Towards Transferrable Affective Models for Educational Play

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Abstract

Modern computational agents in adaptive educational systems primarily rely on cognitive (i.e. curricular performance) data, while ignoring important multimodal affect cues which human tutors use to personalize their interactions with students. Students' affective responses are highly idiosyncratic, noisy, and dependent on interactive context, challenges which defy many standard assumptions of computational player modeling. As a result, recent research efforts to model student affective response have focused on specific, single-task interactions, limiting the amount and variety of affective input from an individual player.

For my thesis research, I plan to address these limitations in two ways. First, by developing a new paradigm for modeling student affective data, not as a scalar reward signal, but as a *policy label*, i.e., feedback on an agent's recent behavior, and additionally by developing transfer learning methods to apply this policy feedback data across multiple game tasks. Together, these two advances may lead to more data-efficient learning and more flexible and generalizable affective models of players.

1 Motivation and Introduction

In Neil Stephenson's sci-fi epic "The Diamond Age," a young girl named Nell is gifted an interactive device that changes her life: an 'electronic book' called 'The Young Lady's Illustrated Primer' that teaches, inspires, and coaches her through life. The book adapts its content and interacts with Nell based on her age, mood, and environment, providing her with the right content, presented in the right way, at the right time, thereby setting her on a journey towards a lifetime of learning and adventure. Not all of the futuristic technology from The Diamond Age has moved from fiction to feasible, but research on personalized, adaptive tutoring AI has progressed rapidly in recent years.

My research focuses on developing social robot tutors that can model and interact with individual students in ways similar to expert human tutors. I have primarily conducted this research in the context of a suite of educational games designed to help students practice early language and literacy skills through educational play. In recent years, our understanding of children's language development has underscored the the cognitive, affective, and social nature of language learning, suggesting that interactive agents, particularly social robots, can be an effective tool for helping children learn these skills through play-based activities.

Prior research has demonstrated that these systems can increase engagement and improve learning over long-term interactions by leveraging computational models of student's knowledge and personalizing curricular content to each student's level (Vogt et al. 2019). However, these systems typically do not incorporate the rich social channels of student affect and are designed around just a single game activity, repeated over many sessions, leading to decreased engagement over time. A major roadblock to breaking out of this single-task paradigm is the inability of current models to generalize across different learning environments and tasks. In my thesis research, I am developing an agent-based algorithmic framework that uses multimodal social signals and gameplay data to: **(1)** interactively learn affect-based agent models to promote learning and engagement; and **(2)** apply transfer learning methods to enable data and models to be shared across different tasks for more efficient and proficient learning.

1.1 Adaptive, affective social robots for education

Social robot learning companions have great potential to help promote childhood education by engaging children socially and emotionally in learning interactions. Prior research from the field of human-robot interaction (HRI) has demonstrated the efficacy of *personalization* in interactive educational play (Baxter et al. 2017), (Leyzberg, Spaulding, and Scassellati 2014). One particularly intriguing research frontier is the use of real-time multimodal data (e.g., facial expression, body posture) to detect relevant student affective states such as engagement, boredom, or frustration and guide a tutoring agent's interactive behavior (Spaulding, Gordon, and Breazeal 2016).

In educational games and other "intelligent tutoring systems" (ITS), it is primarily 'cognitive' models (i.e. models of student knowledge) that guide interaction, such as the introduction and pacing of specific curricular content. Through my research, I seek to develop more fluent and emotion-

ally resonant interactive experiences by designing *affective* player models that are used to shape the agent's behavior during these games, for example, learning when to offer hints, encourage a student, or switch learning strategies.

An 'affective model' is simply a model of how a player responds 'affectively' or emotionally, encapsulating aspects of player mood, valence, and energy in response to particular in-game events or agent behaviors. Though affective models in adaptive games (e.g. (Lobel et al. 2016)) are still in an early stage (Yannakakis and Paiva 2014), early uses have demonstrated their potential for creating more engaging and 'resonant' learning experiences (Klopfer et al. 2018).

