Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

Improving the Reliability of Service Robots in the Presence of External Faults by Learning Action Execution Models

Alex Mitrevski, Anastassia Kuestenmacher,
Santosh Thoduka, and Paul G. Plöger

May 31, 2017

Motivation: Execution Failures in Service Robotics

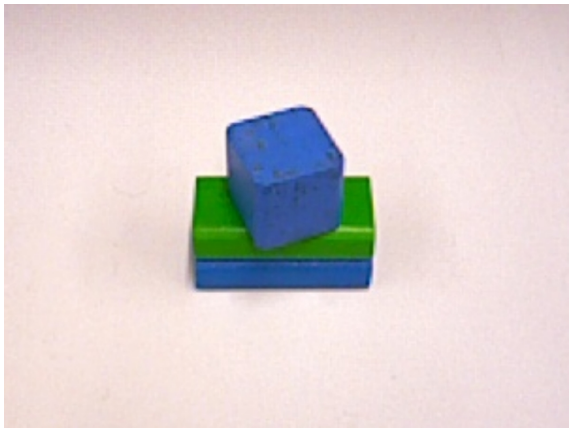
Motivation: Execution Failures in Service Robotics

A common cause of execution failures is the insufficient knowledge about the preconditions of actions

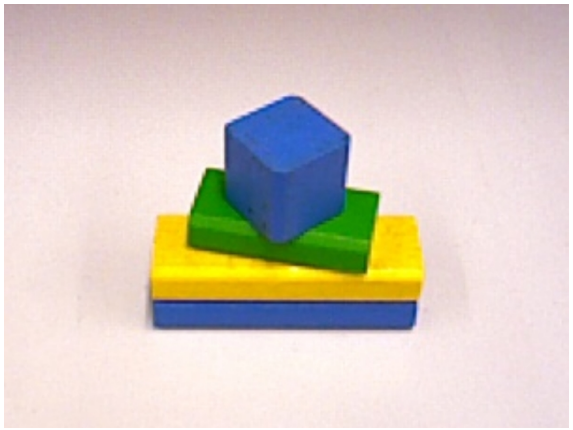
Modelling execution failures is difficult:

- Too many things can go wrong
- Failures are usually scenario-specific

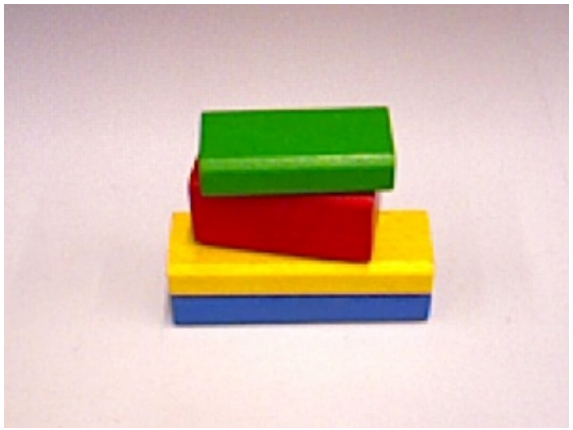
Use Cases: Block Tower and Table



Scenario A: Releasing a cube on top of a block



Scenario B: A three-block tower



Scenario C: A tower with different blocks

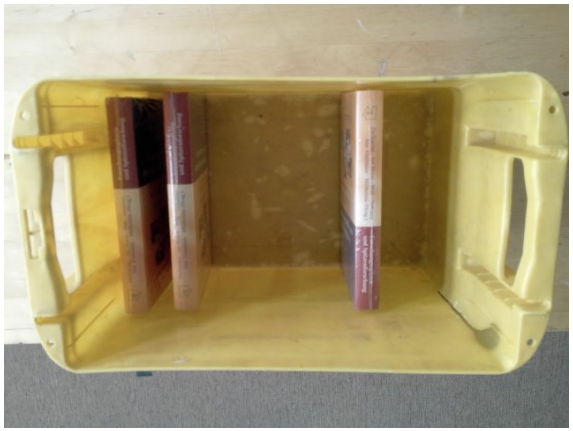
Scenario A: Releasing an object between bottles

