

**ETH** *Shaping the future*

# Next Revolution in Robotics

## *Challenges and Opportunities*

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[www.asl.ethz.ch](http://www.asl.ethz.ch)

**stars**  
FOR LEADERS OF THE  
NEXT GENERATION

stars Switzerland symposium 2025  
*Think the Unthinkable*  
Wolfsberg, Ermatingen, 19-22 September 2025

## Service Robots | key challenges

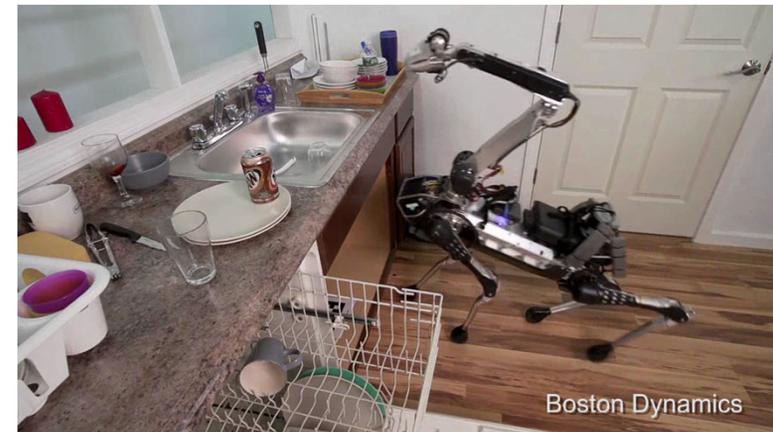
Our real “physical” world is **multi-modal**, very **diverse**, **complex** and **unstructured**.

We need robots that ...

- ... can **dealing** with **uncertain** and **partially available information**
- ... **see, feel** and **understand** their environment
- ... have **torque** and **force** control for **tactile** and **dexterous** interaction (“soft robots”)
- ... offer **intuitive human-machine interfaces**
- ... **learn** and **adapt** every day
- **all this required AI/ML but even more novel perception, actuation and robot concepts!!**



