UNIVERSITÄT BONN

Humanoid Robots Lab
Introductory Meeting

Prof. Dr. Maren Bennewitz
Xuying Huang, Rohit Menon
15th April 2026

Course No.:
BA-INF 051 Projektgruppe
MA-INF 4213, MA-MORO-E09 Seminar
MA-INF 4214, MA-MORO-E06 Lab

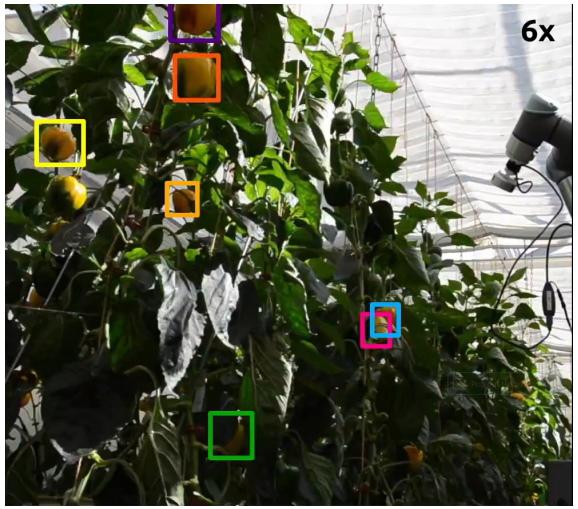
Humanoid Robots Lab

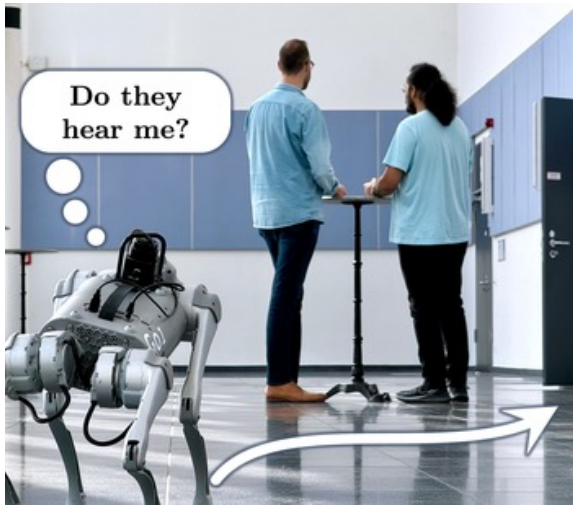
Group leader
Prof. Dr. Maren Bennewitz

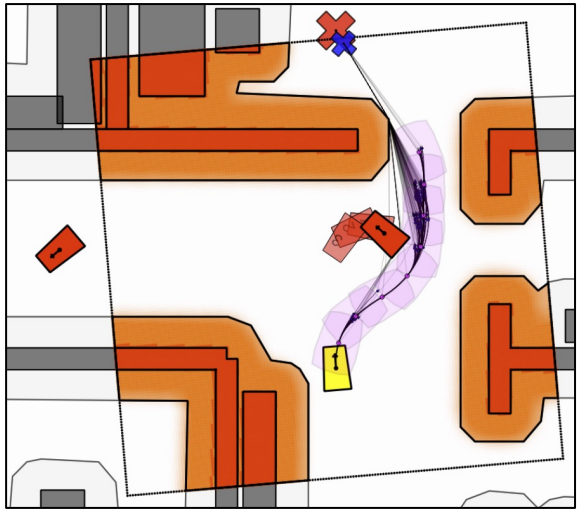
Our research topics:

- Robotics & autonomous systems
- Active perception
- Intelligent manipulation
- Human-robot interaction
- Machine learning

HRL Research Projects







Courses

	Bachelor PG			Master	Master
	Lab	+	Seminar	Lab	Seminar
ECTS points	6	+	3	9	4
Workload	180 h	+	90 h	270 h	120 h

- **Seminar:** Presentation and discussion of relevant scientific work
- **Lab:** Programming robots in simulation and on real hardware
- **Project Group:** Lab (70%) + Seminar (30%)

Course Deliverables

	Bachelor PG			Master	Master
	Lab	+	Seminar	Lab	Seminar
Presentation	X		X	X	X
Lab report	X			X	
Short Research Proposal					X

Seminar

Objective of the Seminar Course

- Transition from coursework understanding → research reasoning
- Evaluate claims vs. evidence, including assumptions and limitations
- Identify failure modes, weak baselines, and gaps in SOTA
- Build foundation for **original research/thesis** work
- Train **scientific thinking**: precision, skepticism, reproducibility

Seminar Overview

- **Presentation and discussion** of relevant scientific work (conference/journal papers)
- Aspects to cover:
  - Contribution of the work?
  - Technique/Methodology used?
  - Strengths & Weaknesses of the approach?
- Presentation: 20 minutes + 5 minutes Q&A
- **Short Research Proposal** (M.Sc. only): A 2-page proposal building on your assigned paper, including a small literature review, a clear gap statement, and a plausible research idea with a high-level evaluation plan (LaTeX template provided on web page).

Seminar Timeline

- **Prepare** during the semester
  - Understand: problem, assumptions, method, experiments, claims
  - Verify: map claims to figures / tables / setups
  - Identify gaps: missing, unexplored, weakly justified aspects
  - Write and submit research proposal (M.Sc. only)
  - Prepare and rehearse a **clear, time-bounded presentation**
- **Seminar Day**
  - **Full day** event: **Mandatory attendance**
  - Present, discuss, and **defend your analysis in Q&A**
  - **Participate in Q&A** of other students

Seminar Grade

- B.Sc. Students:
  - Presentation: 100%

- M.Sc. Students:
  - Presentation: 75%
  - Research proposal: 25%

Seminar Papers
(Only BA-INF 051 Projektgruppe)

