

# Advancing Artificial Intelligence and Machine Learning in Primary Care



Timothy Tsai DO MMCI

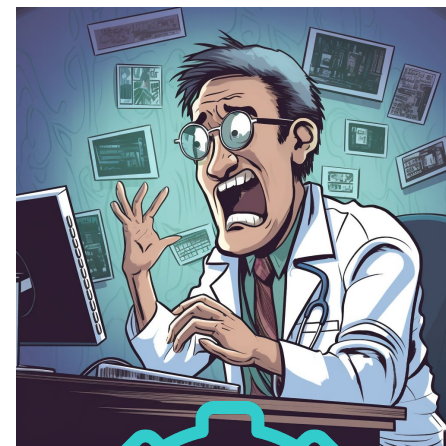
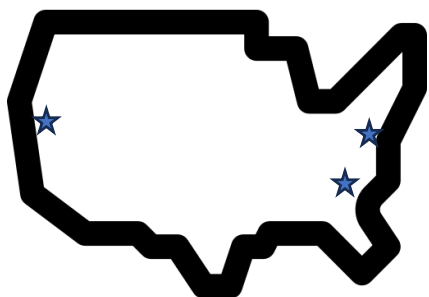


HEART

Stanford Healthcare AI Applied Research Team

Clinical Assistant Professor, Medicine  
Data Lead, Stanford Asynchronous Virtual Co-PCP  
Associate Medical Director, Stanford Healthcare AI Applied Research Team  
Division of Primary Care and Population Health  
Stanford University School of Medicine





# What is Missing in Healthcare AI/ML Today?

Only 3% of FDA approved AI/ML tools is intended for primary care, and 1% of AI/ML research funding goes to primary care

90% of AI/ML models never make it to production, and 97% of FDA approved AI/ML tools never undergo prospective evaluation

AI/ML activity is concentrated in a short list of affluent academic centers, and community engagement is little to non-existent



# How can a Research Team Address These Gaps?

Develop effective  
cross-sectoral  
collaborations

Engage in the  
implementation  
science of AI/ML

Partner in AI/ML  
policy and health  
equity work





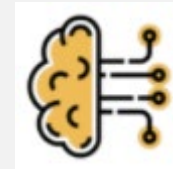
## Mission

To bring leading edge AI technologies from “code to bedside” in support of the Quintuple Aim.

## Vision

To be a national leader in the study and implementation of AI technologies to solve specific, practical problems in healthcare.

## Core Competencies



Translational AI  
research study design  
and AI implementation



Clinical integration  
workflow design and  
simulation



Quality improvement  
and design thinking  
methodology

Triple Aim  
2007

1. Improved Patient Experience
2. Better Outcomes
3. Lower Costs

Quadruple Aim  
2014

4. Clinician Well-Being

Quintuple Aim  
2021

5. Health Equity

Better Health

Improved Economy





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## Clinical Decision Making

Google Health



Santa Clara Family Health Plan

Dermatology in Primary Care

Predicta Med

Autoimmune Disease



Stanford MEDICINE

Clinical Excellence Research Center

Behavioral Health

## Population Health Management



Stanford HEALTH CARE



omada

Remote Patient Monitoring

verily

Hypertension & Heart Failure



Stress Sensing

## Value Based Care

CODEX

Predicting ED/Hospitalizations

Google Health

Digital Care Coordinator



Stanford University Human-Centered Artificial Intelligence

Care Gap Voice Assistant

## Transitions of Care



Stanford HEALTH CARE

Epic



QUADRANT

Predicting Clinical Deterioration in Hospitals



BMIR  
Stanford Center for Biomedical Informatics Research  
CONNECTING DATA TO HEALTH

