Sistema Socio Sanitario
Fondazione IRCCS Istituto Nazionale dei Tumori
Regione Lombardia

POLITECNICO MILANO 1863

I³LUNG

Apollo 11
STRENGTH IS UNITY

How to translate AI in Clinical Cancer care

AI-ON-Lab

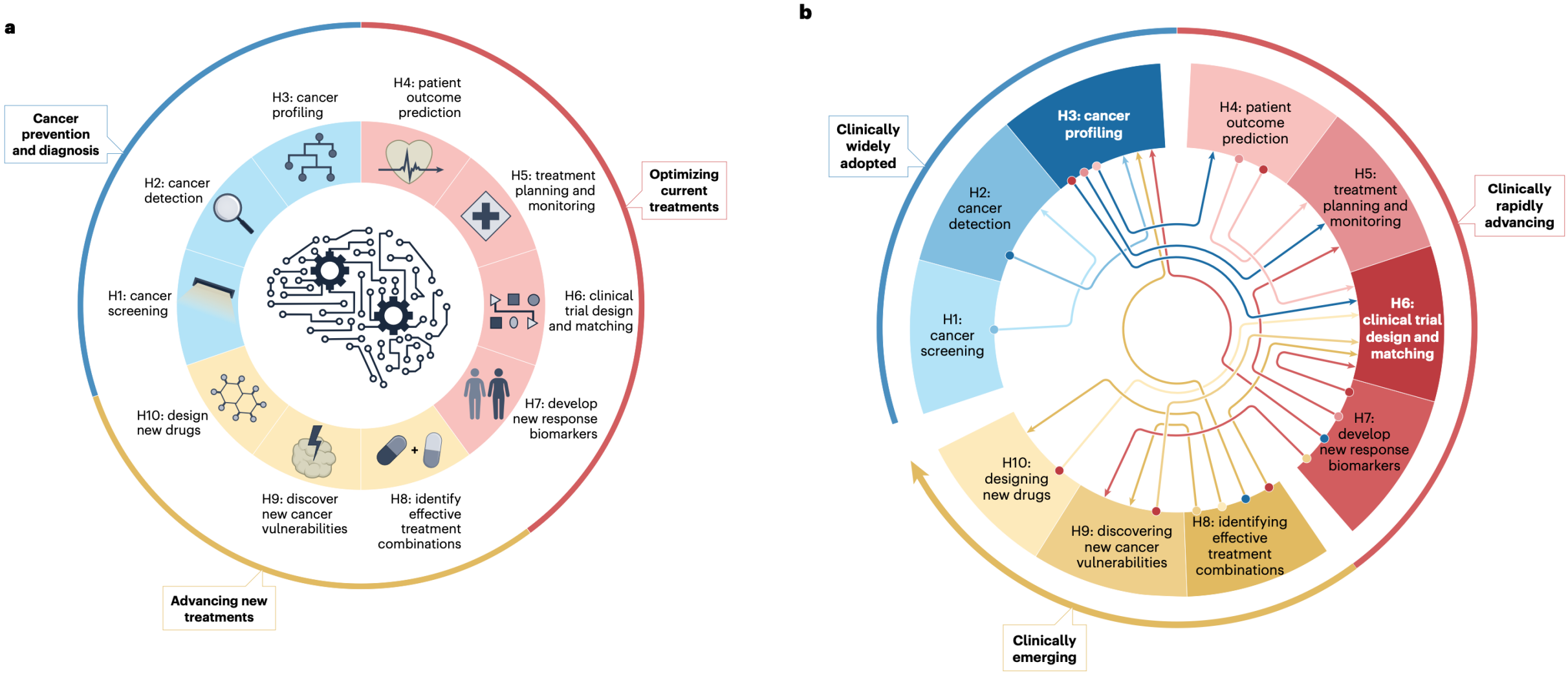
Arsela Prelaj, MD, PhD

AI-ON-Lab leader (Artificial Intelligence for Oncology lab), and Medical Oncologist, at Istituto Nazionale Tumori di Milano
PhD in Bioengineering and AI, Politecnico di Milano, Italy;
ESMO Real-World Data and Digital Healt working group mem
ESAC President

Declaration of Interest

Consulting/advisory role for BMS, AstraZeneca, Novartis, MSD, Lilly, Amgen, Pfizer, Jonsson & Jonsson; travel, accommodations, or other expenses paid or reimbursed by Roche and Jonsson & Jonsson; principal investigator of Spectrum Pharmaceuticals, BMS, Bayer, MSD, Lilly outside this presentation.

HALLMARKS OF AI IN PRECISION ONCOLOGY



Chang, TG., Park, S., Schäffer, A.A. et al. Nat Cancer (2025). https://doi.org/10.1038/s43018-025-00917-2

WE NEED BIG DATA

BIOData-driven model in lung cancer: APOLLO11 use case

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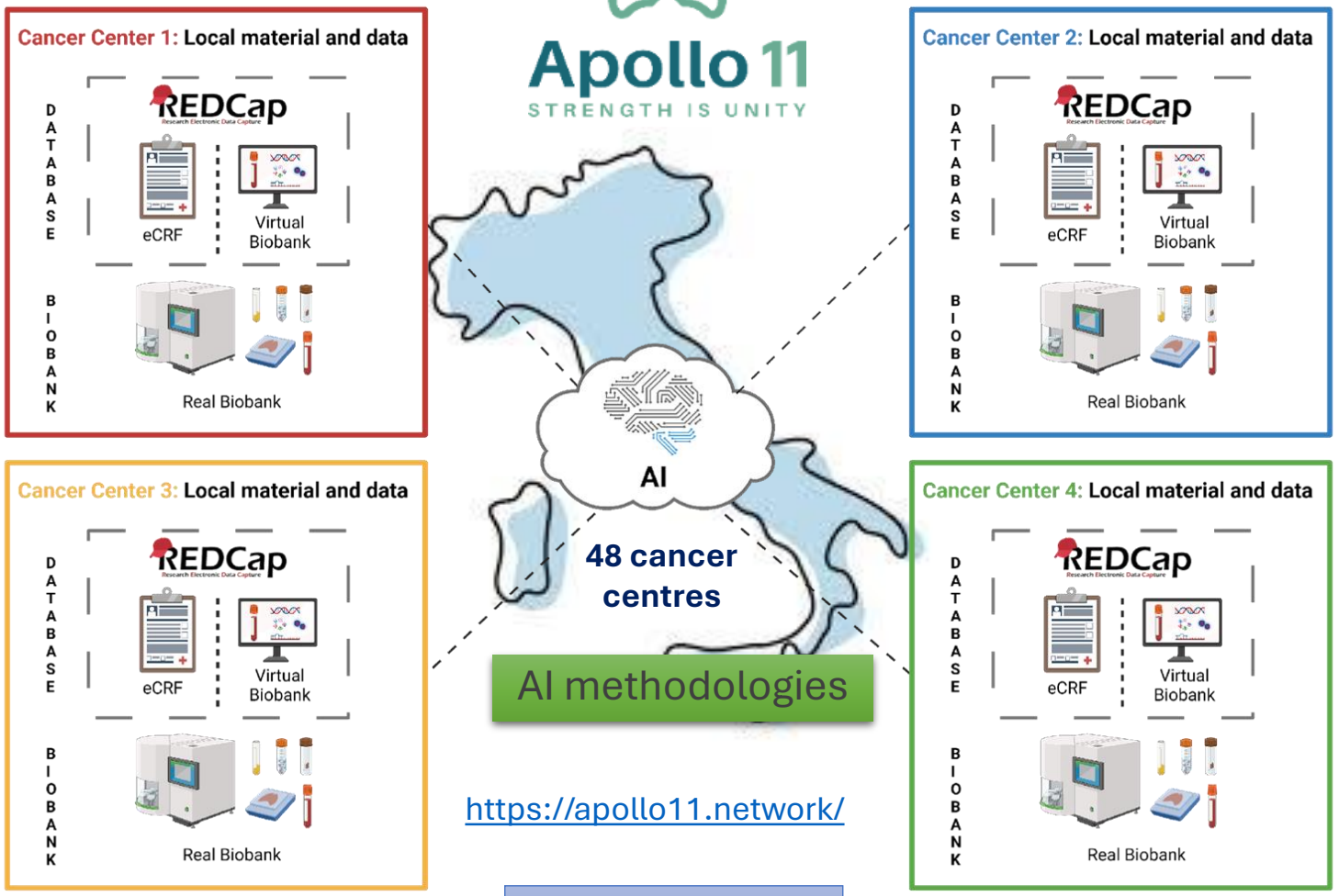
RWD data

Medical Images



AI methodologies

https://apollo11.network/

Federated Learning

Local biobanking
Virtual Centralized Biobank
Annotation

Decentralized Platform

Prelaj A, et al. APOLLO 11. Clin Lung Cancer. 2024

APOLLO11 Study Design and Workflow

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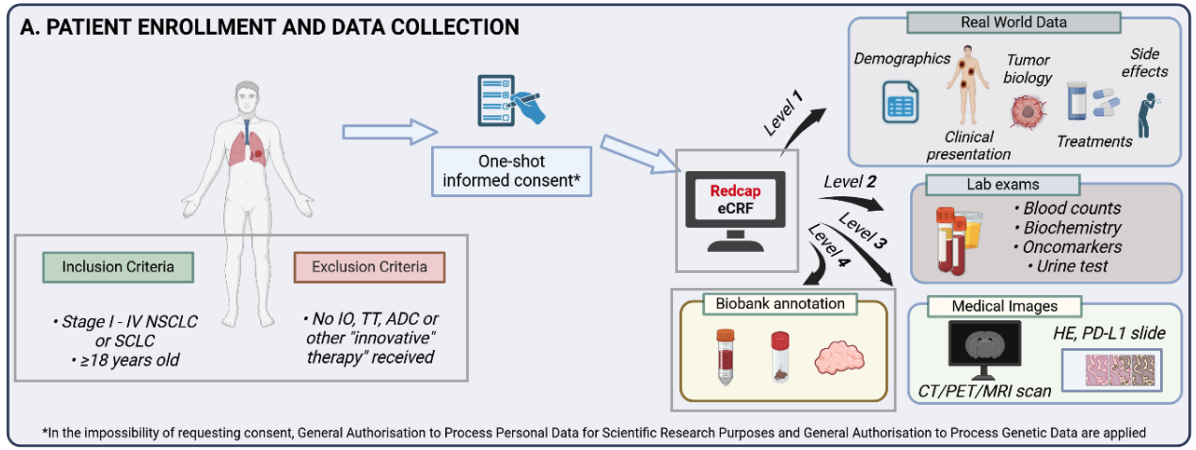
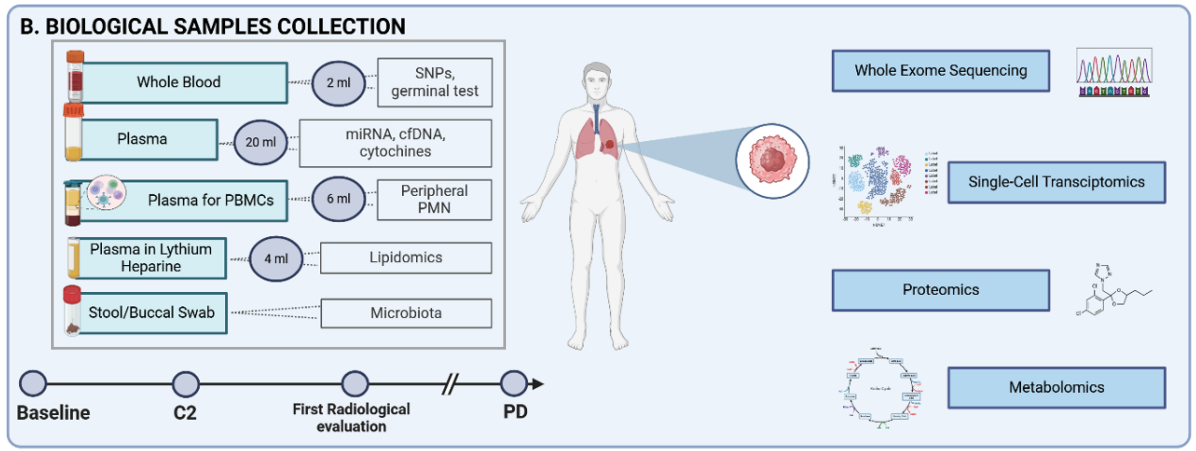
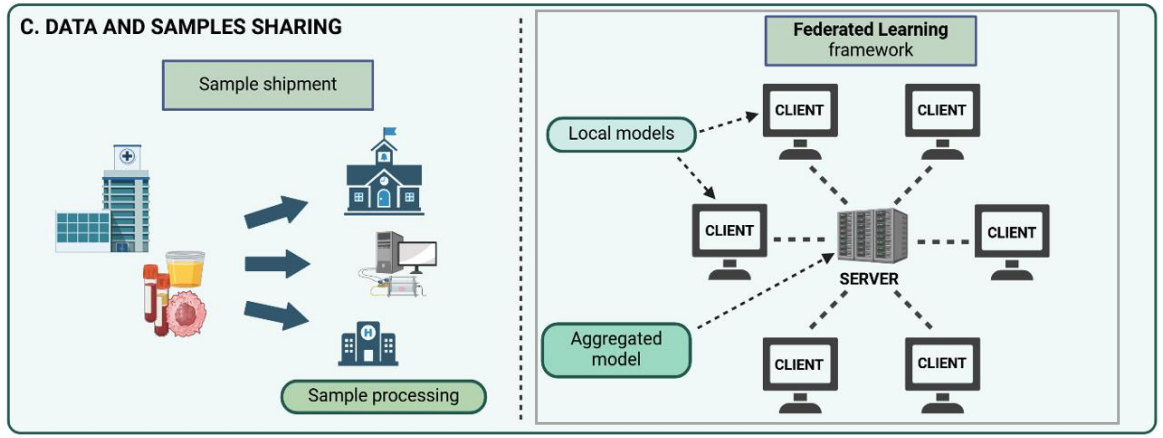
Broad inclusion criteria

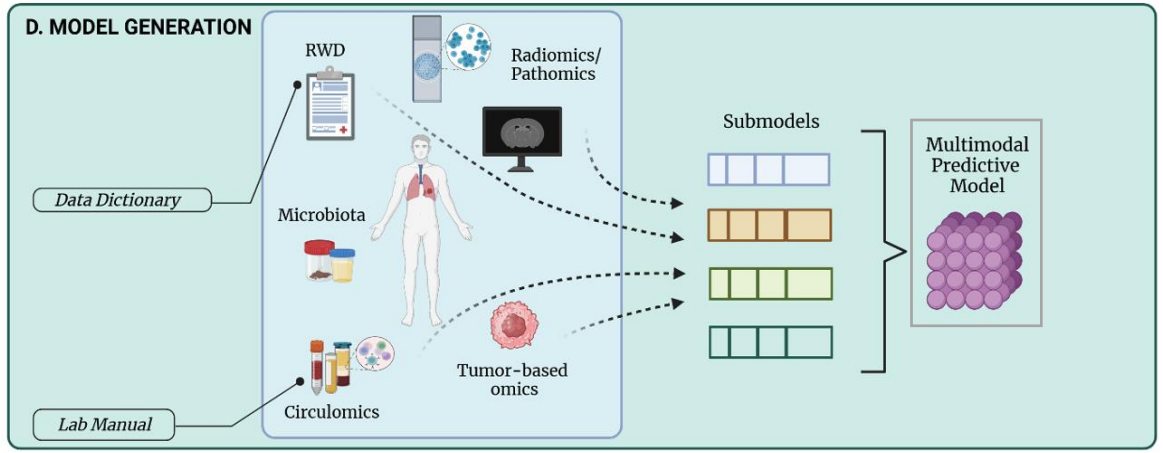
Samples availability annotation

Overcoming ethical barriers









Harmonization of prospective data collection

Higher prediction performances

Comprehensive models

Higher clinical applicability!

