

Applying AI and HRI results of competitions in service robotics ERL and SciRoc: Lessons Learned and Future of AI

Juan G Victores | April 13th, 2021





Introduction



Global architecture



Target scenarios



Results of competitions

Introduction

What are service robots?

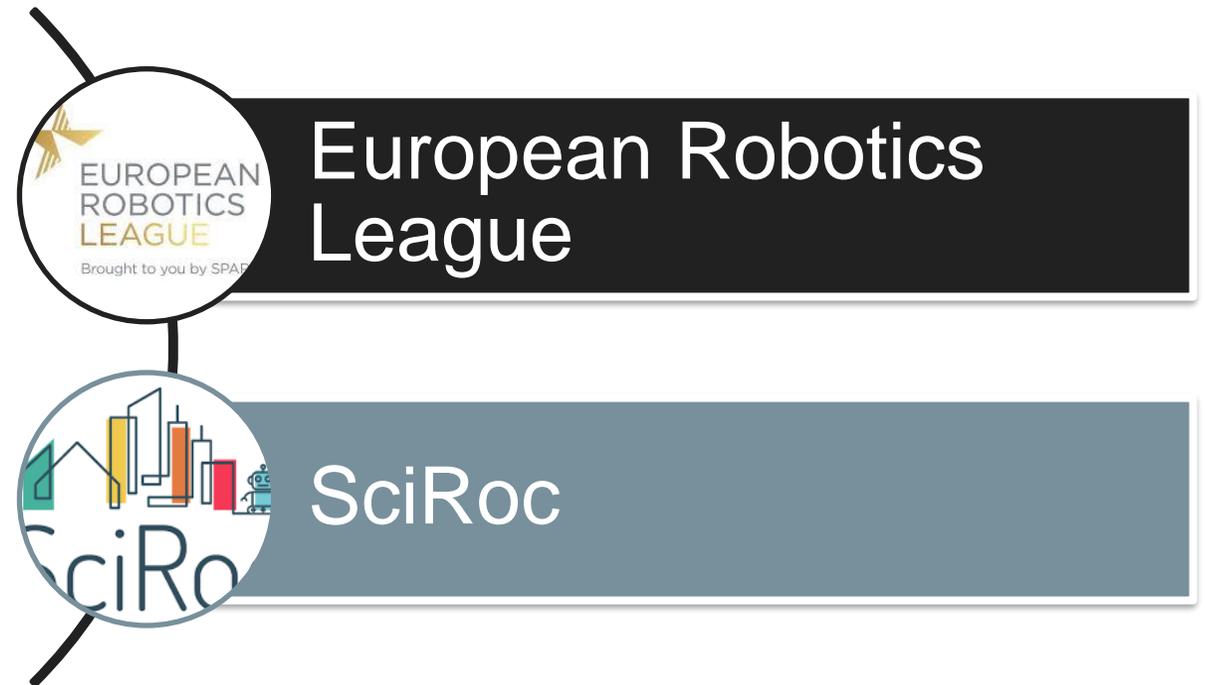
- Branch of robotics that works outside of the industrial setting, typically unstructured and dynamic environments
- Applications in tasks of support and/or assistance for human end-users
- Design and implementation with direct Human-Robot Interaction (HRI) in the loop



Introduction

ERL and SciRoc competitions

- European Robotics League (ERL) was launched in 2016 under the SPAR Partnership for Robotics in Europe, building on the success of EU funded projects. ERL Consumer, ERL Emergency and ERL Professional Service Robots.
- SciRoc continues this pan-European robotic competition tradition since 2019 as part of Horizon 2020.

