Developing a Multidisciplinary Workforce Skilled in Collaborative AI

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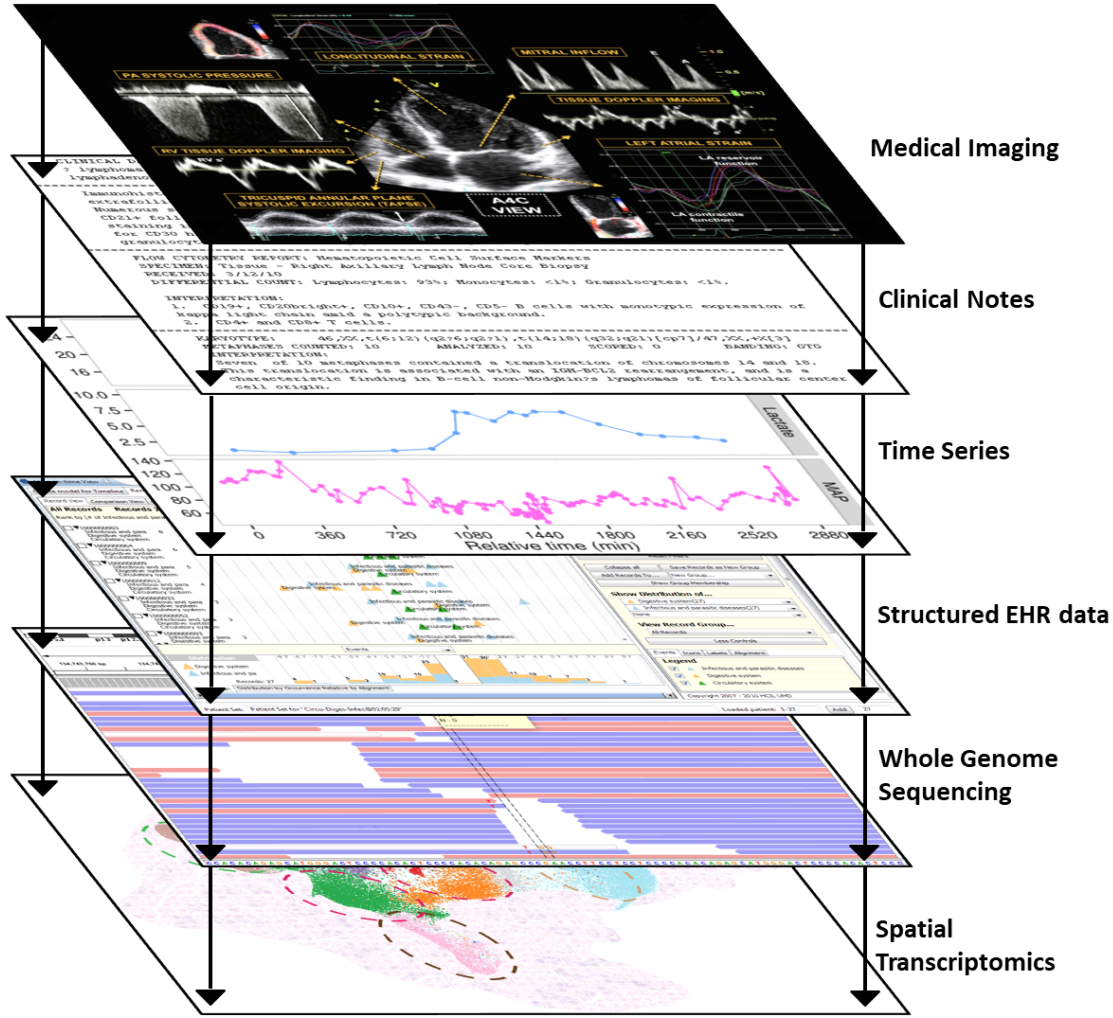
7/31/2024