Advance Care Planning

## Care Team Burnout



Microsoft



DeepScribe



QUADRANT



OpenAI

Automating Clinical Documentation

Message Categorization

Message Auto Reply

## Health Policy, Education and Development



NATIONAL ACADEMY of MEDICINE

Equity & Governance



AAFP



STFM  
SOCIETY OF TEACHERS OF FAMILY MEDICINE

Advocacy & Education



American Board of Family Medicine

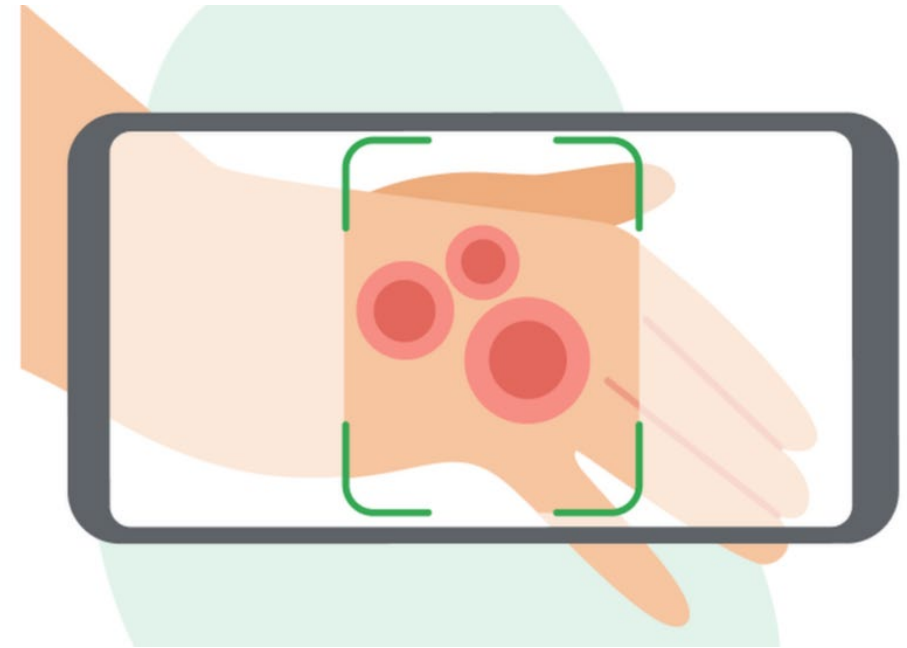
Research Capacity Building

GORDON AND BETTY MOORE FOUNDATION



# Improving Access to Skin Disease Diagnosis

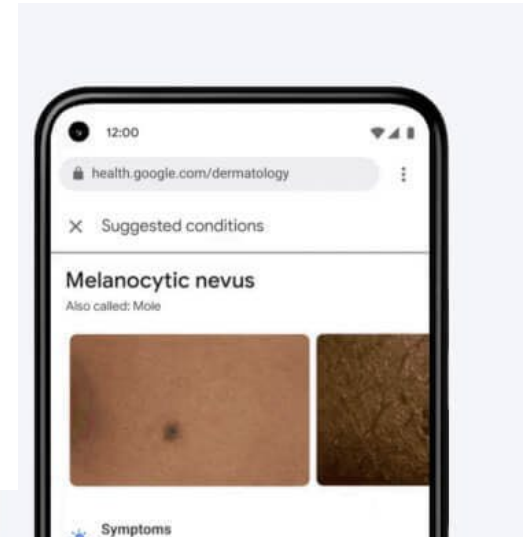
- **Problem:** Primary care providers manage 70% of skin cases, and access to dermatology is lacking in many community settings
- **What's been done:** AI is non-inferior to dermatologists, and can improve PCP diagnoses
- **What we're doing:** Testing the AI's feasibility, acceptability, and performance in the community





# A deep learning system for differential diagnosis of skin diseases

AI built using 16K cases can distinguish between 419 skin conditions, and is non-inferior to dermatologists and superior to PCPs on 963 validation cases



