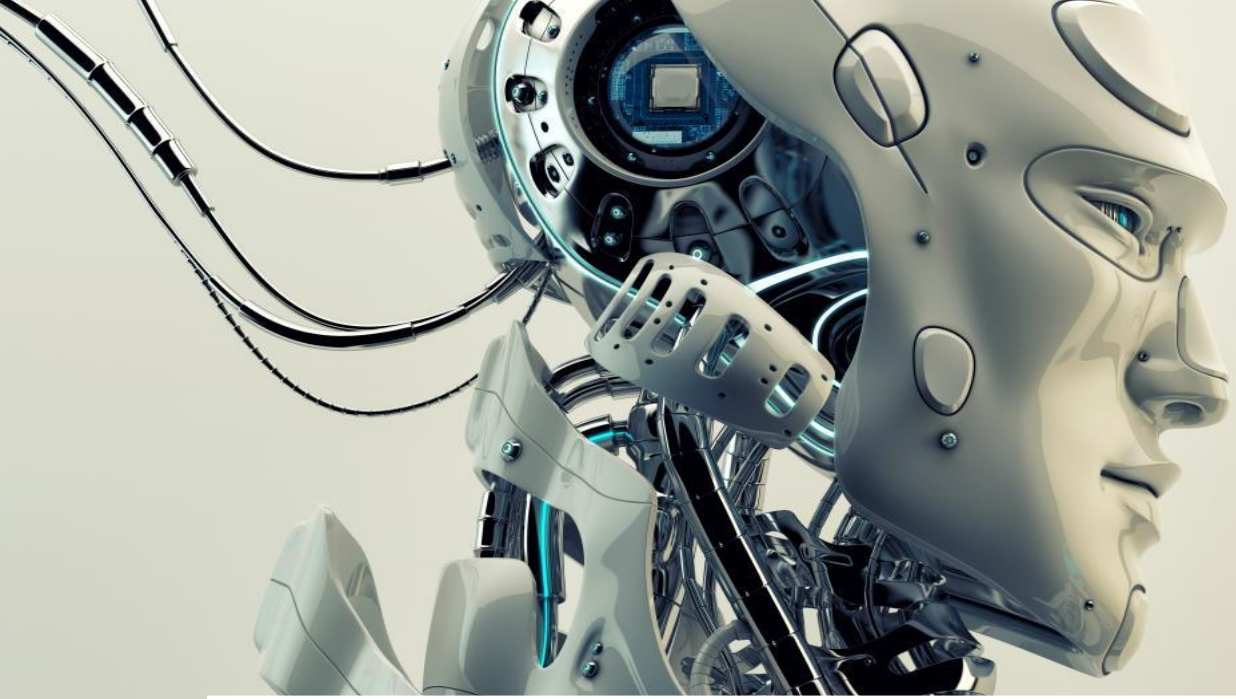

KNOWLEDGE PROCESSING FOR ROBOTS

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MOTIVATION

- Robots are required to perform complex tasks *e.g pick up and place can on the table*

- **Problem**: A robot need spatial information about the scene, and a deep semantic knowledge of its surrounding, the task to perform, access to different reasoning mechanisms…