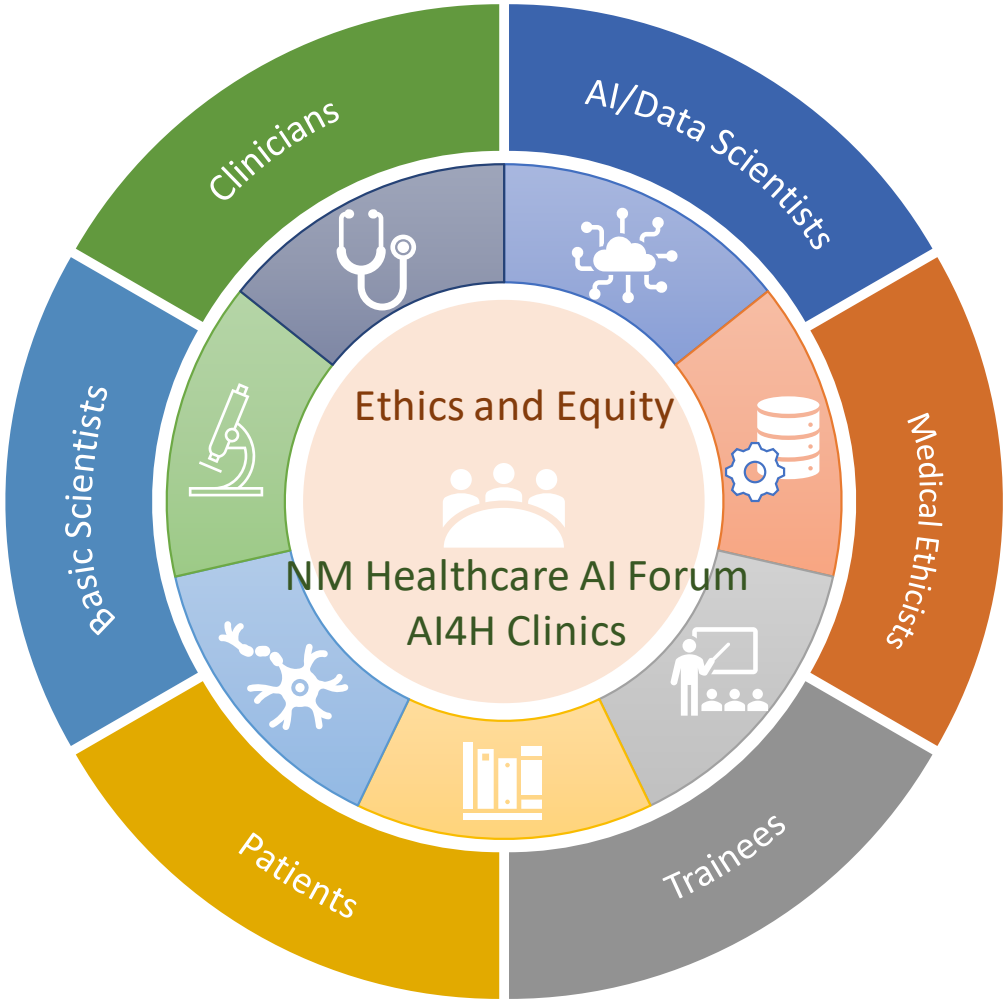
Northwestern University

AI/ML to integrate multi-modal health data with collaborative partnership

Multi-modal health data infrastructure

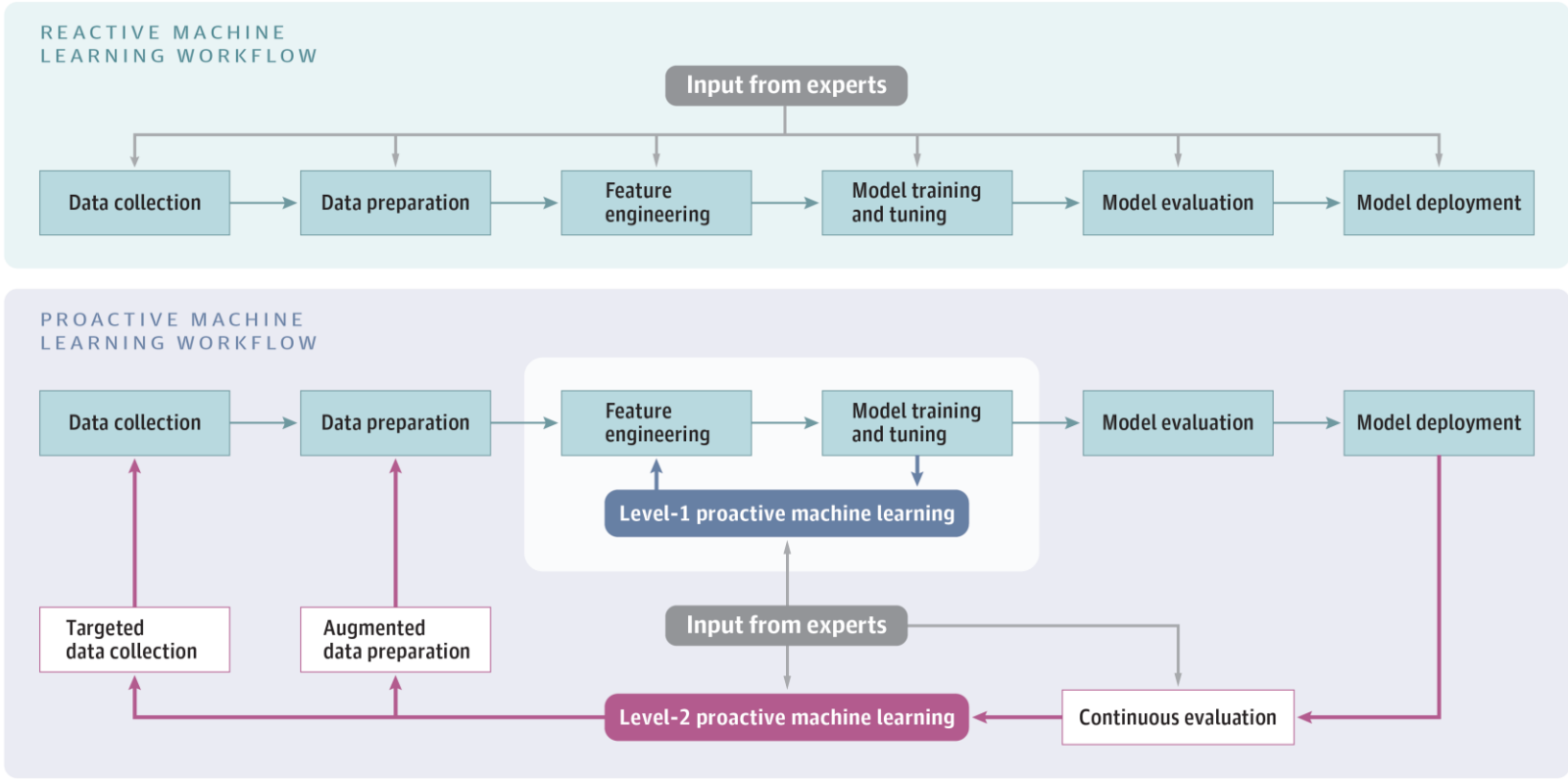


Collaborative partnership



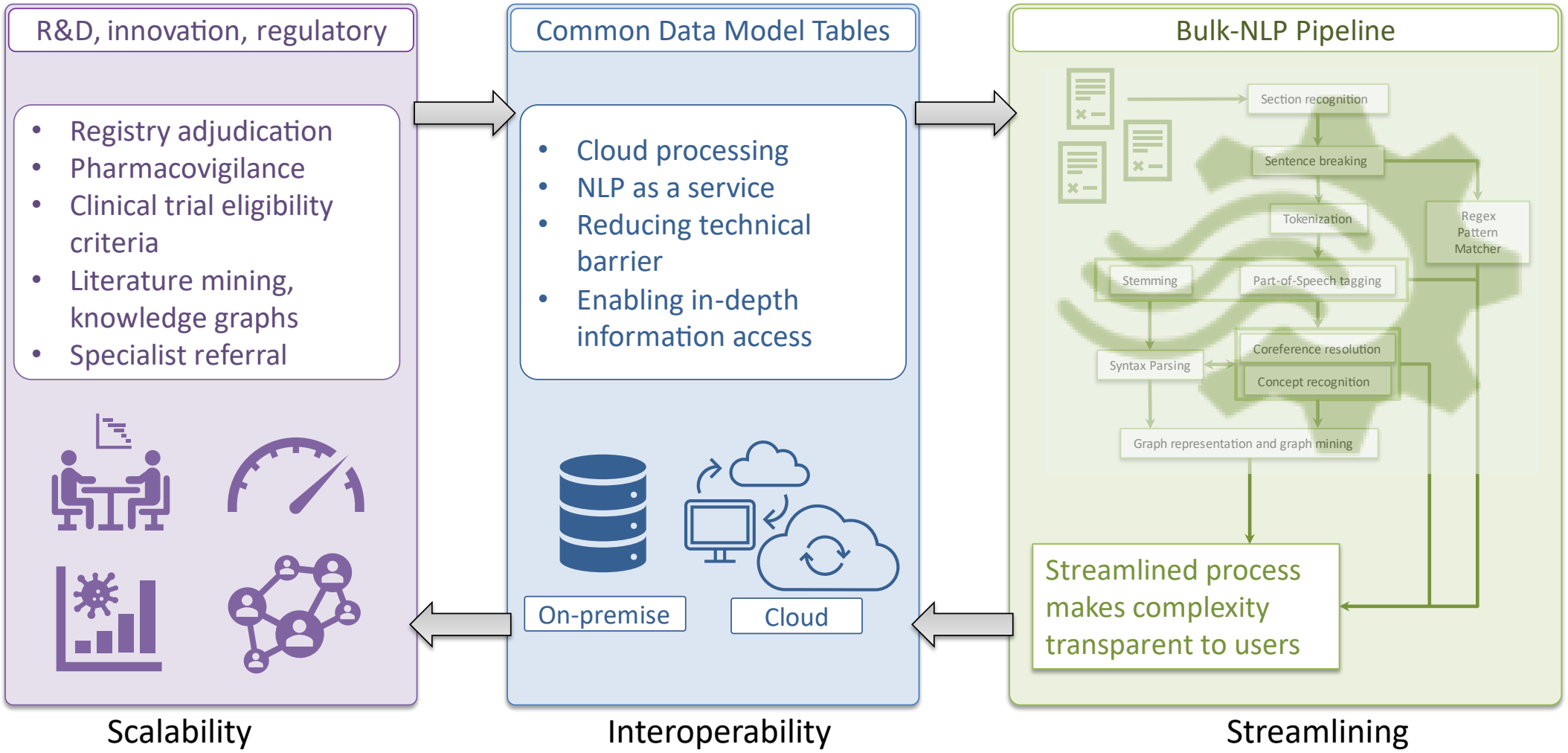
Data science and AI in health care as an iterative sequence optimization

Moving from reactive to proactive machine learning



Luo Y, Wunderink RG, Lloyd-Jones D. Proactive vs Reactive Machine Learning in Health Care: Lessons From the COVID-19 Pandemic. *JAMA. 2022.*

Streamlined, interoperable and scalable NLP to democratize resource and tooling



Democratize AI/ML resource and tooling to lower access barriers for stakeholders

Interoperability and CDM enable building flagship datasets to unlock health data value and transform care of the sickest patients

Collaborative **R**esource for **I**ntensive care **T**ranslational science, **I**nformatics, **C**omprehensive **A**nalytics, and **L**earning, 4 year, $5M total support

NIH National Center for Advancing Translational Sciences

Credentialed access | Federated access

	SBP	DBP	Na	K	Cl	Glucose	Ca	…	Pathology Reports	Discharge Summaries	…
John	78	49	143	4	111	162	5.8	…			…
Lucy	123	68	NA	3	108	119	9.1	…			…
Jane	127	66	140	4.3	109	NA	8.9	…			…
…	…	…	…	…	…	…	…	…			…

