

Crystal Chao

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INTERESTS human-robot collaboration, behavior architectures, mobile manipulation, autonomous systems, situated dialogue, interactive learning, multimodal interaction, artificial intelligence

EDUCATION **Georgia Institute of Technology**, Atlanta, GA, USA
Ph.D. Robotics, 2015
Thesis title: *Timing multimodal turn-taking in human-robot cooperative activity*
Thesis advisor: Andrea Thomaz
Thesis committee: Ronald Arkin, Henrik Christensen, Karen Feigh, Candace Sidner

Massachusetts Institute of Technology, Cambridge, MA, USA
B.S. Computer Science & Engineering, 2008
Minor: Music and Theater Arts
Senior project supervisor: Cynthia Breazeal

EXPERIENCE **Georgia Institute of Technology**, Atlanta, GA, USA
Postdoctoral Fellow, Socially Intelligent Machines Lab May 2015 –
Graduate Research Assistant, Socially Intelligent Machines Lab 2008 – 2015
Supervisor: Andrea Thomaz

- Developed CADENCE: Control Architecture for the Dynamics of Embodied Natural Coordination and Engagement. CADENCE uses timed Petri nets to manage physical and spoken turn-taking, and generates socially appropriate robot behavior in the modalities of speech, gesture, gaze, and manipulation. CADENCE also features a deep semantic dialogue manager for embodied collaboration with a human.
- Developed and evaluated multiple domains of human-robot interaction on the Simon robot, including collaborative model assembly, Towers of Hanoi, and “Simon Says.”
- Developed a framework for learning tasks interactively from demonstration. The framework abstracts high-level concepts from low-level features, and also generates active learning queries through dialogue. Demonstrated and evaluated the framework on the Simon robot and the Honda humanoid robot with a set of kitchen tasks.
- Acted as the primary architect and maintainer for the lab’s shared codebase.
- Mentored undergraduates on projects in task planning, RGBD perception, sound source separation, and data visualization.

Musician/Programmer, New Music Ensemble Spring 2013
Project supervisor: Gil Weinberg

- Developed autonomous control for the marimba robot Shimon to play Steve Reich’s *Piano Phase* (1967) with a human keyboardist.
- Played the keyboard in a live performance with the robot.

MIT Media Lab, Cambridge, MA, USA
Undergraduate Researcher, Personal Robots Group 2006 – 2008
Project supervisors: Cynthia Breazeal, Matthew Berlin

- Developed a hand gesture interface using Vicon motion capture for humans to perform virtual object manipulation with the Leonardo robot.

- Implemented perception on the Leonardo and Huggable robots, including object recognition using color and shape, and panoramic scene stitching.
- Conducted a user study to evaluate a robot social learning approach.

Google, Inc., Mountain View, CA, USA

Software Engineering Intern, Firefox Group

Summer 2006

Project supervisors: Tony Chang, Annie Sullivan

- Implemented features in Google Toolbar for Firefox (custom buttons and auto-fill).

MIT Computer Science and Artificial Intelligence Lab, Cambridge, MA, USA

Undergraduate Researcher, User Interface Design Group

Summer 2005

Project supervisor: Rob Miller

- Developed a Firefox extension for running terminal commands in a browser DOM context.

JOURNAL
ARTICLES

C. Chao and A.L. Thomaz. Establishing common ground in human-robot collaboration with spoken and physical joint action (under review).

C. Chao and A.L. Thomaz. Timed Petri nets for fluent multimodal turn-taking in human-robot collaboration (under review).

C. Chao and A.L. Thomaz. Controlling social dynamics with a parametrized model of floor regulation. *Journal of Human-Robot Interaction*, 2(1), 4–29, 2013.

C. Chao and A.L. Thomaz. Timing in multimodal turn-taking interactions: Control and analysis using timed Petri nets. *Journal of Human-Robot Interaction*, 1(1), 4–25, 2012.

J. Lee, **C. Chao**, A.F. Bobick, and A.L. Thomaz. Multi-cue contingency detection. *International Journal of Social Robotics*. 4(2), 147–161, 2012.

A.L. Thomaz and **C. Chao**. Turn-taking based on information flow for fluent human-robot interaction. *AI Magazine: Special Issue on Dialog with Robots*, 32(4), 53–63, 2011.

M. Cakmak, **C. Chao**, and A.L. Thomaz. Designing interactions for robot active learners. *IEEE Transactions on Autonomous Mental Development*, 2(2), 108–118, 2010.

