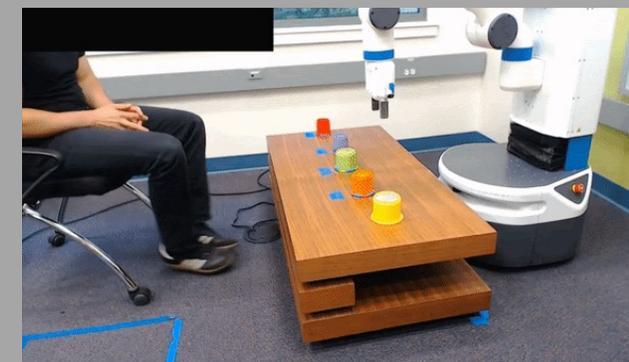
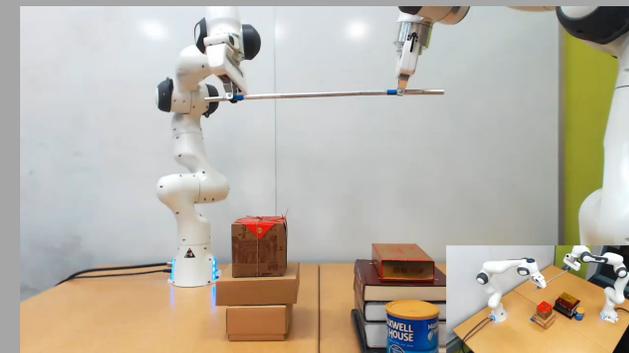


# The NSF CAREER Journey

*Dorsa Sadigh*  
*Stanford University*



# Who am I?

- Graduated from EECS at UC Berkeley in August 2017

**Safe and Interactive Autonomy: Control, Learning, and Verification**

Dorsa Sadigh

*EECS Department, University of California, Berkeley, August 2017*



Dorsa Sadigh

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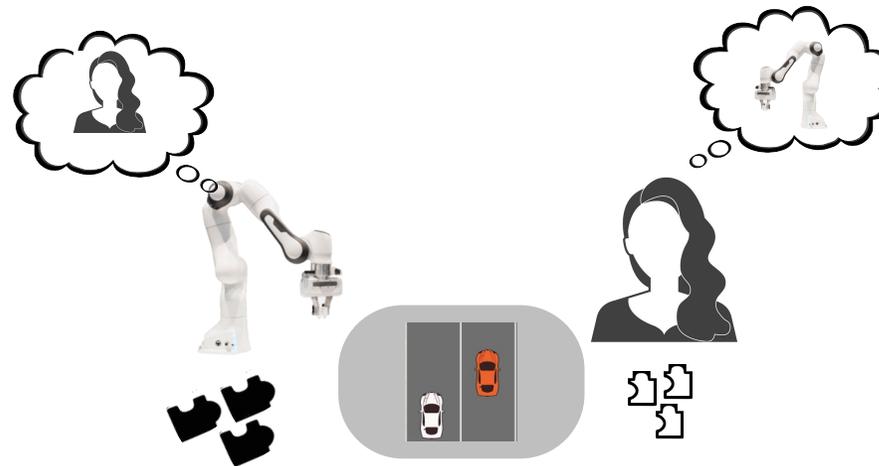
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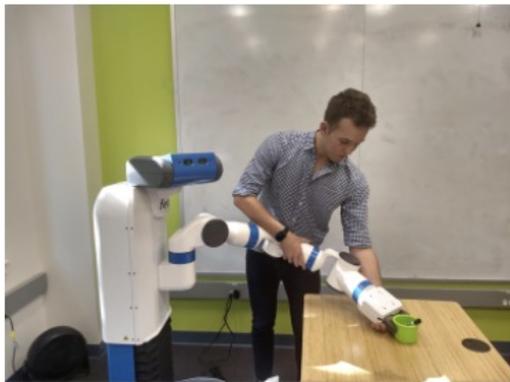
*EECS Department, University of California, Berkeley, August 2017*



