Minds at play

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It is a happy talent to know how to play.
– Ralph Waldo Emerson

Overview

Play and curiosity are unmistakable signatures of an active mind. It is perhaps unsurprising then, that recent advances in machine learning and robotics have used algorithmic approximations of curiosity to build artificial agents that can intelligently explore their environments, learn more efficiently, and acquire more generalizable skills (e.g. Chitnis et al., 2020; Lynch et al., 2020; Forestier et al., 2017).

This burgeoning interest in the computational study of curiosity and exploration is accompanied by a long history of studies linking play and learning in people and animals (Bruner et al., 1976; Singer et al., 2009; Lillard, 2015; Groos, 1901, 1898; Pellegrini et al., 2007; Schulz, 2012; Smith, 1982). Yet, despite numerous accounts of the role of play in learning and thinking, fundamental questions remain about the nature and function of curiosity, exploration, and play. After more than a century of research, what has the cognitive science of play taught us, and what is the path forward?

Reaching a field-wide consensus will require conversations between different empirical and computational perspectives. This full-day workshop brings together researchers studying animals, humans, and artificial agents to explore the full complexity of play and its relationship to learning, thinking, and planning. A panel discussion at the end will help participants review and integrate these emerging perspectives, and set exciting research agendas at the intersection of cognition and motivation.

Our speakers represent a broad cross-section of the conference, spanning multiple disciplines (computer science, ethology, psychology, education), perspectives (computational, evolutionary, developmental), and career stages (from graduate students to full professors). All of them share a strong background and interest in understanding the cognitive systems that support flexible learning and thinking, or in the effort to engineer curiosity and exploration into artificial agents in ways inspired by minds at play.

More specifically, key topics of discussion include (but are not limited to):

- What are the signature characteristics of a mind at play?
- What representational structures and mechanisms would it take for an artificial agent to play?
- What motivates us to be more curious about and engaged with some problems and goals over others?
- How do we generate new goals, problems, and ideas during play?
- How can the study of play shed light on links between motivation and cognition?
- How can we draw on the intrinsic motivations and sense of enjoyment in play to improve educational experiences?

Organizers and presenters

The following organizers, presenters, and panelists (alphabetical order) have confirmed their attendance:

Junyi Chu (Organizer) is a PhD student at MIT working in Laura Schulz's Early Childhood and Cognition Lab. Junyi is interested in the interaction of motivation and cognition, and studies diverse phenomena such as play and explanation to understand how goals shape thinking and decision-making.

Laura Schulz (Organizer) is a professor of cognitive science at MIT. Laura investigates cognitive processes including causal inference, discovery, and learning, with a focus on early childhood development.

Alice von Auersperg is a cognitive biologist at University of Veterinary Medicine, Vienna. Alice is interested in how animals and human infants perceive, sample and understand their physical environment and in how they innovate new solutions to technical problems.

Elizabeth Bonawitz is an associate professor of education at Harvard University. Elizabeth's work bridges cognitive development with computational modeling to study how social and cognitive mechanisms shape learning.

Natalie Evans is a PhD student at Temple University, working with Kathy Hirsh-Pasek at the Temple Infant and Child Lab. Her work examines the relation between curiosity, exploration, and creativity.

Roberta Golinkoff is a professor of education, psychology, and linguistics and cognitive science at the University of Delaware. Roberta studies early language and spatial development and the benefits of playful learning.

Alison Gopnik is a professor of psychology and philosophy at the University of California at Berkeley. Alison investigates how human minds learn, with a focus on how children acquire intuitive theories of the world.

Kathryn Hirsh-Pasek is a professor of psychology at Temple University and a senior fellow at the Brookings Institution. Kathy's research examines the development of early language and literacy, and the role of play in learning.

George Kachergis is a research scientist at Stanford. George investigates the mechanisms of human learning, memory, and categorization and builds computational models of how people represent knowledge.

Angeline Lillard is a professor of psychology at the University of Virginia. Angeline investigates social-cognitive development, especially pretend play, theory of mind, media effects on executive function, and Montessori education.

Emily Liquin is a PhD student at Princeton University, working with Tania Lombrozo and Alison Gopnik. Emily studies how children and adults learn about the world by exploring and asking questions, with a focus on how and why information search is selective.

Pierre-Yves Oudeyer is a research director and head of the FLOWERS lab at the French Institute for Research in Computer Science and Automation (Inria). Pierre-Yves investigates lifelong autonomous learning processes in machines and humans, with a focus on algorithms and theories of curiosity-driven exploration.

Amanda M. Seed is a Senior Lecturer of Psychology and Neuroscience at St Andrews University and Director of the Living Links to Human Evolution Research Center. Amanda investigates the evolution of flexible problem-solving and abstract thought, in particular the representational and executive processes that uniquely human thinking.

Tom Silver is a PhD student with Leslie Kaelbling and Josh Tenenbaum at MIT. Tom develops computational algorithms for more effective exploration and planning.

Joshua B. Tenenbaum is a professor of cognitive science at MIT. Josh's research sits at the intersection of cognitive science and machine learning with a focus on hallmarks of human intelligence; in particular, the ability to learn rapidly and flexibly from limited data.

Tomer Ullman is an assistant professor of psychology at Harvard University. Tomer investigates common-sense reasoning, with a focus on building computational models to explain how children and adults acquire new knowledge.

Workshop structure

We propose a full day workshop consisting of 20-minute presentations, split into four sessions presenting recent advances in understanding the processes of ***play in children***, the relevance of motivation and ***play in education***, insights on cognition from studying ***play across species***, and new work in ***play and computation*** to shed light on the representations and mechanisms involved.

We will incorporate brief intermissions and breakout rooms throughout the day to foster discussion among workshop attendees. We will end the workshop with a 45-minute panel discussion on insights from developmental, comparative, and computational studies of play.

Presenter	Topic
1. *Play in Children*	
Alison Gopnik	Exploration decisions across development
Elizabeth Bonawitz	Curiosity: A Behavioral and Neurological Account in Development
Junyi Chu	Hacking utility functions in play
2. *Play in Education*	
Angeline Lillard	Play, motivation, and cognition in Montessori education
Natalie Evans	The role of exploration in children's creativity
3. *Play across Species*	
Alice von Auersperg	Object play and tool innovation in animals
Amanda Seed	Exploratory play and learning in children and monkeys
3. *Play and Computation*	
Tomer Ullman	Imagination and the generation of ideas
Tom Silver	Goal babbling for learning predictive models for planning
George Kachergis	Modeling developmental changes in curiosity about physical interactions
Emily Liquin	Drivers of curiosity: a computational account
Pierre-Yves Oudeyer	Intrinsically motivated autonomous learners
5. *Panel Discussion*	

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