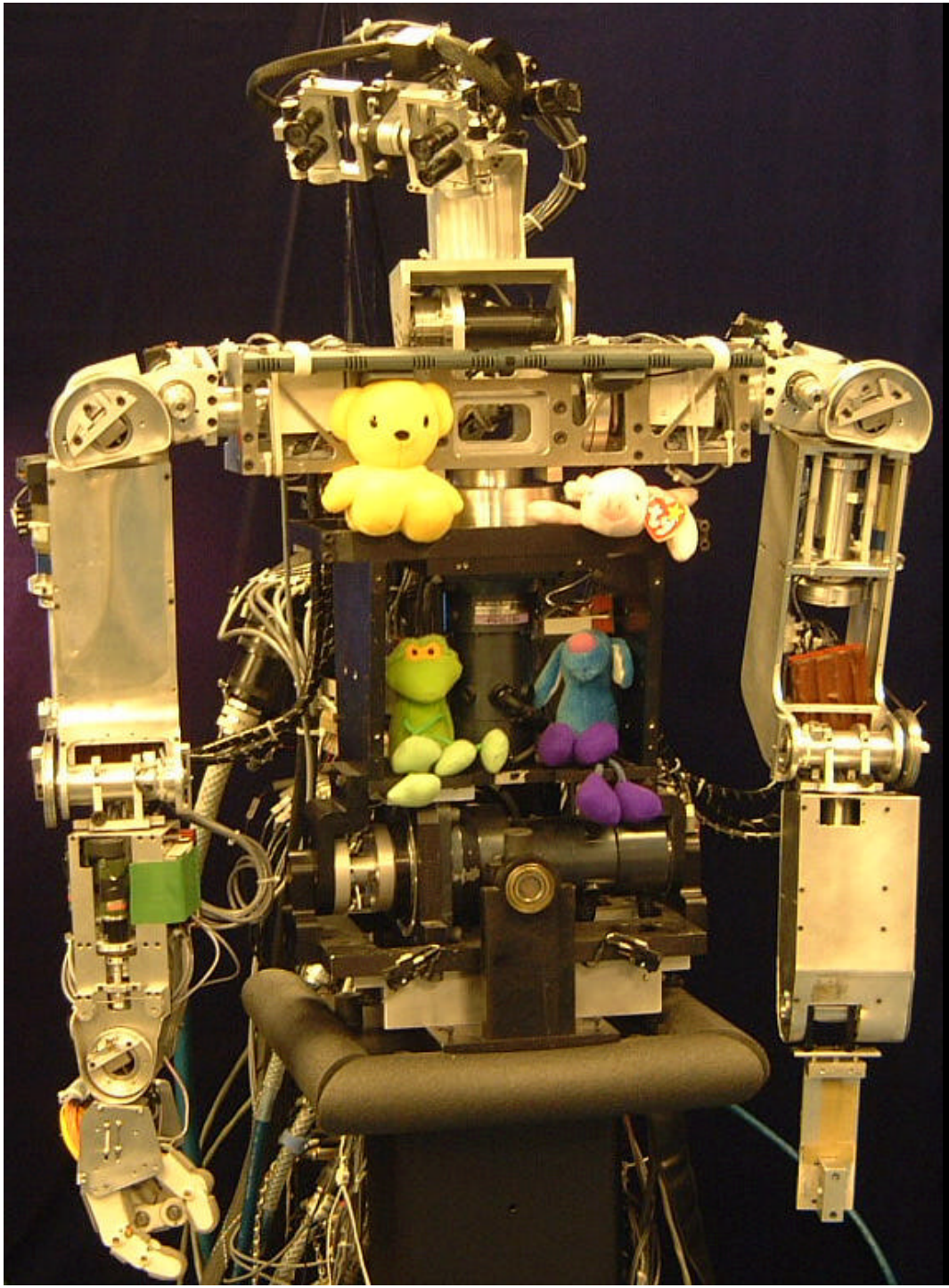


Life in the

Humanoid Robotics Group

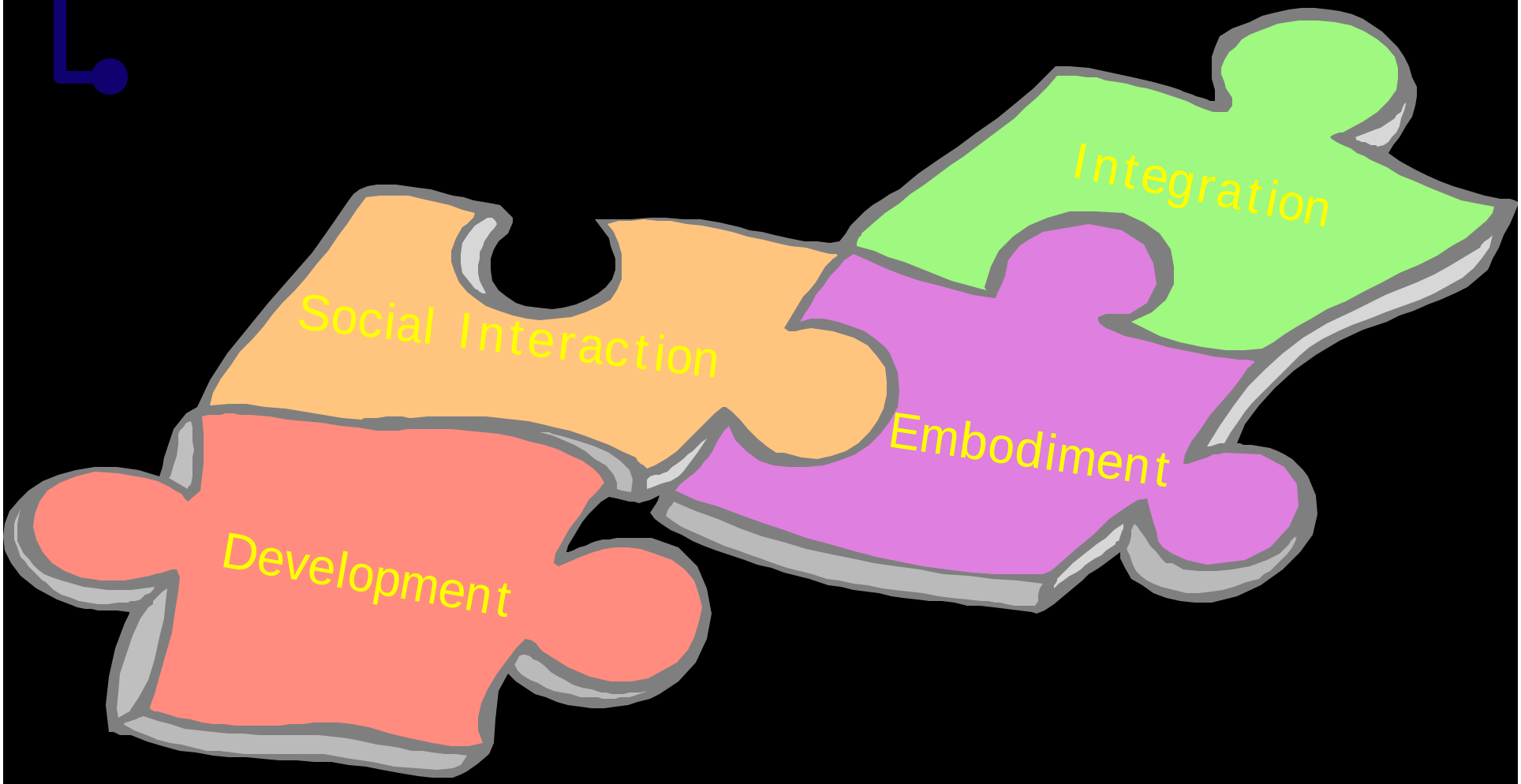
MIT AI Lab

Paul Fitzpatrick

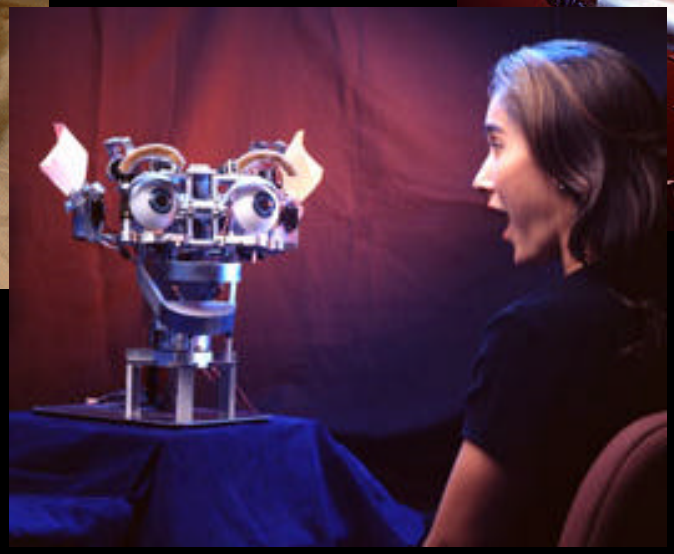
Our Goal

- Natural tasking
- Respond to humanoid cues
- Exhibit humanoid cues

Our Methodology



Our Robots



Research Issues

Our Approaches

	Knowing what to imitate	Mapping between bodies	Correcting failures and recognizing success	Chaining actions together	Generalizing to more complex tasks	Intuitive Interactions
Social Interaction	Uses attentional cues to recognize task relevant events		Identifies and displays emotional states for reinforcement			Allows humans and robots to share similar social cues
Development	Limits search space by incremental refinement of perception	Simplifies mapping by incremental refinement of motor