AI in Medicine & Healthcare Ventures

PSYC180/MED180

Spring 2023
Today

- Class Format & Intro
- US Healthcare System
- Artificial Intelligence
- Medicine & Healthcare
- Lean Launchpad Methodology
Today

Class Format & Intro

US Healthcare System

Artificial Intelligence

Medicine & Healthcare

Lean Launchpad Methodology
Instructor and Office Hours

Ehsan Adeli, Ph.D.,
Computer Science,
AI, Healthcare, Neuroscience

Office hours: Coordinated via email (or Tuesdays 1:30-2:30pm)
Location: Gates Building Rm 300 (or Zoom)
Thanks

Stephen Su
CS Student

Daniel Wu
CS Student

Edwin Pan
EE Student

Student Initiated Course in 2021

MED 18SI
Artificial Intelligence in Medicine and Healthcare Ventures

Department of Medicine, Stanford University, Spring 2021
Class

- Location Building 420 - Main Quad, Room 041
- Zoom (only accessible through Canvas). Please do not share the Zoom links outside the class.
- **Time:** Tuesdays 11:30am - 1:20pm

- **Course Website:**
  - [https://aimedv.Stanford.edu/](https://aimedv.Stanford.edu/)

- **Canvas:**
  - PSYC180: [https://canvas.stanford.edu/courses/174256](https://canvas.stanford.edu/courses/174256)
  - MED180: [https://canvas.stanford.edu/courses/175858](https://canvas.stanford.edu/courses/175858)
Format

1-Unit
- lecture only, 11:30AM-12:30PM
- Students are encouraged to stay for the second half too
- **Grading:** Submit a summary of each week's lecture, question asked in the class (assignments, link on the website)

2-Units
- attending discussion section in a Lean LaunchPad-style training program
- Completing a project in a team (team-based learning)
- **Grading:** Deliver a pitch presentation in front of an invited Panel
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Time</th>
<th>Speaker/Title/Institution</th>
<th>Topic/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apr 4, 2023</td>
<td>11:30am-12:30pm</td>
<td>Ehsan Adeli, Course Instructor</td>
<td>Introduction (20 min) + Course Overview (10 min) + U.S. Healthcare System Overview (20 min) + Opportunity Evaluation (for course projects) (10 min)</td>
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<tr>
<td></td>
<td></td>
<td>12:30pm-1:28pm</td>
<td>Stephen Xu, Stanford UCME Student</td>
<td>A Digital Health Playbook - An overview of various digital health companies, their business models, and what worked or didn’t work</td>
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<td>2</td>
<td>Apr 11, 2023</td>
<td>11:30am-12:30pm</td>
<td>Robert Chess, Lecturer at Stanford Graduate School of Business</td>
<td>The Healthcare Landscape - Stakeholders and major players</td>
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<td></td>
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<td>12:30pm-1:28pm</td>
<td>Ehsan Adeli, Course Instructor</td>
<td>Year building - Project planning and preparing for loan/launchpad training</td>
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<tr>
<td>3</td>
<td>Apr 18, 2023</td>
<td>11:30am-12:30pm</td>
<td>David Enns, President and CEO of Stanford Healthcare (SHC)</td>
<td>The Healthcare Landscape - Current tools and techniques (How\ SHC\ is\ building\ AI)</td>
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<td></td>
<td>12:30pm-1:28pm</td>
<td>Ehsan Adeli, Course Instructor</td>
<td>Search versus Execution - Search for a business model in the healthcare climate</td>
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<td>4</td>
<td>Apr 25, 2023</td>
<td>11:30am-12:30pm</td>
<td>Kevin Schulman, Professor of Medicine, Associate Chair of Business Development and Strategy in the Department of Medicine</td>
<td>Healthcare Landscape: current tools, techniques, and pitfalls (Economics of Healthcare)</td>
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<td>12:30pm-1:28pm</td>
<td>Narciso Garcia, Senior Software Quality Engineer at WellDoc, Inc.</td>
<td>Healthcare Tech Landscape from a regulatory point of view: A discussion around Medical Device, Software as a medical device (SaMD), FDX, Quality, and aspects</td>
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<td>5</td>
<td>May 2, 2023</td>
<td>11:30am-12:30pm</td>
<td>Jordan Jacobs, Co-Founder &amp; Managing Partner at Radical Ventures</td>
<td>Technologies on the Horizon - Upcoming companies, problem areas, and policy breaks</td>
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<td>12:30pm-1:28pm</td>
<td>Ehsan Adeli, Course Instructor</td>
<td>Customer Discovery and Validation - Turning hypotheses to facts</td>
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<td>6</td>
<td>May 9, 2023</td>
<td>11:30am-12:30pm</td>
<td>Gopi Prashanth, Founder, Syn Inc</td>
<td>Case Study: Building to Solve the Problem at Scale - Building to scale is what most entrepreneurial startups do. There is another kind of innovation, which is building to solve the problem which is already at scale. Gopi can speak to both ends of this spectrum and the similarities and differences in entrepreneurial mindset that is required to solve the myriad of challenges throughout the journey.</td>
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<td>12:30pm-1:28pm</td>
<td>Raduianae (Radka) Chopkiewicz, Director of Engineering, Stanford Department of Biology</td>
<td>Team building and leadership practices in healthcare and medicine</td>
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<td>7</td>
<td>May 16, 2023</td>
<td>11:30am-12:30pm</td>
<td>Vivien Hs, Partner at Pear VC, with a focus on health</td>
<td>Healthcare Innovation - Practical considerations and common pitfalls</td>
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<td>12:30pm-1:28pm</td>
<td>Ehsan Adeli, Course Instructor</td>
<td>Operating and decision making in chaos with insufficient data</td>
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<td>8</td>
<td>May 23, 2023</td>
<td>11:30am-12:30pm</td>
<td>Kimberly Powell, Vice President and General Manager, Healthcare at NVIDIA</td>
<td>Case Study: Healthcare innovation, integrating and scaling technologies within large healthcare systems</td>
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<td>Ehsan Adeli, Course Instructor</td>
<td>Teamwork</td>
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<td>Ehsan Adeli, Course Instructor</td>
<td>Teamwork</td>
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<td>9</td>
<td>May 30, 2023</td>
<td>11:30am-12:30pm</td>
<td>Jonathan Berent, CEO of NextSense Inc, Life-Hacker, Director @ X, Moonshot Factory</td>
<td>Case study: Uncovering brain health with real-world data insights and practical, scientific wisdom for daily living</td>
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<td>12:30pm-1:20pm</td>
<td>Lea Sardy, Founder and CEO of new AI healthcare company (stealth)</td>
<td>Case Study: Leading development and commercialization of advanced machine learning, computer vision, diagnostic and digital health technologies that have made a significant impact on healthcare practice</td>
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</tbody>
</table>
| 10   | June 6, 2023  | 11:30am-12:30pm | Students and Ehsan Adeli, Course Instructor | Pitch Project Presentations Panellists:  
- Vivien Ho, Partner at Pear VC (Investing in health: human, planet and financial health)  
- Jay Rughand Partner at Andreas Horowitz (Bio + Health investing team)  
- Partner at Radical VC |
Team Building

