AI in Healthcare

CPSC 470 – Artificial Intelligence

Brian Scassellati

Topics

- AI and drug discovery
- AI and treatment planning
- Personalized health tracking
- Robotic surgery
- AI in the hospital
- Rehabilitation robotics
- Socially assistive robotics

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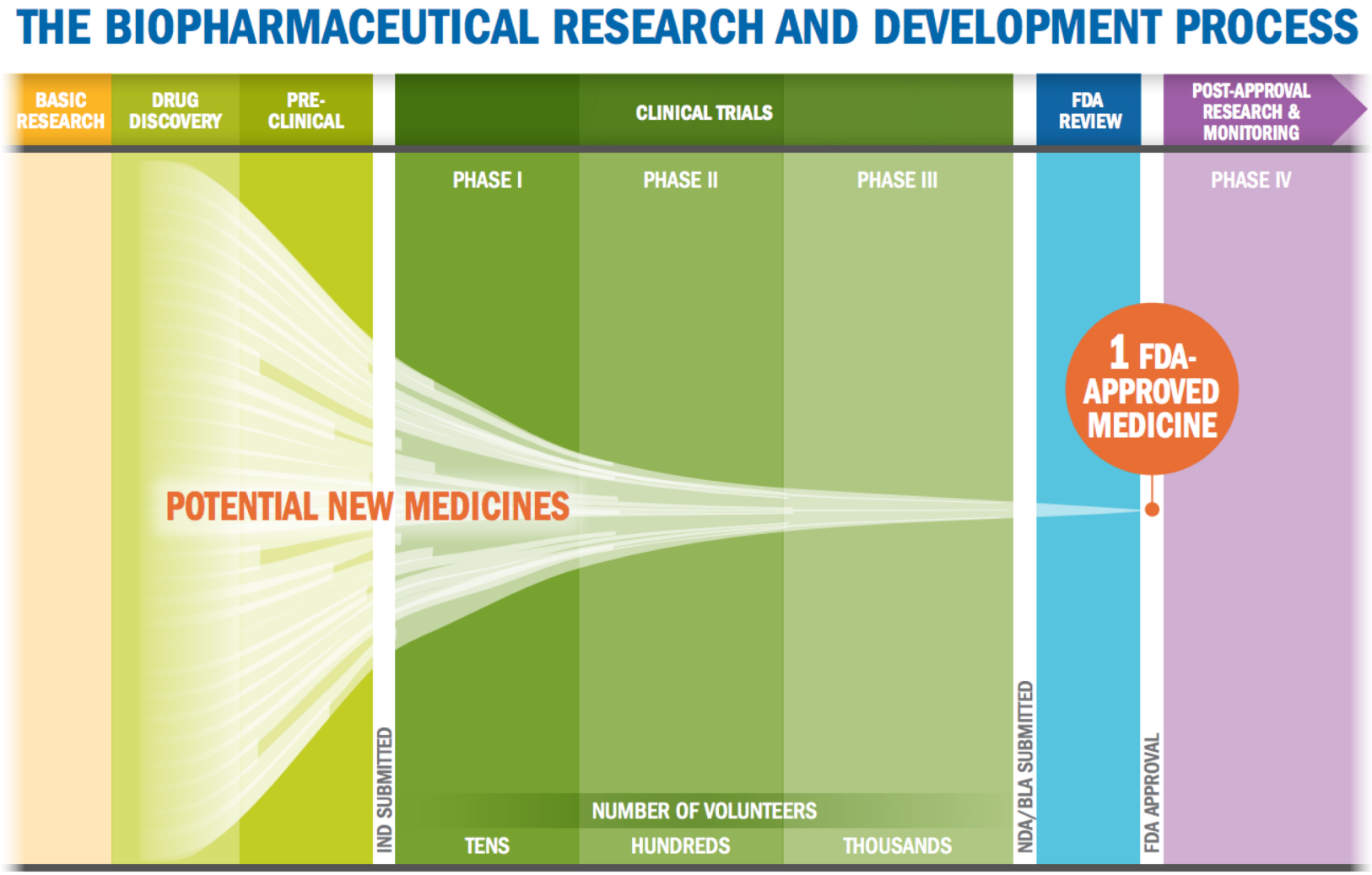
AI and Drug Discovery



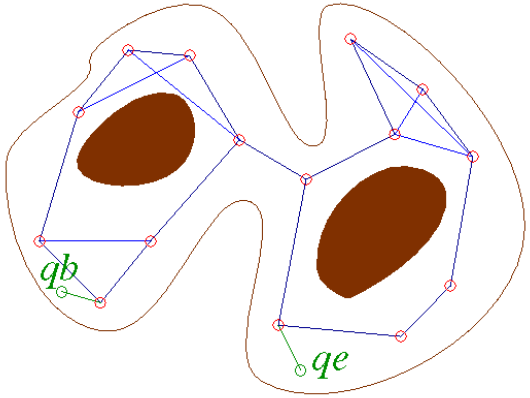
Key: IND: Investigational New Drug Application, NDA: New Drug Application, BLA: Biologics License Application

AI and Drug Discovery

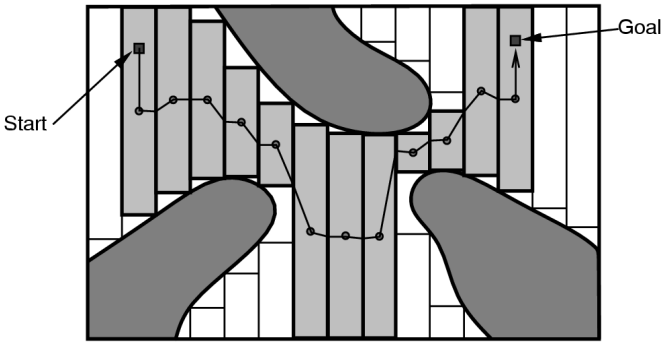
- Find new compounds that could be useful drugs
- Predict what how well potential drugs will do in testing
- Discovery drugs that could work together as a combination for treatment
- Find new uses for previously tested compounds
- Create personalized medicine based on genetic markers

