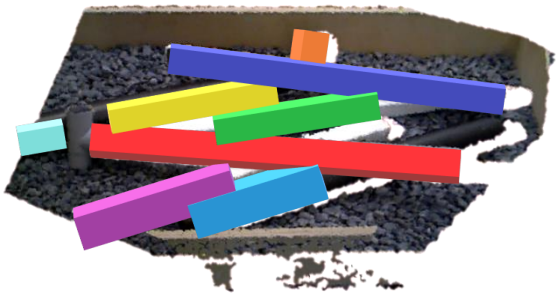
Probabilistic Extraction and Tracking of Primitive Shapes for Spatio-Temporal Segmentation of Unknown Objects

Utilizing the remarkable progress of *Computer Vision* (CV) in robotics remains a difficult problem. Modern CV approaches use massive amounts of labeled data to train neural networks with high precision. *Robotic Vision* (RV) must deal with unknown, dynamic scenes under varying light conditions, which makes the collection of datasets for every possible scenario intractable. On the other hand, RV can exploit the embodiment of the agent to collect data that is unavailable to CV (i.e. interact with the scene, change viewpoint, correlate subsequent images from the camera stream)



For the segmentation of unknown objects, it can be advantageous to divide the object into several known, primitive objects. Here several pipes in a cluttered scene have been decomposed into primitive boxes.

In this work, you will use the temporal dependency of point clouds from different time instances to improve the segmentation of unknown objects in cluttered scenes. Here, the extracted primitive object shapes from previous instances can be used as prior knowledge for the current scene. The extracted knowledge will then be joined with a spatio-temporally consistent representation of the scene via probabilistic methods. This allows subsequent processing steps to be aware of the uncertainty of the information and can be used to detect and prevent failures in the execution.

Relevant research questions include:

- How can prior information be included in the extraction of primitive objects from point clouds?
- What probabilistic approaches work best for the fusion of the semantic information from different time instances?
- Can deep learning-based approaches be used for the extraction of primitives?

In this project, you will work with the humanoid robot ARMAR-6 as well as several robotics and machine learning tools:

- ArmarX (C++, Python): armarx.humanoids.kit.edu
- Tensorflow 2(Python): tensorflow.org
- Open3d (C++, Python): scikit-learn.org

Contact: Christoph Pohl (christoph.pohl@kit.edu)