B.Sc. Students:
Paper will be assigned to you by your supervisor

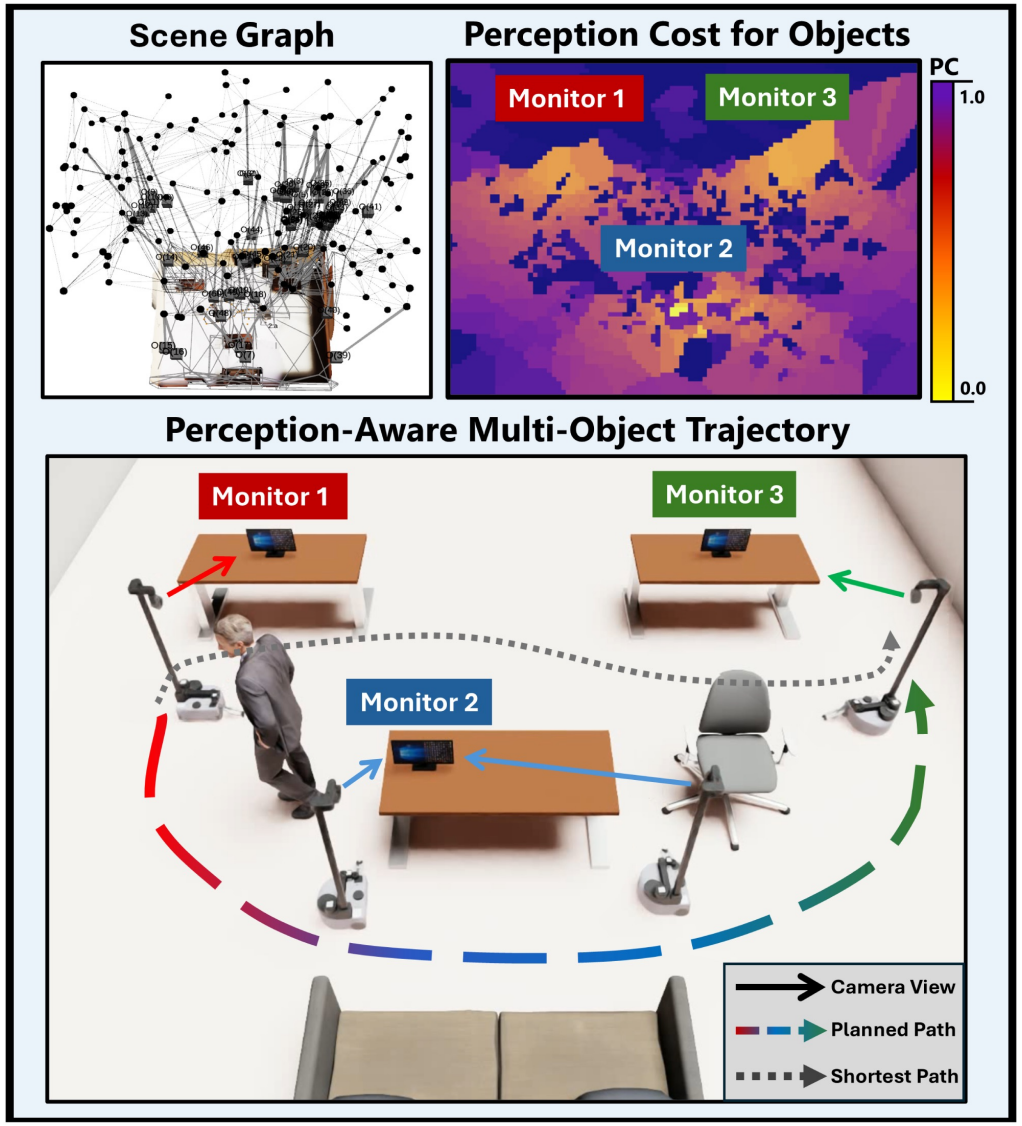
Seminar Papers
(Only MA-INF 4213 and MA-MORO-E09 Seminar)

M.Sc. Students:
You can choose from the following selection

Sampling-Based Motion Planning With Scene Graphs Under Perception Constraints

Meng *et al.*
RAL 2026
Supervisor: Rohit Menon

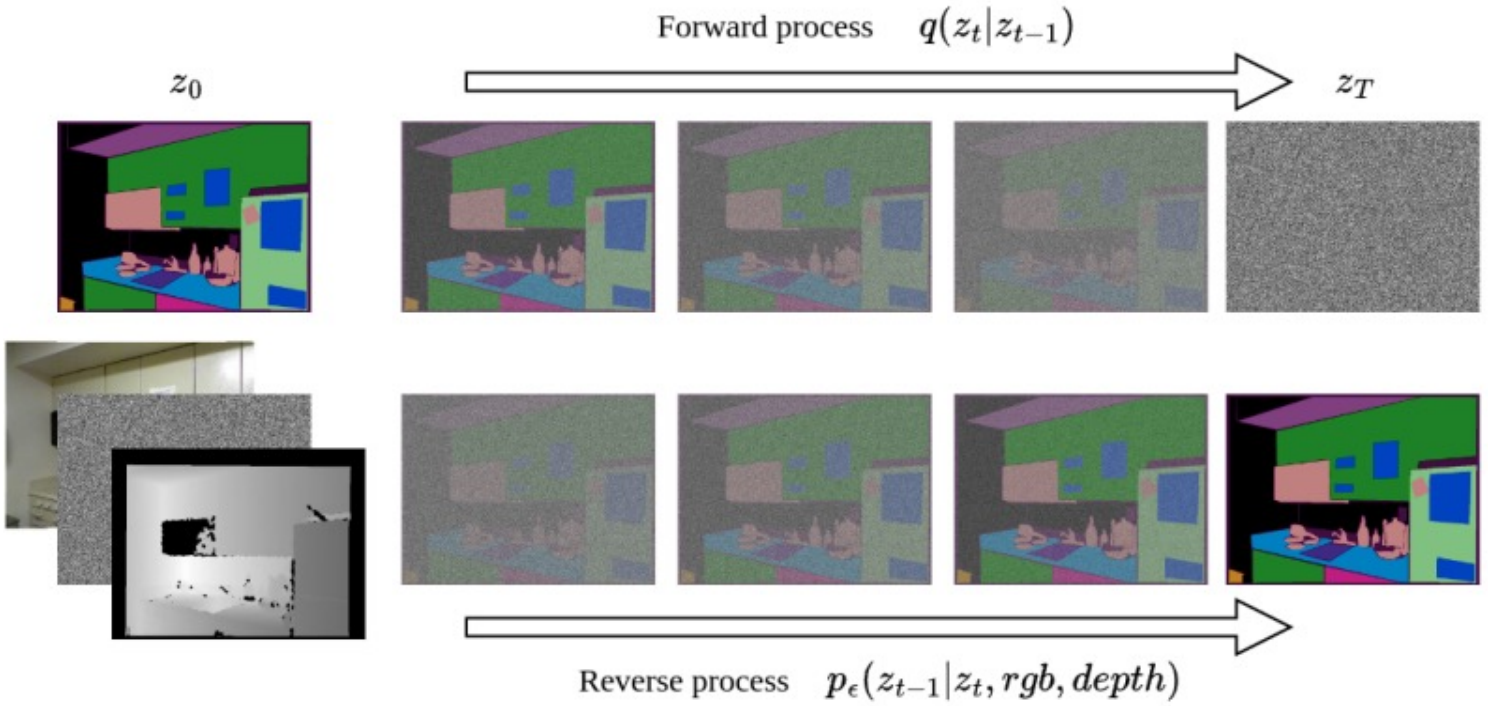
- **Goal:** Plan robot trajectories ensuring simultaneous visibility of multiple objects under kinematic and environmental constraints
- **Problem:** Existing planners handle single-object or low-DoF perception, failing to scale to multi-object monitoring in high-DoF robots
- **Approach:**
  - Embed perception cost in scene graph
  - Perception-aware sampling for PRM construction
  - A* search balancing motion and perception costs