skills		Provides natural decomposition of complex tasks	Exploits incremental learning to build new skills	Provides methods for building social skills
Embodiment	Constrains movement which assists directed perception	Simplifies body mapping between human and robot	Enables simple but robust low-level behaviors	Places physical limits on successive actions		Allows the human to observe natural social feedback cues
Integration	Allows robot to recognize cues in multiple modalities		Increases robustness through redundancy		Assists in transfer to new modalities	Allows human to use natural modalities (voice, gesture, facial expressions)

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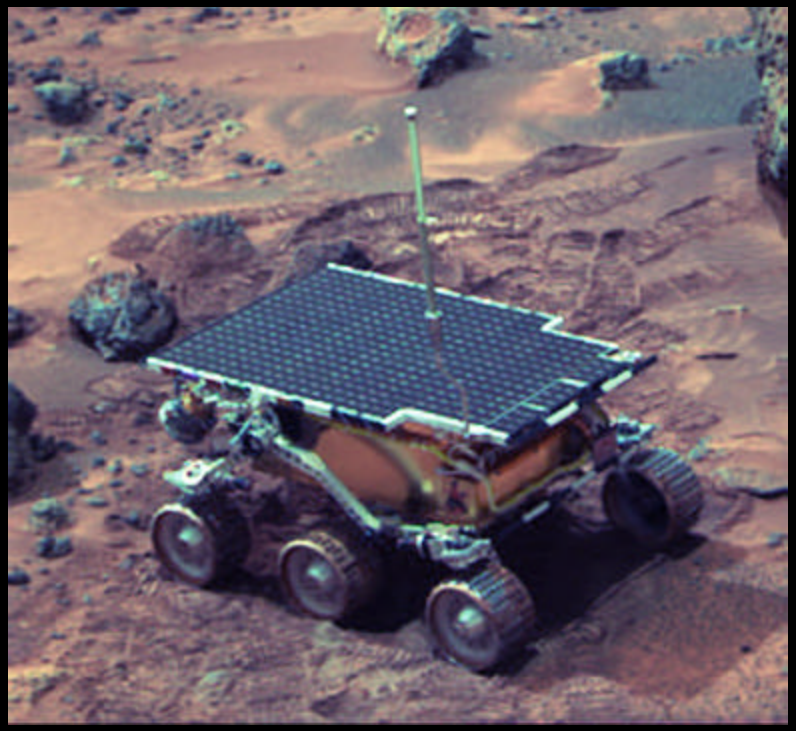
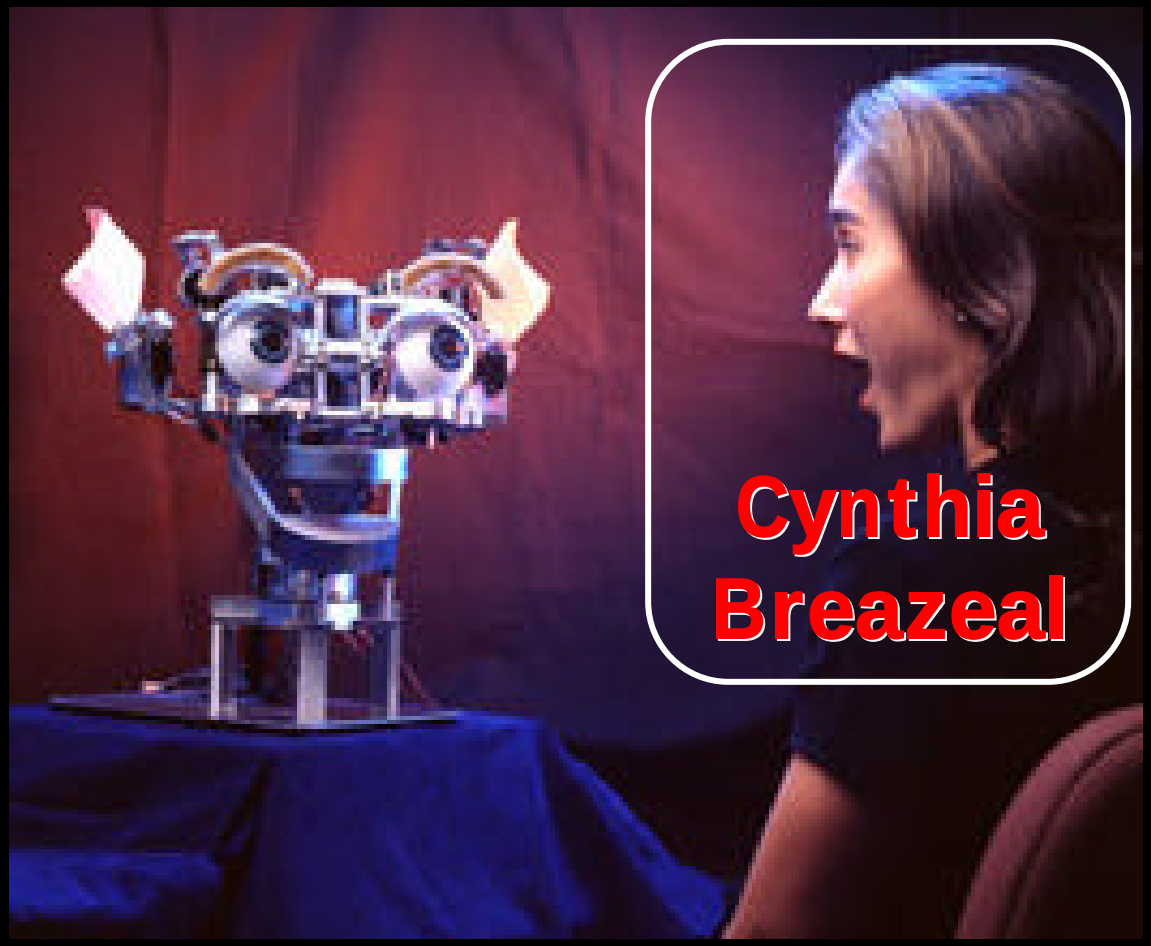
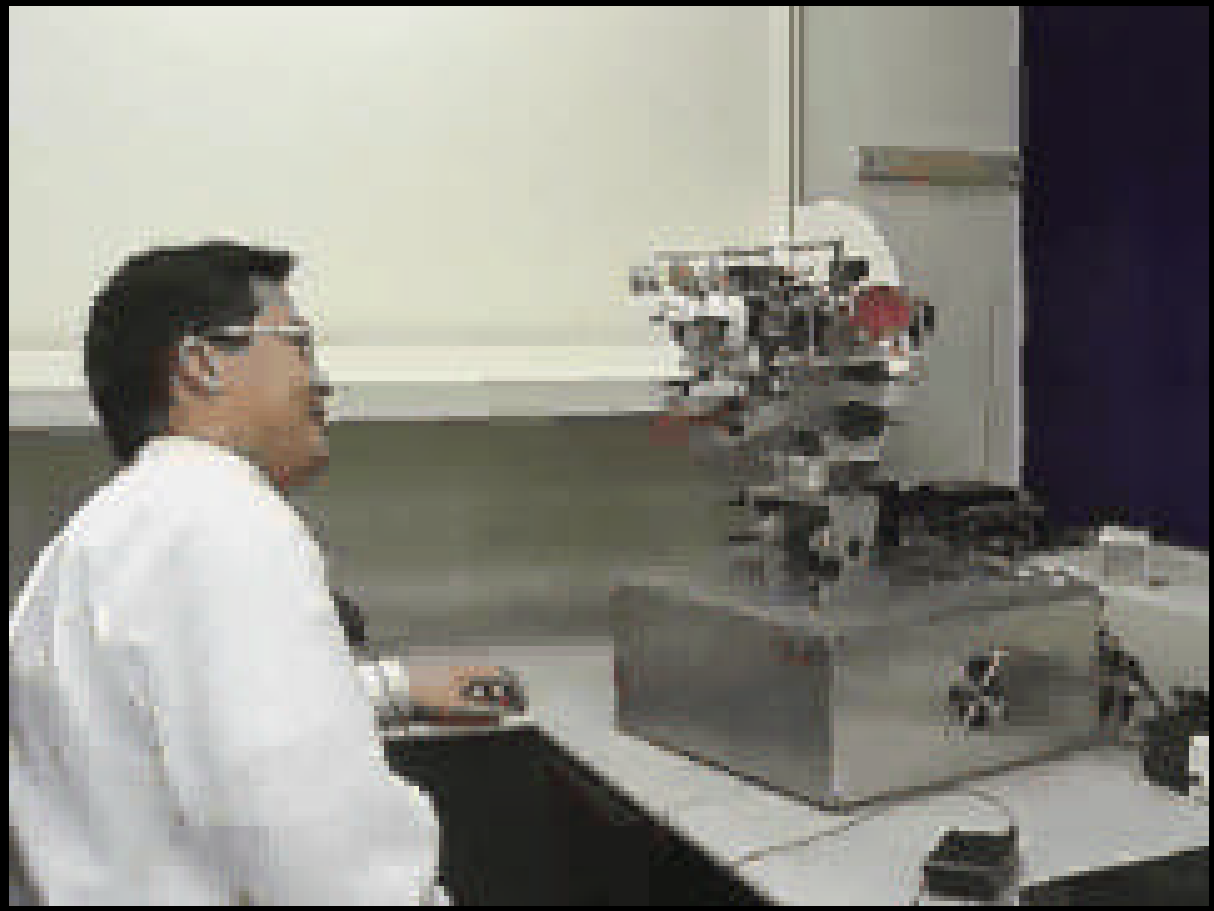
Social Interaction




