Innovations in Artificial Intelligence and Machine Learning for Application in Education

Cornelius A. James, MD
Erkin Ötleş, MS

2/22/2023

COI Statement

- Cornelius has no disclosures
- Erkin: has a patent pending for the University of Michigan for an AI-based approach for the dynamic prediction of health states for patients with occupational injuries. Small amount of IRA stock in various technology and healthcare companies. Provide AI advising for several startups.

Objectives

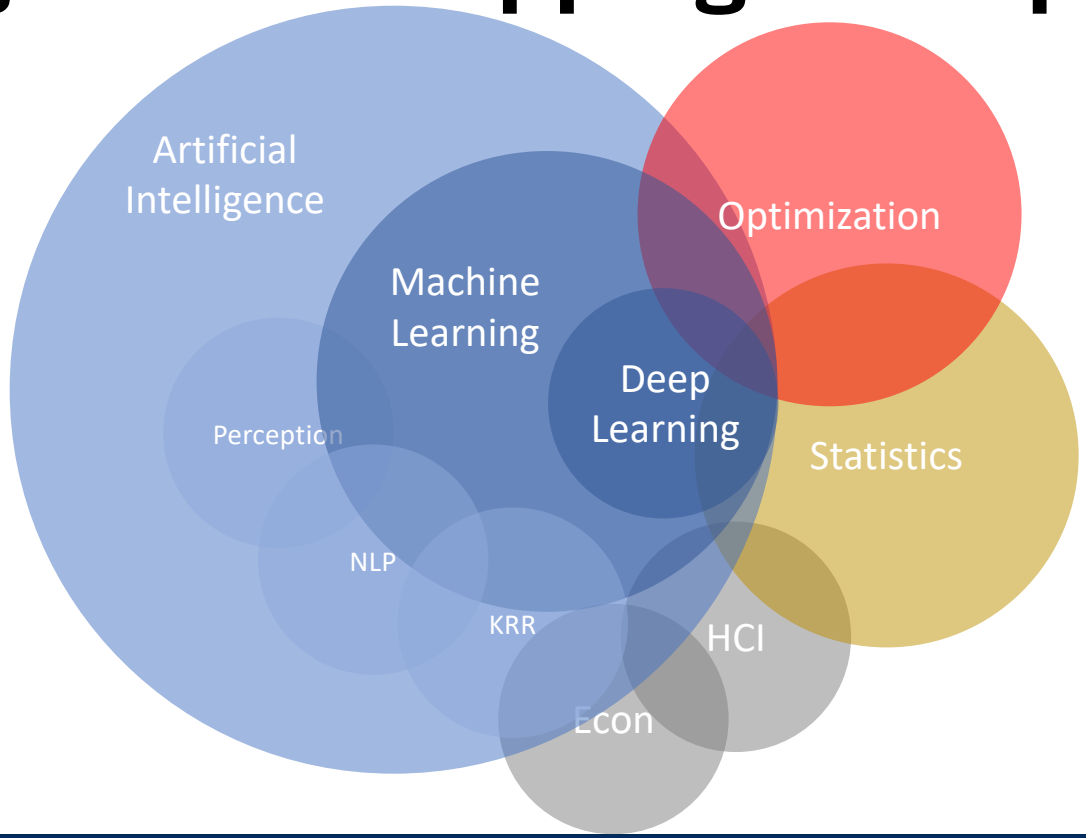
- Define artificial intelligence (AI) and machine learning (ML)
- Describe the impact that AI/ML will have on healthcare
- Summarize the current state of AI/ML in medical education
- Provide a vision for AI/ML in medical education
- **Provoke thought and dialogue**

First, some definitions

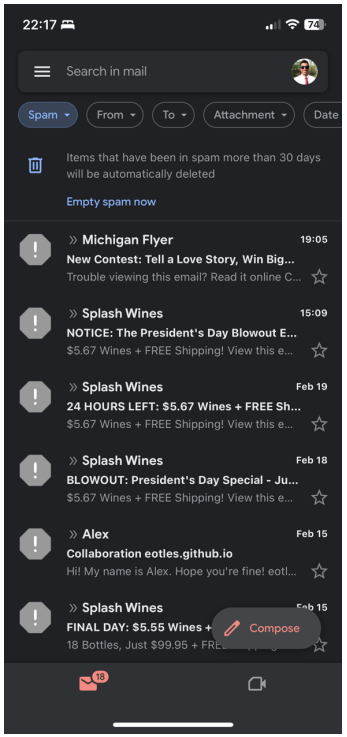
Artificial Intelligence (AI): *intelligence* (perceiving, synthesizing, and inferring information) demonstrated by machines.

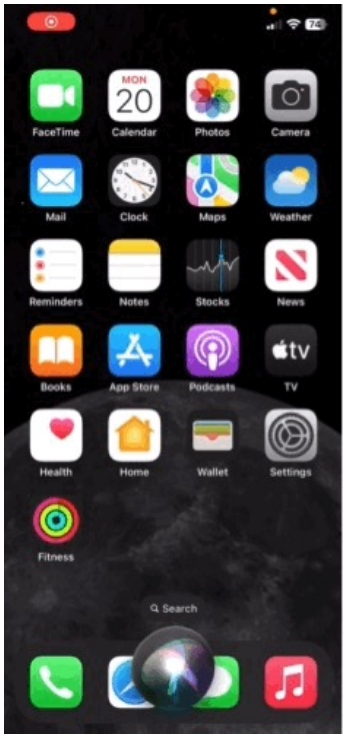
Machine Learning (ML): field of inquiry devoted to understanding and building methods that *learn* (use data to improve performance on a task).