Four Methods for Path Planning in Configuration Space

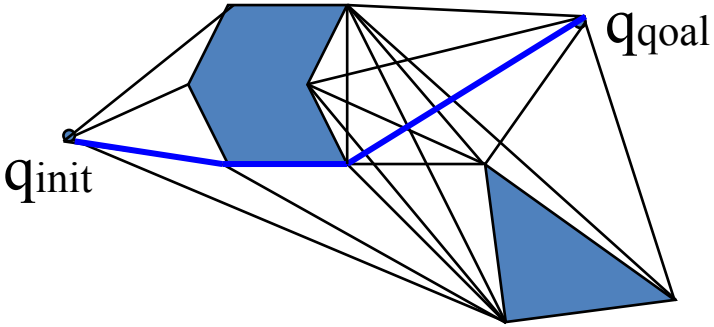
Probabilistic Roadmap



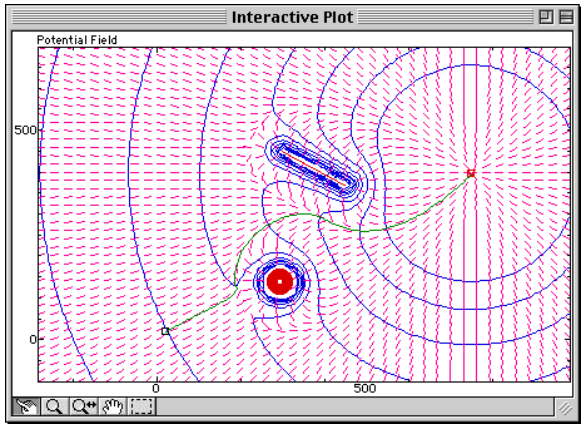
Cell Decomposition

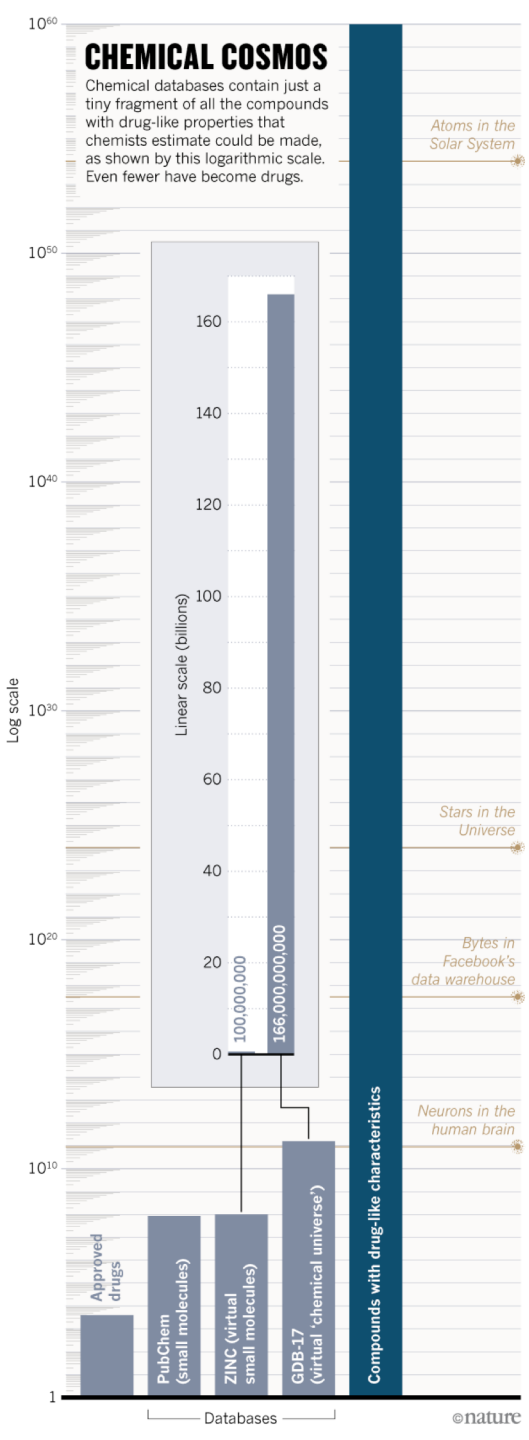


Visibility Graphs



Potential Fields





Scope

- GDB-17 database
  - 166 billion compounds
  - all the chemically feasible organic molecules made of up to 17 atoms
- Structural considerations
- Stability and toxicity

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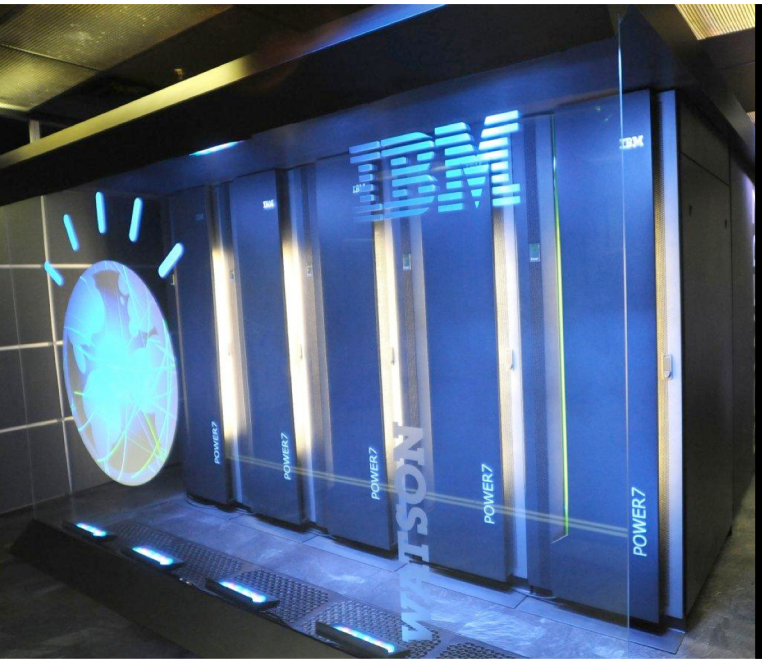
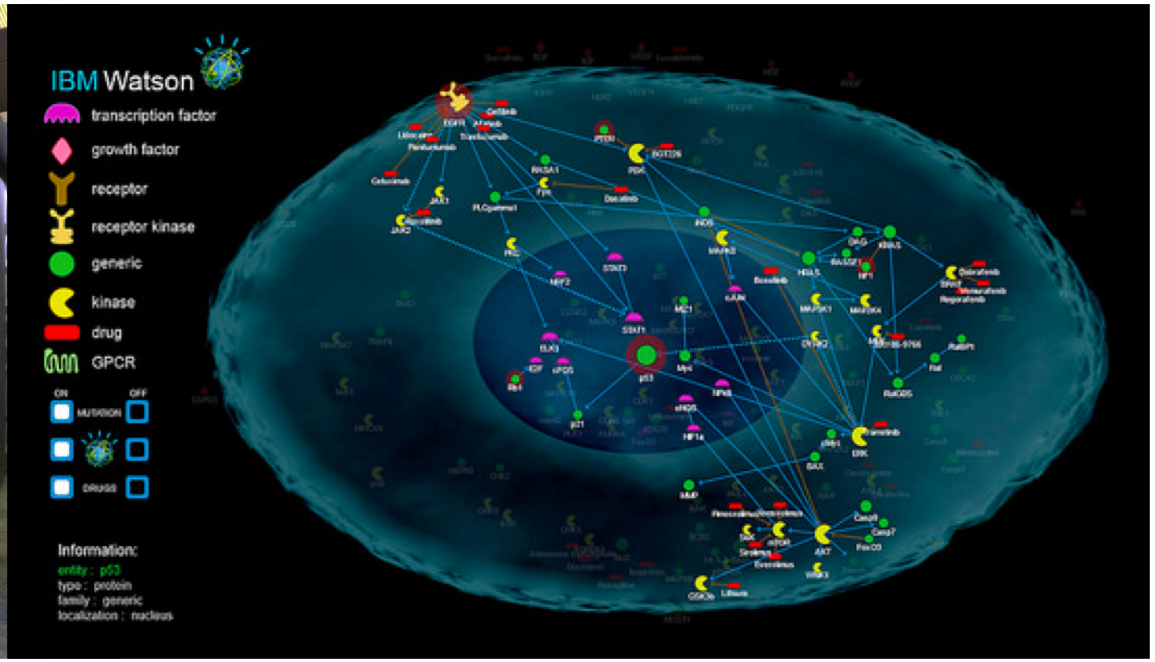
IBM Watson: AI Techniques + Big Data





- Treatment planning: scan medical journals and patient records, find similar structures
  - Requires large database of medical records
- Personalized medicine

Hype and Reality

REUTERS

BIOTECH

AI Hunts for New ALS Treatments

Artificially intelligent machines could analyze huge databases to find potential targets for the devastating disease

By Ben Hirschler, Reuters on August 10, 2017

11 Aug 2017 | 15:00 GMT

IBM Watson Makes a Treatment Plan for Brain-Cancer Patient in 10 Minutes; Doctors Take 160 Hours

The AI doctor analyzed a patient's full genome, then suggested drugs and clinical trials

WORLD NEWS U.S.