JAMA  
Network | **Open**<sup>TM</sup>



**Original Investigation** | Dermatology

## Development and Assessment of an Artificial Intelligence–Based Tool for Skin Condition Diagnosis by Primary Care Physicians and Nurse Practitioners in Teledermatology Practices

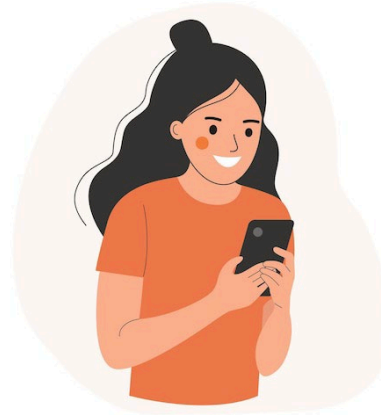
AI was associated with improved PCP diagnoses for 1 in every 8-10 validation cases







Enrolled **110**  
diverse community  
participants across  
4 health fairs



**73%** of participants  
were extremely or  
very satisfied with  
the app



Clinicians: app was  
concordant with their  
own assessments in  
**86%** of cases





Merging **research**, **product development** and **community service** into a single pursuit may help bridge the gap between academia, industry and community in AI/ML science, innovation and equity







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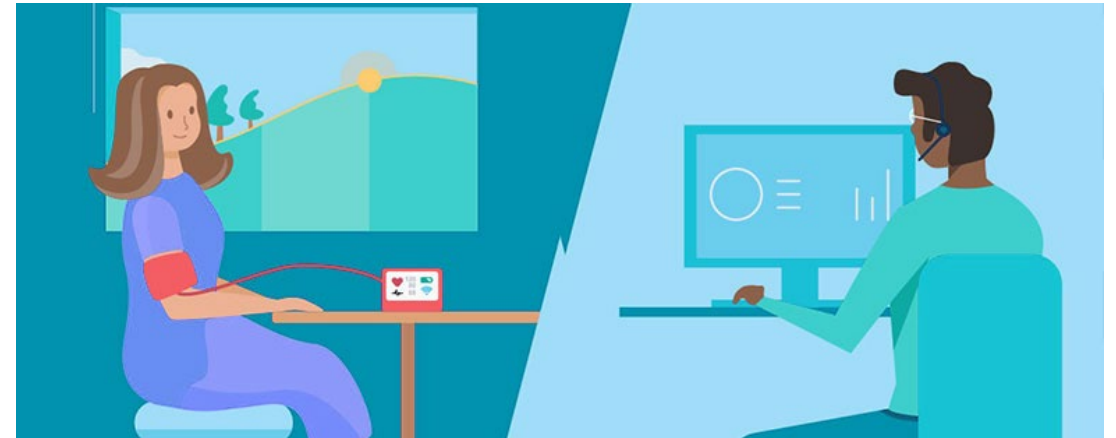
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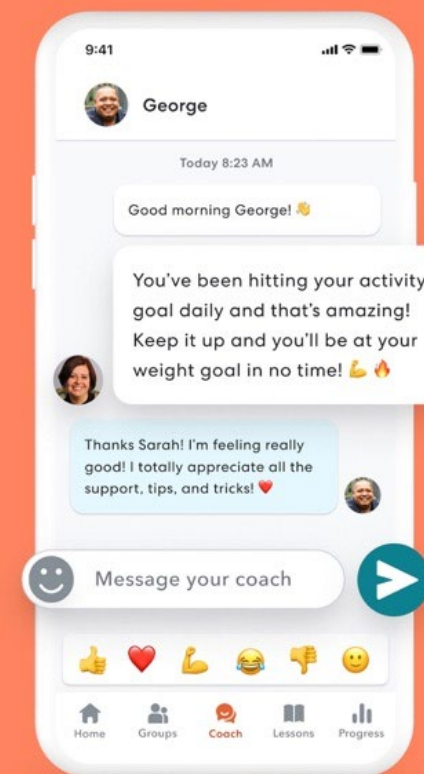
# Improving Chronic Care With Remote Monitoring

