and many other English exams

Why you need these tests?
To ensures that you have the necessary English skills to understand academic writing, produce scholarly writing, and communicate effectively with your supervisors during the study/work

How to pass these tests?
Courses (books, exercises) offered by approved entities such as academic institutions & require fees

Your expectations?
Access education/work
Get knowledge about the language and culture

How can OSRC help?

An example to show the case

Research Proficiency

Why you need research proficiency?
To access study/work
To build startup
To gain knowledge about the scientific approach to problem solving

How to gain research proficiency?
Courses (books, exercises) offered by senior researchers

Your expectations?
Access education/work
To gain knowledge about the scientific approach to problem solving