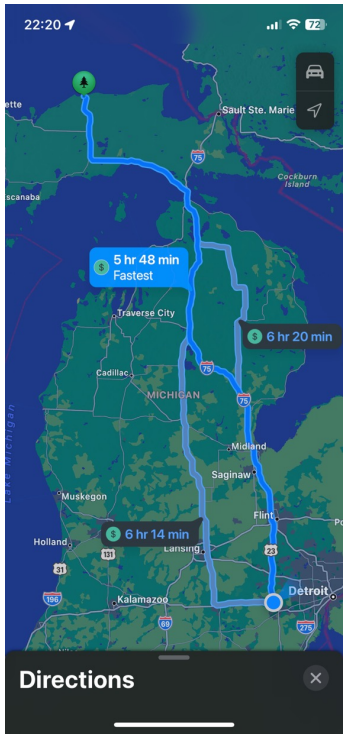
Nesting and overlapping concepts



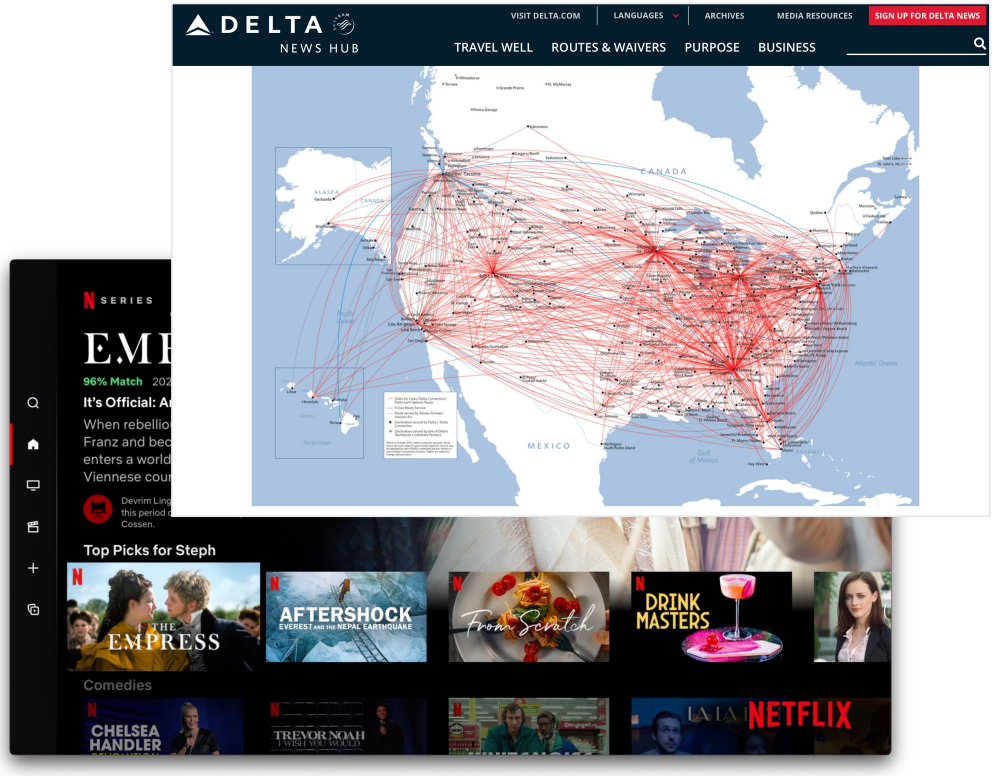
AI is ubiquitous in everyday life







Many industries depend on AI



What routes should we fly?

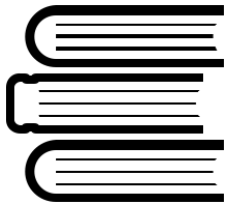
When should we service our planes?

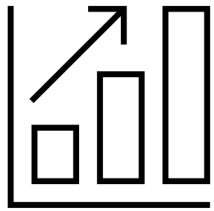
How should we price a product?

What content should we serve?

What products should we stock?

AI has the potential to advance medicine





AI has techniques to rapidly **summarize** information, **predict** outcomes, and **learn** over time

Society has big expectations for AI in medicine

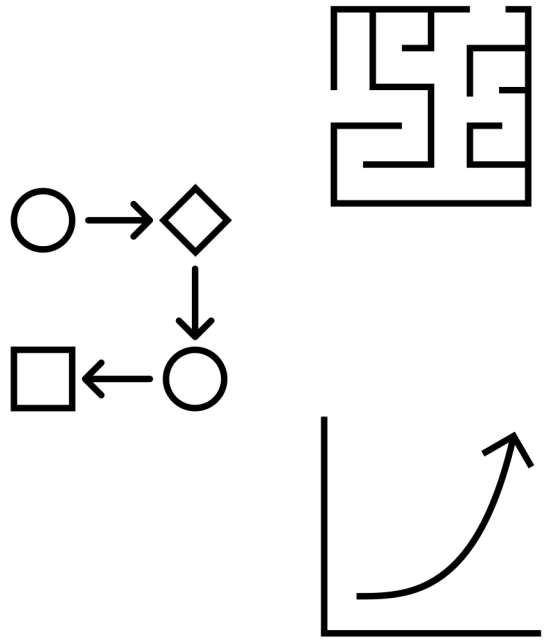
AI is not a part of medical education

Use of AI in medicine is not straightforward

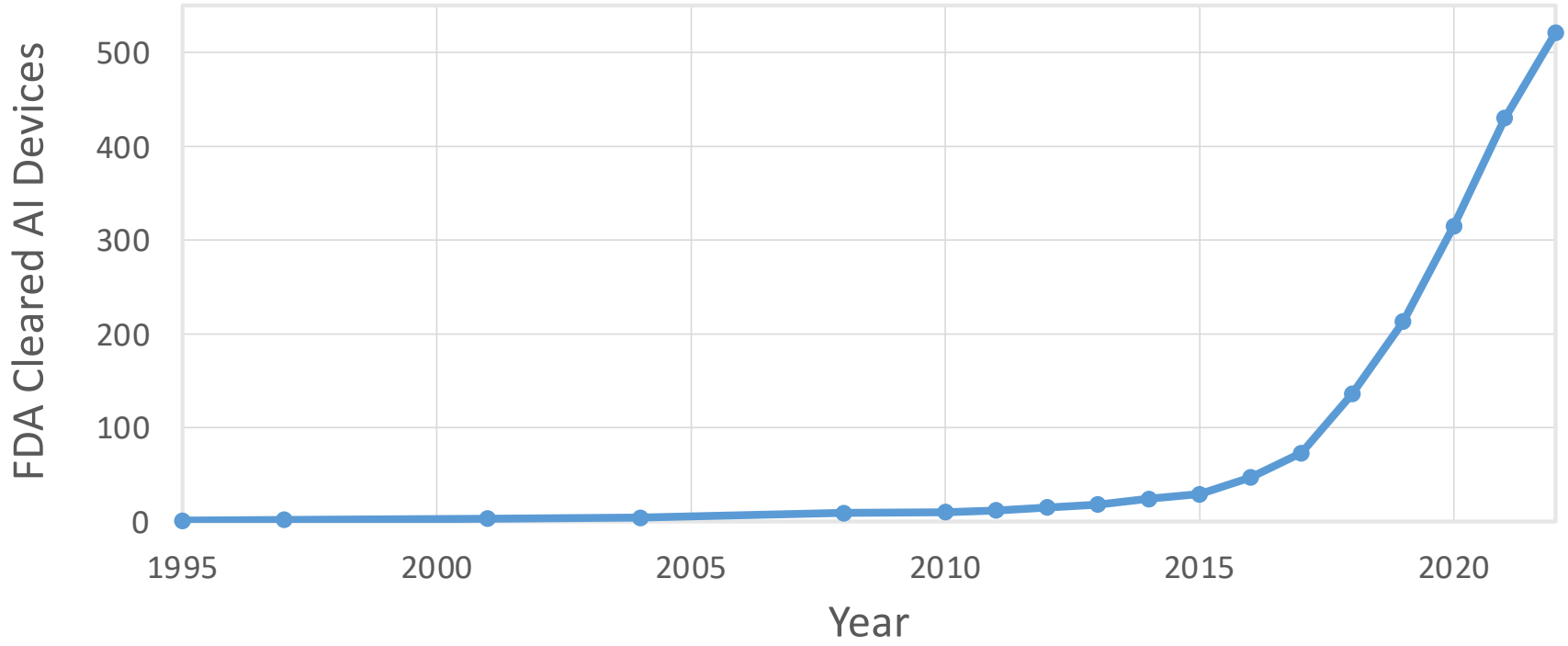
AI tools depend on complicated data and workflows that physicians understand