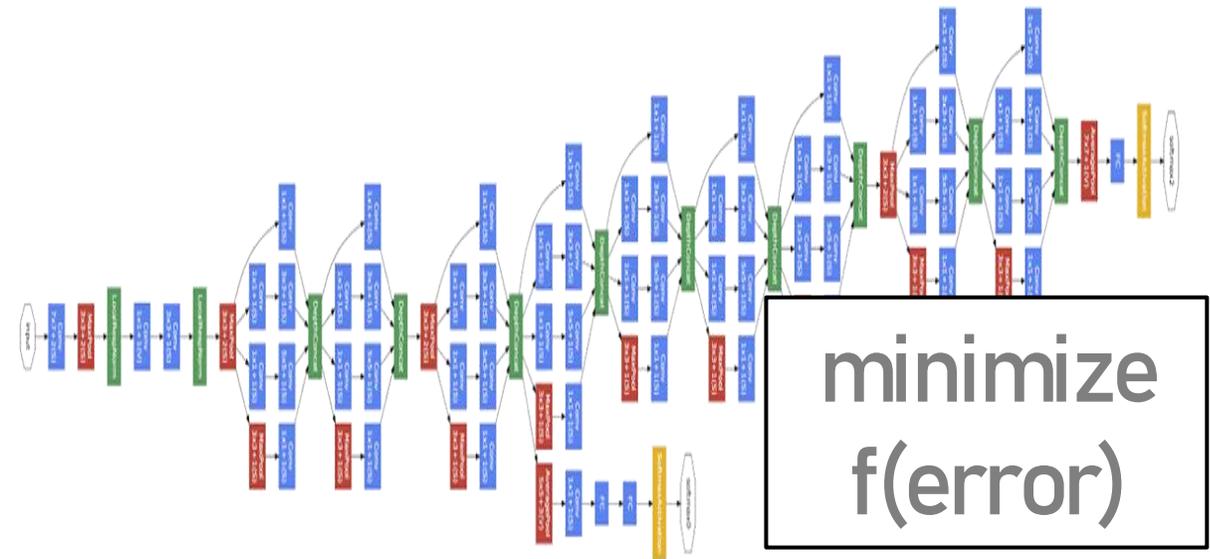


Introduction

Where is the Intelligence in AI?

- Major advances in classification, regression, and even in generative tasks since AlexNet in 2014
- Best results with images, sound and even more recently with natural language processing since GPT-3 in 2020
- Limitations include being restricted to *narrow* AI tasks, as well as costly advances towards decision taking in real world scenarios with Deep Reinforcement Learning (DRL)

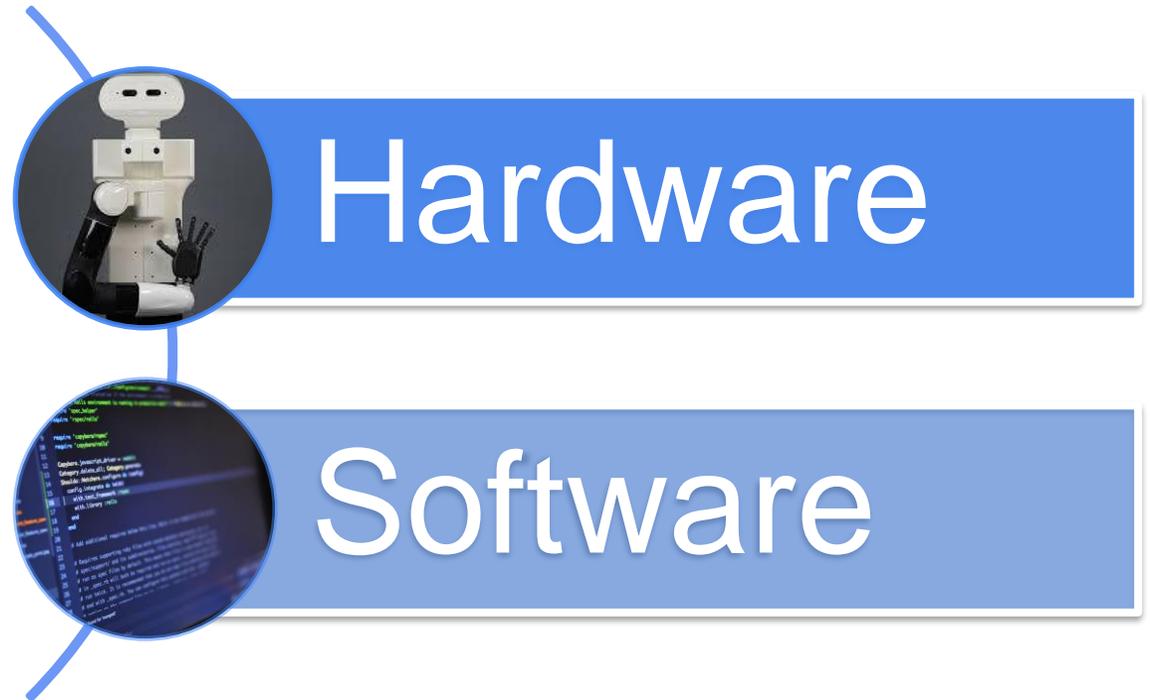
Input: Image, sound...



