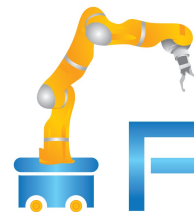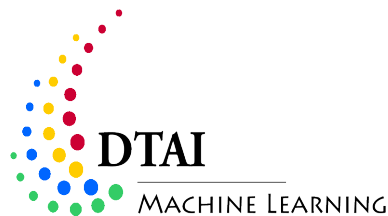# Opening Doors
An Initial SRL Approach

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Robotics

- Autonomous robots in indoor environments
- Mobile manipulation tasks
- Navigation requires operating doors
- One of the three scenarios
  of the FIRST-MM EU project

# Door Opening Problem

- Detecting and localising door
- Detecting and localising handle
- Recognising grasping points
- *Finding the right actionable point*
- *Finding the right action to apply*
- Performing the action on the handle

- *Initial Idea*

Relational Domain Motivation

- Relations at the grasping point level
  - Relative positions of candidate points
  - Contact points on the door
  - Robot hand type might limit choices
  - Uncertainty in handle shape detection
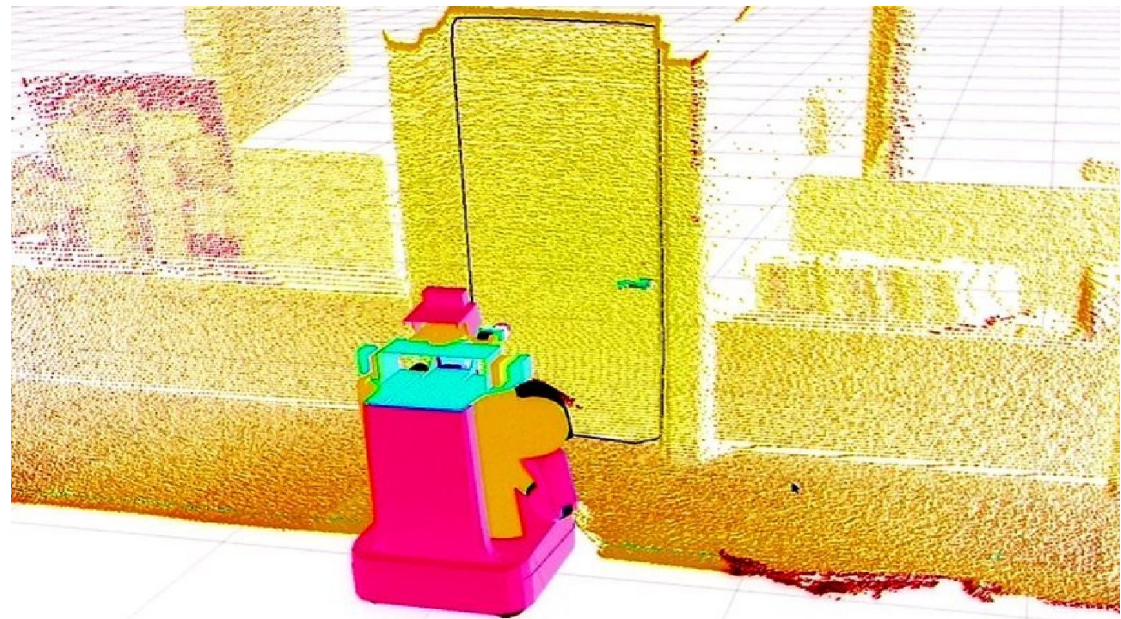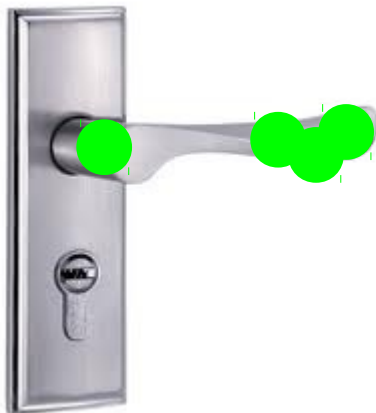
Relational Domain Motivation