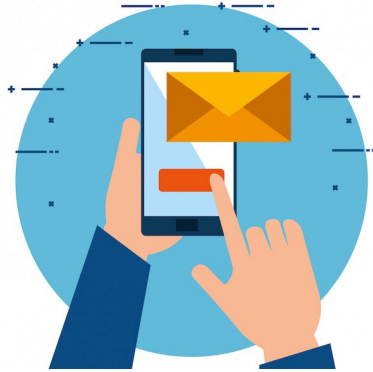
- **Problem:** Episodic visits are not sufficient for controlling chronic diseases at the population level
- **What's been done:** AI-assisted RPM is promising, but evidence is inadequate and RPM vendors operate outside health systems
- **What we're doing:** Testing an AI-assisted RPM program vs usual care for HTN in a pragmatic RCT





Connect with your coach via direct messaging.





Reached out to  
**11,000+** patients  
via patient portal  
and text messages



Collected and  
entered **1,500+**  
BP readings into  
EHR for pop health



Enrolled **300**  
patients in fully  
remote fashion







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# Using AI to Draft Replies to Patient Messages

- **Problem:** COVID-19 hastened the adoption of virtual care resulting in 1.6-fold increase in electronic patient messages
- **What's been done:** AI chatbots can draft replies to messages with human-quality text
- **What we're doing:** Testing a ChatGPT-powered Epic “draft auto-reply” feature with PCPs





# In Basket Burden

**COVID exacerbated the gender disparity in physician electronic health record inbox burden**

Lisa Rotenstein<sup>1</sup>, A Jay Holmgren<sup>2</sup>

## **Association of Electronic Health Record Inbasket Message Characteristics With Physician Burnout**

Sally L Baxter<sup>1 2</sup>, Bharanidharan Radha Saseendrakumar<sup>1</sup>, Michael Cheung<sup>3</sup>,  
Thomas J Savides<sup>2</sup>, Christopher A Longhurst<sup>2 4</sup>, Christine A Sinsky<sup>5</sup>, Marlene Millen<sup>2</sup>,  
Ming Tai-Seale<sup>2 3</sup>

## **Increased Clinician Time Using Electronic Health Records During COVID-19 Pandemic**

Timothy Tsai<sup>1 2 3</sup>, Mina Boazak<sup>1 4 3</sup>, Eugenia R McPeck Hinz<sup>1</sup>



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# In Basket Burden

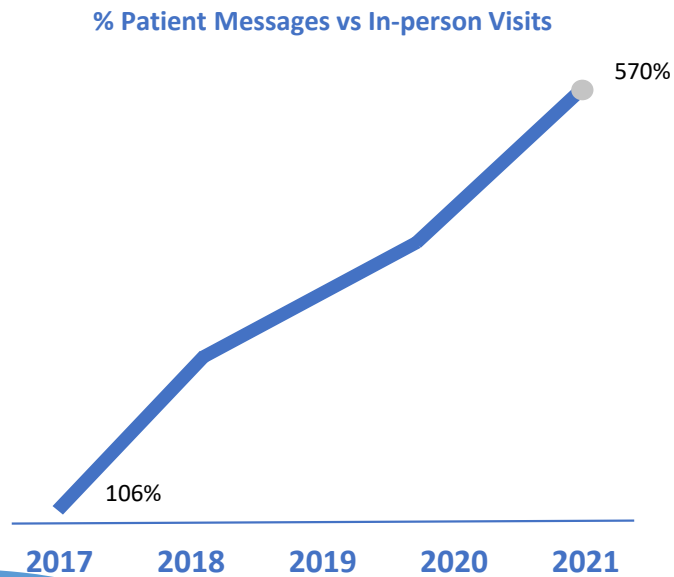
How did we get here?

