FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

computer languages

Reasoning Capabilities for a Cognitive-assistive Assembly System

Masterstudium:

Computational Intelligence

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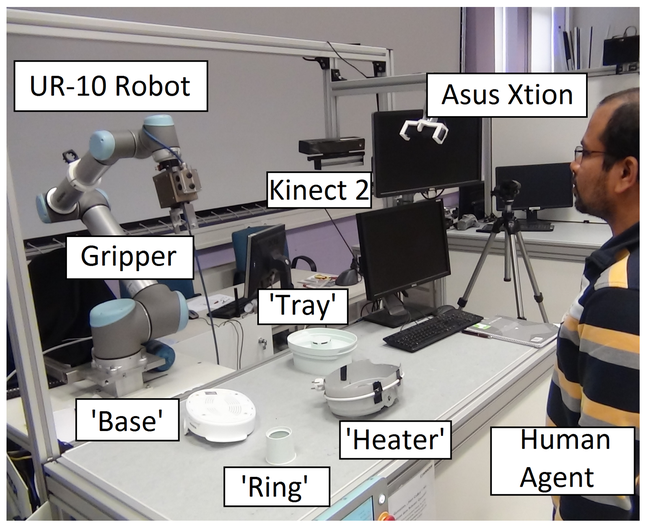
Motivation & Problem statement

- Human-Robot-Cooperation is considered as a key technology to improve efficiency of production systems
- The ability of the robot to recognize and learn the current state of an assembly task improves the quality of the Human-Robot-Cooperation



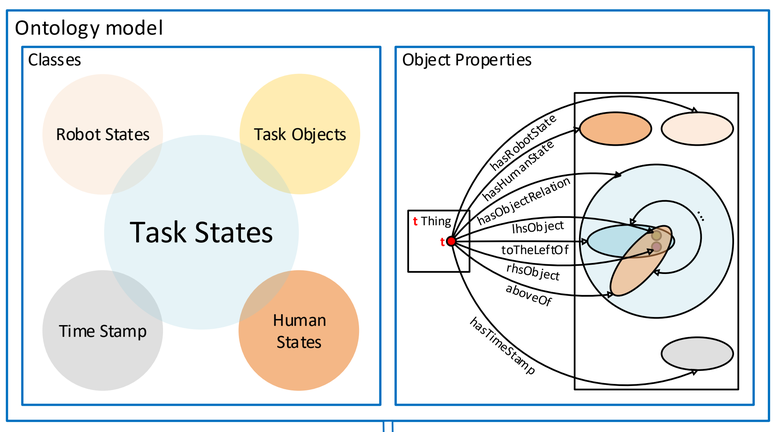
Goal: Design, implement, and evaluate a reasoning system which hypothesizes the current state of the assembly task with the help of the most suitable Machine Learning classifier

Contribution

- Design, implementation, and evaluation of a reasoning system which is used in a proximate cooperation, that is able to predict the current state of the assembly task
- The reasoning system consists of:
  1. A RosJava package that provides the use of Machine Learning classifiers
  2. A KnowRob module on which:
     - an ontology is constructed to model the assembly task
     - a mechanism for accessing and processing the constructed ontology model is provided
     - the service offered by the Machine Learning module is called in order to predict the unknown class (task state) of the fetched data from the perception system
- The ontology model is crucial in our contribution, it represents human states, robot states, object relations and task states of the assembly task
- The reasoning system is initially used for an assembly task at Profactor GmbH
- Our contribution can be applied in a more general Human-Robot-Cooperation problem
- A performance evaluation between four Machine Learning classifiers is conducted

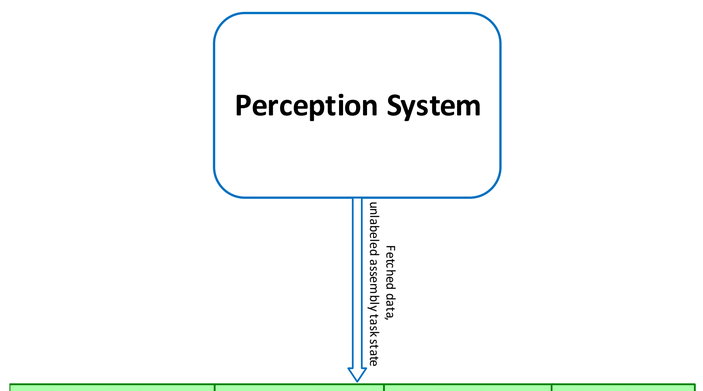
Workflow of the reasoning system

Step 1 - Construct the ontology assembly model and preprocess it



ObjRelations	HumanState	RobotState	TaskState
toTheLeftOf ...	Idle	Idle	InitialState
toTheRightOf ...	Picking	HandingOver	SecondState
aboveOf ...	Holding	PlaceObj	ThirdState
...	...	...	...