IBM's Watson gives proper diagnosis for Japanese leukemia patient after doctors were stumped for months

By ALFRED NG | NEW YORK DAILY NEWS | AUG 07, 2016 | 2:47 PM

FEBRUARY 23, 2017

MD Anderson Cancer Center's IBM Watson project fails, and so did the journalism related to it

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Healthcare – Personalized Health

(New emerging markets some with low cost entry)

Data Access and Privacy Concerns

A life insurance company wants to track your fitness data

Vox, 9/20/18

As Insurers Offer Discounts For Fitness Trackers, Wearers Should Step With Caution

NPR, 11/19/18

Apple and Aetna team up for personalized health-tracking app

Engadget, 1/29/19

Want cheaper insurance? You'll have to wear a fitness tracker and send in your data

Miami Herald, 9/20/18

John Hancock will include fitness tracking in all life insurance policies

Reuters, 9/19/18

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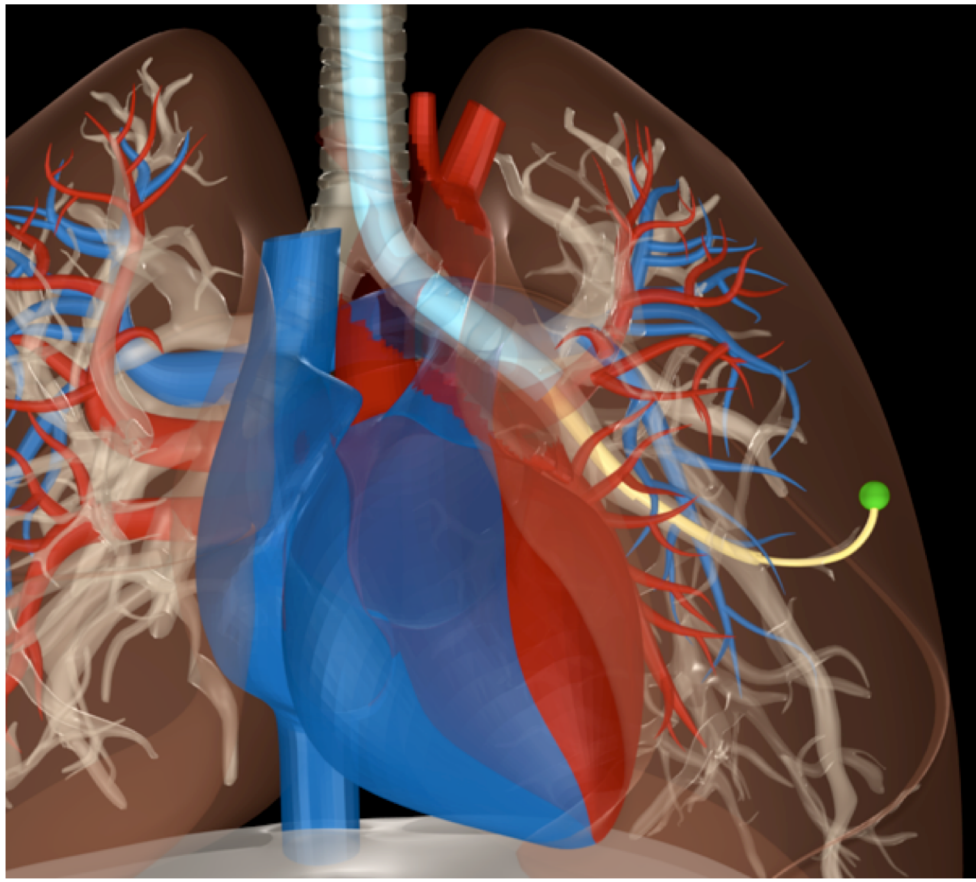
Healthcare – Robotic Surgery

Benefits of Robotic Surgery

- **For Surgeons**
  - Greater visualization
  - Enhanced dexterity
  - Greater precision
- **For Patients**
  - Shorter hospitalization
  - Reduced pain and discomfort
  - Faster recovery time and return to normal activities
  - Smaller incisions, resulting in reduced risk of infection
  - Reduced blood loss and transfusions
  - Minimal scarring
- FDA-approved for more than 50 procedures (2018)

Challenges in Robotic Surgery

- Manipulator design
- Path planning with moving tissue
- Cost and training
- Future techniques:
  - NOTES: Natural orifice transluminal endoscopic surgery
  - LESS: laparo-endoscopic single-site surgery



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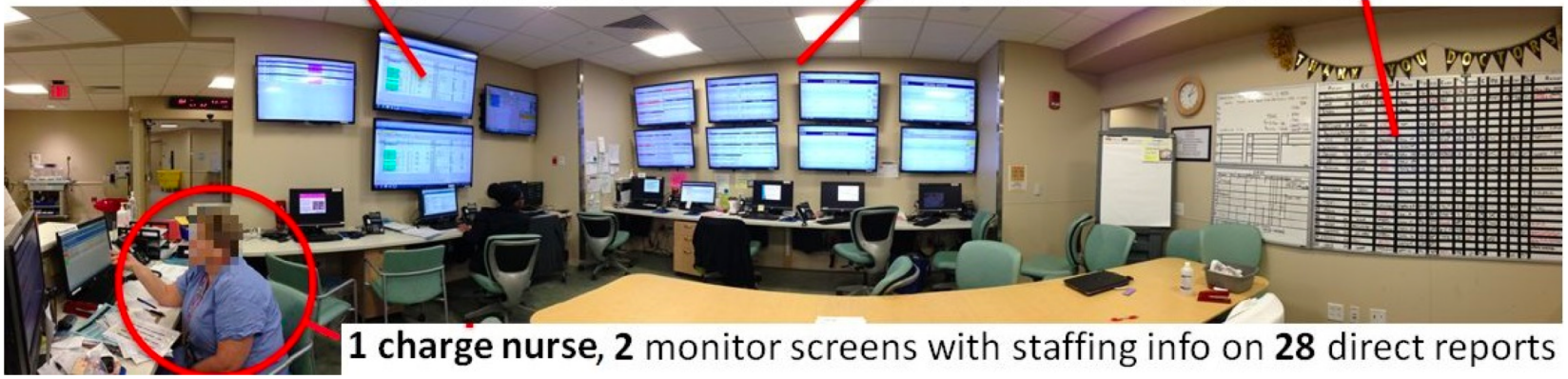
Resource Management via Apprenticeship Scheduling