Cynthia
Breazeal

Showing and Reading



Evaluation Metrics

- Must consider human response as well as robot's behavior
- Can people intuitively read and do they naturally respond to Kismet's social cues?
- Does Kismet elicit social cues (scaffolding) from the human that could be used to benefit learning?
- Can Kismet perceive and appropriately respond to these naturally offered social cues?
- Does the human adapt to the robot, and robot adapt to the human, in a way that benefits the interaction? (entrainment)

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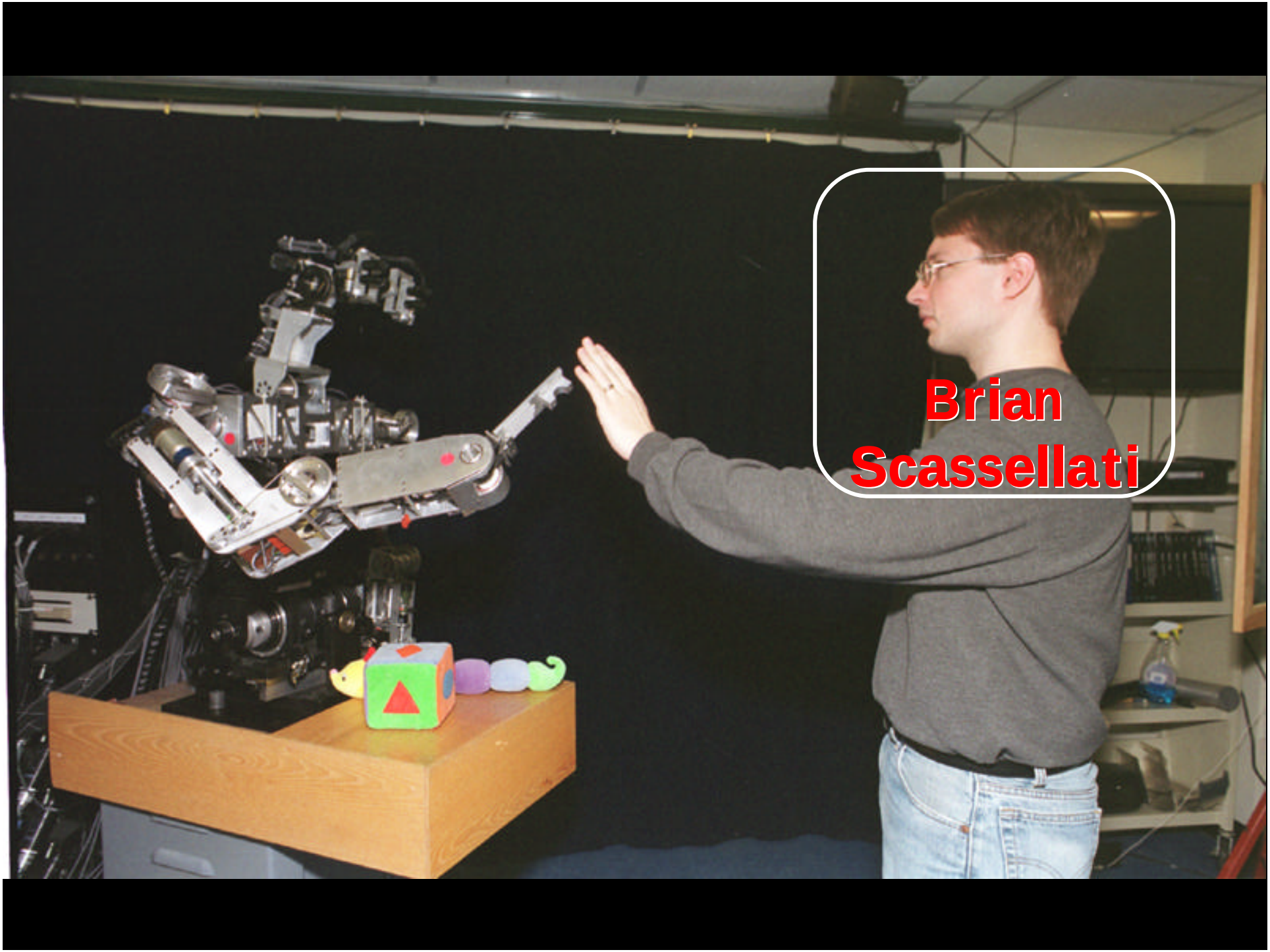

