

Learning for Task Based Grasping

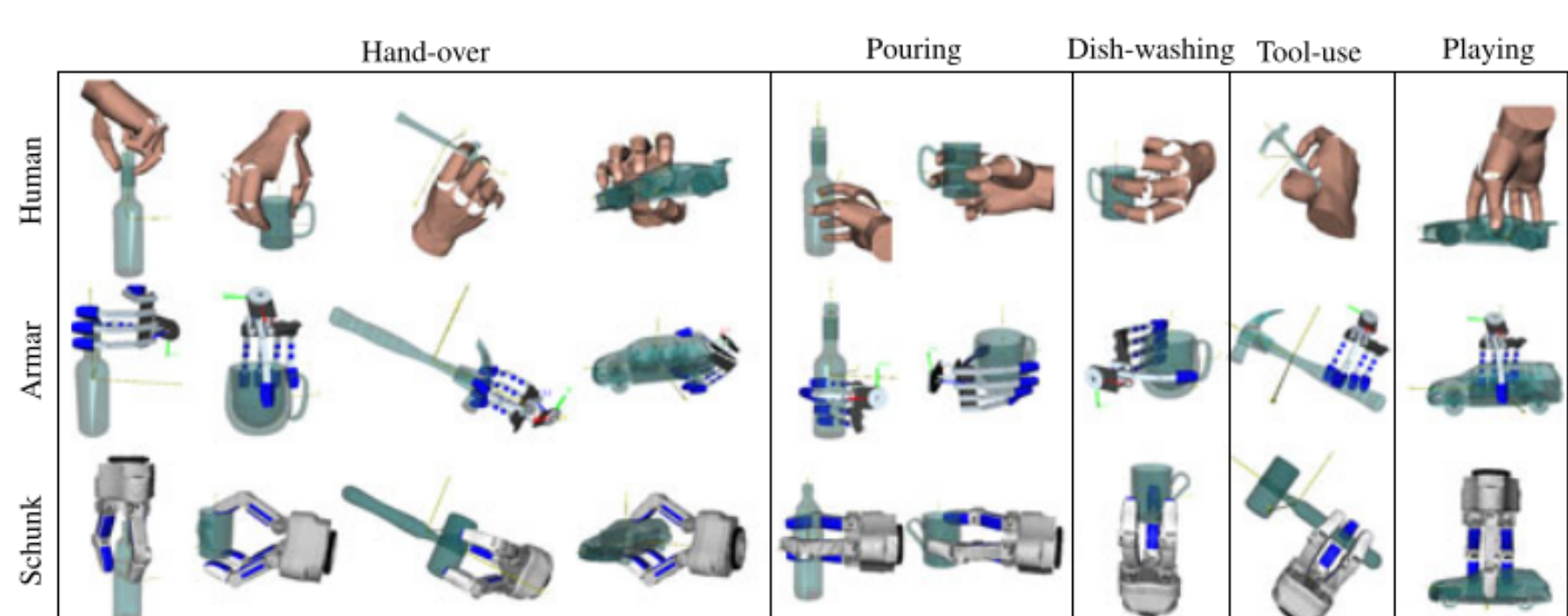
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Description:

For a service robot, grasping and manipulating everyday objects in a goal-directed manner is an important ability but also challenging in real-world scenarios where sensorimotor uncertainty is prevalent. In this project we focus on reasoning about task requirements and grounding these in the sensorimotor information. Objects belonging to different categories which have a similar part can be used for the same manipulation task. These parts as well as hand orientation with respect to object and a grasp type pose a set of constraints on how to grasp the object for a specific manipulation task.

Background & Motivation



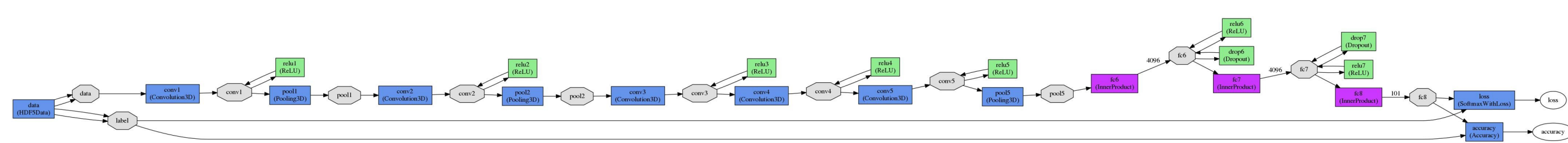
If we consider planning a grasp for a specific manipulation task, the stability of the grasp is no longer sufficient to describe all of the constraints on the grasp. Such constraints include relative hand orientation with respect to the object, specific object parts the hand should or should not make contact with and grasp type.