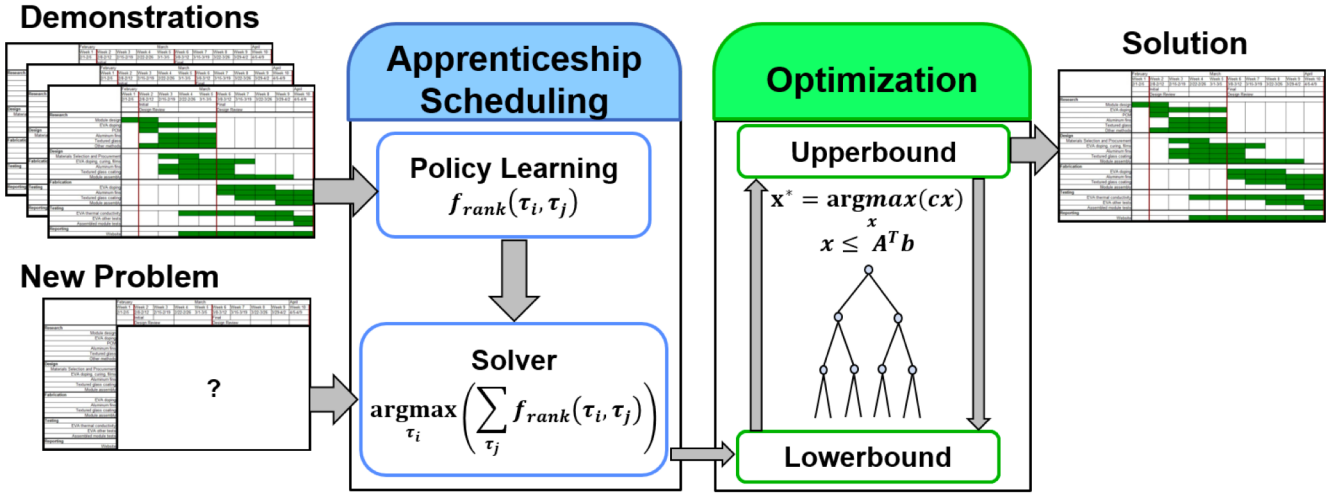
4 large LCDs with bed management info (**22** LDR, **5** OR)

8 small LCDs with **20** fetal heart tracings

1 manual dashboard **15** C x **30** R



1 charge nurse, 2 monitor screens with staffing info on **28** direct reports



(Gombolay, Jensen, Stigile, Golen, Shah, Son & Shah, AIJ, 2018)

Courier Systems for Hospitals
HelpMate (Pyxis) Robotics

Features (from the promotional literature):

- Less expensive than human couriers
- Completely autonomous
- Independent of any external guidance system, such as tracks or wires
- Deals easily with cluttered, unstructured environments
- Gets on and off elevators without assistance
- Painless installation, no disruption to current operations
- Simple user-interface; easy to learn
- Few facility modifications
- 6 cubic feet, 200-pound payload

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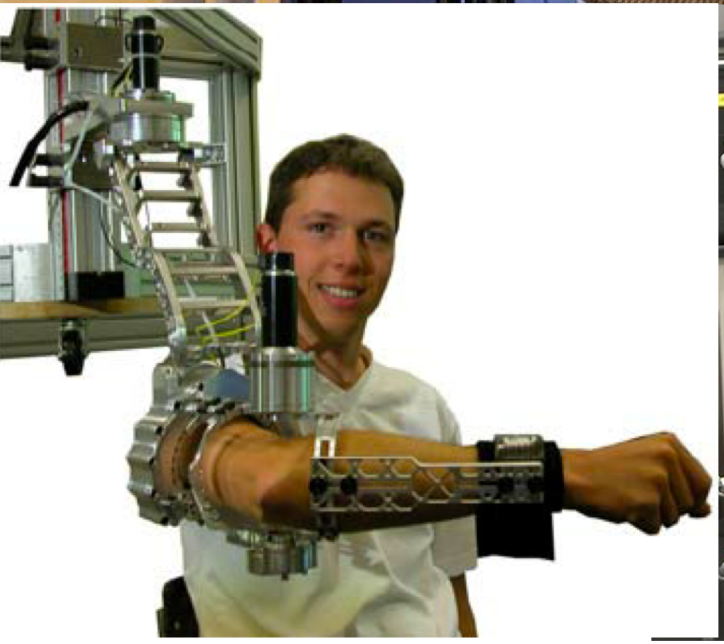
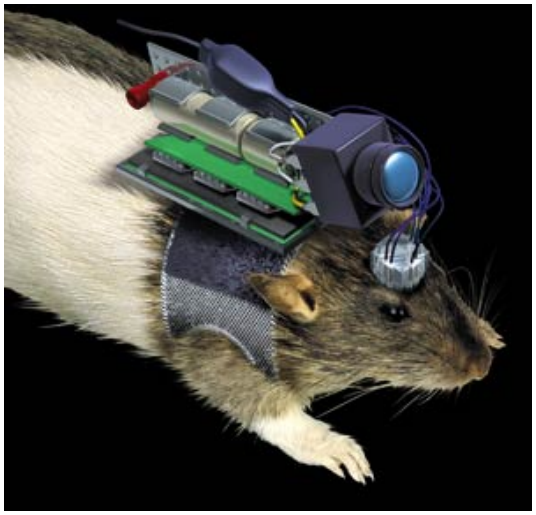
HOBBIEAP

