Humanoid Robotics

Introduction

Maren Bennewitz

UNIVERSITÄT BONN

About This Lecture

- Introduction to **perception**, **manipulation**, and **locomotion** of humanoid robots
- Basic principles as well as selected state-of-the-art approaches
- Goal: students gain theoretical and practical knowledge in the area of humanoid robotics
- Slides will be provided on the web page

Content

- Sensing and perception
- World representations
- Active perception
- Inverse kinematics, arm motion planning
- Reinforcement learning for manipulation planning
- Grasping
- Interactive perception
- Balance control
- Walking
- Footstep planning
- …

General Information

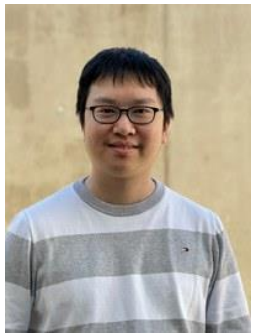
- Lecture: usually Thursdays (but exceptions, see schedule on webpage)
- Tutorial: two hours, usually Tuesdays
- Exercise sheets: practical and theoretical work
- Prerequisite exams: 50% of the reachable points from the exercise sheets
- Exam dates: August 18-19 and September 23
- Oral/written exam: tba

Co-Organizers / Tutors

- Subham Agrawal
- Murad Dawood
- Nils Dengler
- Shahram Khorshidi
- Rohit Menon
- Sicong Pan
- Ahmed Shokry





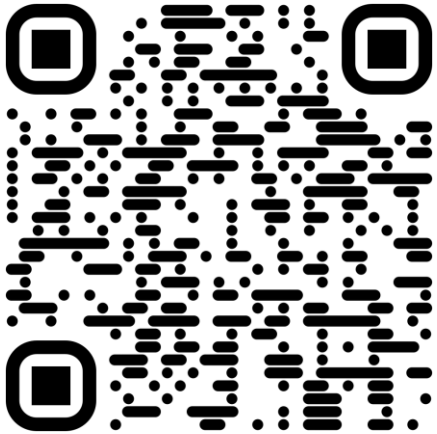

https://www.hrl.uni-bonn.de/people

Tutorial / Exercise Sheets

- Active participation highly recommended
- Focus on practical work and implementation of the approaches presented in the lecture
- Programming in Python
- Lecture+tutorial is a good preparation for the exam as well as for projects and theses in the area of humanoid robotics
- Submission of solutions via the form on the webpage

Registration

- Details on lecture webpage:
  https://www.hrl.uni-bonn.de/teaching/ss25/humanoid-robotics/
- Specify team partners
- Groups of up to 3 students
- **Registration deadline: April 16**