1.2 Prior Research

Long-term interactions are recognized by the HRI community as a necessary challenge to confront, for better science and for real-world impact (Irfan et al. 2019). Two prior studies [(Gordon et al. 2016) and (Park et al. 2019)] have demonstrated that incorporating sensed affect as a scalar input to an RL reward function used to train an agent's educational behavior can boost engagement and learning over a long-term interaction. However, these past projects also highlight the challenges of affect modeling in long-term interactions. For instance, while the model-free RL approaches in these projects have advantages in domain flexibility, treating affective data as a form of human-generated reward is generally not very sample-efficient. This in turn leads to an emphasis on modeling within a single educational task, repeated several times over the course of a long-term interaction. Affect personalization helps maintain engagement longer than non-personalized interactions, but after a few sessions we still see engagement decline, a phenomenon well-known among HRI researchers as the "novelty effect".

2 Transferrable Affective Models

2.1 Affective Policy Shaping

Instead of modeling player affect response as a scalar reward, I propose to model affect as behavior feedback label, under the framework of 'policy shaping'. Policy shaping (Cederborg et al. 2015) is a (relatively) efficient form of interactive agent behavior learning in which humans label behaviors as correct or incorrect as agents perform a task, and has been shown to help agents improve complex task learning under more realistic conditions (e.g., even when humans are inattentive or distracted (Kessler Faulkner et al. 2019)).

Human affective response, however, unlike expert policy labels, is typically ambiguous, automatic, and unconscious. It unfolds over interactive turns of several seconds ? thousands of data points, sensed at a typical 30fps frequency. For an agent to use this data as a policy label, affective data must be *interpreted* after detection. As part of my thesis research, I developed a complete pipeline for analyzing, interpreting, and using affective facial expressions in interactive context, detailing the challenges of affect interpretation and emphasizing its distinct role in a framework for affect-aware agents. I showed that simple methods of personalization in affect interpretation substantially improve the quality of the inferred labels (Spaulding and Breazeal 2019), laying the foundation for continued research of policy shaping as an approach for modeling human affect and learning personalized affect-based behavior policies.

2.2 Affective Model Transfer

Alongside research on affective policy shaping for single-task behavior models, I propose to apply transfer learning methods to affective policy labels, aimed at using data from one interactive game task to more quickly train behavior policies in a separate game interaction. Player affect data, particularly in educational games, is highly idiosyncratic and heavily dependent on interactive context (Chen et al. 2020). As a result, many traditional approaches to personalized modeling (e.g. training on group data and fine-tuning on personalized data) are infeasible for affect-based learning applications. Instead, I propose a more direct transfer learning approach, adapting personalized affective data from one learning task to another, leveraging known structural similarities between task contexts. Specifically, I am developing an instance-weighting algorithm, transferring affective policy label data from a source task to a novel target task, with the transfer weight determined by task similarity metrics.

Due to the unique design requirements of each game interaction, the agent may have non-overlapping action sets available in each tasks. Some actions (e.g. highlighting an object or displaying content) will be unique to each game, whereas others (e.g., offer a hint, give verbal encouragement) are common to all. Transferred policy labels could help the agent start off with more accurate model of the common actions, allowing the agent to explore the impact of novel actions in familiar state spaces or familiar actions in novel state spaces while maintaining an acceptable level of interaction performance.

2.3 Planned Evaluation

I have been developing a pair of educational games designed to help students practice either rhyming and spelling. Each game features unique mechanics to elicit different behavioral data (e.g., matching or sorting) and have already been playtested or evaluated in pilot studies with students. During the final years of my PhD, I plan to finalize the system infrastructure and evaluate the policy shaping approach for affect modeling in each game individually, then evaluate the transfer learning methods and the unified system in a final study in partnership with a local elementary school in which children engage in each game activity sequentially over the course of a multi-session interaction.

My initial research questions primarily concern the effect of policy shaping and model transfer on model inference and student engagement. How does a policy shaping personalization approach affect sample-efficiency of learning, compared to more standard RL methods? How does a final model for the target game task, seeded with data from the source game task, compare to a model personalized only via the target task? By answering these algorithmic questions, grounded in educational game scenarios, I hope to advance research towards more flexible, adaptable, and efficient computational tutors.

References

Baxter, P.; Ashurst, E.; Read, R.; Kennedy, J.; and Belpaeme, T. 2017. Robot education peers in a situated primary school study: Personalisation promotes child learning. *PLoS One* 12(5):e0178126.

Cederborg, T.; Grover, I.; Isbell, C. L.; and Thomaz, A. L. 2015. Policy shaping with human teachers. In *Twenty-Fourth International Joint Conference on Artificial Intelligence*.

Chen, H.; Park, H. W.; Zhang, X.; and Breazeal, C. 2020. Impact of interaction context on the student affect-learning relationship in child-robot interaction. In *Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*, 389–397.