Dorsa Sadigh

- Joined Stanford CS in September 2017

# What have I done in the past 5 years?



Learning from Diverse Interactions



Learning to Improve Interactions



Large Scale Interactions



Learning from Diverse Interactions

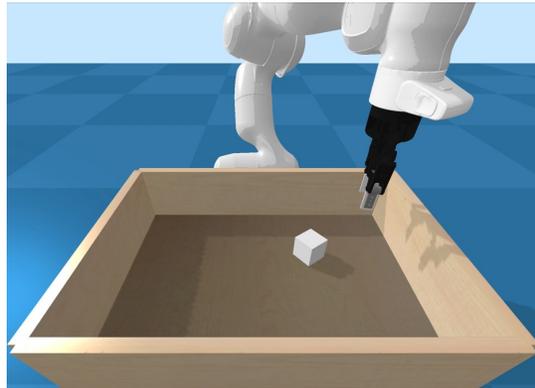


Learning to Improve Interactions

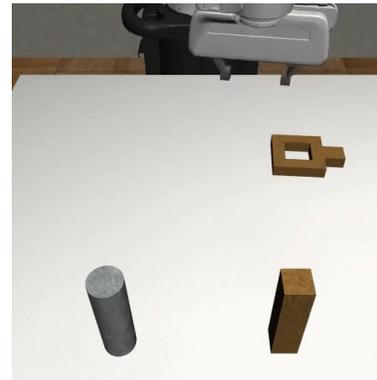


Large Scale Interactions

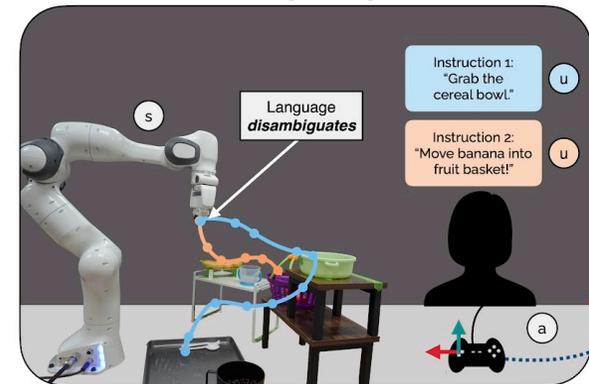
Play



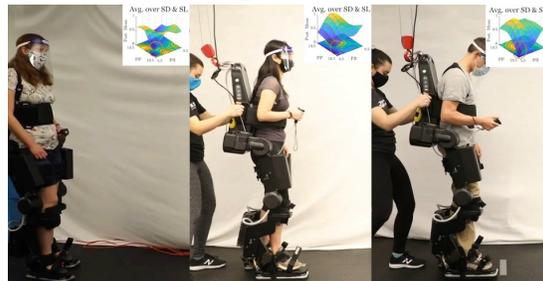
Suboptimal Demonstrators



Language



Comparisons



High Pelvis Pitch and Low Pelvis Roll

Physical Corrections





Learning from Diverse Interactions



Learning to Improve Interactions



Large Scale Interactions



Learning from Diverse Interactions

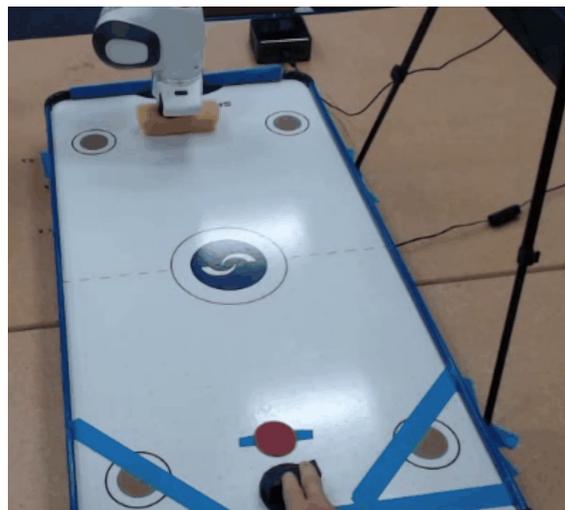
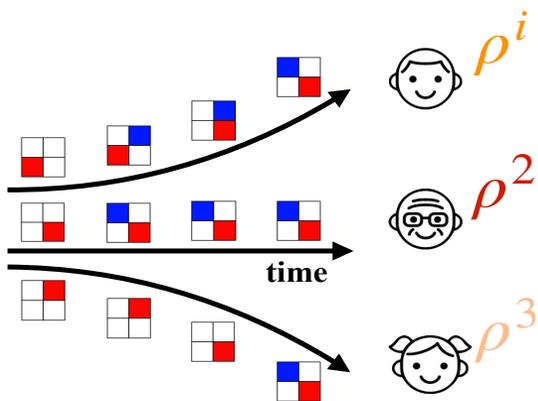


