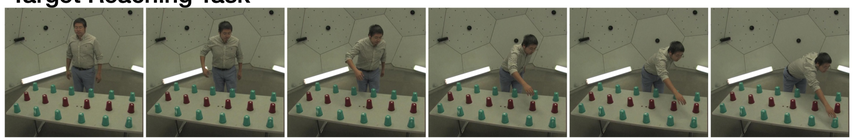
Modeling human intention inference in continuous 3D domains by inverse planning and body kinematics

Yingdong Qian, Marta Kryven, Tao Gao, Hanbyul Joo, Josh Tenenbaum

How to build AI that understands human intentions?

Target Reaching Task

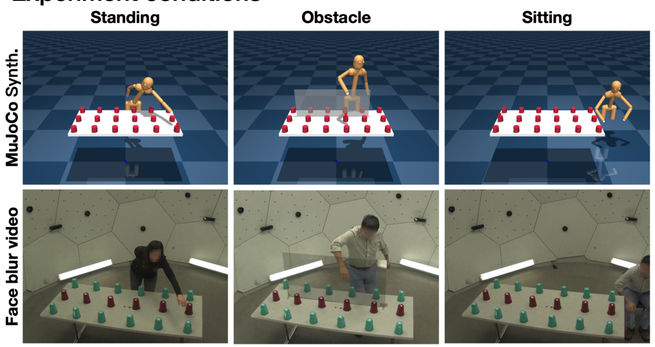


Which target is the actor reaching for? Can you infer the target early without seeing the whole trajectory?

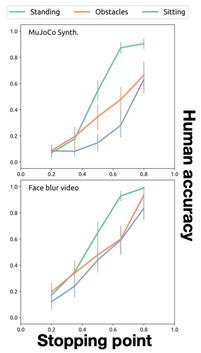
Hypothesis

To perform intention inference humans could simulate the agents' physical constraints and affordances to predict how they may move to minimize physical effort while achieving their goals.

Experiment conditions



Human Experiment 1



Three environment:

Standing

Obstacle (Plexiglas obstacle in the middle of the table)

Sitting (Actor sit in a chair at the right side of the table)

Two presentation style:

Face Blur (video recording with face blurred out)

MuJoCo Synthesized animation (3D reconstruction in Mujoco from motion capture)

Reaching trajectories predicted by the three models.

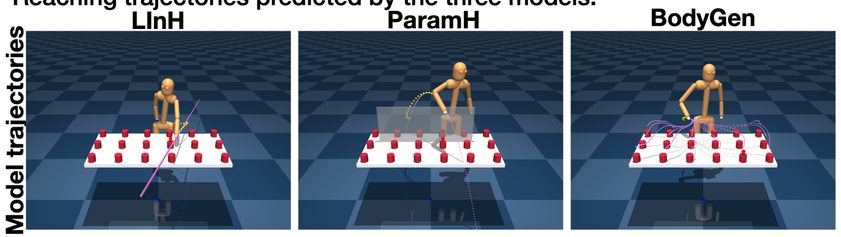
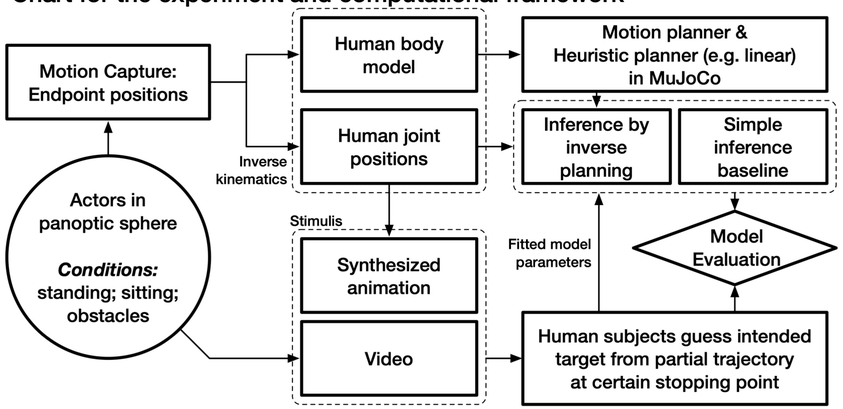


Chart for the experiment and computational framework



Computation models

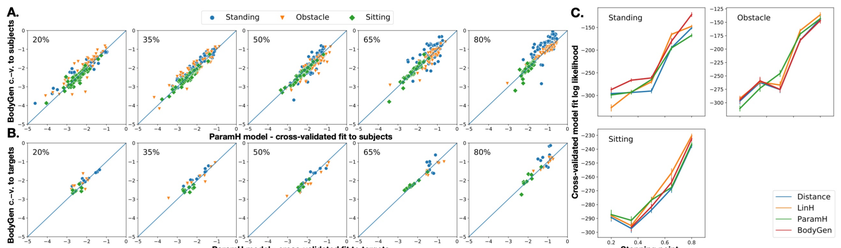
Linear Extrapolation Heuristic (**LinH**): extrapolate the endpoints of wrist to a straight line.

