CS 294-115 Algorithmic Human-Robot Interaction **Fall 2016**

Lecture 1: Intro to Algorithmic HRI

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1.1 Logistics

- □ Section 294-115, *Soon 287H*
- □ web: `http://people.eecs.berkeley.edu/~anca/AHRI.html`
- □ On website is a tentative list of topics with papers in the order we will cover them
- □ Read learning objectives and paragraph of expectations (please no phones or laptops)

Class Organization

- □ Classes will be *either* lectures and student presentations
- □ We will try to study each topic through three different lenses: *Robotics, HRI, and Psychology*
- □ Presentations can either be on PowerPoint or the whiteboard (but either way we must have a good understanding of the material and present well, or else that would be unfair to everyone else who has to listen)
- □ For student presentations, there will generally be $\approx$ 2 papers, *and for each paper we will have* 1 PRO presenter (15-20 min) and 1 CON presenter (5-10 min)
- □ Short quizzes will be 10 min each, used as a "forcing function" to lightly ensure we revise lecture material and read the assigned papers. These will be graded on a $+$, $-$, or ✓ basis, with a broad understanding of material to suffice a ✓ or a $+$
- □ The final project can either be *Research* or *Survey* based, though a research project is more encouraged. We are further encouraged to integrate our own research interests and relate them to AHRI (though the topic must be substantially relevant to the field of AHRI). The final project will consist of a proposal, report, and final presentation

Breakdown of Grading

- □ 30% Presentations
- □ 10% Discussions
- □ 20% Quizzes
- □ 35% Final Project
- □ 5% Scribing

NOTE: Though there will not be any formal "homework". We are still expected to show up to class and complete the readings and do a final project. Furthermore, we are encouraged to implement some of the algorithms described in the papers (e.g. using Python for a 2d point robot), especially if we are presenting. Even if it is just a toy example, this extra work can help solidify our understanding of the material. Finally, for presentations, it is a good idea to include demos/videos if possible. More on giving presentations in a later lecture.

1.2 What & Why

Robotics: Algorithms that enable robots to autonomously generate behavior to achieve useful tasks.

- Emphasis on *function* and *generalization*
- This is already getting better

Traditional Robotics: (using the example of autonomously clearing a table)

- Perception / estimation: *e.g. how can we correctly register the bowls and plates from the rest of the clutter? Perception encompasses more than just vision – haptic and proprioceptive feedback*
- Motion planning / control: *e.g. how can we manipulate the objects without breaking them? Challenges include physical constraints, many degrees of freedom (DOF)*
- Physics model (integrated into planning): *how can we model the effects of our actions on the physical world?*
- Task planning (also integrated into motion planner / controller): *e.g. which object to pick when, and where to place it, etc.*
- Learning: *Learning tries to recover a policy that maps states to actions ($\pi: s \mapsto a$). This can bypass needing an analytical physical model and/or planning. An example is model free reinforcement learning. A challenge associated with this is determining how to assign credit, needing to fail in order to learn something is bad, and amount of data needed.*

Nonetheless, we see progress. There are now companies working on self-driving cars, quadrotors, collaborative manufacturing, assistive robots. **AUTONOMY IS INEVITABLE.**

All these robots are meant to support people: drive passengers, take photos of people during extreme sports, help people with disabilities live independently, help workers do their jobs more efficiently. **AUTONOMY *THAT INTERACTS* IS INEVITABLE.**

Where Traditional Robotics is Not Sufficient: (using self-driving cars as an example)

- Needs to interact with other cars / pedestrians / passengers
- If we go in front, the other car might slow down – it is not just an obstacle, we rely on it to make decisions.
- Not just the physical world changing when we act, what people do and think changes too.
- Needs to predict / anticipate what people will do
- Involves collaborative planning / coordination

AUTONOMY THAT INTERACTS (NOT IN ISOLATION) IS HAPPENING

Robotics with interaction: Algorithmic HRI

- □ Perception / estimation: *not just skeleton tracking, but human intent prediction, motion anticipation*
- □ Physics model: *need model of human behavior not just physical world*
- □ Motion planning / control: *Safety, real-time adaptation (adjust to humans moving), predictability (need to move in a way that is easy for humans to predict), legibility (intent expression)*
- □ Task planning: *Collaborative planning*
- □ Learning: *opportunity: Learning from demonstration (learning from people)*

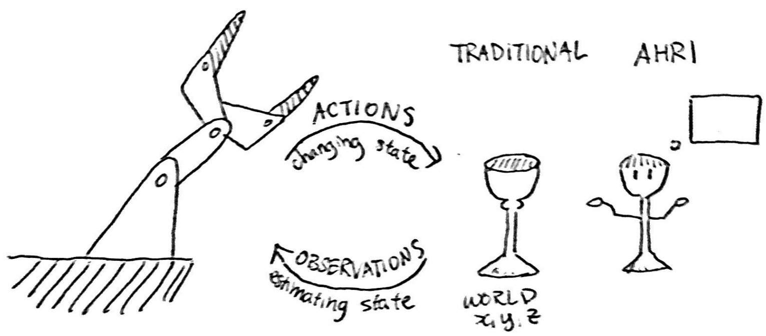

Figure 1.1: Anca's cartoon depiction of traditional robotics and AHRI

Actions also change human state (beliefs, emotional state, goals, plans).

AHRI: Algorithms that enable robots to autonomously generate behavior to achieve useful tasks *while interacting, coordinating, coexisting, assisting humans.*

- □ Emphasis on *interaction*, but also still a focus on *generalization*

HRI is different:

- □ not an algorithmic/generalization focus; more about studying how interaction ought to work, how people react to different robot behaviors, etc.
- □ AHRI is also called interactive autonomy/robotics, technical/computational HRI, or simply just hRi