Learning to Improve Interactions

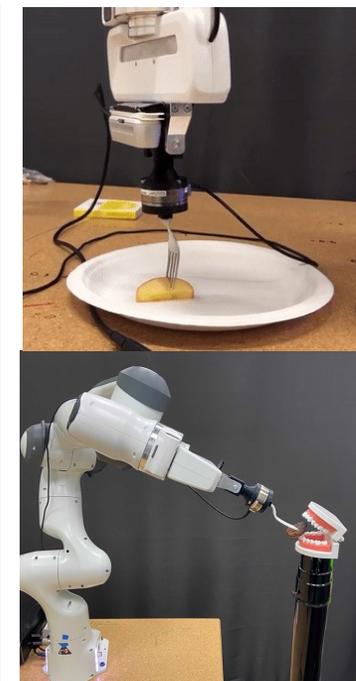


Large Scale Interactions

Partner Modeling



Assistive Feeding: Acquisition & Transfer





Learning from Diverse Interactions



Learning to Improve Interactions



Large Scale Interactions



Learning from Diverse Interactions

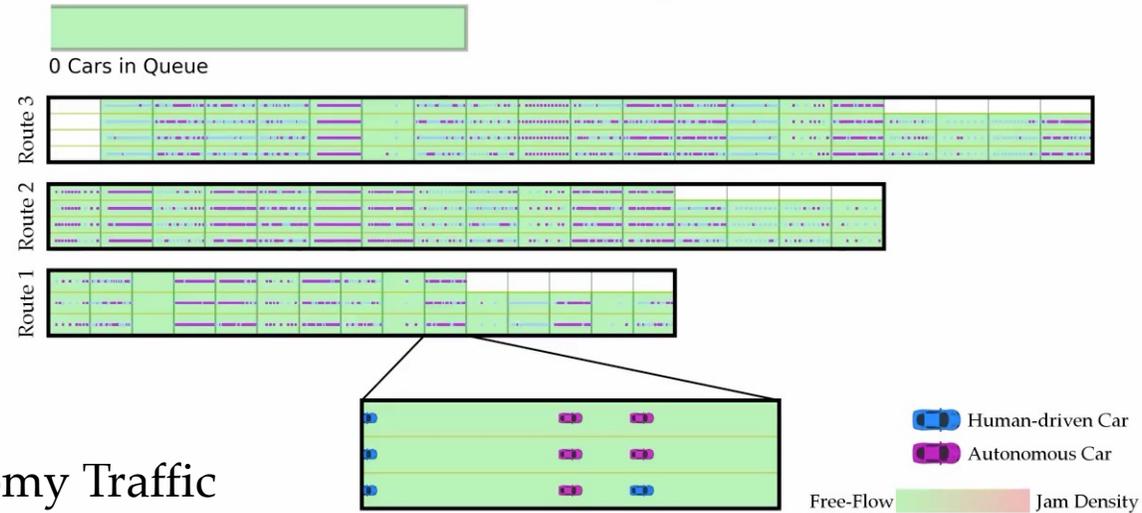


Learning to Improve Interactions



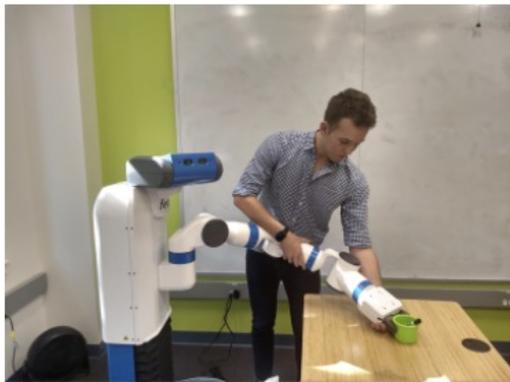
Large Scale Interactions

RL Routing



Routing Mixed-Autonomy Traffic

# What have I done in the past 5 years?



Learning from Diverse Interactions



Learning to Improve Interactions



Large Scale Interactions

How was my first year? (2017)

Got Married in October!



# Lots of robot and furniture shopping



# Recruited my first student



Erdem Biyik

He is on the job market this year!

# Taught Courses

## Graduate Course in Fall

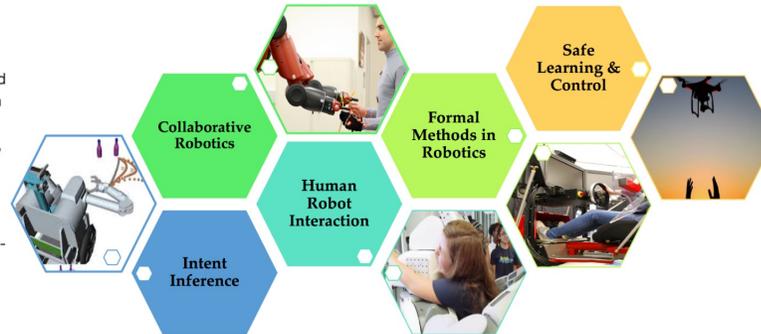
### CS 333: Safe and Interactive Robotics

Fall 2017-2018, Class: Tue, Thu 3:00-4:20pm, McMurtry 360

#### Description:

Once confined to the manufacturing floor, robots are quickly entering the public space at multiple levels: drones, surgical robots, service robots, and self-driving cars are becoming tangible technologies impacting the human experience. Our goal in this class is to learn about and design algorithms that enable robots to reason about their actions, interact with one another, the humans, and the environment they live in, as well as plan safe strategies that humans can trust and rely on.

This is a project-based graduate course that studies algorithms in formal methods, control theory, and robotics, which can improve the state-of-the-art human-robot systems. We focus on designing new algorithms for enhancing safe and interactive autonomy.



Undergraduate AI in Spring (enrollment 400)