Industrie-Roboter



Boston Dynamics

Service Robots

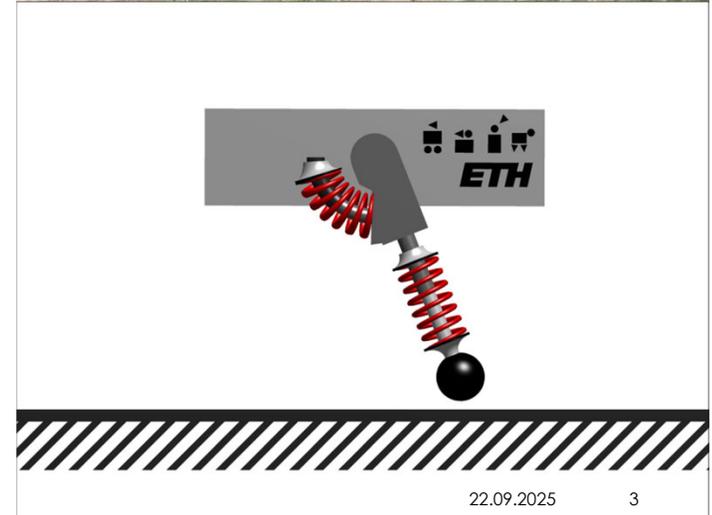


# Walking Robot ANYmal | *designed for challenging environments*

**ANYmal** – “soft” interaction with the environment  
| the ultimate quadruped

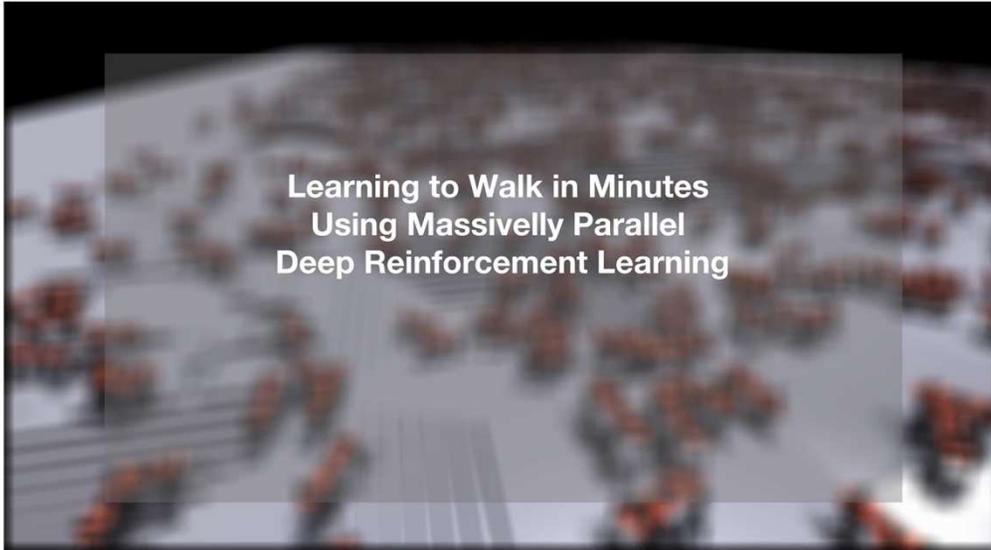
