Computational Creativity

Computational Co-creativity

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Approaches to Computational Co-Creativity

Davis et al (2015) distinguish three approaches:

Creativity Support Tools

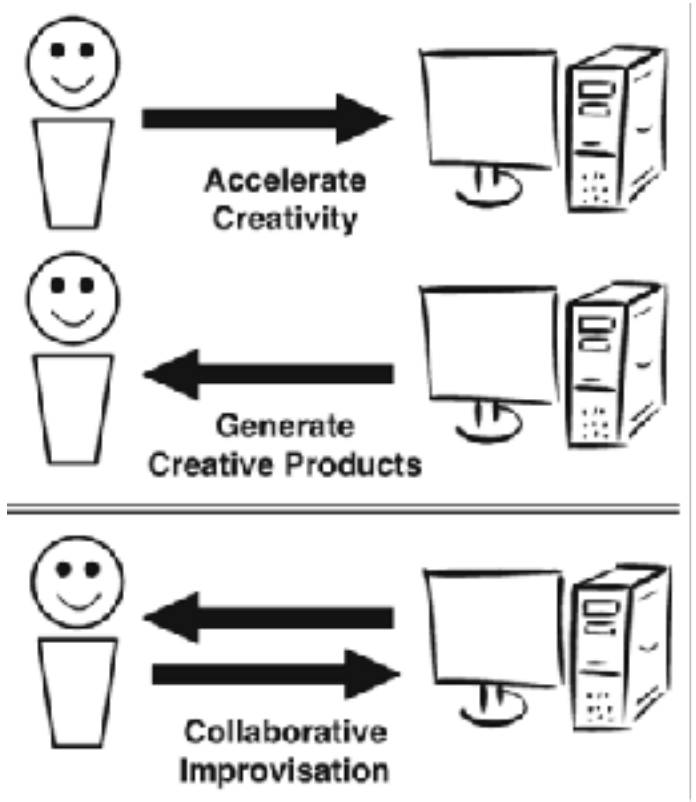
Track history, simulate and explore alternatives to support a creative person

Generative Systems

Programs that automatically generate novel, surprising, and valuable creative products

Computer Colleagues

Co-creative agents **collaborate** with humans in *continuous* realtime improvisation



Source: Davis et al (2015)

Creativity Support Tools

Shneiderman (2007) distinguishes:

Productivity Support Tools

1. Clear task with known requirements
2. Well-defined success metrics
3. Known and relatively well-understood set of users

Creativity Support Tools

1. Ill-defined domains with unknown requirements
2. Ill-defined or vague success measures
3. Unknown or unpredictable user base

Types of Creativity Support Tools

Nakakoji's (2006) provides the following metaphors:

Running shoes: *improve the abilities of users* to execute a creative task they are already capable of, e.g., highlighting grammatical mistakes in text

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Dumbbells: *support users learning* about a domain to become capable without the tool itself, e.g., explaining why mistakes are ungrammatical

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Skis: *provide users with new experiences* of creative tasks that were previously impossible, e.g., simultaneously translating into many diverse languages

Photo by Matthieu Pétiard on Unsplash

Generative Computational Creativity

Autonomous Creative Systems

- Computational models of observable behaviours of creativity
  - e.g. narrative, poetry, ideation, games, analogy, design, etc.
- Deferred integration with embodied and situated aspects of creativity

Computational Model

- System interprets a large corpus of material, i.e., its "inspiring set"
  - Corpus is carefully selected to produce interesting combinations
- System traverses "conceptual space" to produce novel outputs
  - Conceptual space can be restructured to reveal additional mappings
- Construction and manipulation of symbols in knowledge base
  - No feedback loop with the environment unlike human cognition

Computer Colleagues

Co-creativity in Humans

Peers collaborate equally in creative process (Mamykina et al. 2002)

Unlike cooperation where result represents sum of contributions

Improvisation in creative process based on actions of peers

Mix of experiences, capabilities and motivations of team

Creative product emerges through interaction and negotiation

Emergent results greater than sum of individual contributions

Co-creative Human-Computer Collaborations

Collaborate to produce **new kinds of human-computer creativity**

Behaviours of Computer Colleagues

Mimicry: Familiar modes of production eases co-creation

Shimon mimics human musicians by analysing the rhythm and pitch of musical performances and generating synchronised melodic improvisations

Improvisation: Structure facilitates co-creative interaction

Shimon structures interaction using call-and-response where each party modifies and builds on the previous contributions