CS 221: Artificial Intelligence: Principles and Techniques

*Spring 2017-2018*

# What proposals did I write during my first year?

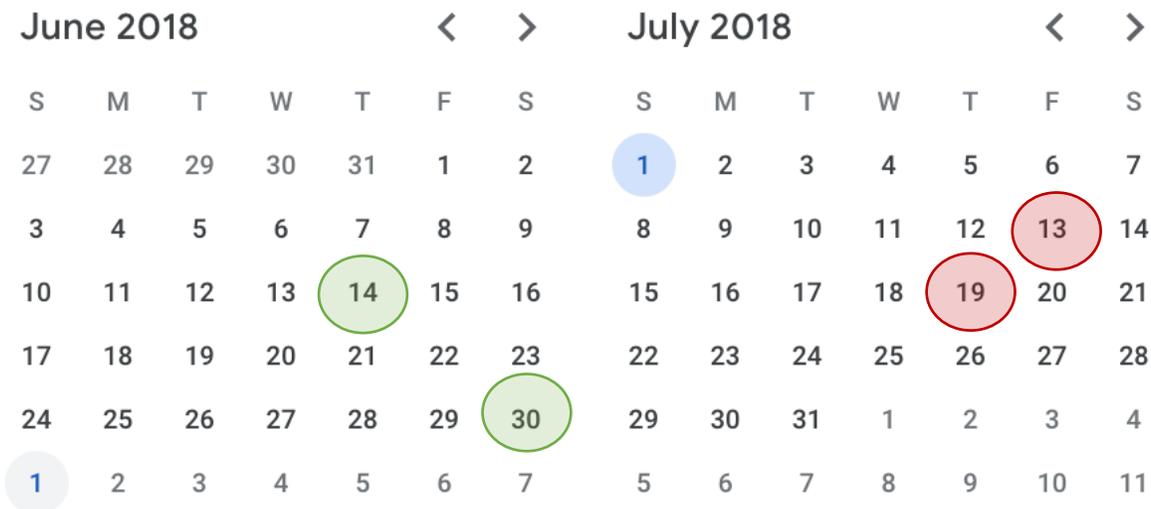
- NSF NRI (Winter) (with a more senior PI) → **Rejected**
- NSF CPS (Winter) (with a junior PI) → **Rejected**

## Non-NSF Proposals

- Army project → Another faculty at Stanford added me in
- Toyota Research Institute → two projects (**Accepted**)

# Decision to not write the NSF CAREER in 2018

- Deadline was on July 19
- I wanted to start at least two months in advanced
- Classes at Stanford end very late ... grades were due on June 14
- RSS was June 26-30... I hadn't started then
- It was too late and too stressful!



# What proposals did I write during my first year?

- NSF NRI (Winter) (with a more senior PI) → Rejected
- NSF CPS (Winter) (with another junior PI) → Rejected
- NSF CRII (Summer) → Accepted
- NSF Formal Methods in the Field (Summer) (with another junior PI) → Rejected
- NSF NRI (Winter) (with a more senior PI) → Rejected
- NSF Future of Work... (with a lot of people) → Rejected

 2018-CPS	
 2018-CRII	
 2018-FMitF	
 2018-NRI	
 2018-NSF-FWHTF	
 2019-CHS	
 2019-FMitF	
 2019-NSF-CAREER	
 2019-NSF-CPS	
 2019-NSF-EPCN	
 2019-NSF-Expedition	
 2019-NSF-Frontier	
 2020_NSF_FMRG	
 2020-NSF-AI Institute	
 2020-NSF-NRI	
 2020-NSF-Science of Learning	
 2020-NSF-STC	
 2021-NSF ERC - UIUC/Stanord/Berkeley/UNM	
 2021-NSF-AI Institute	
 2021-NSF-CPS-Negar	
 2021-NSF-CPS-Sanjay	
 2021-NSF-EPCN-Ramting/Yaser	
 2021-NSF-NRI-Monroe	
 2021-NSF-NRI-Tapo	

Decision to write the NSF CAREER in 2019

March 25: Went to an NSF Panel and talked to CPS and RI Program Directors (Jonathon Sprinkle and David Miller)

March 2019

< >

S	M	T	W	T	F	S
24	25	26	27	28	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

April 2019

< >

S	M	T	W	T	F	S
31	1	2	3	4	5	6
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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4
5	6	7	8	9	10	11

May 2019

< >

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19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

June 2019

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23	24	25	26	27	28	29
30	1	2	3	4	5	6

July 2019

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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

# What did I do in April?

March 2019							<	>	April 2019							<	>
S	M	T	W	T	F	S	S	M	T	W	T	F	S				
24	25	26	27	28	1	2	31	1	2	3	4	5	6				
3	4	5	6	7	8	9	7	8	9	10	11	12	13				
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17	18	19	20	21	22	23	21	22	23	24	25	26	27				
24	25	26	27	28	29	30	28	29	30	1	2	3	4				
31	1	2	3	4	5	6	5	6	7	8	9	10	11				

Am I submitting to **RI** (Robust Intelligence: CISE) or **CPS** (Cyber-Physical Systems: ENG)?