Medical AI adoption increasing

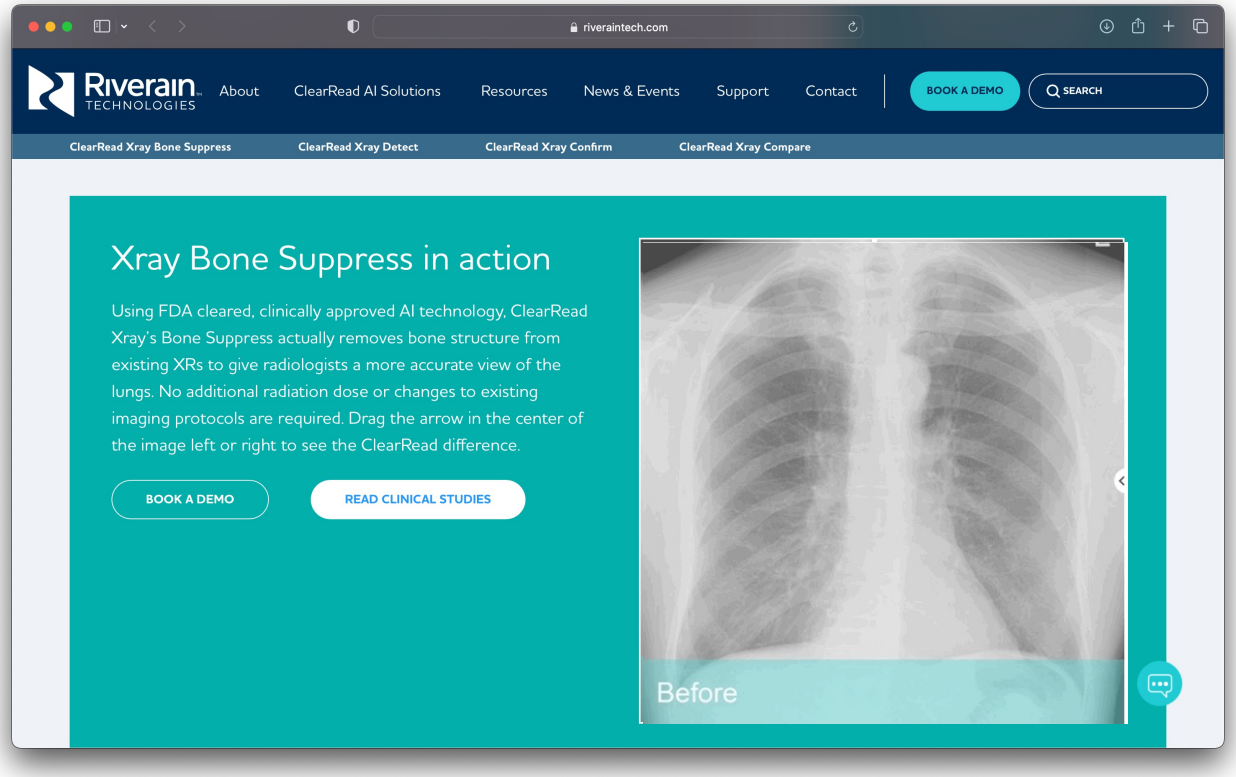
Learners unprepared to use, assess, and develop AI tools



Increasing prevalence of medical AI



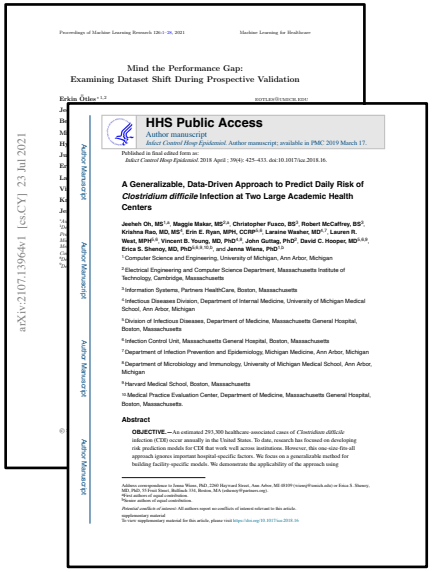
AI in use at Michigan Medicine



Michigan AI in use

Development and Validation of Models to Predict Pathological Outcomes of Radical Prostatectomy in Regional and National Cohorts

Prostate Cancer Outcomes



Mind the Performance Gap: Examining Dataset Shift During Prospective Validation

HHS Public Access

A Generalizable, Data-Driven Approach to Predict Daily Risk of *Clostridium difficile* Infection at Two Large Academic Health Centers

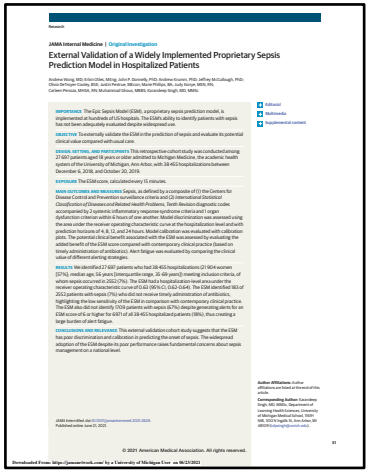
In Hospital Infection Risk

Early identification of patients admitted to hospital for covid-19 at risk of clinical deterioration: model development and multisite external validation study

ORIGINAL RESEARCH

Evaluating a Widely Implemented Proprietary Deterioration Index Model among Hospitalized Patients with COVID-19

Deterioration Risk



External Validation of a Widely Implemented Proprietary Sepsis Prediction Model in Hospitalized Patients

In Hospital Sepsis Risk

We've got to start training physicians on AI fundamentals

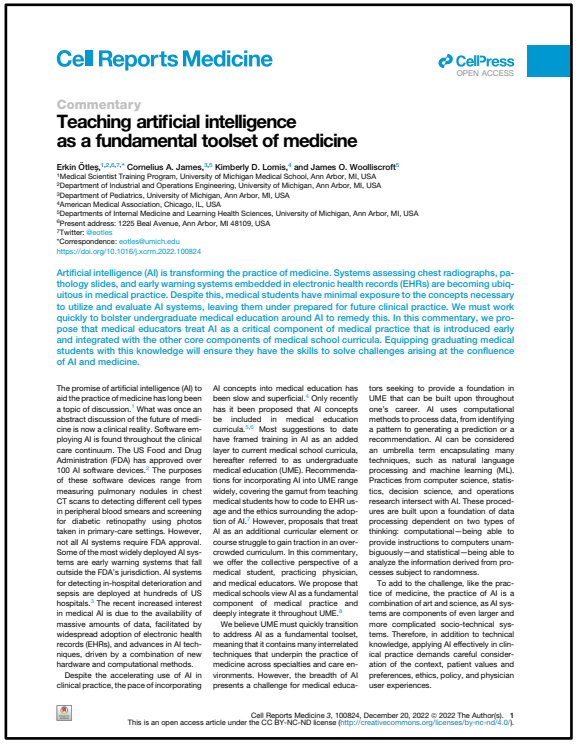
Physicians shouldn't just be "users"