CONFERENCE
PROCEEDINGS

C. Chao. Timing multimodal turn-taking for human-robot cooperation. In *Proceedings of the 14th ACM Intl. Conf. on Multimodal Interaction (ICMI)*, 309–312, 2012.

C. Chao, M. Cakmak, and A.L. Thomaz. Towards grounding concepts for transfer in goal learning from demonstration. In *Proceedings of the IEEE Intl. Conf. on Development and Learning (ICDL)*, 2, 1–6, 2011.

C. Chao, J. Lee, M. Begum, and A.L. Thomaz. Simon plays Simon says: The timing of turn-taking in an imitation game. In *Proceedings of the IEEE Intl. Symposium on Robot and Human Interactive Communication (RO-MAN)*, 235–240, 2011.

C. Chao, M. Cakmak, and A.L. Thomaz. Transparent active learning for robots. In *Proceedings of the ACM/IEEE Intl. Conf. on Human-Robot Interaction (HRI)*, 317–324, 2010.

C. Breazeal, M. Berlin, J. Gray, and **C. Chao**. Teaching robots via natural nonverbal cues. In *Proceedings of the Intl. Symposium on Experimental Robotics (ISER)*, 54, 211–220, 2009.

M. Berlin, C. Breazeal, and **C. Chao**. Spatial scaffolding cues for interactive robot learning.

In *Proceedings of the IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, 1229–1235, 2008.

SYMPOSIA,
WORKSHOPS,
AND DEMOS

C. Chao, J. Smith, and A.L. Thomaz. CADENCE for collaboration and companionship with robots. *Proceedings of the AAAI Symposium on Artificial Intelligence for Human-Robot Interaction*, 2014.

C. Chao and A.L. Thomaz. Timed Petri nets for multimodal interaction modeling. *ICMI Workshop on Speech and Gesture Production in Virtually and Physically Embodied Conversational Agents*, 2012.

C. Chao and A.L. Thomaz. Turn-taking for human-robot interaction. In *Proceedings of the AAAI Symposium on Dialog with Robots*, 2010.

C. Chao, M. Gielniak, J.W. Yoo, and A.L. Thomaz. Interactive learning by demonstration with the Simon robot. *AAAI Robot Learning from Demonstration Challenge*, 2010.

A.L. Thomaz, C. Cakmak, **C. Chao**, N. DePalma, and M. Gielniak. Interactive robot task learning. *CHI Media Showcase*, 3037–3040, 2010.

C. Chao, M. Cakmak, and A.L. Thomaz. Interactive task learning with discrete and continuous features. *IJCAI Robot Exhibition and Workshop*, 2009.

AWARDS

Outstanding Doctoral Consortium Paper Award, ICMI, 2012
President’s Fellowship, Georgia Tech, 2008–2012
HRI Pioneer, 2010
6.UAT Conference Best Talk, MIT, 2007

ORGANIZER

HRI Workshop on Timing in Human-Robot Interaction, 2014
Young Researchers’ Roundtable on Spoken Dialogue Systems (YRRSDS), 2014

PROGRAM
COMMITTEE /
REVIEWER

Journal of Human-Robot Interaction (JHRI), International Journal of Social Robotics (SORO), Robotics: Science and Systems Conference (RSS), Conference on Artificial Intelligence (AAAI), ACM/IEEE International Conference on Human-Robot Interaction (HRI), ACM International Conference on Multimodal Interaction (ICMI), IEEE International Conference on Robotics and Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), ACM Transactions on Interactive Intelligent Systems (TiiS), IEEE Transactions on Human-Machine Systems (THMS), IEEE Transactions on Affective Computing (TAC), IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)

POPULAR MEDIA

“Georgia Tech lab turning computers into companions.” *CBS News*. December 29, 2014.

“Social Robots.” *NOVA scienceNOW*. 2011.

“Students, meet your new teacher, Mr. Robot.” Benedict Carey and John Markoff. *The New York Times*. July 10, 2010.

SKILLS

Languages: Java, C/C++, C#, Objective-C, Javascript, Python, Scheme, Matlab
Libraries/frameworks: ROS, MoveIt!, PCL, OpenCV, Gurobi, Weka

LANGUAGES

English (native), French (studied through college), Mandarin (basic), German (basic)

CITIZENSHIP

USA