**March 25:** Went to an NSF Panel and talked to CPS and RI Program Directors (Jonathon Sprinkle and David Miller)

March 2019

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S	M	T	W	T	F	S
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31	1	2	3	4	5	6

April 2019

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21	22	23	24	25	26	27
28	29	30	1	2	3	4
5	6	7	8	9	10	11

May 2019

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S	M	T	W	T	F	S
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

*April 26: overview*  
*May 3-10: background*  
*May 17: research plan*  
*May 24: education plan*  
*May 31: other sections*

June 2019

< >

S	M	T	W	T	F	S
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
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July 2019

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S	M	T	W	T	F	S
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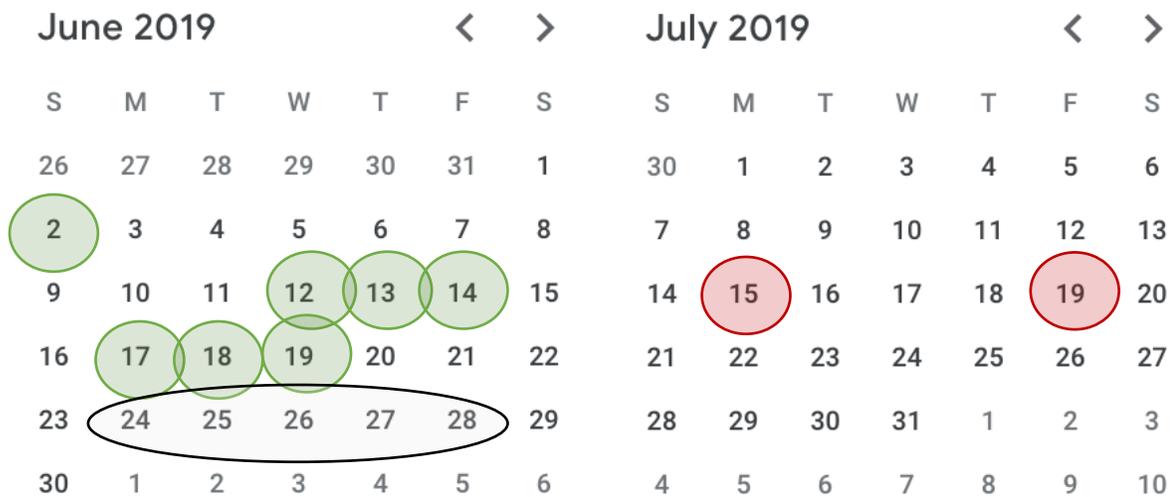
**April 26 – May 31:** Plan was to write a section, reality mostly thought about it.

**June 2:** Total freak out! Really need to write!

**June 12 – June 19:** WRITE!!!

**June 18:** Sent an email to Dave Miller!

**June 24-28:** Enjoy RSS in Germany!!



**April 26 – May 31:** Plan was to write a section, reality mostly thought about it.

**June 2:** Total freak out! Really need to write!

**June 12 – June 19:** WRITE!!!

**June 18:** Sent an email to Dave Miller!

**June 24-28:** Enjoy RSS in Germany!!

### Around June 17:

Emailed 3 senior faculty: MIT, USC, Cornell (I was pretty naïve probably would not do that again!)

Emailed 4 junior people from UW, Berkeley, MIT, GATech (probably more acceptable! Do recommend!)

Emailed 3 Stanford people (junior, mid-career, senior) (probably more acceptable! Do recommend!)

Some didn't respond or were traveling, or too short notice!

Detailed feedback from 2-3 people... led to some big changes!