Brian
Scassellati

Theory of Mind

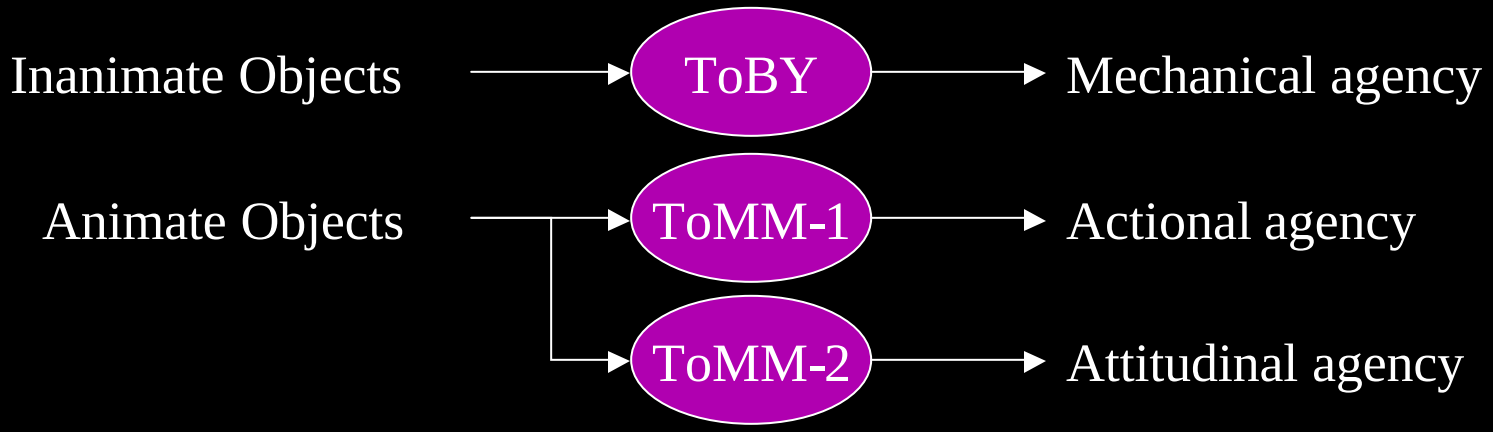
- For complex learning tasks the robot needs to

  understand what it is the human knows
  - about the world
  - about the robot's current state

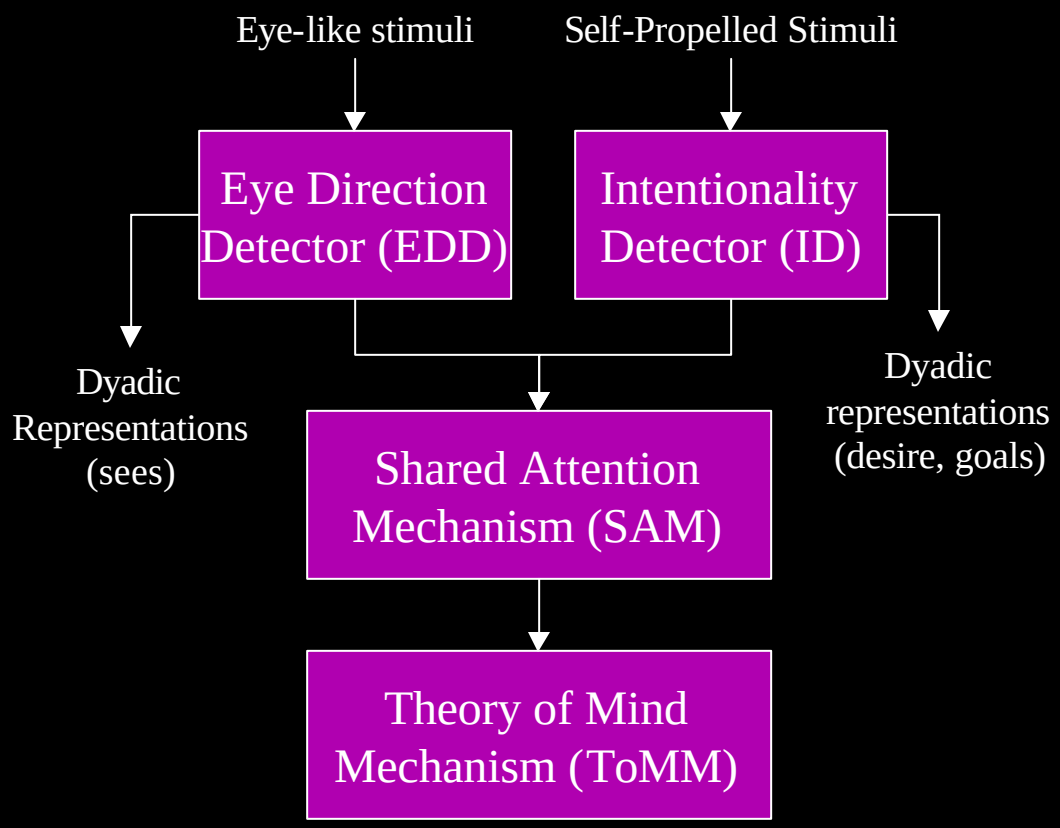
  understand what the human is doing and why