- HITEC Act and meaningful use
  - Adoption of EHR-based patient portals
- 21<sup>st</sup> Century Cures Act
- COVID 19 pandemic
  - Telehealth
  - Remote Care



# In Basket Burden

Electronic messaging within electronic health records (EHRs) has emerged as a leading cause of clinician burnout



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# In Basket Burden

- Loss of the therapeutic relationship
- Clinician burnout
- Exacerbation of inequalities from the Digital Divide

**Table 4.** Physician Time Distribution During Office Hours, by Task Category

Task Category, by Activity During Office Hours	Tasks, <i>n</i>	Mean Time to Complete Task, <i>s</i>	Tasks per Hour, <i>n</i>	Time Spent (95% CI), %	
				Total*	By Task Category
<b>Direct clinical face time</b>				33.1 (31.9-34.5)	
With patient	4483	93	10	-	27.0 (25.8-28.3)
With staff and others (patient not present)	2121	45	5	-	6.1 (5.7-6.5)
<b>EHR and desk work</b>				49.2 (47.8-50.6)	
Documentation and review	8623	69	20	-	38.5 (37.3-39.8)
Test result	1661	59	4	-	6.3 (5.8-6.8)
Medication order	622	59	1	-	2.4 (2.2-2.5)
Other order	610	52	1	-	2.0 (1.9-2.2)
<b>Administrative tasks</b>				1.1 (0.9-1.3)	
Insurance	191	49	<1	-	0.6 (0.5-0.7)
Scheduling	125	59	<1	-	0.5 (0.3-0.6)
<b>Other tasks</b>				19.9 (18.2-21.6)	
Closed to observation	163	524	<1	-	5.5 (4.5-6.5)
Other (aggregated)	969	183	2	-	5.2 (4.3-6.0)
Transit	2946	15	7	-	2.9 (2.8-3.0)
Personal	902	109	2	-	6.3 (5.6-7.1)

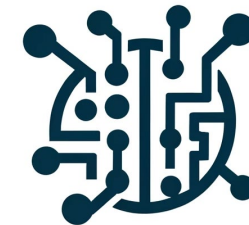
EHR = electronic health record.

\* Total sums to 103.3% because the Work Observation Method by Activity Timing platform allows recording of 2 tasks done in parallel. Multitasking results in overlapping time records, which are additive. Thus, the total task time is >100% of the total time observed.