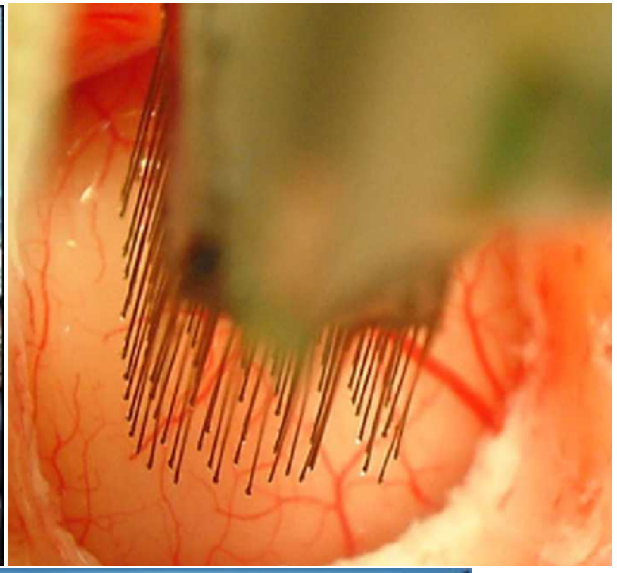


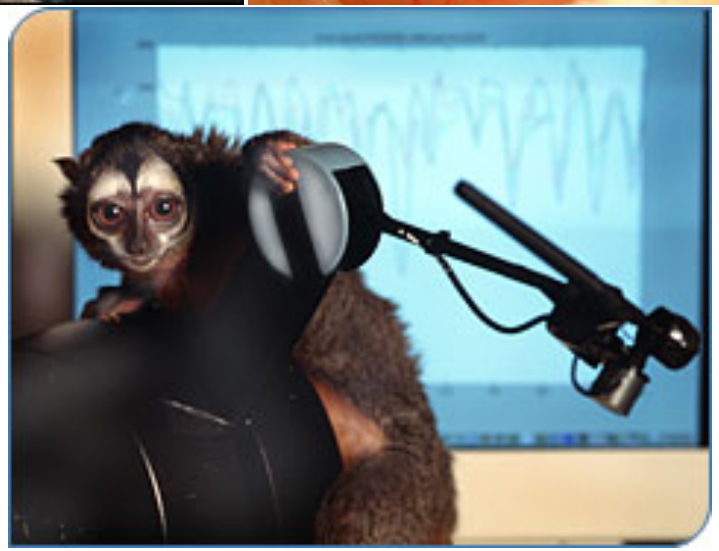

APL
STEM CORPS
Applied Physics Laboratory


C500

Brain-Machine Interfaces







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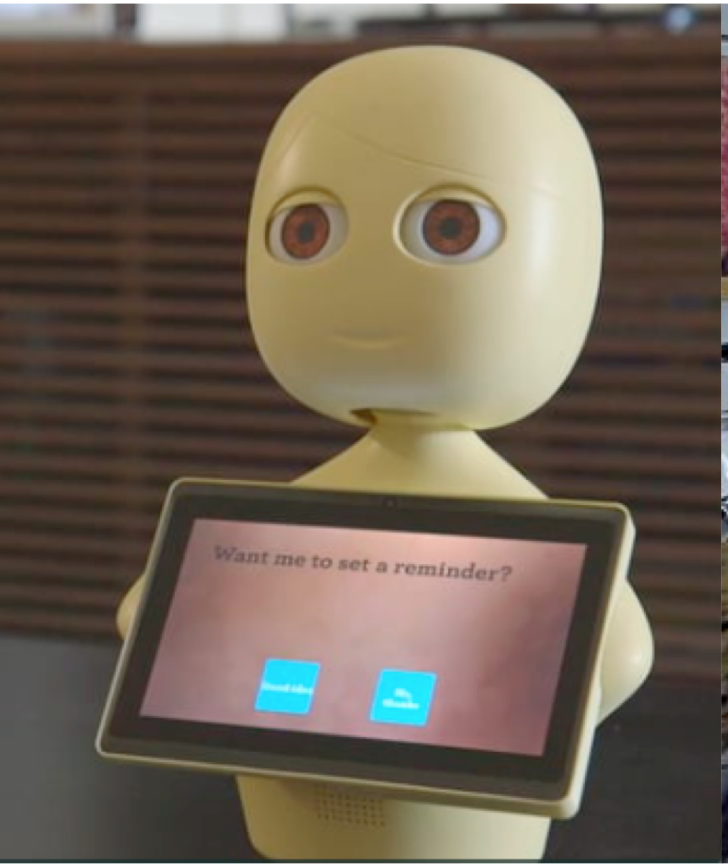
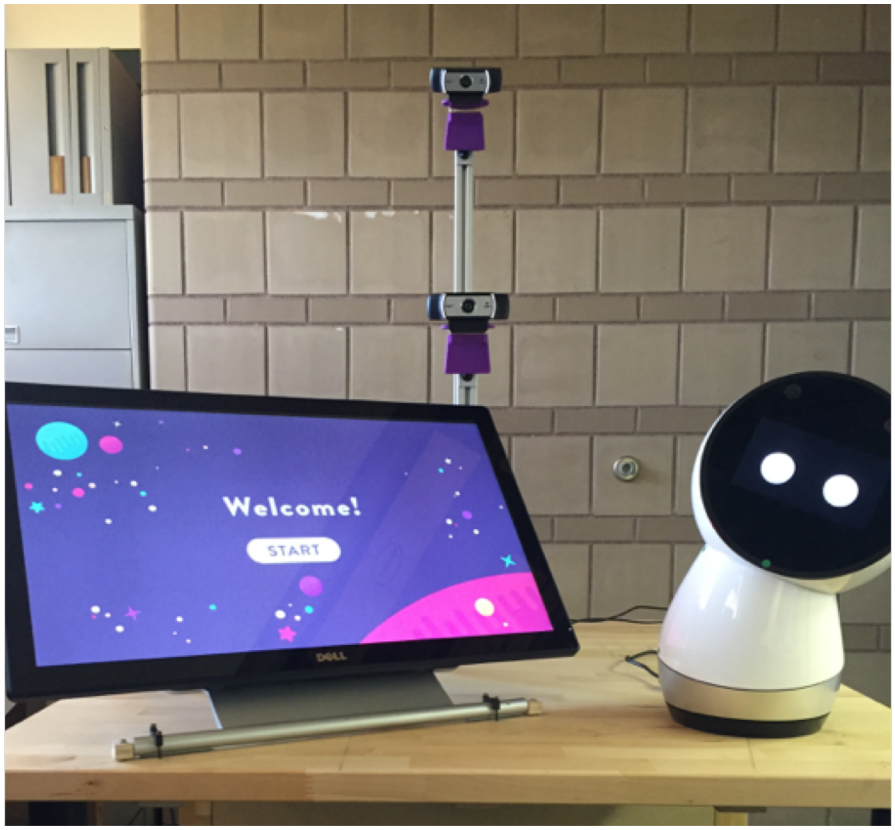
Socially Assistive Robots (SAR)

SAR for Eldercare

(Demographic changes opening large markets)