- **SOTA: KnowRob2.0[1]**

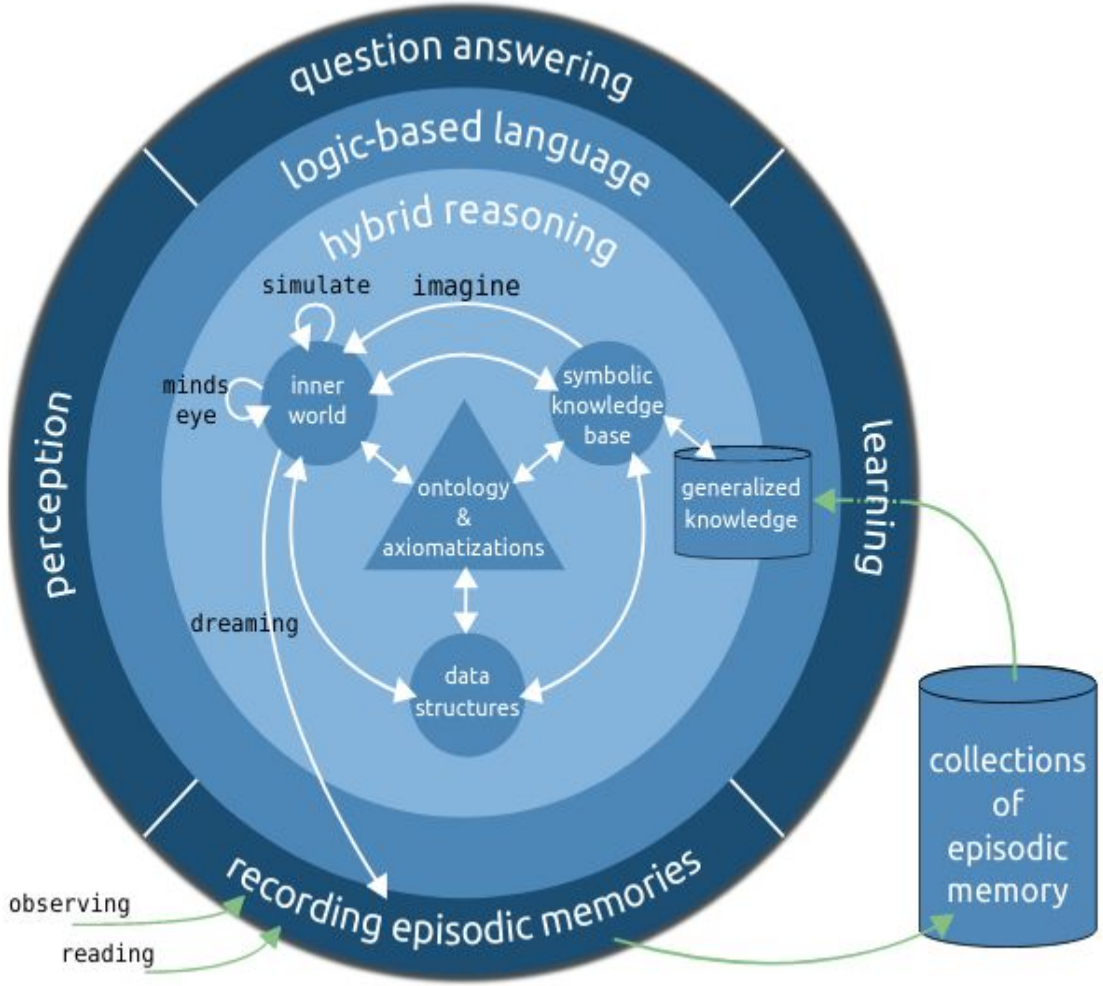
- **Developed Solution**: Package for ontology-based knowledge representation of the robot, the scene and manipulation tasks.

TAL TECH

1 http://www.knowrob.org/

KNOWROB

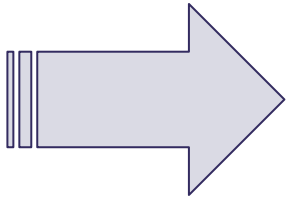
- **End-to-end framework built at the University of Bremen for knowledge representation and reasoning in robotics[1]**
  - Core Layer / Hybrid reasoning
    - Ontologies-based reasoning
    - Simulation-based reasoning
    - Reasoning from previous experiences
  - Logic-based language
  - Interface Layer
    - Querying interface via Prolog predicates
    - Perception modules
    - Learning modules (Weka platform)



1 http://www.knowrob.org/

KnowRob2.0 is under migration, so what could be done?

- **The Core layer is under migration**
  - DUL[1] is used as standard ontology
  - Physical and social concepts of tasks are modelled with SOMA[2]
- Logic and interface layers are obsolete



Package for knowledge representation and processing

- On top of ROS stack
- Python3 binding to allow use of ontology directly in robot's control code
- Ontology in OWL language for :
  - Tiago
  - Surrounding environment
  - Simplified manipulation task

