Universität Bremen

Institute for Artificial Intelligence

Faculty 03

Mathematics &

Computer Science

Workshop

Teaching & Training Students Cognitive Robots in the Cloud

Arthur Niedźwiecki, Yanxiang Zhan

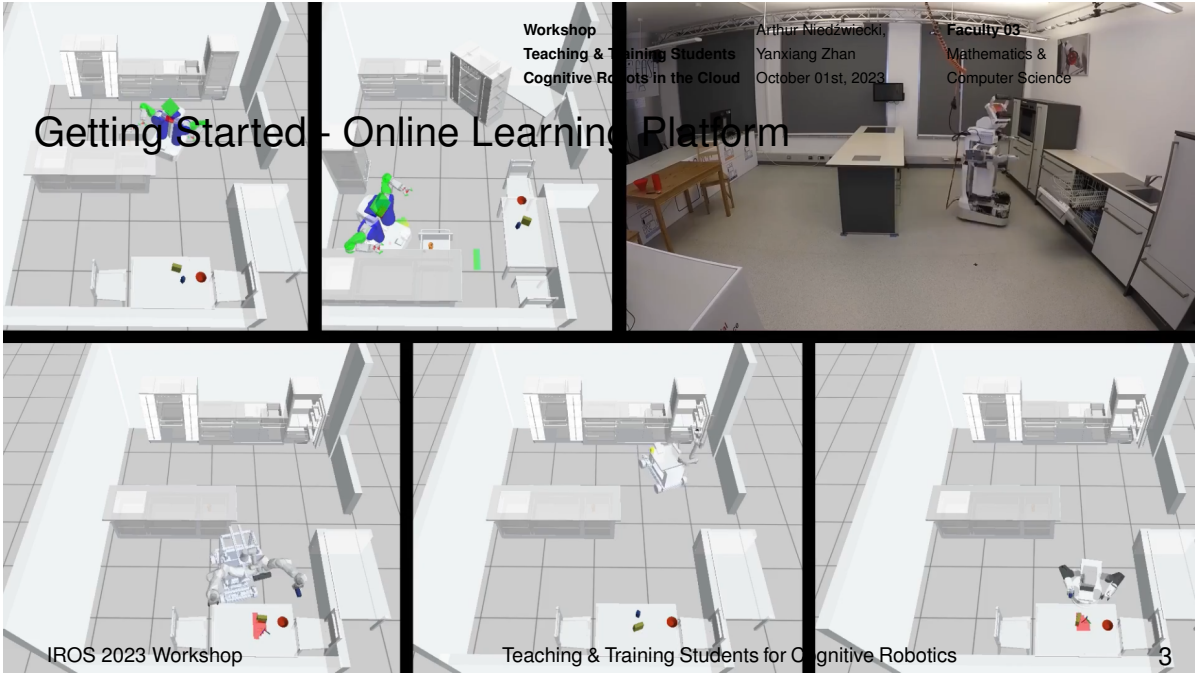
October 01st, 2023

OCTOBER 1 - 5, 2023

IEEE/RSJ International Conference on Intelligent Robots and Systems

Overview

Getting Started - Online Learning Platform

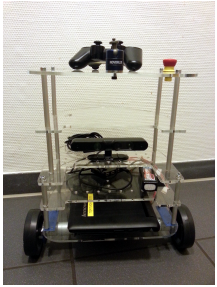


Getting Started

How do I introduce somebody to robotics software?

Getting Started - Lecture on Robot Programming

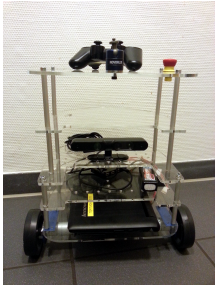
Participation



Getting Started - Lecture on Robot Programming

Participation

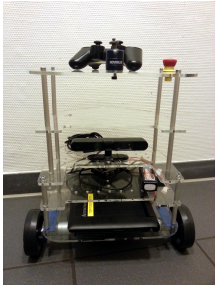
- First lecture attended by 90% of signed-up students



Getting Started - Lecture on Robot Programming

Participation

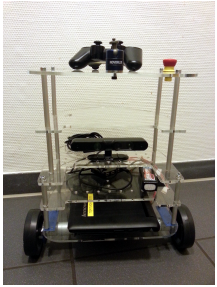
- First lecture attended by 90% of signed-up students
- Assignments submitted by 50% of first lecture attendees