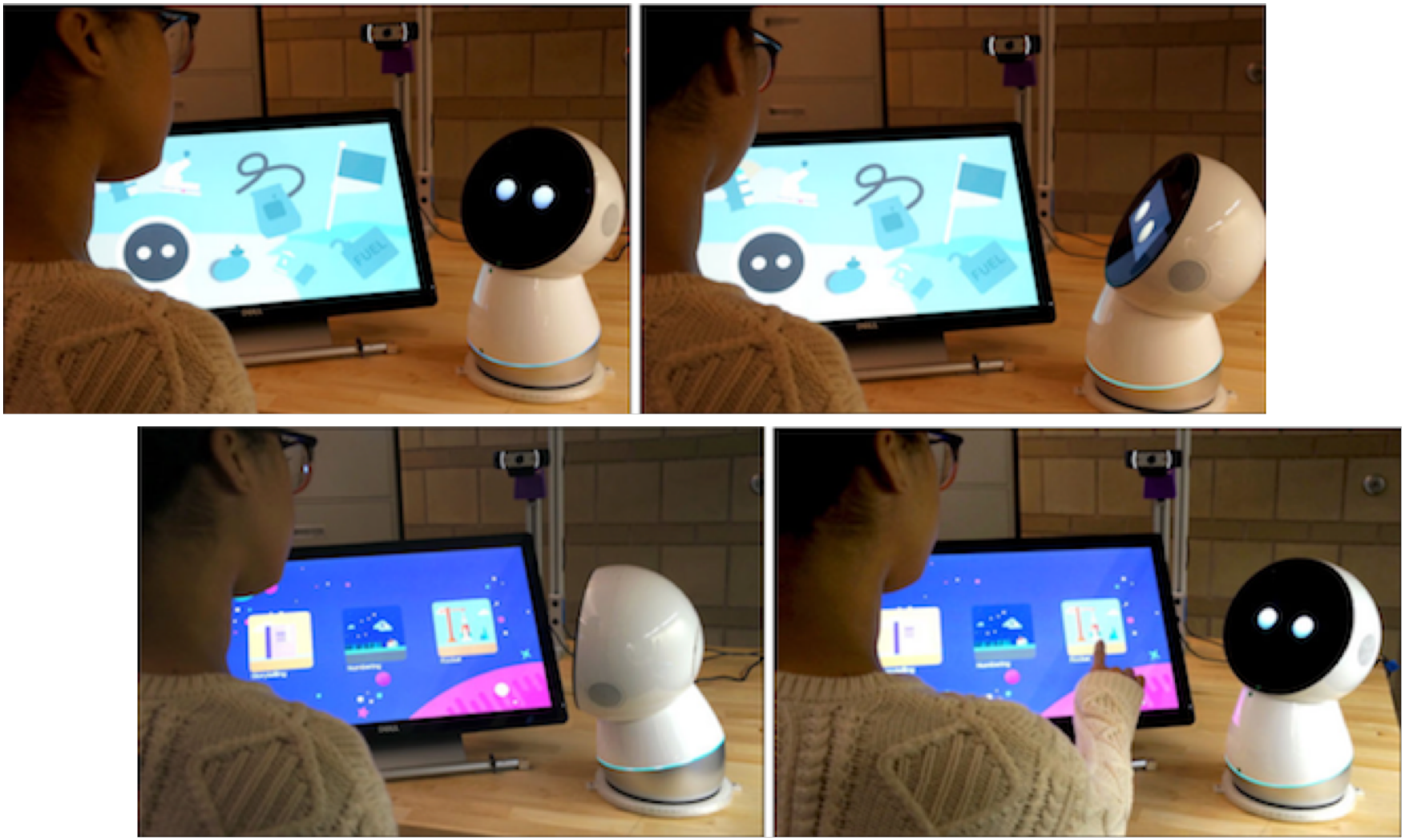


In-home, Long-term Social Skills Training for Children with ASD



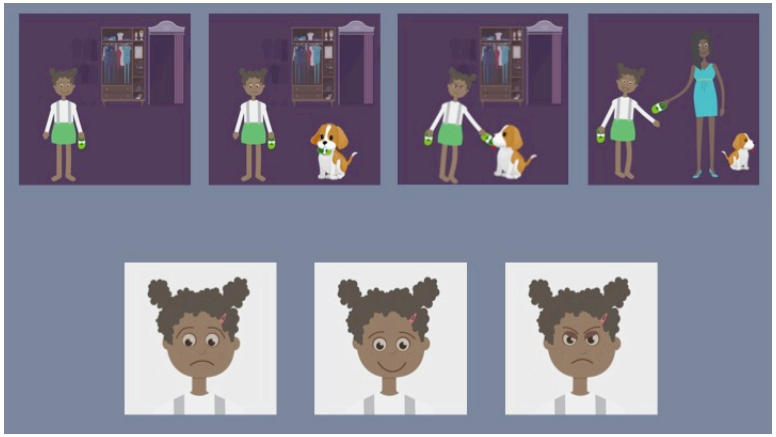
(Scassellati et al., *SciRob* 2018)

Encouraging Social Engagement

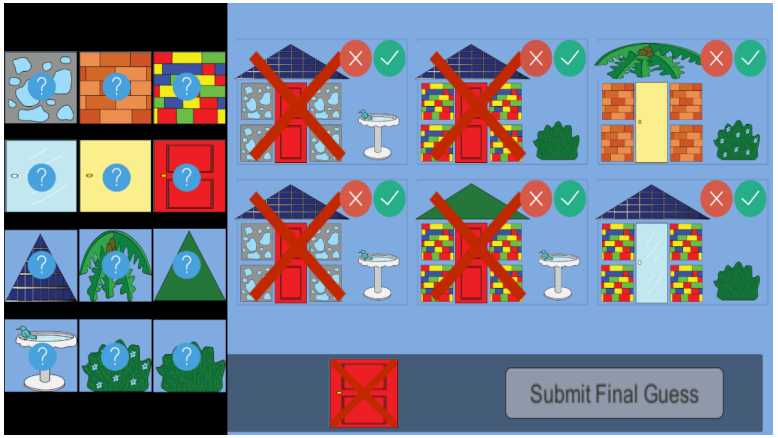


(Scassellati et al., *SciRob* 2018)