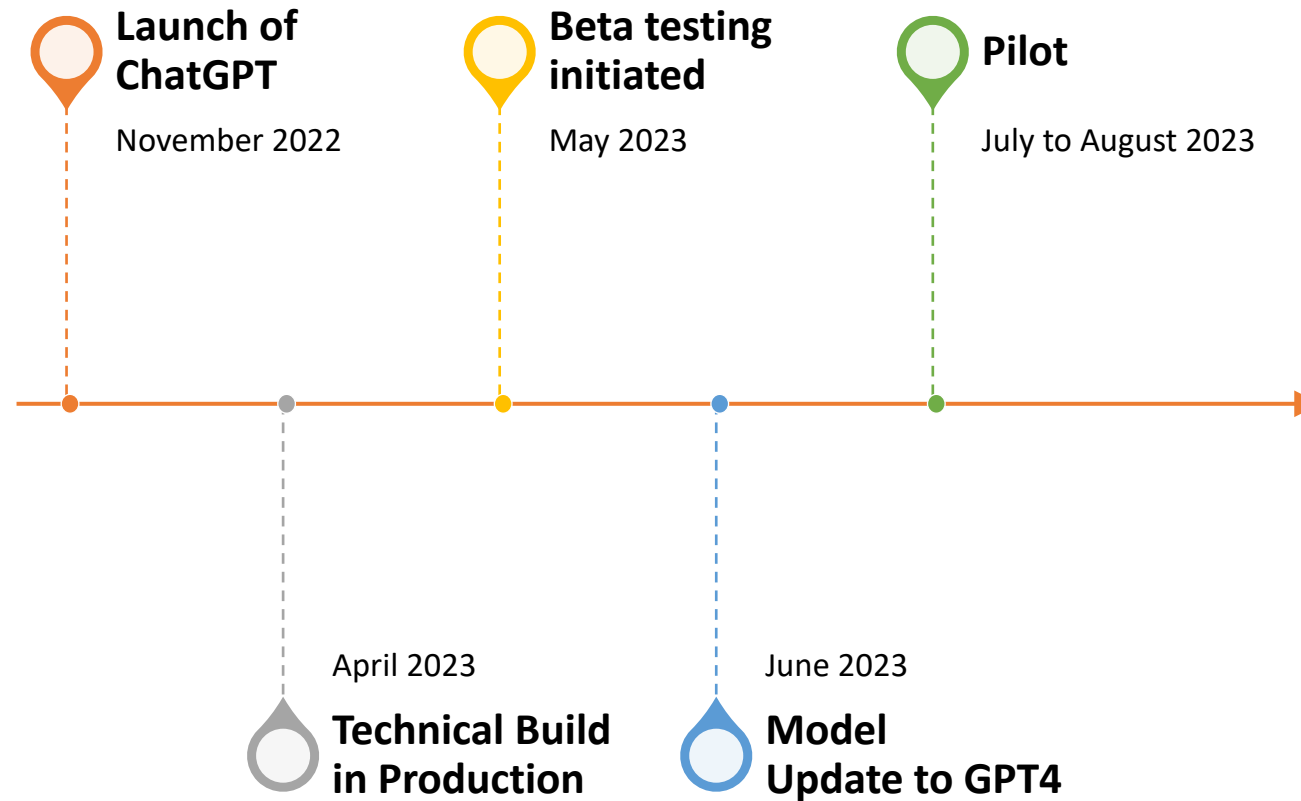


# Strategies to Address In Basket Burden

- Billing for patient messages
- Automated message categorization and triage
- Multidisciplinary teams to address message pools
- **AI-generated draft patient messages**



# Beta testing with GPT 3.5



# LLM Draft Replies Pilot Study: A developmental assessment for quality improvement (QI) purposes leveraging the RE-AIM evaluation framework for AI (GPT4) generated draft replies for patient messages

Enrolled 206 users in Primary Care and GI including frontline providers (MDs/APPs), RNs, and clinical pharmacists

1

Explore the utility of the AI LLM tool and possible impact on burnout/burden

2

Assess barriers and facilitators to broad implementation

3

Inform iterative improvements to the AI LLM tool

Pre and Post Surveys  
(NASA TLX, Burnout, Usability)

Reporting  
(Clarity, Signal)

Pilot Feedback Channels  
(Point of message feedback in Epic, ad hoc emails)

**Analysis performed on 80 providers for whom we have both pre- and post- surveys**



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Care Team  
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Health Policy,  
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Develop effective  
cross-sectoral  
collaborations

Engage in the  
implementation  
science of AI/ML

Partner in AI/ML  
policy and health  
equity work





# The Future

AI is not going to replace humans, but humans with AI are going to replace humans without AI

Karim Lakhani  
Professor, Harvard Business School



[Figure 1](#)

A "Fundamental Theorem" of informatics.

