

# 90-835: Designing Smart and Healthy Systems: Applying Artificial Intelligence to Healthcare

Mini 4, Spring 2024 (3 units)

Classes held in person from 9 AM- 4:30 PM on Saturdays of March 30 and April 20, 2024, room TBD, and in one on-line session on Saturday, April 6.

## Overview

This course will give students with no previous experience in artificial intelligence a chance to learn about applications of AI to health care. Drawing on consulting experience for healthcare clients, this course will survey several real-life healthcare applications of AI capabilities, including predictive modeling, intelligent computer interaction, social network analysis, computer vision, and large language models. Along the way, we will also discuss concepts from behavioral economics, causal inference, gamification and more. Beyond introducing students to the field, the course aims to build critical thinking skills, so for their final project, teams of students will describe an AI healthcare application and a critical evaluation of claims made by researchers or vendors for that application

## Course Learning Outcomes

The main learning objectives of the course are to:

1. Describe a range of real-world applications of AI to healthcare including both achievements and challenges faced.
2. Understand why large language models have generated such excitement for health care, along with limitations and risks of the technology.
3. Apply a range of techniques for evaluating AI healthcare applications and results, including experimental design, and causal inference.

## Course Prerequisites

Prerequisites: None but a basic knowledge of statistics (such as statistical significance) will be helpful for the material on evaluating applications.

## Instructor: David Steier (PhD, CMU SCS '89)

David Steier joined the CMU faculty in 2018 as a Distinguished Service Professor in the Heinz College School of Information Systems and Management. He teaches courses on data science for product management, managing analytics projects, designing smart systems and artificial intelligence. Prior to joining CMU, David was Managing Director in Deloitte Consulting's Data Science practice. At Deloitte, David helped clients use advanced data analytics and visualization in a variety of industries including health care, banking, retail, manufacturing, telecommunications, media and the public sector. Prior to Deloitte, David was Director in the Center for Advanced Research at PwC, Senior Director of Technology and Business Development at Kanisa, and Managing Director at Scient. David was also a Continuing Lecturer at the University of California Berkeley's School of Information, where he was course lead for the capstone class in the Masters in Information and Data Science program. David holds a Ph.D. in computer science from CMU and a bachelor's degree in computer science from Purdue University.

## Course Resources and Policies

### Canvas

An online site with the syllabus, selected readings, and other resources will be on Canvas. Rather than emailing questions, students are encouraged to post questions on Canvas, so that other students can see the answers and join in discussions as needed.

### Readings

There is no textbook for the course. Online readings as listed below are required.

### Grading

Grading in this class will be based on class participation, a quiz, and a final project. The class participation portion of the grade (20%) is based on attendance and participation in discussions at all three sessions (two in-person and one online). The quiz (20%) will be administered over Zoom. The final project to be done by team will count for 60% of the grade: 10 % for the project proposal due April 10<sup>th</sup>, 25% for the final presentation on April 20<sup>th</sup>, and 25% for the final report due April 24<sup>th</sup>. There is no final exam for this class. Grading is on a straight scale: 90.0% and above is an A, 80.0% and above is a B, and so on (no rounding up).

## Course Outline

This is a “micro-mini” course taught mainly in person in two full-day Saturday sessions (march 30<sup>th</sup> and April 20<sup>th</sup>) and a briefer on-line session on April 6

### Saturday, March 30

DRAFT: Work in progress subject to change, last edited November 3, 2023, © David Steier

- 9:00 – 10:00 AM: Overview of AI in healthcare
  - **Topics**
    - Introductions
    - Course structure and policies
    - Review of artificial intelligence
    - AI in healthcare
  - **Readings**
    - Davenport, T. and Kalakota R., "The potential for artificial intelligence in healthcare," *Future Healthcare Journal*, 2019 Jun; 6(2): 94–98.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/>
    - M. Lenharo, "An AI revolution is brewing in medicine. What will it look like?", 24 October 2023, <https://www.nature.com/articles/d41586-023-03302-0>
  
- 10:15 - 11:15 AM: Improving diabetes patient engagement in Mexico
  - **Topics**
    - Overview of diabetes in Mexico
    - The Clinicas del Azucar (CdA) approach to treating diabetes
    - Overview of the CdA data
    - Analysis and findings on patient engagement
    - Recommendations
  - **Readings**
    - World Health Organization , "Quality of care is key to tackling Mexico's diabetes emergency," *Bulletin of the World Health Organization* 2017; 95: 393-394,  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5463818/>
    - CdA Data dictionary (attached to Canvas)
    - J. Lozano, et. al, "Pathway Analysis for Care Adherence Modeling," Poster presented at APHA, 2020 (attached to Canvas)
  