Output: Classification, regression...

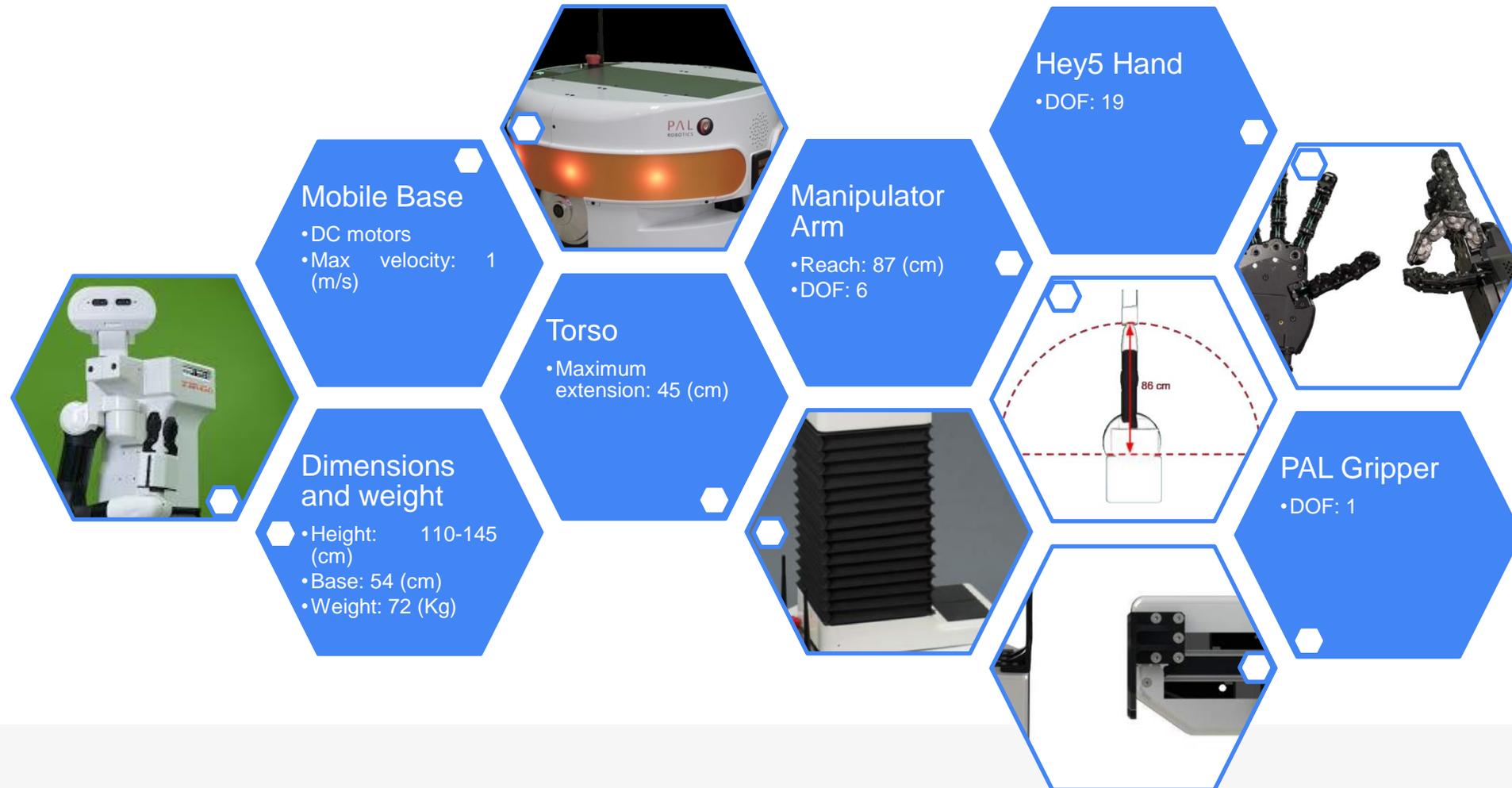
Global architecture

Based on robot platform: TIAGo (PAL Robotics)



Global architecture

Hardware: TIAGo (PAL Robotics) (I)



