CS 294-115 Algorithmic Human-Robot Interaction **Fall 2015**

Lecture 1: Intro to Algorithmic HRI

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1.1 What & Why

As robots are becoming capable of performing more and more complex tasks, they will become widely used in environments other than caged factory floors where robots have to collaborate and coordinate with people. Algorithmic HRI is the study of algorithms for how to make this interaction between human and robot happen efficiently and fluently.

Even achieving functional tasks without dealing with interaction is hard; even simple tasks that may seem trivial to humans are hard to achieve for robots since they have to deal with abundant difficulties. For instance, picking up a bowl requires the robot to overcome complications such as:

- adapting itself to unstructured, novel environment,
- perception (more than vision as it needs to locate objects),
- motion planning (tough due to many degrees of freedom in robots),
- motion control (complex dynamical models of robots),
- manipulation,
- reinforcement learning (may not be necessary, but helpful in some cases).

So far, the way robots are dealt with is through Figure 1.1 where robot affects physical world via its actions and the observations it receives are considered as feedback helping the robot estimate the state of the world and select its future actions.

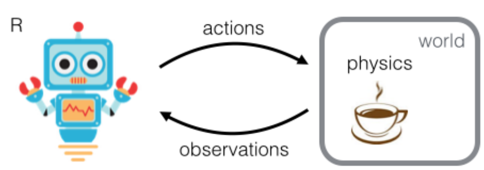

Figure 1.1: Functional view of robotics.

Despite these difficulties, we see robots starting to be used in the real world, for different applications (Figure 1.2) revealing the fact that they are going to interact with people present in robot's field of application. Self-driving cars and personal robots are instances of robots in contact with people.

(a) Kinova (b) Factory robots outside of cages (c) Self-driving Google car (d) Hexo Drone

Figure 1.2: Example of robots that will interact with humans.

Examples:

1. Self-driving cars interact with people via
   - other drivers - need to coordinate yield/wait, merges
   - passengers - need to feel safe
   - pedestrians - need to understand ”has it detected me, will it stop”
2. Personal robots
   - People don’t want robot to do everything because they want to stay active
   - People need to be safe, comfortable with the robot, able to predict what the robot is planning to do, etc.

In other words, it is not just the autonomy which is inevitable, autonomy that interacts is inevitable. This presence of humans in the loop reinforces the need to develop algorithms that encapsulate both parts of the world: humans and physical world (Figure 1.3).

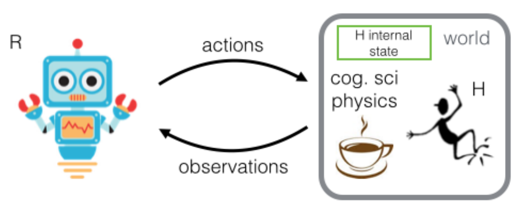

Figure 1.3: Robots interact with the world and with humans.

Due to the multidisciplinary nature of this course, it has two personalities:

1. Social Science Studies
2. Robotics Algorithms

Topics: motion, learning from demonstration, coordination, natural language, collaboration (task level) shared autonomy. There will be four classes per topic: lecture, cogsci theory papers, robotics algorithms papers, HRI papers (algs or studies).

Algorithmic HRI (Human Robot Interaction) is a relatively new area of research; thus, there’s often no solution, and definitely no course textbook.

1.2 How

Class will be in two styles:

- Lectures - usually whiteboard. (Taking notes is suggested)
- Papers - student presentations; 2 teams of 2 per paper (PRO and CON teams)

1.3 Assessment

Course grade is evaluated by:

35% **Project.**
1 page project proposal
final presentation
final report
choice between novel research and survey

20% **Quizzes.** Not meant to be onerous.
10min at start of class
Grading: $+, -, \checkmark$

30% **Presentations.** 2/3 papers.
2 papers: 20min @ PRO Team, 10min @ CON team, 5min @ buffer.
3 papers: 15min @ PRO team, 5min @ CON team, 3min @ buffer.

5% **Scribing.** Template on website.

10% **Participation.** Please no laptops or cell phones. Ask and answer questions.

See the course website for further details. `http://www.eecs.berkeley.edu/~anca/AHRI-F2015.html`

1.4 Advice on how to give talks

Main point: **identify key insight** and **don't be procedural**

"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 Dennett

Aside: Dennett has four steps for composing a successful critical commentary. The above is the first step, the other three are:

2. *You should list any points of agreement (especially if they are not matters of general or widespread agreement).*

3. *You should mention anything you have learned from your target.*
4. *Only then are you permitted to say so much as a word of rebuttal or criticism.*

1.4.1 PRO team

Hourglass structure: start with the bigger picture, motivation, problem statement, why is it hard, then key insight, then details, and then results and back out to the broader picture and restate that the key insight helped address the problem. Be detailed: write toy code on a toy problem to help explain things in depth.

1.4.2 CON team

1. Be constructive
2. Be polite
3. Be compassionate

Both teams: Bring it all back to the context of the course: unify social science insights with robotics algorithms.

1.4.3 Slides

- Have useful titles, not just 'Introduction', 'Motivation', 'Experiments', etc.
- 1 point per slide; use builds (not everything at once, but items appearing on the slide as needed)
- Explain all equations you use
- Never have anything on a slide that you aren't talking about
- Be visual; explain math with graphics/figures.
- Don't have a lot of text: can't listen to you and read text at the same time