Diffusion-based RGB-D Semantic Segmentation with Deformable Attention Transformer

Minh et al.
ICRA 2025
Supervisor: Xuying Huang

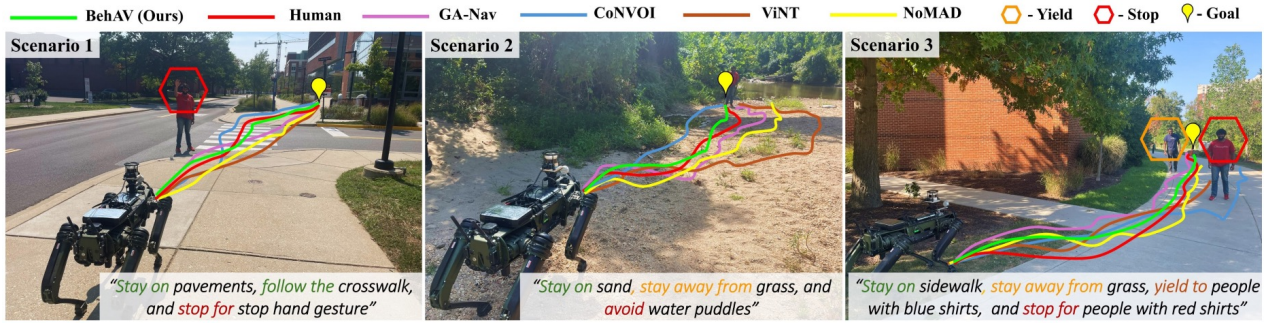
- **Goal:** Robust RGB-D semantic segmentation under noisy raw depth.
- **Problem:** Real-world depths often contain unavoidable noise and invalid pixels, which challenges standard discriminative methods.
- **Approach:** Conditional diffusion with a Deformable Attention Transformer for RGB-D fusion and mask denoising.

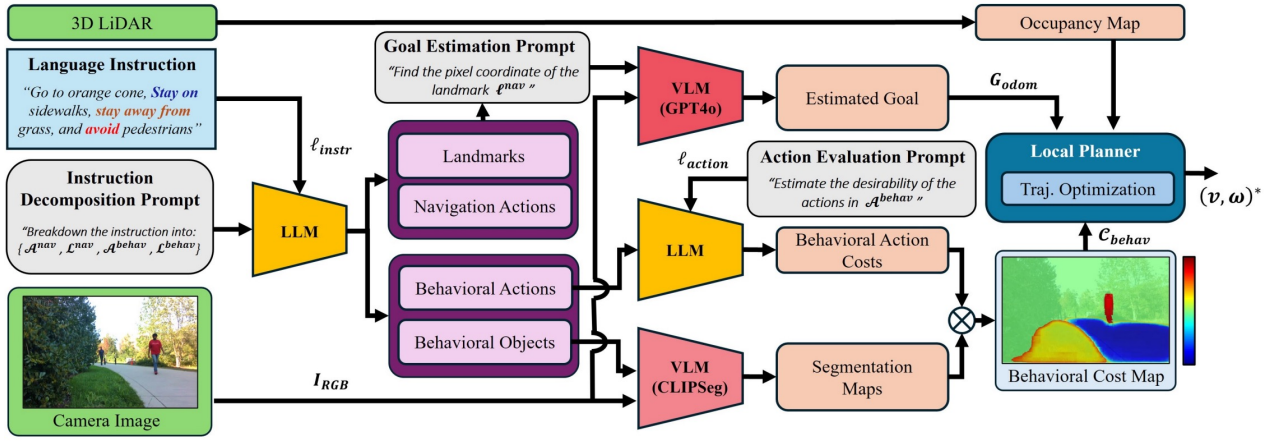


BehAV: Behavioral Rule Guided Autonomy Using VLMs for Robot Navigation in Outdoor Scenes

Weerakoon et al.
ICRA 2025
Supervisor: Subham Agrawal

- **Goal:** Enable robots to handle scene-specific behaviours for navigation in outdoor settings while being directed by human instructions.
- **Problem:** Existing methods struggle to generalize to unseen behavioral objectives, and existing VLM-based planners suffer from low inference rates.
- **Approach:** BehAV, a framework that decomposes language instructions to build a real-time behavioral cost map, which an unconstrained Model Predictive Control (MPC) uses to safely navigate toward visual landmarks.