Northwestern

	SBP	DBP	Na	K	Cl	Glucose	Ca	…	Pathology Reports	Discharge Summaries	…
Mike	81	56	132	NA	115	171	6.8	…			…
Yang	115	NA	145	3.9	110	NA	8.1	…			…
…	…	…	…	…	…	…	…	…			…

WUSTL

	SBP	DBP	Na	K	Cl	Glucose	Ca	…	Pathology Reports	Discharge Summaries	…
David	91	53	151	5	NA	184	4.7	…			…
Mary	NA	71	135	3	99	125	6.5	…			…
Robert	143	72	156	NA	102	160	8.6	…			…
Andrea	136	NA	138	4.7	120	115	NA	…			…
…	…	…	…	…	…	…	…	…			…

Tufts

UAB

MIT
Technology Advisory from the MIMIC Team

CRITICAL

Discover and design AI/ML algorithms

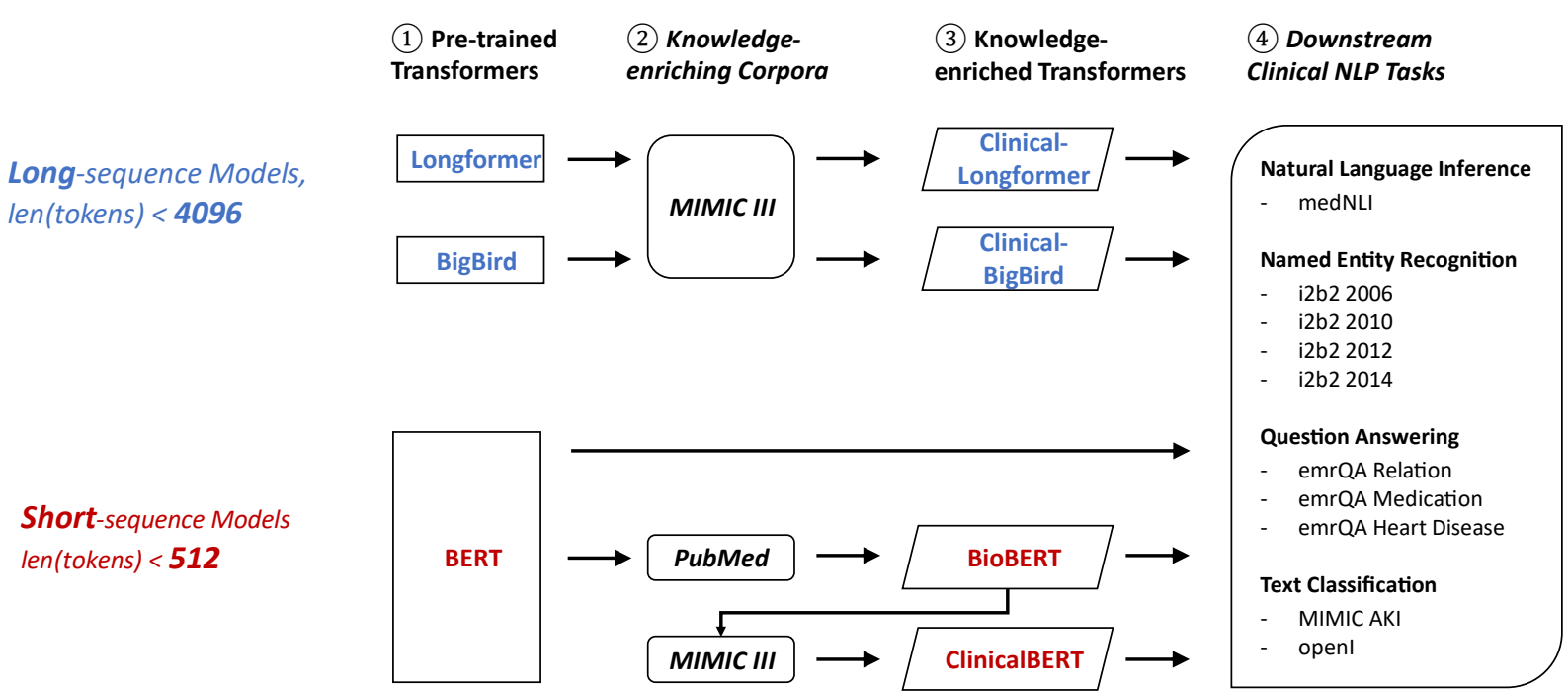
- Early prediction of impending sepsis, cardiogenic shock, hematoma expansion etc.
- Allow earlier intervention and reduction of complications and hospital stay duration
- Emulated clinical trials
- Drug repurposing
- Precision treatment

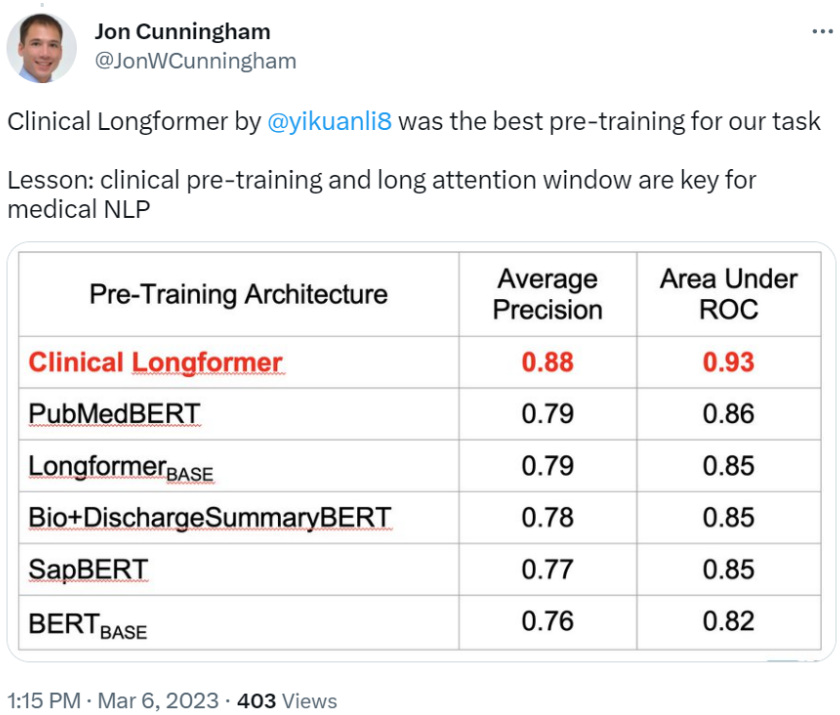
eMERGE Network electronic medical records & genomics