Prelaj A et al. Submitted

APOLLO11: data

Apollo 11
STRENGTH IS UNITY

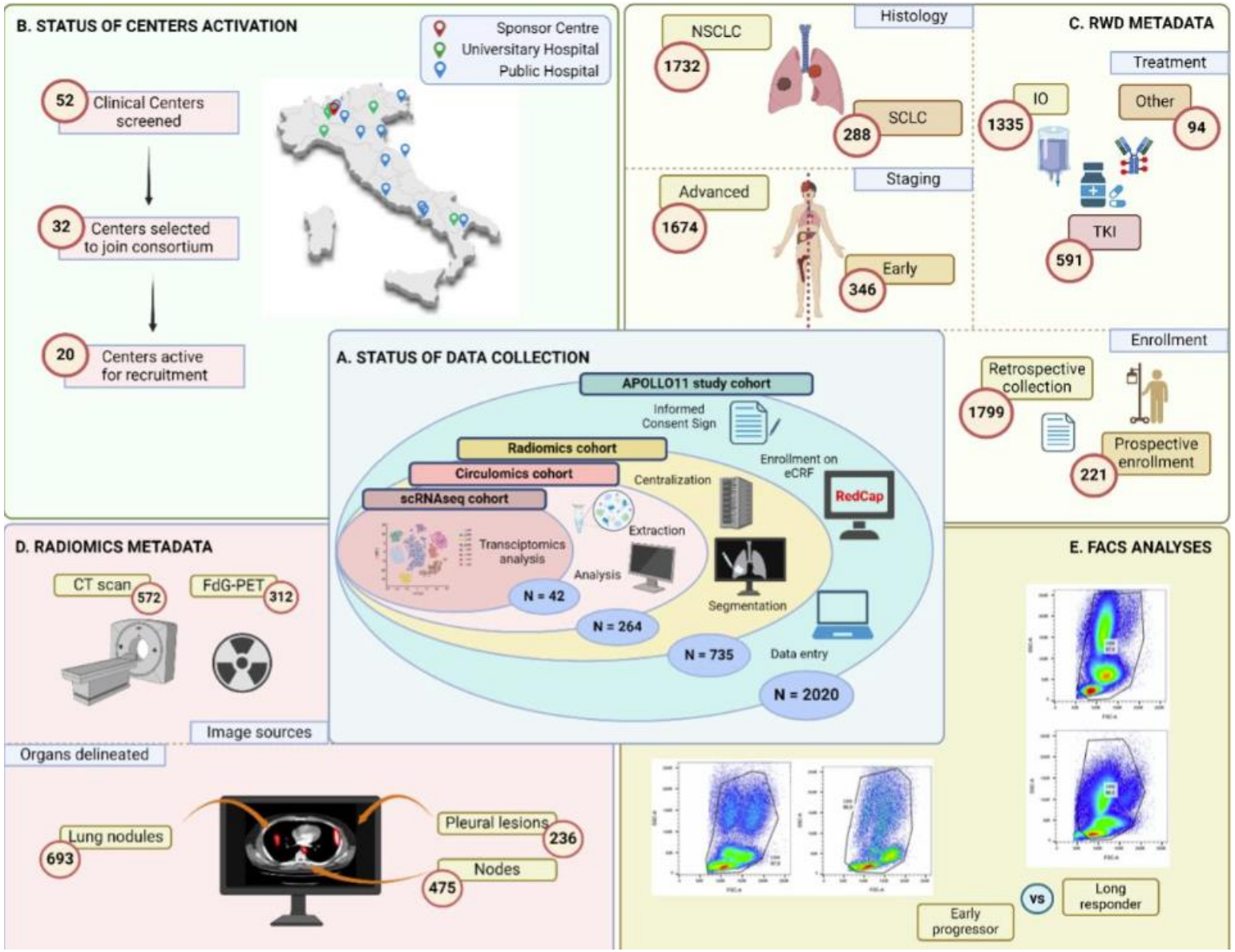
32 CENTRES WILL BE ACTIVATED IN TOT SOON

20 CENTRES ARE RECRUITING

2498 PATIENTS ENROLLED

With NSCLC e SCLC

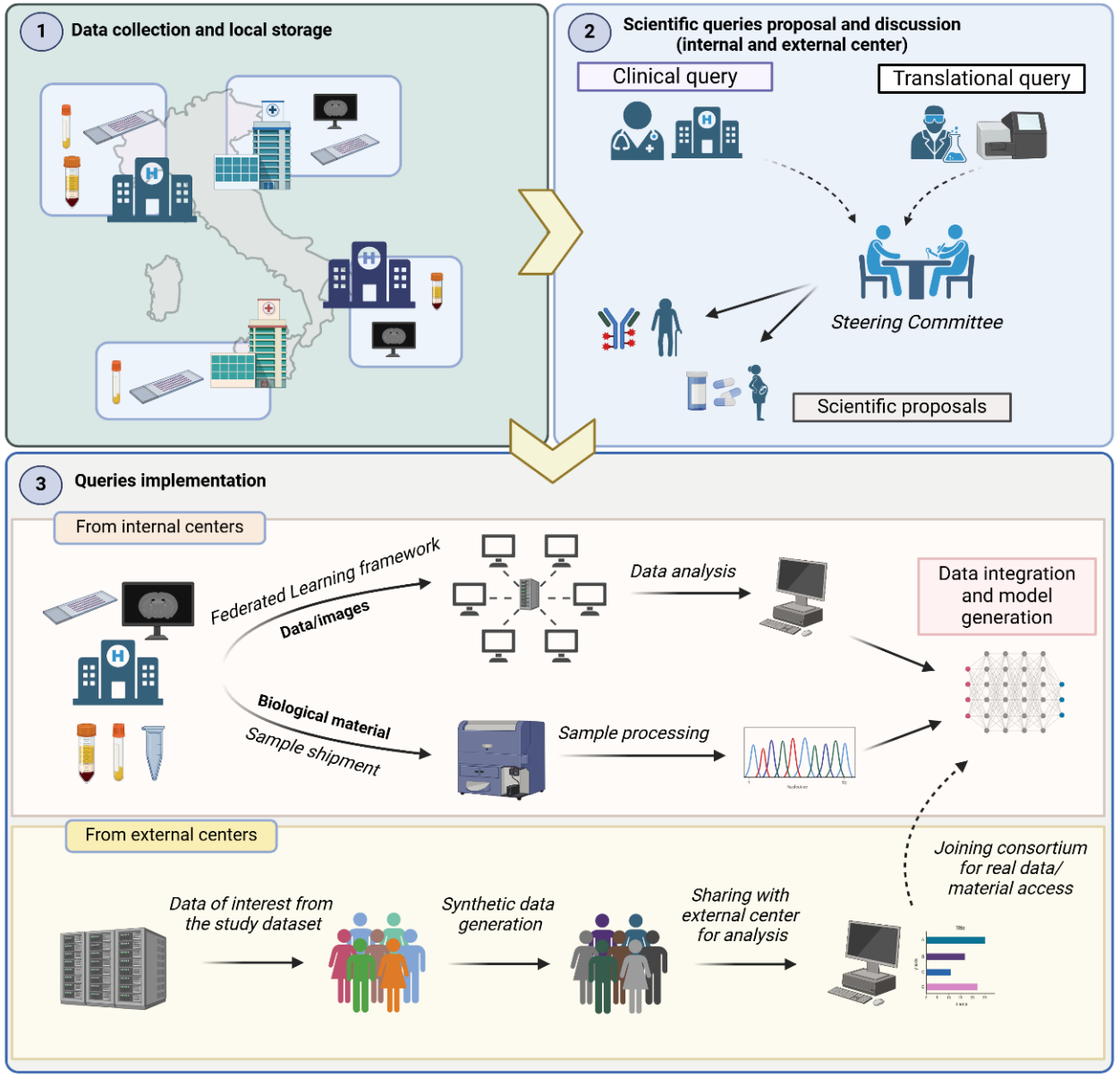
From Stage I to stage IV



Prelaj et al. Submitted

APOLLO11 Queries Implementation

Updated collection…



Hypotheses Sharing

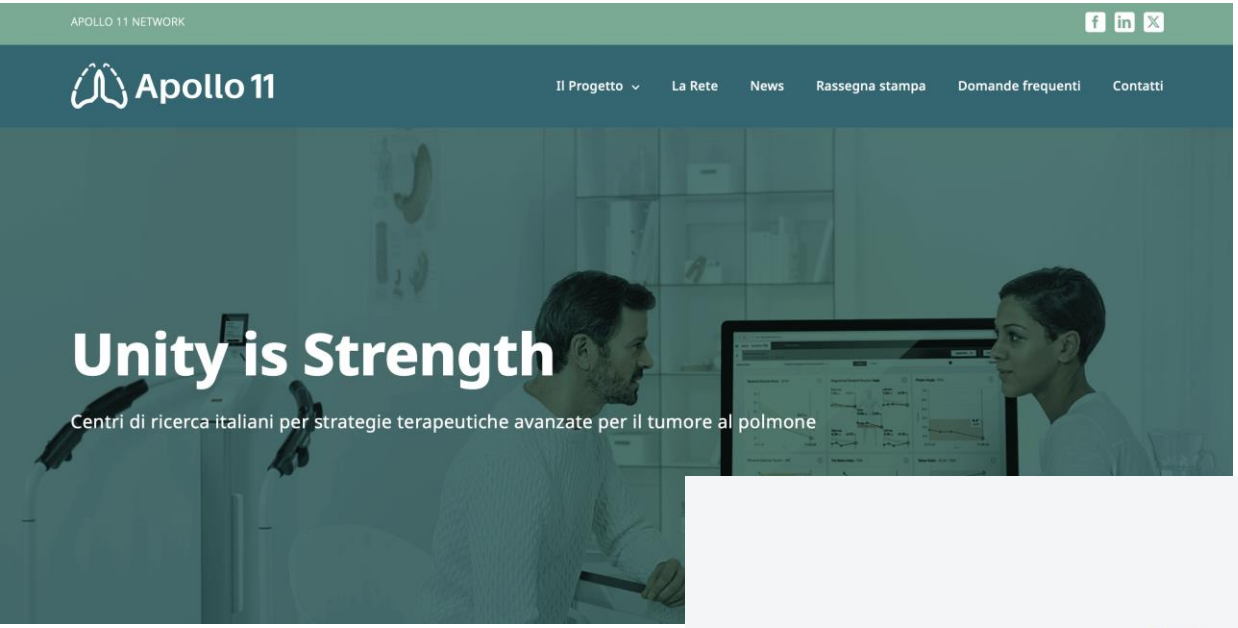
Fairness among centers

Scientific queries process as the core of data-driven research

Precision Oncology

Leveraging Synthetic Data to share data beyond the consortium

Prelaj A et al. Submitted



APOLLO 11
2021

FEDERATED NETWORK

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https://apollo11.network/

48 Centri di ricerca avanzata sul tumore al polmone

Creazione di una rete di centri italiani che si occupano di pazienti affetti da tumore del polmone NSCLC avanzati già trattati o candidati a ricevere una terapia a base di ICI

Real world data da tutti i centri attivi

Sviluppo di un database nazionale Real World per i pazienti affetti da tumore del polmone trattati con TERAPIE INNOVATIVE (ad es. immunoterapia, terapie target, anticorpi coniugati)

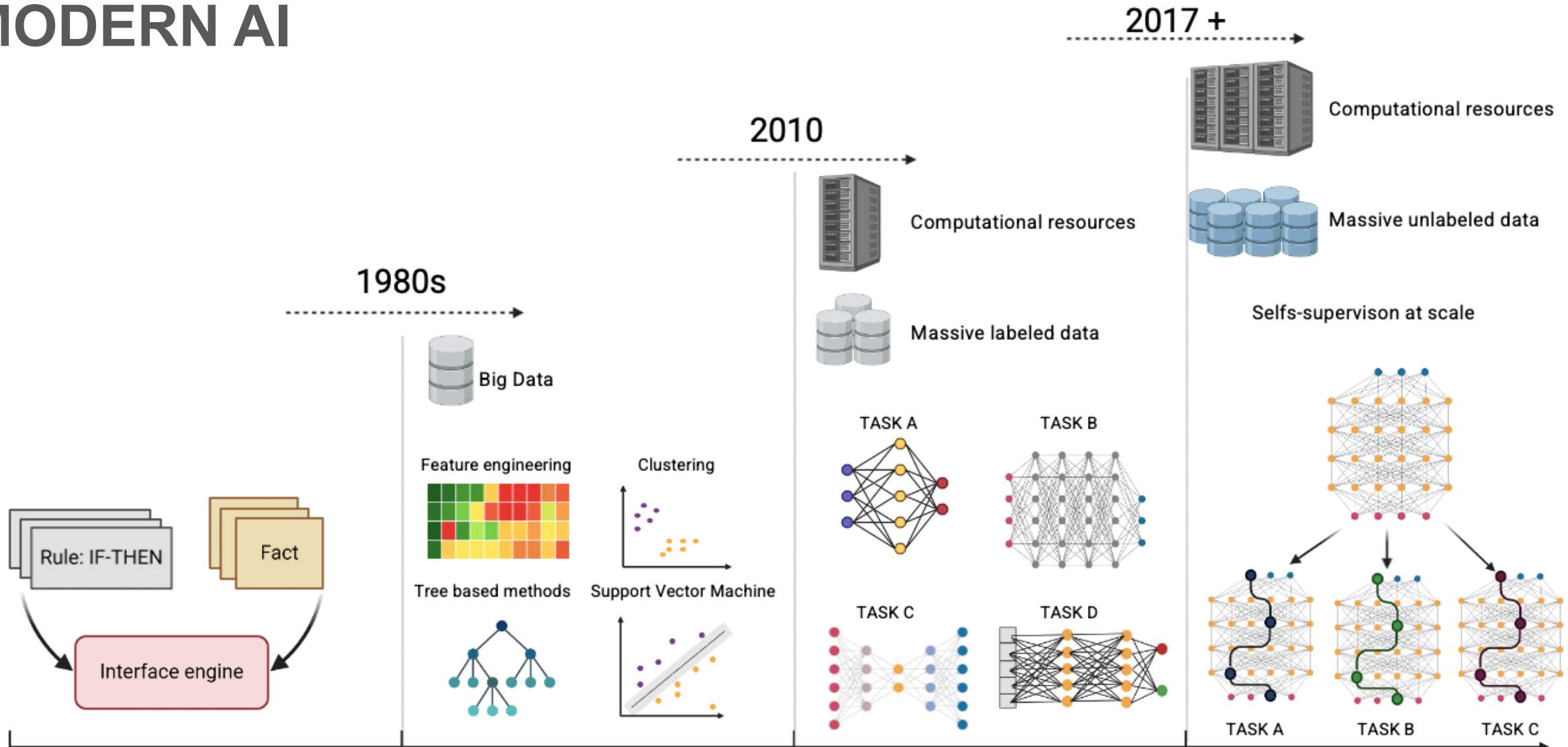
Biobanche

Sviluppo di una biobanca multilivello nazionale registrata con impostazione e armonizzazione delle procedure operative per la raccolta, la conservazione e la spedizione dei campioni biologici.

Intelligenza Artificiale

Creazione di un modello predittivo di intelligenza artificiale (AI) per migliorare la previsione della risposta, portando in ultima analisi a una migliore sopravvivenza e qualità di vita dei pazienti oncologici

MODERN AI



EXPERT SYSTEMS

- Manually-crafted symbolic representations and rules
- No use of data
- Rigid

MACHINE LEARNING

- Less rigid (supervised/unsupervised)
- Manual labor
- Extensive data preparation and feature engineering

DEEP LEARNING

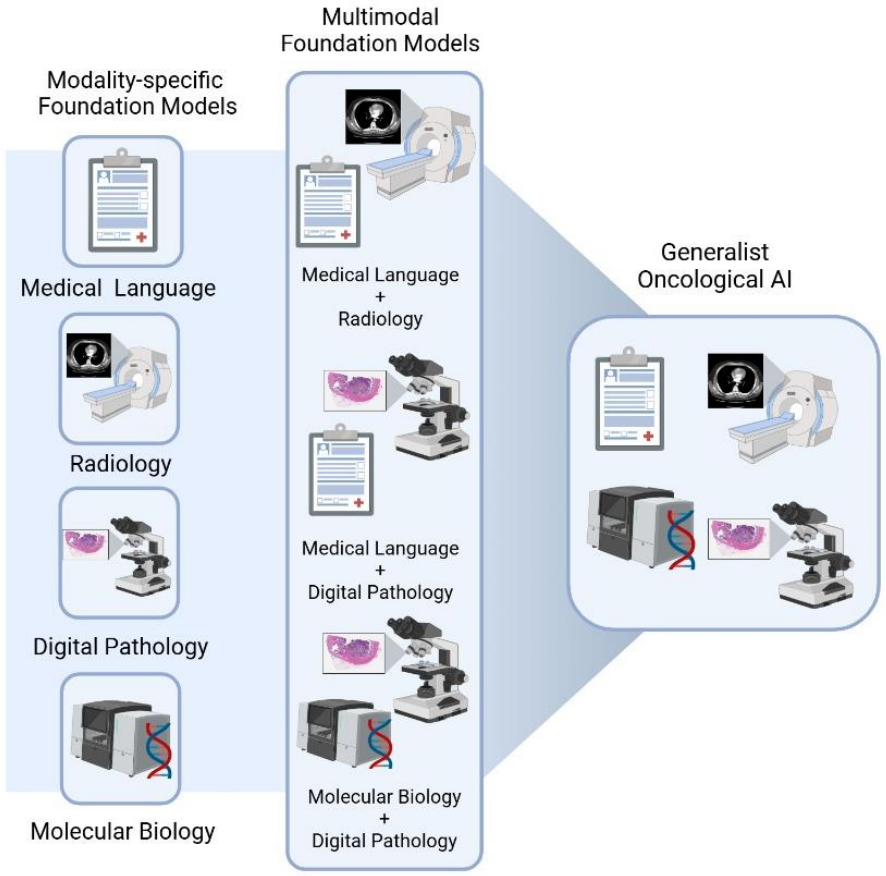
- Automatically learns if labeled data available in massive
- Limited by availability of labeled data

FOUNDATION MODELS

- Automatically learns from massive data **without labels!**
- Quick adaptation to new tasks using limited labeled data

LLMs and Foundation Models uni and multimodal

From uni to multimodal: A PANCANCER approach



- Help us to maximize the use of small datasets as extractors
- Help us to specialize the tasks as predictors
- AI Agents: Interactive, adapted for all tasks