  understand what is the human

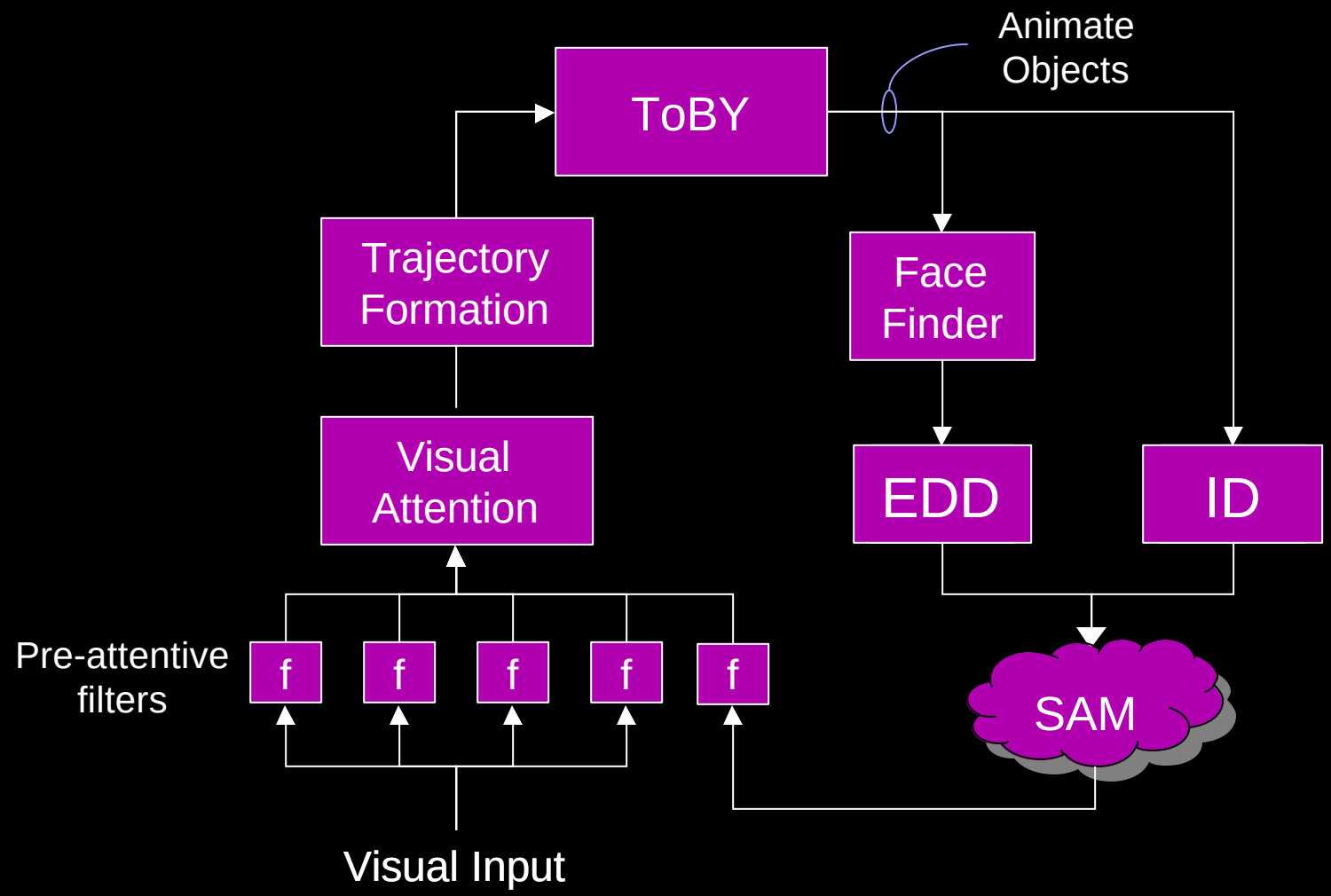
Leslie's Model



Baron-Cohen's Model



Scassellati's Model



Animacy Detection

Animate

Inanimate

Animate

Animacy Experts

Straight Line Expert

$$\min \sum \sqrt{(v - \bar{v})^2}$$

Minimize the sum of the deviations from the mean velocity

Energy Expert

$$\tfrac{1}{2} m v_y^2 + mgy$$

Constant mass and the inertial system provides the gravity vector

Elastic Collision Expert

$$v_{t-1}^1 + v_{t-1}^2 = v_{t+1}^1 + v_{t+1}^2$$

Look for transfer in velocities before and after collision

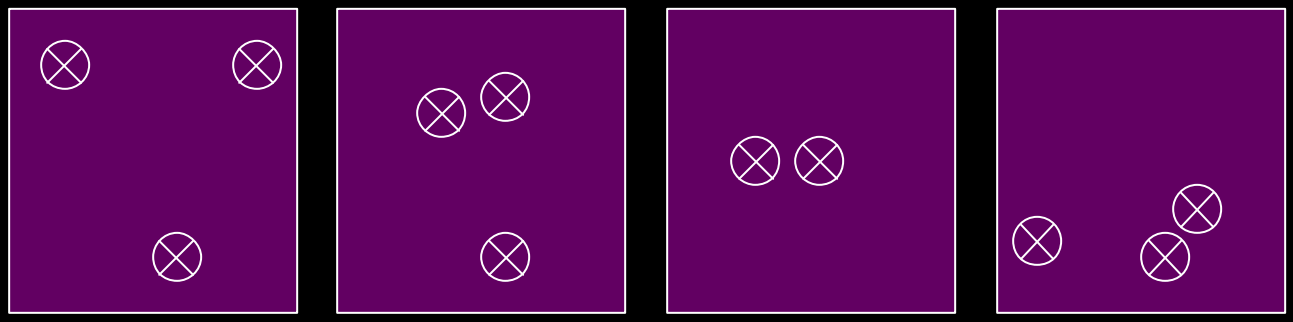
Acceleration Sign Change Expert

$$\text{sgn}(v_t) \neq \text{sgn}(v_{t+1})$$

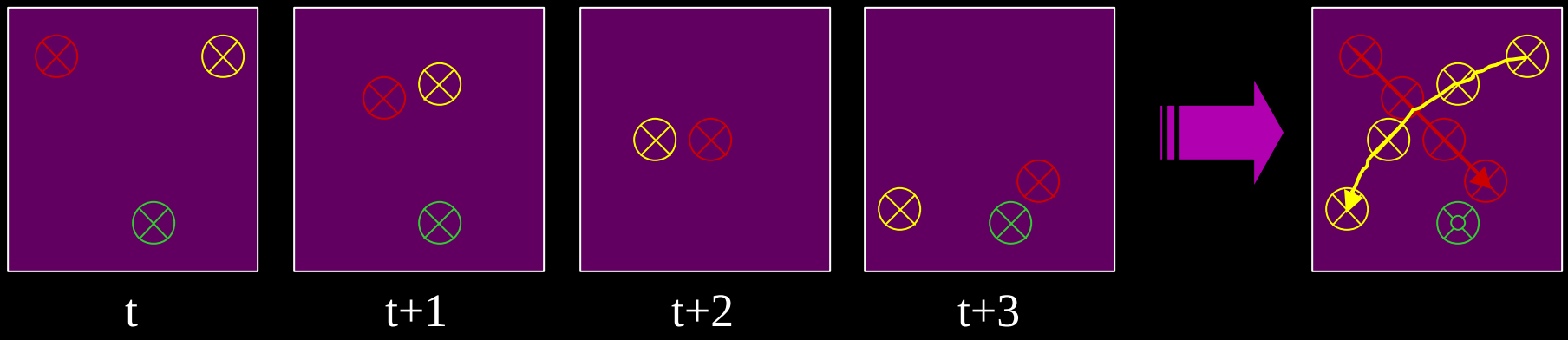
Look for multiple sign changes in the acceleration