Social Skills Training Games

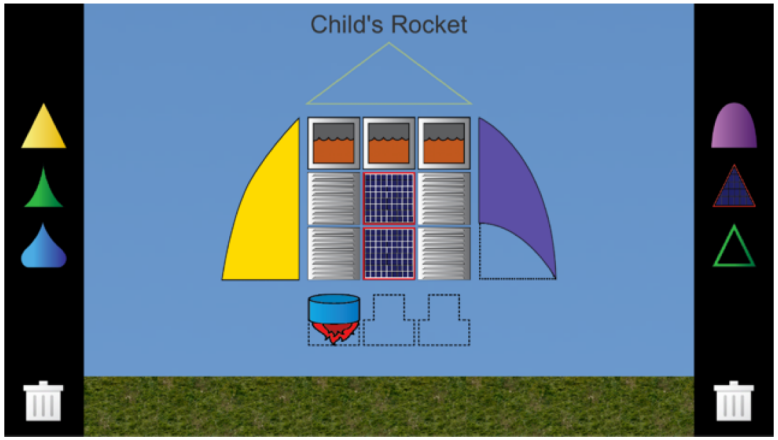


Emotion Understanding



Joint Attention

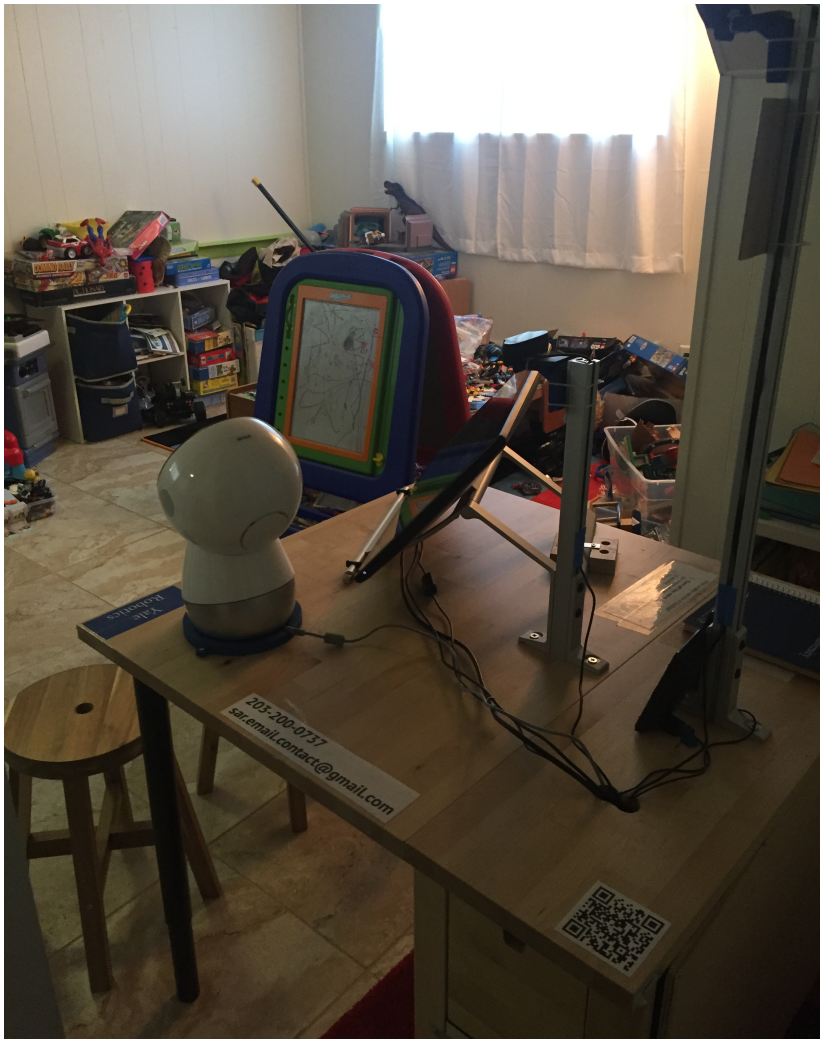
Turn Taking



Perspective Taking

(Scassellati et al., *SciRob* 2018)

Complex Home Environments



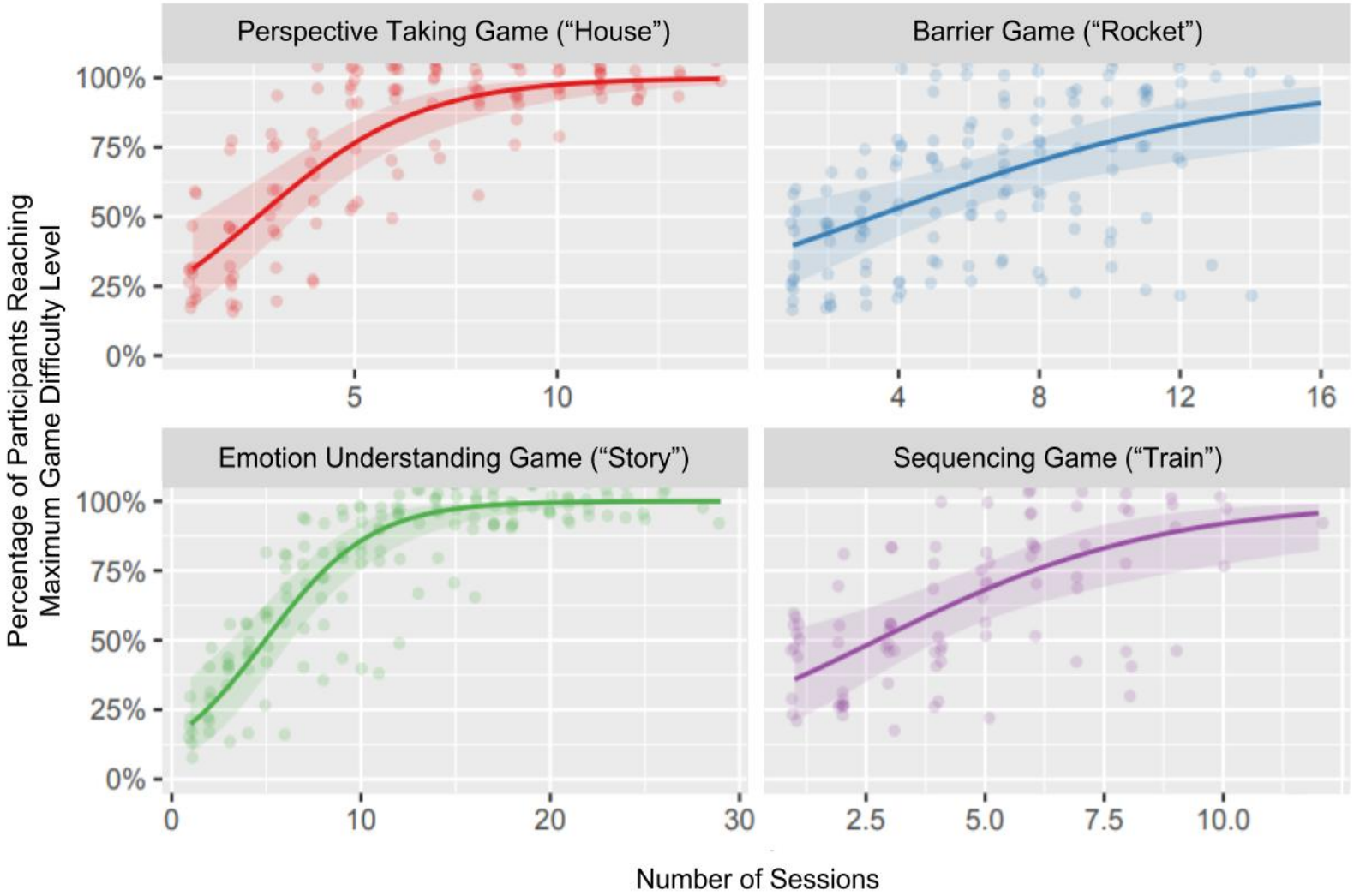
(Scassellati et al., *SciRob* 2018)

Differences from Prior Art

- Autonomous: 30 days without contact
- Adaptive: alters curriculum and engagement patterns to match strengths and preferences of individual child
- In-home: complex and challenging environment
- Tests generalized skill use: high bar for showing learning; new context, standardized clinician validated protocol

(Scassellati et al., *SciRob* 2018)