Gordon, G.; Spaulding, S.; Westlund, J. K.; Lee, J. J.; Plummer, L.; Martinez, M.; Das, M.; and Breazeal, C. 2016. Affective personalization of a social robot tutor for children's second language skills. In *Thirtieth AAAI Conference on Artificial Intelligence*.

Irfan, B.; Ramachandran, A.; Spaulding, S.; Glas, D. F.; Leite, I.; and Koay, K. L. 2019. Personalization in long-term human-robot interaction. In *2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 685–686. IEEE.

Kessler Faulkner, T.; Gutierrez, R. A.; Short, E. S.; Hoffman, G.; and Thomaz, A. L. 2019. Active attention-modified policy shaping: socially interactive agents track. In *Proceedings of the 18th International Conference on Autonomous Agents and MultiAgent Systems*, 728–736.

Klopfer, E.; Haas, J.; Osterweil, S.; and Rosenheck, L. 2018. *Resonant games: Design principles for learning games that connect hearts, minds, and the everyday*. MIT Press.

Leyzberg, D.; Spaulding, S.; and Scassellati, B. 2014. Personalizing robot tutors to individuals' learning differences. In *Proceedings of the 2014 ACM/IEEE international conference on Human-robot interaction*, 423–430. ACM.

Lobel, A.; Gotsis, M.; Reynolds, E.; Annetta, M.; Engels, R. C.; and Granic, I. 2016. Designing and utilizing biofeedback games for emotion regulation: The case of nevermind. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 1945–1951.

Park, H. W.; Grover, I.; Spaulding, S.; Gomez, L.; and Breazeal, C. 2019. A model-free affective reinforcement learning approach to personalization of an autonomous social robot companion for early literacy education. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 33, 687–694.

Spaulding, S., and Breazeal, C. 2019. Frustratingly easy personalization for real-time affect interpretation of facial expression. In *2019 8th International Conference on Affective Computing and Intelligent Interaction (ACII)*, 531–537. IEEE.

Spaulding, S.; Gordon, G.; and Breazeal, C. 2016. Affect-aware student models for robot tutors. In *Proceedings of the 2016 International Conference on Autonomous Agents & Multiagent Systems*, 864–872. International Foundation for Autonomous Agents and Multiagent Systems.

Vogt, P.; van den Berghe, R.; de Haas, M.; Hoffman, L.; Kanero, J.; Mamus, E.; Montanier, J.-M.; Oranç, C.; Oudgenoeg-Paz, O.; García, D. H.; et al. 2019. Second language tutoring using social robots: A large-scale study. In *2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 497–505. Ieee.

Yannakakis, G. N., and Paiva, A. 2014. Emotion in games. *Handbook on affective computing* 459–471.

Samuel Spaulding
Personal Statement - AIIDE 2020 Doctoral Consortium

In my experience as a graduate student, I have found that the best way to refine research ideas is through discussion with other researchers, especially those from different institutions and with diverse backgrounds. This intellectual cross-pollination leads to stronger ideas and novel insights.

Last June, I was introduced to the “AI & Games” community through a summer school program hosted at NYU by Professors Julian Togelius and Georgios Yannakakis. During that program, many of the attendees and host students were working on submissions to AIIDE and, while listening to them describe their paper topics, I was struck by the essential similarities between their research questions and those in my own ‘home field’ of human-robot interaction (HRI).

One of the things I most appreciated about that program was the sheer diversity of topics, techniques, and backgrounds of people that had come together to work under the banner of “AI & Games”. This summer, I hope to more firmly establish a connection to the community by submitting a full paper to the conference, attending AIIDE, and participating in the doctoral consortium.

My research focuses on developing social robots that interactively learn transferrable models of student’s behaviors and mental states across different educational game task. This kind of interdisciplinary work draws on perspectives from social signal processing, educational interaction design and evaluation, and interactive agent behavior planning. Feedback from other game developers and AI researchers is a top priority at this stage of the project, and connecting with other researchers with deployed player modeling and analytics experience will help me develop technical focus and best practices for field evaluations to enhance the quality and impact of my research.