**THIS WAS SOOOOO HELPFUL!**

# How did my proposal look like?

## Education Plan!

### CAREER: Safe and Influencing Interactions for Human-Robot Systems

PI, Dorsa Sadigh, Stanford University

**Long-Term Vision – Robotics algorithms that are cognizant of their effects on society.** One of the key challenges when studying robotics systems that interact with people is that we do not have access to a general model of human behaviors. Humans usually do not follow a fixed stationary model. They change and adapt to each other and to the robots over time. *We gain experience* – our driving behavior when interacting with an autonomous car will be significantly different after many interactions [132]. In assistive robotics, human responses will change as robots adapt [76]. Routing decisions of autonomous cars influence our routing choices and can result in undesirable global properties such as congestion [100].

My work is at the intersection of human-robot interaction, control theory, and formal methods. This enables me to leverage a set of exciting and unique tools and techniques for studying the effects and impacts of interactions between humans and robots. My **long-term research goal** is to develop a theory that formalizes the effects and societal implications of interactions, collaborations, coordinations, or even co-existence of autonomous systems and humans.

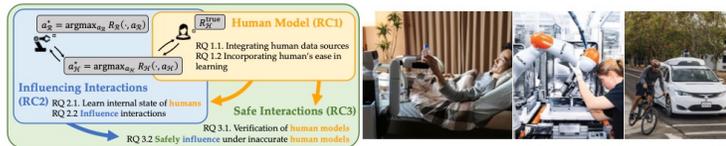


Figure 1: Adaptive Repeated Two-Player Game – an overview of the Research Plan (left). Assistive robotics, manufacturing, and autonomous driving that can benefit from our proposed research (right).

**This Project – Safe and Influencing Interactions.** This project lays the foundations of my career with the goal of formally analyzing and planning repeated interactions between humans and robots, which entails many applications (as shown in Fig. 1) including assistive robotics, collaborative manufacturing, and interactions with autonomous cars. This project is a first step for accomplishing my vision by focusing on one of the key components of safe and interactive robotics – formalizing *influencing interactions*, i.e., interactions that influence people, their actions, or their internal states. I plan to investigate three core challenges of this vision:

1. **Human Models:** We will develop data efficient methods to learn computational models of human behaviors while interacting with robots. A key challenge in human-robot interaction is the lack of data from humans. We plan to develop active learning techniques that intelligently *query* and *integrate* different types of data collected from humans.
2. **Influencing Interactions:** It is clear that humans can be influenced by simple interactions with each other, e.g., we plan to arrive late if we are meeting a friend who is always late. Similarly, our behavior changes when interacting with robots. If we observe an autonomous car being stuck at an intersection multiple times, we decide to navigate around it. In this work, we plan to design robotics algorithms that are mindful of how they can change the humans' behavior over interactions, and how that can help the overall system.
3. **Safe Interactions:** When planning for interactions that influence people, the robot will rely on learned human models. However, having access to a truly correct and reliable human model can be challenging due to lack of data, or insufficient model parameters. We thus

Long-term vision!

Overview figure with all the research questions

What is this project about!

**Education Plan.** My education plan consists of four components designed to facilitate influencing interactions and educate faculty and students at all levels.

1. **Graduate Students and Faculty: Story-Telling Forum.** Facilitating influencing interactions between faculty and students in underrepresented groups and our larger research community: I plan to initiate a story-telling forum with the goal of educating the larger community beyond inclusion groups about issues such as implicit bias.
2. **Graduate and Undergraduate Students: AI Mentoring Program.** Facilitating influencing interactions between graduate students in AI and early career undergraduates: I plan to organize an AI mentoring program to connect URM and female undergraduate students with graduate students to discuss their career plans and connect with research labs.
3. **Graduate and Undergraduate Students: Integration of Interaction in Courses.** Educating students about safe and influencing interactions: I plan to integrate interactions and its influences in the AI and robotics curriculum at Stanford.
4. **High School Students: Collaboration with Local Schools.** Educating the younger generation about safe and influencing interactions: I plan to host high school students and teachers in my lab over the duration of this project, and develop an outreach robotics module.