Mental Modelling: Anticipation and adaptation

Mental models of agents, actions, intentions, and objects supports the structure, organise, interpret, and act on sensory data in real time

Shimon (Source: Georgia Tech)

Enactive Computational Creativity

Enactive Co-creativity

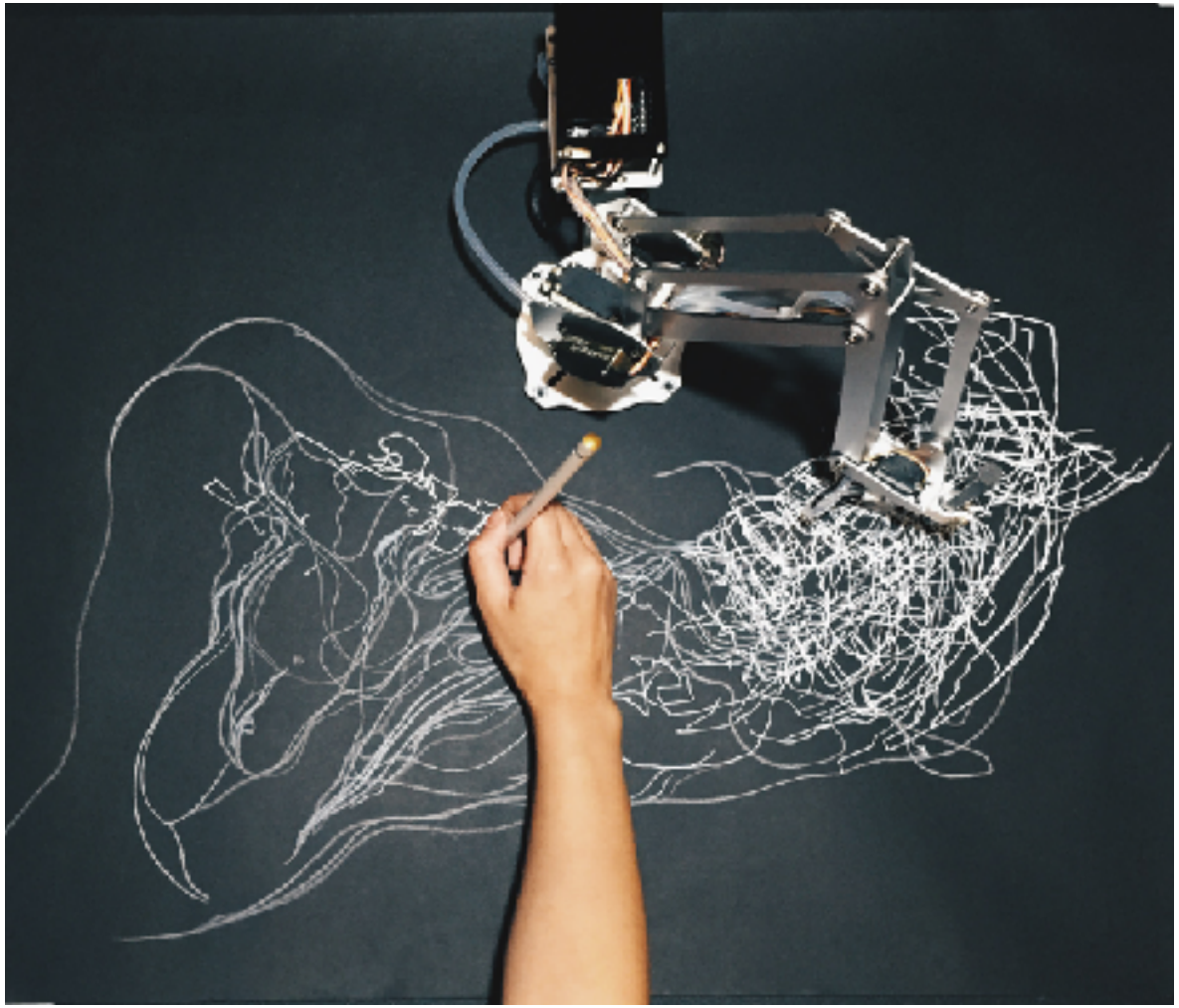
Coordinated co-creativity is difficult for traditional (cognitivist) approaches to Artificial Intelligence

Improvisational Collaborative Agents

Continual, active and dynamic interaction with an environment and agents

Perception-action feedback loop *not* goal-oriented planning and discrete actions

Creativity emerges from interaction with creative humans



Drawing Operations (Source: Sougwen Chung)

Enactive Creativity

Creativity as Enactive Learning

- Learning by experimenting and perceiving effects in feedback loop
  - Practice develops percept-action couplings
- Enactive expertise is knowing *how* to interact to navigate their domain of expertise
  - e.g. restructuring sensing (change viewpoint) or environment (take action)
- Enactive expertise does not rely on representations manipulated by rules
  - Unlike cognitivism, e.g., traditional approaches to analogical reasoning etc.