HEARTSHARE

SCRIPT Successful Clinical Response In Pneumonia Treatment

Large Language Models (LLMs) to democratize resource and tooling

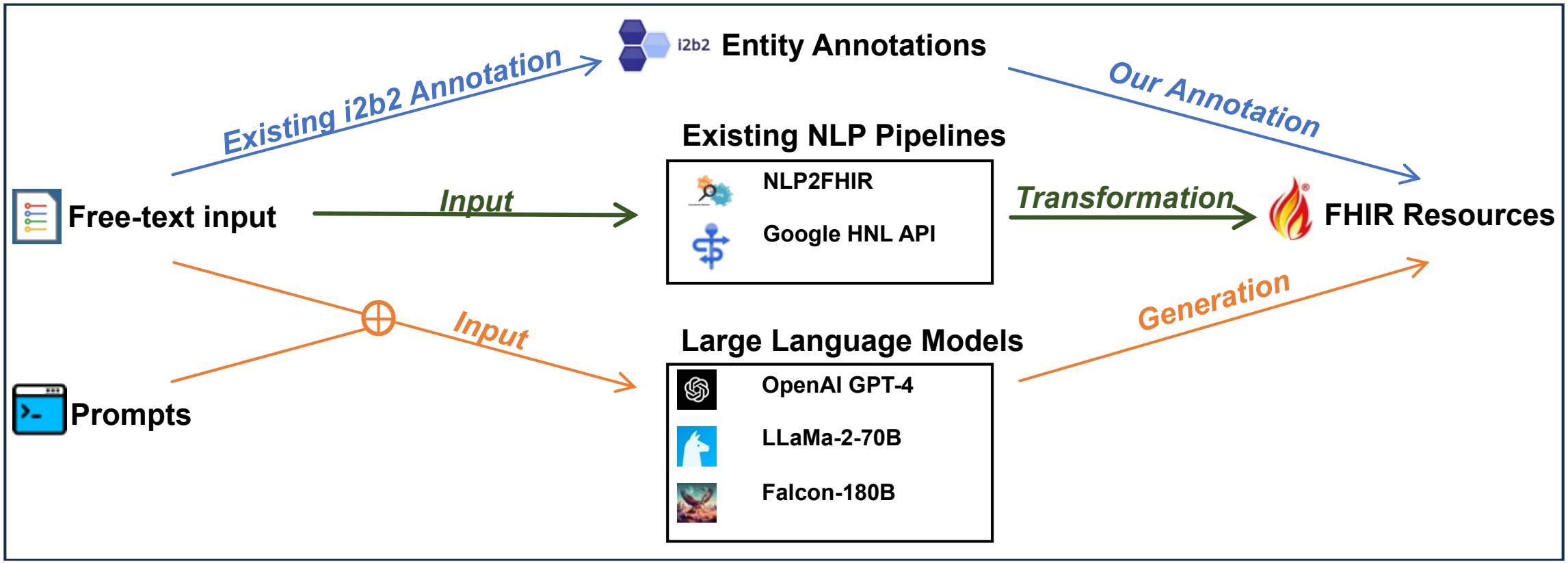




Pre-Training Architecture	Average Precision	Area Under ROC
Clinical Longformer	0.88	0.93
PubMedBERT	0.79	0.86
$Longformer_{BASE}$	0.79	0.85
Bio+DischargeSummaryBERT	0.78	0.85
SapBERT	0.77	0.85
$BERT_{BASE}$	0.76	0.82

Y Li, R Wehbe, F Ahmad, H Wang, Y Luo*. A Comparative Study of Pretrained Language Models for Long Clinical Text. *JAMIA 2023 30(2):340-7.*

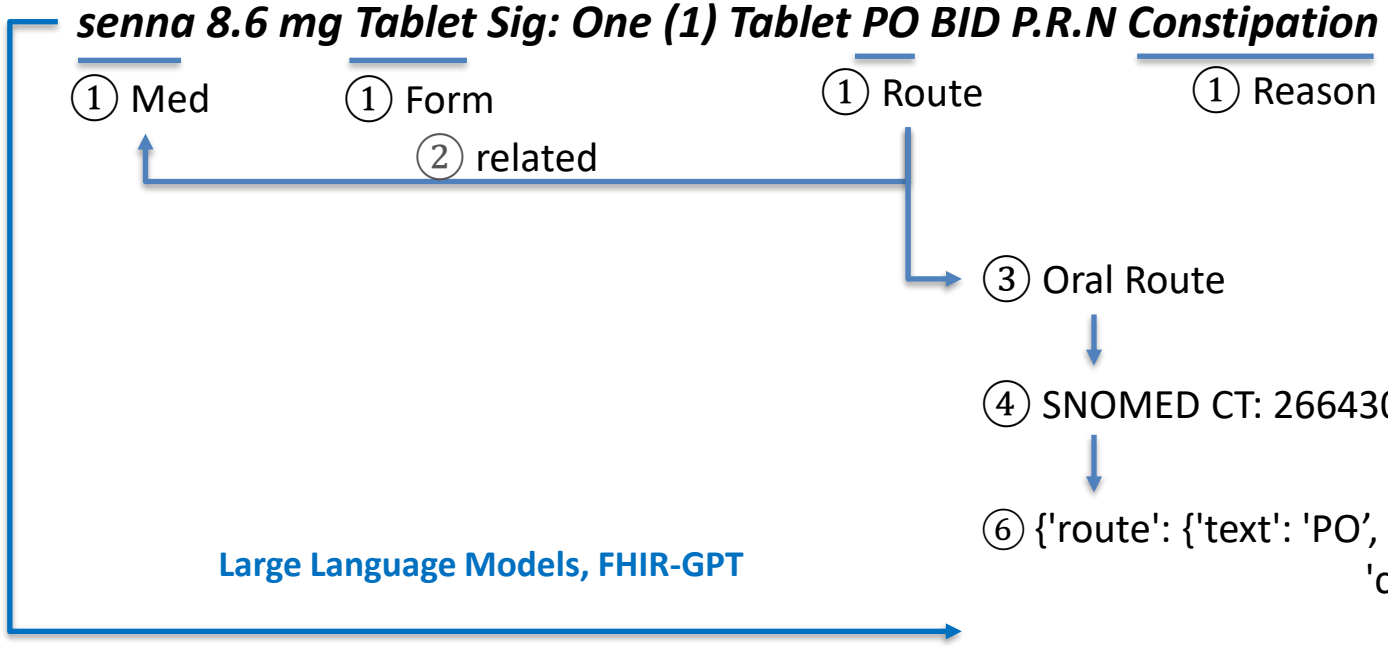
LLMs for converting clinical notes to FHIR resources to enhance interoperability



Li Y, Wang H, Yerebakan HZ, Shinagawa Y, Luo Y. FHIR-GPT Enhances Health Interoperability with Large Language Models. *New England Journal of Medicine AI 2024 accepted.*

From multi-step NLP to end-to-end LLMs

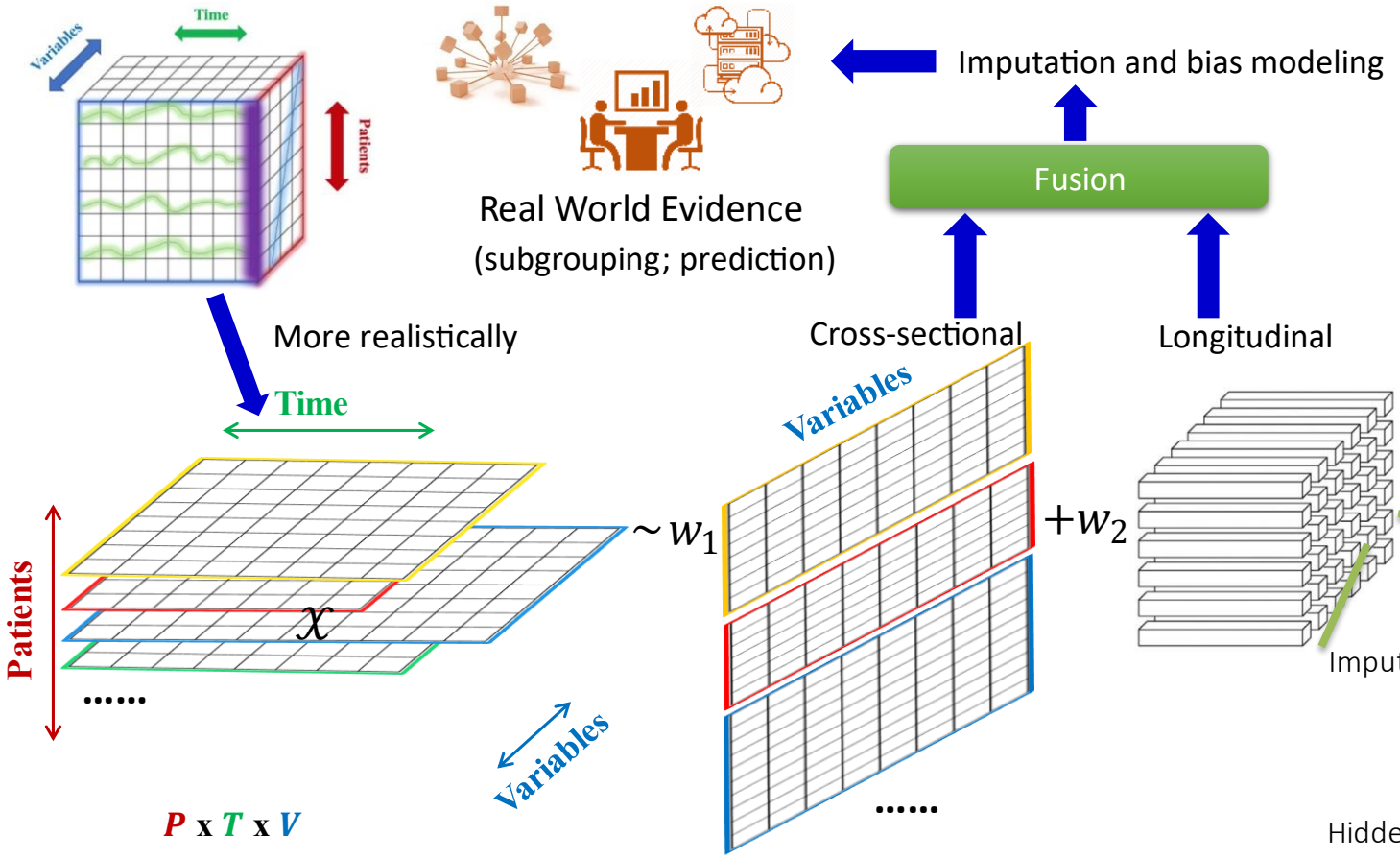
- **Enhance health data interoperability by standardizing contextual health data to their associated FHIR resources using large language models (LLMs)**