- 11:30 AM – Noon: Gamification to increase physical activity
  - **Topics**
    - Gamification to increase physical activity
    - Design of the STEP-UP trial
  - **Readings**
    - Health Catalyst Editors, "Healthcare NLP: The Secret to Unstructured Data's Full Potential," April 2, 2019,  
<https://www.healthcatalyst.com/insights/how-healthcare-nlp-taps-unstructured-datas-potential>
    - Mitesh S. Patel, Dylan S. Small, Joseph D. Harrison, Michael P. Fortunato, Ai Leen Oon, Charles A. L. Rareshide, Gregory Reh, Gregory Swartz; James Guszcz; David Steier; Pameljit Kalra; Victoria Hilbert, "Gamification Interventions With Social Incentives for Increasing Physical Activity Among Overweight and Obese Adults Across the United

States: The STEP UP Randomized Clinical Trial,” JAMA Intern Med.  
Published online September 9, 2019.

<https://www.ncbi.nlm.nih.gov/pubmed/31498375>

- Mitesh S. Patel and X. Shirley Chen, <https://hbr.org/2020/11/digital-health-tools-offer-new-opportunities-for-personalized-care>

- 1 PM – 2 PM: Other applications of AI in healthcare

- **Topics**

- Reducing unplanned hospital readmissions
- Social network analysis for predicting prescription behavior
- Diagnoses from medical imagery
- Robot-assisted spinal surgery
- Clinical trial generation
- Drug discovery
- Protein folding

- **Readings**

- TBD

- 2:15 – 3:15 PM: Evaluating AI applications in healthcare

- **Topics**

- Criteria for evaluating healthcare applications
- Experimental design
- Causal inference for observational data

- **Readings**

- Imbens, G.W., and Rubins, D.B. Chapter 4 “A Taxonomy of Classical Randomized Experiments,” in *Causal Inference for Statistics, Social and Biomedical Sciences*, Cambridge University Press, 2016

- D.E. Rubin, “Causal Inference,” in *International Encyclopedia of Education*, (3<sup>rd</sup> edition), 2010, <https://www.sciencedirect.com/science/article/pii/B9780080448947013130>

- 3:30- 4:30 PM: Final project working session

- **Topics**

- Introduction to final projects
- Brainstorming on final project topics
- Prepare for next session’s quiz

Saturday, April 6 (on Zoom)

DRAFT: Work in progress subject to change, last edited November 3, 2023, © David Steier

- 1 – 1:30 PM: Quiz
- 1:45 – 2:30 PM: Project team breakouts
- 2:45 – 3:30 PM: Project check-ins

Saturday, April 20

- 9 – 10 AM: Large Language Models in Healthcare
  - **Topics**
    - What are large language models?
    - Potential and limitations of LLMs in healthcare
    - LLMs as medical chatbots
    - LLMs for summarizing medical notes
  - **Readings**
    - Strong E, DiGiammarino A, Weng Y, et al. Chatbot vs Medical Student Performance on Free-Response Clinical Reasoning Examinations. *JAMA Intern Med.* 2023;183(9):1028–1030. doi:10.1001/jamainternmed.2023.2909
    - Ayers JW, Poliak A, Dredze M, et al. Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum. *JAMA Intern Med.* 2023;183(6):589–596. doi:10.1001/jamainternmed.2023.1838
- 10:15 – 11 AM: Guest lecture
- 11:15 AM- Noon: Team work time
- 1 - 4:30 PM Final project presentations and discussion

## Academic Integrity

Students are expected to strictly follow Carnegie Mellon University rules of academic integrity in this course. This means in particular that unless otherwise specified, homework are to be the work of the individual student using only permitted material and without any cooperation of other students or third parties. It also means that usage of work by others is only permitted in the form of quotations and any such quotation must be distinctively marked to enable identification of the student's own work and own ideas. All external sources used must be properly cited, including author name(s), publication title, year of publication, and a complete reference needed for retrieval. The same work may not be submitted for credit in multiple courses. Violations will

DRAFT: Work in progress subject to change, last edited November 3, 2023, © David Steier

be penalized to the full extent mandated by the CMU policies. There will be no exceptions.

## Diversity

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups.

## Disability Accommodations

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

## Mental Health

As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at: <http://www.cmu.edu/counseling/>. Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.

**Suicide Prevention Hotline: 800-273-8255 (TALK)**