Getting Started - Lecture on Robot Programming

Participation

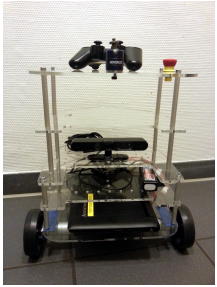
- First lecture attended by 90% of signed-up students
- Assignments submitted by 50% of first lecture attendees
- Exams taken by 90% of submitters



Getting Started - Lecture on Robot Programming

Participation

- First lecture attended by 90% of signed-up students
- **Assignments submitted by 50% of first lecture attendees??**
- Exams taken by 90% of submitters



Getting Started - Lecture on Robot Programming

First assignment:

Getting Started - Lecture on Robot Programming

First assignment:

- Install Linux

Getting Started - Lecture on Robot Programming

First assignment:

- Install Linux
- Set up SSH and GitHub

Getting Started - Lecture on Robot Programming

First assignment:

- Install Linux
- Set up SSH and GitHub
- Install Robot Operating System (ROS)

Getting Started - Lecture on Robot Programming

First assignment:

- Install Linux
- Set up SSH and GitHub
- Install Robot Operating System (ROS)
- Install a few packages

Getting Started - Lecture on Robot Programming

First assignment:

- Install Linux
- Set up SSH and GitHub
- Install Robot Operating System (ROS)
- Install a few packages
- Modify a Lisp file with Emacs

Getting Started - Setup is frustrating

- Requires specific operating system

Getting Started - Setup is frustrating

- Requires specific operating system
- Collides with existing software

Getting Started - Setup is frustrating

- Requires specific operating system
- Collides with existing software
- Complex and fragile setup takes time

Getting Started - Setup is frustrating

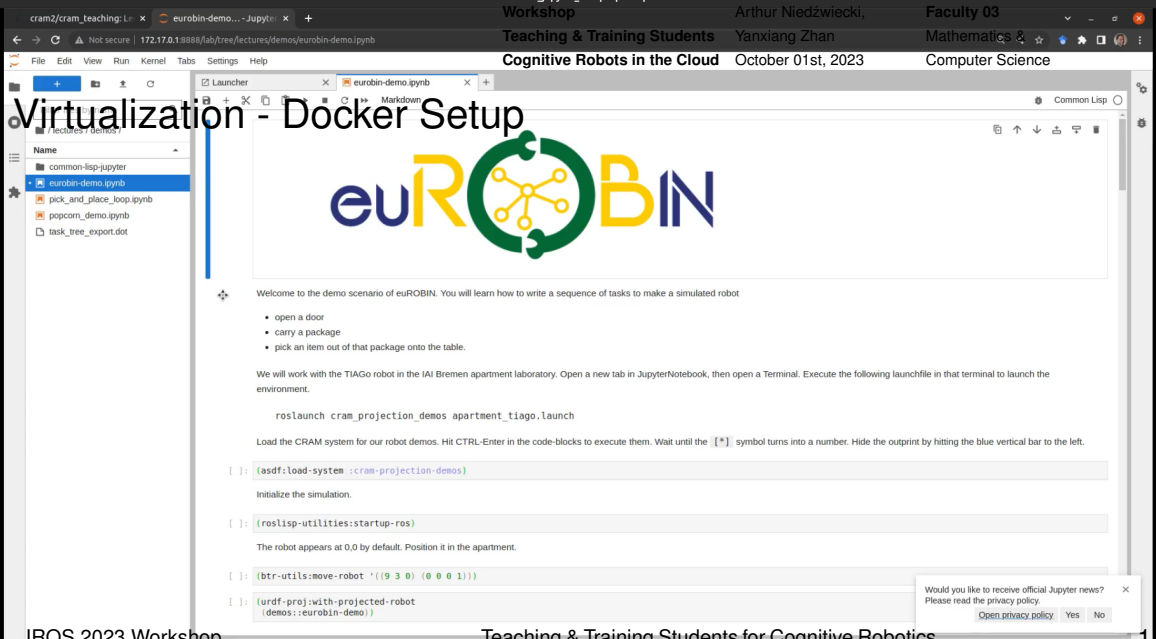
- Requires specific operating system
- Collides with existing software
- Complex and fragile setup takes time
- Documentation has low priority

Virtualization

Virtualization

How can I make my platform easier accessible?