<https://www.youtube.com/watch?v=E11zBTYpXW0>

Locomotion



# Reinforcement Learning | robot learning to walk

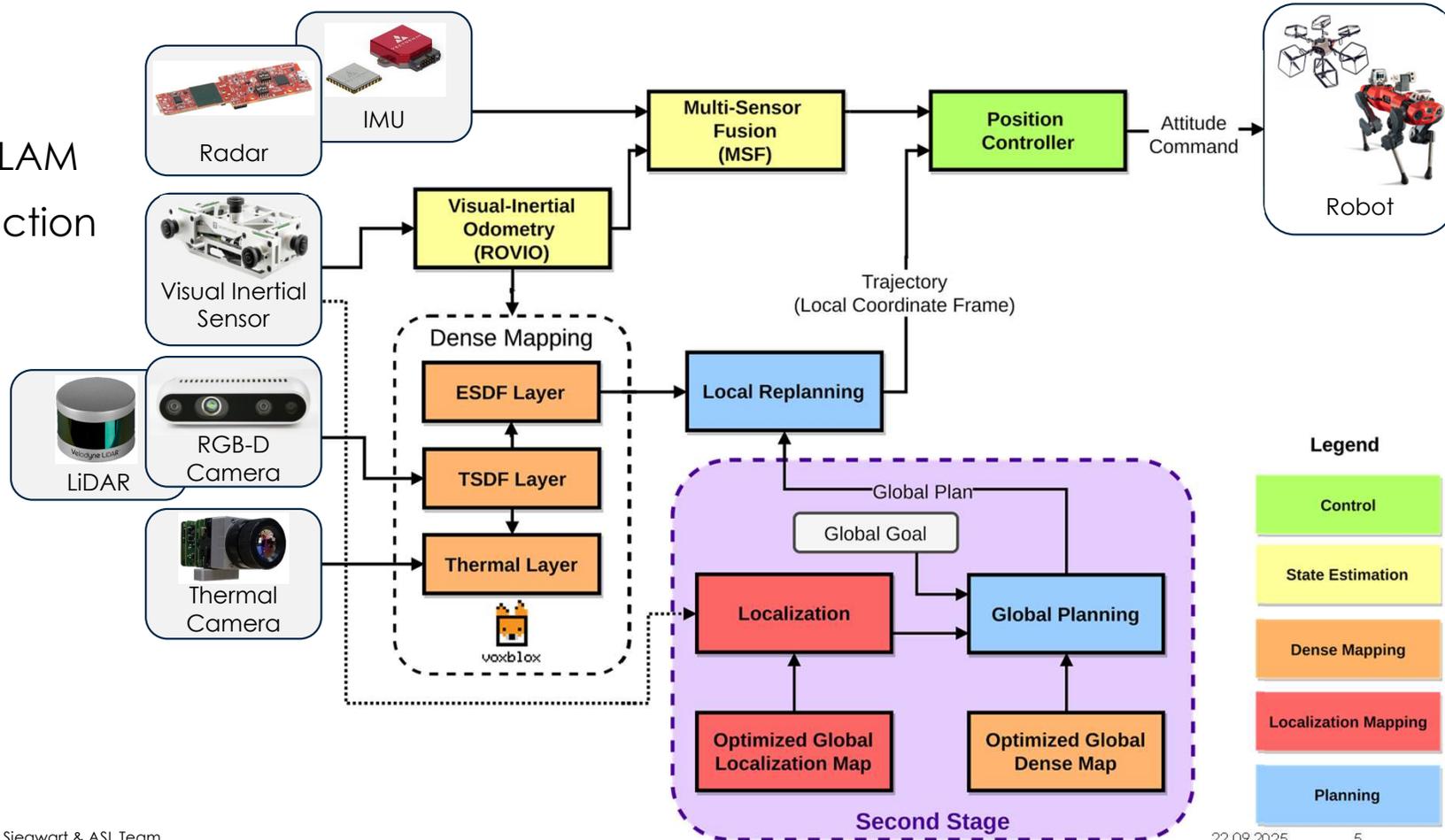
- Goal: given the actual state, learn the best action (leg movements) to achieve the optimal next state.