This year’s AIIDE Doctoral Consortium represents an amazing opportunity to share ideas and experiences from my research and further dialogue with other early-career researchers. I am especially enthusiastic about establishing lasting channels of feedback over a wide-ranging set of interests spanning multimodal perception, interactive machine learning, and game design and evaluation, particularly as each aspect relates to educational interactions. I look forward to the opportunity to contribute to the workshop program, to the research of the other participants, and to joining the vibrancy and diversity of the AIIDE community.

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Research Interests

I work on interactive A.I. systems, mostly in the context of Human-Robot Interaction, with particular emphases on designing embodied agents that can construct models of other agents throughout an interaction, take actions based on these models, and reason about and refine their actions and models. I apply this work across various multimodal channels, including verbal/linguistic (i.e. speech and language) and non-verbal (e.g. facial expression, body pose, and motion) cues, with the goal of creating interactive agents that can flexibly and fluently support engaging and educational experiences.

Education

2017–present **Ph.D. Media Arts & Sciences**, *MIT Media Lab*, Cambridge, MA, USA.
Advisor: Cynthia Breazeal

2013–2015 **S.M. Media Arts & Sciences**, *MIT Media Lab*, Cambridge, MA, USA.
Advisor: Cynthia Breazeal. Thesis: "Developing Affect-Aware Robot Tutors."

2009–2013 **B.S. Computer Science**, *Yale University*, New Haven, CT, USA.
Graduated with Distinction in the Major. Senior thesis advised by Brian Scassellati.

Research Experience

2017-present, 2013-2015 **Graduate Research Assistant, Personal Robots Group**, *MIT Media Lab*, Cambridge, MA.
Developing interactive social robots and novel computational models to enable fluent social interaction and collaboration between humans and robots, particularly through the use of multi-modal, affective user data

Summer 2012 **Research Associate, Disney Research - Boston**, *Walt Disney Imagineering*, Boston, MA.
Worked with Jonathan Yedidia on a novel sentiment analysis system for Walt Disney Imagineering. Our project, **"Making Sense of the Blogosphere: Semantic Analysis of Text Mined from the Web"** won the **Judges' Special Distinction Award for Methodology** in company-wide Business Intelligence and Data Analytics Competition

2010 - 2013 **Research Assistant, Yale Social Robotics Lab**, *Yale University*, New Haven, CT.
Worked with Dan Leyzberg and Brian Scassellati to develop and evaluate robot tutors capable of personalizing to individual learning differences.

Industry Experience

2015-2017 **Robot Skills & Character AI Engineer**, *Jibo, Inc.*, Boston, MA.
Worked with Design and Hardware teams to develop innovative applications and developer tools for a consumer home robot that delivers an intelligent, rich, and cohesive character experience.

Summer 2011 **Software Development Engineering Intern**, *Amazon, Inc.*, Seattle, WA.
Built internal bug analysis tool and received return offer. Member of four-person team whose submission, an Android app called "SmileIKnow" was a finalist at the 2011 Amazon Mobile Security Hackathon

Other Experience

June 2019 **Invited Participant**, *2nd Conversational Intelligence Summer School*, UMass Lowell, Lowell, MA, Invited to attend week-long intensive summer school program, covering modern neural approaches to natural language processing (NLP) and interactive dialogue.

May 2019 **Invited Participant**, *2nd Summer School on AI and Games*, NYU, New York, NY, Invited to attend week-long intensive summer school program, covering topics in modern AI and games research including interactive player modeling, procedural content generation, and generalizable game-playing agents.

June 2017 **Invited Participant**, *1st Summer School on Cognitive Robotics*, MIT, Cambridge, MA, Invited to attend week-long intensive summer school program, covering topics in robotics including scheduling, perception, and activity planning under uncertainty.

Awards and Honors

- **(2013-2018) National Science Foundation Graduate Research Fellowship**, Awarded national fellowship to support graduate education in the sciences
- **(2015) HRI Pioneers Travel Award**, Awarded funding support to attend the Human-Robot Interaction (HRI) Pioneers workshop, a selective workshop that seeks to foster creativity and collaboration across the disciplines of HRI researchers.
- **(2013) Mellon Undergraduate Research Grant**, Awarded funding support to attend HRI 2013 in Tokyo, Japan
- **(2012) Sigma Xi Undergraduate Research Award**, Awarded funding support and membership in Sigma Xi Scientific Society
- **(2011) First Place, Academic Competition Federation (ACF) National Championship**, As part of Yale's Quiz Bowl team, won the premier national event for collegiate academic quiz competition.
- **(2010) First Runner-up, Jeopardy! College Championship**, Won 3 of 4 games and second place overall in the Season 27 Jeopardy! College Championship.