Creativity as Sense-making

- Experimental interactions produces structured and meaningful interactions
  - Emergent process of (participatory) sense-making through interactions
- Sense-making process results in creativity based on real-time interaction

Drawing Apprentice (Davis et al. 2014)

Co-creative Agent

Collaborates with users to draw abstract artworks on a digital canvas in real time

Structured (Turn-Taking) Improvisation

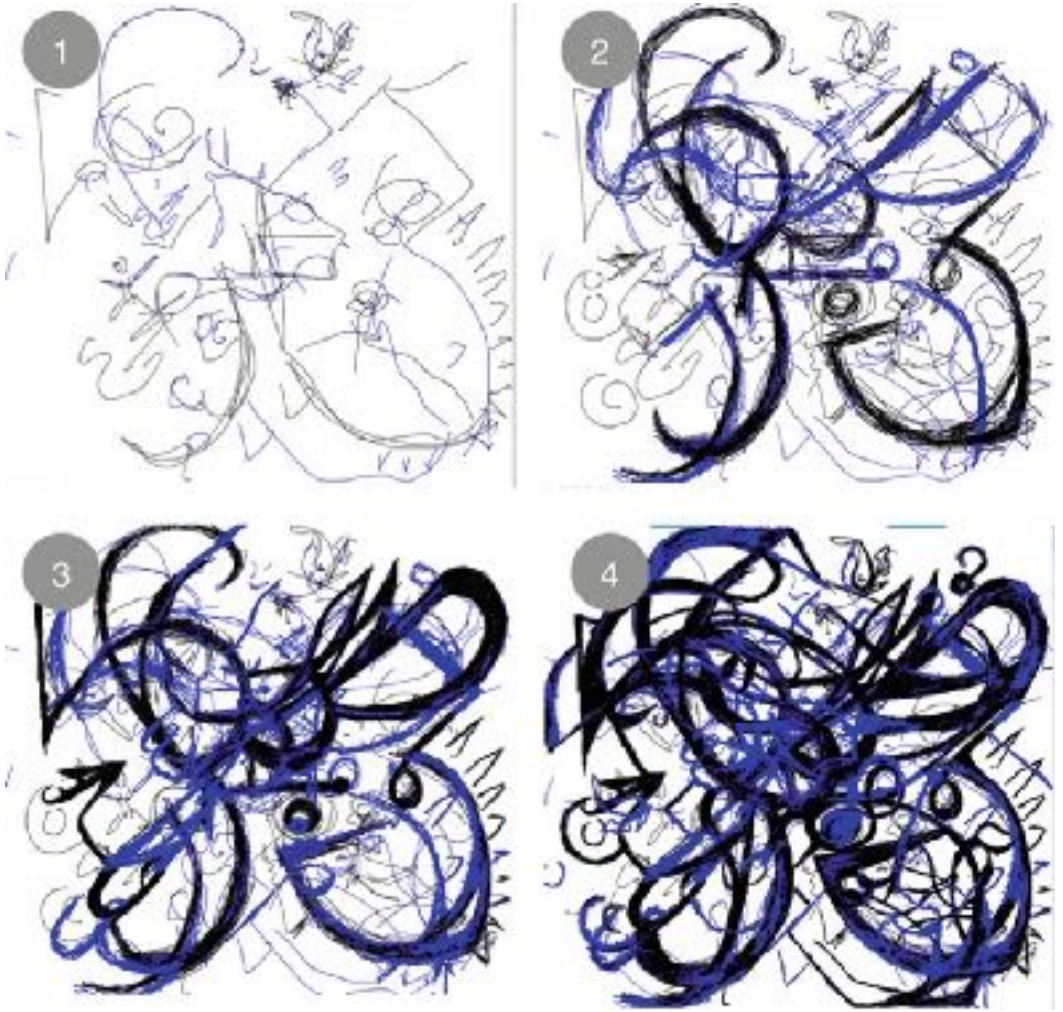
Analyses drawing behaviour (e.g. line length, speed, time between strokes, location, etc.) to construct directives

Agent perceives and acts at three levels:

Local: perceives individual lines and redraws using operation (e.g. mirror, translate, scale, etc.)