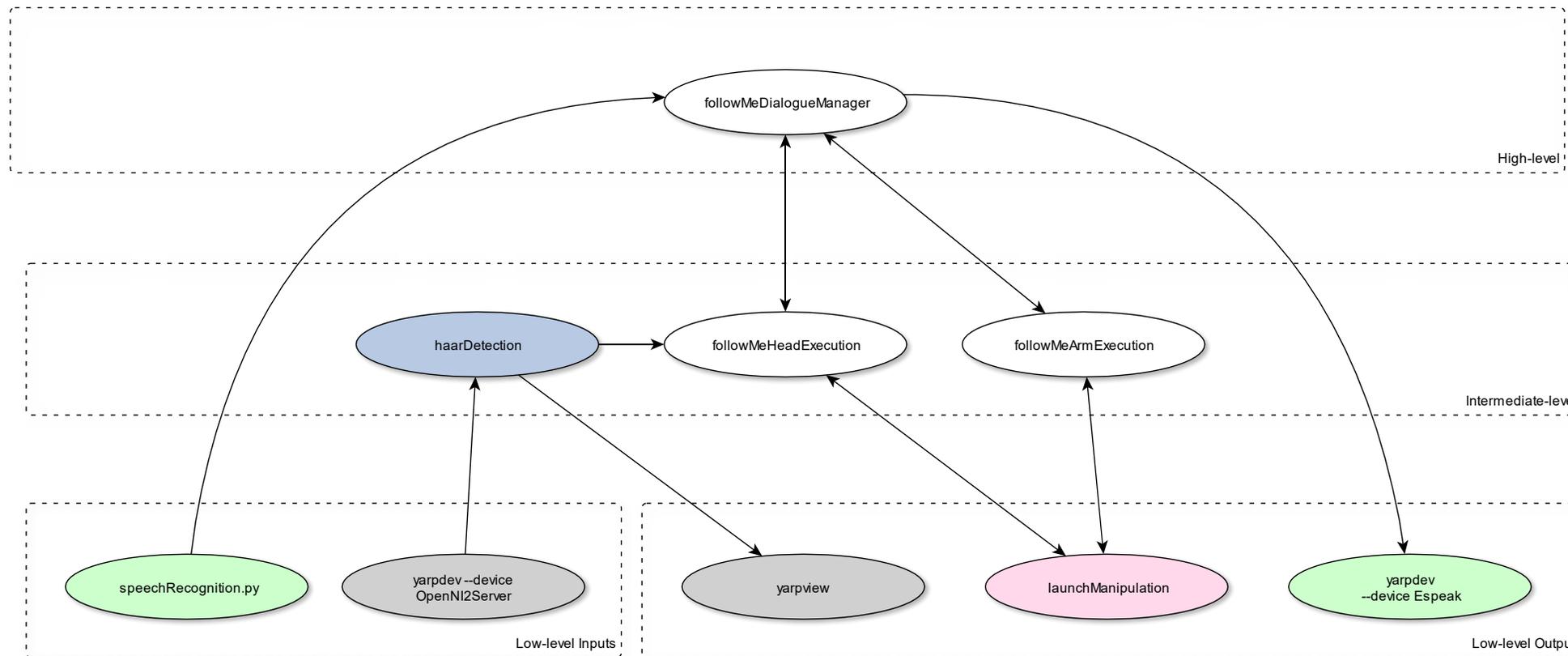
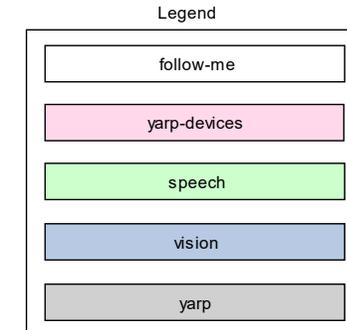
Global architecture

Hardware: TIAGo (PAL Robotics) (II)