Scenario B: Different objects on the table

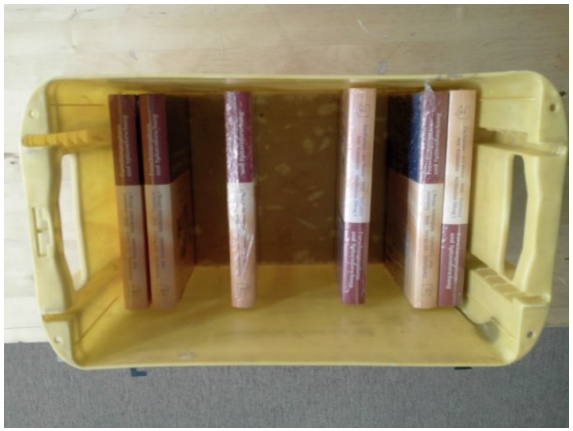
Scenario C: Cluttered table

Use Cases: Container and Fridge

Scenario A: Releasing a book in a book container



Scenario B: Less space in the container



Scenario C: A container that is almost filled

Scenario A: Releasing a bottle on a fridge door

Scenario B: Less space on the door

Scenario C: More space on the door

Focus of This Work

- Object release actions
- Failures due to lack of knowledge about object properties

We particularly address the following questions:

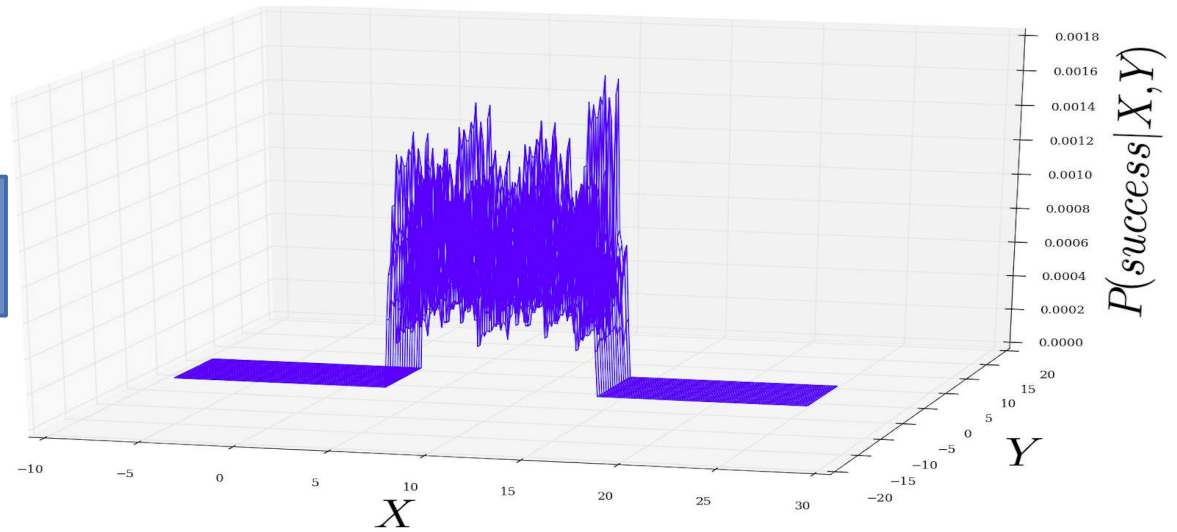
- How to represent action execution knowledge
- How to generalise execution knowledge
- How to update the knowledge if necessary