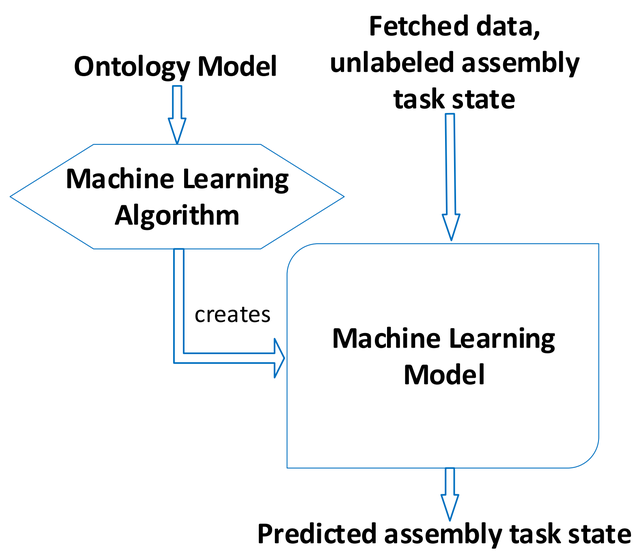
Step 2 - Fetch the real-time data from the perception system



ObjRelations	HumanState	RobotState	TaskState
toTheLeftOf ...	Idle	Idle	?

The perception System outputs the data that represents the relation between objects, the human states, and the robot states. This fetched data is preprocessed in order to have the same format as the preprocessed data in the ontology assembly model.

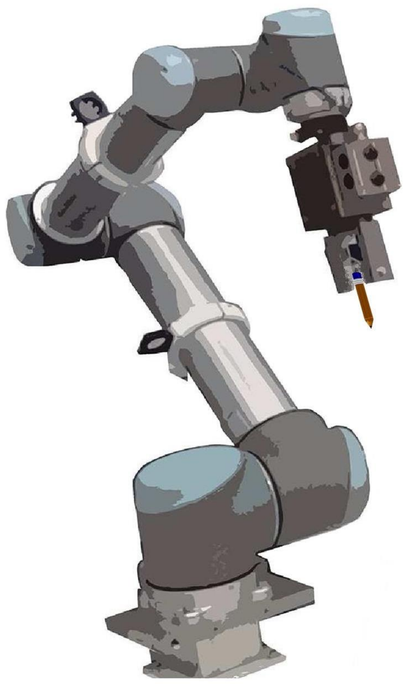
Step 3 - Predict the unlabelled assembly task state by considering the preprocessed ontology model, fetched data, and Machine Learning model



The preprocessed ontology model is given to a Machine Learning algorithm in order to derive a Machine Learning model which will be used for predicting the unlabelled assembly task state.

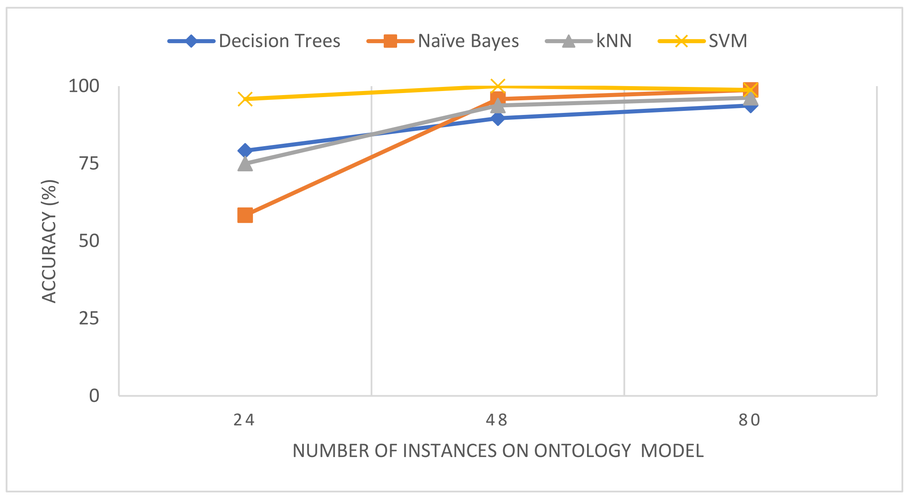
Conclusions & Results

1.



I am able to reliably hypothesize the current state of the assembly task

2. The performance evaluation of classifiers in terms of accuracy



Three ontology assembly models are considered which consists of 24 instances, 48 instances and 80 instances.

References:

- Moritz Tenorth, Michael Beetz. "KnowRob – Knowledge Processing for Autonomous Personal Robots", In IEEE/RSJ International Conference on Intelligent Robots and Systems, 2009.
- Moritz Tenorth, Michael Beetz. "A Unified Representation for Reasoning about Robot Actions, Processes, and their Effects on Objects", In 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2012.

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