Multi-Target Tracking

Trajectory Formation

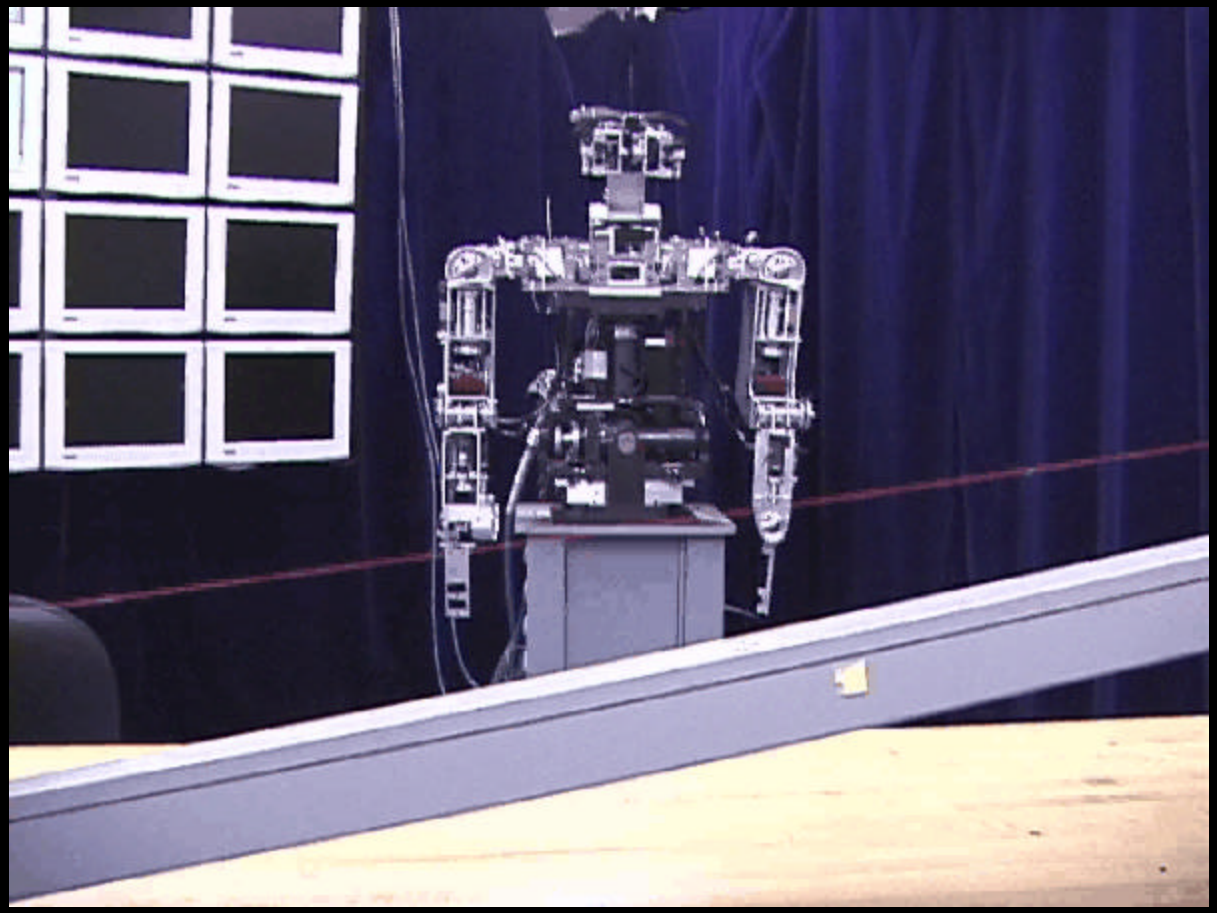


Motion Correspondence



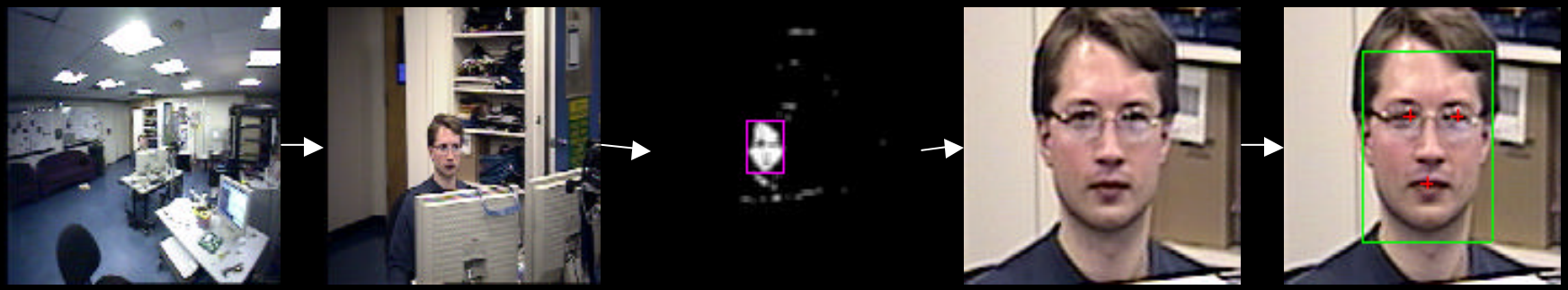
(Reid 1979 • Cox and Hingorani 1996)

Mimicry



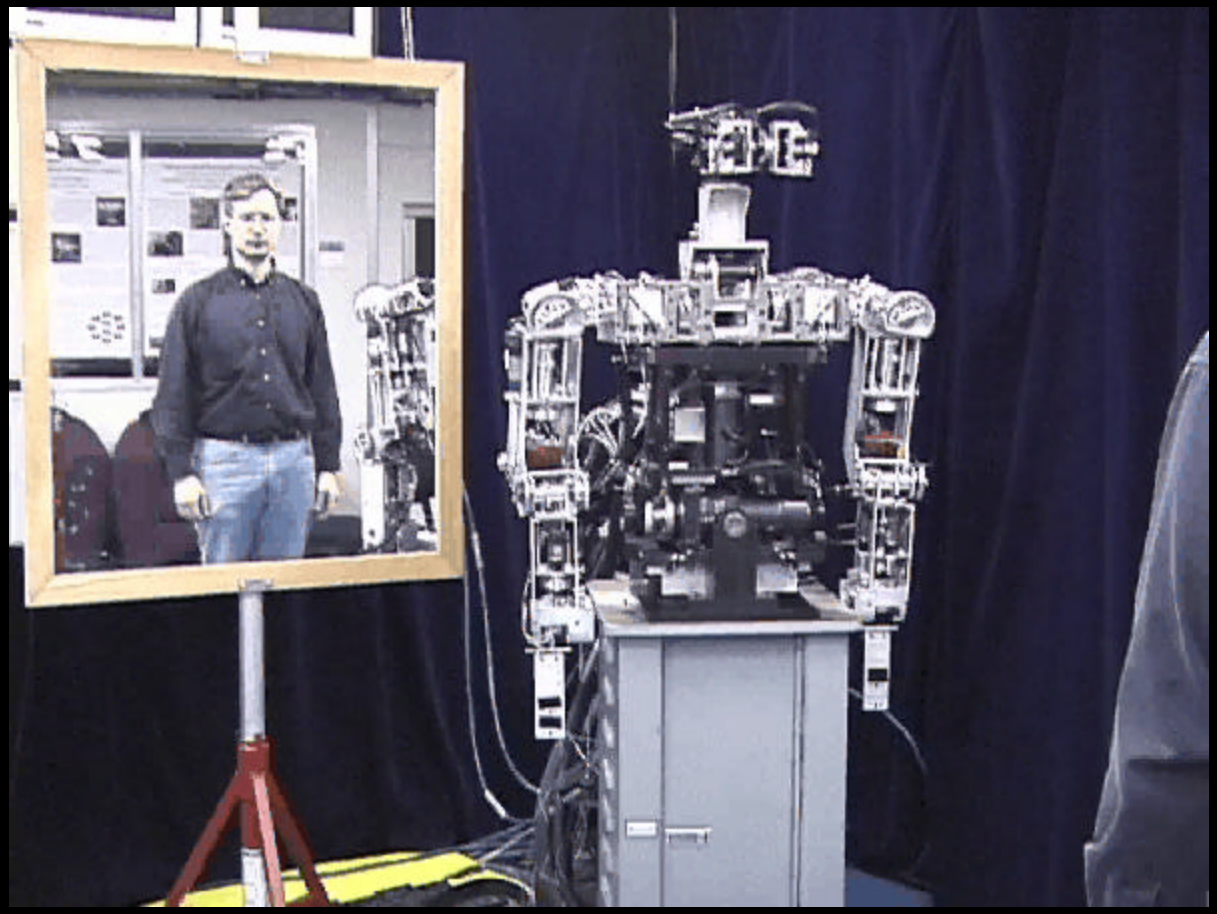
Faces and Eyes

Locate target In wide field → Foveate Target → Apply Face Filter → Software Zoom → Feature Extraction



