Semantics for Robots

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Machine Perception and Interaction Lab
Center for Applied Autonomous Sensor Systems
Örebro University
- 15,300 students
- 450 Ph.Ds
- 82 programs
- 980 courses
- 1,600 employees
- 880 teachers
- 135 professors
- 8 schools
Center for Applied Autonomous Sensor Systems, Örebro University

Focus on the Perceptual and Cognitive Abilities of Autonomous Systems that are developed for the service of humans

Autonomous Mobile Manipulation Lab
At the AMM lab we strive to enable mobile robots to perform complex interaction with their environment. We perform research on perception and motion synthesis for mobility and manipulation.

Cognitive Robotic Systems Lab
R&D on cognitive abilities for embedded physical systems such as robots and/or sensor systems. These cognitive abilities include: knowledge-representation, planning and scheduling, and hybrid reasoning/inference.

Machine Perception and Interaction Lab
R&D on sensor-based perception for intelligent systems and evaluation of the quality of interaction of systems with multi-actors. Focus on representation learning of sensor data, semantic perception and human-systems interaction including human-robot interaction.

Mobile Robots and Olfaction Lab
R&D on perception for robots: rich 3D maps (3D optical/laser data augmented with additional sensor data and semantic information); robot vision for mapping, localization and navigation (e.g., VSLAM); and mobile robot olfaction – gas discrimination and quantification, statistical gas distribution modelling and gas source localization with mobile robots.

Multi-Robot Planning and Control Lab
R&D on automated planning and control for robots and multi-robot systems. Focus on integrated task and motion planning, coordination, hybrid reasoning about time, space, motions, resources and tasks, plan-based robot control with realistic boundary conditions, and online multi-robot planning.
Deep learning has enabled rapid progress in object detection, recognition, and segmentation, but objects are much more complex than simply pixels in an image.
Non-trivial view on objects

• Multiple and changing properties
• Relations and Affordances
• Deeper Semantics associated to objects
  • permanence
  • (de) composition
  • Impact their surroundings
Robots that have a deeper "understanding" of the objects around them

- Easily instruct using natural language e.g. "Pick up all the toys, Move box, find my glasses"

- Enable better mechanisms for action and interaction
  - Permit understanding of the meaning of observations
  - Infer beyond what can be measured
  - Handling of complex tasks
  - Shared understanding
My own interest in the subject - olfaction

"A rose by any other name would smell just as sweet". (Romeo&Juliet, Shakespeare)


In Gas Distribution mapping often the highest measured concentration of an odour is not co-located at the source.
Three examples of semantics for robots (projects)

• Neural-Symbolic Integration for Object Affordance Inference
• Grounded Language Learning
• Large Scale Semantic Perception for Urban Settings
How we learn to reason about objects

Same challenge for Intelligent Systems
Combine Machine Learning with Reasoning

Ball-1  (front-of ball-1 cup-1)

Cup-1

anchoring  

reasoning

Symbol system

n ~ poisson(6).

pos(P) ~ uniform(0, N) ←

N ~ n, between(1, N, P).

pos(P) ~ gaussian(X + 3, X) ←

X ~ pos(P).
Three examples of semantics for robots

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Grounded Language Learning

Grounded Language Learning

Transfer learning to Real Robot

A. Sequence of real-world images

Perform action with novel objects and visualise the output

Input

Generated Output

1 → 2: move the red small cube left of red big sphere
2 → 3: remove the blue big pyramid
3 → 4: replace the green small cube with a blue big pyramid
4 → 5: add a green small cube on top of red big sphere
Three examples of semantics for robots

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Goal: Automatically augment satellite imagery with annotations about objects, functions, and relations to enable 1) users to query the map 2) improve the recognition of objects and entities with 100,000’s of objects
Large Scale Perception

Use ML to determine each object/entity in an satellite image
Connect that information to high level representations e.g. Open Street Map
Queries for humans and robots

“Where are the shelters”

✔ Since RRT is not complete, it may not find a path but it can use semantic constraints to assist it in the process.

Fly to point A to B avoiding water
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- Better AI algorithms
Thanks you for your attention

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