- Start forming teams
- Enter info here (Deadline April 11):
  - https://forms.gle/sdyTr8whWbwqQxTFY9
Today

Class Format & Intro

US Healthcare System

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Lean Launchpad Methodology
U.S. Health System
U.S. Health System (cont’d)

https://doi.org/10.1787/health_glance-2017-en
Where & How AI Provides Opportunities for Improvement

- Current context of healthcare and drivers for its change
  - Automation
  - Information synthesis and recommendation

- To
  - Patients
  - fRamilies (friends and family)
  - Clinical team
Where & How AI Provides Opportunities (cont’d)

- Technology Innovations & Funding
- Business Criteria
  - Profit
  - Efficiency
  - Return on Investment
- U.S. Public & Government Views of Healthcare
- Healthcare as social good
  - Healthcare as economic commodity

eadeli@stanford.edu - PSYC180/MED180 - Spring 2023
Where & How AI Provides Opportunities (cont’d)

▪ Use cases:
  ▪ reduce cost and gain efficiencies through prioritizing human labor focus on more complex tasks
  ▪ identify workflow optimization strategies
  ▪ reduce medical waste
    ▪ failure of care delivery,
    ▪ failure of care coordination,
    ▪ overtreatment or low-value care,
    ▪ pricing failure,
    ▪ fraud and abuse,
    ▪ administrative complexity
  ▪ automate highly repetitive business and workflow processes by using reliably captured structured data
Critical to be
- thoughtful,
- equitable,
- inclusive

To avoid
- adverse events
- unintended consequences

Ensuring that AI tools
- align with the preferences of users and end targets
- do not exacerbate historical inequities in access and outcomes
National Academy of Medicine Report

- Stakeholders
  - AI model developers,
  - clinical implementers,
  - clinicians and patients,
  - regulators,
  - policy makers
  - ...

- Outlines key considerations for moving forward
Summary

- **Population-representative** data accessibility, standardization, quality is vital.
- **Ethical** health care, equity, and inclusivity should be prioritized.
- The dialogue around **transparency** and trust should change to be domain- and use-case differential.
- Near-term focus should be on **augmented intelligence** rather than full automation.
- Develop and deploy **appropriate training and educational programs** to support health care AI.
- **Leverage existing frameworks** and best practices within the learning health care system, human factors, and implementation science.
- **Balancing** degrees of regulation and legislation of AI to promote innovation, safety, and trust.
This week’s assignment
Healthcare is hard
Selling into healthcare is hard

Healthcare is generally BIG, SLOW, and BUREAUCRATIC

Adoption of innovation lags

The regulatory and compliance environment leads to deal cycles that are at minimum 6 months, but more likely a year

Sell into healthcare organizations,

• the hurdles to overcome,
• how not to get stuck in a "pilot" mode,
• understanding payment models and deal structure

The general belief is that the next company that rises to be the largest company in the world will likely be a healthcare company!