SHIFT AI

PREDICIVE AI

PREDICIVE AI + GENERATIVE AI

GENERATIVE AI

AI Agents

LLMs and FMs

Deep Learning

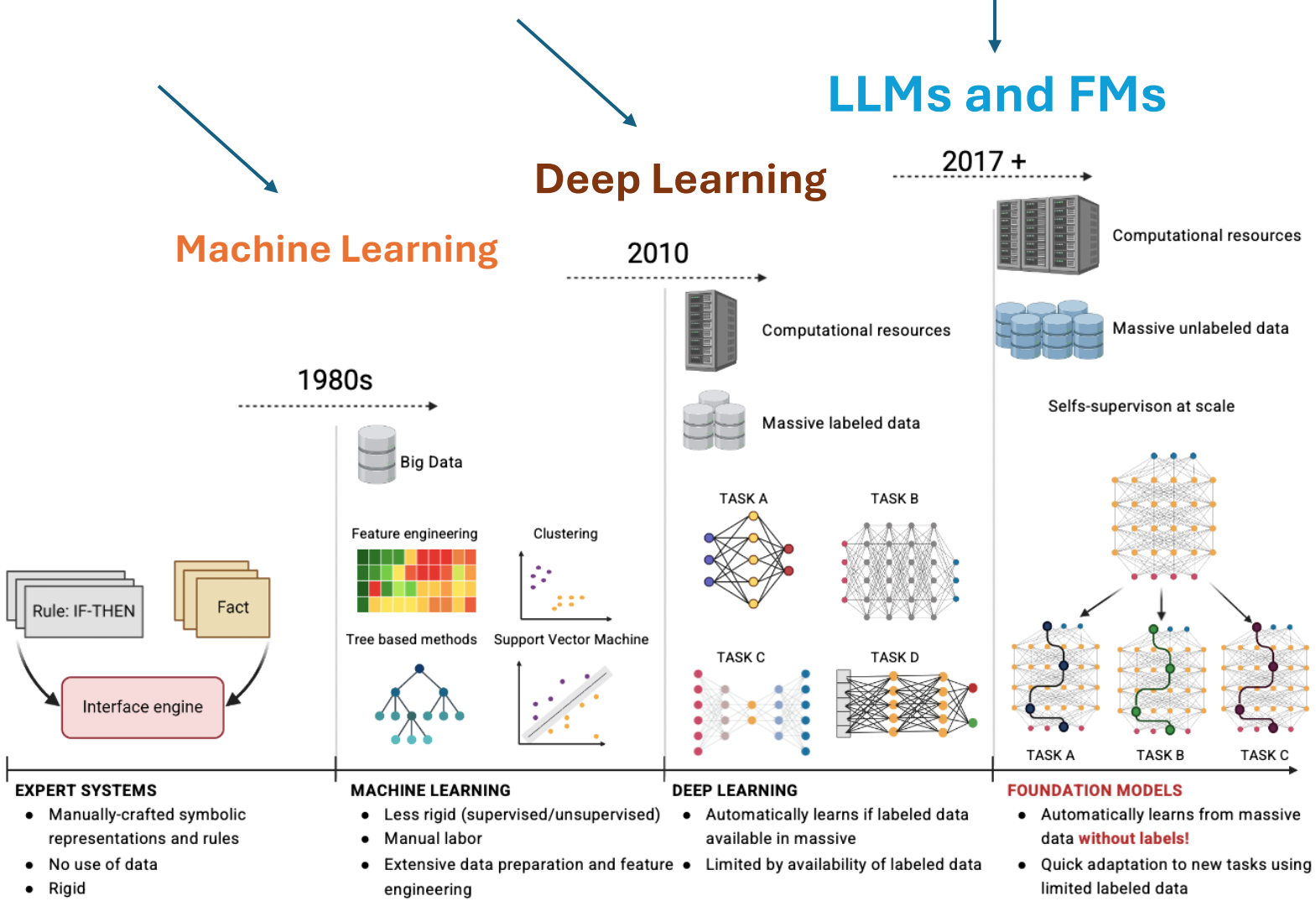
Machine Learning

2021 +

2017 +

2010

1980s



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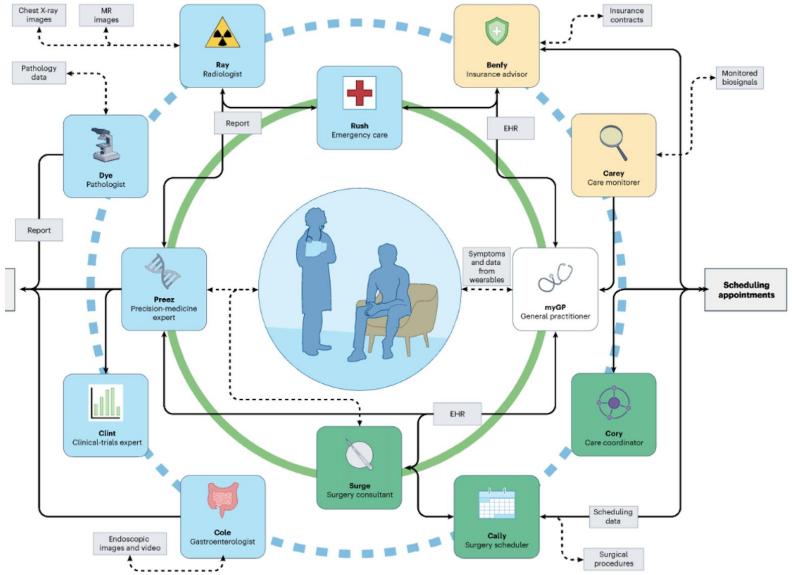


AI AGENTS
- Autonomous agent chooses autonomously the AI models to solve
- Able to refine the actions through the tool… adjustments

AI Agent

Agent-Layers

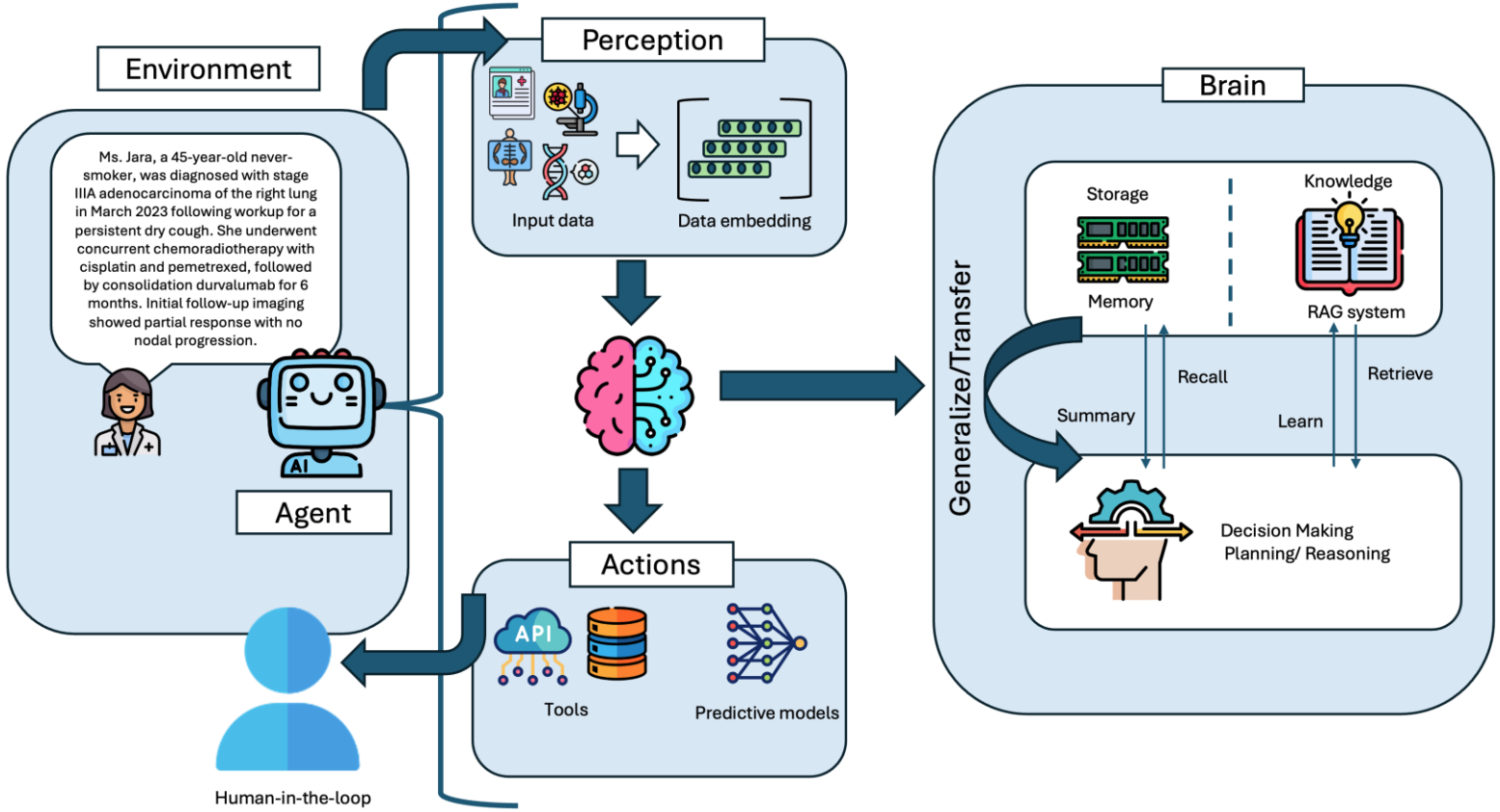
AI Agent

Foundation / Generative AI
(LLMs, Vision-Language Models)

Predictive AI / Specific Tools
(QA, Image Captioning, etc.)

Knowledge Integration / RAG
(External Sources & Internal Data)

Agent-Workflow

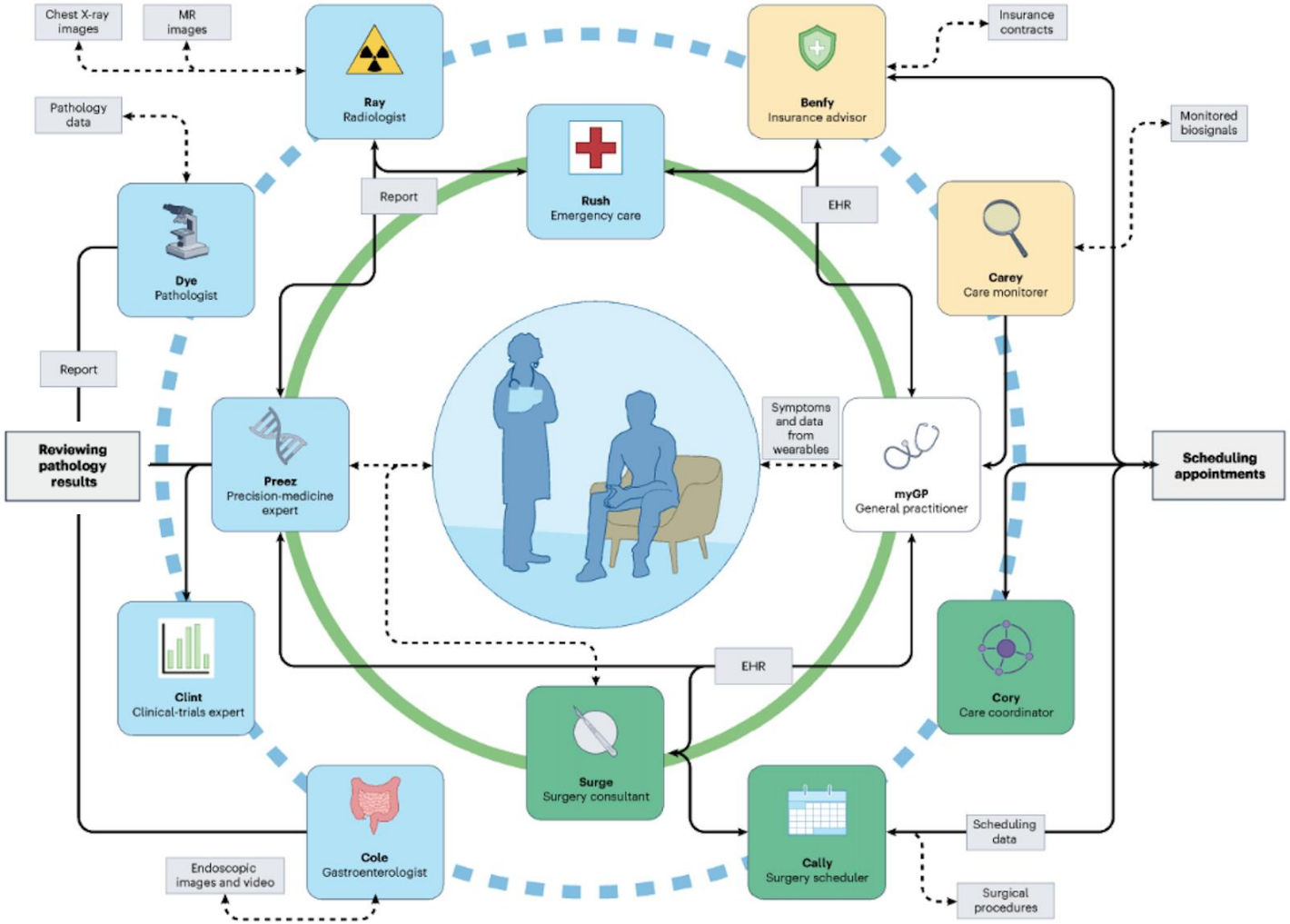


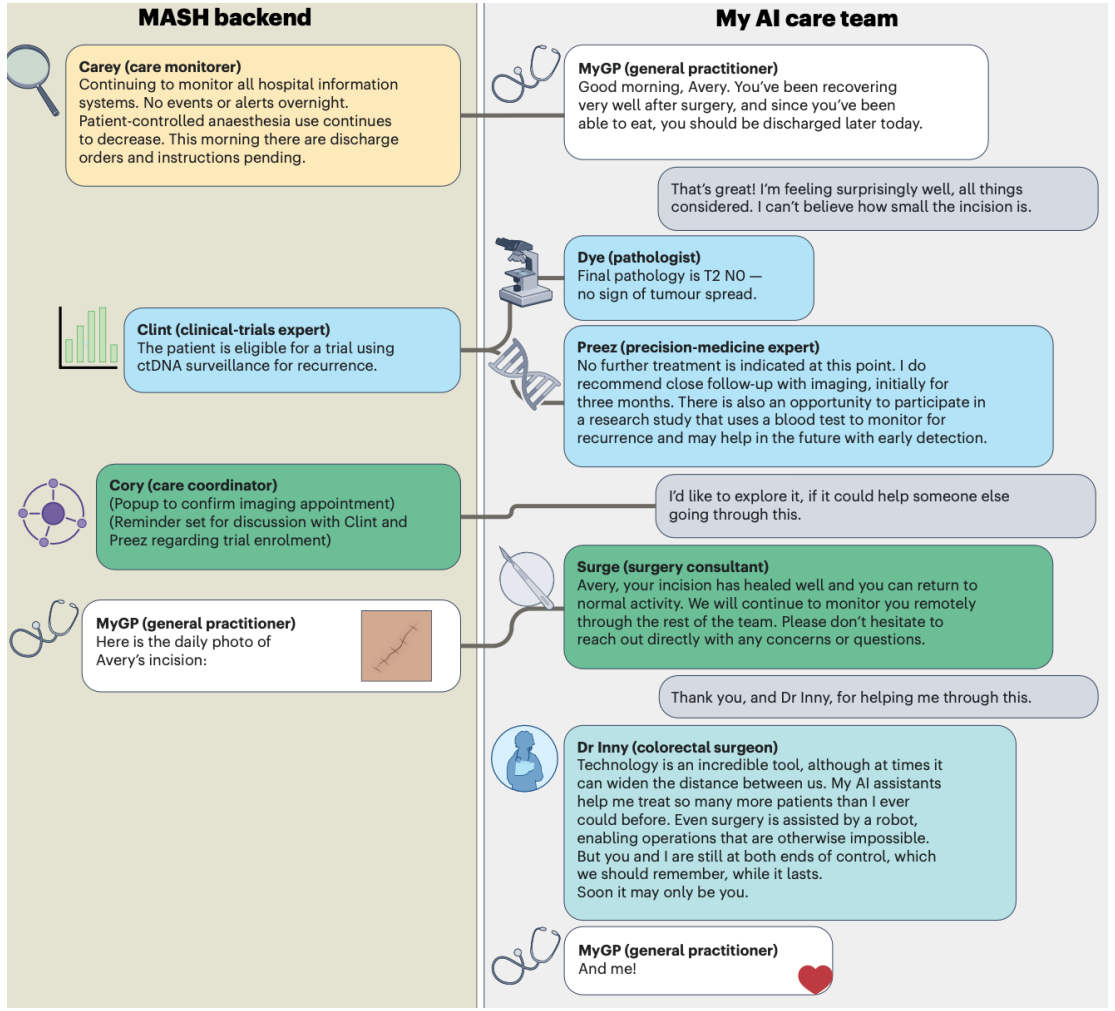
https://doi.org/10.1038/s41551-025-01363-2

