Delivering meaningful AI

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ERS digital health summit - 04/06/2021

The focus of today

AI for decision support systems and patient management

It is hard for MDs to cope with today's health management complexity…

There are ***limitations in a human MD….***

- Extensive knowledge to retain
- Multiple and diverse type of data to consider
- Expensive operations
- Tiredness and fatigue
- Time-consuming procedures

Image source: vectorstock.com

…but AI can come to the rescue

Based on global knowledge and updates

Able to integrate and consider multiple and diverse types of data

Cheaper and cost-effective

Tireless and restless

Faster and efficient

*…**AI** can **solve** most of the **human limitations**…*

Image source: vectorstock.com

Is AI really the solution? What challenges does it pose?

Key AI considerations

Trust in a black box

Access data in compliance with GDPR

Does data always hold the answer?

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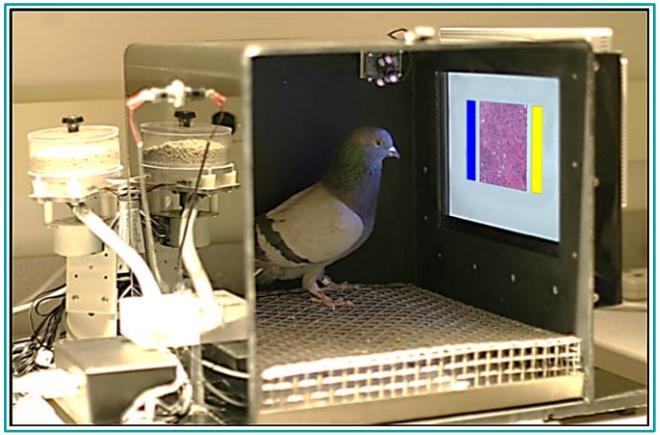
What is going on in a pigeon brain?



Studies have shown that **pigeons** can serve as promising **surrogate observers of medical images** to distinguish benign from malignant human breast histopathology and to be capable of **detecting cancer-relevant microcalcifications** on mammogram images[1].

Would you trust the Buddy to diagnose your cancer?

Deep learning

Extremely effective *but*…

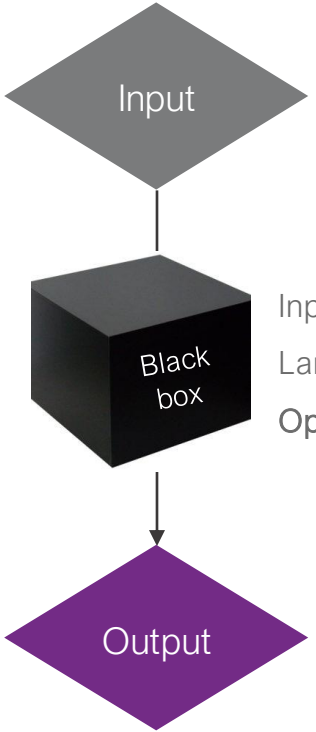
- It requires **a lot** of information
- works as a **black box**:

1. no real-world interpretation
2. only good for the purpose it was developed for

1 Levenson RM, Krupinski EA, Navarro VM, Wasserman EA (2015) Pigeons (Columba livia) as Trainable Observers of Pathology and Radiology Breast Cancer Images. PLoS ONE 10(11): e0141357. https://doi.org/10.1371/journal.pone.0141357

Question: *does it need to be a **black box**?*

PERCEPTION



Inputs and operations **not visible** to the user.

Largely **self-directed** process.

Opaque implementation.

REALITY

Handcrafted features extraction.
Explainable internal working.
Transparent algorithm.

Answer: *not necessarily*

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What about data access and ensuring privacy

American and Chinese companies have established their frontline positions in AI technology. But what is the impact on data protection? And what is the EU's stance on individual rights and civil liberties?

GDPR

The General Data Protection Regulation (EU) 2016/679 (GDPR) is a regulation in EU law on data protection and privacy.

The aim is to give individuals control over their personal data.

The patient has right to be informed, to access his data, to restrict and object to processing, but also to rectification and erasure.

EU's AI Law

The European Commission wants the EU to become a safe space for AI innovation.

Only high-risk AI systems (among them, AI-powered healthcare) that have gone through quality management and conformity assessment procedures will be allowed in the EU.

Some requirements the draft lays out include the need for data sets to be high quality, have human oversight and transparency, as well as be "robust".