Vision: Service Robots as Assistants in Domestic Environments

source: Tesla

source: Honda

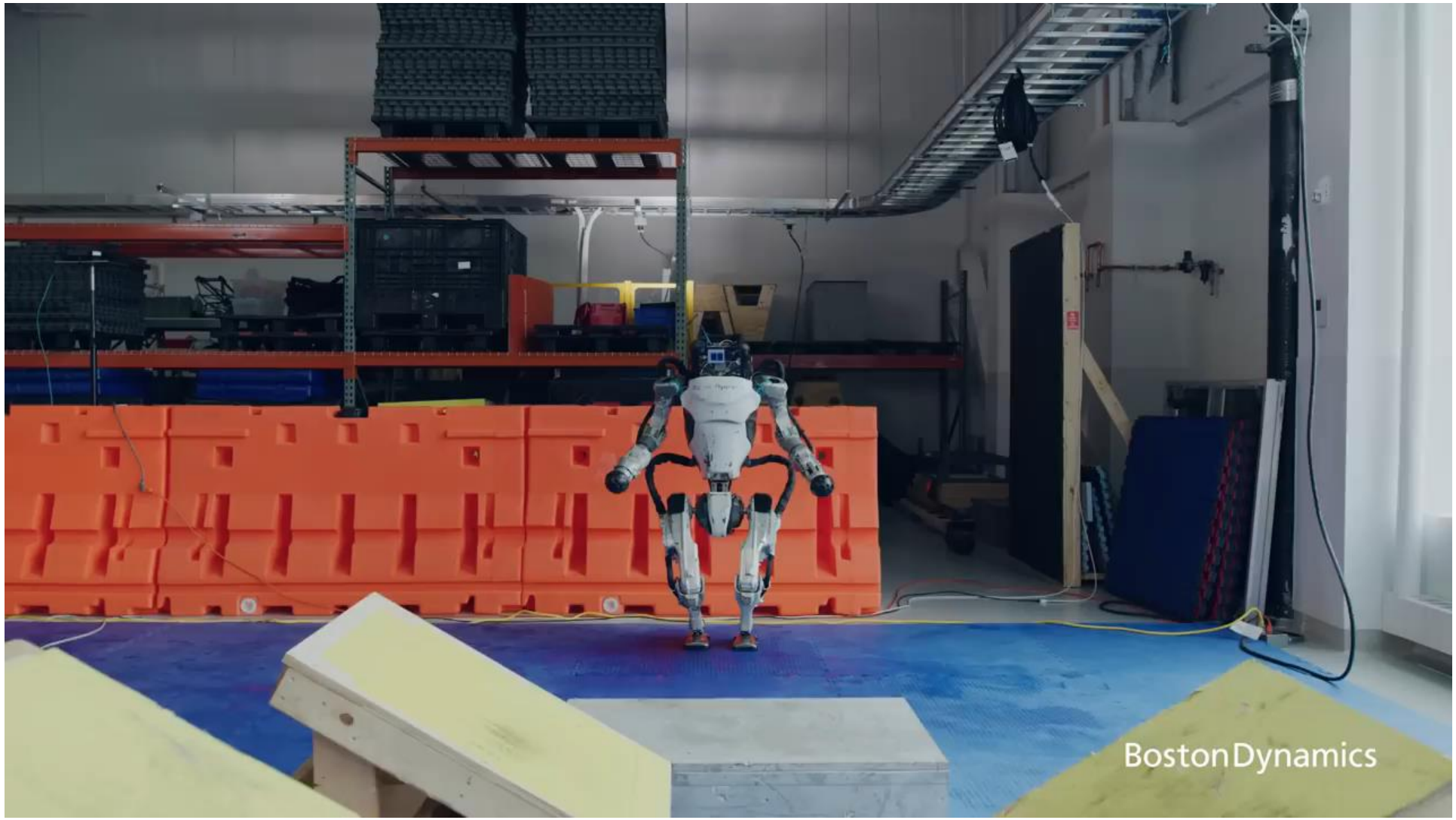
Requirements

- Perception of the environment
- Environment modeling
- Planning of navigation actions
- Planning of manipulation actions
- Reliable action execution
- Learning

What Makes it Difficult?

