Syllabus: Human-AI Complementarity for Decision Making
(10-736/88-836; 88-436)

Spring 2025

Instructor:
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Office hours:
- Coty Gonzalez: Tuesdays, 9:00-10:00, Porter Hall 223-F
- Hoda Heidari: Thursdays, 14:00–15:00, GHC 8229
- Chase McDonald: Mondays 12:00-13:00, Porter 223G; or via Zoom
- Jennifer Hsia: Mondays 16:00–17:00, GHC 8007 or via Zoom

Lecture time and location: Tuesdays and Thursdays, 15:30 -16:50 Hrs, GHC 4101

Capacity:
- Note that the course is cross-listed between SCS/MLD (10-736) and Dietrich/SDS (88-836-PhD and 88-436-Undergrad). Please register for the appropriate listing.

Level: Junior/Senior, M.Sc., Ph.D.

URL: https://canvas.cmu.edu/courses/44677

Course Description

Humans and AIs bring distinct strengths to decision-making in uncertain, dynamic, and complex environments. How can we design human-AI decision making systems that draw on the strengths of humans and AI technologies to remedy the limitations and weaknesses of each one in isolation and improve the quality of the resulting decisions?

This course will explore the emerging science of human-AI decision-making, focusing on how humans and AIs can complement each other. The course will teach students to identify the conditions and criteria for human-AI complementarity, determine the major research gaps in prior research, and put forward an interdisciplinary research agenda to mitigate and address these gaps. The students in the course are expected to define and write down a concrete research proposal addressing one of the core topics of the course.

The course's primary goals are: (a) to introduce students to the nascent area of human-AI complementarity for decision making, (b) to prepare students to critically analyze emerging issues of Human-AI complementarity, and (c) to guide students to identify research gaps and propose concrete research projects to address these gaps.

Key Topics

This course will cover:
- Human and AI intelligence

- Human and AI biases and weaknesses
- Models of Human and AI decision making
- Human mental models of AI and AI models of human decision makers
- Human-AI complementarity, causes and mediators.

Prerequisite Knowledge

- Familiarity with basic AI concepts (e.g., Supervised Learning, Reinforcement Learning), basic knowledge of probability, statistics, linear algebra, and optimization as it pertains to introductory AI topics.
- General knowledge of human decision making (e.g., Prospect Theory, Optimal Stopping, Sequential Decision Making), cognitive biases, learning and psychological aspects of human decision making.
- Critical thinking capabilities to read, analyze, critique research articles in both AI and cognitive and psychological sciences.
- Excellent writing and verbal communication skills that would serve the generation of new research proposals

Prerequisite/Corequisites/Antirequisite Courses

One of the following courses from SCS [07180 or 15281 or (10301 or 10315)]. The class is a reading and writing heavy class with no programming project.

Course Relevance

The successful use of AI in practice increasingly requires human decision-makers knowing how to interact with AI. It is, therefore, imperative for AI experts and practitioners to understand and design for human-AI complementarity in new decision-making tasks and environments that may arise in their work.

Course Goals

The course's primary goals are to raise awareness regarding the relevant issues surrounding the nascent area of Human-AI complementarity for decision making.
The course will guide students to learn about the topics

The course's primary goals are: (a) to introduce students to the nascent area of human-AI complementarity for decision making, (b) to prepare students to critically analyze emerging issues of Human-AI complementarity, and (c) to guide students to identify research gaps and propose concrete research projects to address these gaps.

At the end of this course, students will be able to:
- Demonstrate familiarity with state of the art research and practice in human-AI complementarity for decision making.
- Articulate research gaps and the relevance of addressing these gaps in the theme of human-AI complementarity selected for the final project.
- Describe the research methods that will be proposed to answer the research questions of the proposed project.
- Articulate the technical details and innovations of the proposed approach.
- Be able to explain verbally a synthesis of a proposed project.

Assessment Structure

Assessment will be based on student classroom activities and a written research proposal for a student's choice of a human-AI complementarity for Decision Making problem.

Participation in classroom activities (20%)
- Submit questions about articles assigned for reading to discuss in class
- Engagement in critical discussions about the articles assigned during class
- Engagement in lectures and other classroom activities

Project Milestones (45%)
You will receive feedback from the teaching team on each deliverable. At every phase, you should submit your entire work so far, and we expect feedback from previous rounds to be addressed in the next deliverable.

1) Initial topic selection (5%): Conduct an initial study of your *research topic*, draft the research questions, and a present initial justification (why are the questions important? What is the societal impact of answering those questions?).
2) Introduction and background draft (10%): This deliverable will establish the *research questions*, providing the context and establishing novelty and theoretical and applied significance of those questions, through a comprehensive *literature review* and identifying knowledge gaps. The draft introduction should discuss the broader goals of the proposed research and relevance to society and human life.
3) Research methodology draft (10%): This deliverable will provide a detailed research plan. It will provide an explanation of the *proposed methodology* to address the above research question. What are the methods that are proposed to answer the research questions? How does the proposed research program answer the research questions? Why are the proposed methods and techniques appropriate for the current project? What are the expected results and deliverables?
4) Project management draft (5%): Describe the personnel required, other resources and facilities required, timeline, budget (personnel, equipment, supplies), and the timeline.
5) Limitations and risks (5%): What are the limitations of the proposed approach? What are the ways in which the plan may fail?
6) Proof of concept (5% + 5% extra credit) to show the feasibility of the proposed research.
7) Critical peer feedback (5%): Each student will be required to read and provide critical feedback regarding the deliverables above: (1) Research proposal topic and justification, (2) introduction and background, (3) research methodology, and (4) project management, to another student. The student assigned to read and give feedback will be different for each of the three deliverables.