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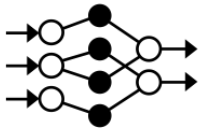
The standard AI approach working with large dataset

Standard AI approach

Collect heterogenous data

Develop and validate model



Release model

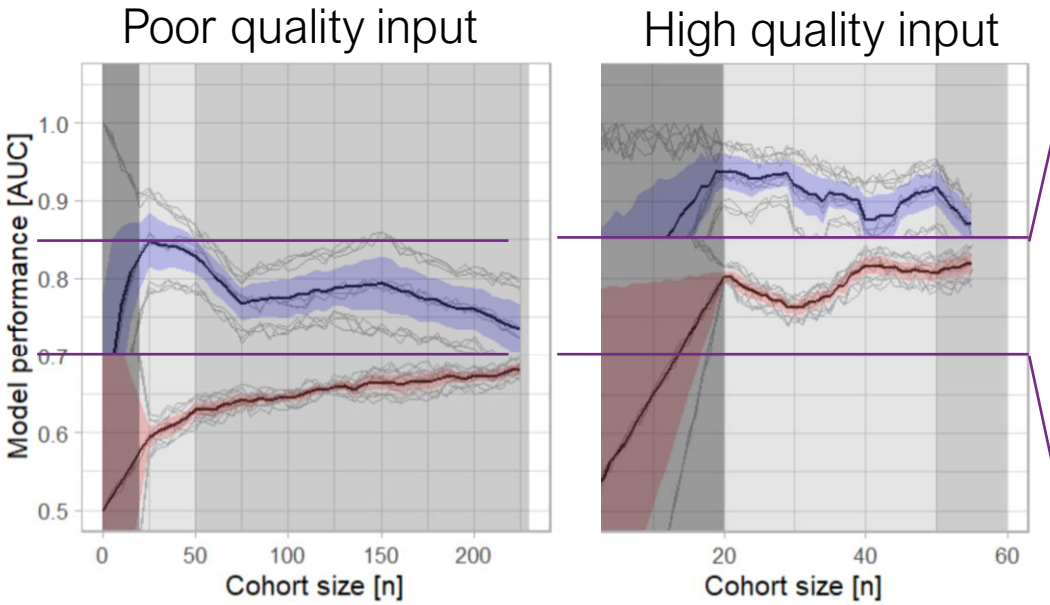
Drawbacks

- More difficult to capture signal
- Not clear what are the working conditions for the final model
- Requires large data sets

Data quantity vs quality

Finding the right balanced between **quantity** and **quality** is the key for successful AI

- AI does **not** necessarily require big dataset.
- Simulations show how the analysis of a **smaller cohort can lead to better results**, overcoming the noise threshold, which simulations with bigger cohort could not.
- **Quality** over **quantity**.



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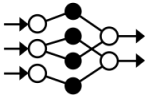
The alternative approach of smaller and higher quality datasets

Alternative Approach

Select high quality curated data

Develop and validate model



Test model with data variability

Advantages

- Develop model by understanding underlying reality
- Clearly define conditions for model to work

Question: *how does AI **help** in clinical decision making?*

- It is not about replacing doctors. It is about supporting and enhancing their performance.

EFFICIENCY: Speeding up simple but time-consuming operations

SAFETY: Reducing error probability

EFFICACY: Going beyond what can meet the eye

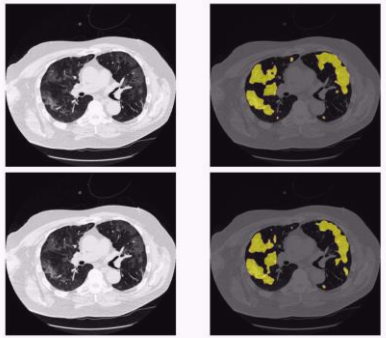
Using the human expertise in the most efficient way possible

Speeding up simple but time-consuming operations

AI can help radiologists by **rapidly analyze images and data registries**, supporting them in several tasks such as:

- Segmentation of the organs
- Segmentation of the abnormalities
- Differential diagnosis
- Image assessment and volumetric measurements (RECIST evaluation)