# Autonomous Navigation

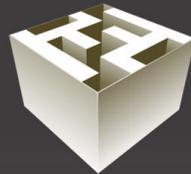
## Perception, Localization, Mapping, Planning and Acting

- perception
- localization
- Mapping / SLAM
- 3D reconstruction
- planning
- locomotion



Navigation

# Vollautonome Such und Rettung DARPA Subterranean Challenge – “World Championship of Robots”

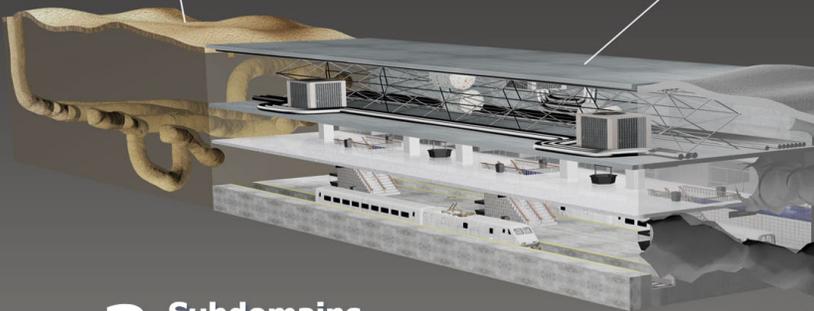


**DARPA**  
SUBTERRANEAN  
CHALLENGE