300 msec → 66 msec

Mimicry



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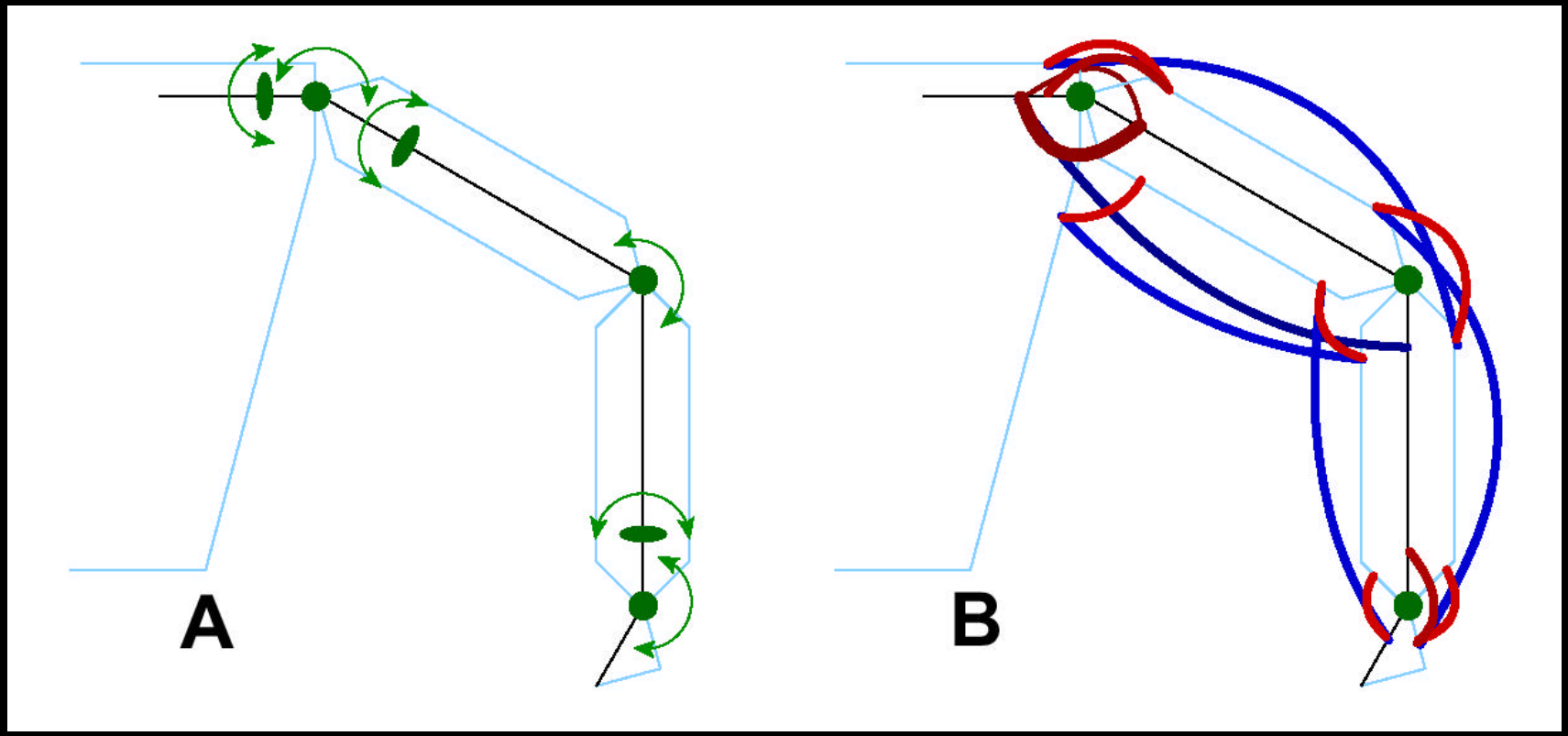
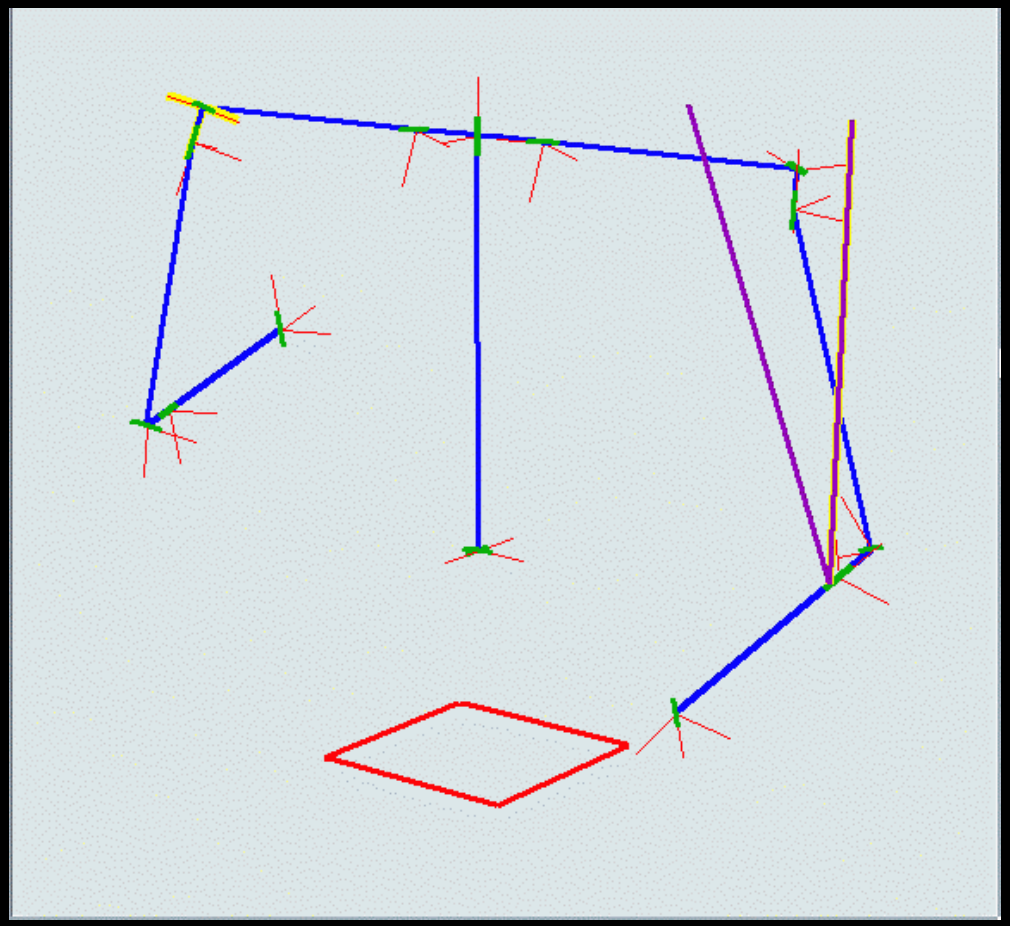
Matthew
Marjanovic

“Trying to make a hard thing easier,
By making it much harder.”