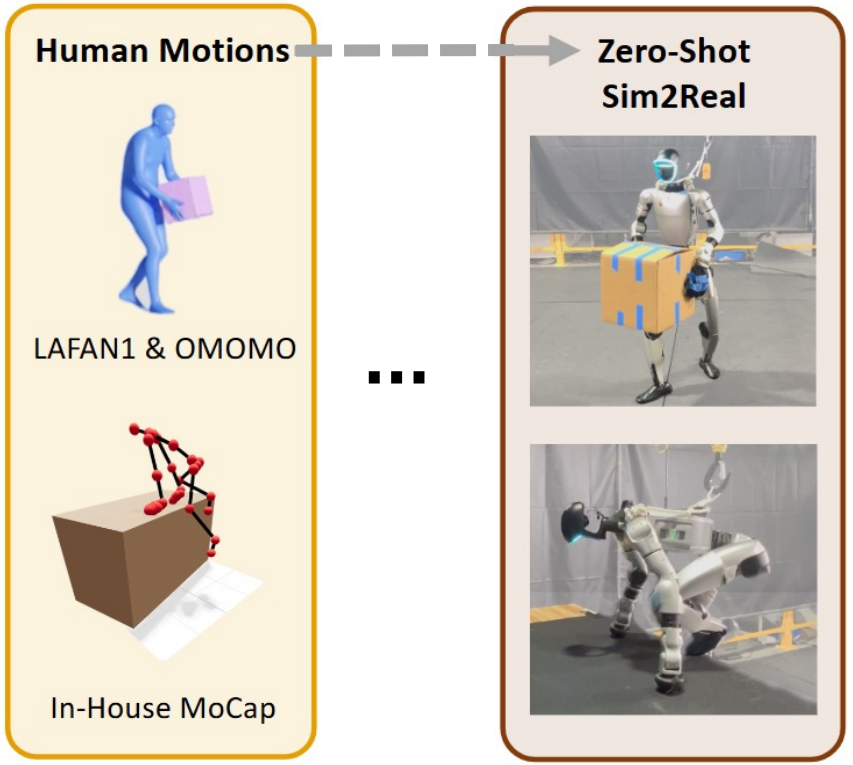




OmniRetarget: Interaction-Preserving Data Generation for Humanoid Whole-Body Loco-Manipulation

Yang et al.
ICRA 2026
Supervisor: Shahram Khorshidi

- **Goal:** Teaching humanoid robots complex skills by retargeting human motions.
- **Problem:** Existing retargeting pipelines produce physically implausible artifacts due to the **embodiment gap** between humans and robots
- **Approach:** Preserving the crucial spatial and contact relationships between an agent, the terrain, and manipulated objects



Identifying Terrain Physical Parameters from Vision

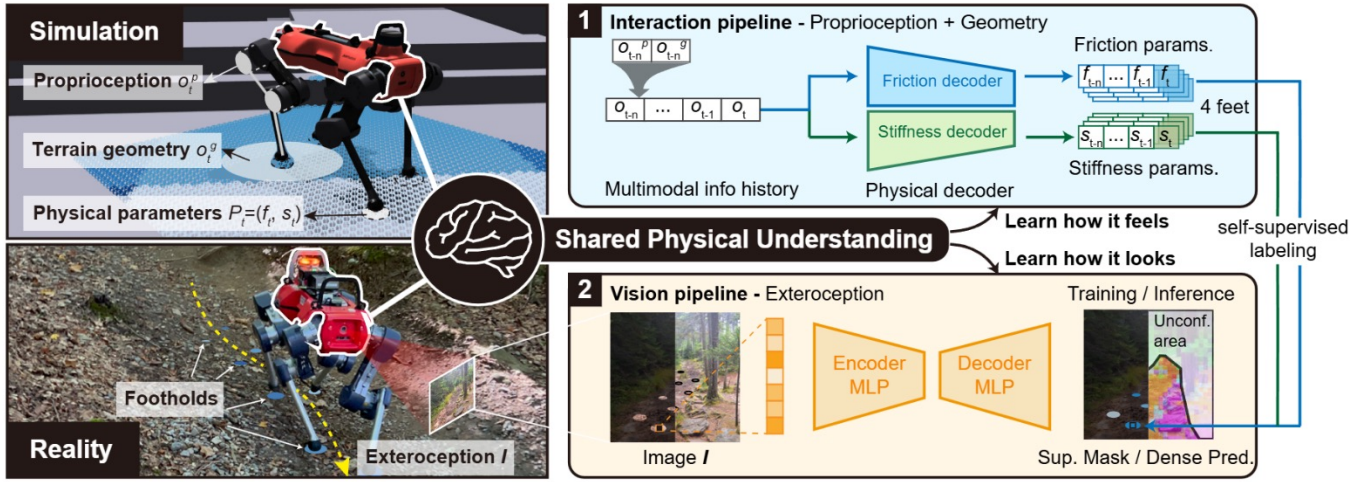
Towards Physical-Parameter-Aware Locomotion and Navigation

Chen et al.