Should be actively involved in creating, evaluating, and improving AI

Leadership in AI dependent on:

understanding how it works &

partnership with engineers



Cell Reports Medicine

CellPress
OPEN ACCESS

Commentary

Teaching artificial intelligence as a fundamental toolset of medicine

Erkin Ötles,[1,2,6,7,*] Cornelius A. James,[3,5] Kimberly D. Lomis,[4] and James O. Woolliscroft[5]
[1]Medical Scientist Training Program, University of Michigan Medical School, Ann Arbor, MI, USA
[2]Department of Industrial and Operations Engineering, University of Michigan, Ann Arbor, MI, USA
[3]Department of Pediatrics, University of Michigan, Ann Arbor, MI, USA
[4]American Medical Association, Chicago, IL, USA
[5]Departments of Internal Medicine and Learning Health Sciences, University of Michigan, Ann Arbor, MI, USA
[6]Present address: 1225 Beal Avenue, Ann Arbor, MI 48109, USA
[7]Twitter: @eotles
*Correspondence: eotles@umich.edu
https://doi.org/10.1016/j.xcrm.2022.100824

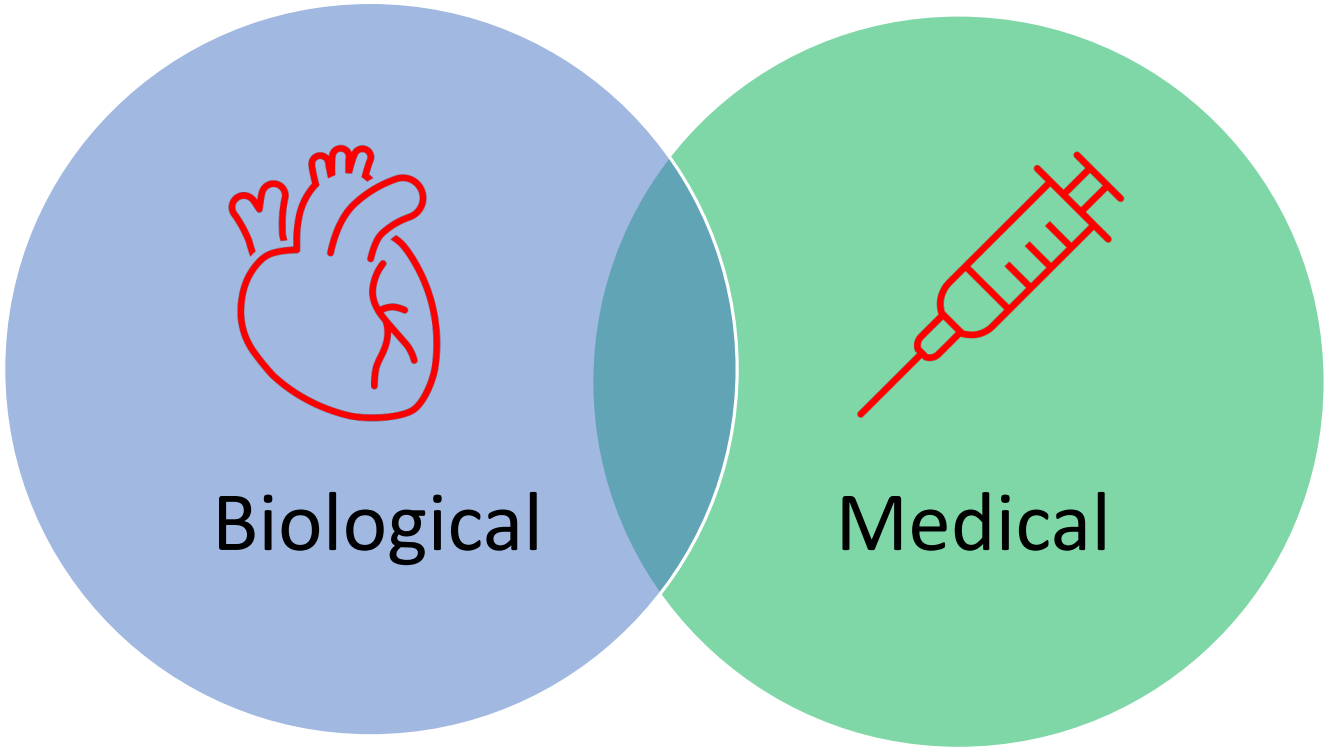
Artificial intelligence (AI) is transforming the practice of medicine. Systems assessing chest radiographs, pathology slides, and early warning systems embedded in electronic health records (EHRs) are becoming ubiquitous in medical practice. Despite this, medical students have minimal exposure to the concepts necessary to utilize and evaluate AI systems, leaving them under prepared for future clinical practice. We must work quickly to bolster undergraduate medical education around AI to remedy this. In this commentary, we propose that medical educators treat AI as a critical component of medical practice that is introduced early and integrated with the other core components of medical school curricula. Equipping graduating medical students with this knowledge will ensure they have the skills to solve challenges arising at the confluence of AI and medicine.

The promise of artificial intelligence (AI) to aid the practice of medicine has long been a topic of discussion.[1] What was once an abstract discussion of the future of medicine is now a clinical reality. Software employing AI is found throughout the clinical care continuum. The US Food and Drug Administration (FDA) has approved over 100 AI software devices.[2] The purposes of these software devices range from measuring pulmonary nodules in chest CT scans to detecting different cell types in peripheral blood smears and screening for diabetic retinopathy using photos taken in primary-care settings. However, not all AI systems require FDA approval. Some of the most widely deployed AI systems are early warning systems that fall outside the FDA's jurisdiction. AI systems for detecting in-hospital deterioration and sepsis are deployed at hundreds of US hospitals.[3] The recent increased interest in medical AI is due to the availability of massive amounts of data, facilitated by widespread adoption of electronic health records (EHRs), and advances in AI techniques, driven by a combination of new hardware and computational methods.

Despite the accelerating use of AI in clinical practice, the pace of incorporating AI concepts into medical education has been slow and superficial.[4] Only recently has it been proposed that AI concepts be included in medical education curricula.[5,6] Most suggestions to date have framed training in AI as an added layer to current medical school curricula, hereafter referred to as undergraduate medical education (UME). Recommendations for incorporating AI into UME range widely, covering the gamut from teaching medical students how to code to EHR usage and the ethics surrounding the adoption of AI.[7] However, proposals that treat AI as an additional curricular element or course struggle to gain traction in an overcrowded curriculum. In this commentary, we offer the collective perspective of a medical student, practicing physician, and medical educators. We propose that medical schools view AI as a fundamental component of medical practice and deeply integrate it throughout UME.[8]