- Spatial reasoning, some tasks-related constraints

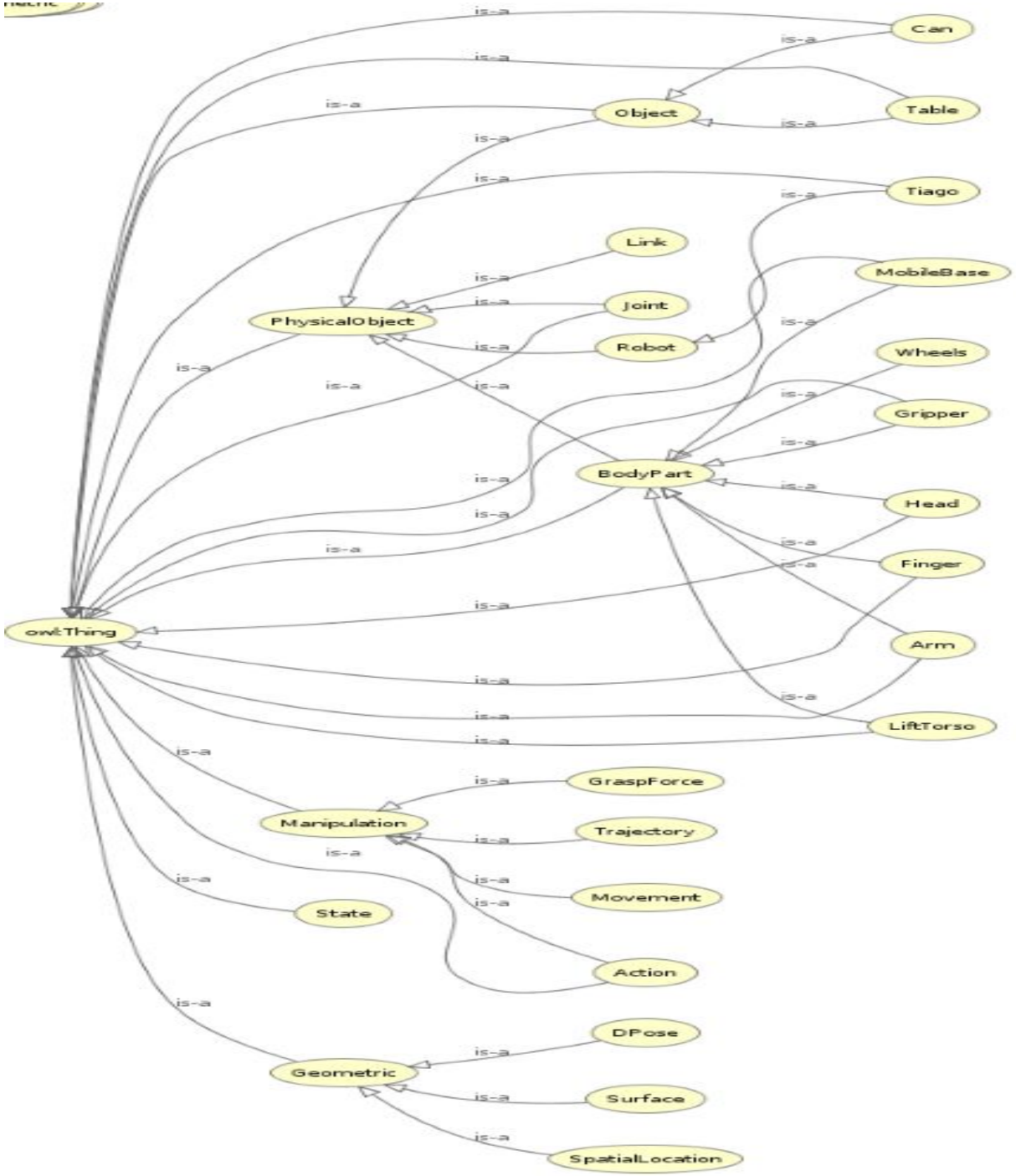
TAL TECH

1 http://ontologydesignpatterns.org/wiki/Ontology:DOLCE+DnS_Ultralite

2 https://ease-crc.github.io/soma/

ONTOLOGY

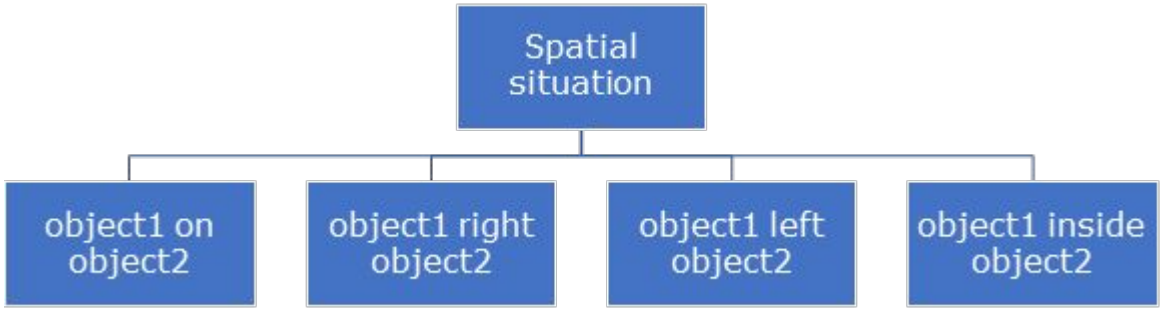
- Inspired by SOMA, simplified, in OWL
- Representation for:
  - the robot
  - its surrounding
  - manipulation tasks (simplified)



