



**CSCI-699: Computational Human
Robot Interaction**

Units: 4

Spring 2020_ MW 3:30-5:20pm

Location: TBD

Instructor: Stefanos Nikolaidis

Office: TBD

Office Hours: TBD

Contact Info: nikolaid@usc.edu

Course Description

In this advanced graduate-level class, you will learn about the theory and algorithms that enable robots to account for people in their decision making in a principled way. The course will contrast decision-theoretic and learning-based paradigms that allow robots to reason in the presence of uncertainty with studies in human-robot interaction. It will then focus on what makes some of these algorithms particularly effective and scalable in real-world human-robot interaction scenarios. By the end of this class, you will be able to describe and compare algorithms for deployed robotic systems interacting with people, design user studies to evaluate these algorithms and communicate your ideas to a peer audience. Evaluation is mainly based on student presentations, a final project and short weekly quizzes based on the assigned reading material.

Learning Objectives

In this course, you will gain knowledge about planning and learning algorithms in human-robot interaction and skills in interpreting and presenting research. By the end of this course you should be able to:

- identify and discuss the different components that make up decision-theoretic reasoning (e.g., MDPs, POMDPs) and learning-based techniques (learning from demonstration, reinforcement learning) that support human-robot interaction
- explain the computational and practical challenges of applying these techniques in real-world interaction settings and compare them in terms of robustness, scalability and performance
- analyze the design and implementation of a user study to evaluate algorithms for HRI
- critique a research paper's methods and analysis
- communicate effectively scientific research to a peer audience

Recommended Preparation: Knowledge of probability theory and linear algebra is strongly encouraged

Description and Assessment of Assignments:

Paper Presentations: Each week, students will present assigned papers in class, on a rotating schedule. Presentations will be about 15 minutes long. You will be evaluated based on your demonstrated understanding of the technical content, how you relate the paper to the lectures and previous readings, the clarity, structure and timing of the presentation and how well you answer questions.

Final Project: This should be a substantial piece of work and is expected to take between 60-80 hours over 8 weeks. In the beginning of the class, we will discuss your background and research interests, and we will promptly give you a list of potential projects that relate to the course material and that match your interests. Examples of projects include an in-depth, publication quality literature review; a user study; or the novel implementation of an algorithm. You will write a project proposal, work on the project upon approval and present it at the end of the term. You will be evaluated based on proposal quality, demonstrated mastery of content, novelty of contribution or categorization of previous work in the case of a survey, and quality of the final presentation.

Weekly Quizzes: Before each student presentation day, there will be a short (10 minute) quiz on the material from the previous lecture and the readings for the day. The quiz will frequently connect different concepts from multiple readings and/or the material. This quiz is intended to ensure that you are keeping pace with the material and are prepared for the

day's presentations, and is not meant to be onerous. We will drop your lowest quiz grade when calculating your final grade in the course.

Participation: Students will get the most out of this class if they are active and engaged. This includes asking questions and participating in discussions. There will be explicit time for questions and discussion after each student presentation. We also encourage students to participate during any and all lecture sessions.

Grading Breakdown

Component	Percentage
Paper Presentations	30%
Final Project	40%
Weekly Quizzes	20%
Participation	10%

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 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 in class.
- 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.

Additional Policies

Unless you are assigned to compile lecture notes, please refrain from using laptops or other electronic devices during class.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings/Preparation
Week 1	What is Computational HRI?	<ul style="list-style-type: none"> Human modeling for human–robot collaboration, Hiatt et al. (Optional) Computational Human-Robot Interaction, Thomaz, Hoffman (Optional)
Week 2	Probability and Bayesian inference	<ul style="list-style-type: none"> Russell & Norvig (2009). Artificial Intelligence: a Modern Approach. Prentice Hall. Chapters 13, 14 and 15.
Week 3	Bayesian inference (cont'd) and decision making under uncertainty	<ul style="list-style-type: none"> Russell & Norvig (2009). Artificial Intelligence: a Modern Approach. Prentice Hall. Chapter 16.
Week 4	Markov decision processes and applications in HRI	<ul style="list-style-type: none"> Russell & Norvig (2009). Artificial Intelligence: a Modern Approach. Prentice Hall. Chapter 17.1- 17.3.
Week 5	Action selection for collaboration (student presentations)	<ul style="list-style-type: none"> Cost-Based Anticipatory Action Selection for Human-Robot Collaboration, Buss and Breazal. Joint action: bodies and minds moving together, Sebanz et al.
Week 6	Experimental Design	<ul style="list-style-type: none"> Toward a science of robotics: Goals and standards for experimental robotics, Takayama. (optional)
Week 7	Training of human teams and shared	<ul style="list-style-type: none"> The Impact of Cross-Training on Team Effectiveness, Marks et al.

	mental models (student presentations)	<ul style="list-style-type: none"> • The Influence of Shared Mental Models on Team Process and Mathieu et al.
Week 8	Action coordination in human-robot teams (student presentations)	<ul style="list-style-type: none"> • Human-Robot Cross-Training: Computational Formulation, M Evaluation of a Human Team Training Strategy, Nikolaidis and • Improved Human-Robot Team Performance Using Chaski, A Plan Execution System, Shah et al.
Week 9	Intent inference (student presentations)	<ul style="list-style-type: none"> • Goal Inference as Inverse Planning, Baker et al. • Planning-based Prediction for Pedestrians, Ziebart et al.
Week 10	Expressiveness in robot motion (student presentations)	<ul style="list-style-type: none"> • Expressing thought: improving robot readability with animation Takayama et al. • The Illusion of Robotic Life, Ribeiro and Paiva.
Week 11	Generation of expressive motion (student presentations)	<ul style="list-style-type: none"> • Generating Legible Robot Motion, Dragan and Srinivasa.) • Enhancing Interaction Through Exaggerated Motion Synthesis Thomaz.
Week 12	Planning with partial observability	<ul style="list-style-type: none"> • Planning and acting in partially observable stochastic domains
Week 13	Planning with partially observable human states (student presentations)Planning	<ul style="list-style-type: none"> • Intention-aware motion planning, Bandyopadhyay et al.

	with human state dynamics (student presentations)	<ul style="list-style-type: none"> • Belief Space Planning for Sidekicks in Cooperative Games, Ma
Week 14	Planning in shared autonomy domains (student presentations)	<ul style="list-style-type: none"> • Shared Autonomy via Hindsight Optimization, Javdani et al. • Autonomy Infused Teleoperation with Application to BCI Ma Muelling et al.
Week 15	Learning techniques for HRI	<ul style="list-style-type: none"> • Russell & Norvig (2009). Artificial Intelligence: a Modern App Prentice Hall. Chapter 20.
FINAL	Project report due	

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age,

physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
uscsa.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu

Non-emergency assistance or information.