Book Chapters

[B1] Goren Gordon, **Samuel Spaulding**, Susan Engel, and Cynthia Breazeal. **Curious Robots for Curious Children**. In *The New Science of Curiosity*. Nova Science Publishers, 2018

Highly-Refereed Conference Publications

[C9] **Samuel Spaulding** and Cynthia Breazeal. **Frustratingly Easy Personalization for Real-time Affect Interpretation of Facial Expression**. In *Proceedings of the 18th International Conference on Affective Computing & Intelligent Interaction* (ACII 2019, **40% acceptance rate**).

[C8] Hae Won Park, Ishaan Grover, **Samuel Spaulding**, Louis Gomez, and Cynthia Breazeal. **A Model-free Affective Reinforcement Learning Approach to Personalization of an Autonomous Social Robot Companion for Early Literacy Education**. In *Proceedings of 33rd AAAI Conference on Artificial Intelligence* (AAAI 2019, **16% acceptance rate**).

[C7] **Samuel Spaulding**, Huili Chen, Safinah Ali, Mike Kulinski, and Cynthia Breazeal. **A Social Robot System for Modeling Children's Word Pronunciation**. In *Proceedings of the 17th International Conference on Autonomous Agents and Multiagent Systems* (AAMAS 2018, **30% acceptance rate**).

[C6] W. Bradley Knox, **Samuel Spaulding**, and Cynthia Breazeal. **Learning from the Wizard: Programming Social Interaction via Teleoperated Demonstrations** . In *Proceedings of the 15th International Conference on Autonomous Agents and Multiagent Systems: Extended Abstracts* (AAMAS 2016 Extended Abstracts).

[C5] **Samuel Spaulding**, Goren Gordon, and Cynthia Breazeal. **Affect-aware Student Models for Robot Tutors**. In *Proceedings of the 15th International Conference on Autonomous Agents and Multiagent Systems* (AAMAS 2016, **25% acceptance rate**).

[C4] Jacqueline Kory Westlund, Goren Gordon, **Samuel Spaulding**, Jin Joo Lee, Luke Plummer, Marayna Martinez, Madhurima Das, and Cynthia Breazeal. **Lessons From Teachers on Performing HRI Studies with Young Children in Schools**. In *Proceedings of the 11th ACM/IEEE International Conference on Human-Robot Interaction: alt.HRI* (alt.HRI 2016)

[C3] Goren Gordon, **Samuel Spaulding**, Jacqueline Kory Westlund, Jin Joo Lee, Luke Plummer, Marayna Martinez, Madhurima Das, and Cynthia Breazeal. **Affective Personalization of a Social Robot Tutor for Children's Second Language Skills**. In *Proceedings of the 30th AAAI Conference on Artificial Intelligence* (AAAI 2016, **26% acceptance rate**).

[C2] Dan Leyzberg, **Samuel Spaulding**, and Brian Scassellati. **Personalizing Robot Tutors to Individuals' Learning Differences**. In *Proceedings of the 9th ACM/IEEE International Conference on Human-Robot Interaction* (HRI 2014, **24% acceptance rate**)

[C1] Dan Leyzberg, **Samuel Spaulding**, Mariya Toneva, and Brian Scassellati. **"The Physical Presence of a Robot Tutor Increases Cognitive Learning Gains**. In *Proceedings of the 34th Annual Conference of the Cognitive Science Society* (COGSCI 2012, **40% acceptance rate**).

Lightly-Refereed Publications

[W9] Gary Yeung, Alison L. Bailey, Amber Afshan, Marlen Q. Perez, Alejandra Martin, **Samuel Spaulding**, Hae Won Park, Abeer Alwan, & Cynthia Breazeal. **Towards the Development of Personalized Learning Companion Robots for Early Speech and Language Assessment**. In *Annual Meeting of the American Educational Research Association* (AERA 2019)

[W8] **Samuel Spaulding** and Cynthia Breazeal. **Pronunciation-based Child-Robot Game Interactions to Promote Literacy Skills**. In *Proceedings of the 14th ACM/IEEE International Conference on Human-Robot Interaction: Late-Breaking Reports* (HRI 2019 Late-Breaking Reports).