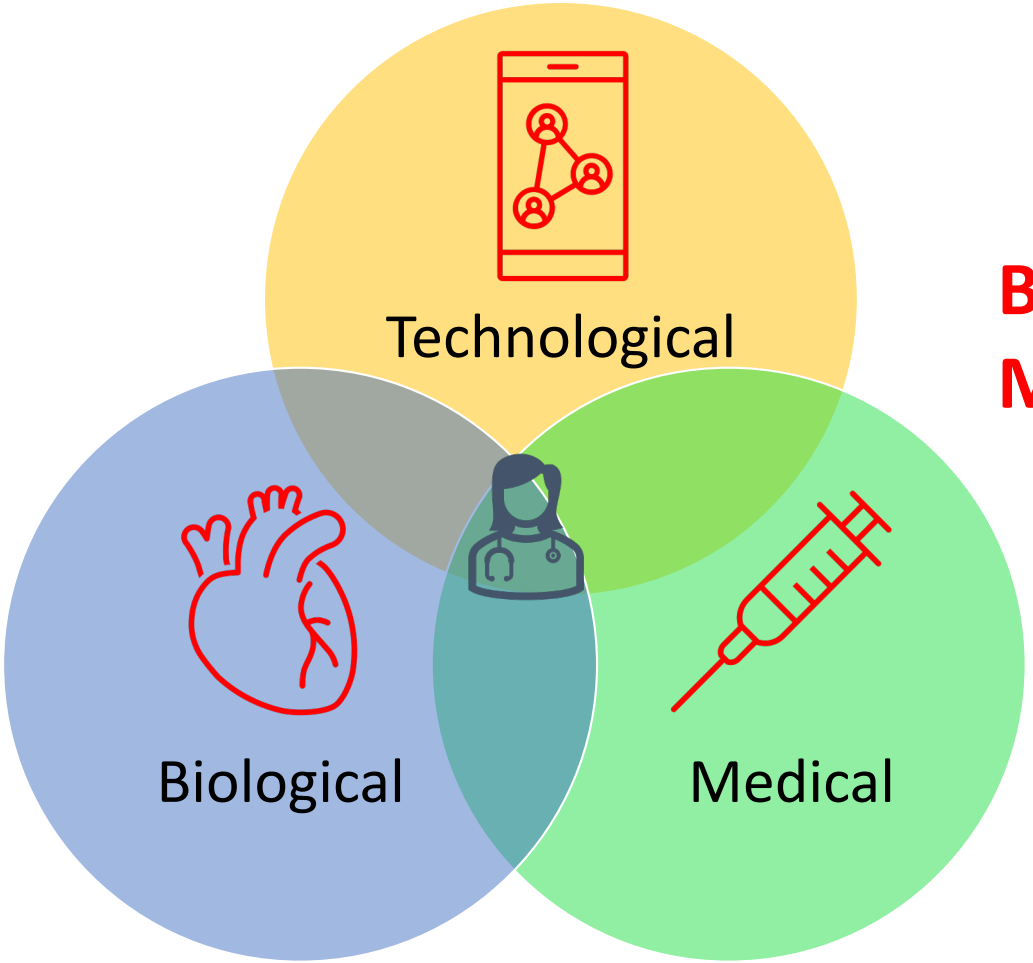
We believe UME must quickly transition to address AI as a fundamental toolset, meaning that it contains many interrelated techniques that underpin the practice of medicine across specialties and care environments. However, the breadth of AI presents a challenge for medical educators seeking to provide a foundation in UME that can be built upon throughout one's career. AI uses computational methods to process data, from identifying a pattern to generating a prediction or a recommendation. AI can be considered an umbrella term encapsulating many techniques, such as natural language processing and machine learning (ML). Practices from computer science, statistics, decision science, and operations research intersect with AI. These procedures are built upon a foundation of data processing dependent on two types of thinking: computational—being able to provide instructions to computers unambiguously—and statistical—being able to analyze the information derived from processes subject to randomness.

To add to the challenge, like the practice of medicine, the practice of AI is a combination of art and science, as AI systems are components of even larger and more complicated socio-technical systems. Therefore, in addition to technical knowledge, applying AI effectively in clinical practice demands careful consideration of the context, patient values and preferences, ethics, policy, and physician user experiences.



Biomedical Model

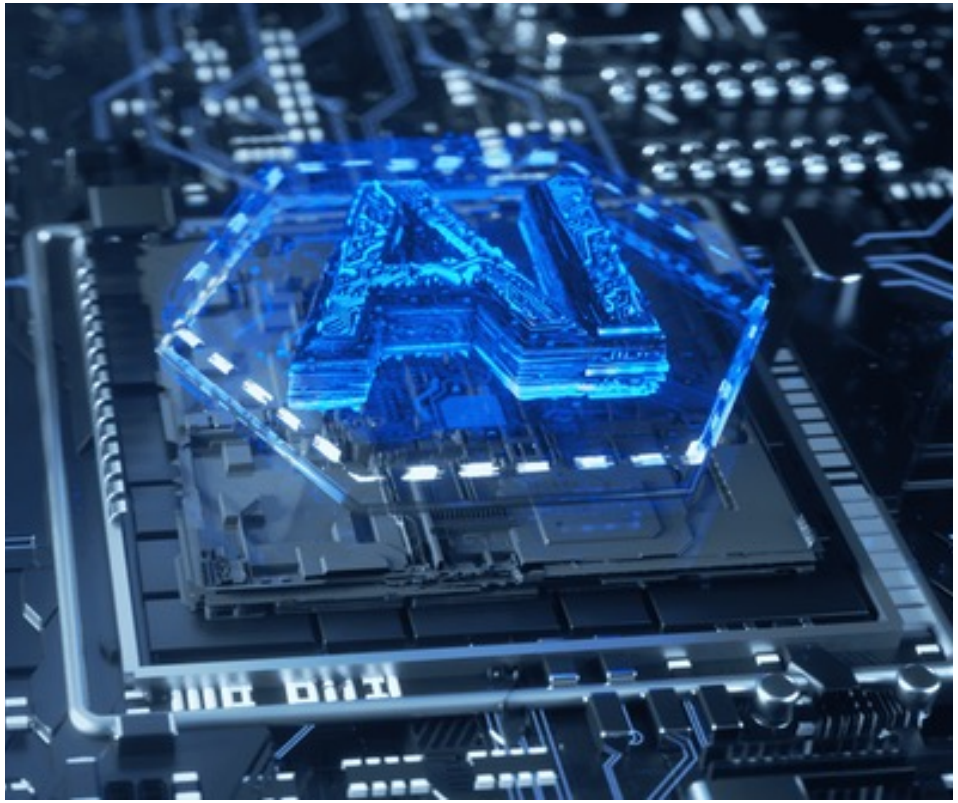
Duffy TP. The Flexner Report--100 years later. *Yale J Biol Med*. 2011;84(3):269-276.



