

ROB 498/599: Computational Human-Robot Interaction

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Lectures: TuTh 15:00 - 16:30 (1060 FMCRB)

Office hours: TBD

Course description: This is an advanced course, covering computational techniques that enable robots to work with and around people. Topics will include estimation, planning, and control techniques, discussed in the context of applications like crowd navigation and collaborative manipulation. Besides algorithmic foundations, the course will explore topics in experiment design, discussing evaluation methodologies that will enable smooth deployment of robots in human environments. Through student-led paper presentations and a team project, students will gain exposure to the state of the art in computational HRI. The class will be split in roughly two parts: in the first, the instructor will cover some of the essential topics in computational HRI, and in the second, students will present and discuss foundational and state-of-the-art papers. The class will also feature experts from different areas of HRI that will discuss their research and interact with students. The class will close with presentations of students' projects.

Learning objectives: In this class, students will gain exposure to computational techniques used to develop human-robot interaction applications and systems and get familiar with the process of interpreting and presenting research. Specifically, by the end of the class, students will be able to:

- Recognize and understand the components of an HRI system.
- Understand the importance of accounting for users when developing algorithmic frameworks for HRI.
- Understand the landscape of essential computational tools for developing HRI applications.
- Design a user study to evaluate an HRI system.
- Interpret and critically analyze the methodology of research papers in HRI (and beyond).
- Communicate effectively research methodologies and evidence to a peer audience.

Prerequisites: There are no formal prerequisites but mathematical maturity (e.g., ROB 101, Math 215, IOE 265) and programming background (e.g., ROB 320 or EECS 281) are expected. A foundation on the design of human-robot systems (e.g., ROB 204) is recommended.

Textbook: There is no official textbook. Background for most of the course components can be found in the book Computational Human-Robot Interaction by Thomaz, Hoffman and Cakmak (pdf). Background on probability and filtering can be found in Probabilistic Robotics by Thrun, Burgard, and Fox (pdf). Additional background on planning can be found in Planning Algorithms by Lavalley (pdf).

Expectations: You can expect me to come to class on time, clearly communicate expectations for the presentations structure, format and clarity, give you feedback on your presentations and projects in a timely manner, adjust lecture material based on performance on presentations and quizzes.

I can expect you to come to class on time, be attentive and engaged, take notes and ask questions when something is not clear, spend an adequate amount of time on the readings each week (at least 3 hours), spend 60-80 hours on your final project. Please refrain from using laptops during the lecture unless instructed to do so for completing the quizzes or compiling notes.

Deliverables and grading

1. **Paper Presentations (40%):** After completing the discussion of topics from the foundations of HRI (led by the instructor), students will present assigned papers in class, on a rotating schedule. Presentations will be about 15 minutes long. Students will be evaluated based on their demonstrated effort in understanding the technical content, their discussion and its relationship to the class themes, the clarity, structure and timing of the presentation, and the ability to respond to questions.
2. **Project (40%):** Students will develop and work on team projects to solidify their understanding of Computational HRI and get practical experience. Students are expected to devote between 60-80 hours over two months (October, November) to the project. The instructor will guide students towards project topics aligned with the class but also with students' background and research interests. For the project, students are expected to write a short **project proposal** document (end of September), give a short **project update** presentation by the end of October, give a **final project presentation** at the end of November, and submit a **final**

project report at the end of November. Examples of successful project include but are not limited to: an in-depth, publication-quality literature review; a design and implementation of a user study; a development of a new algorithm; a thorough evaluation of existing algorithms. Ideally, students will be incentivized to complete their projects towards a submission at a relevant venue (e.g., HRI, RSS, IROS, AAMAS). Project teams will be graded based on their comprehensive presence throughout the semester across the deliverables and specifically based on the demonstrated mastery of the literature and the technical content, the novelty of the contribution the insight in the categorization of previous work, the quality of the final presentation.

3. **Weekly Quizzes (15%):** Every Tuesday, there will be a short (10 minute) quiz on the material from the previous lecture and the readings for the day. The quiz will connect concepts from multiple readings and/or the material. This quiz will not be challenging and is only meant to motivate a consistent contact with the material throughout the semester. We will drop your lowest quiz grade when calculating your final grade in the course.
4. **Participation (5%):** This class is intended to be interactive, and discussion driven. Thus, all students are encouraged to ask questions and participate in the discussions. Every class will feature a dedicated time for questions and discussion.