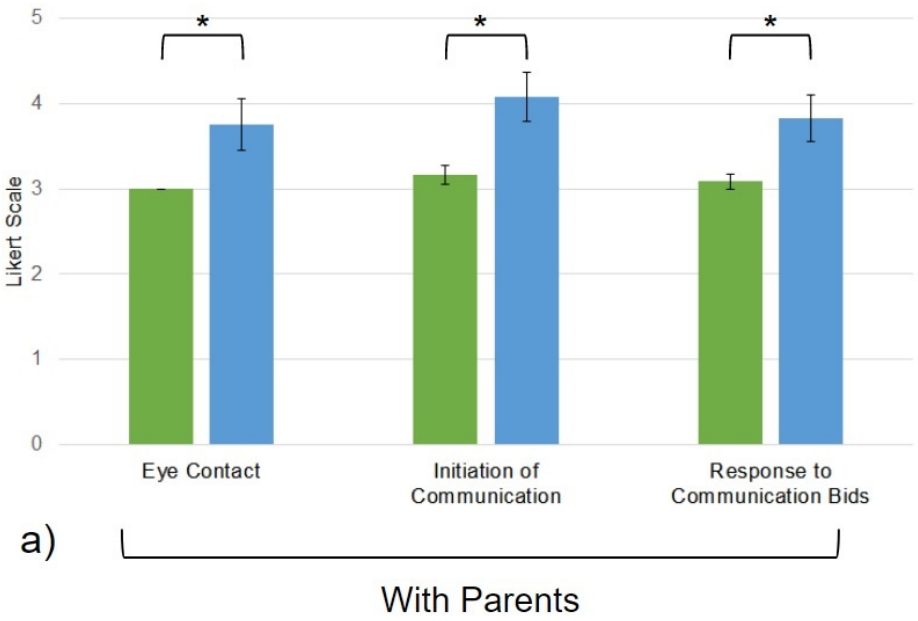
Skill Performance Improvements

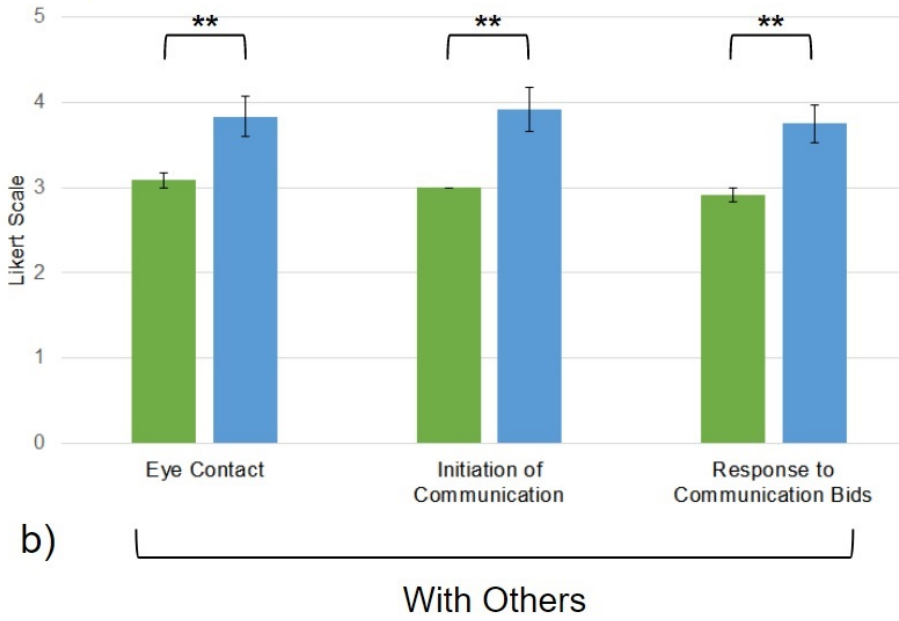


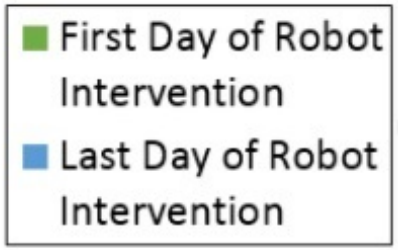
127 hours of data, 837 games played

(Scassellati et al., *SciRob* 2018)

Parent ratings





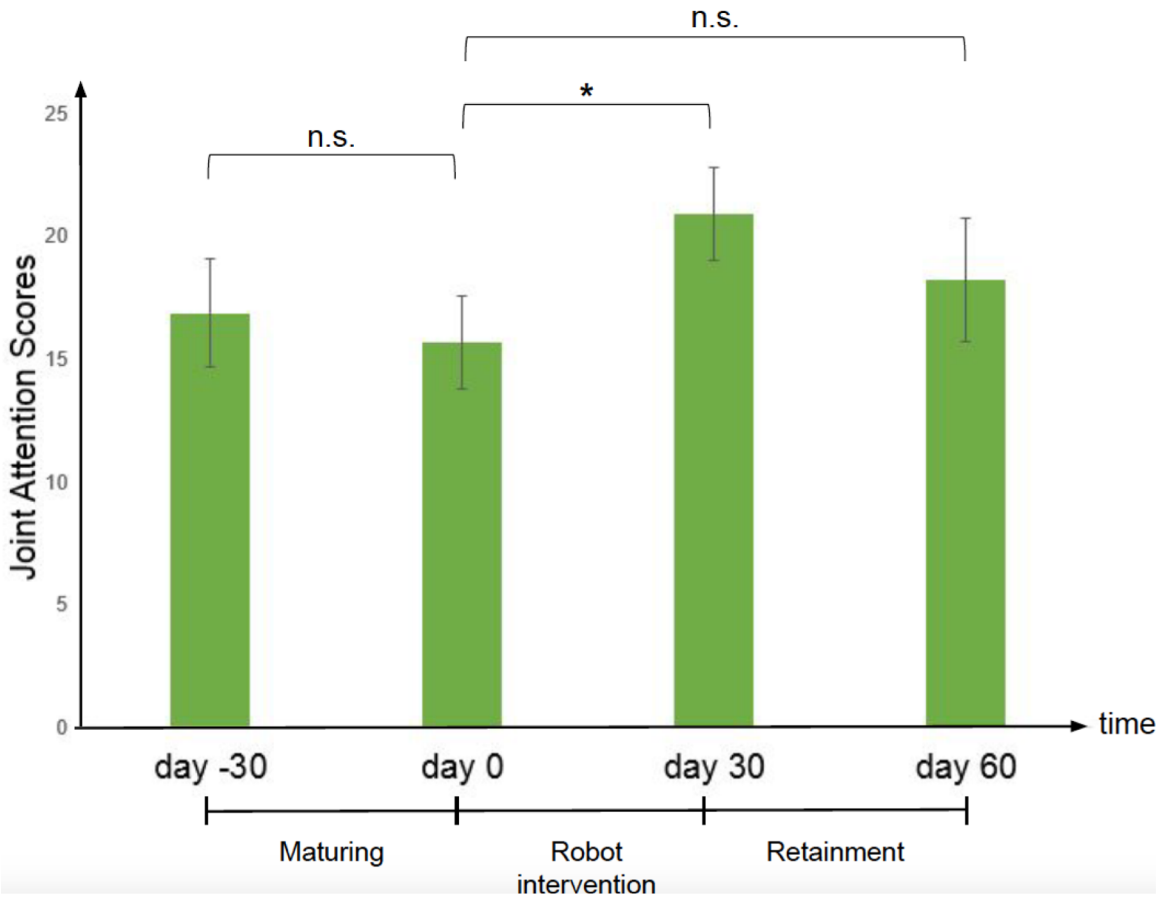


(Scassellati et al., *SciRob* 2018)

Family Responses

(Scassellati et al., *SciRob* 2018)

Clinical Assessment



t(8)=2.863, p = 0.02

- Bean & Eigsti's joint attention probes
- Clinician administered
- Naturalistic assessment
- For school-age children
- Similar to ADOS

Bean, J. L., & Eigsti, I. M. (2012). Assessment of joint attention in school-age children and adolescents. *Research in Autism Spectrum Disorders*, *6*(4), 1304-1310.

(Scassellati et al., *SciRob* 2018)

Discussion Topics

- How do we evaluate AI techniques in personalized medicine?
- To what extent should medical data (which often cannot be anonymized properly) be made available to ML systems?
- Should we be building systems that use social pressure to manipulate people (into taking medication, doing therapy, etc.)?
- What checks and balances are needed for systems that operate with elderly or at-risk populations?
- How do we plan for the exit of these technologies?