RA-L 2024

Supervisor: Shahram Khorshidi

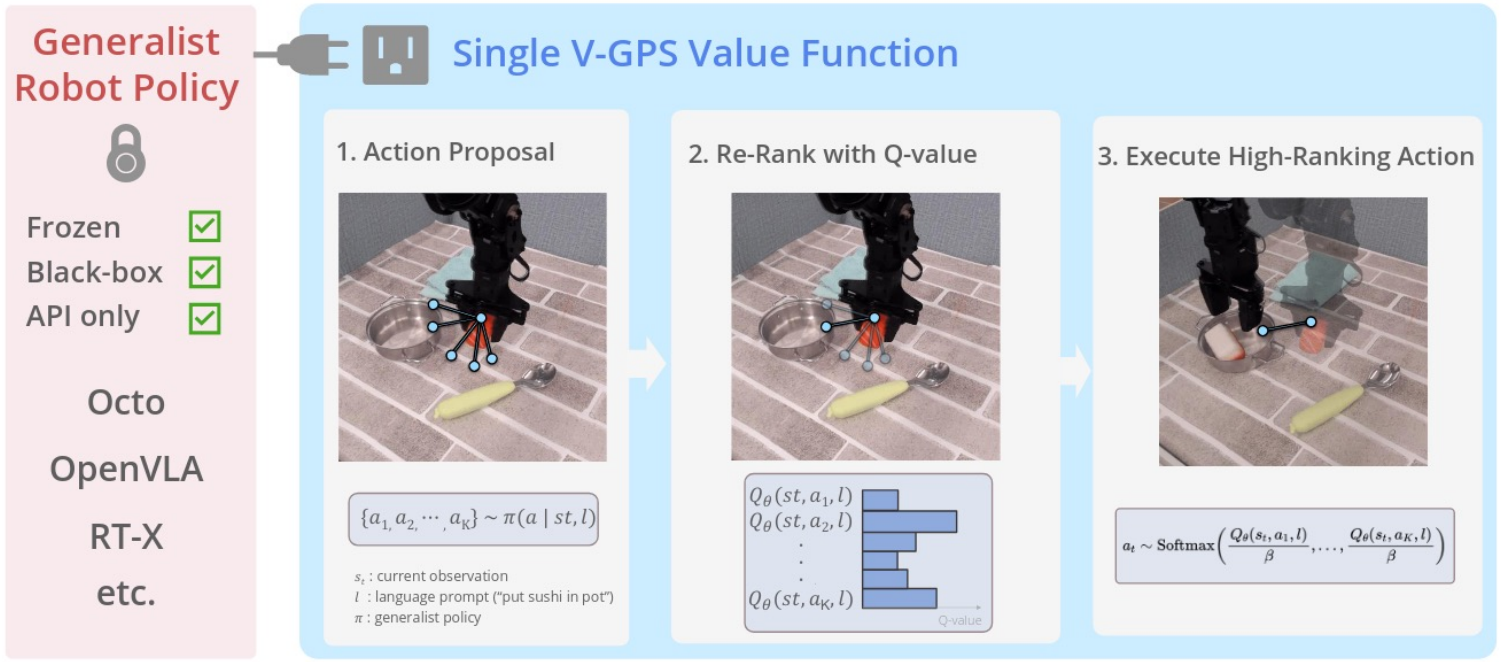
- **Goal:** Estimating the physical parameters of the environment from vision.
- **Problem:** How to know the friction and stiffness of the different terrains before contact.
- **Approach:** Using vision data and self-supervised learning to predict these parameters.



Steering Your Generalists: Improving Robotic Foundation Models via Value Guidance

Nakamoto et al.
CoRL 2024
Supervisor: Ahmed Shokry

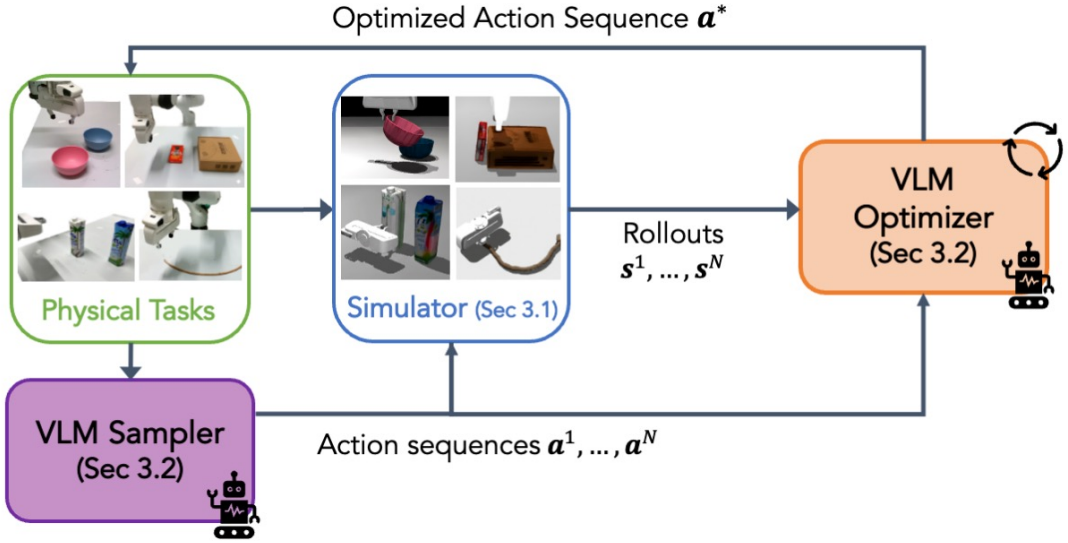
- **Goal:** Enhance the performance of robotic foundation models.
- **Problem:** Existing models produce only one action which may be sub optimal.
- **Approach:** Produce multiple actions from the model and train a critic network to choose the action with the highest expected return.

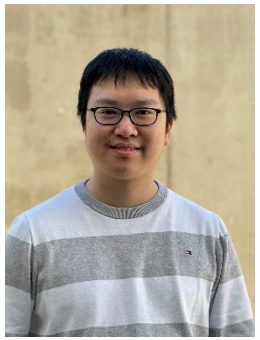


SIMPACT: Simulation-Enabled Action Planning using Vision-Language Models

Liu *et al.*
CVPR 2026
Supervisor: Benno Wingender

- **Goal:** Enable physics-aware robotic action planning by giving VLMs grounded physical reasoning at test time.
- **Problem:** Standard VLMs understand semantics and language, but do not model physical dynamics well enough for fine-grained manipulation.
- **Approach:**
  - Build physics simulation from RGB-D observation
  - VLM proposed action, evaluate them in simulation
  - Iteratively refine the plan given the outcome