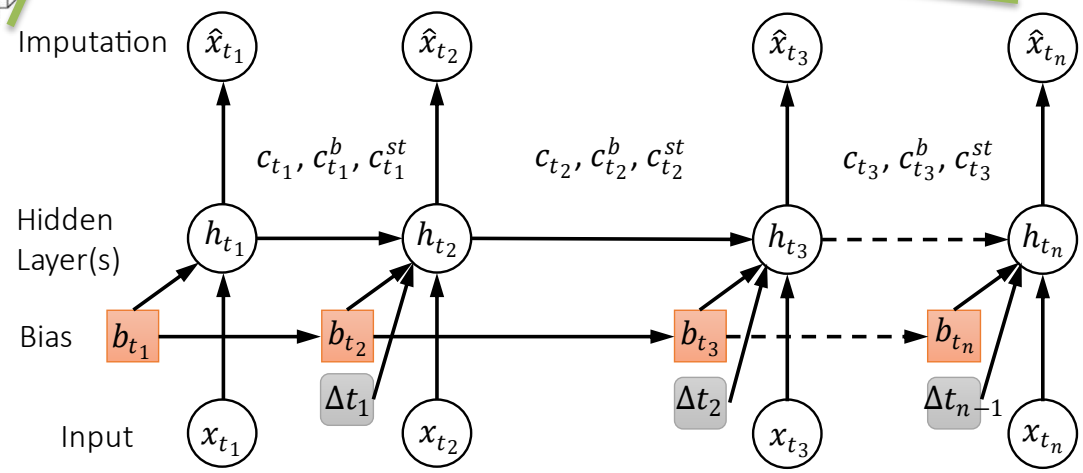
Human Annotation / Existing NLP Approaches

- ① Named Entity Recogntion
- ② Relation Extraction
- ③ Standardization
- ④ Concept Lookup
- ⑤ Calculation
- ⑥ Formatting

Enhance data quality and RWE to inform point-of-care recommendations



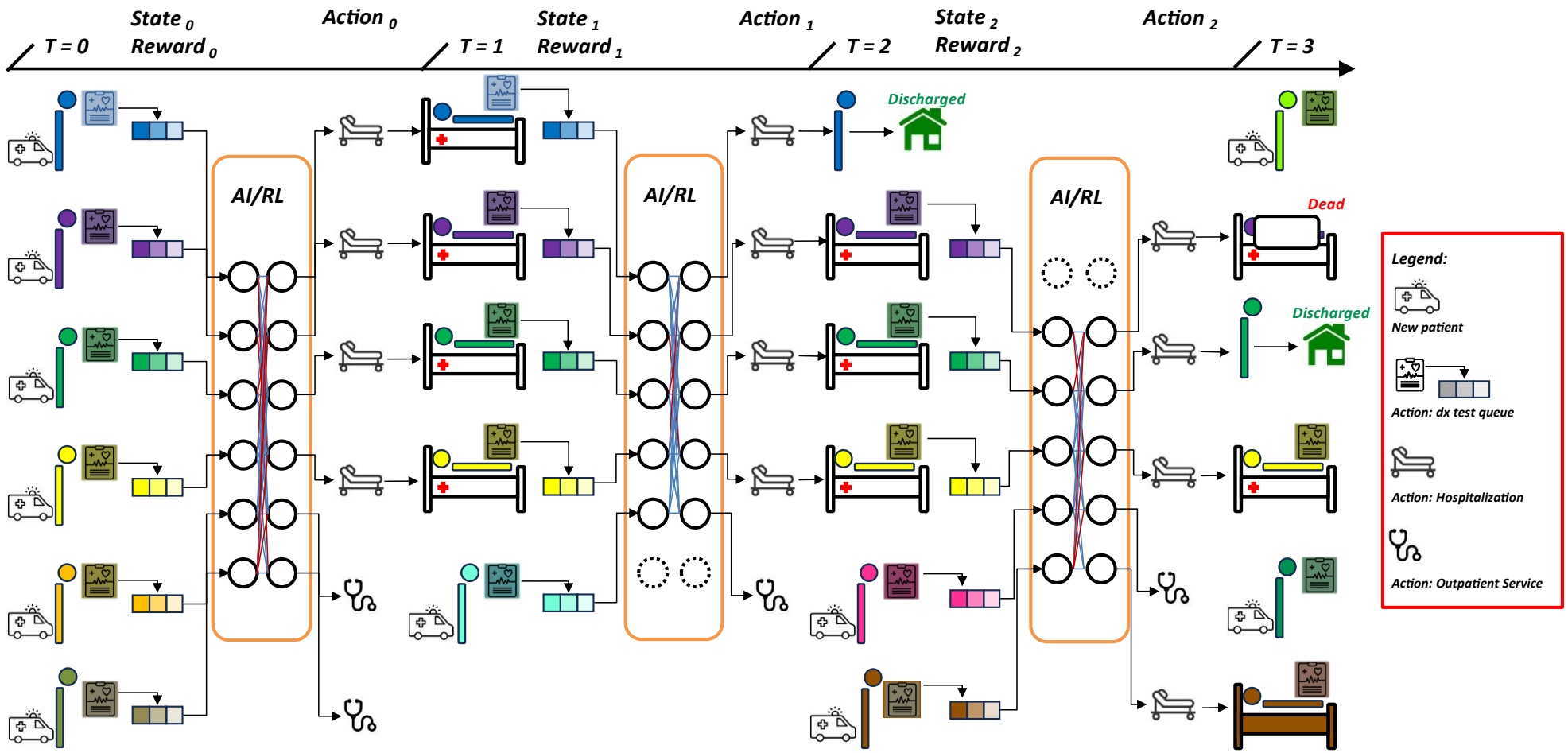
- Strengthen RWE by exposing and correcting biases or compensating for missing data
- Combine trial data and RWE to demonstrate value to payer
- RWE to support treatment course and dosage adjustment
- Monitor unmet patient need at HCP level



Luo Y, Evaluating the state-of-the-art in missing data imputation for clinical data, *Briefings in Bioinformatics 2022 23(1) 1-9*

McDermott M, Dighe A, Szolovits P, Luo Y, Baron J. Using machine learning to develop smart reflex testing protocols. *Journal of the American Medical Informatics Association. 2024 Feb 1;31(2):416-25.*

