Computational Human-Robot Interaction

Instructor: Stefanos Nikolaidis

Course Website: http://stefanosnikolaidis.net/comphri.html
What is Computational HRI?
Robots interacting with the world
Robots interacting with people

AUR
a robotic desk lamp

Guy Hoffman

MIT Media Lab
May 2007
Robots interacting with people

Automatic Feeding with Assistive Robot Arm

Laura V. Herlant
The Robotics Institute
Carnegie Mellon University

Siddhartha S. Srinivasa
University of Washington
Robots interacting with people
Robots interacting with people
Intentionality

Communication

Learning

Intentionality

Communication
Planning under uncertainty
Game-theoretic reasoning

Algorithmic Teaching
Intentionality

Learning

Communication

Learning from demonstration
Multimodal communication

Collaboration
Learning Objectives

• identify and discuss the different components that make up decision-theoretic reasoning and learning-based techniques that support human-robot interaction

• explain the computational and practical challenges of applying these techniques in real-world interaction settings

• 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
Preliminary List of Topics

- Bayesian Inference
- Task planning
- Experimental design
- Shared mental models and human team training
- Collaboration in human-robot teams
- Learning from demonstration
- Reinforcement learning and learning with human feedback
- Verbal communication
- Multi-modal communication and signaling
- Algorithmic teaching and pedagogical reasoning
# Class Logistics

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CRN</th>
<th>Credits</th>
<th>Type</th>
<th>Time</th>
<th>Days</th>
<th>Section</th>
<th>Room</th>
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<tbody>
<tr>
<td>30096D</td>
<td>048</td>
<td>4.0</td>
<td>Lecture</td>
<td>10:00-11:50am</td>
<td>Tue, Thu</td>
<td>8 of 25</td>
<td>LVL 13</td>
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Paper presentations (30%)
Final project (40%)
Weekly quizzes (15%)
Participation (10%)
Scribing (5%)
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Paper Presentations

- 2-3 papers presented for 20’ minutes each
- ~15’ discussion section
- Rotating schedule, papers are matched randomly
- Papers will be on the website one week before
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Final Project

• Expected 60-80 hours work

• Project proposal (due October 23rd)

• Meet with me to discuss ideas and progress

• Project presentation and report at the end of the term

• Research project or survey
Research Project

• Identify a “good” problem – the hardest part:
  • implementation of a new computational framework, method or algorithm
  • extension of an existing algorithm and evaluation in a new setting
  • design and execution of a novel user study

• Relate it to your research!

• Think of it as precursor to a conference paper

• Discuss ideas with instructor and with each other
Survey

• ~50 papers

• Identify scope – what will you include?

• Think of a taxonomy to group previous work

• Identify gaps in the literature
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Weekly Quizzes

• ~10 min in the beginning of class

• Goal:
  • ensure paper reading
  • link ideas between assigned papers

• Grading: +, ✓, -
Weekly Quizzes (example)

Name and compare two representations for representing rotation apart from the rotation matrix
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Participation

• Show up in class

• Be attentive and engaged

• Ask questions to presenters and participate in discussion
Paper presentations (30%)

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Reading and Presenting a Research Paper
Reading a Research Paper

• Pass 1: Title, Abstract, Introduction, Conclusion

• Pass 2: Full Paper
  • read critically for flaws in design, logical holes, and assumptions (implicit and explicit)
  • read creatively for novel contributions, improvement upon the state of the art, and extensions

slide by Katharina Muelling, Carnegie Mellon University
Structuring a Paper Presentation

1. What is the big problem?
2. Why is it important?
3. Why is it hard?
4. What have others done? (by the time the paper was published)
5. What is the **key insight**?
6. What are the technical details?
7. What are the results?
8. Are there any logical holes or limitations? (there always are)
9. How did the paper impact subsequent work (bigger picture)?
10. End by restating how the key insight helped solve the problem
Key Insight

The clever part of the paper -- it needs to be summarized in one sentence.
Guidelines on slides

• Have only the most important points

• Use videos, figures

• Respect timing

• Avoid small fonts

• Explain everything on the slide
Making connections

Relate paper to lecture notes and other assigned readings
Giving **good** talks

You should attempt to re-express your target’s position so clearly, vividly, and fairly that your target says, “Thanks, I wish I’d thought of putting it that way.” Daniel Dennet
Giving **good** talks

Slides by Siddhartha Srinivasa
Boeing Endowed Professor
The University of Washington, CS&E
Making a talk

Delivering a talk

Answering questions
Don’t PowerPoint prematurely

- Start with whiteboard/paper/editor
- Collect all of your thoughts
- Organize thoughts

Be ready to give the talk without any slides
A talk is not about details.
A talk is about insight.
Big picture
Focus
Details
Focus
Big picture
Callout slides emphasize key insights.
Introduction
Manipulation is all about constraints

Results
CHOMP produces better paths faster
Avoid unexplained content
Be visual but not too visual
THE ANTS GO MARCHING
Illustrated by Jeffrey Scherer

[Image of ants marching in the rain with Scholastic logo]
Making a talk

Delivering a talk

Answering questions
Fail – Atone – Succeed

A Hero’s Journey
A play by Steve Jordan and Patrick Baker

The Hero with a Thousand Faces
By Joseph Campbell
Making a talk

Delivering a talk

Answering questions
Be honest

- Cite others generously
- State assumptions clearly
- Don’t claim to be the final word
- Always be polite and humble
Always maintain control
Always be correct
Accept flaws immediately
Giving good talks

Slides by Siddhartha Srinivasa
Boeing Endowed Professor
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My strategy on Q&A

1. Start by restating the question

2. Provide specific information that answers the question

3. Relate answer to a bigger picture
Getting to **know** each other
Name:
Email:
Undergraduate / graduate:
Department / Major:
Academic Advisor:

1. Do you have a background in programming, probability, AI, machine learning, robotics or HRI?

2. Describe briefly your research interests:

3. What would you like to get out of this class?

4. Have you worked with a physical robot (e.g., Nao) and do you have access to one?

5. What is the thing that you have done that you are the most proud of?