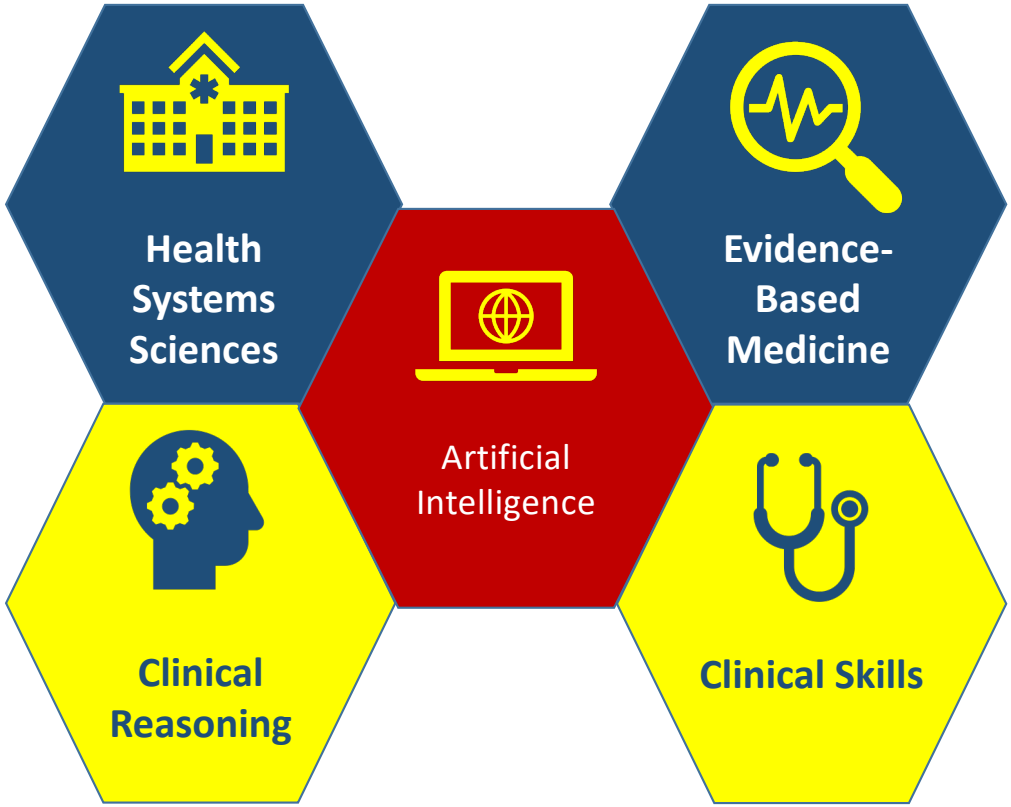
Biotechnomedical (BTM) Model

Current State

- Electives
- Online courses, modules
- Workshops
- Certificate programs
- Interest groups



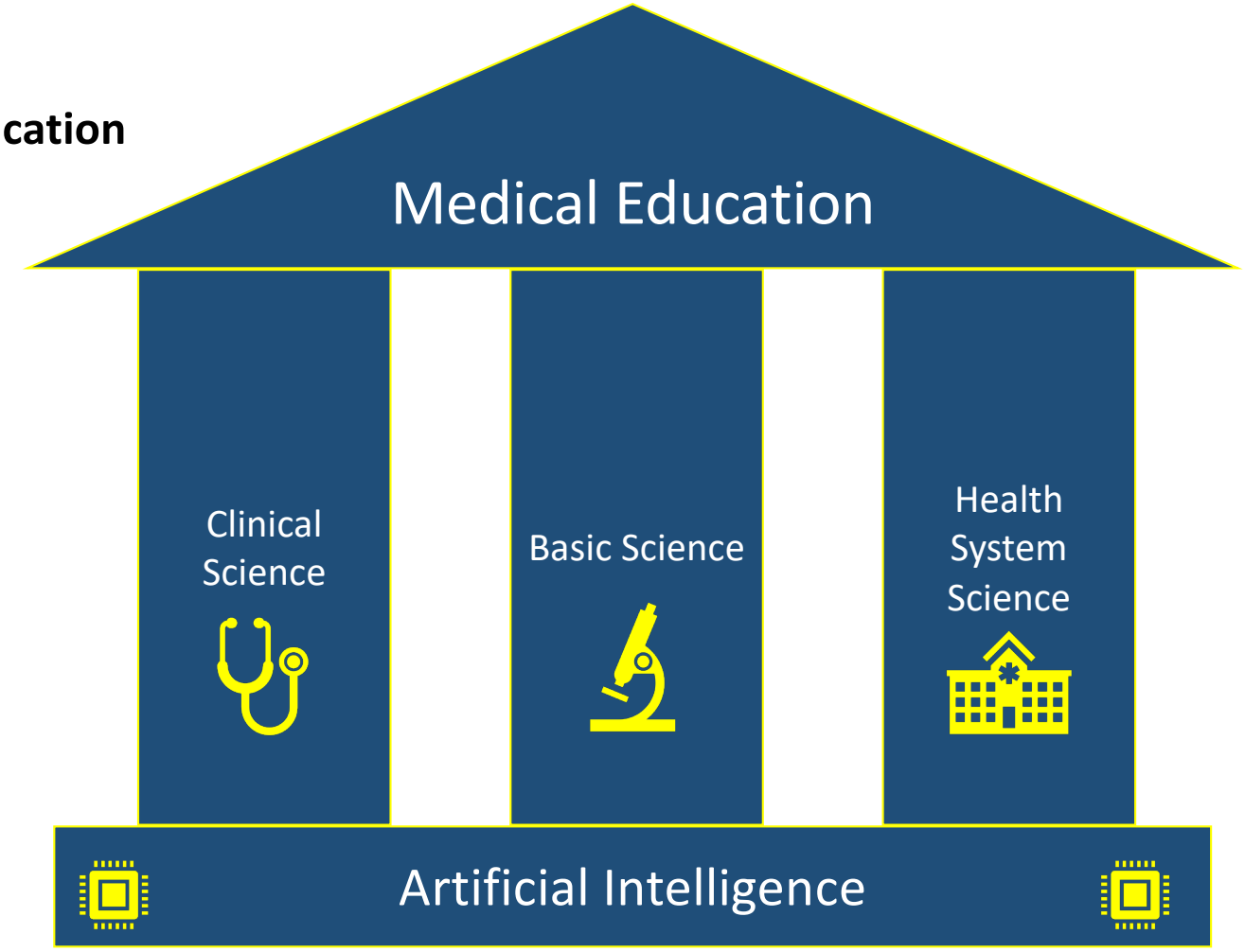
1. Paranjape K, Schinkel M, Nannan Panday R, Car J, Nanayakkara P. Introducing Artificial Intelligence Training in Medical Education. *JMIR Med Educ*. 2019;5(2):e16048.
2. Lee J, Wu AS, Li D, Kulasegaram KM. Artificial Intelligence in Undergraduate Medical Education: A Scoping Review. *Acad Med*. 2021;96(11S):S62-S70.