TAL TECH

SPATIAL REASONING

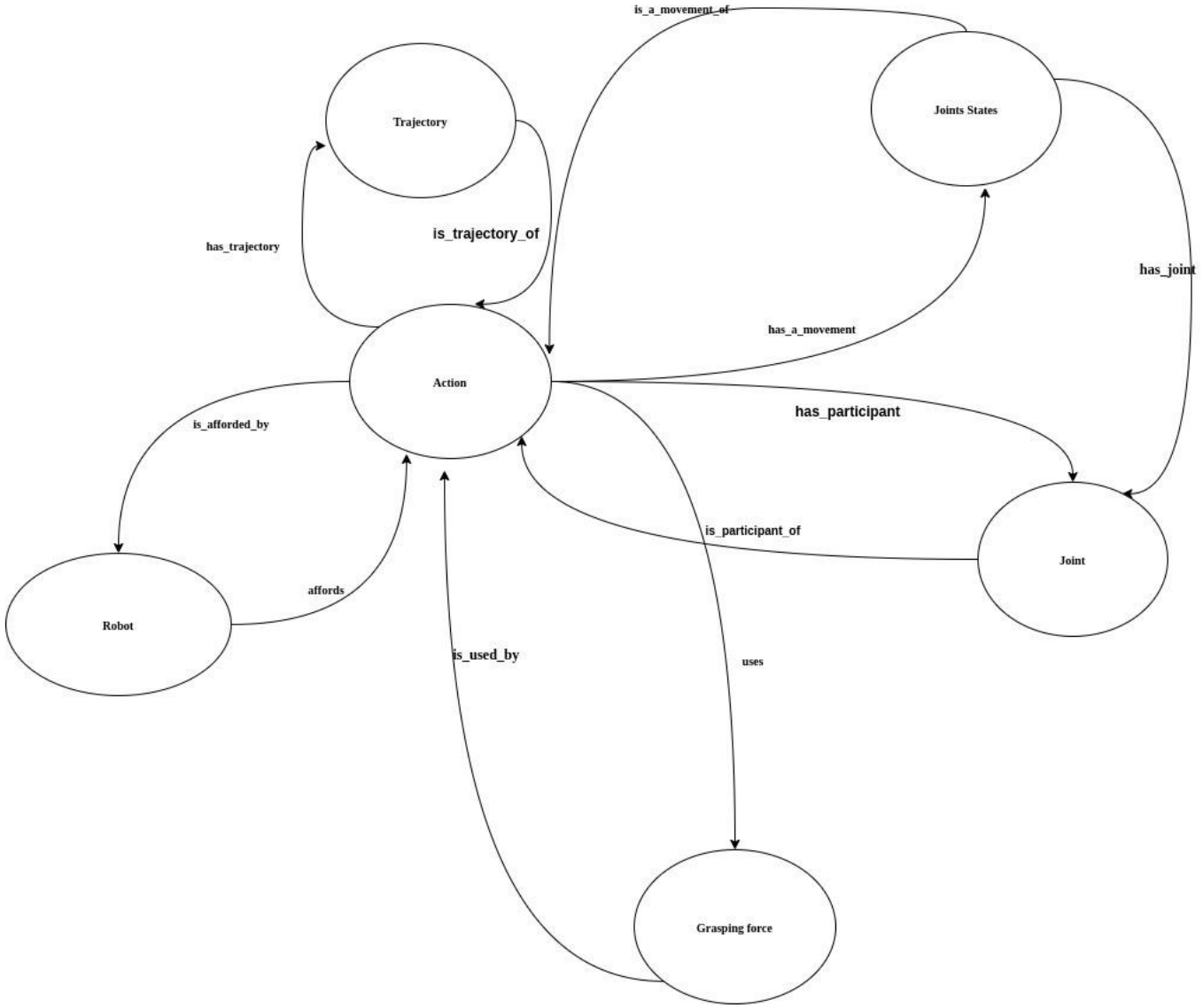
- **?right(ObjA,ObjB)**
  - diff on x axis less than threshold
  - right obj has higher coord on Y
- **?left(ObjA,ObjB)**
  - diff on x axis less than threshold
  - left obj has lower coord on Y
- **?on(ObjA,ObjB)**
  - Obj A can fit in Obj B
  - Comparison of dims and coords
- **?in(ObjA,ObjB)**
  - diff on Z axis less than threshold
  - Object on top has higher Z coord