Virtualization - Docker Setup



Virtualization - Docker

- Virtual Machine

Virtualization - Docker

- Virtual Machine
- Prepare everything needed

Virtualization - Docker

- Virtual Machine
- Prepare everything needed
- Preconfigure program execution

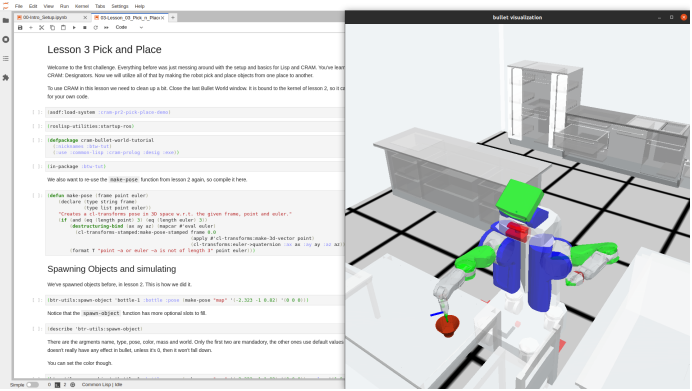
Virtualization - Docker

- Virtual Machine
- Prepare everything needed
- Preconfigure program execution
- ‘Simply’ download and execute

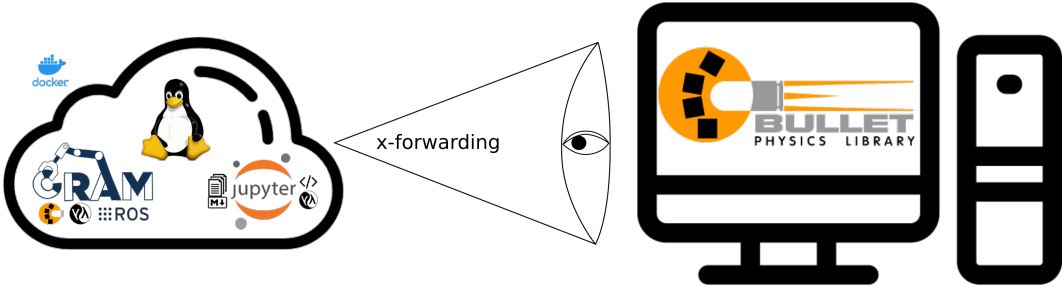
Virtualization - Docker

Install everything in a build-script

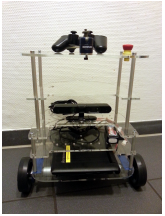
Virtualization - Docker



Virtualization - Docker



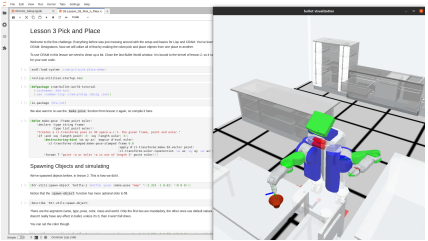
Virtualization - Docker



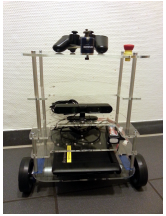
Benefits:

- Integrated with local ROS network

Limitations:



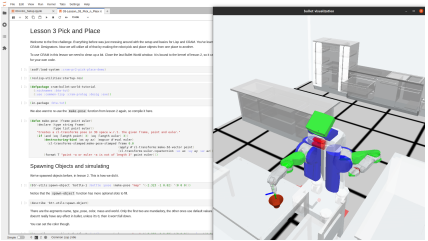
Virtualization - Docker



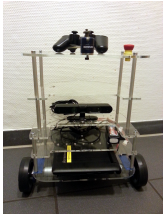
Benefits:

- Integrated with local ROS network
- Control real-world robot from Jupyter

Limitations:



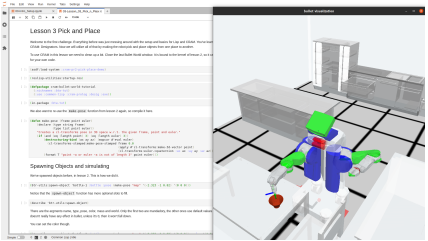
Virtualization - Docker



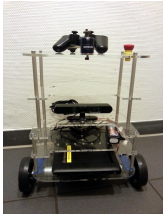
Benefits:

- Integrated with local ROS network
- Control real-world robot from Jupyter
- Documentation, code and simulation

Limitations:



Virtualization - Docker

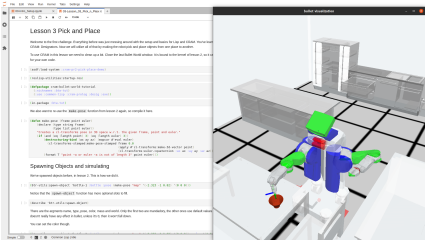


Benefits:

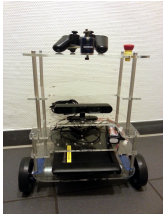
- Integrated with local ROS network
- Control real-world robot from Jupyter
- Documentation, code and simulation

Limitations:

- Docker is not entirely platform independent



Virtualization - Docker

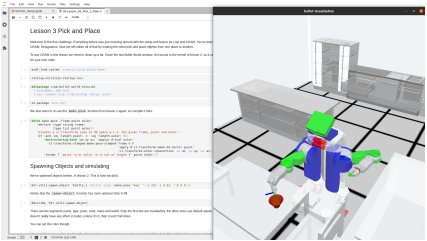


Benefits:

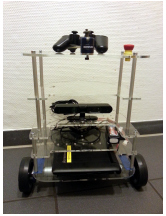
- Integrated with local ROS network
- Control real-world robot from Jupyter
- Documentation, code and simulation

Limitations:

- Docker is not entirely platform independent
- Exhausts client machine resources



Virtualization - Docker

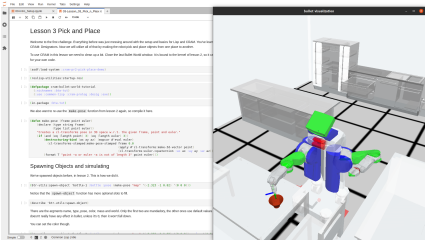


Benefits:

- Integrated with local ROS network
- Control real-world robot from Jupyter
- Documentation, code and simulation

Limitations:

- Docker is not entirely platform independent
- Exhausts client machine resources
- Still too much setup overhead



Into the cloud

Into the cloud

How can I give a lecture including complex software the most platform-independent?

eurobin_jupyter_setup.mp4 - mpv

cram2/cram_teaching: Le × eurobin-demo... - Jupyter ×

Not secure | 172.17.0.1:8888/lab/tree/lectures/demos/eurobin-demo.ipynb

File Edit View Run Kernel Tabs Settings Help

Filter files by name

/ lectures / demos /

Name

- common-lisp-jupyter
- eurobin-demo.ipynb
- pick_and_place_loop.ipynb
- popcorn_demo.ipynb
- task_tree_export.dot

Launcher | eurobin-demo.ipynb

Markdown | Common Lisp

euROBIN

Welcome to the demo scenario of euROBIN. You will learn how to write a sequence of tasks to make a simulated robot

- open a door
- carry a package
- pick an item out of that package onto the table.

We will work with the TIAGo robot in the IAI Bremen apartment laboratory. Open a new tab in JupyterNotebook, then open a Terminal. Execute the following launchfile in that terminal to launch the environment.

```
roslaunch cram_projection_demos apartment_tiago.launch
```

Load the CRAM system for our robot demos. Hit CTRL-Enter in the code-blocks to execute them. Wait until the `[*]` symbol turns into a number. Hide the outprint by hitting the blue vertical bar to the left.

[ ]:
```
(asdf:load-system :cram-projection-demos)
```

Initialize the simulation.

[ ]:
```
(roslisp-utilities:startup-ros)
```

The robot appears at 0,0 by default. Position it in the apartment.

[ ]:
```
(btr-utils:move-robot '((9 3 0) (0 0 0 1)))
```

[ ]:
```
(urdf-proj:with-projected-robot
 (demos::eurobin-demo))
```

Would you like to receive official Jupyter news? Please read the privacy policy.

Open privacy policy | Yes | No

Simple | Common Lisp | Idle | Mode: Command | Ln 1, Col 1 | eurobin-demo.ipynb | 1