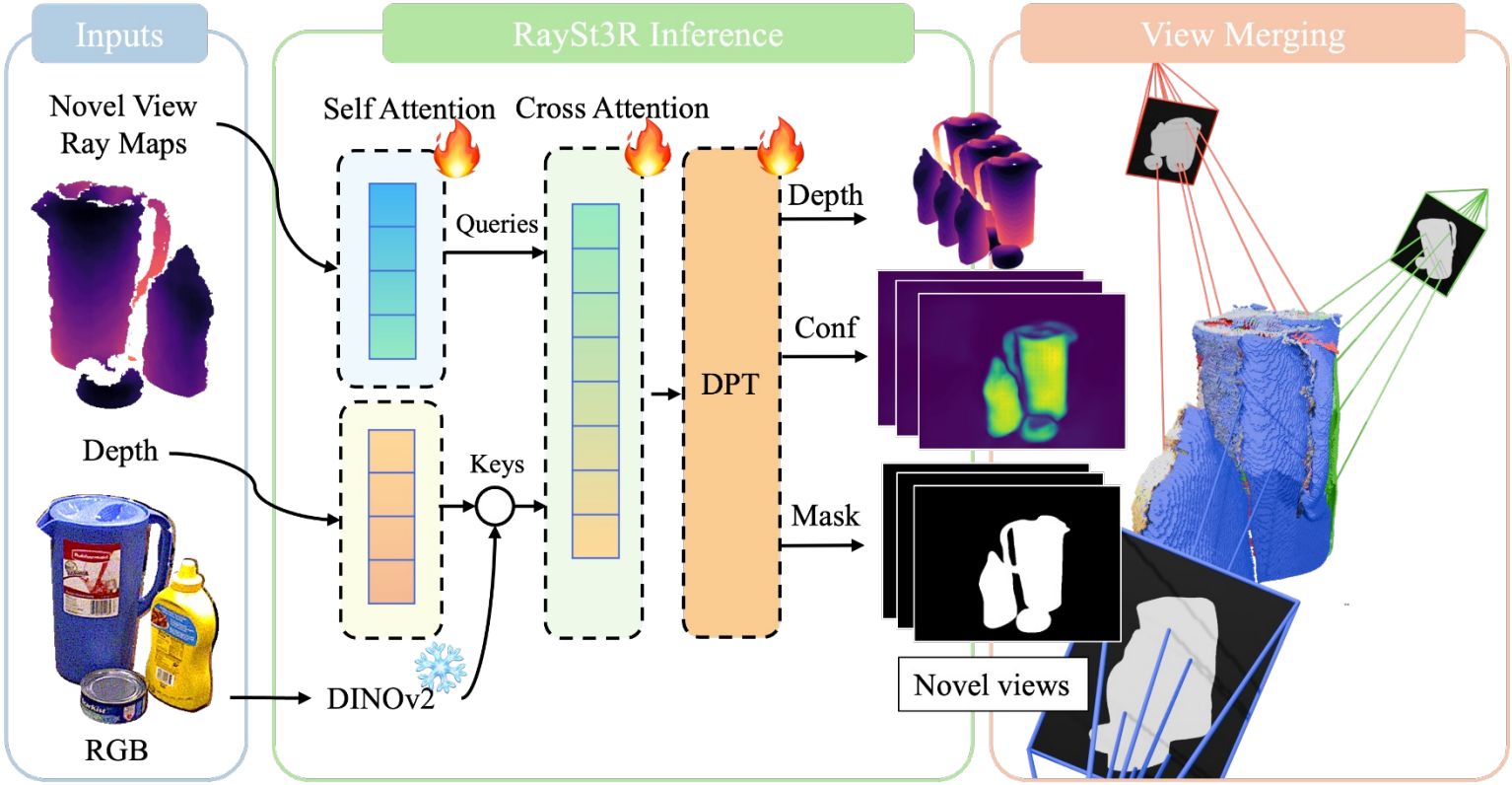




RaySt3R: Predicting Novel Depth Maps for Zero-Shot Object Completion

Duisterhof et al.
NeurIPS 2025
Supervisor: Sicong Pan

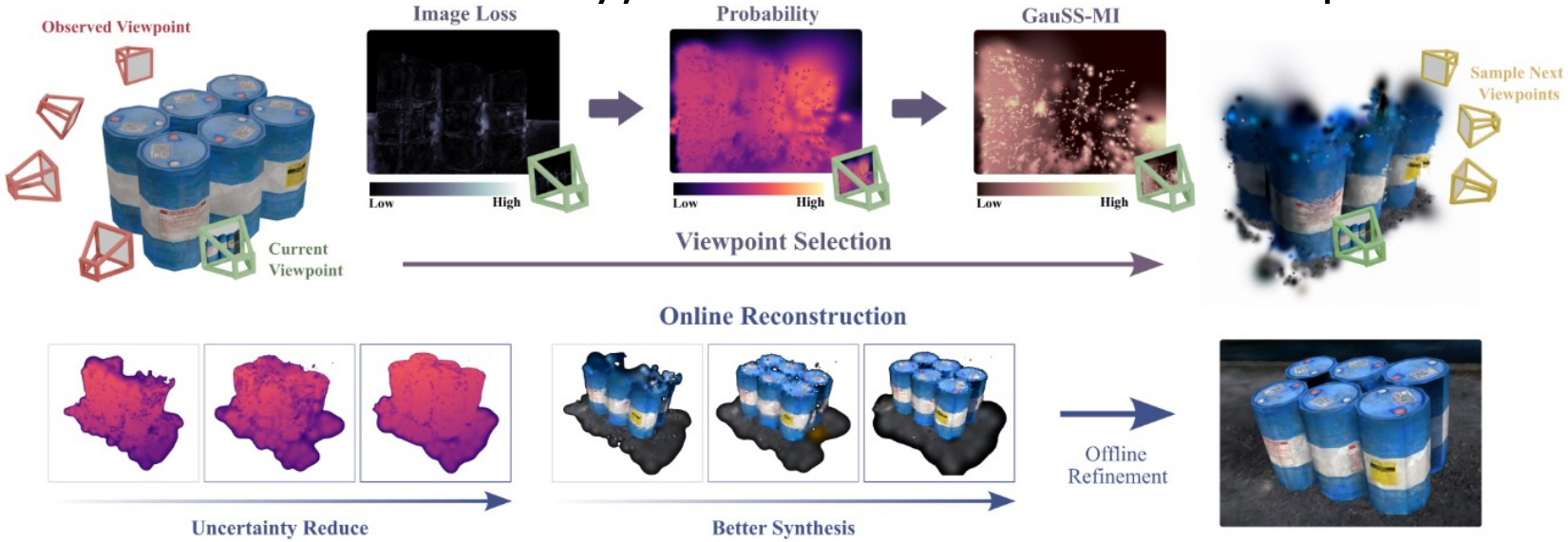
- **Goal:** Consistent and efficient 3D shape completion.
- **Problem:** Existing methods are costly and lack sharp boundaries.
- **Approach:** Recast shape completion as novel view synthesis, avoiding explicit resolution-limited shape reconstruction.