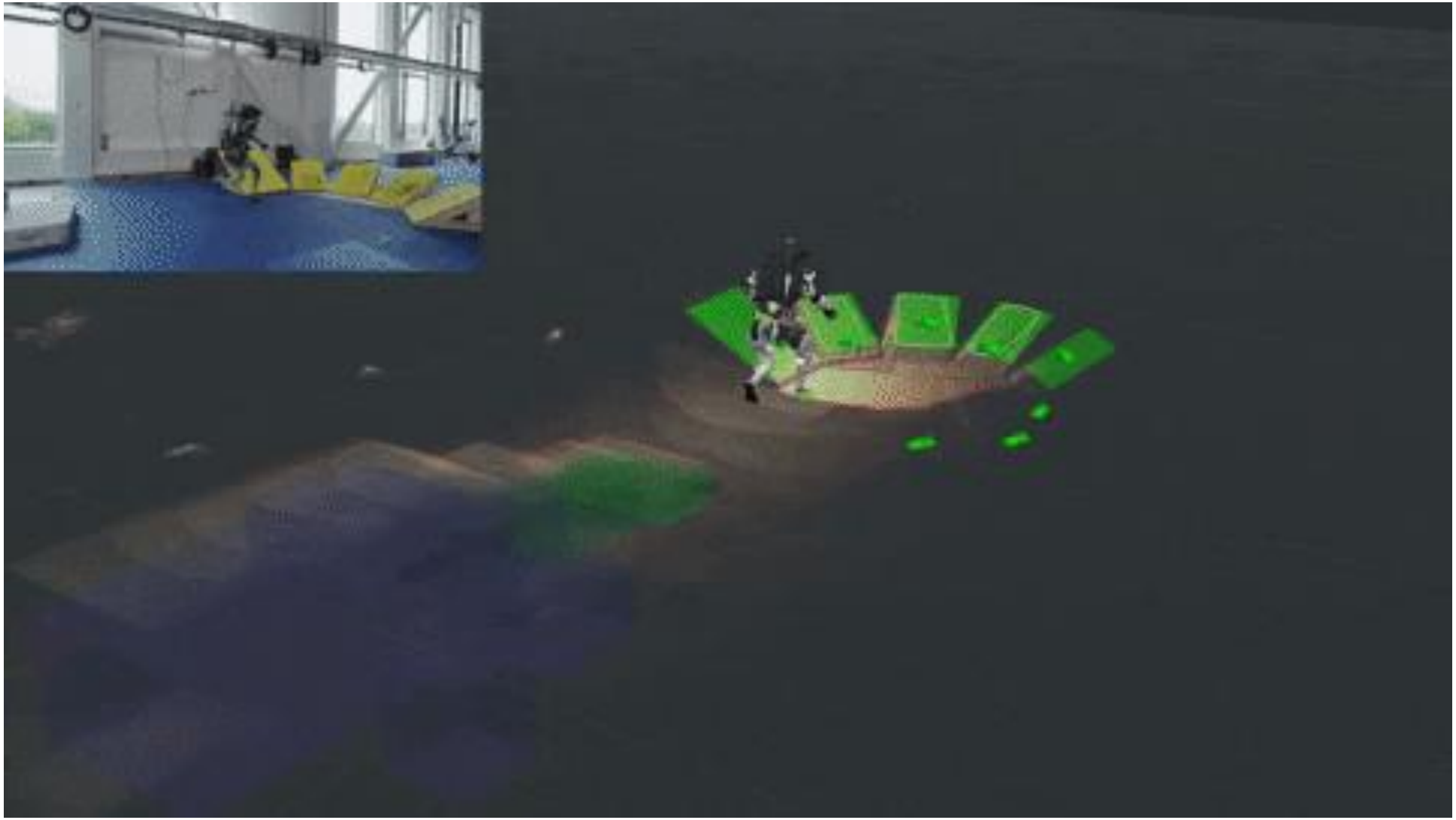
- Noisy sensor data
- Extraction of relevant information
- Inaccurate motion execution
- High-dimensional state space