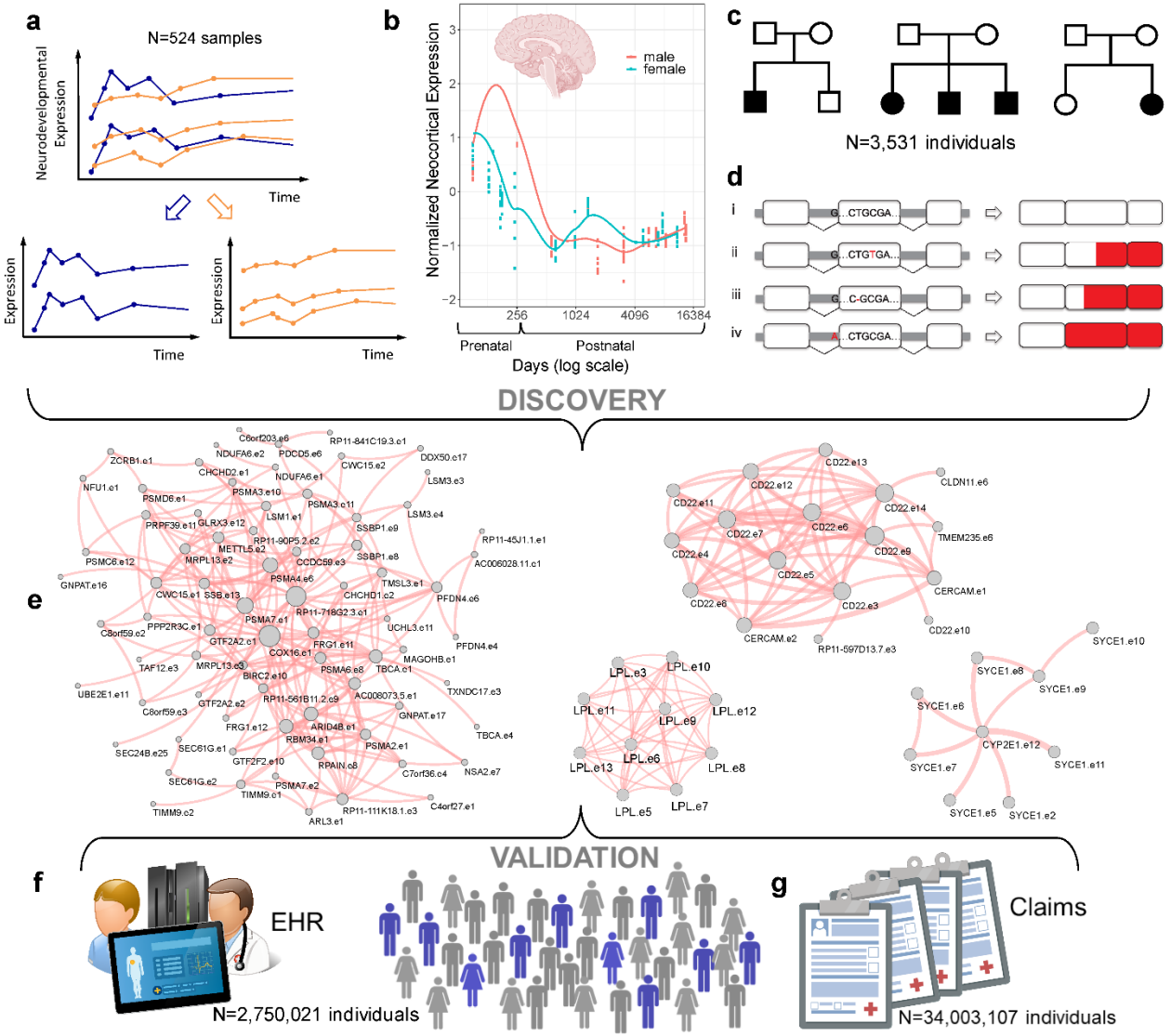
AI and reinforcement learning to solve clinically vexing issues (operations, missed dx etc.)

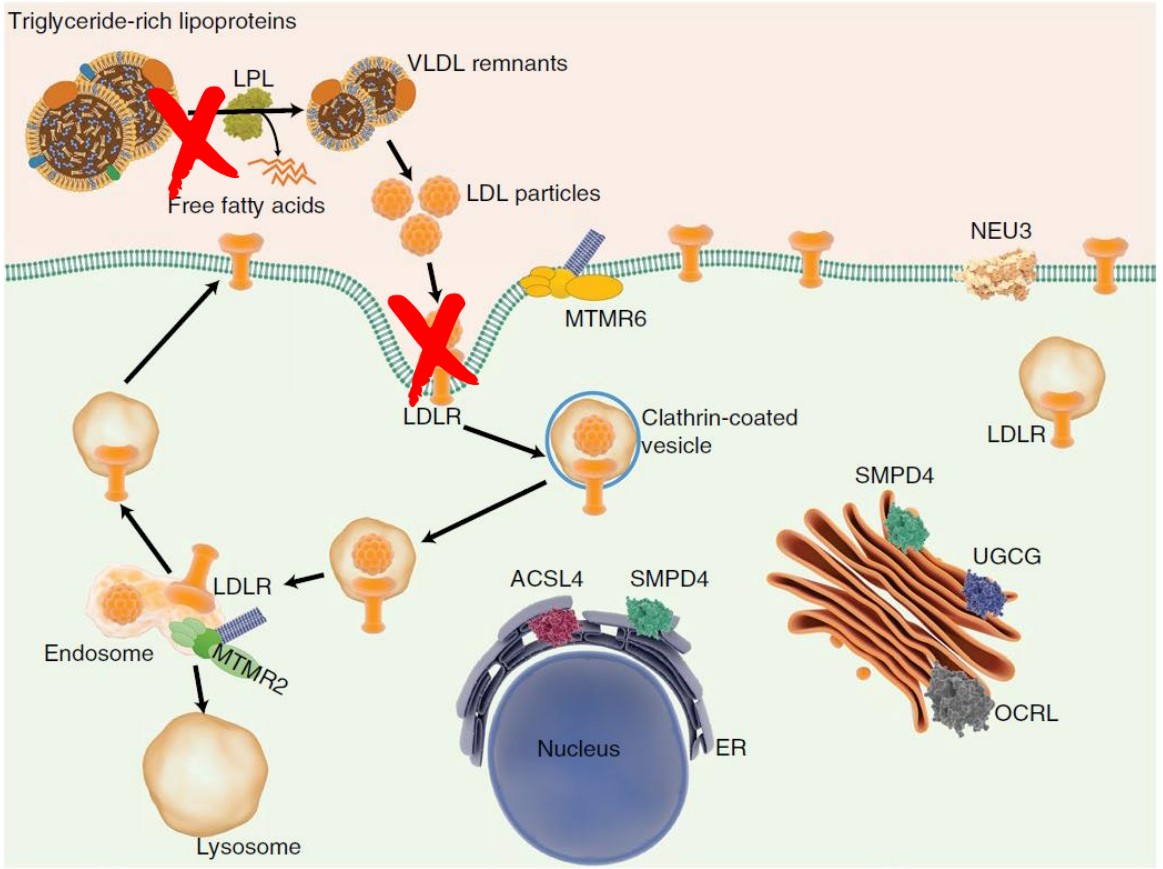


Continuous improvements to optimize operations, save cost, reduce missed diagnoses, and transform care

Yu Z, Li Y, Kim J, Huang K, Luo Y, Wang M. Deep reinforcement learning for cost-effective medical diagnosis. *International Conference on Learning Representations (ICLR). 2023*