Coordinated AI agents for advancing healthcare

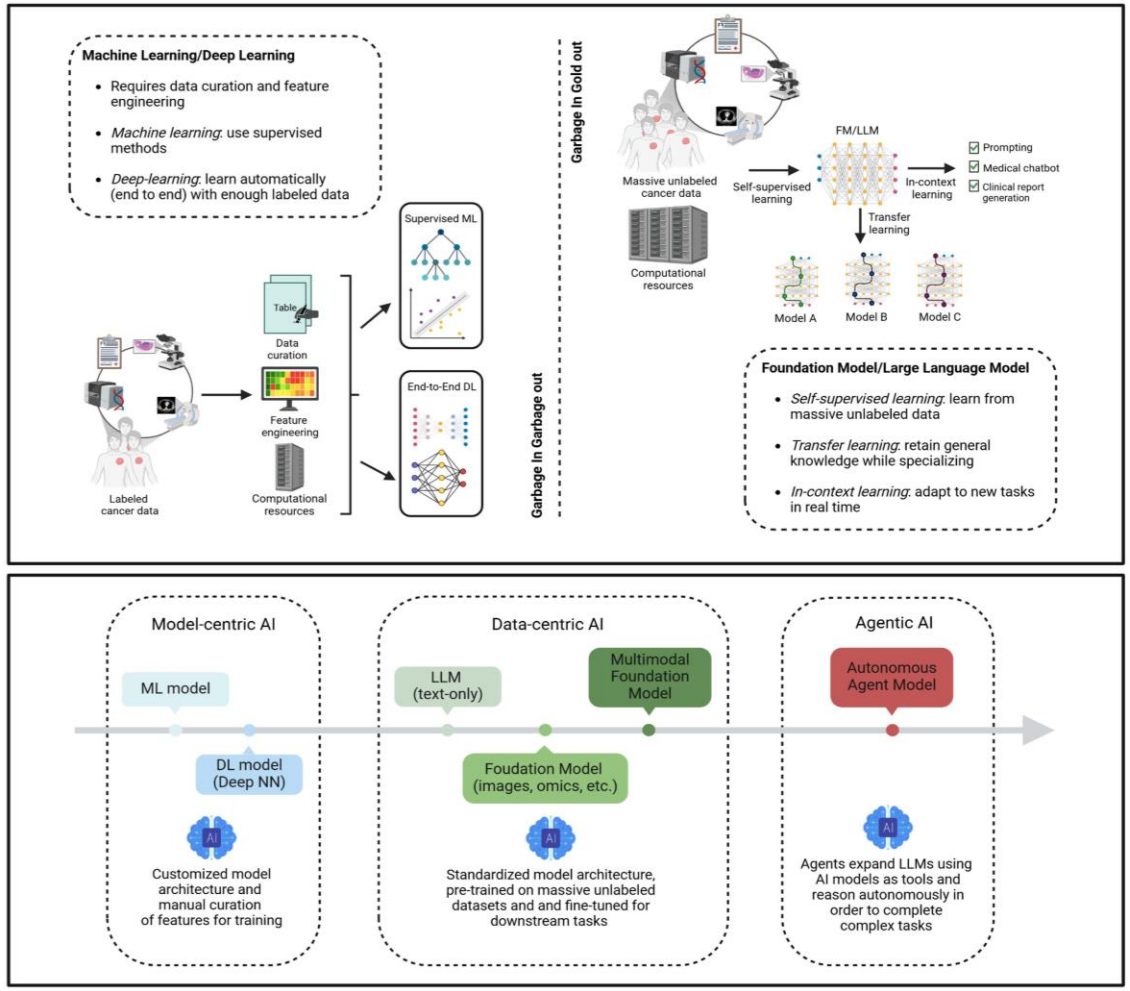
Michael Moritz, Eric Topol & Pranav Rajpurkar

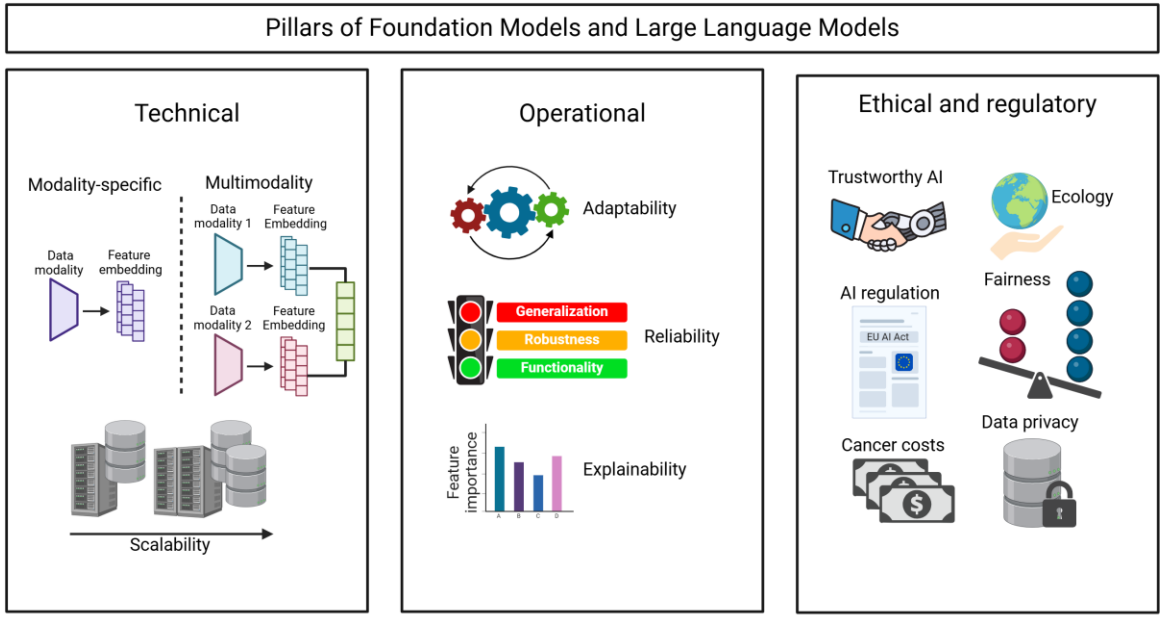
Autonomous (AI independent) &
Assistive (Human in the loop)





GIGO: GARBAGE IN - GOLD OUT





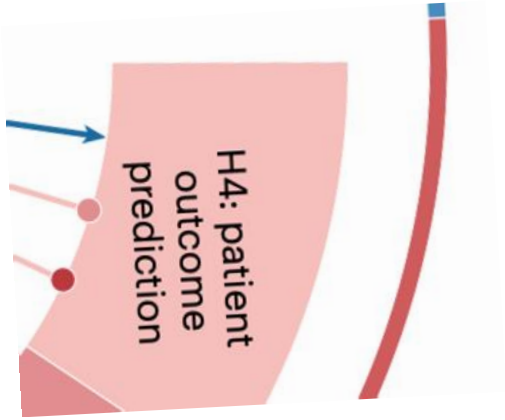
Panel a: Garbage In Gold Out is the paradigm shift in oncology driven by FMs and LLMs. This paradigm enhances the potential of FMs and LLMs in transforming cancer data, i.e., Garbage In, into highly valuable insights, i.e., Gold Out . Panel b: Evolution of AI models in cancer research from traditional model-centric AI, to data-centric AI (FMs and LLMs) and very recently to Agentic AI (autonomous AI Agent). Panel c: These pillars are requested for effective and safe development and deployment in clinical oncology.

Corso et al. Under revision Nature Cancer

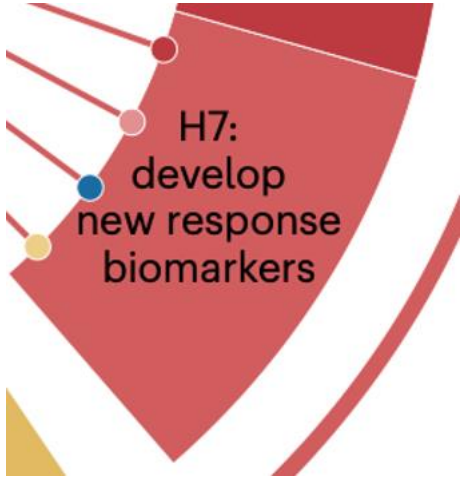
Arsela Prelaj, MD, PhD, Fondazione IRCCS Istituto Nazionale Tumori of Milan, Italy

TAILORING TREEATMENT STRATEGIES: DELAY

H4. Patient outcome prediction



H7. New Response Biomarker



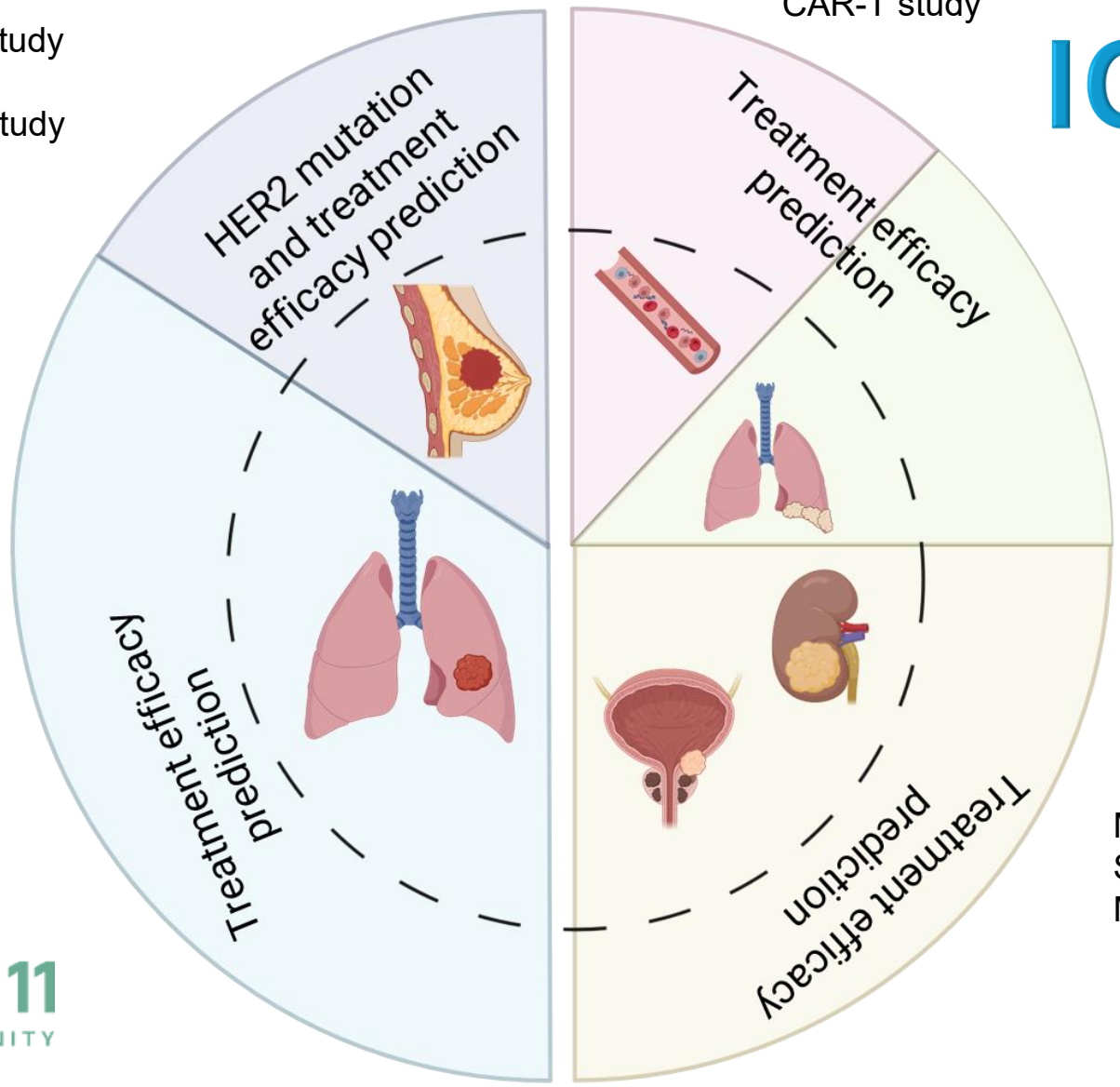
Ongoing projects: analyzed 6078 pts with IO-based

PALMARES Study

Radiosphere study

CAR-T study

IO: 900pts



Mesothelioma project

IO 50 pts

IO I³LUNG

A project funded by the European Union

2650 pts

MeeTURO
SamurAI
Malva

IO

1178 pts

IO

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1300 pts

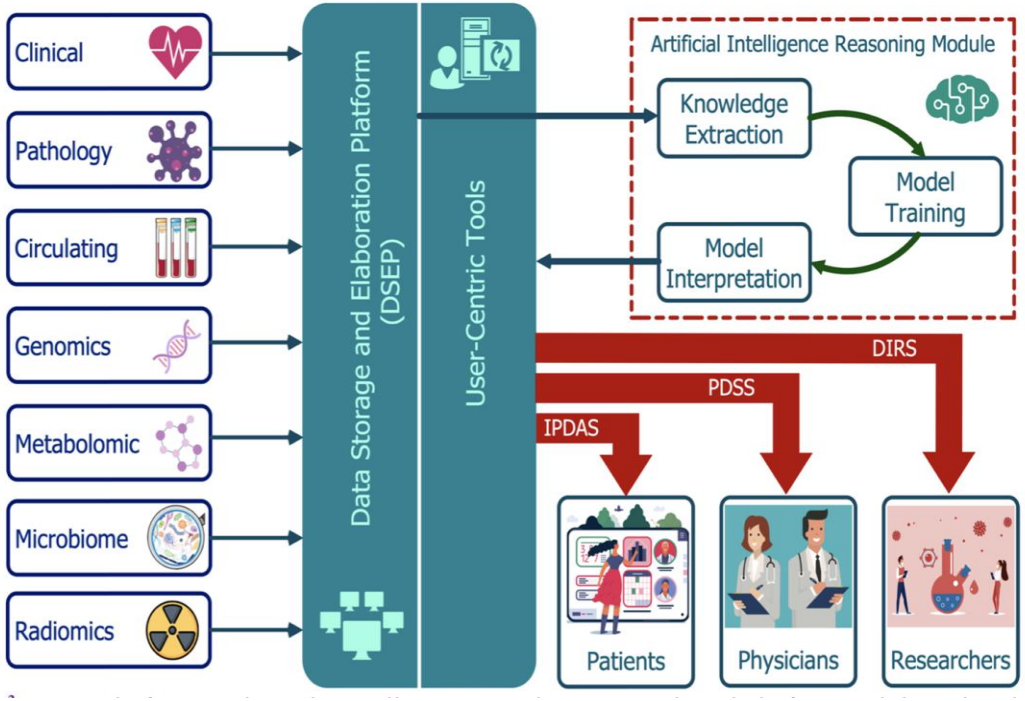
Physician Decision Support Systems (PDSS) for Immunotherapy

Integrating Predictive AI and Generative AI for clinical decision making

I³LUNG

A project funded by the European Union

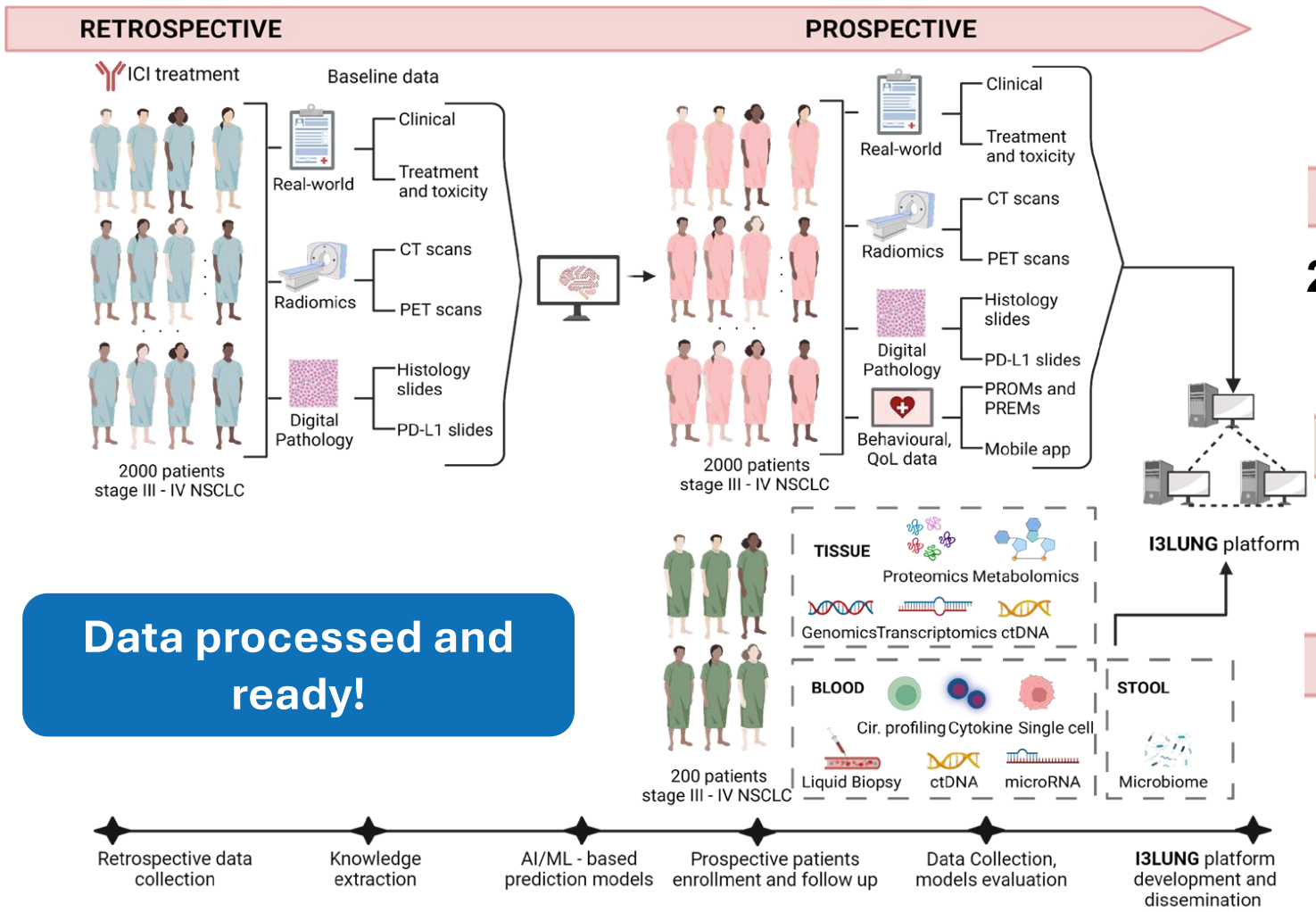
I3LUNG: A European and beyond project on AI, IO and NSCLC



Goal: Develop a Data storage and Elaboration Platform (DESP) by integrating **Real world** and **multiomics** data in NSCLC patients treated with immunotherapy with the aim to produce a clinical decision-making tool using AI approaches

Prelaj et al. CLC 2023

I3LUNG: Patients Cohort



Data processed and ready!