GauSS-MI: Gaussian Splatting Shannon Mutual Information for Active 3D Reconstruction

Xie *et al.*
RSS 2025
Supervisor: Niklas Mueller-Goldingen

- **Goal:** Select the next camera viewpoint that maximally improves a 3D reconstruction
- **Problem:** Existing methods rely on heuristic uncertainty or expensive evaluation of candidates
- **Approach:** Lightweight online 3D Gaussian Splatting of the scene, Shannon Mutual Information for candidate view utility, offline refinement after exploration



MA-INF 4214 Lab
&
BA-INF 051 Projektgruppe
(Lab Part)

Lab Overview

- Small groups of **2-3 people**
- A selection of projects involving perception, reasoning and action generation for different robots
- Recommended experience: Python, C++, ROS 1/2, OpenCV
- **Midterm presentation**: Progress feedback
- **Demonstration** and written lab **report**
  (7-10 pages incl. figures and references,
  LaTeX template provided on web page)

Lab Timeline

1) Project work
   - Plan how to achieve the project goal
   - Program the simulated/real robot(s)
2) Midterm presentation
   - Present your progress, problems and plans
   - Get feedback from all supervisors and peers
3) Demonstration day
   - **Everybody must be present the whole day!**
   - Show both (if available), simulation and real robot
   - Prepare a video as backup

Bi-weekly supervisor meeting:
Talk about progress, problems and plan the next steps

Lab Grade

- **Individual grade** for each group member
- Depends on **participation** during the semester and the performance of the system in the final demonstration
- Lab report is a precondition!
- **Written lab report** of the work
  (LaTeX template provided on web page)

Available Lab Projects

OPEN-VOCABULARY MOBILE MANIPULATION (B.Sc./M.Sc.)

Goal: Enable open-vocabulary pick-and-place on a mobile manipulator

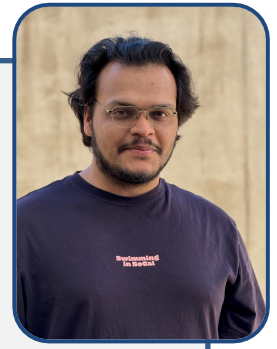
Challenge: Perception integration, command grounding, manipulation and control, deployment and evaluation

VLM-BASED ROBOT NAVIGATION (B.Sc./M.Sc.)

Goal: Teach a robot to navigate given spoken instructions

Challenge: Spoken instructions, navigation, environment perception

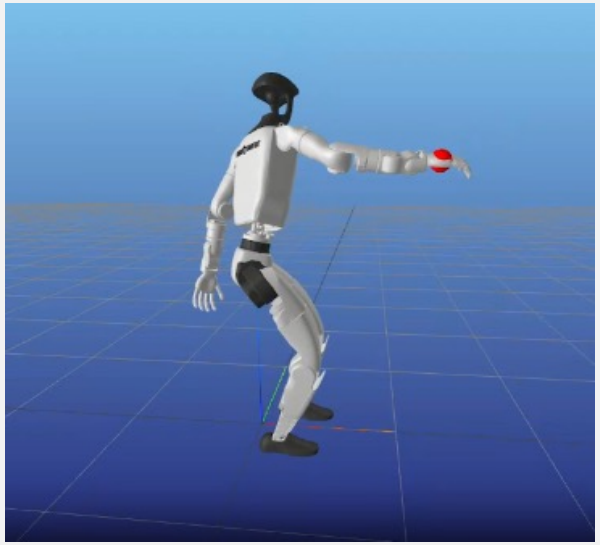
SOCIAL FORCE MODEL (M.Sc.)



Goal: Implement the social force model for crowd simulation

Challenge: Complex scenarios, 3D visualization, photorealistic environment, several metrics

HUMANOID WHOLE-BODY CONTROL (M.Sc.)



Goal: Enable simultaneous locomotion and manipulation

Challenge: Linear model predictive control, task coordination, whole-body control

GENERATIVE POLICIES FOR REARRANGEMENT (M.Sc.)

Goal: Training generative policies for rearrangement tasks

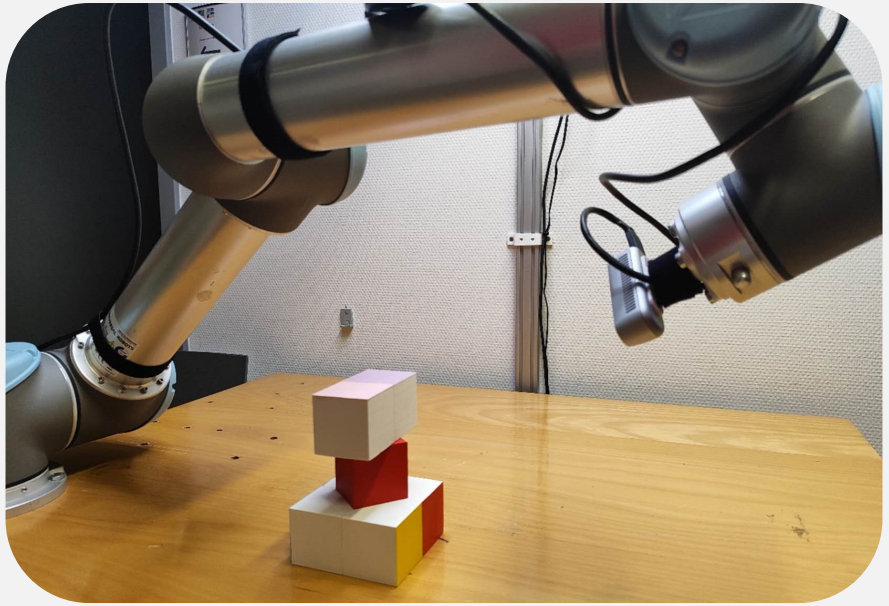
Challenge: Generative multimodal policy, imitation learning, rearrangement tasks

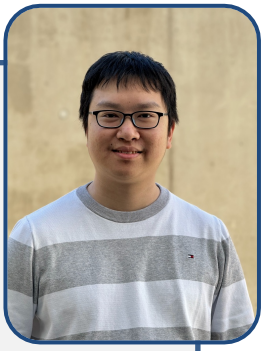
SUPERMARKET-ROBOT (M.Sc.)