Action Execution Model Representation

Symbolic model

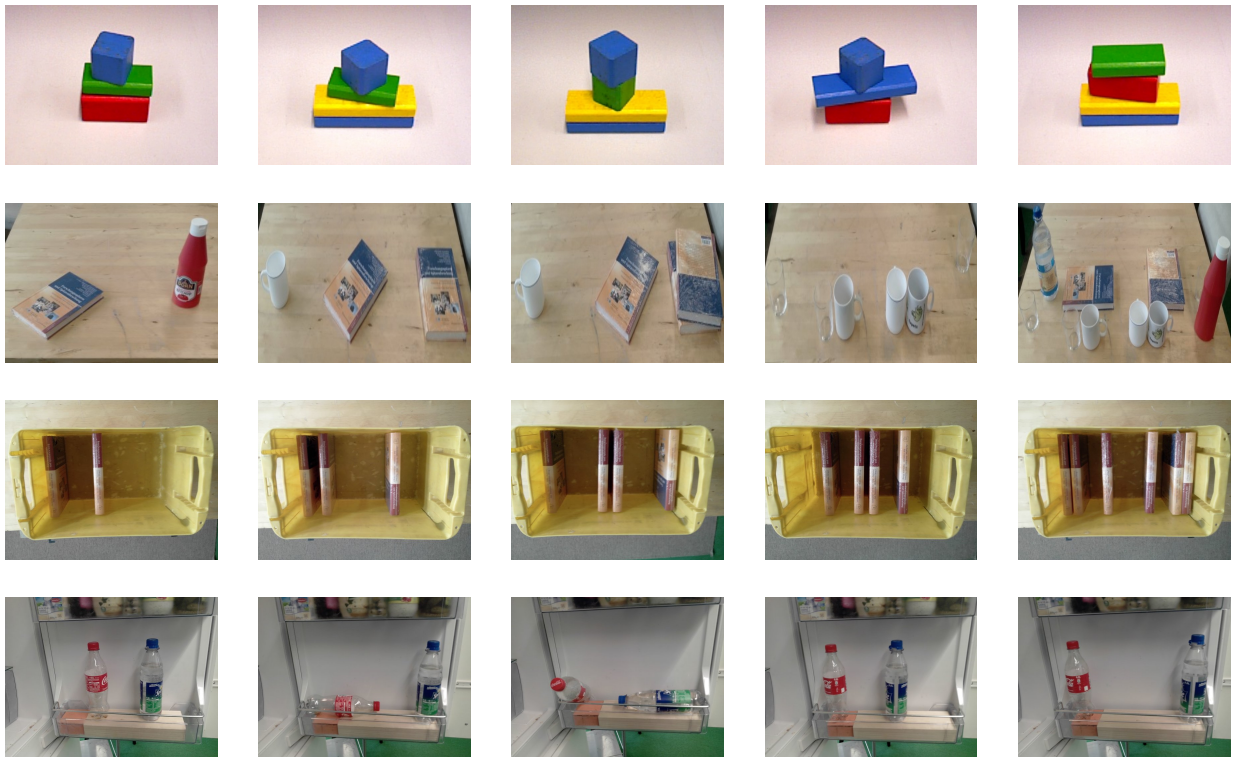
```
rightOf(ChipsCan, Bottle1) & dc(ChipsCan, Bottle1) &
leftOf(ChipsCan, Bottle2) & dc(ChipsCan, Bottle2) &
leftOf(Bottle1, Bottle2) & dc(Bottle1, Bottle2)
```