In collection phase

PROSPECTIVE I

2000 NGRW patient's cohort

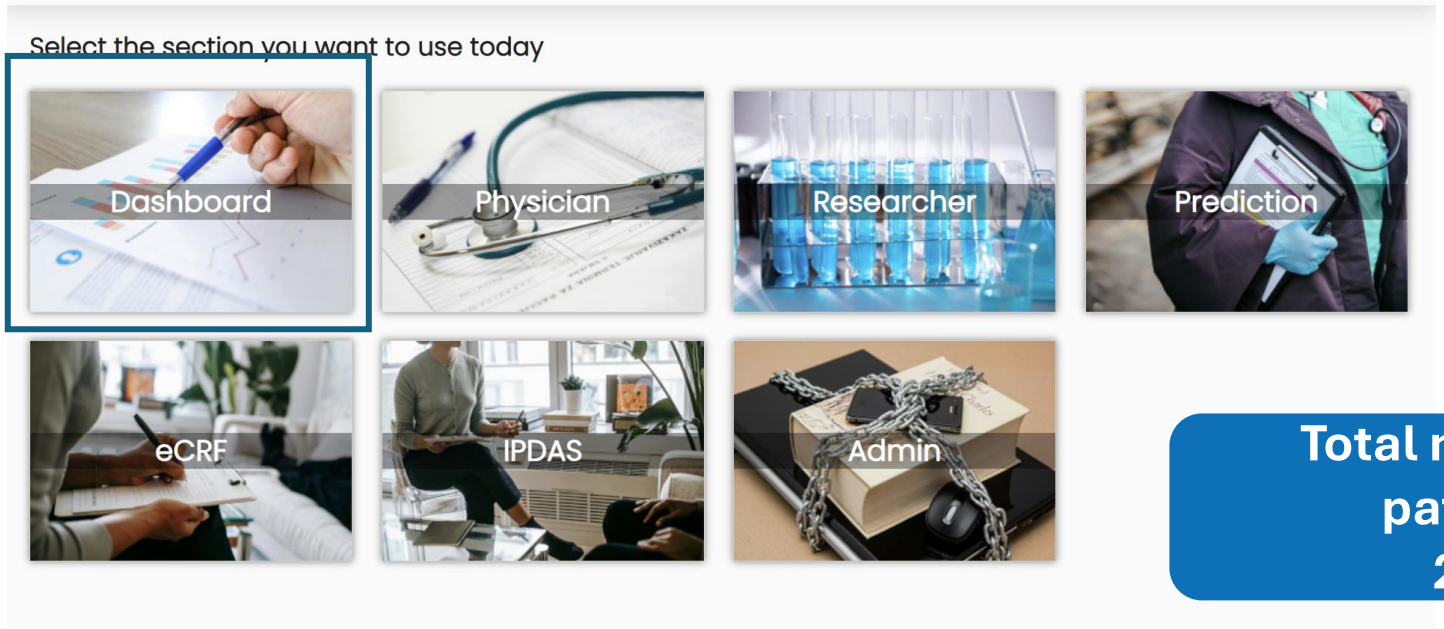
PROSPECTIVE II

200 SEMI-OMICs patient's cohort

PROSPECTIVE II

200 MULTIOMICs patient's cohort

I3LUNG: Platform and patients

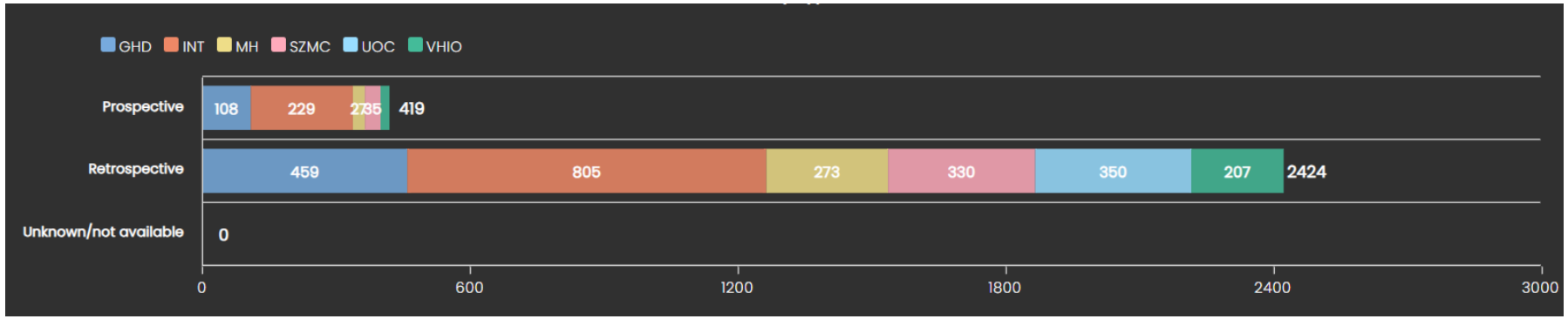


Cancer clinical centers:

INT – Milano, Italy
VHIO – Barcelona, Spain
SZMC – Jerusalem, Israel
UOC – Chicago, USA
MH – Athens, Greece
GHD – Grosshansdorf, Germany

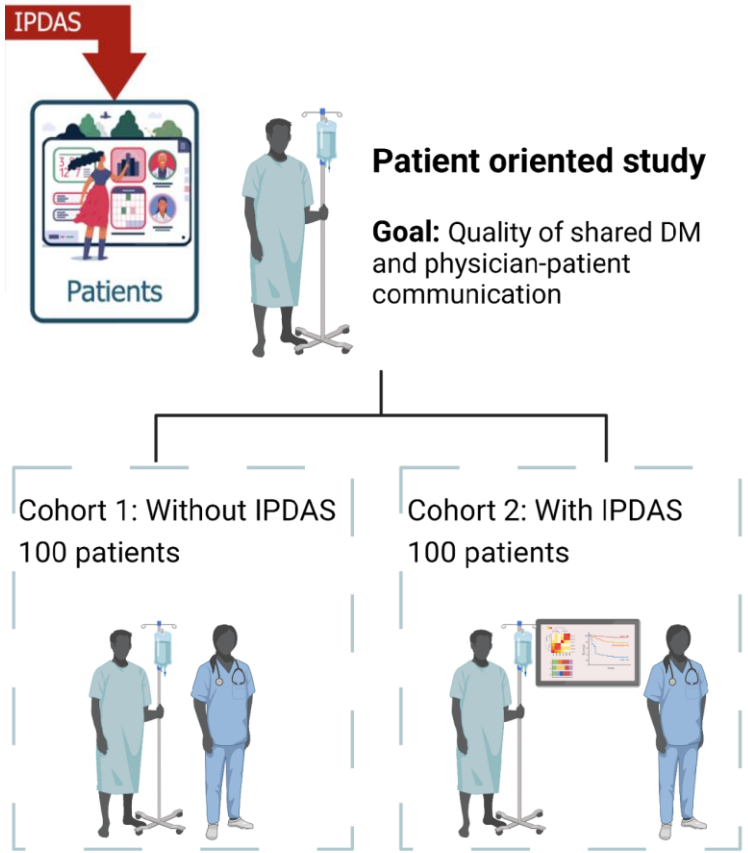
Total number of patients: 2843

Retrospective: 2425
Prospective: 419

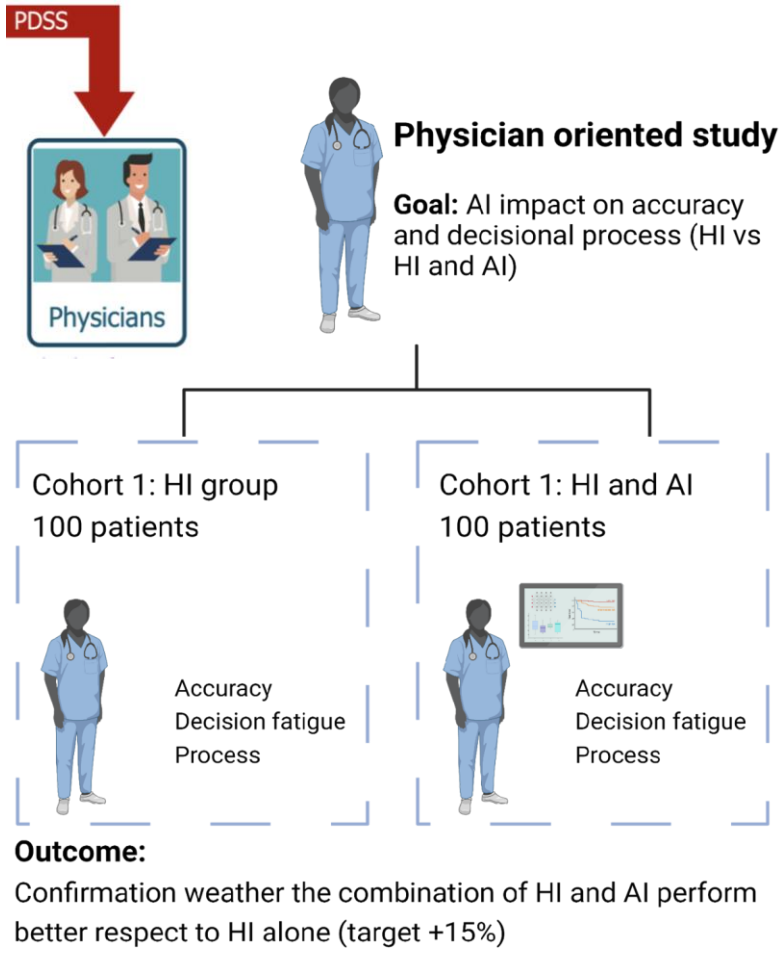


Updated to
April 2025

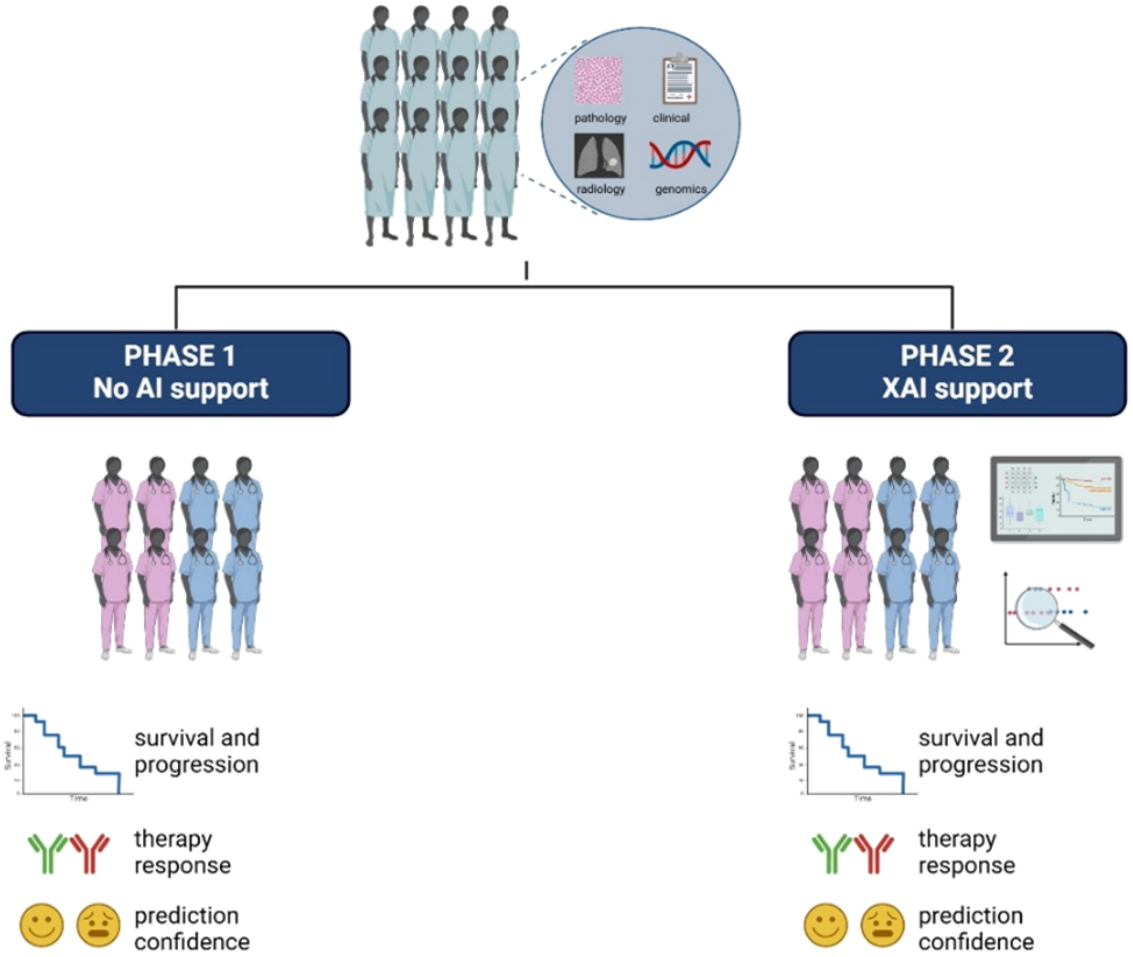
I3LUNG: tools, for PATIENTS AND DOCTORS



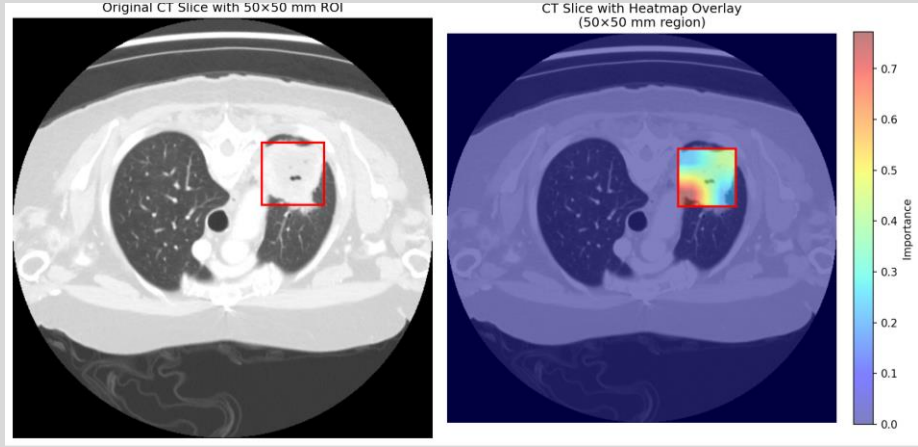
Papers Tools Under submission

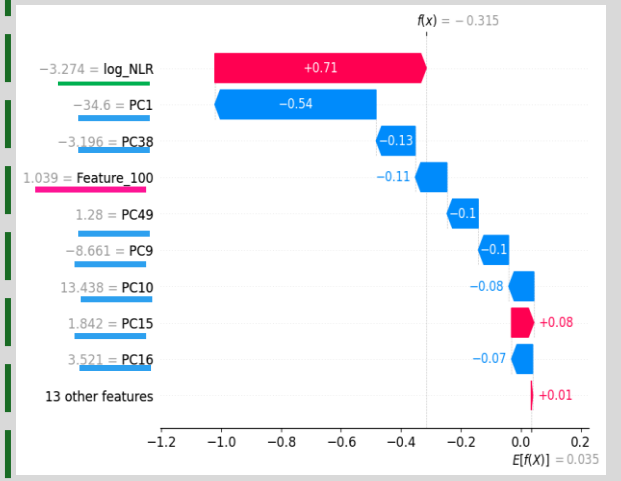


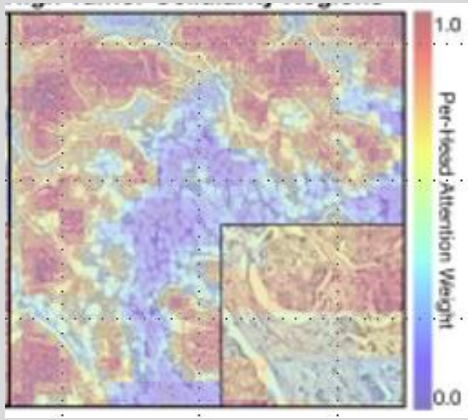
I3LUNG: Clinical Usability of the tool



Multimodal Model Explanation







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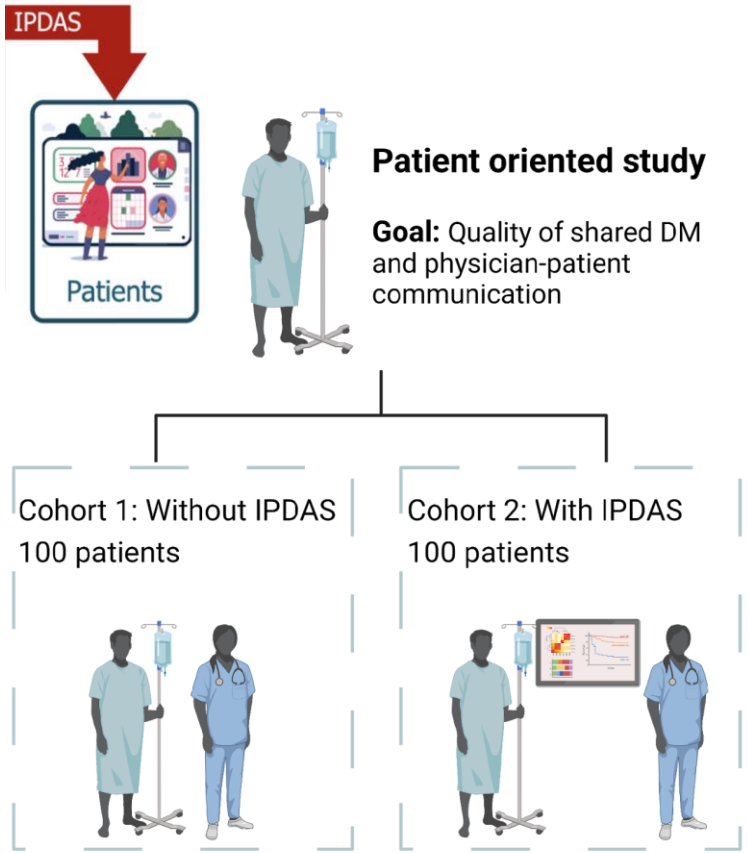