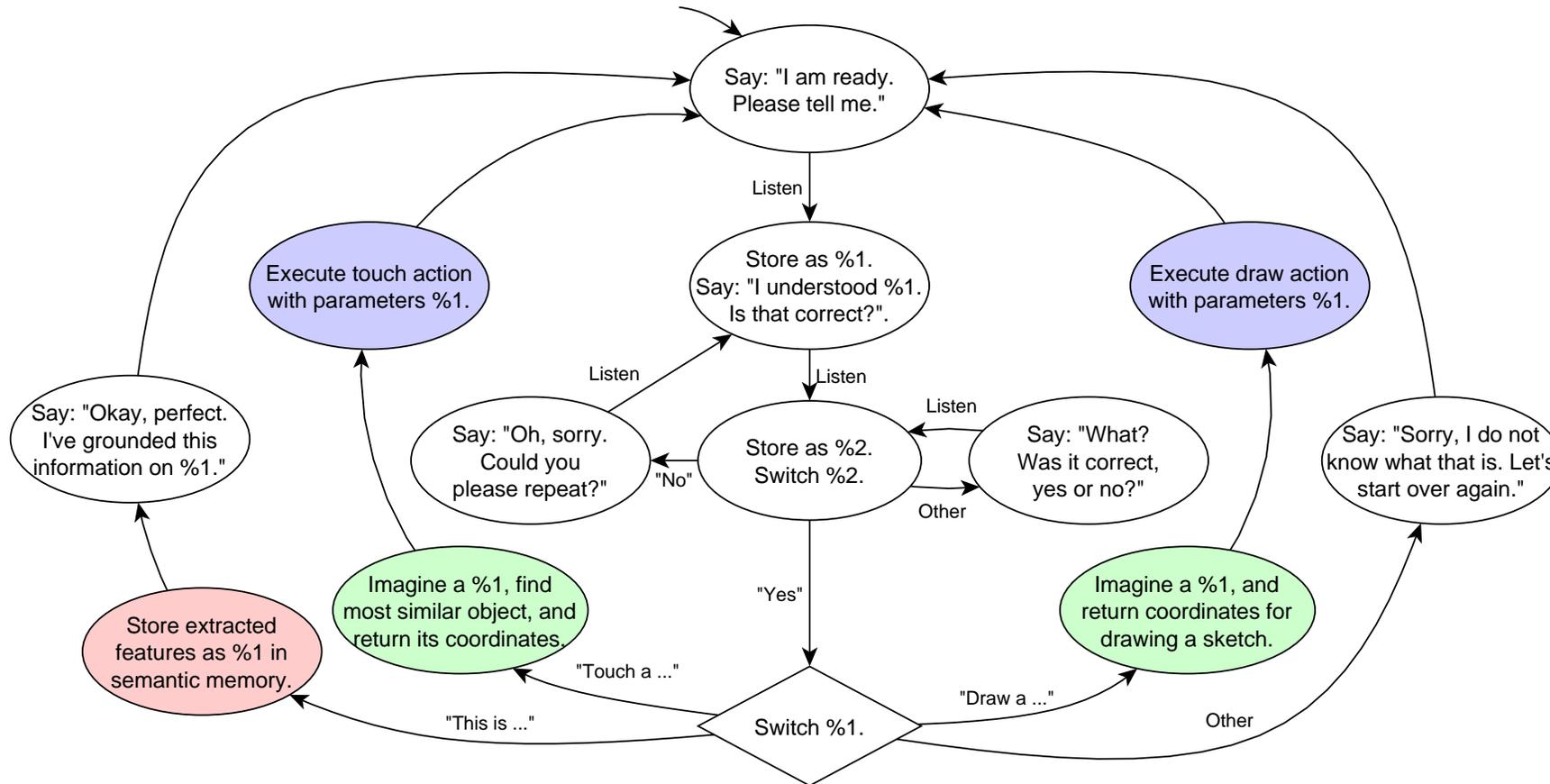
Global architecture

Software: Full-stack development (ROS/YARP middlewares)



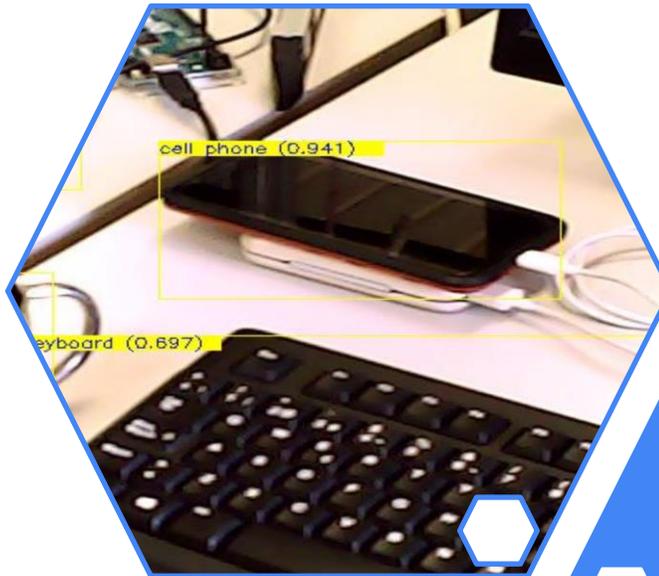
Global architecture

Software: Finite State Machine (typically ad-hoc for each competition task)



