COMPUTER SCIENCE & ENGINEERING
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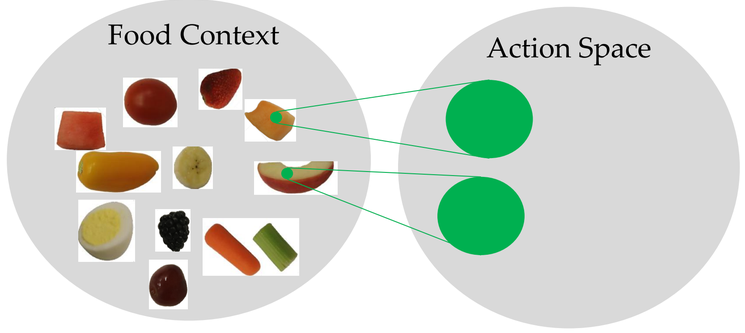
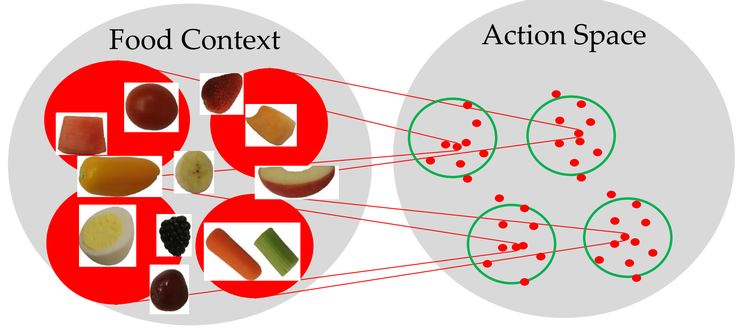
Towards General Single-Utensil Food Acquisition with Human-Informed Actions

In Food Manipulation, almost all humans are experts, but collecting data is hard. Food is hard to simulate. Experiments can be messy and destructive, and there are too many foods to learn how to handle all of them offline.

Key Insight: An *a priori* human-informed actions-space reduction allows for tractable online learning.

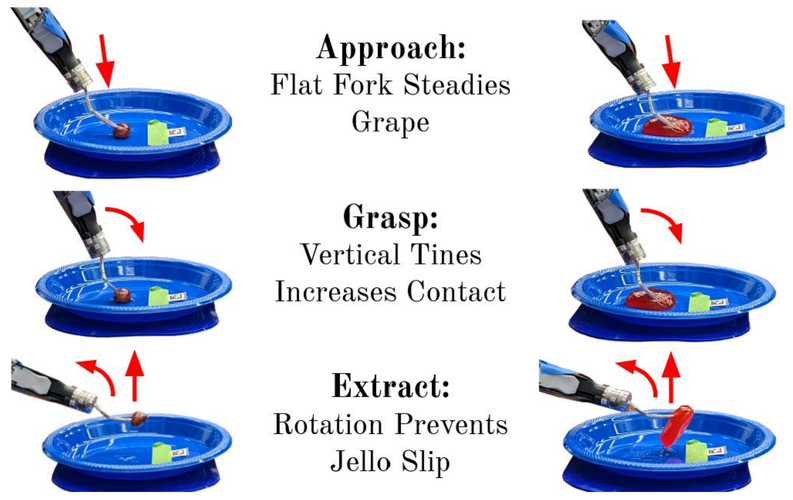


(1) Create an action space that is *continuous*, i.e., similar actions perform similarly.



(2) Collect an expert distribution. Discretize with clustering for spatially-diverse sampling.

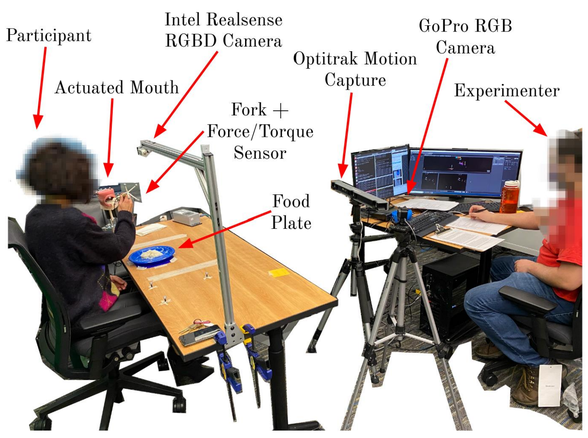
Key Contributions:
- A parameterized continuous action schema.
- A discrete action space (N=10) that covers a variety of food items.
Example below: Grapes and Jello are both covered by the same action.