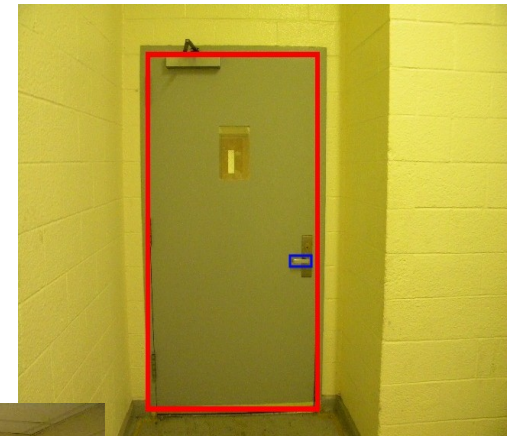- Relations in the scene
  - Relative position of handle to door
  - Handle and door relative sizes
  - Relative position of door in the room
  - Other objects in the scene: hinges, light switch, ...
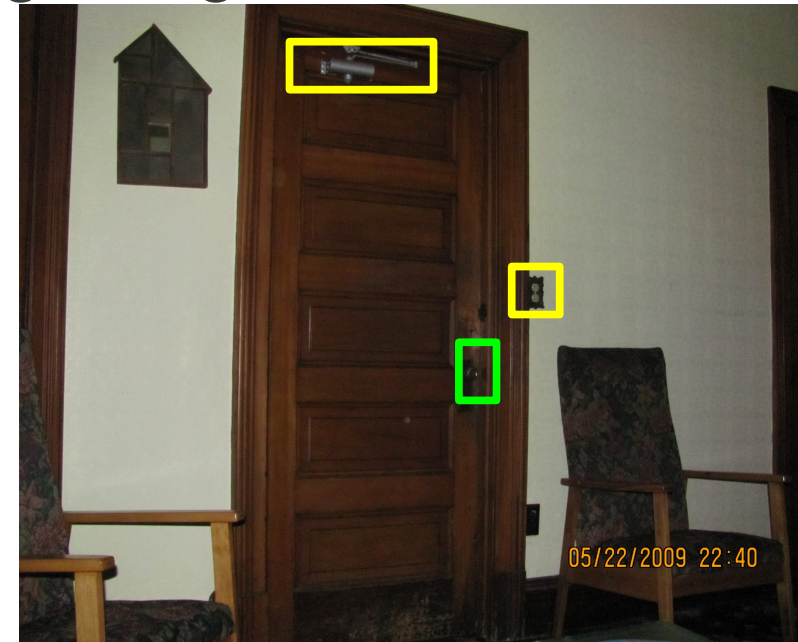
Task Specification

- Assume door and handle detected

- Images with labelled bounding boxes

- Predict discretised:

  - Action: push in, out, left, …

  - Action location: left, right, centre, ...
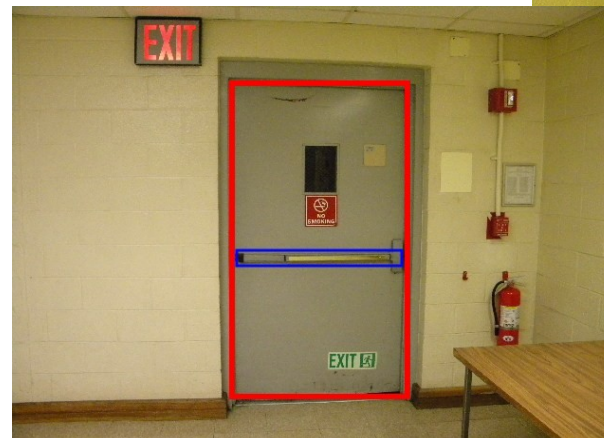
Initial Setting

- Extract (5) independent features:

  - Handle aspect ratio, relative width/height, …

- Action prediction:

  - Use Naive Bayes classifier
  - MAP estimate: $\quad argmax_A \prod_{i=1}^{5} P(F_i|a)$

- Action point prediction:

  - Depends on action and handle relative location
  - Use Bayesian Network (features dependent)

- Learn parameters from examples

Towards a Relational Domain

- Define prior probability distributions

- Add background knowledge – reduce number of parameters to learn

- Use logical rules:

```
handleRelativeWidth(I) :- (A=in;A=out), hrw(I,A), action(A).

actionpoint(centre) :- (A=turn_clock;A=turn_counter), action(A).
```

- Investigate relational extensions

Results

- 60 door dataset annotated with bounding boxes
- Randomly split between train/test
- Repeated 5 times

Predict	Experiments	Avg. Success	Pct.
Action	30	23.6	78.67%
Action Point	30	23	76.67%

Future Work

- Use point cloud data – detection uncertainty

- Extend relational domain

  - Actionable point level

  - Scene level

- Temporal relational aspect:

  - Push handle down before pushing door inwards

Questions?