Global architecture

Software: YARP computer vision (I)

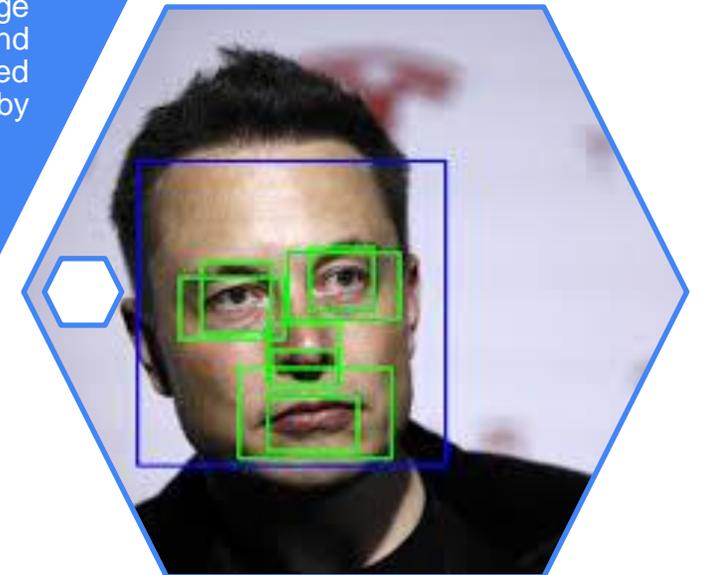


tensorflowDetection2D

- Online detection of objects and people in. Use of TensorFlow. YARP support.
- Incoming image reception by Port. Publish processed image and detections by YARP port, as well as detection coordinates.

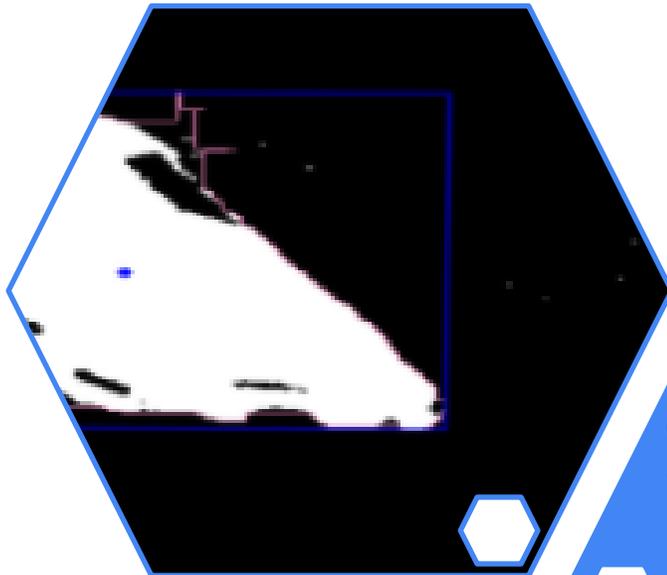
haarDetection2D

- Object and person detection using OpenCV Haar and LBP classifiers. Training done for 10 common objects.
- YARP support. Image reception by port and publication of processed image and detections by ports.



Global architecture

Software: YARP computer vision (II)



colorRegionDetection2D

- Detection of target color areas. Obtaining centroid and areas.
- YARP support. Image reception by port and publication of processed image and detections by ports.

facialRecognitionDetection

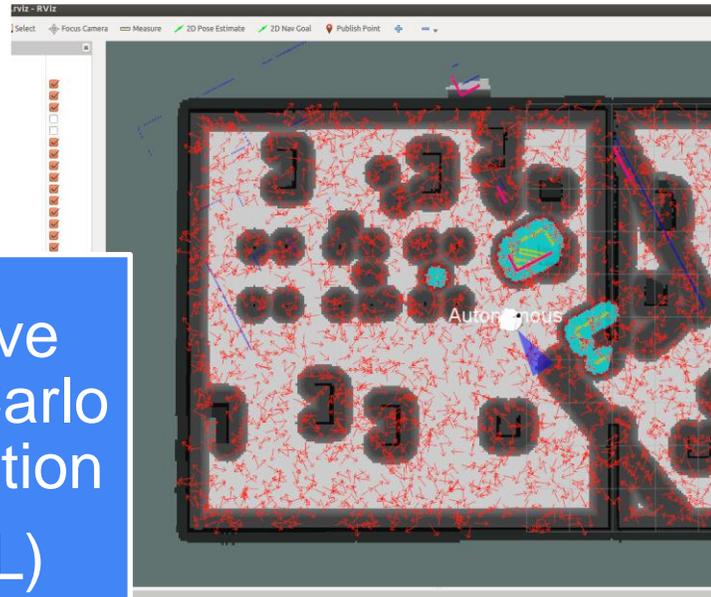
- Facial recognition of users in real time. Training based on a photograph of the user.
- Incoming image reception by port. Publish processed image and detections by YARP port, as well as detection of coordinates.