Atlas Performing a Challenging Parkour



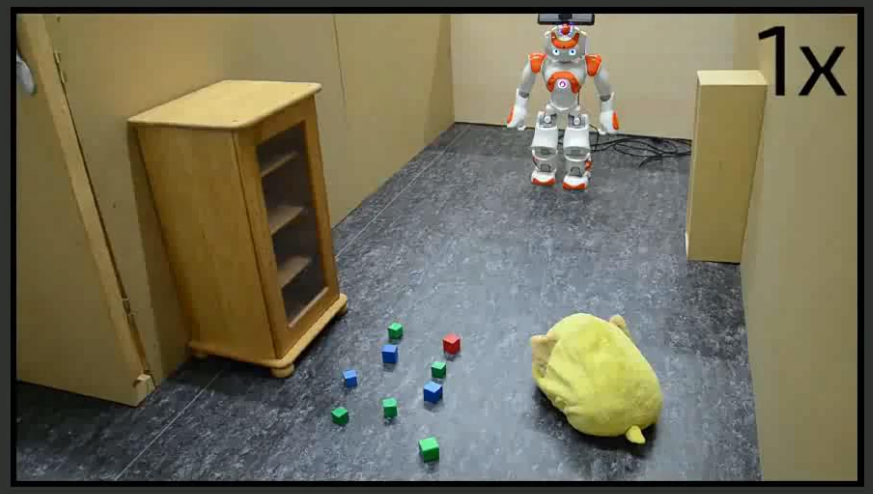
courtesy of Boston Dynamics

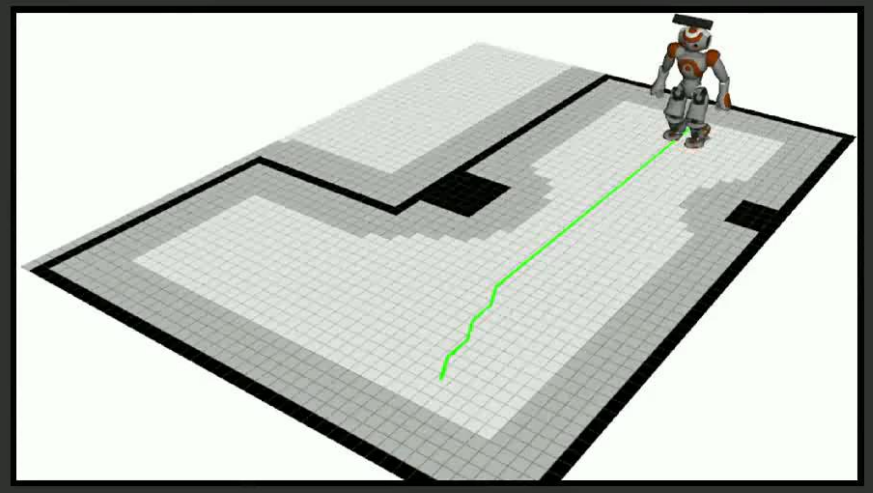
Environment Representation



courtesy of Boston Dynamics

Exploiting Knowledge about Obstacle Classes During Navigation

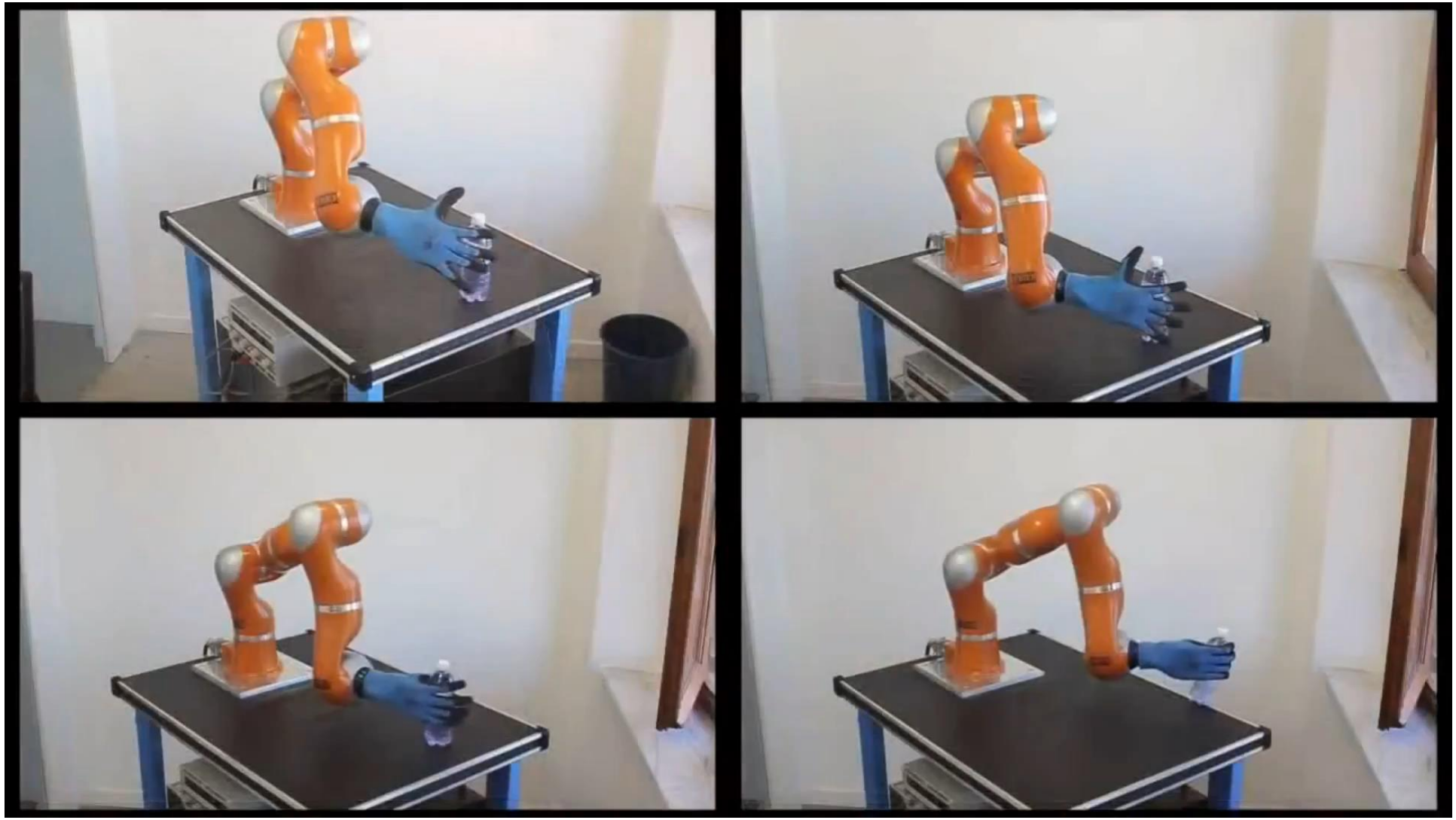




The Nao robot needs to reach the bottom part of the map.

For that it will need to navigate through the toy blocks or the stuffed animal.

Object Grasping and Manipulation

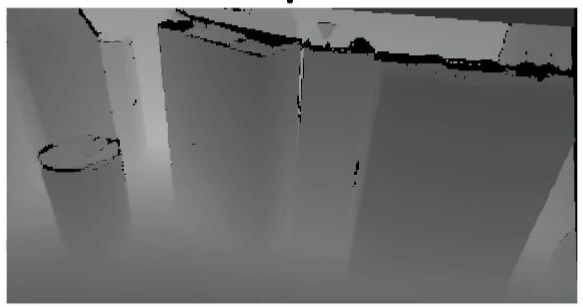


courtesy of IIT

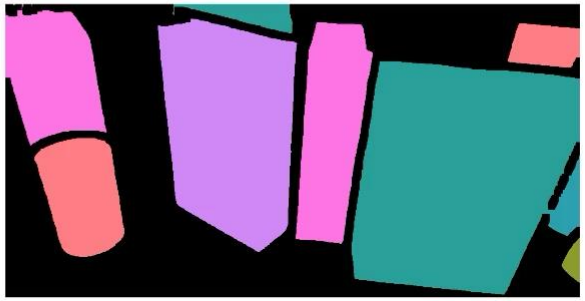