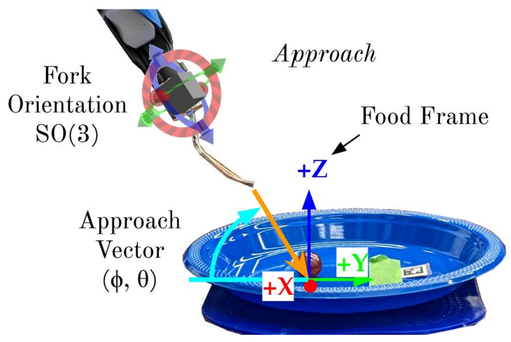


Building the Action Space

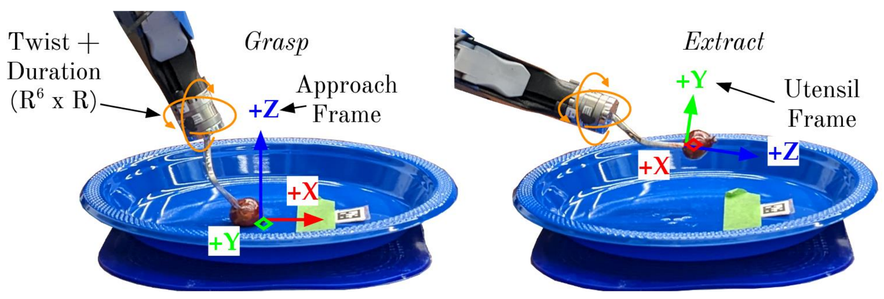
Hypothesis: There is redundancy in the space of food contexts. Therefore, a small action space is sufficient for many different food items.

Method: Capture context-agnostic human acquisition motions and map them into an interpretable robot-based metric space.