# Things that helped with getting the sections right:

1. Samples of other CAREER proposals
  - mostly from friends who have received CAREER. Don't assume people are okay with sharing these, but email them! I had 3-4 samples.
2. Reading the review criteria
3. Serving on a panel
4. Writing other proposals with more senior people (find out rules of thumb)
  - Don't make it a wall of text! Make it easy to read and super clear.
  - Around three research thrusts, maybe two research questions under each
  - Talk about how to evaluate your ideas
  - Make sure to answer Heilmeier questions
  - 20 figures (5 figure\*), 100 citations, 2 pages for broader impacts for robotics proposals

# Dorsa's format of each research challenge

## 1. **Research Challenge:** Human Models

1.1. Background

1.2. Preliminary Results

1.3. Proposed Research

    Question 1 (*something that is maybe we already have some ideas about, paper submission*)

    Question 2 (*more forward looking*)

1.4. Evaluation Plan (*if you have studies, clear variables, metrics, hypotheses*)

1.5. Risk and Mitigation Plan (*optional*)

1.6. Expected Outcomes

# Education Plan

- Tie it to your research:
  - Why is this an education plan for this CAREER proposal, and how does this project help with the education plan!
- How would you evaluate it!
- It would be good to have a single unique plan, and not a laundry list of things.

# Education Plan

**Education Plan.** My education plan consists of four components designed to facilitate influencing interactions and educate faculty and students at **all levels**.

Somewhat unique!  
Connection to research was  
very forced!

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Somewhat generic

# Education Plan: Treat it the same as your research plan

## 2.1 Graduate Students and Faculty: Story-Telling Forum

**Objective.** I strongly believe that we need to educate our larger community beyond inclusion groups (groups focused on female, and URM members) about concerns and challenges that affect and are usually discussed only in inclusion groups. During this project, I plan to initiate a story-telling online forum for graduate students and colleagues to share stories about their challenges and experiences. I plan to use this forum as a platform to communicate and educate **everyone** beyond inclusion groups to be mindful of issues such as implicit bias, confidence building, and other issues [72]. This is inspired by other story-telling forums such as ACM SIGARCH article entitled "What Happens to Us Does Not Happen to Most of You" [15]. This forum will take research ideas of this project such as safe and positively influencing interactions beyond human-robot systems to human-human interactions in our larger robotics community.

**Preliminary Work.** I am on the diversity and inclusion committee in the EE department at Stanford, and I am the faculty mentor of the Inclusion in AI graduate student group. I have already created an internal list of quotes and stories from a small group of faculty and graduate students in the form of an online document shared internally.

**Proposed Work.** In collaboration with Prof. Anca Dragan at UC Berkeley (see collaboration letter), we plan to move our internal quotes and stories to a public online forum, where other members of the community can include their own experiences and stories. We will use the forum to raise awareness about issues such as implicit bias and educate the broader community.

**Evaluation Plan.** I will carry out an online survey 3 months after the release and advertisement of the online forum to graduate students in the CS and EE departments at Stanford to measure the effect of this forum on raising awareness and behavior change.

# Most common type of reviews

- Too large of a thing to do in 5 years
- Too small of a thing to do in 5 years
- No evaluation plan for things including education plan

If you want to takeaway anything form this talk:

1) Start early

2) Get feedback

# I gave this advice to my husband!

- Applied a year later in Summer 2020
- Started three days before the deadline
- Wrote a 13 page proposal
- Got it!
- Sooooo.....
- But to be fair he probably knew exactly what he was going to write, and is a much more efficient writer than me!

If you want to takeaway anything form this talk:

1) Start early

2) Get feedback



KONA  
GREGORY K. CLARK



If you want to takeaway anything form this talk:

1) Start early

2) Get feedback