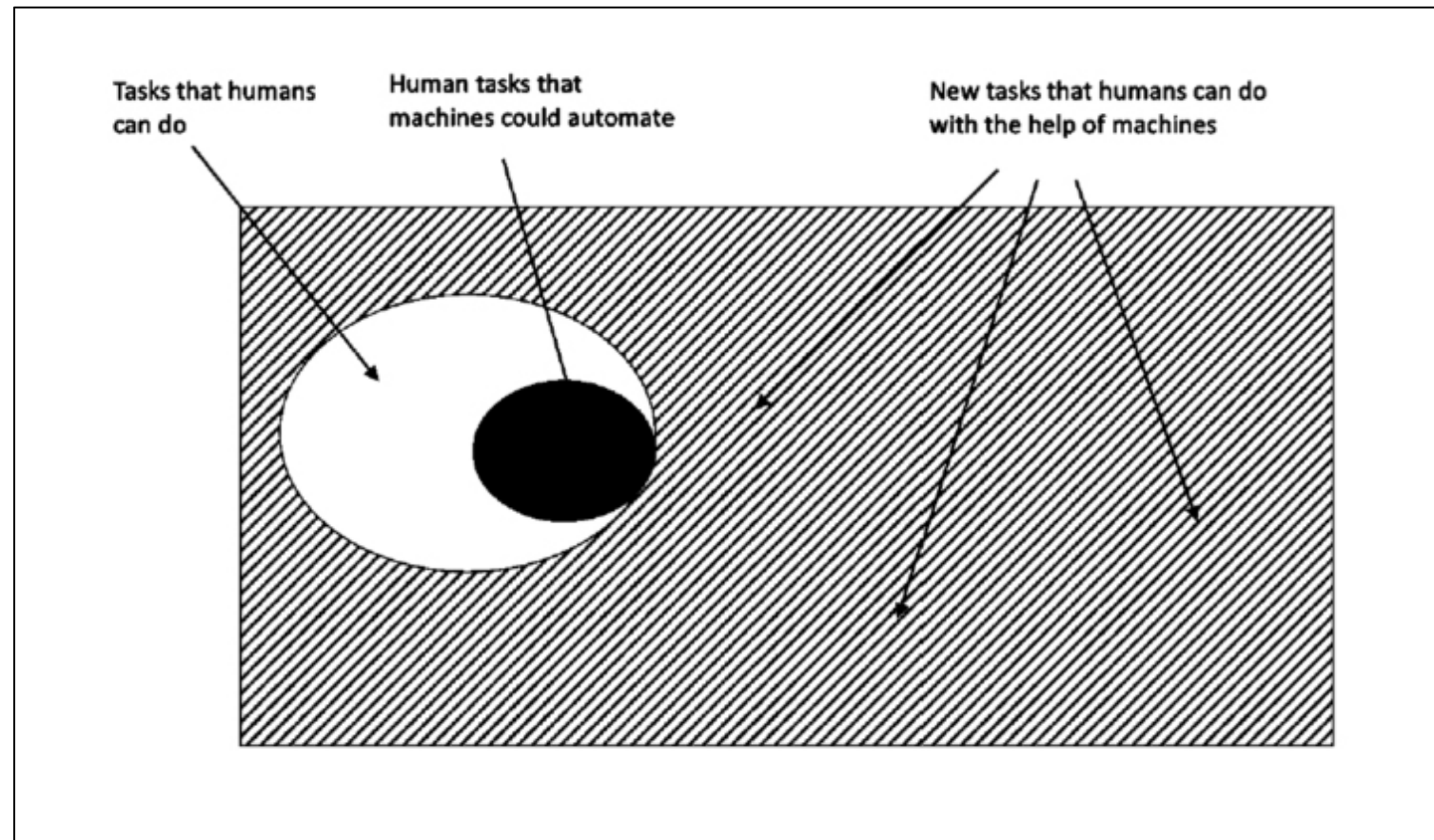
Charles Friedman, 2009  
-A "fundamental theorem" of biomedical informatics. J Am Med Inform Assoc. 2009 Mar-Apr;16(2):169-70.



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# The Future



Erik Brynjolfsson, Professor, Director Stanford Digital Economy Lab

<https://digitaleconomy.stanford.edu/news/the-turing-trap-the-promise-peril-of-human-like-artificial-intelligence/>



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# Thank you! Questions?



<https://med.stanford.edu/healthcare-ai.html>

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