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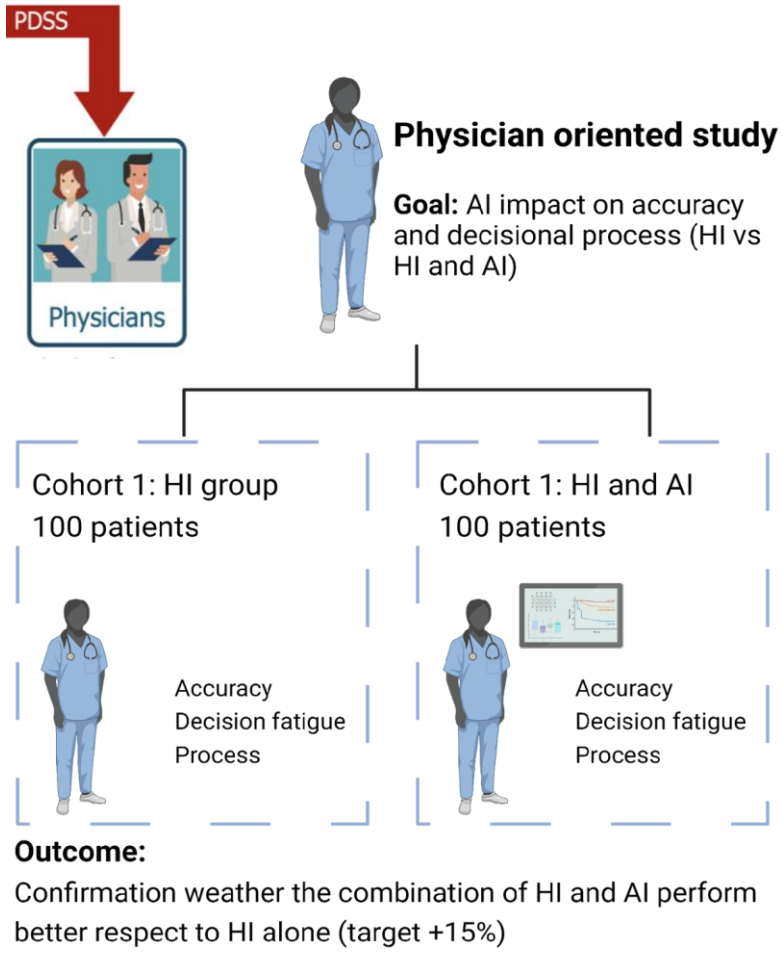
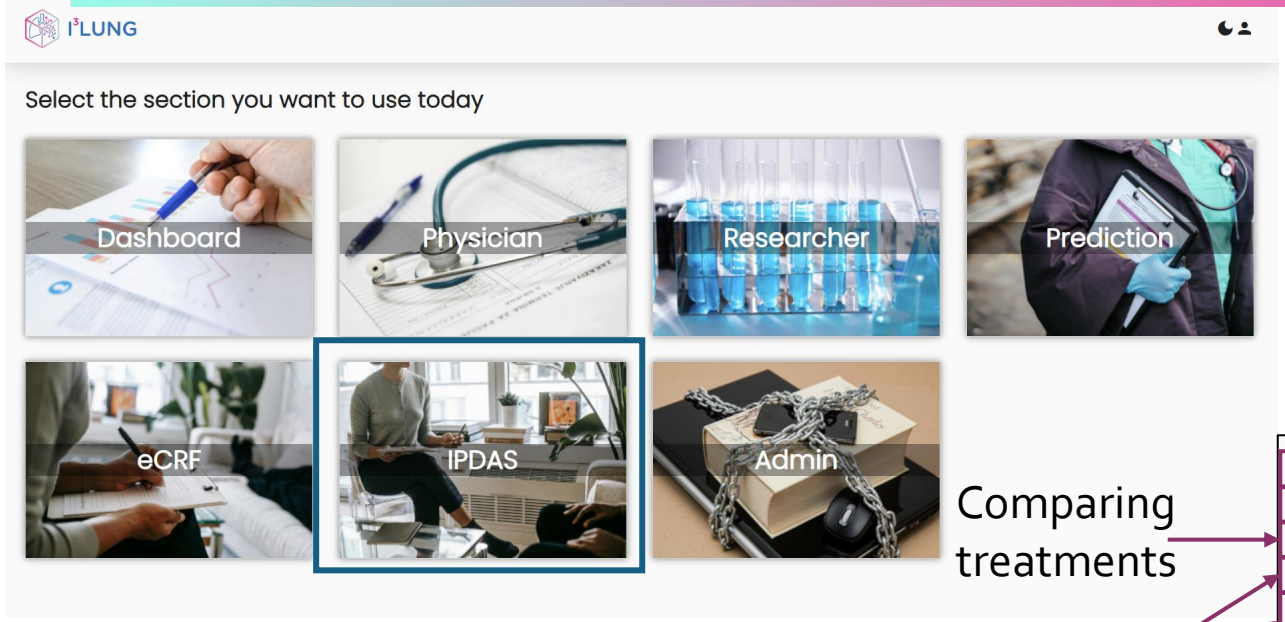


I3LUNG: Co-Decision Making tool for patient



Comparing treatments

Test your knowledge

Life impact aspects

Show all results

Medical terms

information about disease

Possible treatments

Mobile App for

- Detection of Toxicity
- Detection of progression
- Detection of Relapse

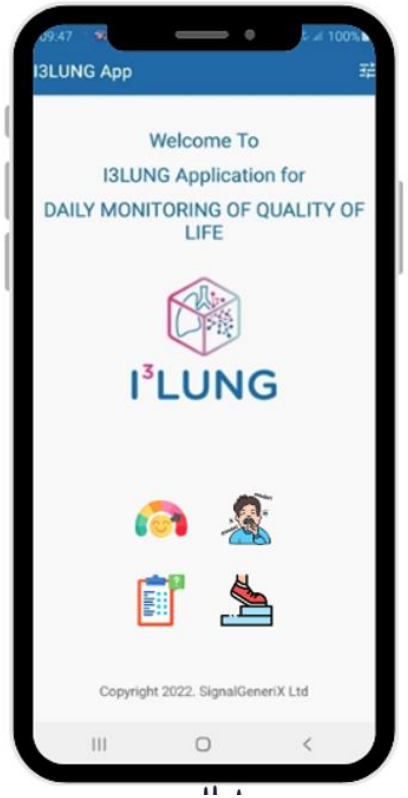
I3LUNG: mobile app – QoL monitoring

Voice for emotion monitoring

Computation of acoustic features for speech emotion recognition

QoL questionnaire

Users answer to digitalized version of the EQ-5D-5L



Cough analysis

Daily coughs are recorded and analyzed to relate them with trend of therapy

Physical activity

Transparent tracking of daily steps walked

App vs PREMs and PROMs

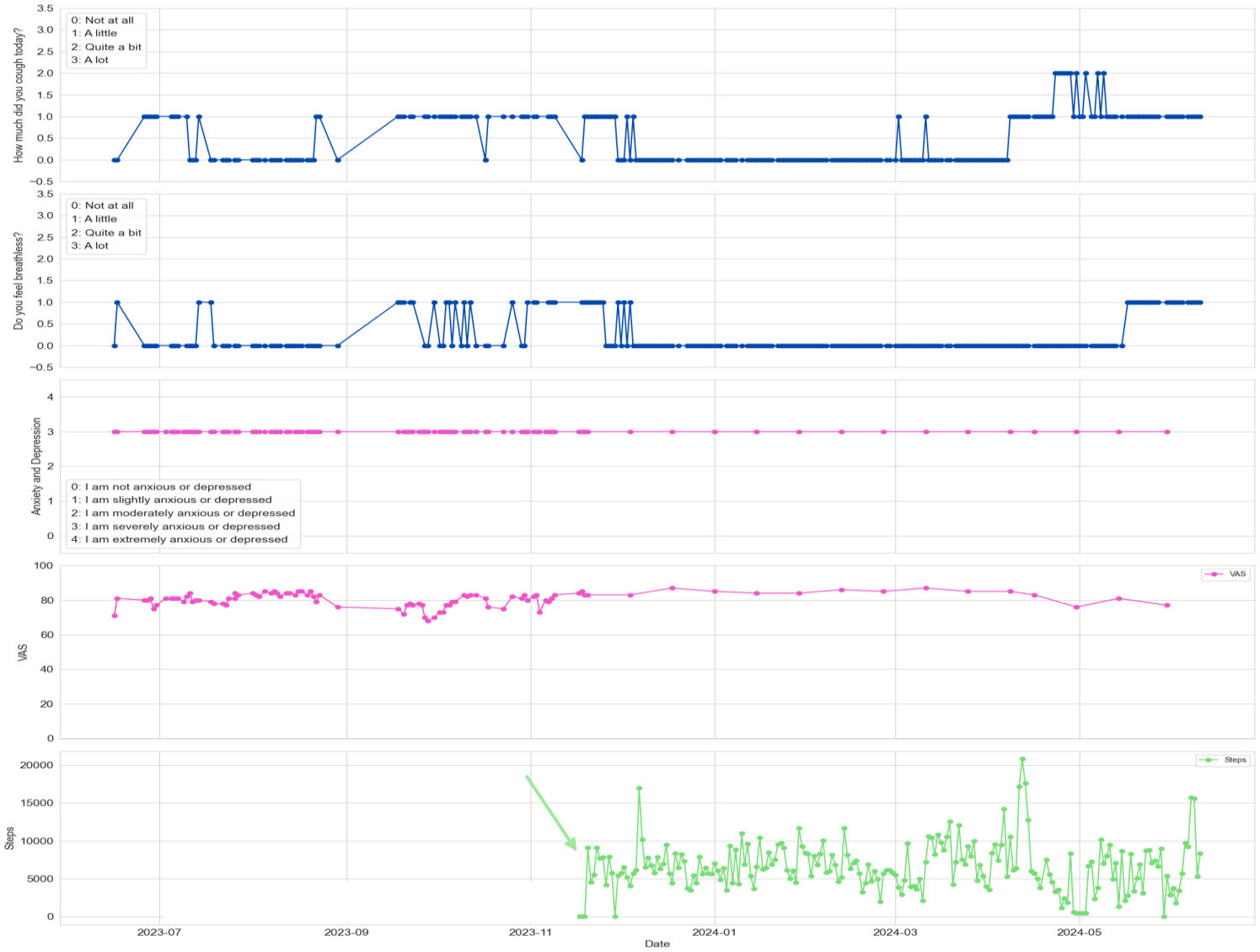
App allows to collect additional data outside of the fixed time points

Cognitive sensing

Integrated machine learning models for **automatic processing** of voice and **prediction** of quality of life

PATIENTS' STORIES THROUGH THE APP -

- How much cough
- Breathlessness
- EQ-5D-5L Feelings of depression and anxiety
- VAS: How the health is perceived
- Number of steps



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Diagnosis

PATIENTS' STORIES THROUGH THE APP -

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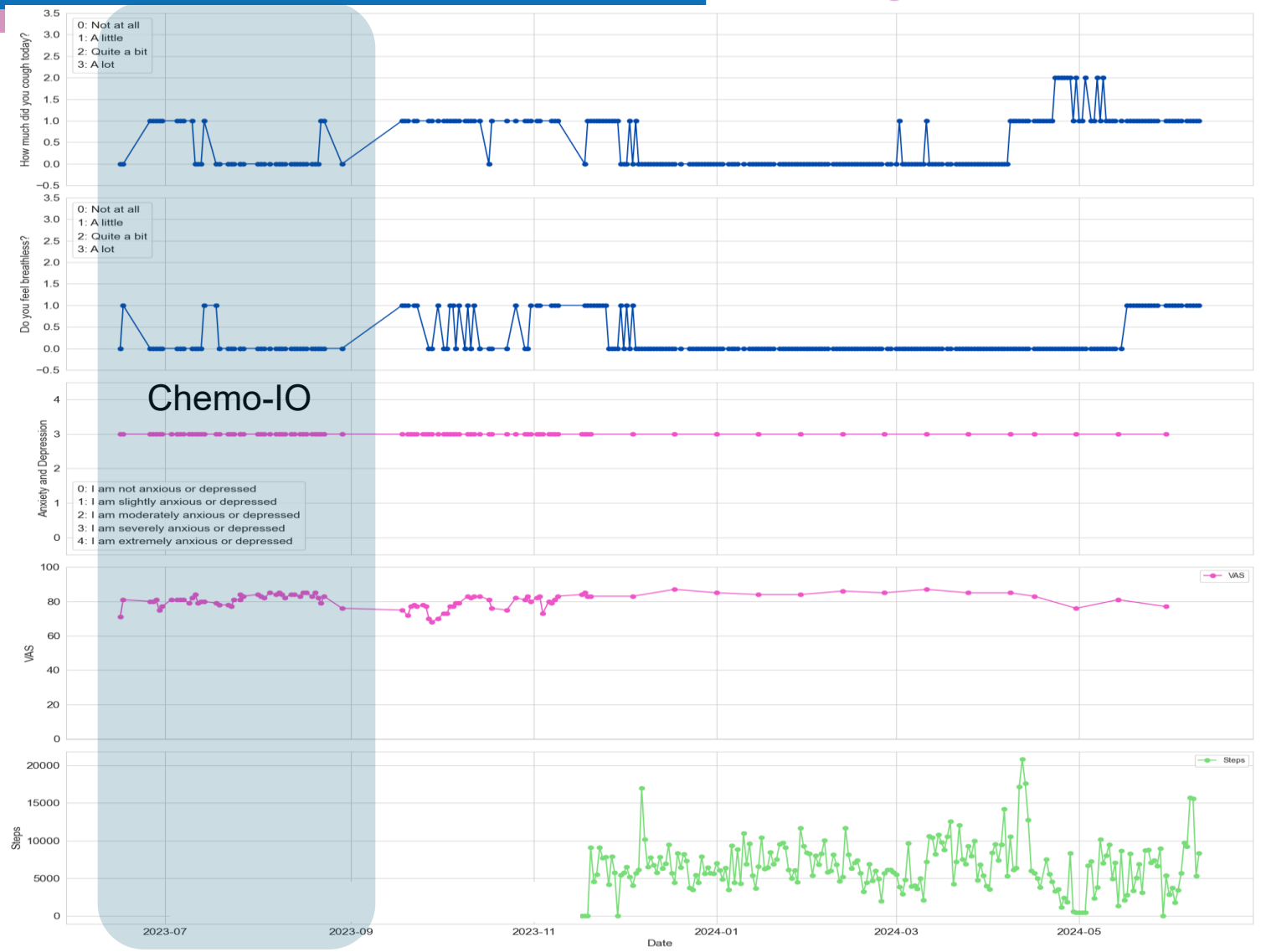