Regional: gestalt principles to group lines into regions and redraws using operation

Global: perceives relationships between regions for overall composition (e.g. balance)



Drawing Apprentice Collaboration (Source: Davis et al. 2015)

Shimon (Hoffman and Weinberg 2010)

Marimba-playing Robot

- Improvises with human musicians
- Analyses rhythm and pitch of musical performances
  - Mimics musician by playing real instrument
  - Structures interaction with call-response sessions
  - Anticipates and adapts to playing style of collaborators

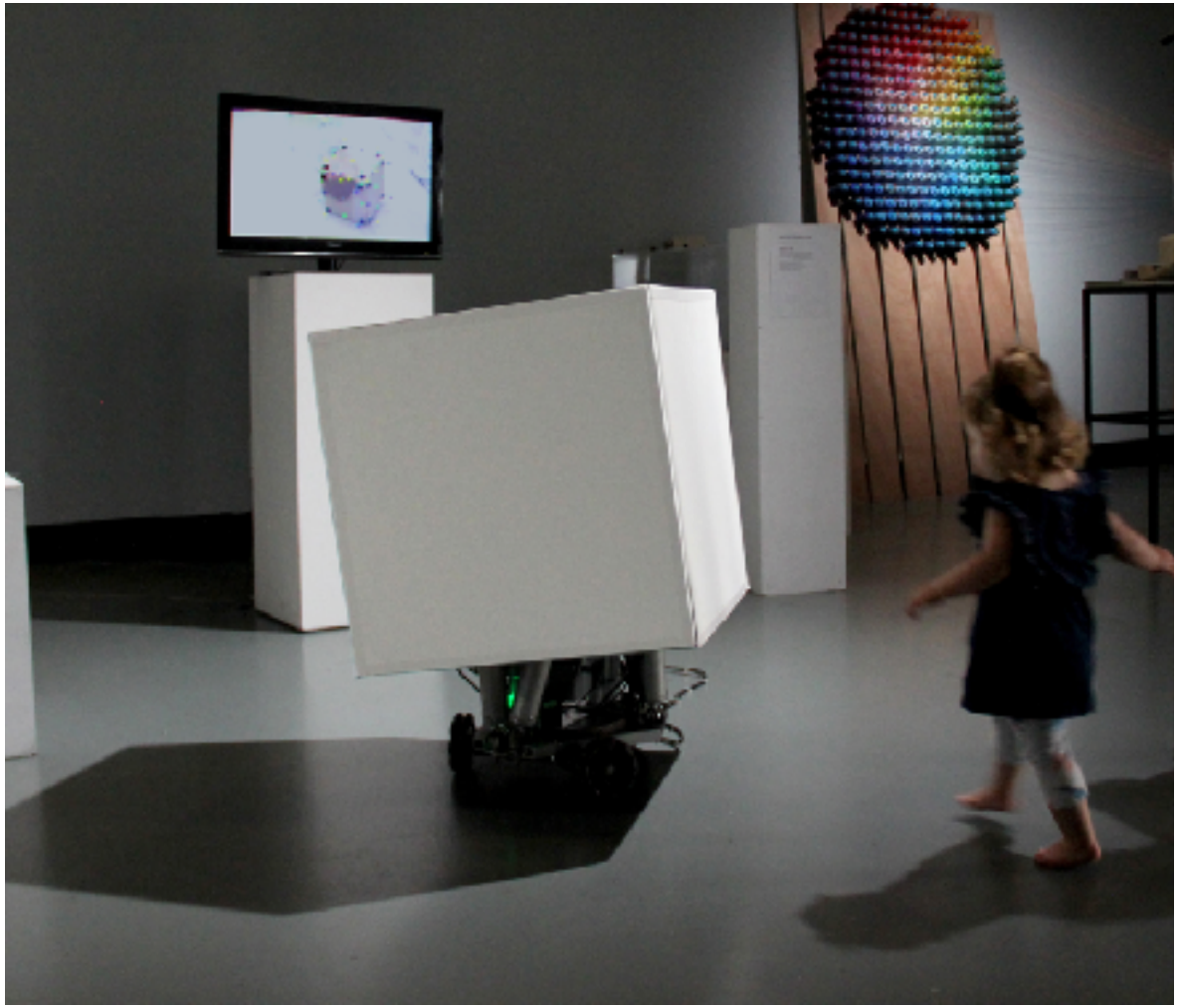
Shimon (Source: Georgia Tech)