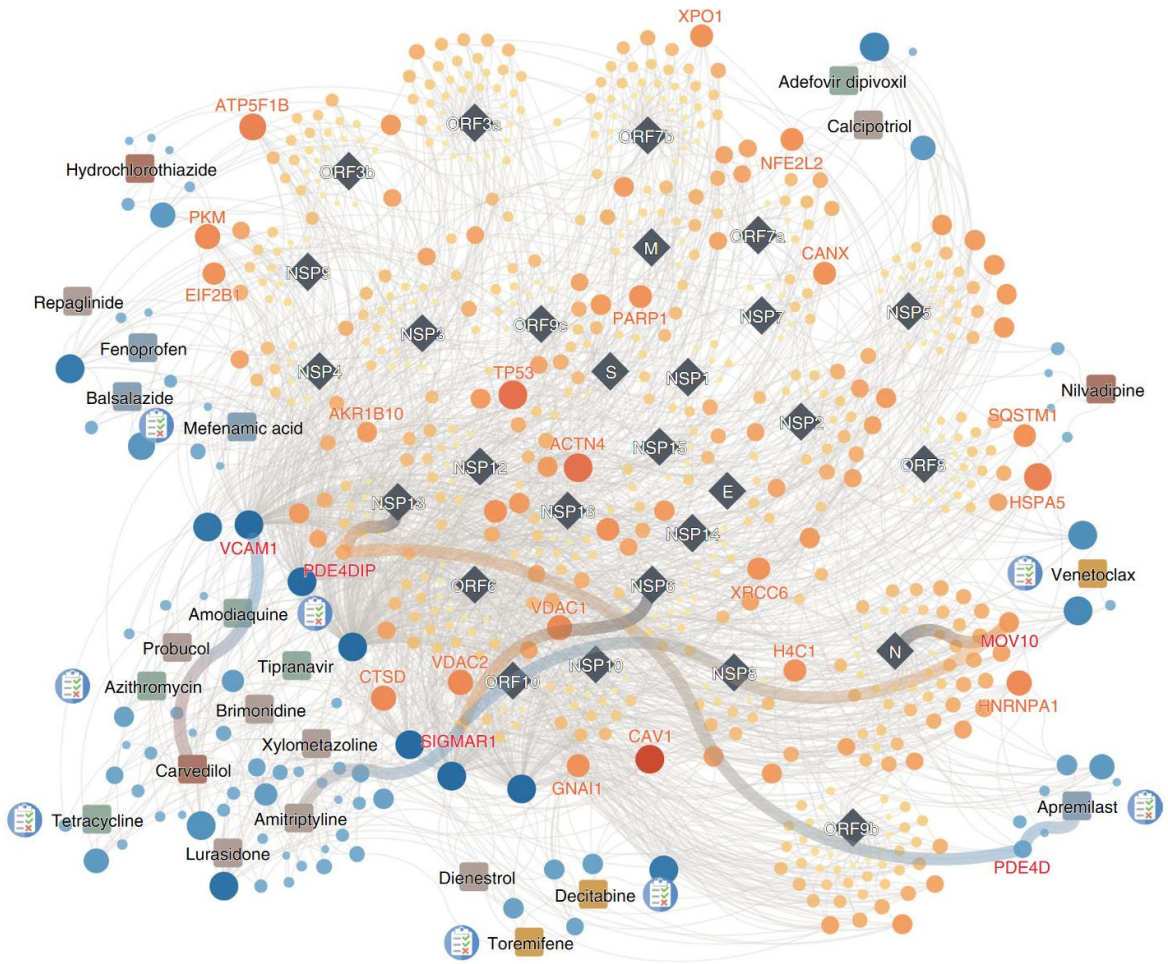
Integrating multi-modal data for better understanding and early screening complex diseases

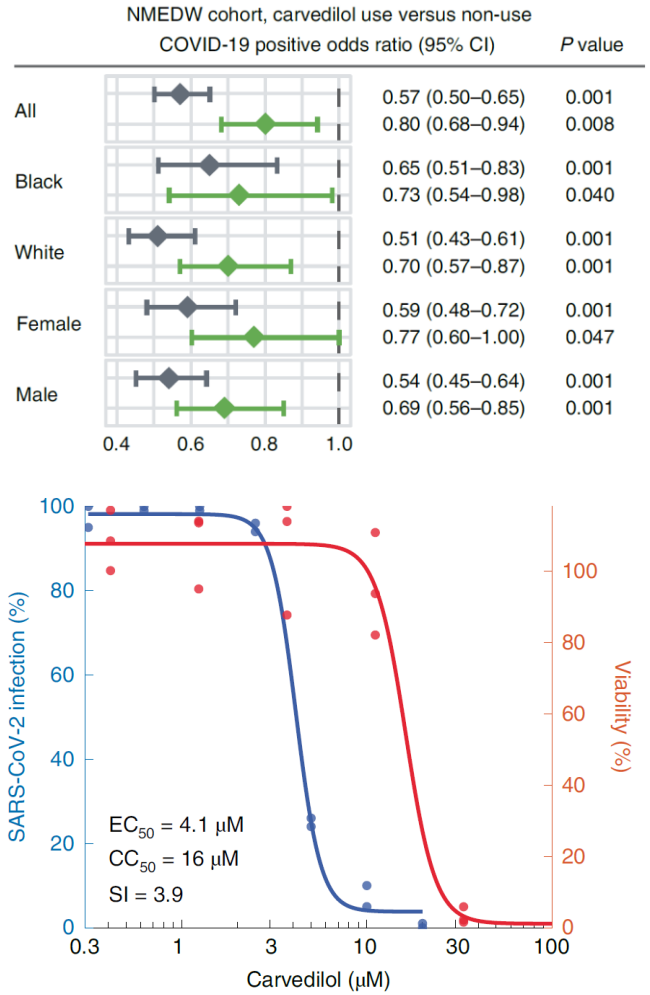




Y Luo†, A Eran†, N P. Palmer, P Avillach, A Levy-Moonshine, P Szolovits, I S. Kohane. A Multidimensional Precision Medicine Approach Identifies an Autism Subtype Characterized by Dyslipidemia. *Nature Medicine 26, 1375–1379, 2020*

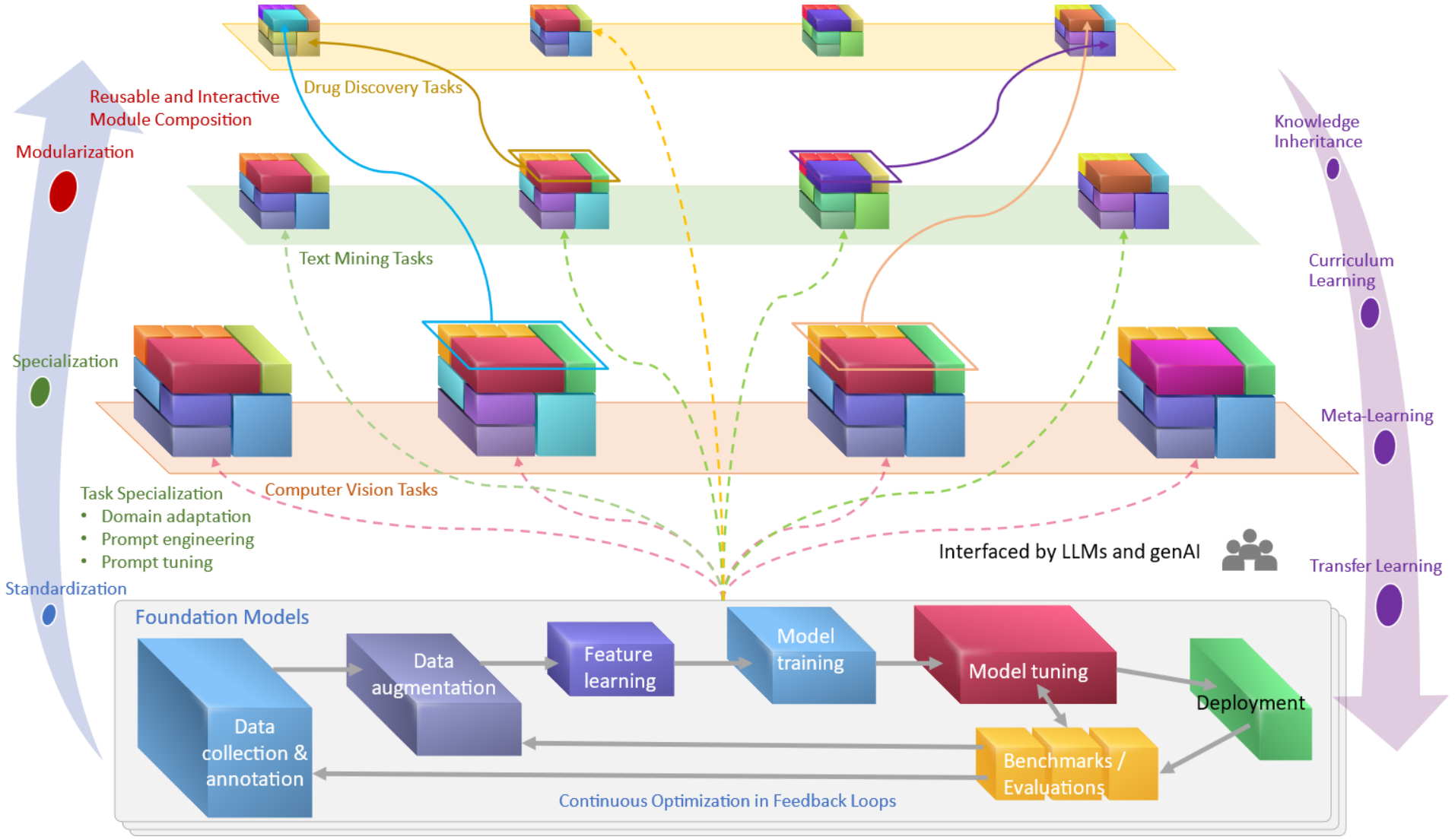
Integrating multi-modal data to robustly identify therapeutic targets and hits