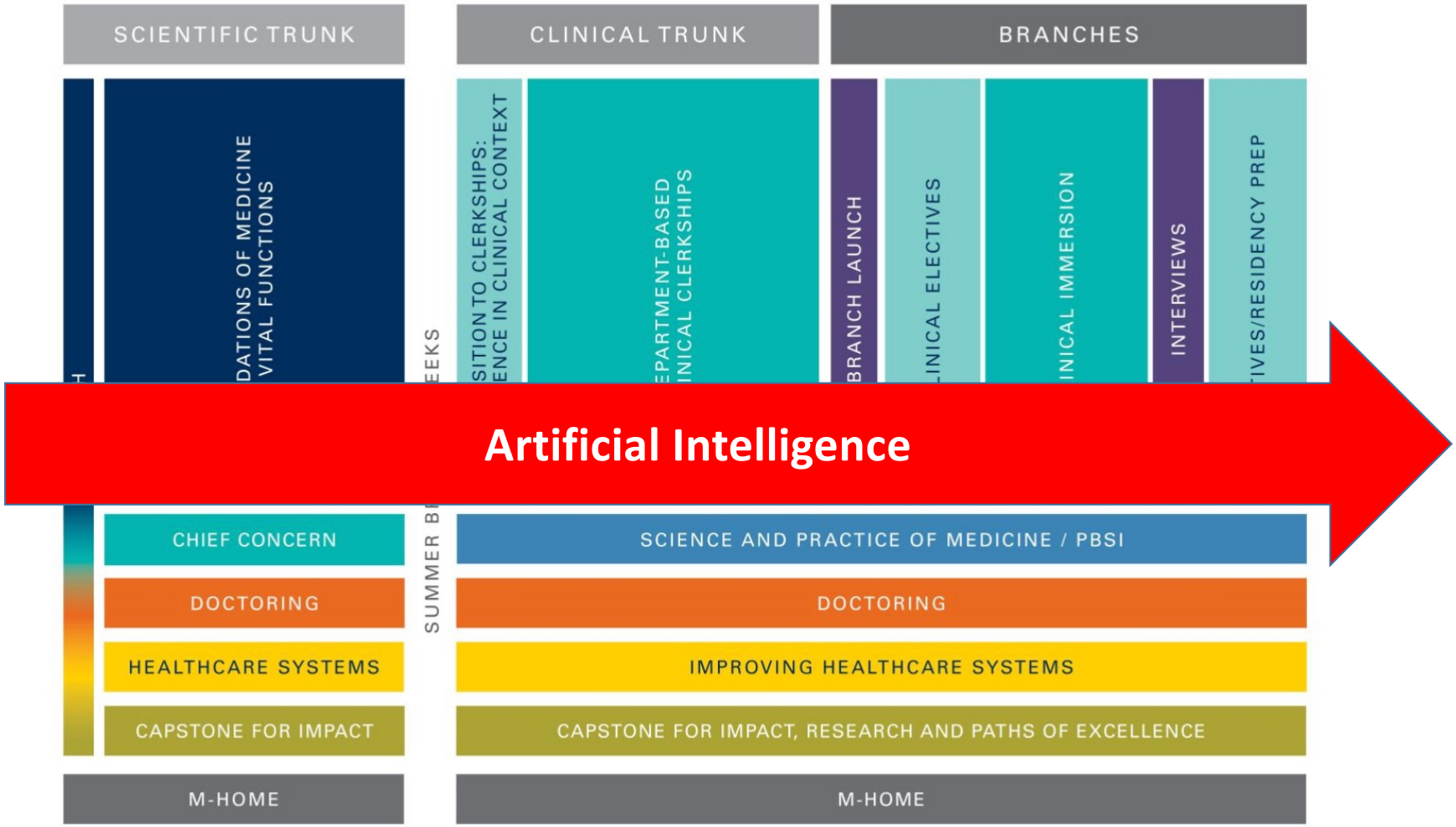
Integration

James CA, Wheelock KM, Woolliscroft JO. Machine Learning: The Next Paradigm Shift in Medical Education. *Acad Med*. 2021;96(7):954-957.

Pillars of Medical Education



Fred HL, Gonzalo JD. Reframing Medical Education. *Tex Heart Inst J.* 2018;45(3):123-125.


SCIENTIFIC TRUNK
CLINICAL TRUNK
BRANCHES
DATIONS OF MEDICINE
VITAL FUNCTIONS
SITION TO CLERKSHIPS:
ENCE IN CLINICAL CONTEXT
EPARTMENT-BASED
INICAL CLERKSHIPS
BRANCH LAUNCH
LINICAL ELECTIVES
INICAL IMMERSION
INTERVIEWS
TIVES/RESIDENCY PREP
EEKS
SUMMER B
Artificial Intelligence
CHIEF CONCERN
DOCTORING
HEALTHCARE SYSTEMS
CAPSTONE FOR IMPACT
SCIENCE AND PRACTICE OF MEDICINE / PBSI
DOCTORING
IMPROVING HEALTHCARE SYSTEMS
CAPSTONE FOR IMPACT, RESEARCH AND PATHS OF EXCELLENCE
M-HOME
M-HOME