[W7] **Samuel Spaulding**. **Personalized Robot Tutors that Learn from Multimodal Data**. In *Proceedings of the 17th International Conference on Autonomous Agents and Multiagent Systems: Doctoral Consortium* (AAMAS 2018 Doctoral Consortium).

[W6] Kory Westlund, J. M., Lee, J., Plummer, L., Faridi, F., Gray, J., Berlin, M., Quintus-Bosz, H., Harmann, R., Hess, M., Dyer, S., dos Santos, K., Adalgeirsson, S., Gordon, G., **Spaulding, S.**, Martinez, M., Das, M., Archie, M., Jeong, S., & Breazeal, C. **Tega: A Social Robot.** In *Proceedings of the 11th ACM/IEEE International Conference on Human-Robot Interaction: Video Presentations* (HRI 2016 Video Track) Best Video Nominee.

[W5] **Samuel Spaulding** and Cynthia Breazeal. **Towards Affect-Awareness for Social Robots**. In *AAAI 2015 Fall Symposium Series: Artificial Intelligence for Human-Robot Interaction* (AI-HRI 2015)

[W4] Jacqueline Kory Westlund*, Goren Gordon*, Samuel Spaulding, Jin Joo Lee, Luke Plummer, Marayna Martinez, Madhurima Das, and Cynthia Breazeal, **Learning a Second Language with a Socially Assistive Robot.** In *Proceedings of New Friends: The 1st International Conference on Social Robots in Therapy and Education* (New Friends 2015)

[W3] **Samuel Spaulding** and Cynthia Breazeal. **Affect and Inference in Bayesian Knowledge Tracing with a Robot Tutor**. In *Proceedings of the 10th ACM/IEEE International Conference on Human-Robot Interaction: HRI Pioneers* (HRI Pioneers 2015)

[W2] **Samuel Spaulding** and Cynthia Breazeal. **Exploring Child-Robot Tutoring Interactions with Bayesian Knowledge Tracing**. In *AAAI 2014 Fall Symposium Series: Artificial Intelligence for Human-Robot Interaction* (AI-HRI 2014)

[W1] W. Bradley Knox, **Samuel Spaulding** and Cynthia Breazeal. **learning Social Interaction from the Wizard: A Proposal**. In *Proceedings of the 3rd Workshop on Machine Learning for Interactive Systems* held at AAAI 2014

Invited Talks

Invited Speaker **2020** *"Personalized Robot Learning Companions for Early Literacy and Language Skills"*, Harvard CRCS Workshop on AI for Social Impact

Guest Lecturer **2019** *"Models of Persuasion and Behavior Change"*, MAS S60: AI for Mental Health

Invited Speaker **2019** *"Social Robots: A New Medium for Behavior and Attitude Change"* MIT TechReview: EmTech Caribbean Conference

Invited Speaker **2018** *"Learning Affective and Cognitive Models for Robot Tutoring"* IBM T.J. Watson Research Center

Guest Lecturer **2017** *"Social Robotics and Human-Robot Interaction: An Overview"* MAS.111: Media Arts & Sciences Freshman Symposium

Invited Speaker **2016** *"Affect-aware Social Robot Tutors"* Affectiva Inc.

Invited Speaker **2015** *Personal Robots Research Overview* MIT Media Lab Spring Member Event.

Invited Speaker **2014** *"Fascinating Alumni: Short Talks"* Jonathan Edwards College Reunion

Invited Speaker **2013** *Yale Undergraduate Science Symposium*

Invited Speaker **2013** *Yale Engineering and Science Weekend Symposium*

TEDx Speaker **2013** *"TEDxYale: Solve for Y"* Conference

Invited Speaker **2012** *Yale Undergraduate Science Symposium*

Invited Speaker **2012** *Yale Engineering and Science Weekend Symposium*

Invited Panelist **2010**, Yale Computer Science Department *IBM Jeopardy! Challenge Discussion*

Teaching

Summer 2018 **Kaufman Teaching Certificate Program**, *Massachusetts Institute of Technology*.
Completed a series of workshops and teaching activities designed to prepare early-career researchers for teaching at the university level. Topics included **Course and Syllabus Design**, **Class Session Planning**, **Interactive Teaching and Active Learning**, **Constructing Effective Assessments**, and **Teaching Inclusively**, among others

Fall 2012 **Course Assistant, CS 201: Introduction to Computer Science**, *Yale University*.
Assisted students with core course concepts. Covered basic topics like recursion through introductions to more advanced concepts including formal language theory, logic, and computability theory