Zhou Y, Liu, Y, Gupta S, Paramo M, Hou Y, Mao C, Luo Y et al. A comprehensive SARS-CoV-2–human protein–protein interactome reveals COVID-19 pathobiology and potential host therapeutic targets. *Nature Biotechnology. 41.1 (2023): 128-139.*

AI's own industrial revolution



Cross pollinating clinicians and AI scientists: AI4H Clinic

- The event is open to all NM clinicians who want to discuss a clinical problem or challenge they face that might be addressable through data science and AI
- Sustained impact across health system and medical school
  - Federal and foundation funding
  - Industry partnership

David Liebovitz, MD, Internal Medicine

Ceylan Cankurtaran, MD, Radiology

James Adams, MD, Emergency Medicine

Sadiya Khan, MD, MSc, Cardiology

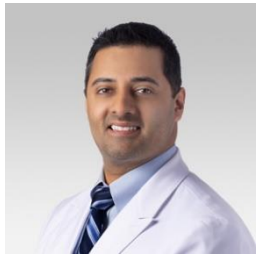
Scott Dresden, MD, Emergency Medicine

Srikanth Divi, MD, Orthopaedic Surgery

Amit Phull, MD, Emergency Medicine

Seema Khan, MD, Surgery, Oncology

Faraz S Ahmad, MD, MS, Cardiology



Christopher S. Ahuja, MD, PhD, Neurological Surgery

Lazaro Sanchez-Pinto, MD, Pediatric Critical Care

Parambir S Dulai, MD, GI & Hepatology

Sanjiv Shah, MD, Cardiology

Andrew M Naidech, MD, MSPH, Neurology & Critical Care

Education and mentorship to grow the next-gen talents

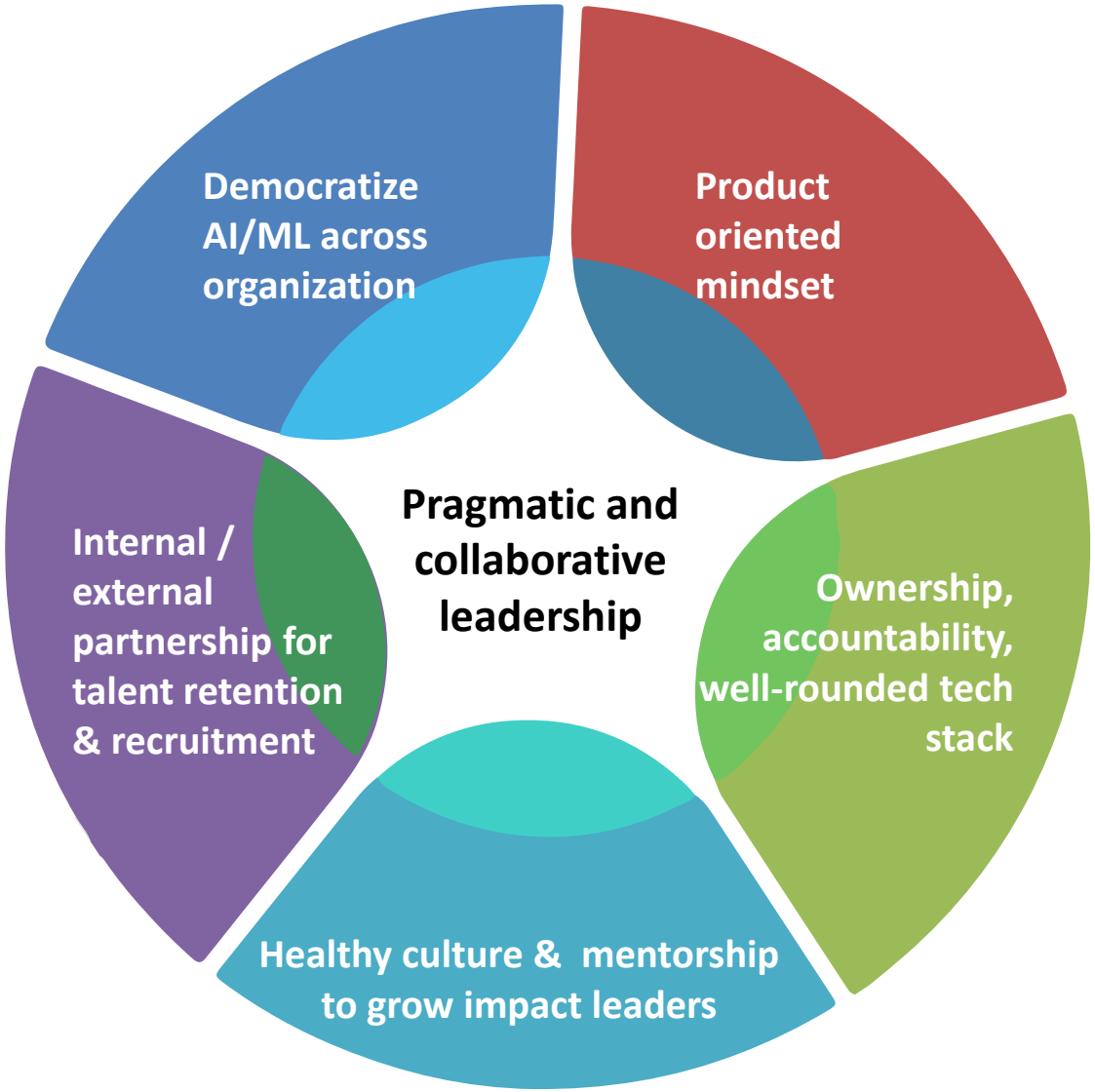
- Cutting-edge developments in the field of AI for healthcare and open discussion among attendees
- Establish a thriving healthcare AI ecosystem that fosters collaboration and supports a network of dedicated scholars and professionals
- Student organizing committee

- Advisory board comprises
  - Faculty from the fields of medicine, engineering, art and science
  - Senior leaders of the healthcare system

- Open to Northwestern Medicine professionals and the broader research community within Northwestern University and the Greater Chicago area
- Open to industry participation and sponsorship


HEALTH CARE AI AND DATA SCIENCE
YEAR IN REVIEWS

Grow impact leaders that adapt to changing health care landscape



Grow impact leaders that adapt to changing health care landscape

01 **Multi-modal AI/ML allows triangulation of evidences to understand complex disease and inform targeted therapeutics**

02 **Collaborative partnership allows effective embedding of AI/ML throughout end-to-end journey of clinical practice and therapeutic development**

03 **Proactive AI/ML framework propels the data-model-experiment-clinical feedback loops of the iterative sequence optimization**

04 **Build, lead and grow a cohort of versatile talents from diverse backgrounds to maximize Data Science and AI/ML contribution to health care**

Let us work together and bring it to a whole new level

Yuan Luo

Chief AI Officer & Prof. at Northwestern | Healthcare AI