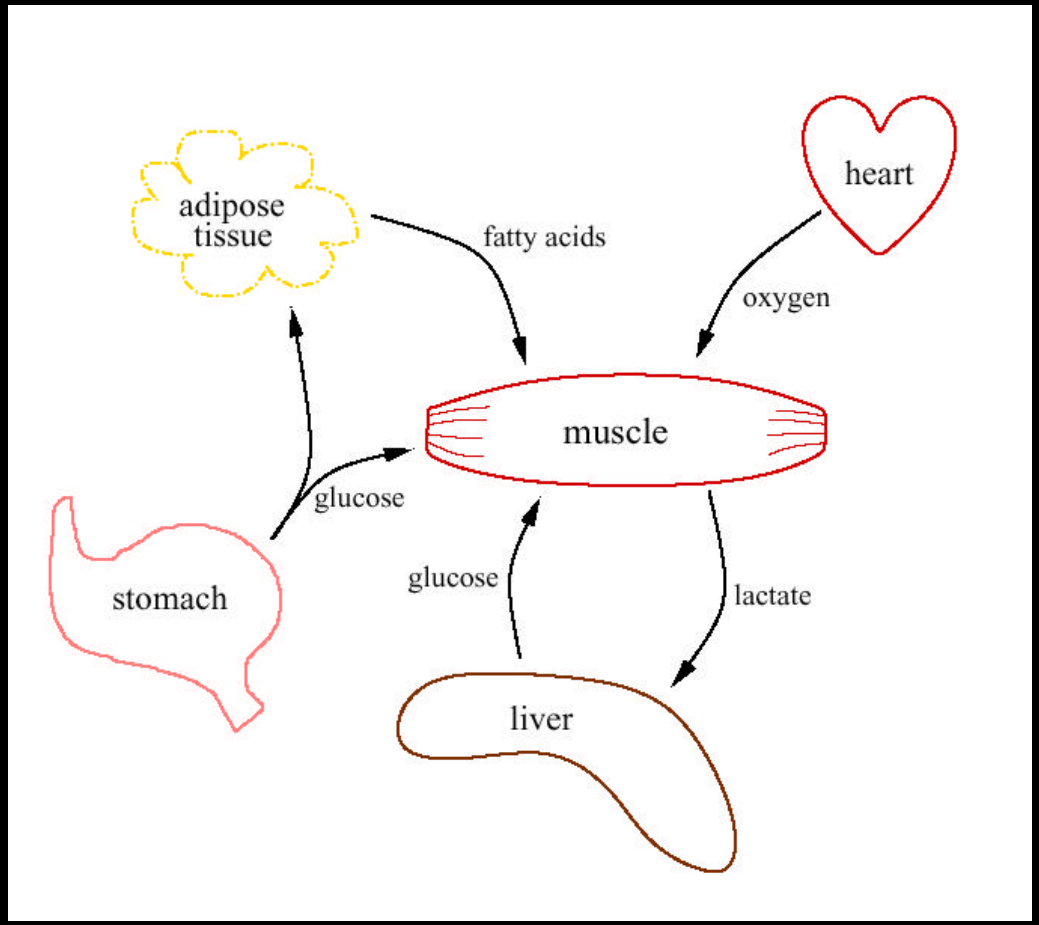
Virtual Musculature



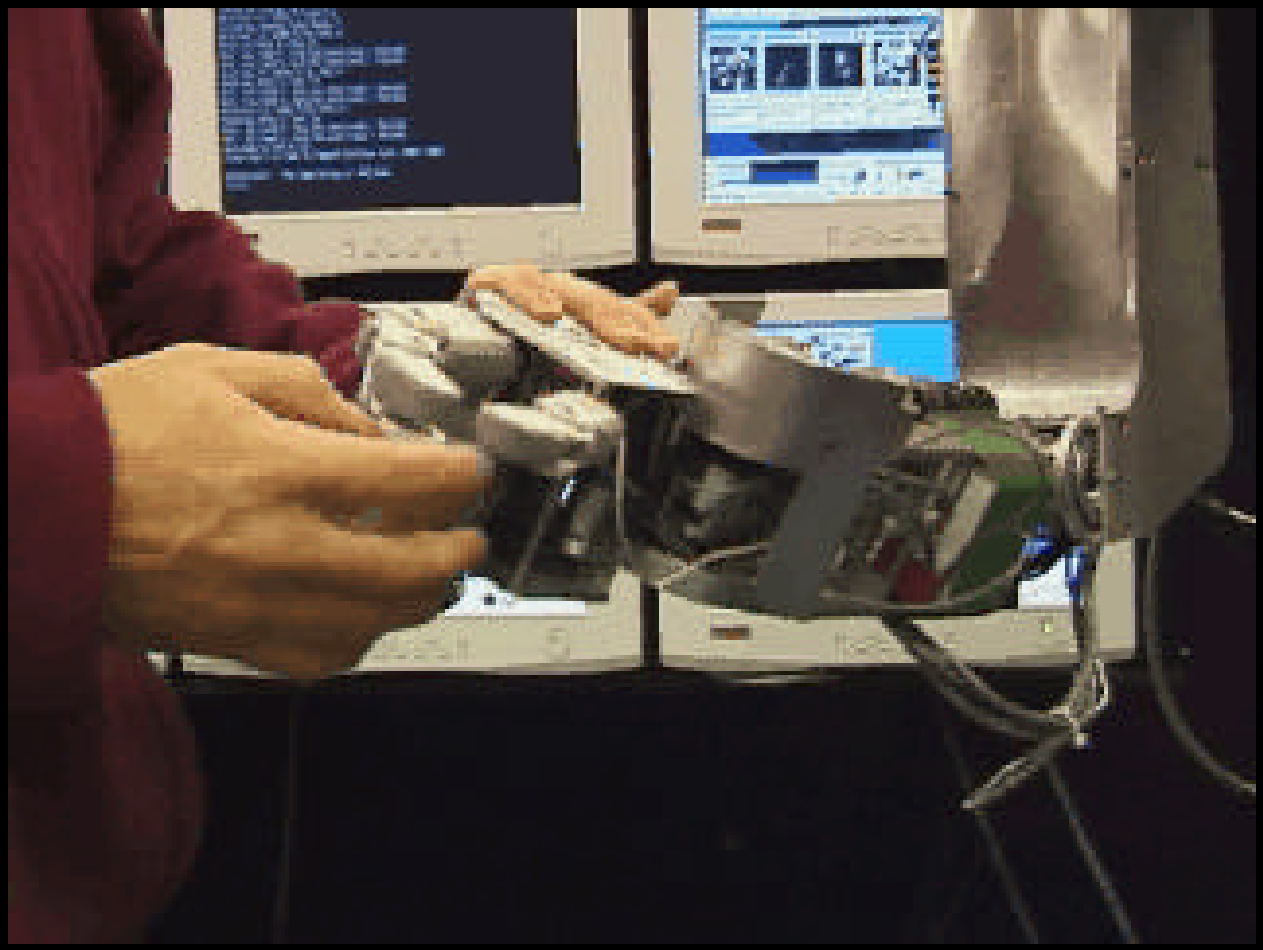
Configurable Musculature



Virtual Metabolism

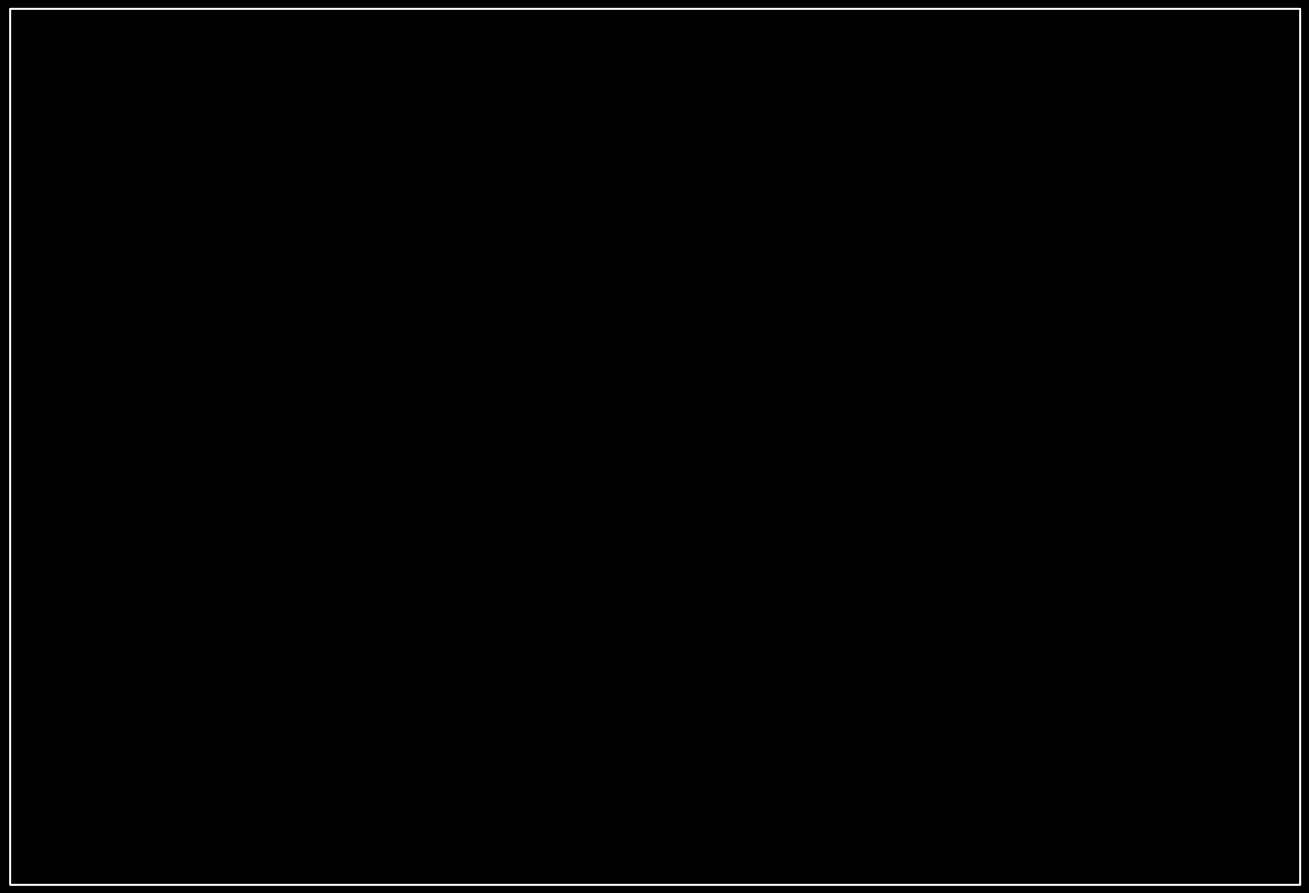


Hand




Giorgio
Metta

Reaching



Cog's Sensitive Side