Parametric Curve Extrapolation Heuristic (**ParamH**); extrapolates the endpoints of the actor's wrists to a parametric parabola curve.

Generative Body Kinematics (**BodyGen**):

- Two skeletal body models in MuJoCo are fitted with body proportions of two actors.
- A kinematic planning engine generates possible reaching trajectories to the candidate targets.
- Proximity of the generated trajectories to the observed human movement.

Model comparison, Experiment 1

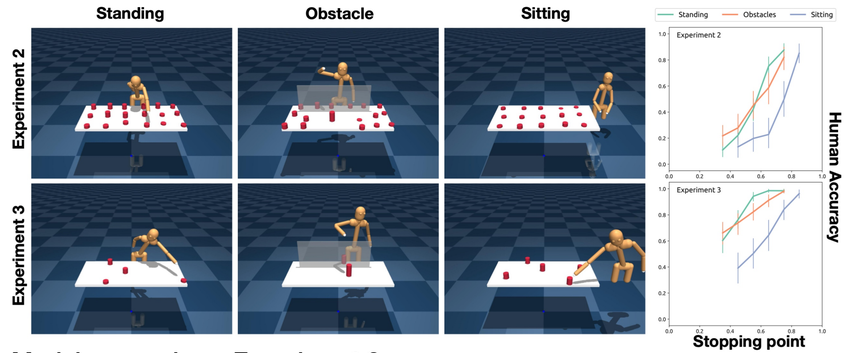


(Lower log–likelihood => Human data better explained by that model)

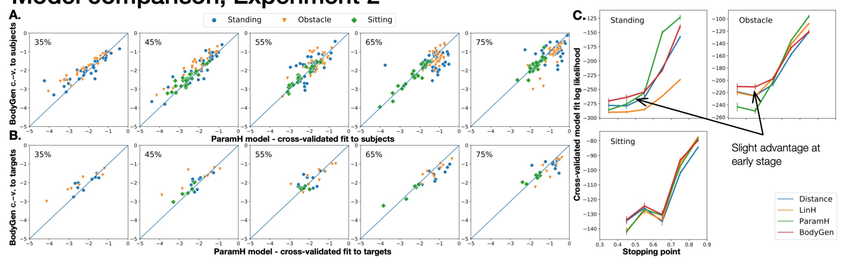
Experiment 2: To remedy the noise in the 3D recording by shifting the targets to the ending position of the human wrist.

Experiment 3: Decrease the number of distractors to simplify inference

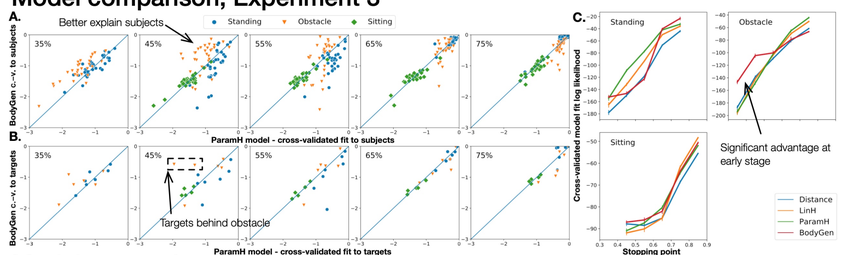
Experiment conditions



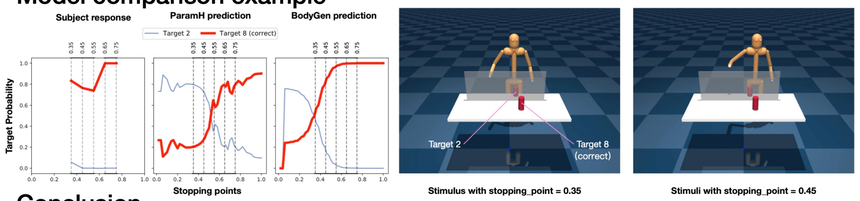
Model comparison, Experiment 2



Model comparison, Experiment 3



Model comparison example



Conclusion

Human efficiency in real-life intention inference is, at least in part, due to using information about body kinematics, and show that modeling body kinematic can improve performance of inference algorithms.