TAL TECH

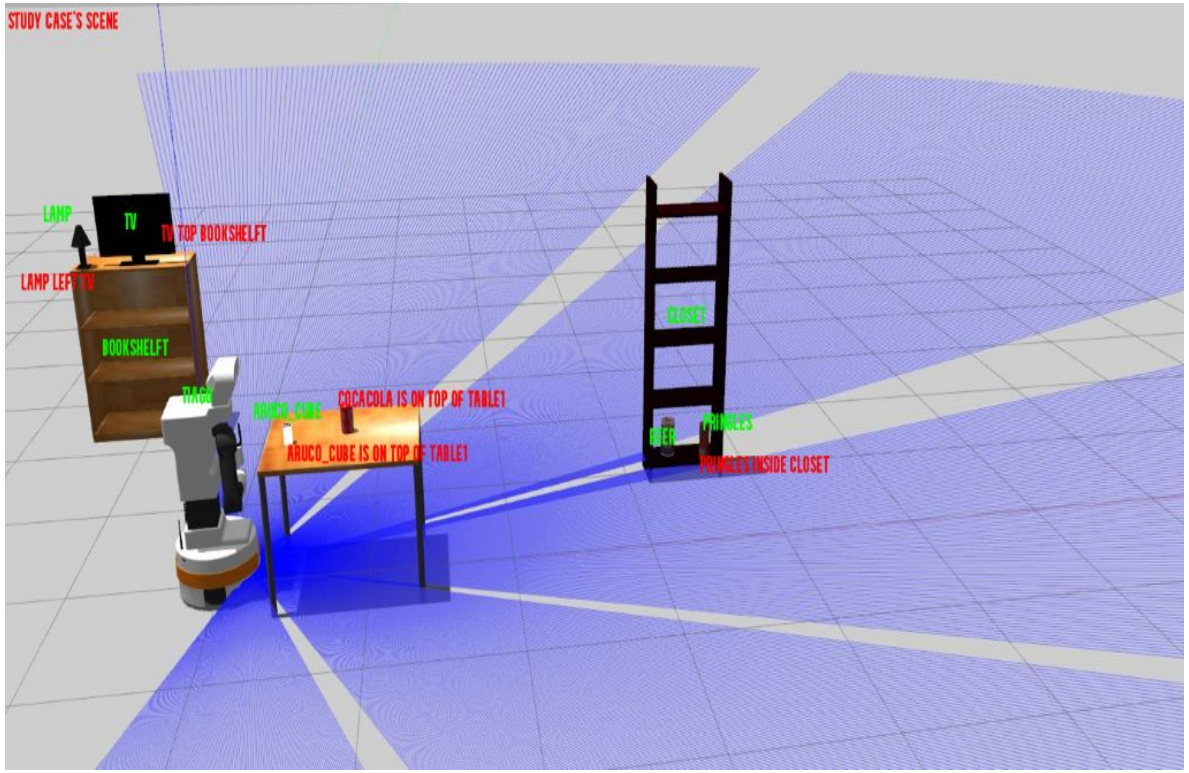
TASK MODELING

- Relations between :
  - tasks and agents
  - tasks and agents' lower components
- Semantic information on tasks specific details
- Manipulation constraints:
  - Affordance
  - Availability of a region



EXAMPLE- Pg 1

- ROS nodes to listen to models's pose, joint states
- A pick up and place task is used
- Knowledge base populated and saved
- Knowledge base can be visualised in Protege, queries can be runned with DL, SparkQL, or Python3 (Python is used in this case)



EXAMPLE- Pg 2

- Examples of questions that can be answered ?
  - which object(s) are/is where ?
  - what is the location of an object ?
  - what are the performed tasks ?
  - who are the participants of a task? (robots, joints)
  - how much effort needed to grasp a goal object ?
  - on which object to place the goal object?

TAL TECH

WHAT IS NEXT ?

- Some improvements :
  - Automatic parsing of description files to OWL ontology
  - Integration of perception modules
- Deeper representation to allow extraction of more semantics from tasks
- Learning methods to allow predictions of unknown behaviours using large data in knowledge base

TAL TECH

THANK YOU