Tunnel Environment

Urban Environment

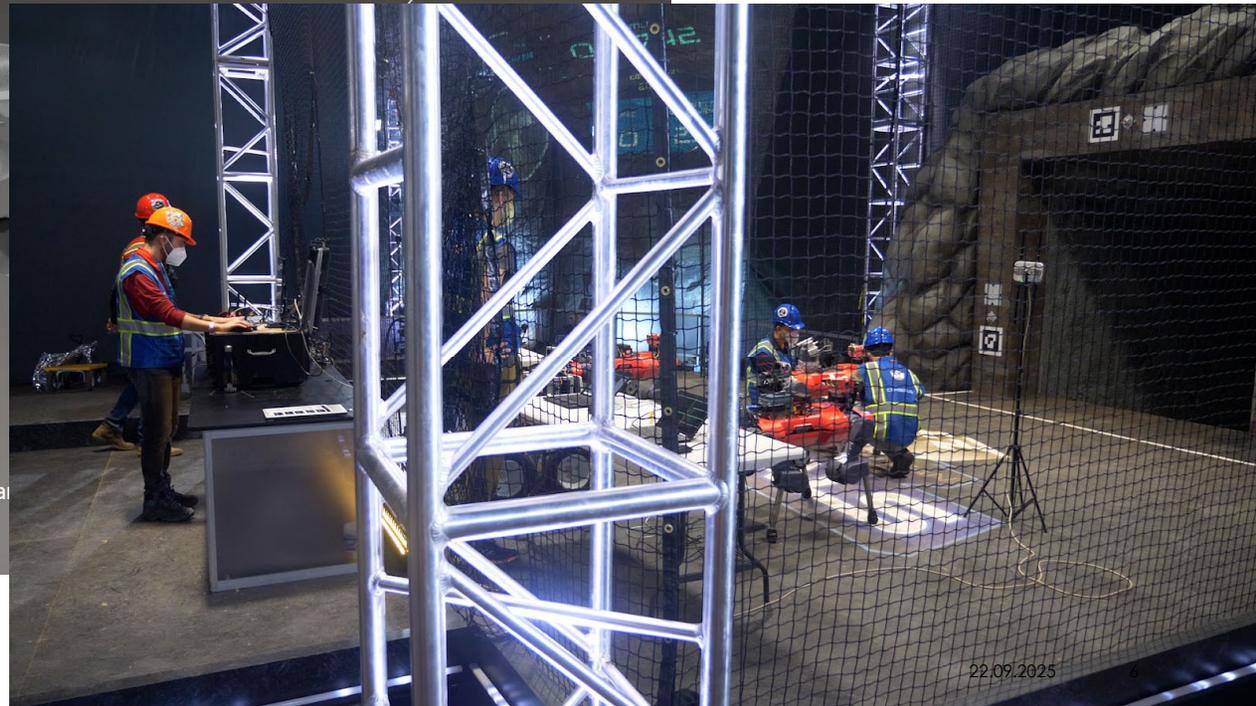
Cave Environment

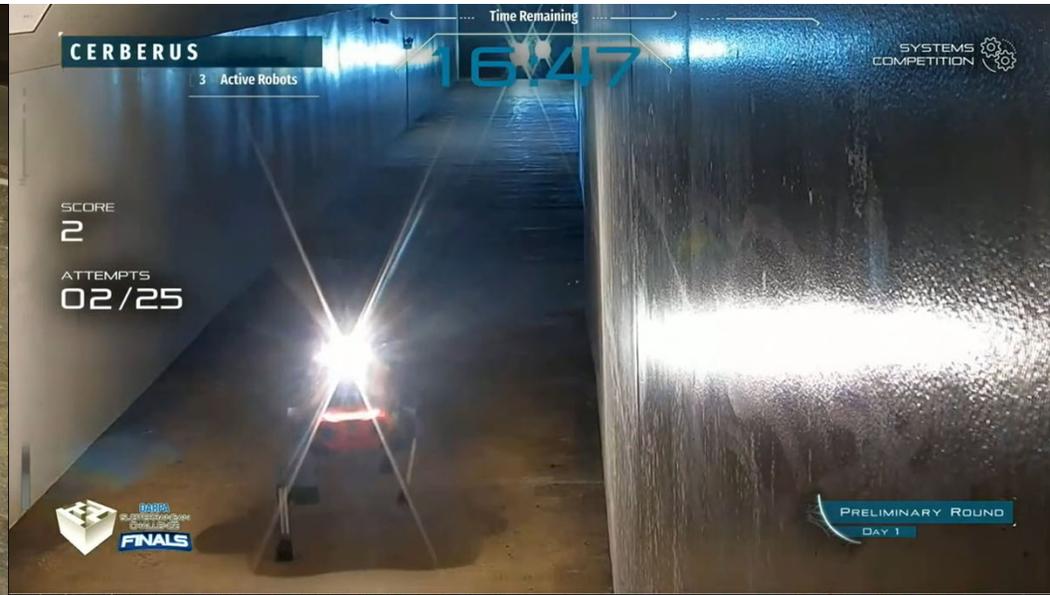


**3 Subdomains**  
Tunnel Systems • Urban Underground • Cave Networks

**2 Competitions**  
Systems • Virtual

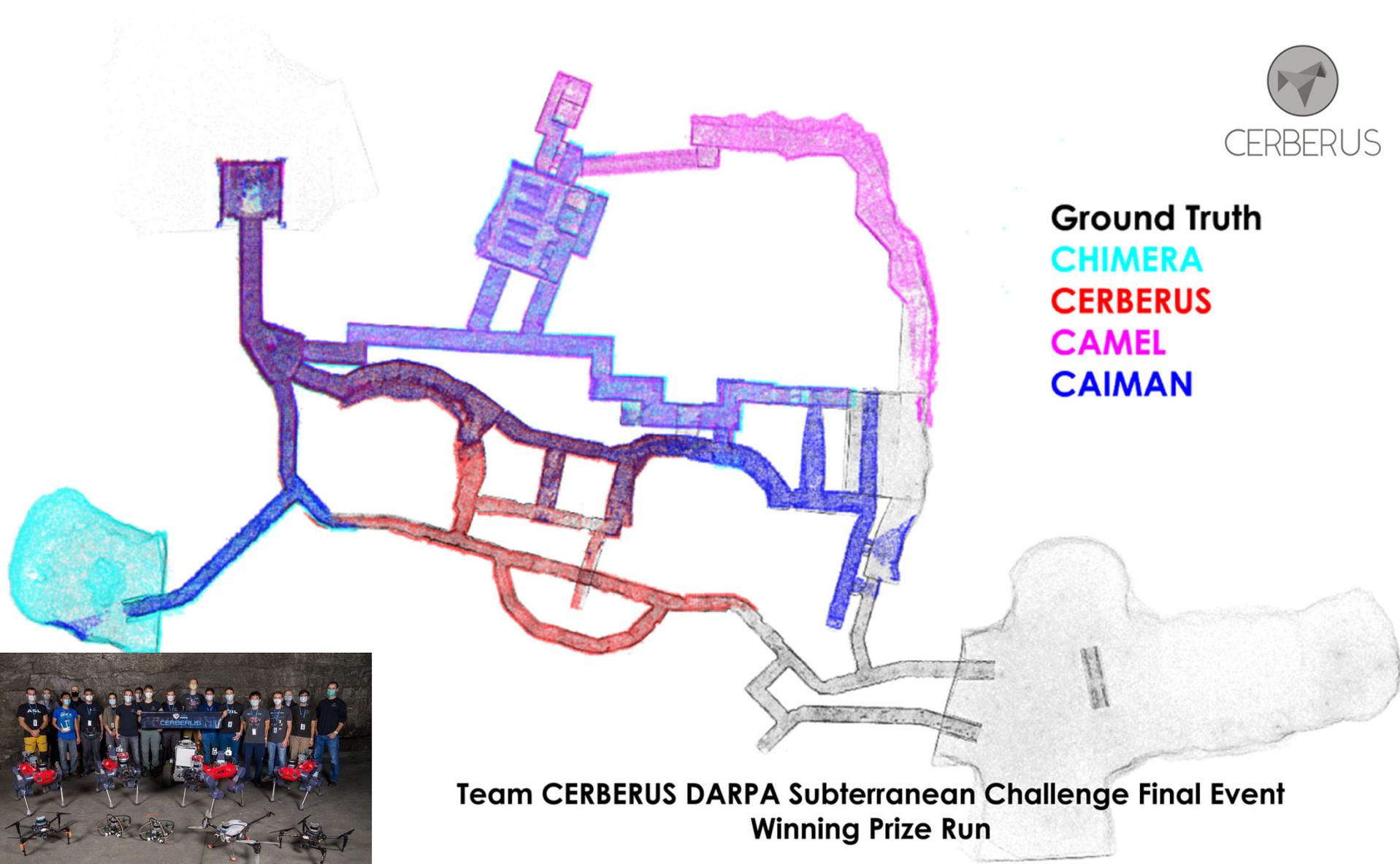
**1 Revolutionary Vision**  
Create breakthrough technologies aimed at  
for underground operations