Kim Petty, OnWard Co-Founder and CEO
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Meaning

AI systems:
- model human reasoning to solve a problem
- ignore human reasoning and exclusively use large volumes of data to generate a framework to answer the question(s) of interest
- attempt to incorporate elements of human reasoning but do not require accurate modeling of human processes.
Declares computers can ID objects better than humans
Artificial Intelligence

Methods
- Machine Learning
  - Neural Networks (Deep Learning)
  - Support Vector Machines
- Probabilistic Methods
  - Bayesian Networks
  - Hidden Markov Models
- Logic
  - Fuzzy
  - Reasoning
- Expert Systems
  - Natural Language Processing
- Evolutionary Computation
  - Information Retrieval
  - Information Extraction
  - Translation
- Computer Vision
  - Image Recognition
  - Video Analysis (Activity Recognition)
- Planning/Scheduling
- Predictive Analytics
- Robotics
- Speech
  - Text to Speech
  - Speech to Text
  - Speaker Verification

Applications
- Natural Language Processing
- Information Retrieval
- Information Extraction
- Translation
- Computer Vision
- Image Recognition
- Video Analysis (Activity Recognition)
- Planning/Scheduling
- Predictive Analytics
- Robotics
- Speech
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Large Language Models (LLMs)
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Timeline of Medical History

Prehistoric
8000 BC

Ancient
Chinese
3000 BC

Ancient
Babylonian
2000 BC

Ancient
Greeks & Romans
400 BC – 300 AD

Middle Ages
(Dark Ages)
500 – 1400 AD

The
Renaissance
1400 – 1700 AD

Ancient
Indians
3000 BC

Ancient
Egyptian
2000 BC

Islamic Medicine
700 – 1500 AD

Modern Medicine
18th – 21st century

AD
Latin: anno domini
‘In the year of our Lord’
(Birth of Christ)
Innovations in Medical and Biological Engineering

- 1950s and earlier
  - Artificial Kidney
  - X ray
  - Electrocardiogram
  - Cardiac Pacemaker
  - Cardiopulmonary bypass
  - Antibiotic Production technology
  - Defibrillator
Innovations in Medical and Biological Engineering

• 1950s and earlier
  • **Artificial Kidney**
  • X ray
  • Electrocardiogram
  • **Cardiac Pacemaker**
  • Cardiopulmonary bypass
  • **Antibiotic** Production technology
  • Defibrillator

• 1960s
  • Heart valve replacement
  • Intraocular lens
  • **Ultrasound**
  • Vascular grafts
  • Blood analysis and processing

• 1970s
  • Antibody production

• 1980s
  • Laser surgery
  • Artificial heart

• 1990s
  • Magnetic resonance imaging

• 2000s
  • Genetic engineering for gene therapy
  • Nanotechnology
  • Stem cell therapy
Innovations in Medical and Biological Engineering

• 1950s and earlier
  • Artificial Kidney
  • X ray
  • Electrocardiogram
  • Cardiac Pacemaker
  • Cardiopulmonary bypass
  • Antibiotic Production technology
  • Defibrillator

• 1970s
  – Computer assisted tomography
  – Artificial hip and knee replacements
  – Balloon catheter
  – Endoscopy
  – Biological plant food engineering
Innovations in Medical and Biological Engineering

• 1960s
  – Heart valve replacement
  – Intraocular lens
  – Ultrasound
  – Vascular grafts
  – Blood analysis and processing

• 1980s
  – Magnetic resonance imaging
  – Laser surgery
  – Vascular grafts
  – Recombinant therapeutics

• Present day
  • Genomic sequencing and microarrays
  • Positron Emission tomography
  • Image guided surgery
WHAT IS CHAT-GPT, THE AI CHATBOT THAT’S TAKING THE INTERNET BY STORM
- Medical Note Taking
- Inference over Innate Medical Knowledge
- Medical Consultation
- ...

The New England Journal of Medicine

Special Report

AI in Medicine

Benefits, Limits, and Risks of GPT-4 as an AI Chatbot for Medicine

Peter Lee, Ph.D., Sebastien Bubeck, Ph.D., and Joseph Petro, M.S., M.Eng.

NEJM 388;13 NEJM.org March 30, 2023
ChatCAD

Input: medical exam image and chief complaint text

A. Disease Classifier

B. Lesion Segmentor

C. Report Generator

Trainable

Frozen

Online

Prompt text

Network A’s diagnosis prediction: pneumonia.
Network B’s segmentation result: 35% of lung is infected.

Network C generated a report: “... airspace consolidation is noted within the left lower lobe concerning for pneumonia...”

Refine the report based on results from Network A and Network B

Large Language Model (e.g., ChatGPT)

“...have been provided and show 35% of the left lower lobe to be infected, consistent with a diagnosis of pneumonia...”

What medicine should I take?

...In general, bacterial pneumonia is treated with antibiotics, while viral pneumonia is treated with antiviral medications. Pain relievers and cough medicines can also be used to relieve symptoms...

Wang et al. Arxiv 2023
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To be continued next session ...
Thank You!

https://stanford.edu/~eadeli

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