Geometric model



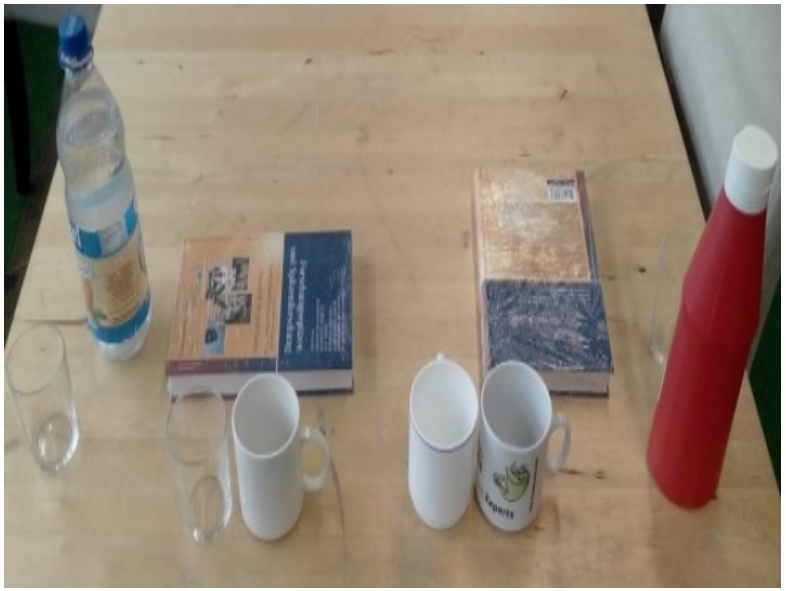
Model Generalisation

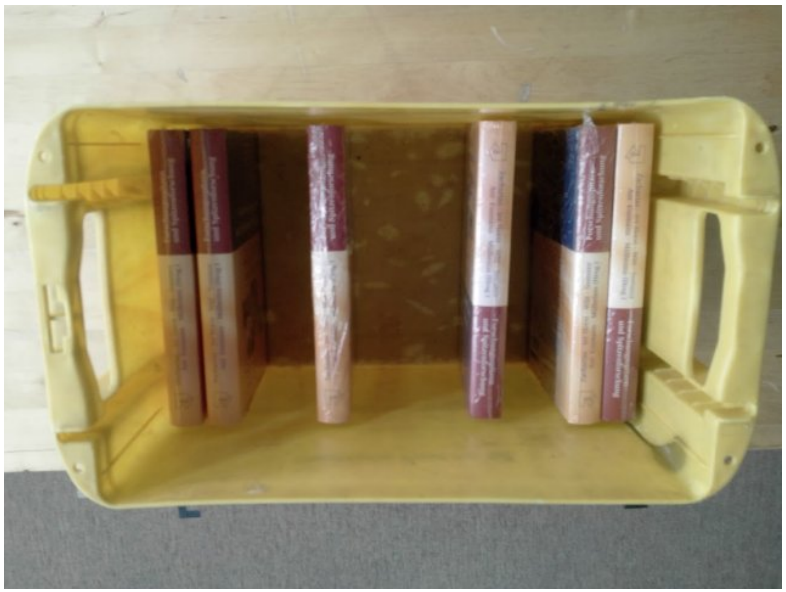
Learning scenarios

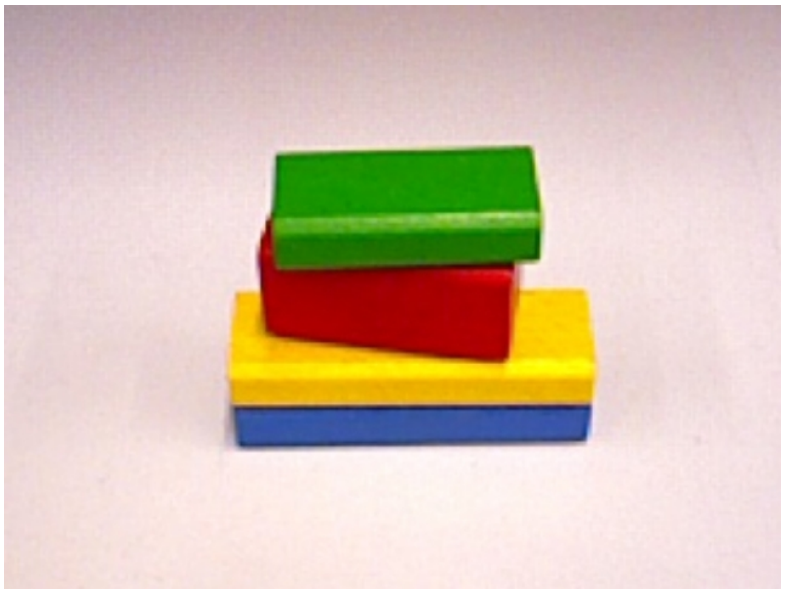


Objective:
Generalisation over a large set of related scenarios

Experiments







What Are Our Models Good For?

Our models

- provide a unified representation of action execution constraints
- are robot-independent
- reduce the search space while learning how to execute actions
- increase the likelihood of execution success/decrease the likelihood of execution failures