**Ground Truth**  
**CHIMERA**  
**CERBERUS**  
**CAMEL**  
**CAIMAN**



**Team CERBERUS DARPA Subterranean Challenge Final Event  
Winning Prize Run**

# Robotics Roadmap

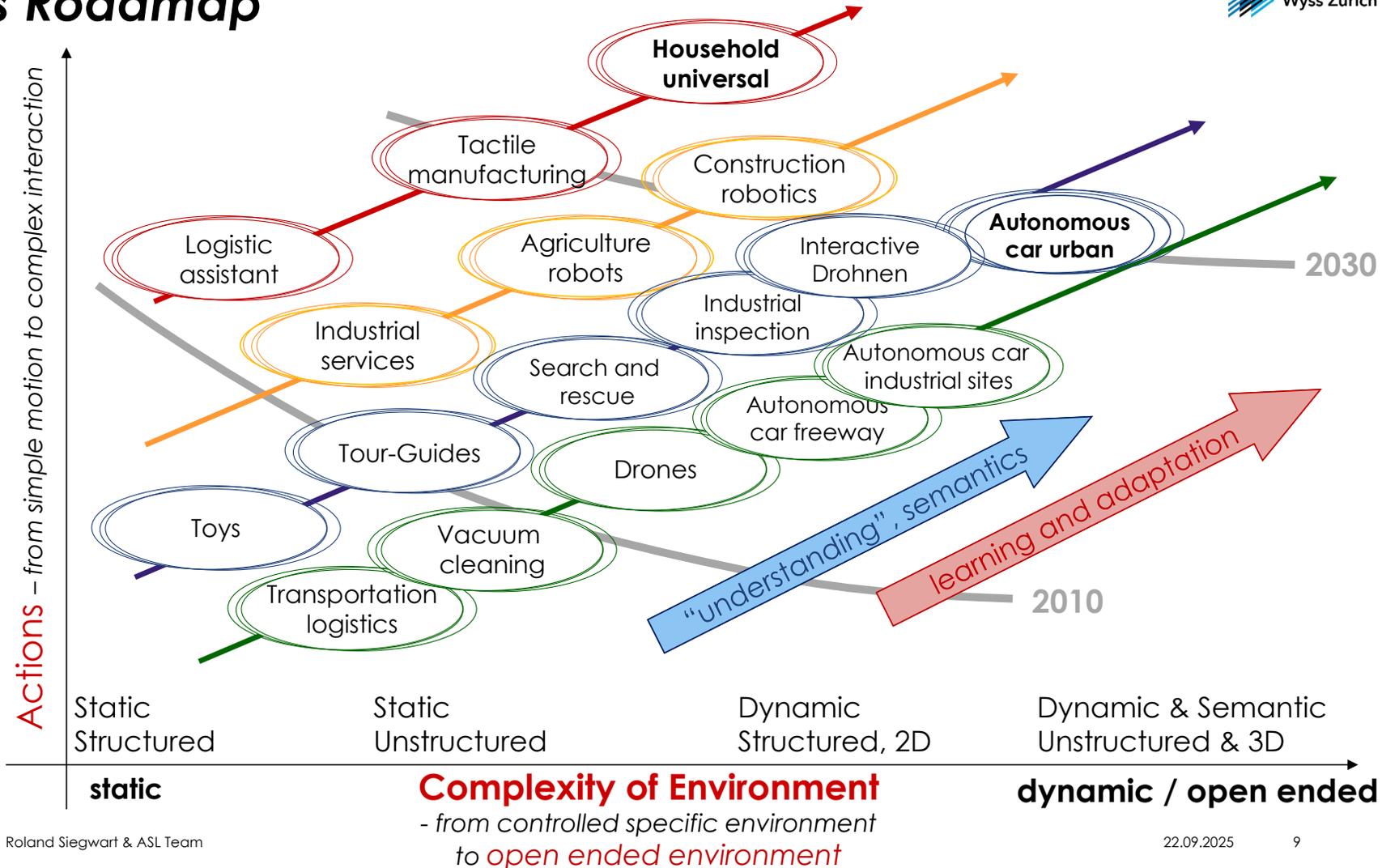
Complexity of Task

Tactile Manipulation

Mobile Manipulation

Advanced Interaction

Autonomous Navigation



# Today | **ETH Robotics Startups**

*30 new startups in the last 12 years*

 **wingtra** | fast 3D Mapping from the air



**ANY**botics | inspection of critical infrastructure



**VOLIRO**  | the hand in the air



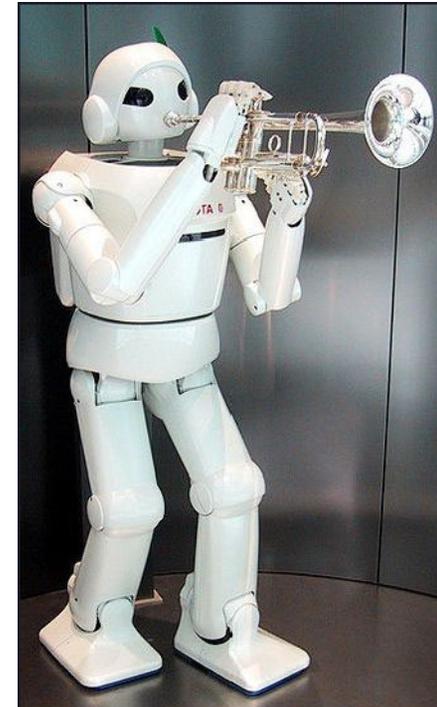
# 25 years ago | Humanoid Robots in



Honda Asimo, 2002/2006



Sony QRIO, 2003



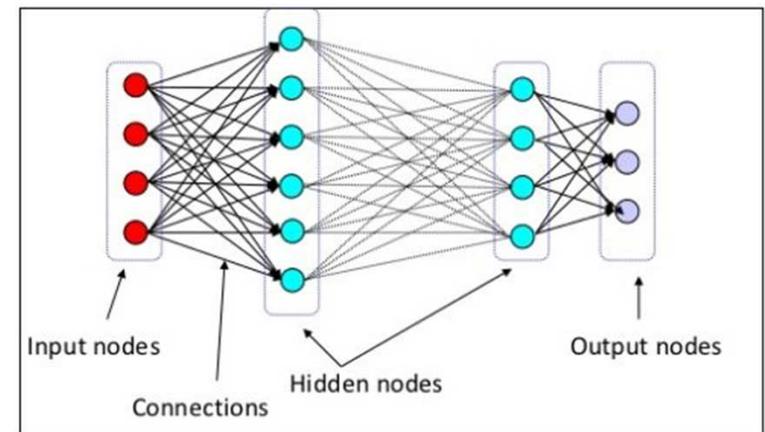
Toyota, 2005

Toyota says it aims to put humanoid “partner robots” into use after 2010 to help people in factories, hospitals, homes and around town.

# The Drivers of Physical-AI Hype

## *Artificial Intelligence and Machine Learning*

- **Locomotion and Interaction**
  - Learning complex robot actions from locomoting to grasping and interaction
  - **RL** (Reinforcement Learning)
- **Understanding the Environment** from sensory input
  - Segmentation, classification and understanding
    - Objects and their relations
    - Best features in an image for localization and mapping