Mentoring + Outreach

Students Supervised

- Matthew Huggins (Fall/Spring 2018-9)
- Jocelyn Shen (Fall/Spring 2018-9)
- Phillip Graham (6.UAP MIT Undergraduate Senior Research Project, Spring 2017)
- Katherine Xiao (MIT UROP, Spring 2016)
- Wei Low (MIT UROP, Fall 2015, Spring 2016)
  Recognized with NCWIT Collegiate Award Runner-up for supervised project

Public Outreach

Video Presenter **2019** *The Children's Media Conference*, Sheffield, UK. Pre-filmed an interview with Panel Chair on the ways in which social robots could be used as a tool to bring socially-sensitive digital education to children on a global scale.

Featured Speaker **2018** *BostonTalks: Robots*, WGBH Boston Studios. Invited to present at WGBH's monthly public-interest speaker series to promote citizen engagement with diverse topics.

Featured Researcher **2016** *I Am A Scientist: Youth-focused STEM Diversity Campaign*, The People's Science. Volunteered for public interview and meet-and-greet event to promote STEM diversity and awareness among 9-13 year-old students.

MIT Booth Coordinator **2014** *World Science Festival: Robotics Showcase*, World Science Festival. Coordinated, developed, and demonstrated innovative robotics projects from the Personal Robots Group.

Professional Service

Reviewer

- ACM Transactions on Human-Robot Interaction (T-HRI)
- ACM Transactions on Affective Computing (T-AffC)
- Journal of Computers and Education (CAE).
- ACM/IEEE International Conference on Human-Robot Interaction (HRI)
- AAAI Conference on Artificial Intelligence (AAAI).

DEI Fellow **2020** Selected as an MIT Diversity, Equity, and Inclusion Fellow. Trained to facilitate difficult conversations about social identities and social justice, helped organize community dialogue events and further training opportunities.

PC Member **2019** *AAAI 2020 Emerging Track: AI for Social Impact (AISI)*. Helped to review submissions, discuss them with other PC members, and help SPC members make acceptance recommendations.

Workshop Organizer **2019** *Workshop on Personalization in Long-term HRI (PLOT-HRI)*. Co-organizer of the first workshop on Personalization in Long-Term Human-Robot Interaction (PLOT-HRI), held in conjunction with HRI 2019.

Student Nominee **2018** *Media Arts & Sciences Department Visiting Committee Meeting*. Nominated by peers to meet with MIT Visiting Committee members to discuss and recommend improvements to department culture, academic structure, and strategic goals

Comittee Member **2016-2018** *Affectiva, Inc. Emotion AI Think Tank Council*. Invited to serve on industry-academic bridge committee focused on future directions and applications of Emotion AI research.

Panel Chair **2016** *HRI Pioneers Workshop*. Responsible for organizing the Pioneers workshop panel, determining topics, soliciting panel members, and hosting/moderating.

Workshop Organizer **2014** *Student Technical Workshop*, NSF Expedition on Socially Assistive Robotics. With students at partner institutions, drafted budget, solicited and curated submissions, and coordinated program.

Patents

Maintaining attention and conveying believability via expression and goal-directed behavior with a social robot. C. Breazeal, F. Faridi, S. Adalgeirsson, **S. Spaulding**, A. Stout, T. Donahue, M. Berlin, J. Gray. *pending* US20180229372A1, filed February 07, 2018.

Technical Skills and Training

Software Extensive experience with Java/C/C++, Python, MATLAB and R. Strong Web Development and Design skills including HTML/CSS/Javascript, Ruby on Rails, and Node.js. Significant Android mobile development experience.

Hardware Significant fabrication training and experience with: Laser Cutter, Vinyl Cutter, CNC Mill, Molding/Casting, Composite Materials, and 3D Printing. Significant electronics experience, including PCB design and fabrication, and circuit design for radio, motor, and sensing applications for mobile robots.

Robots Extensive experience developing and maintaining hardware and software for multiple commercial and in-house robotic platforms, including extensive development experience with ROS and OpenCV.

- Commercial Robot Platforms: iRobot Create, Aldebaran Nao, Beatbots Keepon, and Jibo
- In-house robots: 57 DOF Mobile-Dexterous-Social (MDS) Humanoid, 6 DOF Dragonbot platform, 5 DOF Tega Platform, and 5 DOF Affective Intelligent Driving Agent (AIDA)