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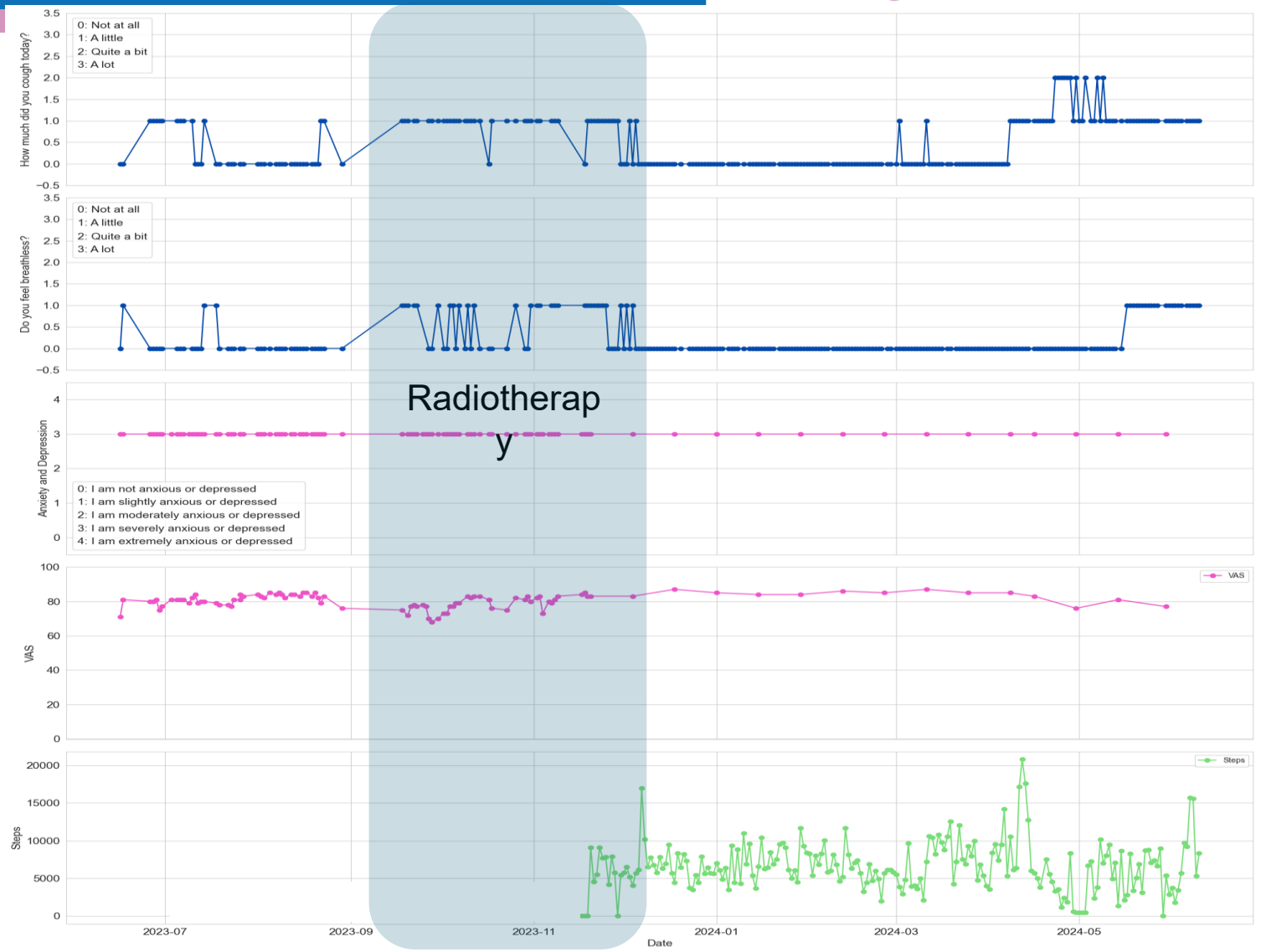

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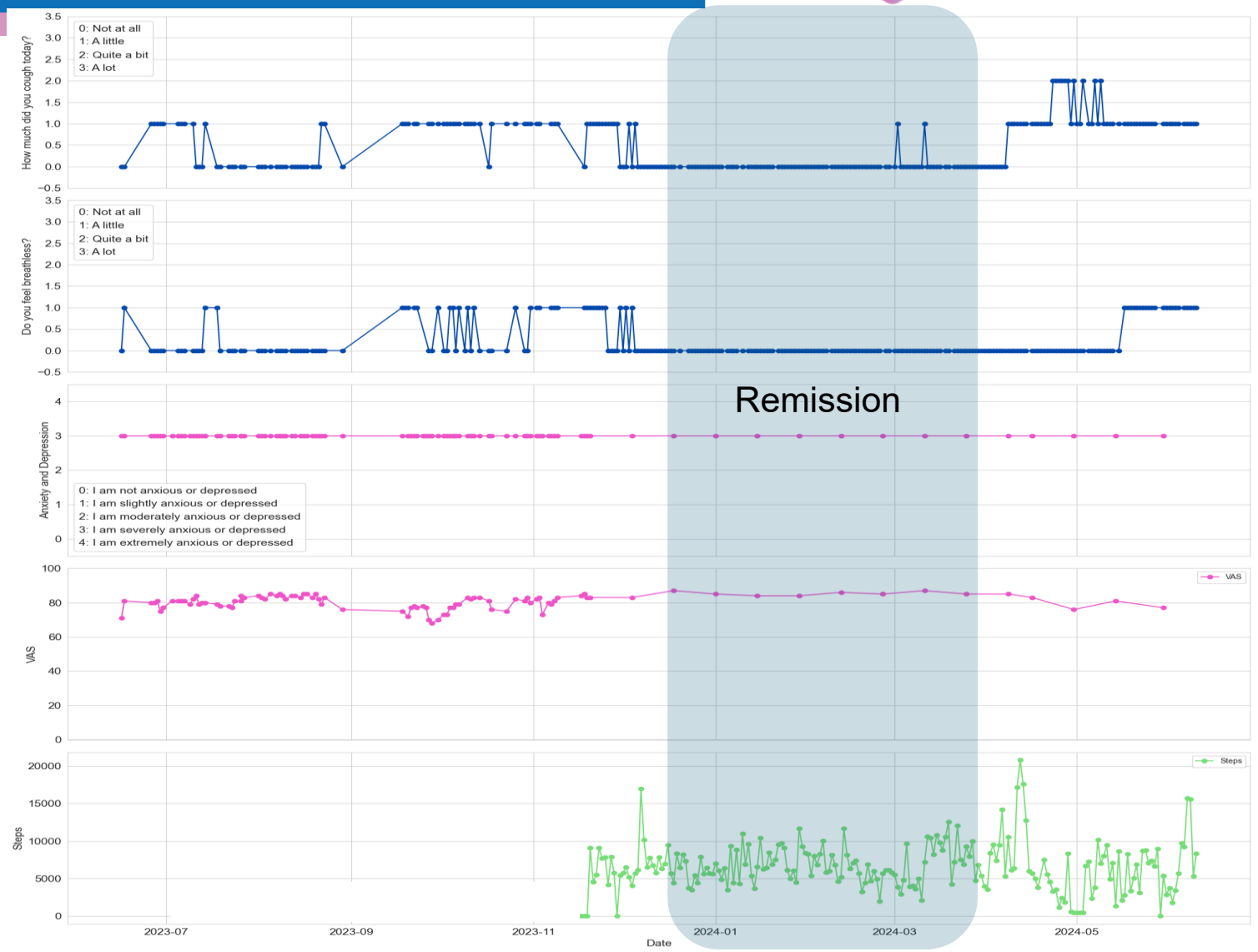


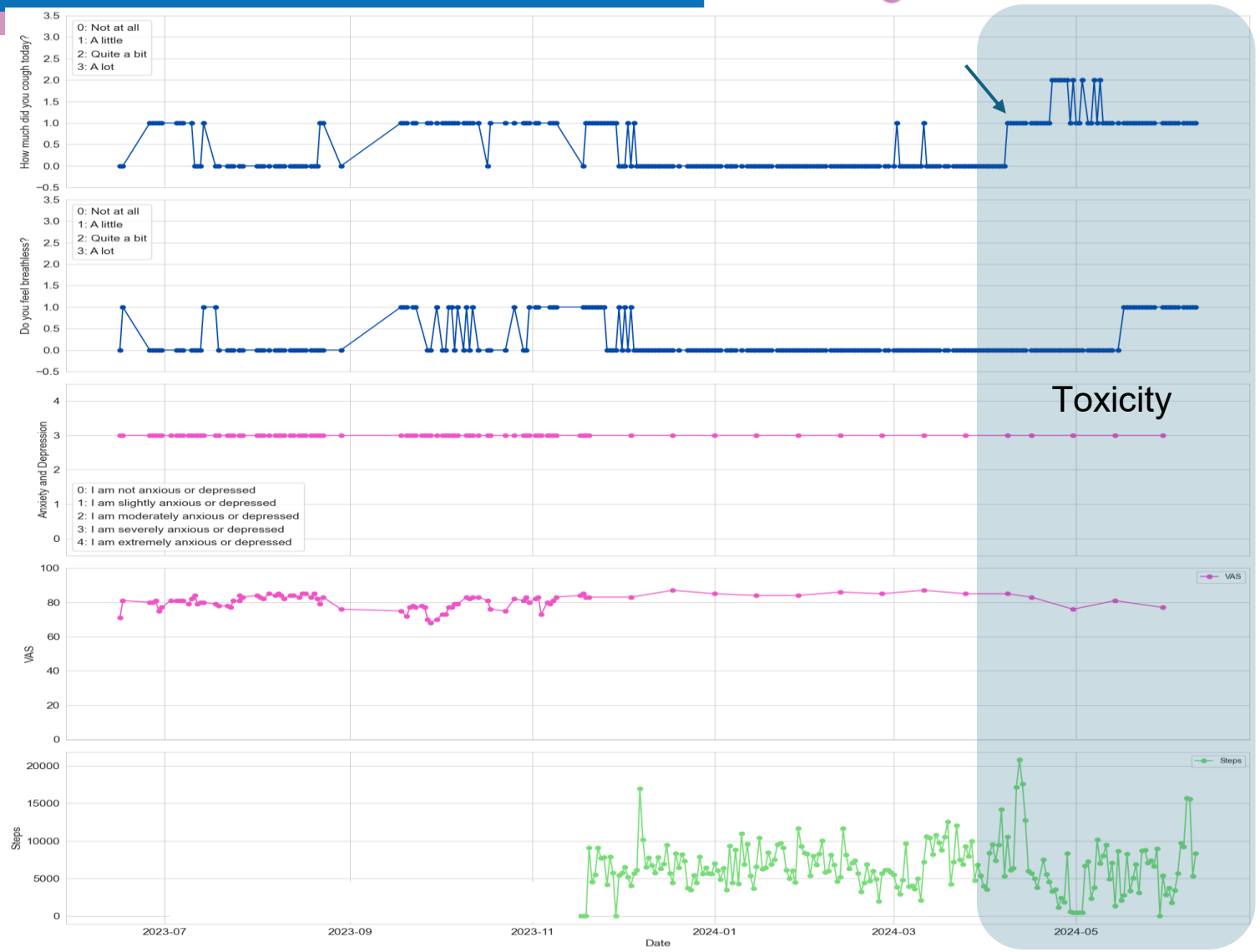
PATIENTS' STORIES THROUGH THE APP -

April 2024: onset of cough symptoms

Mid-May 2024: CT confirms treatment-related pneumonia

Fatal if not timely treated

Can we detect intrasubject variations in cough depending on the trend of treatment?



Mobile app as a digital biomarker

Idea and Goal

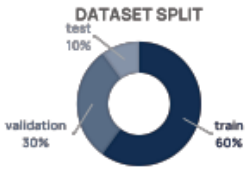
NSCLC Early Detection Gap: Screening mainly target smokers, leaving non-smokers undiagnosed.
Late Diagnosis Issue: Most cases are detected at advanced stages, limiting treatment options.

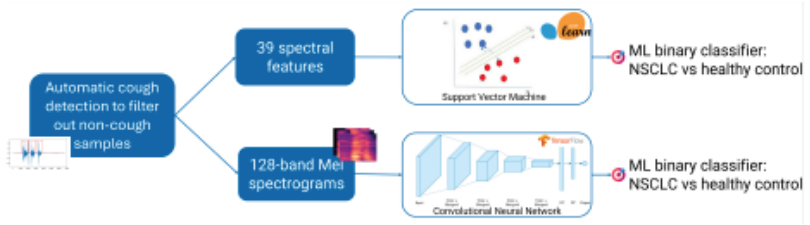
Cough as an Underutilized Biomarker Potential for NSCLC Detection: Currently unexplored, but promising for screening

Investigate AI-based cough analysis for distinguishing NSCLC patients on immunotherapy (IO) treatment from healthy individuals.

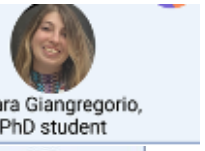
Cough samples collected through a mobile app

Workflow





Support vector Machine (SVM): Hyperparameter tuning on validation set
Convolutional Neural Network (CNN): Adam optimizer with binary cross entropy loss function + early stopping with 15-epoch patience



Chiara Giangregorio, PhD student

Cristina Licciardello, Research Fellow

Giangregorio, Licciardiello et al. ELCC 2025

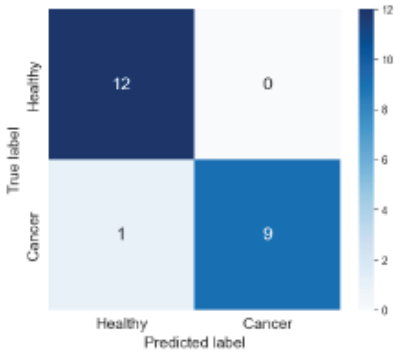
Results

Dataset:

- 91 patients with stage III-IVB NSCLC treated with IO
- 109 healthy controls

Model	Accuracy	Sensitivity	Specificity
SVM	82%	70%	92%
CNN	**95%**	**90%**	**100%**

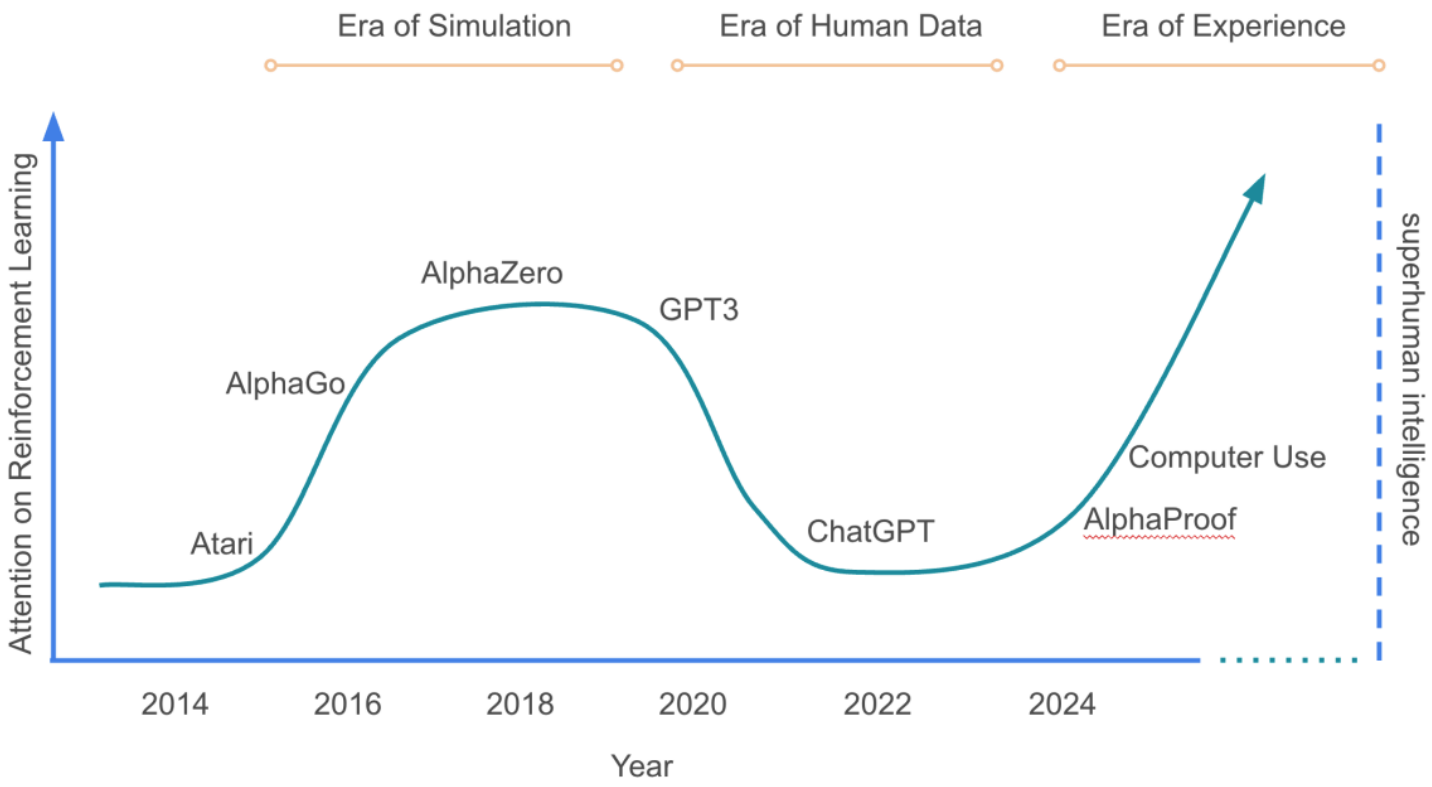
Model performances evaluated on test set for classical machine learning model SVM and CNN.



Confusion matrix on test set for CNN

Potential of using cough as a digital biomarker!