Final Project Presentation (15%)
- Students will be assigned to one of three days for final presentations of research projects.
- Students will submit materials and deliver an oral presentation of the research proposal the day they are assigned. Presentation materials are a deliverable and the grade is earned based on the materials and the way it is presented.
- Attendance to all the students' presentations is mandatory and points will be deducted for each presentation day missed.

Final Research Project Report (20%)

- A 25 page report of a research project (excluding references). The report should incorporate the feedback provided during the milestone submissions. The report should follow the structure of a standard scientific report.
  - Abstract -1 page
  - Introduction - 2 pages
  - Related Work - 5 pages
  - Proposed research questions -1 page
  - Detailed research plan, technical approach, and methodology - 8 pages
  - Management plan -1 page
  - Limitations and risks - 1 page
  - Findings from proof-of-concept - 5 pages
  - Conclusion -1 page

Class Procedure and Learning Resources

We will not be using any textbooks. Each class will consist of short lectures that will present some basic concepts and outline main research issues related to the theme of the class. Then, the class will proceed with discussions of the research papers assigned to each class. The instructors will select some of the discussion questions submitted by each student the day before, and will start the discussion of the research papers that aim at answering those questions.

Each class will have at least one research paper assigned for reading and discussion. The papers will be uploaded to Canvas in a timely fashion. If you encounter any problem accessing any of the course-related resources, please let the teaching staff know.

You will find in Canvas the lecture materials, papers assigned for each lecture, and questions submitted by students for discussion.

Course Tags

Human-AI complementarity
Decision Making
Learning and Dynamics
Human-like capabilities
Human Collaboration & Teamwork
AI competence, reliability, trustworthiness
Models of human and environment
Writing intensive

Schedule

The course spreadsheet outlines the main modules of the course and the tentative topics that may be discussed in each one.

Week	Date	Session	Module	Topic	Description	Primary	Primary Reading	Secondary Reading	Assessments
Tue	Jan-14	1	Introduction	Course Overview	Course Overview; Goals, logistics, milestones. Discuss the process of writing a research proposal; Description of process for course project; Research questions and milestones	CG & HH	2024Vaccaro	2006BorkowskiHoward 2007Keshav	
Thur	Jan-16	2	Introduction	Defining Human Intelligence and	Human Intelligence. Definition from Human	CG	2020Griffiths	1983Sternberg	
Tue	Jan-21	3	Introduction	Defining Human-AI	Measurements, and designing for complementarity	HH	2023Rastogi	2024SteyversKumar	Initial topic selection
Thur	Jan-23	4	Overview of human decision	Behavioral Decision Making:	Behavioral decision making	CG	1981EinhornHogarth	1979Kahneman	
Tue	Jan-28	5	Overview of human decision	Dynamic sequential decision	Decisions form Description and Decisions from	CG	2017GonzalezFakhariBu	2004HertwigBarronWe	
Thur	Jan-30	6	Overview of AI decision	Supervised Learning	Defining AI	HH	RL primer (up to page		
Tue	Feb-04	7	Overview of AI decision	Strengths and weaknesses of AI		HH	2019Noguerol	2023Rastogi	Introduction and
Thur	Feb-06	8	Biases & Heuristics in	Heuristic Decision Making	Heuristic Decision Making	CG	2011GigerenzerGaissmai	2015Gershmanetal	
Tue	Feb-11	9	Biases & Heuristics in	Cognitive AI	Cognitive models of decision making	CG	2012Lejarraga et al	2003Gonzalez et al.	Critical peer feedback
Thur	Feb-13	10	Biases & Heuristics in	AI Biases		HH	2023Black	2019Heidari	
Tue	Feb-18	11	Human-AI Communication	Accuracy, confidence, calibration	Human and AI accuracy, confidence and calibration	CG	2025Lietal.	2019Bansaletal-Beyon	
Thur	Feb-20	12	Human-AI Communication	AI Explainability, Uncertainty	The pitfalls of existing explainability methods	HH	2020Zhang	2019Miller	Research
Tue	Feb-25	13	Human-AI Configurations	Full automation, delegation,		HH	2022Lai	2020Bansal	
Thur	Feb-27	14	Human-AI Configurations	Algorithmic delegates		Sophie	2025Greenwoodetal		Critical peer feedback
Tue	Mar-04				No Class; Spring Break				
Thu	Mar-06								
Tue	Mar-11	15	Human-AI Configurations	Human-like AI and AI to work with	Bulding Machines that Think and Learn WITH people	CG	2024Collinsetal-Machine	2017Lakeetal-Machine	Project Management
Thu	Mar-13	16	AI Adoption by Human	Mental Models	Shared mental models and trust in Human-AI teams	CG	Schelble et al. 2023	Andrews et al 2023	
Tue	Mar-18	17	AI Adoption by Human	External factors impacting AI		Paul	Lehner & Yeo (2025)		Limitations and risks
Thu	Mar-20	18	AI Adoption by Human	AI Appreciation vs. Aversion		HH	2022Passi	2018Logg	
Tue	Mar-25	19	Ethical Reasoning &	Safety, privacy, accountability		HH	International AI Safety		Critical peer feedback
Thu	Mar-27	20	Miscellaneous	Guest Lecture		Ken			
Tue	Apr-01	21	Miscellaneous	AI and Labor		Sarah	Peng, Kalliamvakou,		
Thu	Apr-03				No Class; Spring Carnival				
Tue	Apr-08	22	Miscellaneous	Collective Intelligence in	Anita Woolley	Anita			Proof of concept (5%
Thu	Apr-10	23	Miscellaneous	Guest Lecture - Over Zoom	Henny Admoni	Henny Admoni/CG			
Tue	Apr-15	24	Student presentations	Final presentations	Presentation schedule TBA.	Students			Materials and oral
Thu	Apr-17	25	Student presentations	Final presentations	Presentation schedule TBA.	Students			Materials and oral
Tue	Apr-22	26	Student presentations	Final presentations	Presentation schedule TBA.	Students			Materials and oral
Thu	Apr-24	27	Conclusion	Conclusion	Key takeaways from the course	CG & HH			Final research project