Into the cloud - Server-side Architecture

Applications

MuJoCo GISKARD GRAM

KnowRob RoboKudo

Into the cloud - Server-side Architecture

Packaging

binderhub

docker

jupyterhub

MuJoCo

GISKARD

GRAM

KnowRob

RoboKudo

Into the cloud - Server-side Architecture

Orchestrator

kubernetes

---

binderhub

docker

jupyterhub

MuJoCo

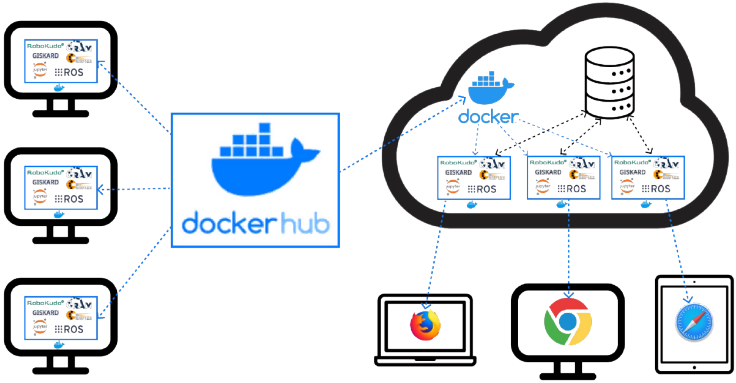
GISKARD

GRAM

KnowRob

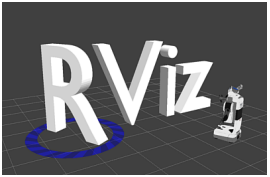
RoboKudo

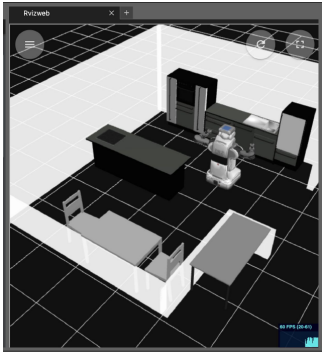
Into the cloud - System Overview



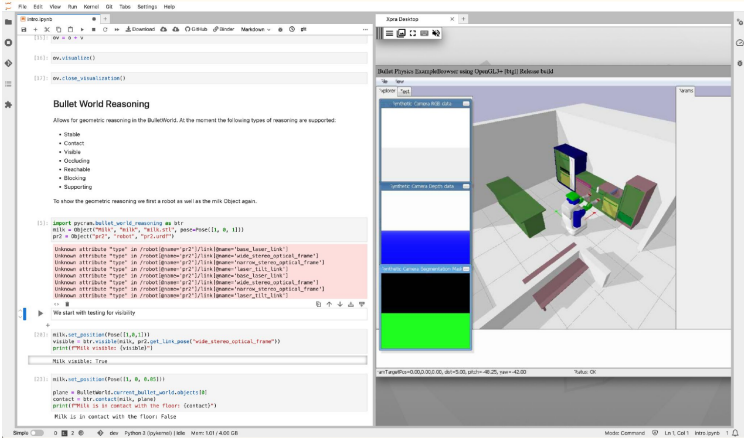
Into the cloud - Robot Web Tools

- Rosbridge, roslibjs, ros3djs, rosbagjs
- Rvizweb, Rosboard, Webviz





Into the cloud - XPRA remote desktop



Into the clouds - Summary

Benefits:

- Easy platform-independant access

Limitations:

Into the clouds - Summary

Benefits:

- Easy platform-independant access
- Vastly extendable

Limitations:

Into the clouds - Summary

Benefits:

- Easy platform-independant access
- Vastly extendable
- Easily shared

Limitations:

Into the clouds - Summary

Benefits:

- Easy platform-independant access
- Vastly extendable
- Easily shared

Limitations:

- No UI applications

Into the clouds - Summary

Benefits:

- Easy platform-independant access
- Vastly extendable
- Easily shared

Limitations:

- No UI applications
- High network load

Into the clouds - Summary

Benefits:

- Easy platform-independant access
- Vastly extendable
- Easily shared

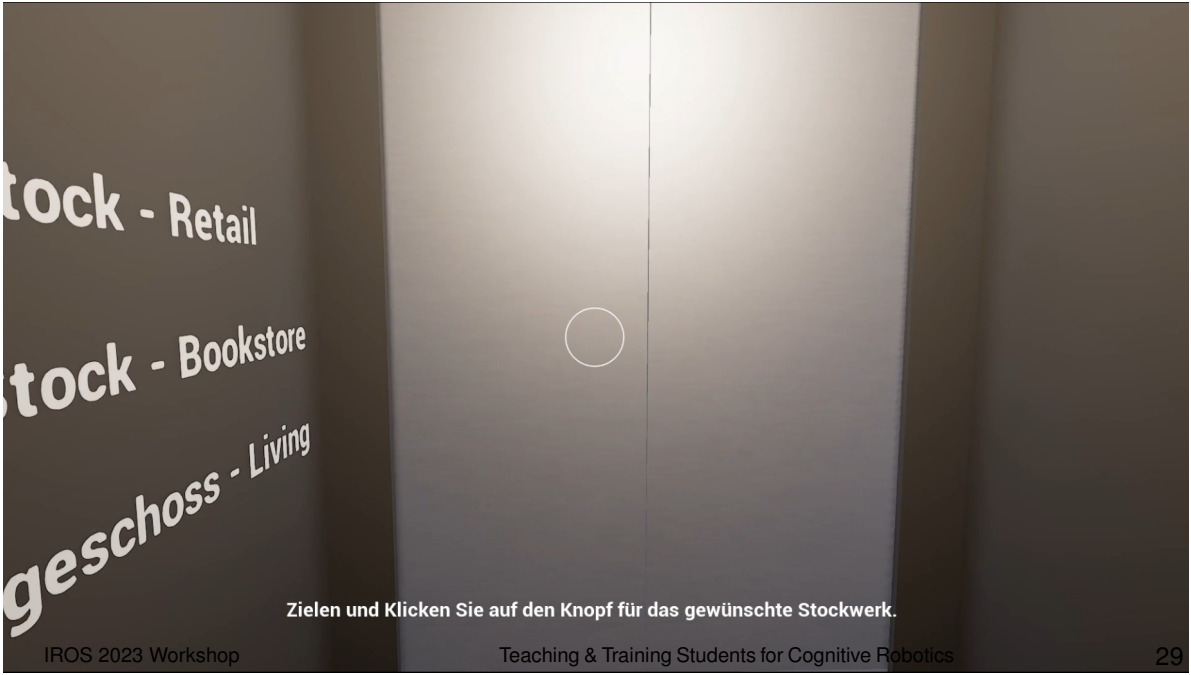
Limitations:

- No UI applications
- High network load
- Network security

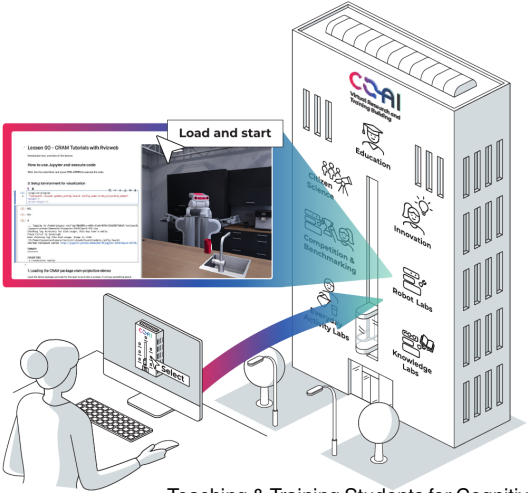
Furthermore

Furthermore

Besides teaching, what else can be achieved with robots in the cloud?


tock - Retail
tock - Bookstore
geschoss - Living
Zielen und Klicken Sie auf den Knopf für das gewünschte Stockwerk.

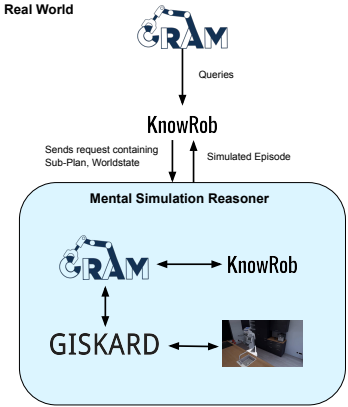
Furthermore - Virtual Research Building



Furthermore - Mental Simulation

Simulate snapshot worlds to determine feasibility for complex manipulation tasks.

- CRAM - Plan Executive
- Giskard - Motion Planner
- Multiverse - Physics Reasoning
- Knowrob - KR & Reasoning



Furthermore - Online Lectures

- Robot Programming with ROS (Lecture)
- EASE FallSchool (Seminar)
- IROS 2023 Conference Tutorials

Furthermore - IROS 2023 Tutorial

Thursday

Tutorial: Everyday Activity Robot Manipulation in an Interactive Learning Environment

Time	Session
8.30 - 8.45	OPENING: Michael Beetz & Jörn Syrbe
8.45 - 10.00	Introduction - Michael Beetz
10.00 - 11.00	COFFEE BREAK
11.00 - 12.30	Hands-on Robot Control in CRAM – Arthur Niedźwiecki
12.30 - 1.30	LUNCH
1.30 - 3.00	Hands-On Robotics Simulation in Multiverse – Giang Nguyen
3.00 - 4.00	COFFEE BREAK
4.00 - 5.30	Hands-On Knowledge openEASE – Sascha Jongebloed
5.30	END

Thank you for your attention!
Enjoy the IROS 2023!

OCTOBER 1 - 5, 2023

IEEE/RSJ International Conference on
Intelligent Robots and Systems