Tentative schedule

| # | Date | Topic | Deadlines |
|----|------------|----------------------------|---------------------------------------|
| 1 | Tue Aug 29 | Introduction | Knowledge survey Team formation |
| 2 | Thu Aug 31 | Bayesian inference | |
| 3 | Tue Sep 5 | Filtering | |
| 4 | Thu Sep 7 | Motion planning | |
| 5 | Tue Sep 12 | Model Predictive Control | |
| 6 | Thu Sep 14 | Planning under uncertainty | |
| 7 | Tue Sep 19 | Inverse Optimal control | |
| 8 | Thu Sep 21 | Human-aware planning | |
| 9 | Tue Sep 26 | Experiment design | |
| 10 | Thu Sep 28 | Benchmarking | Project proposal |

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|----|------------|---------------------------------|----------------|
| 11 | Tue Oct 3 | Guest: Tapomayukh Bhattacharjee | |
| 12 | Thu Oct 5 | Guest: Taylor Kessler Faulkner | |
| 13 | Tue Oct 10 | Social navigation | |
| 14 | Thu Oct 12 | Paper presentations | |
| | Tue Oct 17 | No class - Fall study break | |
| 15 | Thu Oct 19 | Paper presentations | |
| 16 | Tue Oct 24 | Project update presentations | Project update |
| 17 | Thu Oct 26 | Guest: Jesse Thomason | |
| 18 | Tue Oct 31 | Paper presentations | |
| 19 | Thu Nov 2 | Paper presentations | |
| 20 | Tue Nov 7 | Guest: Reuben Aronson | |
| 21 | Tue Nov 9 | Paper presentations | |
| 22 | Tue Nov 14 | Paper presentations | |
| 23 | Thu Nov 16 | Paper presentations | |
| 24 | Tue Nov 21 | Paper presentations | |
| | Thu Nov 23 | No class - Thanksgiving break | |
| 25 | Tue Nov 28 | Final project presentations | |
| 26 | Thu Nov 30 | Final project presentations | |
| 27 | Tue Dec 5 | Closing | |

Statements

Diversity, Equity, and Inclusion

We consider this classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

We are dedicated to helping each of you achieve all that you can in this class. We may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should we do this, please contact us and help us understand so that we may avoid making the same mistake again.

Lived Name/Pronoun

We will gladly honor your request to address you by an alternate name or gender pronoun. Please advise a member of the teaching staff of this preference early in the semester so that we may respond appropriately and make any needed changes to our records. You may also update your name and pronouns on Wolverine Access.

For more information about lived name/pronoun updating:

<https://spectrumcenter.umich.edu/student-support/trans-guide>.

Academic integrity

The College of Engineering Honor Code is a statement of ethical standards by which the faculty and students in the College of engineering conduct themselves. Students are bound by the provisions of the Honor Code; ignorance of it is no excuse to infringe upon it. You are expected to read and abide by the Honor Code:

<http://elc.engin.umich.edu/wp-content/uploads/sites/19/2019/03/Honor-Code-Pamphlet-2018.pdf>.

Disability statement

The University of Michigan recognizes disability as an integral part of diversity and is committed to creating an inclusive and equitable educational environment for students with disabilities. Students who are experiencing a disability-related barrier should

contact Services for Students with Disabilities <https://ssd.umich.edu/>; 734-763-3000 or ssdoffice@umich.edu). For students who are connected with SSD, accommodation requests can be made in Accommodate. If you have any questions or concerns please contact your SSD Coordinator or visit SSD's Current Student webpage. SSD considers aspects of the course design, course learning objects and the individual academic and course barriers experienced by the student. Further conversation with SSD, instructors, and the student may be warranted to ensure an accessible course experience.

Mental health and well-being

Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact us so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being on the Well-being for U-M Students website. You can also search for additional resources on that website.

Sexual misconduct policy

Title IX prohibits discrimination on the basis of sex, which includes sexual misconduct — including harassment, domestic and dating violence, sexual assault, and stalking. We understand that sexual violence can undermine students' academic success and we encourage anyone dealing with sexual misconduct to talk to someone about their experience, so they can get the support they need. Confidential support and academic advocacy can be found with the Sexual Assault Prevention and Awareness Center (SAPAC) on their 24-hour crisis line, 734.936.3333 and at sapac.umich.edu. Alleged violations can be non-confidentially reported to the Equity, Civil Rights, and Title IX Office (ECRT) at ecrtoffice@umich.edu.