Statements

Student Wellness

Please take care of yourself! Make sure to take frequent breaks and move regularly, get enough sleep, eat well, and reach out to your support system or us, if you need to. In addition, please take advantage of the many excellent resources that the university offers to support your overall health and wellness during challenging and stressful times (see, for example, Counseling and Psychological Services).

Diversity

One of our key goals will be to promote fairness, diversity, and inclusion. We all come from different backgrounds and life circumstances and our diverse paths shape the perspectives we bring to the classroom. This diversity is extremely valuable as we engage with difficult topics such as unfairness and discrimination through the use of ML. While we expect there to be rigorous class discussion, we ask that you engage in discussion with care and empathy for the other members in the classroom. This is particularly important in handling disagreements. Remember: every one of us has a role to play in creating a more inclusive environment.

If any of our class meetings conflict with your religious events, please let us know so that we can make alternative arrangements for you. If you have a disability, we encourage you to discuss your accommodations and needs with us as early in the semester as possible (for more information, please see the statement below.)

Accommodations for Students with Disabilities

If you have a disability and have an accommodations letter from the Disability Resources office, we encourage you to discuss your accommodations and needs with us as early in the semester as possible. We 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, we encourage you to contact them at access@andrew.cmu.edu.

Recording Policy

Lectures will not be recorded. Students are not allowed to record any classroom activity without express written consent from the instructors. If you have (or think you may have) a disability such that you need to record or tape classroom activities, you should contact the Office of Disability Resources to request an appropriate accommodation.

Classroom Expectations

In order to attend class meetings in person, all students are expected to abide by all behaviors indicated in A Tartan's Responsibility.

Please bring a **computer device (ideally a laptop)** with you to the classroom to be able to fully participate in classroom polls and activities.

Attendance and Participation Policy

Class presence and participation points are given to encourage your active class participation and discussion. You will receive a full participation score as long as you abide by the participation defined in the assessment structure and actively contribute to the class discussion during lectures.

Late/Make-up work policy

Due dates for every assignment will be posted on Canvas. Unless otherwise stated, assignments are due on those days. However, we recognize that sometimes "life happens." In these instances, you may use your allotted **two flex days** for out-of-class assignments. These days allow you to submit any assignment up to two days late without penalty. You can use these days for any assignment and for any reason. You do not need to provide us with the reason: simply email the course instructors and tell them how many of your flex days you would like to use. When you use a flex day you need to **use the full day**, not part of the day. Once you've exhausted your flex days, then **all points will be forfeited** for any assignment **submitted after the deadline**. You will not be permitted to submit late assignments and no assignments will be accepted after the due date.

Note that you *cannot* use your flex days for *in-class* work (including project presentations, paper discussions, and final project report). If you experience extenuating circumstances that prohibit you from submitting such assignments on time, please let us know as soon as possible and produce the

necessary documentation (e.g., doctor's note). We will evaluate these instances on a case-by-case basis.

Academic integrity

For a clear description of what counts as plagiarism, cheating, and/or the use of unauthorized sources, please see the University's Policy on Academic Integrity. In particular, the policy states that assistance from campus resources (Academic Development, the Global Communication Center, and the Academic Resource Center at CMU-Q) is permitted, but no collaboration is allowed unless specifically permitted by a course instructor.