Fast, accurate, efficient



Automatic segmentation of abnormalities

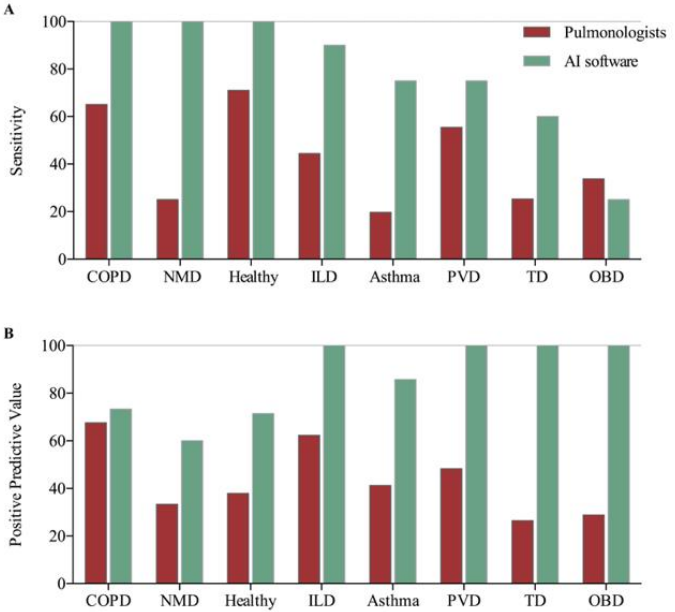
Increased patient safety by correct and consistent reading

Reducing error probability

The interpretation of pulmonary function tests (PFTs) to diagnose respiratory diseases is built on expert opinion that relies on the recognition of patterns and the clinical context for detection of specific diseases.

There is **poor accuracy** and **substantial disagreement** between pulmonologists when interpreting complex pulmonary function data.

Automating interpretation with **AI** provides a **powerful decision support tool in clinical practice**.



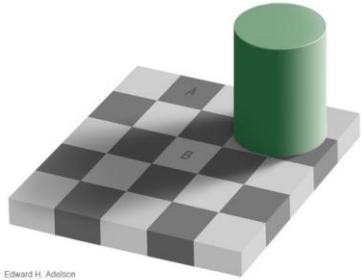
Topalovic M, Das N, Burgel P-R, et al. Artificial intelligence outperforms pulmonologists in the interpretation of pulmonary function tests. Eur Respir J 2019; 53: 1801660 [https:// doi.org/10.1183/13993003.01660-2018].

Improving the efficacy of medical staff

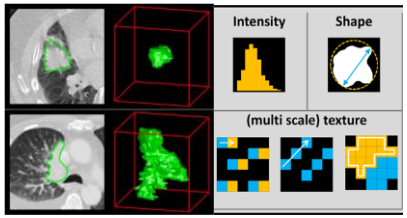
Going beyond what can meet the eye

Human eyes are limited

There is much information beyond what can meet the eyes



Quantitative Image Analysis



Quantitative biological information embedded in standard medical imaging

How do we see the future?

Black box deep learning

Automatic tasks that do not require interpretation
Can be easily checked by a human or any other method

Combining

Understandable and smart machine learning

Understanding scientific questions
Support clinical decision making but not replacing physician

AI for Decision Support Systems and patient Management in COVID-19

The DRAGON project aims to use artificial intelligence (AI) and machine learning to develop a decision support system capable of delivering a more precise **coronavirus diagnosis and more accurate predictions of patient outcomes.** Underpinning all of this will be a federated machine learning system that will allow the use of data from a range of international sources while complying with the EU's General Data Protection Regulation (GDPR).

- Goal: rapid and secure AI imaging-based diagnosis, stratification, follow-up, and preparedness for coronavirus pandemics.
- Lead institution: Radiomics, Belgium.
- 18 partners: high-tech SMEs, academic research institutes, biotech and pharma partners, affiliated patient-centred organisations and professional societies from Belgium, Italy, the Netherlands, Switzerland and the UK.
- Funding: **Innovative Medicines Initiative** (IMI), joint of the DG Research of the European Commission.

DRAGON

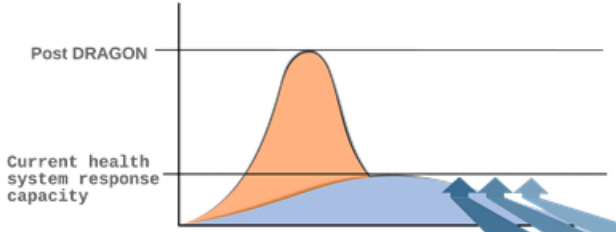
FACTS & FIGURES

Start Date	01/10/2020
End Date	30/09/2023
Call	IMI2 - Call 21
Grant agreement number	101005122

Type of Action:
RIA (Research and Innovation Action)