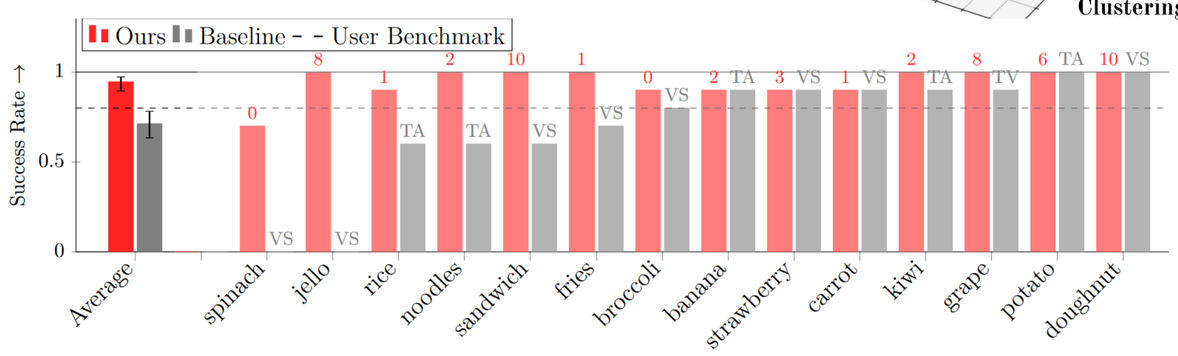




Action Schema: 26 Parameters 3 Phases: Approach, Grasp, Extract

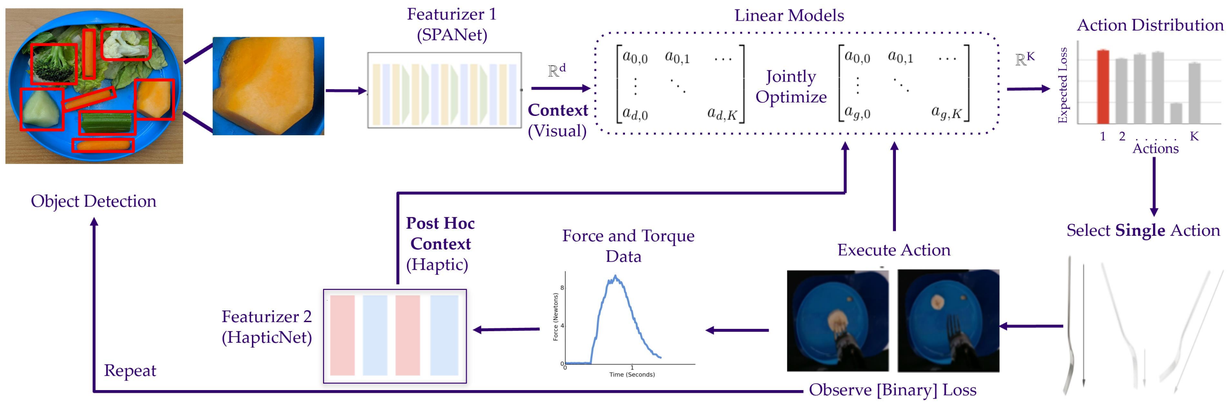


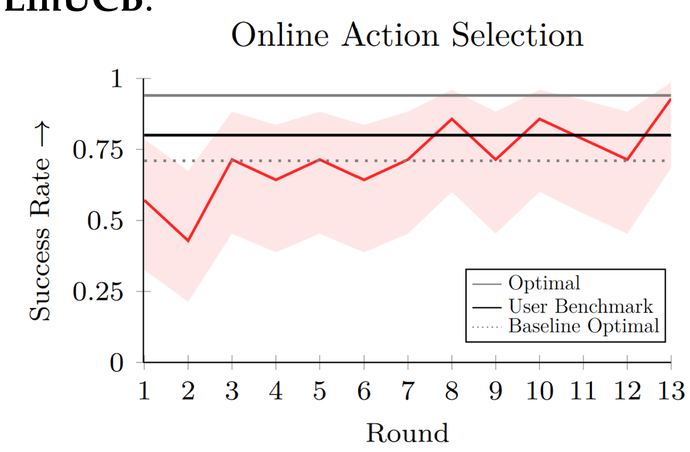
Designed for **similarity** w.r.t. **Euclidean Distance.** Reference frames chosen for *parameter-independence*.



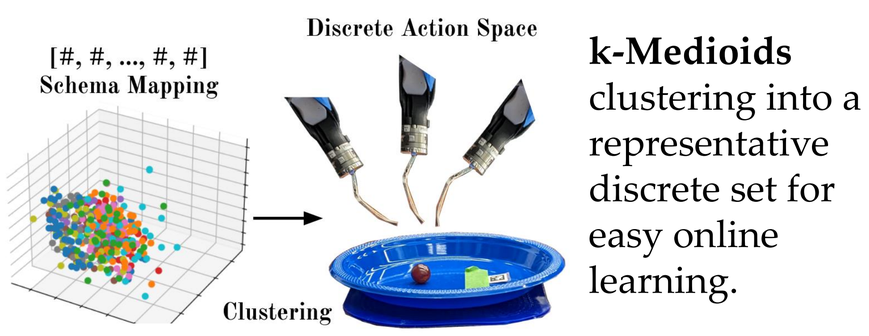
Learning the Optimal Action

Method: Model Acquisition as a Linear Contextual Bandit, Binary Loss, with Visual and *Post Hoc* Haptic Context. Explore with **LinUCB**.





Results: With 10 discrete actions, we reach user-acceptable performance within 10 trials per food type.



k-Medioids clustering into a representative discrete set for easy online learning.

Result: 10 actions that can pick up a diverse set of foods with a user-acceptable success rate (80%).

Future Work: Shooting for the Home

Goal: Install a complete system in a user's home for a whole week of meals. Identify what works and what needs to be done.

Open Hardware: Completely Portable and self-contained on the user's wheelchair.

In partnership with users and co-designers.

Project Webpage

Github Landing

Personal Robotics Lab

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