Research Goal & Questions

Humans manipulate objects by associating their parts to a set of instances instead of recognizing them based on explicit category they belong to. Both cup and a ladle can be used for pouring because they have a similar looking part which affords pouring. This opens up questions such as:

- 1) What kind of object do we need to do a certain task?
- 2) What can we do with an object based on its attributes?
- 3) How to grasp an object to do a certain task?
- 4) What kind of hand do we need to do some subset of tasks a human can do?
- 5) How to solve the problems of grasp knowledge transfer between a teacher and a learner?

Methods



Part detection:

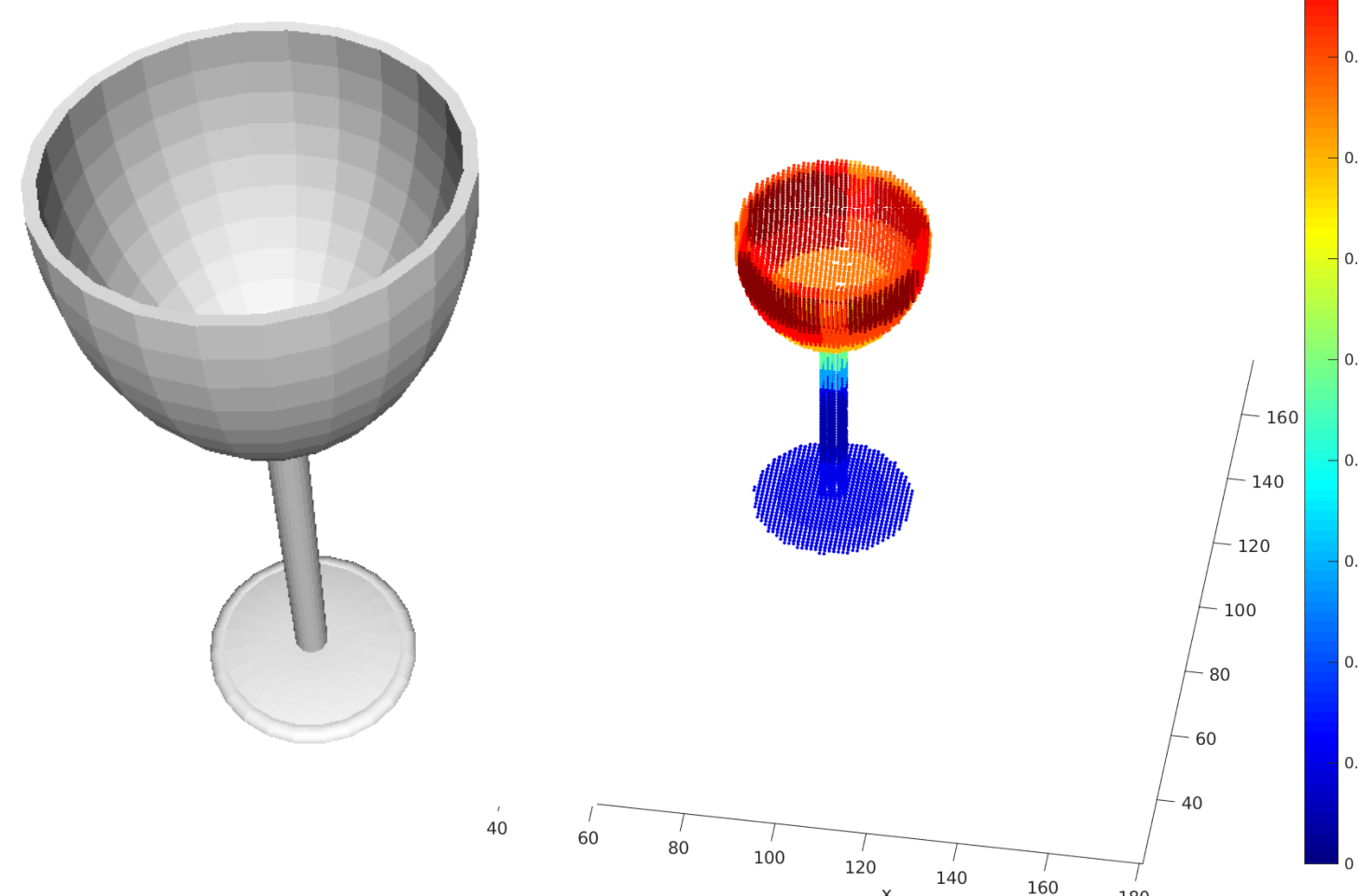
- 3D sliding window
- CNN for part detection

Relative hand orientation:

- CNN for object classifier
- Nearest neighbor
- Orientation detection

Grasping:

- Example grasps on object from different categories
- Grasp planning with constraints on object part and approach direction



Roadmap & Milestones

Main tasks:

- Literature review and evaluation of prior work
- Deep CNN for 3D part detection
- Grasp planning with constraints
- Experiments on a real robot

Additional tasks:

- Learning from demonstration
- Reinforcement learning for manipulation tasks
- In-hand manipulation