The Era of Experience

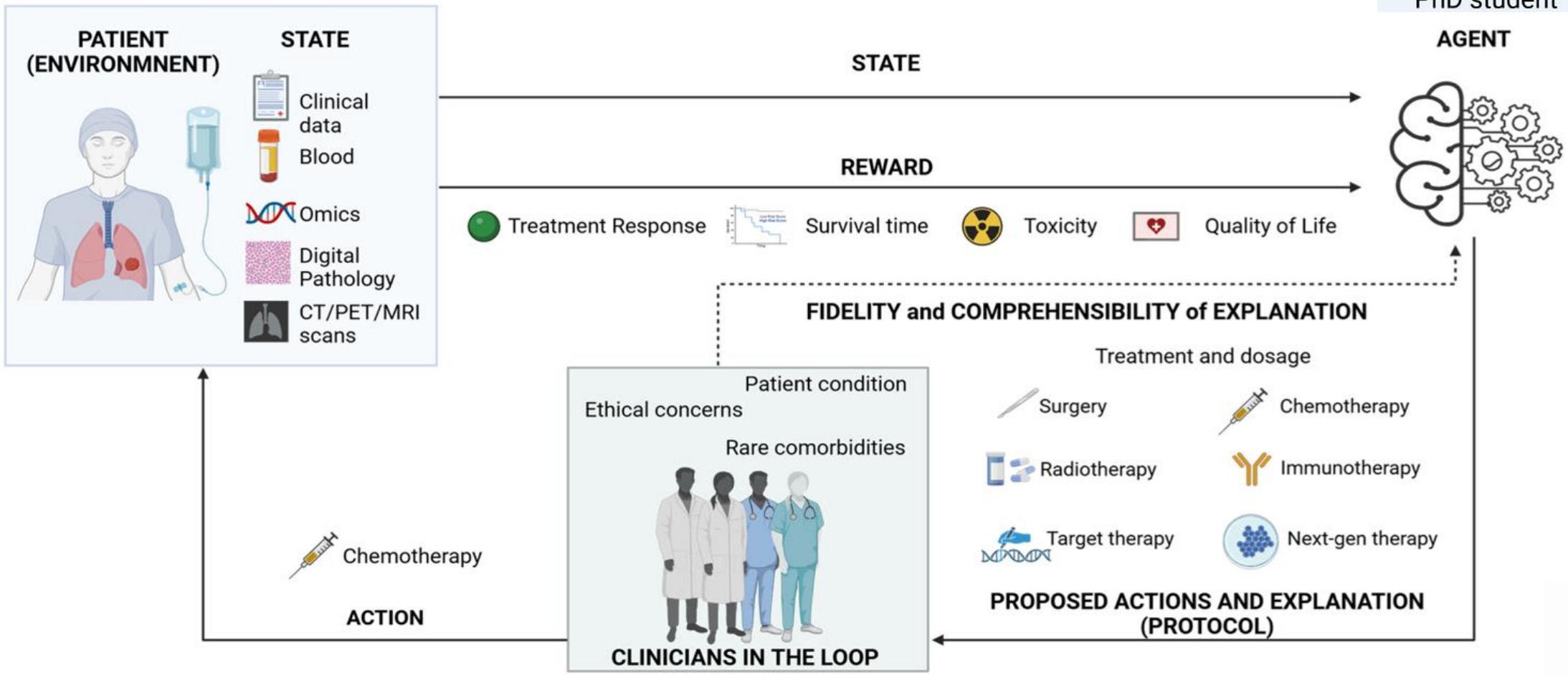


- AI must move beyond static human data.
- Continuous, real-world experience is key.
- Grounded rewards from the environment, not just human feedback.
- Autonomous agents adapt to the real world over time.
- Reinforcement learning drives superhuman capabilities.

David Silver, Richard S. Sutton* Deep Mind June 2025

Modeling The Patient Journey With RL

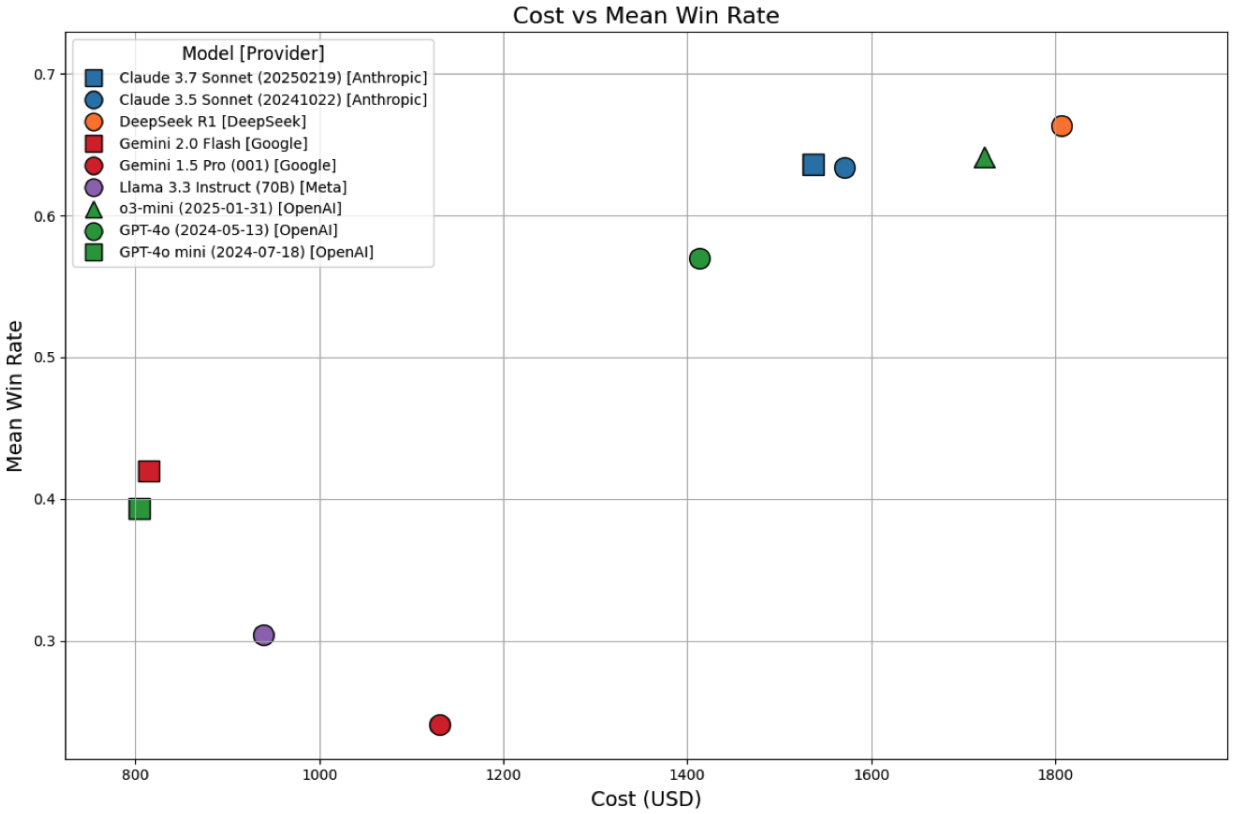
Aleksandra Zec,
PhD student



Zec, Aleksandra, et al. "Open Problem: Leveraging Reinforcement Learning to Enhance Decision-Making in Oncology Treatments.“, ARLET workshop @ICML 2024

AI-ON-Lab

Cost-analysis in the LLMs era: MedHELM

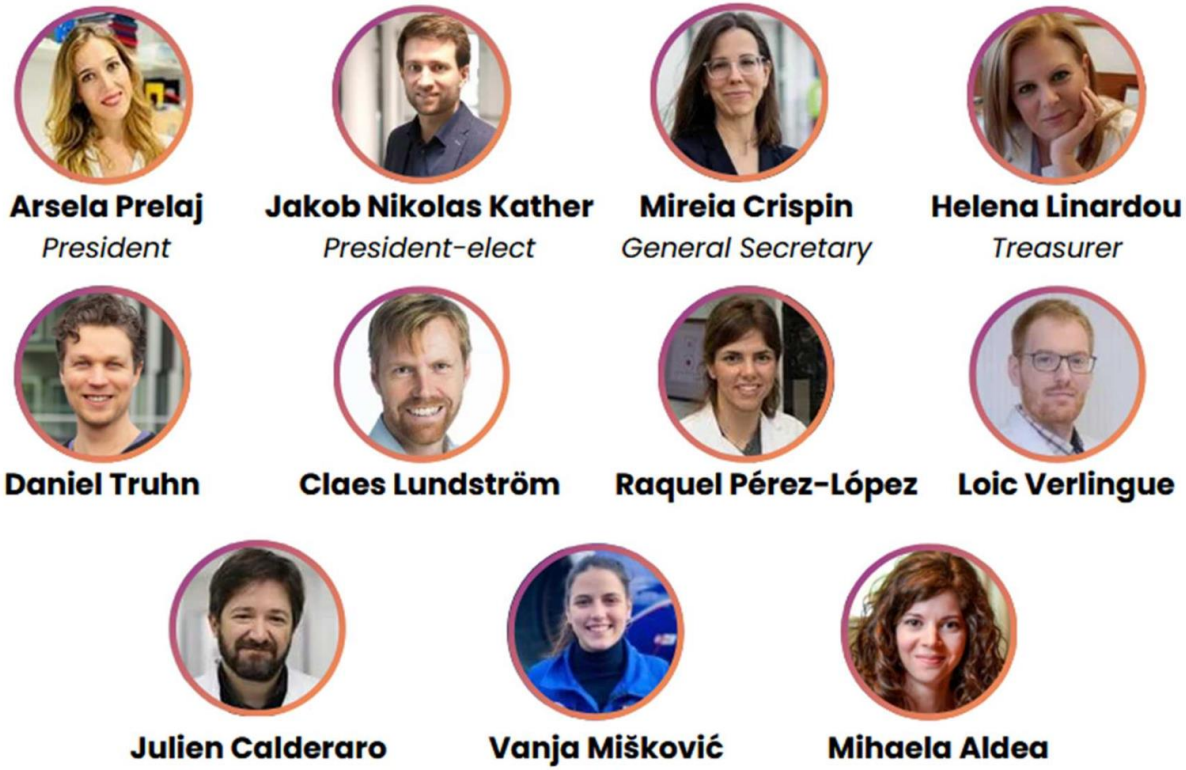


Overall, **non-reasoning models** (GPT-4o mini: $805, Gemini 2.0 Flash: $815) had the lowest costs and decent win-rates (0.39–0.42).
Llama 3.3 Instruct ($940) reached a 0.30 win-rate, while Gemini 1.5 Pro ($1,130) achieved 0.24.
In contrast, **reasoning models** cost more DeepSeek R1 ($1,806) and o3-mini ($1,722) but performed better (0.66 and 0.64).
Claude 3.5/3.7 Sonnet ($1,571/$1,537) offered a solid cost-performance balance (~0.63 win-rate).

Bedi S et al. MedHELM: Holistic Evaluation of Large Language Models for Medical Tasks. June 2025 arxiv

ESAC

European Interdisciplinary Society of Artificial Intelligence in Cancer research. Founded in 19th Dec 2024



Be a catalyst for collaboration

Truly effective AI integration hinges on the combined expertise of a variety of research figures: medical oncologists, imaging specialists (nuclear) radiologists, pathologists, physicists, bioinformaticians and AI engineers.
SPEAK THE SAME LANGUAGE

Build a multidisciplinary network

ESAC aims to bridge strategic alliances with key European initiatives and scientific organizations to amplify AI's impact in research, diagnostic and oncology.
DELIVER AI CARE across Cancer Societies

Comprehensive educational programs

Recognizing the need for specific expertise, ESAC provides training opportunities, from webinars and interdisciplinary conferences.
SUMMER SCHOOL IN CANCER RESEARCH
MASTER: AI IN CANCER RESEARCH

WEBSITE: https://esac-network.eu.
CONTACT US by e-mail: *contact@esac-network.eu*

CONNECT AI DIGITAL CAMPUS

JOIN TODAY !

EARLY BIRD REGISTRATION WITHIN AUGUST 2025

Why join?

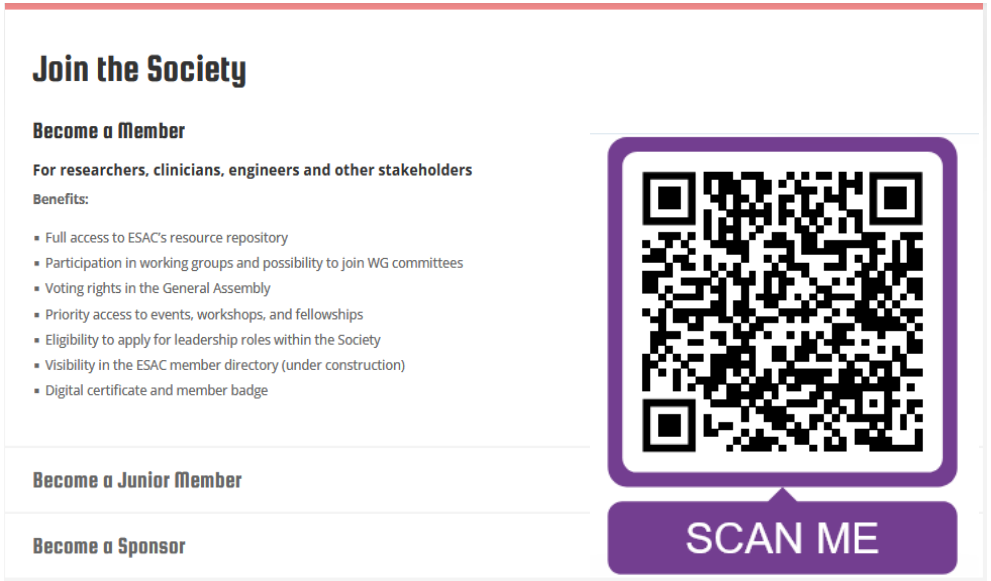
> We bring together EU opinion leaders in cancer AI, from multiple fields of expertise
> You gain access to cross-disciplinary expertise and collaborative opportunities
> You become part of a network with strong ties to all major international cancer care and research societies
> You can contribute to the ethical and impactful integration of AI into cancer research.

Concrete benefits

> Participation in working groups committees and projects
> Access to members directory and network (WIP)
> Voting rights in the General Assembly
> Priority access to events, workshops, and fellowships
> Access to members-only webinars and training courses
> Eligibility to apply for leadership roles in the WGs and Committees

Membership tiers

> 30€/year for ordinary membership (early bird fee), 2-years discount
> Preferential rates for students
* 10€ per year for undergrad/postgrad students
* 20€ per year for PhD students/medical residents



First ESMO AI Conference

ESMO > Meeting Calendar

ESMO AI & Digital Oncology Congress 2025

ESMO - European Society for Medical ...
94.157 follower
3 ore •

🤖 #ESMOAI25: Join us in building an AI-ready community, to make sure AI enhances-not replaces-oncology expertise. Submit your... altro

Mostra traduzione

: 15 : 59 : 44
Hours Minutes Seconds

Scientific Co-Chairs

- Mireia Crispin Ortuzar, Cambridge, UK
- Rudolf Fehrmann, Groningen, Netherlands
- Jakob Kather, Dresden, Germany

AI CONGRESS

Hibrid Event organized by:

ESAC

Co-Local Organizers

Fondazione IRCCS Istituto Nazionale dei Tumori

Sistema Socio Sanitario
Regione Lombardia

POLITECNICO MILANO 1863

Invited speakers from:

THE UNIVERSITY OF CHICAGO

Memorial Sloan Kettering Cancer Center

TECHNISCHE UNIVERSITÄT DRESDEN

VHIO VALL D'HEBRON Institute of Oncology

GUSTAVE ROUSSY CANCER CAMPUS GRAND PARIS

AALBORG UNIVERSITY

UNIVERSITY OF CAMBRIDGE

UCI School of Medicine

HARVARD UNIVERSITY

Endorsed by:

IASLC

ASCO American Society of Clinical Oncology
Making a world of difference in cancer care

Acknowledge

Fondazione IRCCS Istituto Nazionale dei Tumori
Sistema Socio Sanitario Regione Lombardia
POLITECNICO MILANO 1863

AI-ON-Lab

The Thoracic Oncology Team

http//:Ai-onlab.com

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AI DEPLOYMENT

1. **High-Level Prediction Capabilities:** AI now delivers accurate predictions at baseline across screening, diagnosis, prognosis and prediction tasks.

2. **Advanced RWD, Imaging & Genomics Analysis:** AI enhances real-world data (RWD), image and genomics integration improving biological insights (e.g.: from digital pathology to gene).

3. **Automatic Data Extraction:** Significant improvements in automated and structured data retrieval streamline workflows by using NLP and LLMs.

4. **Federated & Swarm Learning Techniques:** Decentralized AI models ensure secure, privacy-preserving multi-institutional collaborations.

5. **New Quality of Life Monitoring through Cognitive Sensing:** AI-driven mobile and wearable technologies provide real-time, adaptive health monitoring, perform much better compared to PROMs and PREMs.

6. **Foundation Models & Generative AI:** Cutting-edge advancements in LLMs and foundation models enable high-quality analysis of complex, high-dimensional data.

7. **AI-Powered Clinical Trial Optimization:** Predictive analytics improve patient recruitment, endpoint selection, and adaptive trial designs CLINICAL TRIAL MATCHING

8. **In-Silico Drug Screening & Molecular Docking and Drug discovery:** AI-powered simulations predict drug-target interactions, reducing experimental costs and time.

AI more DELAY THAN DREAM

1. **Privacy, Data Governance & Democracy:** Ensuring compliance with data protection regulations while enabling secure data sharing.
2. **Trustworthiness, Fairness & Diversity:** Addressing bias, transparency, and ethical considerations in AI models
3. **Advancing Treatment Selection Tools:** Improving AI-driven decision support systems for personalized medicine.
4. **Model Explainability in the Era of Generative AI:** Enhancing interpretability of complex AI-driven decisions.
5. **Scalability of Multiomics Data Integration:** Overcoming small dataset limitations for robust multi-omics (Dream?)
6. **Longitudinal AI & Reinforcement Learning:** Developing scalable models for sequencing prediction and continuous learning (Dream?).
7. **Synthetic Data for Genomics & Imaging:** Validating the use of synthetic data in clinical trial design and drug discovery.
8. **AI Agents & Workflow Integration:** Optimizing the role of AI-powered autonomous systems in clinical care applications.
9. **Computational Power & Cloud Resources**: Addressing GPU limitations and cloud infrastructure challenges and the investments that labs/institutions need to do (Dream?).
10. **Clear educational path:** we need to build next generation scientist, hybrid, brining together the TECNO and HUMANITY