Contributions	**€**
IMI Funding	11 381 970
EFPIA in kind	160 672
Total Cost	11 542 642

imi innovative medicines initiative

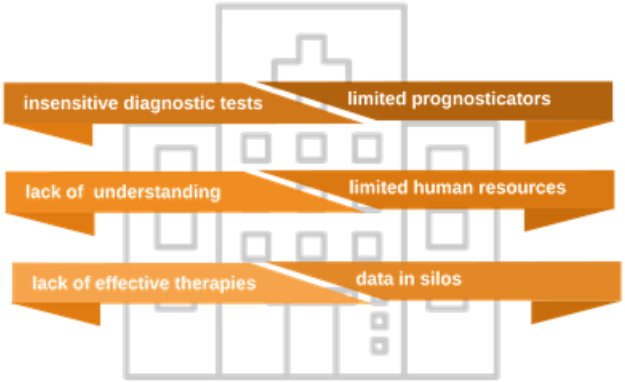


MOVING BEYOND FLATTENING THE CURVE

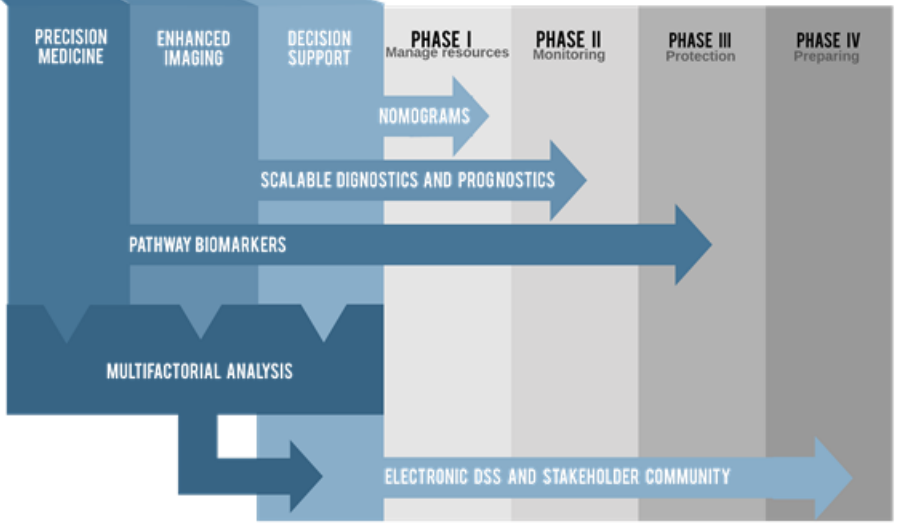
AI driven approaches for elevating health system response capacity

The RapiD and SecuRe AI enhAnced DiaGnosis, Precision Medicine and Patient EmpOwerment Centered Decision Support System for Coronavirus PaNdemics (DRAGON)

FACTORS LIMITING RESPONSE CAPACITY



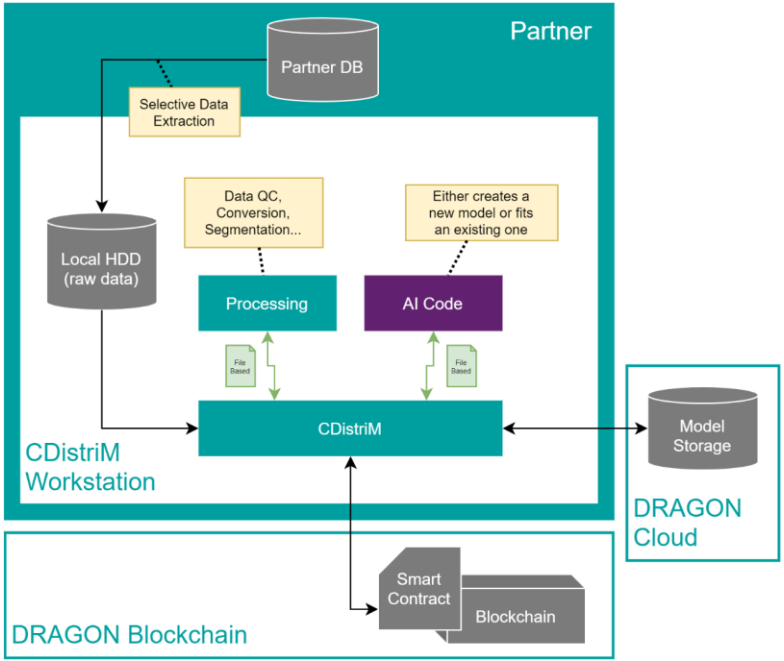
VIRAL PANDEMIC PHASES



CDistriM: towards shared and accessible medical data

- Sharing and accessing medical data is hindered by **legal** and **ethical** consideration
  - A solitary medical center does not have sufficient quality data for the specific task at hand to implement high-performance AI
  - Building accurate and reliable predictive models remains a **challenge**
- **Distibuted learning** aims to share reaserch questions instead of privacy sensitive data
  - Maintain data privacy
  - No individual level data is shared (clinical, genomic, imaging, …)

It allows AI models to be trained on multiple siloed datasets **without** the need for patient **data to leave the firewalls** of each database



Thank you for your attention