Shimon (Hoffman and Weinberg 2010)

Machine Movement Lab

Abstract Social Robot

Interaction constrained to movement

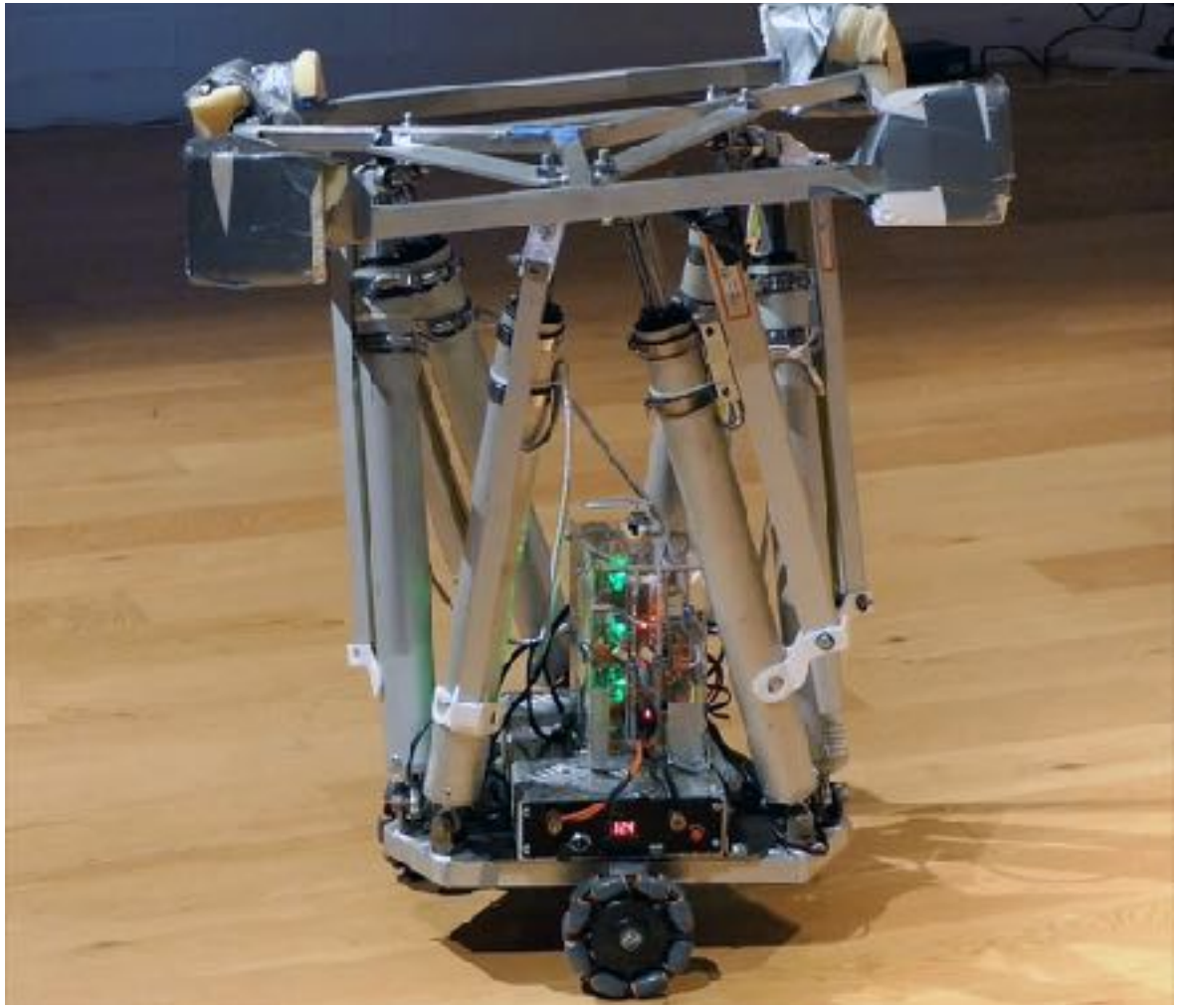


Cube Performer #1 and Lily

Machine Movement Lab

Abstract Social Robot

- Interaction constrained to movement
- Movements grounded in embodiment



Cube Performer #1

Machine Movement Lab

Abstract Social Robot

- Interaction constrained to movement
- Movements grounded in embodiment
- Using movements learned from dancers