  - Transformers and Diffusion Model
- **Generation of complex action sequences**
  - Understand tasks given by humans to the robot and converting them in sequences of robot actions
  - **LLM** (Large Language Models)

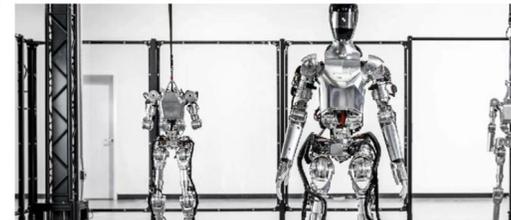


# Take Home Message

- Yes, robotics is booming
  - but it will take some time to bring these complex system to market
- Artificial Intelligence will **not** solve all the issues but importantly contributes
- Progress in robotics is about:
  - Top research
  - The greatest talents
  - Precision Mechanics, Sensing, Actuation, Control and AI
  - Innovation and entrepreneurship

AI Robotics company Figure raises \$675M at \$2.6B valuation from Microsoft, OpenAI, NVIDIA, Intel, Jeff Bezos, others

by Vignesh R. — March 1, 2024 in AI and chatbots, News, Startups



Robotics

**Covariant's robotic picking AI nabs another \$75M**

Brian Heater @bheater / 4:45 PM GMT+2 • April 4, 2023



**Agility Robotics raises \$150M from Amazon and others to build human-like robots used in warehouses**

BY TAYLOR SOPER (HTTPS://WWW.GEEKWIRE.COM/AUTHOR/TAYLOR-SOPER/) on April 22, 2022 at 8:51 am



(<https://www.innovationbanking.cibc.com/home?utrc=D684:4&>)

GeekWire's in-depth startup coverage tells the stories of the Pacific Northwest entrepreneurial scene.