Goal: Implement a robot to retrieve items on a shopping list

Challenge: Scene understanding, manipulation and control, deployment on real robot

FIND THE VIEWPOINT! (B.Sc./M.Sc.)





Goal: Find the viewpoint of the given RGB image

Challenge: Suitable active search method, computational complexity → speed of the search

HUMAN-IN-THE-LOOP INSPECTION & GRASPING (M.Sc.)

Goal: Develop user-guided object inspection and grasping

Challenge: Perception and reconstruction, mobile manipulation, user interaction

Registration

Next Steps

- **Two** separate registrations are necessary!

1) Registration on our web site (first-come-first-serve!)
   until Sunday, 19.04.2026

➡ Project, topic and group assignment
   until Wednesday, 22.04.2026 (notification via e-mail).

2) Registration on **BASIS until Sunday, 26.04.2026**

Website Registration

Responsible HRL Lecturers:

Prof.Dr. Maren Bennewitz

M.Sc. Xuying Huang

Important dates:

All interested students have to attend the Introductory Meeting. In the Introductory Meeting, we will present the projects, the schedule, the registration process, and answer your questions.

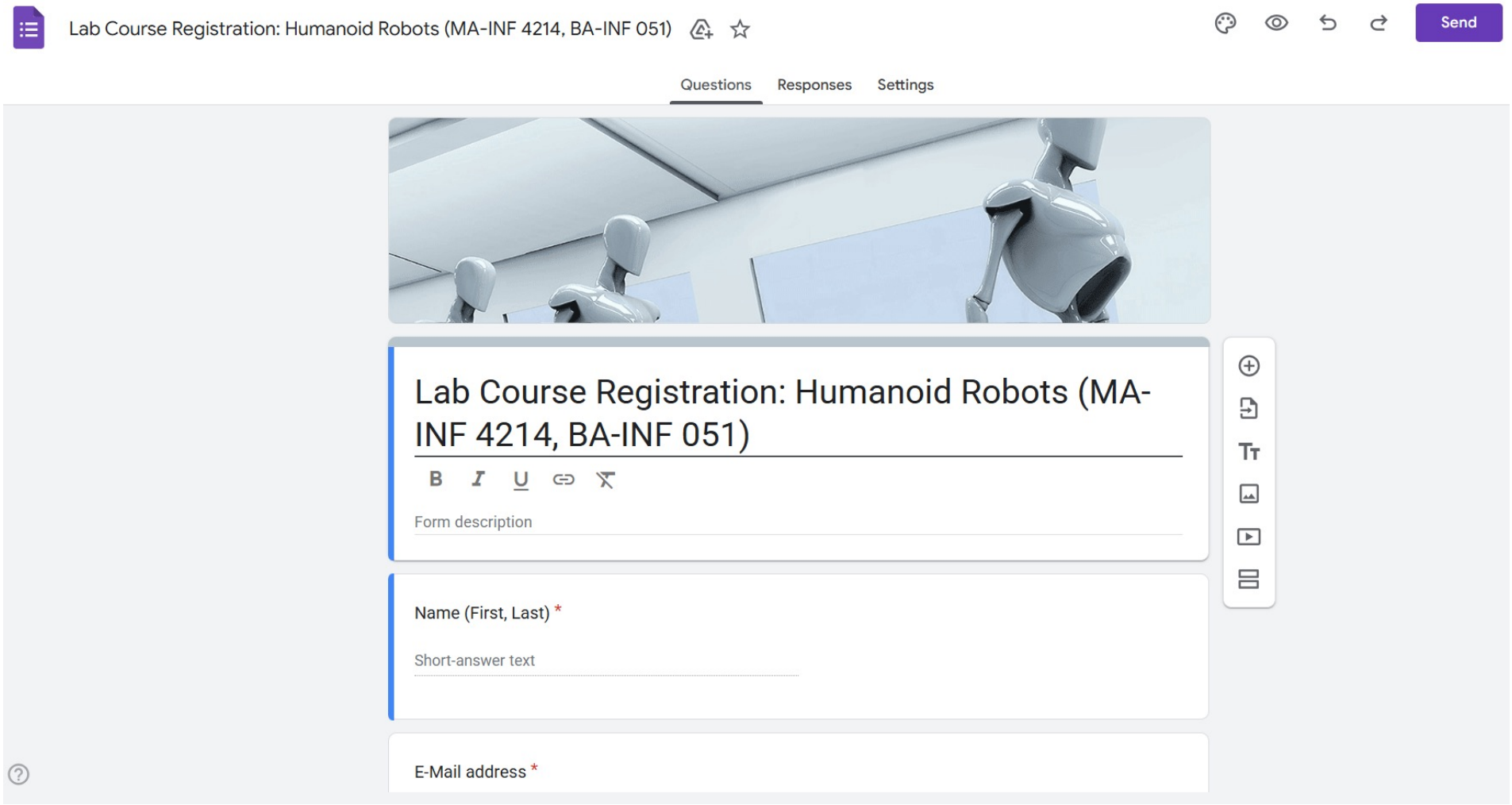
15.04.2026, Wednesday, 10:00-11:00hs (room 2.025)	**Introductory Meeting (mandatory)** [presentation slides]
19.04.2026, Sunday	Registration deadline and topic selection on our website
26.04.2026, Sunday	Registration deadline in BASIS
25.06.2026, Thursday, 10:00-12:00hs (room 2.044)	Midterm lab presentation
24.09.2026, Thursday, 10:00-13:00hs (room 2.044)	Lab demonstration and deadline for lab documentation

After the Introductory Meeting, each participant arranges an individual schedule with the respective supervisor.

Registration

The registration is open. Register here.

Website Registration



Schedule

Date	BSc Project Group	MSc Lab Course	MSc Seminar
Sun, Apr 19	Registration deadline		
Wed, Apr 22	Participation confirmation and topic assignment		
Sun, Apr 26	BASIS registration deadline		
	Supervised lab course in groups during the whole semester		Individual supervision
Thu, June 25	Midterm lab presentation (in person)		
Fri, June 26	Seminar presentation (in person)		• Seminar presentation (in person) • Deadline for the research proposal
Thu, Sep 24	• Lab demonstration (in person) • Deadline for the lab report		

Thank you!

Questions ???