Perception and Belief Representation

RGB

Depth



Semantic

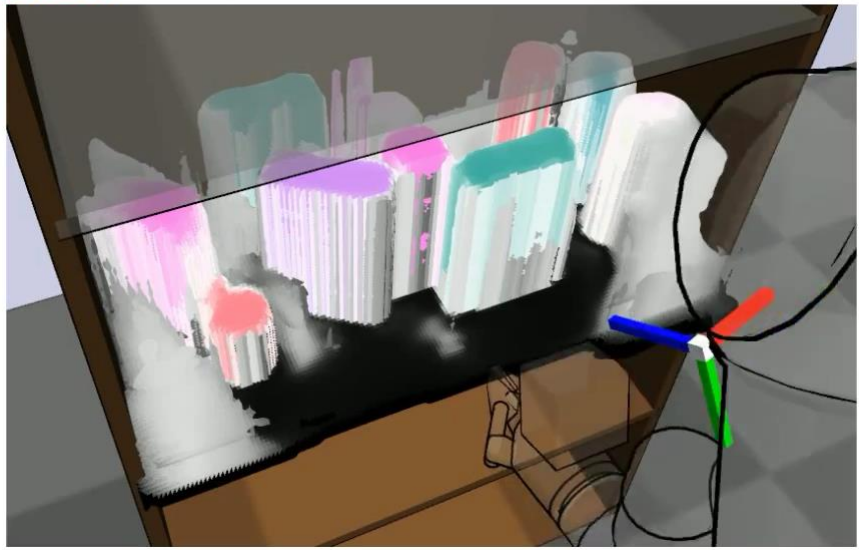


Action:

External View

Observation

Environment Belief



Object Retrieval

About This Lecture

- Human-like robots are an exciting and active research area
- In this lecture, you will learn
  - How humanoid robots **perceive** the environment
  - How they **plan manipulation** actions and **execute** them
  - How they realize **walking** and **path planning**
  - …

Next Steps for You

- Register for the tutorial via Email
- Download the first exercise sheet from the web page
- Enjoy the lecture!