Biomedical Model

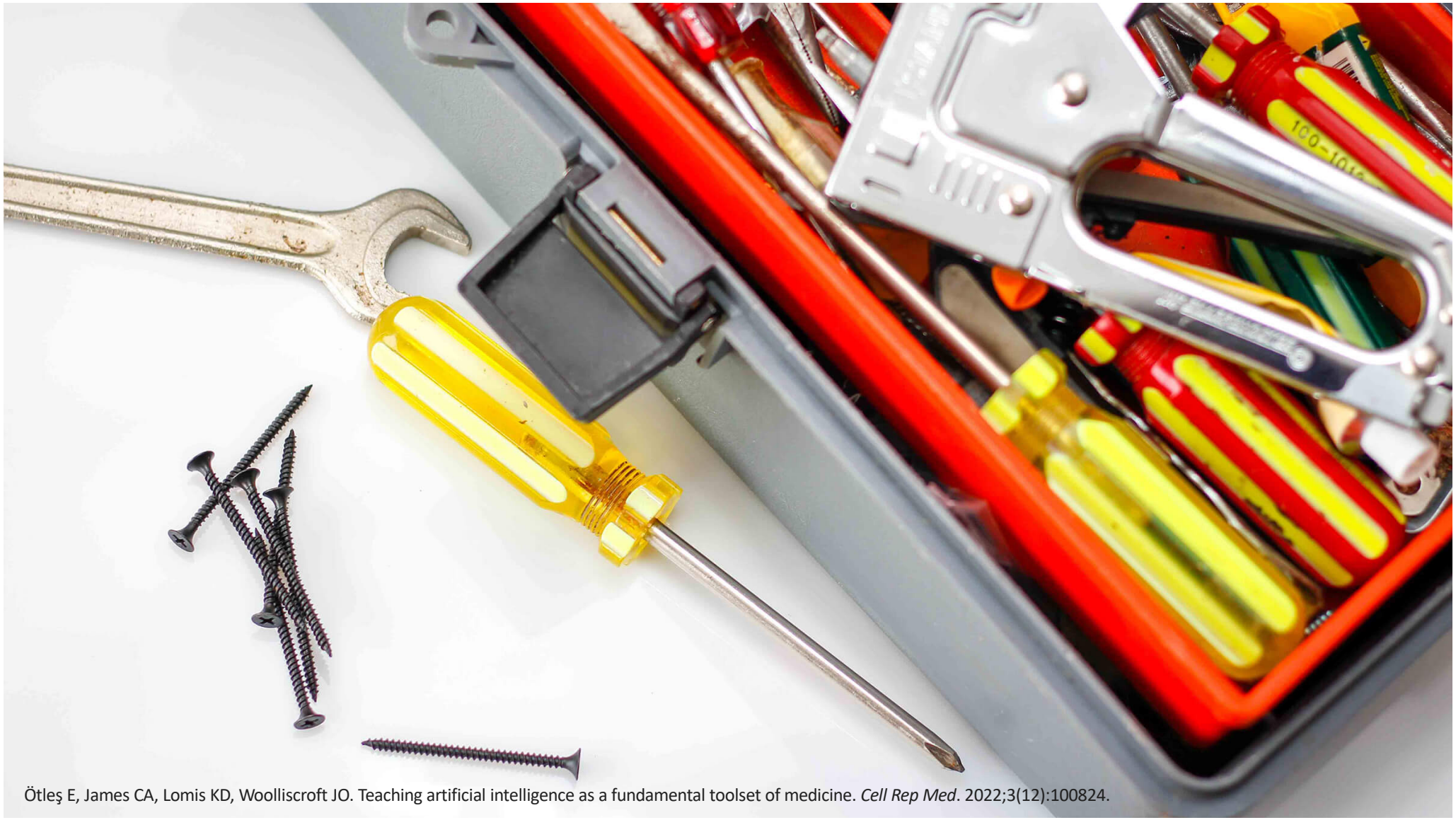
UMMS Scientific Trunk

Current State

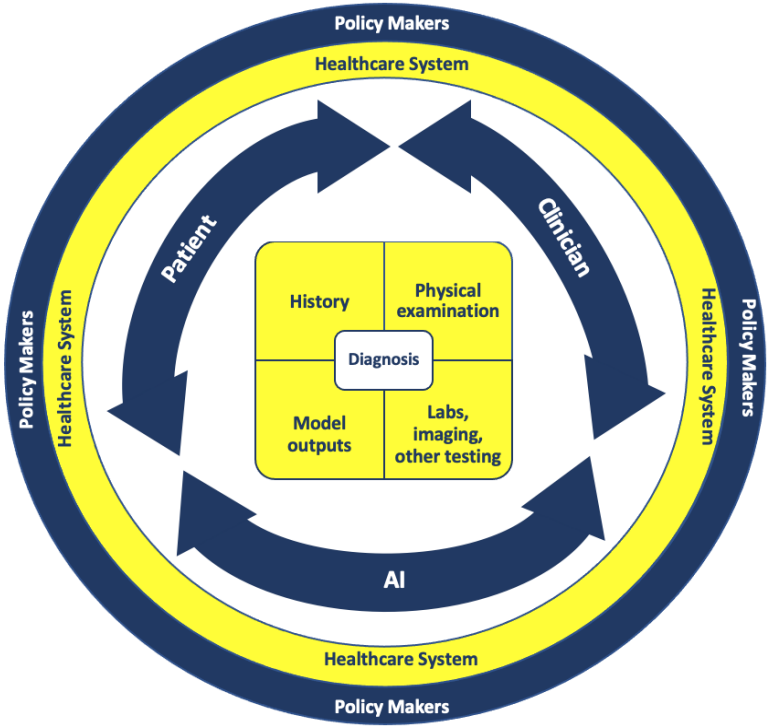
Biotechnomedical Model

UMMS Scientific Trunk

Future State?

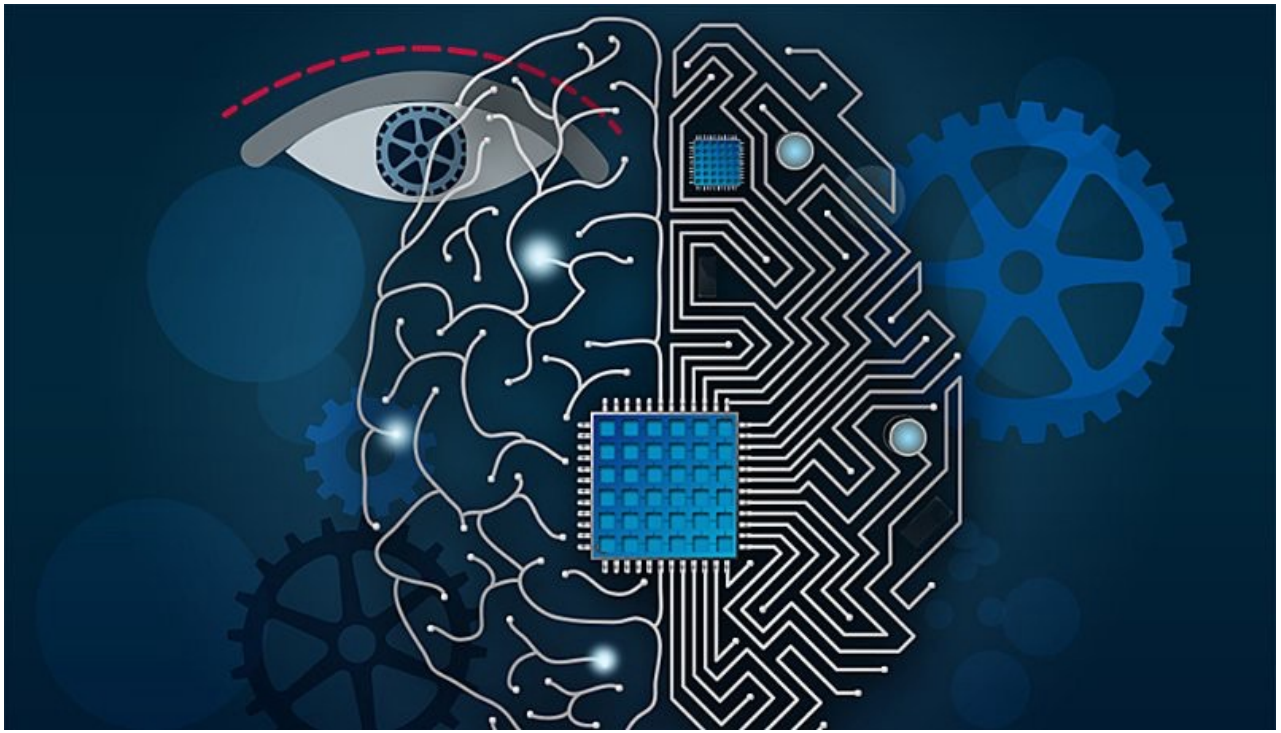


Ötleş E, James CA, Lomis KD, Woolliscroft JO. Teaching artificial intelligence as a fundamental toolset of medicine. *Cell Rep Med*. 2022;3(12):100824.



Future State of the Clinical Encounter- Diagnosis

Data Augmented, Technology Assisted Medical Decision Making (DATA-MD)



DATA-MD Mission

To develop, implement, and disseminate innovative healthcare AI/ML curricula that serve as a foundation for medical educators to develop curricula specific to their own institutions and/or specialties.

DATA-MD

- Use of AI/ML in diagnosis
  - EBM foundation
- Four online modules
  - Intro to AI/ML in Healthcare
  - Foundational Biostats and Epi in AI/ML for Health Professionals
  - Using AI/ML to Augment Diagnostic Decisions
  - Ethical and Legal use of AI/ML in the Diagnostic Process
- Launch 6/2023

CENTER FOR ACADEMIC INNOVATION
UNIVERSITY OF MICHIGAN

coursera

GME INNOVATIONS

DATA-MD

- Seven online modules
  - Intro to AI
  - Methodologies
  - Diagnosis
  - Treatment and Prognosis
  - Law, Ethics, Regulation
  - AI in the Health System
  - Precision Medicine

- Launch late 2023

Leaders and Best