Audrey Rochette in Cube Performer Costume

Machine Movement Lab

Abstract Social Robot

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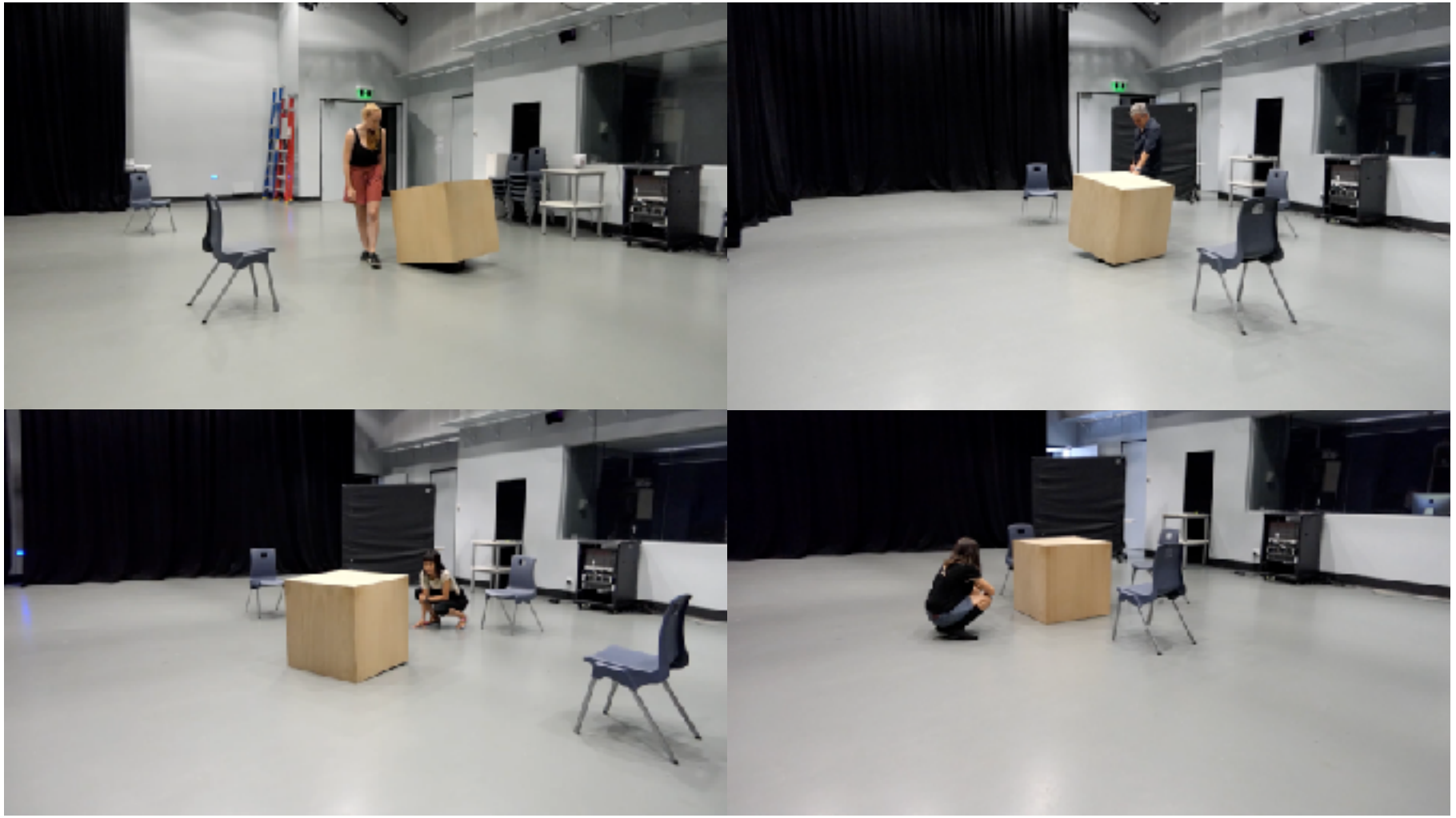
Participatory Sense-making

- Affordances of movement
- Accommodation of actions

Audrey Rochette in Cube Performer Costume

Cube Performer #2



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