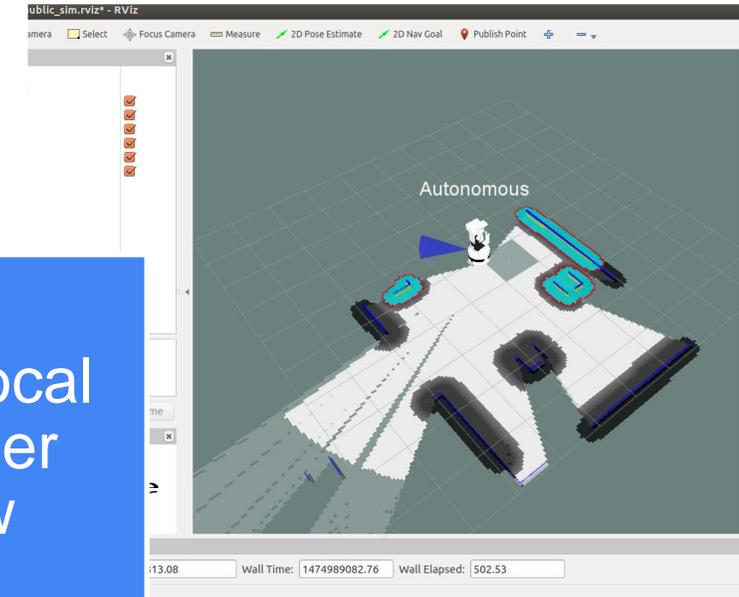
Global architecture

Software: ROS navigation stacks

Adaptive Monte Carlo Localization (AMCL)

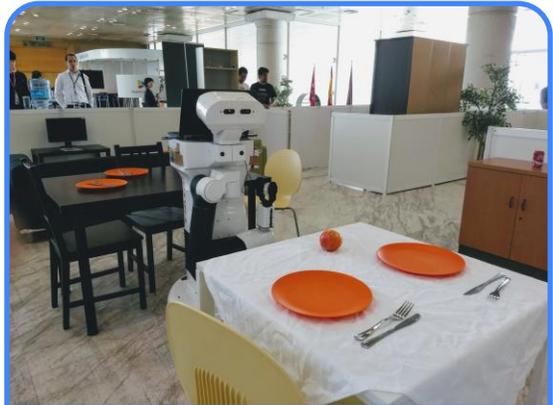


RViz local planner view



Target scenarios

Selection from ERL and SciRoc competitions



Visit my home



Catering for granny Annie's comfort



Take the elevator



Deliver coffee shop orders



Target scenarios

ERL: Visit my home



Visit my home



User tracking

1. User tracking
2. Detection of "STOP" for the end of the task
3. End of task indication



Navigation within the home

1. Navigation to the living room
 2. Navigation to the bedroom
 3. Navigation to the bathroom, user detection and request for passage
 4. Navigation to the living room
- Note: After 3 recalculations, activation of TTS and request for permission to pass



Access to the home

1. Detection of the door via computer vision
2. Approach door and wait for opening via laser sensor
3. Navigation to the approximation checkpoint within the home

Target scenarios

ERL: Catering for granny Annie's comfort



Catering for granny Annie's comfort



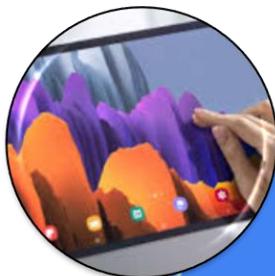
User tracking

1. User tracking
2. Detection of "STOP" for the end of the task
3. End of task indication



Search/Manipulation of objects

1. Navigation to areas of interest of possible location of the object
2. Search for the object by vision
3. If it is required to obtain the object, centering the robot by vision and execution of manipulation trajectory
4. User navigation



Movement towards user

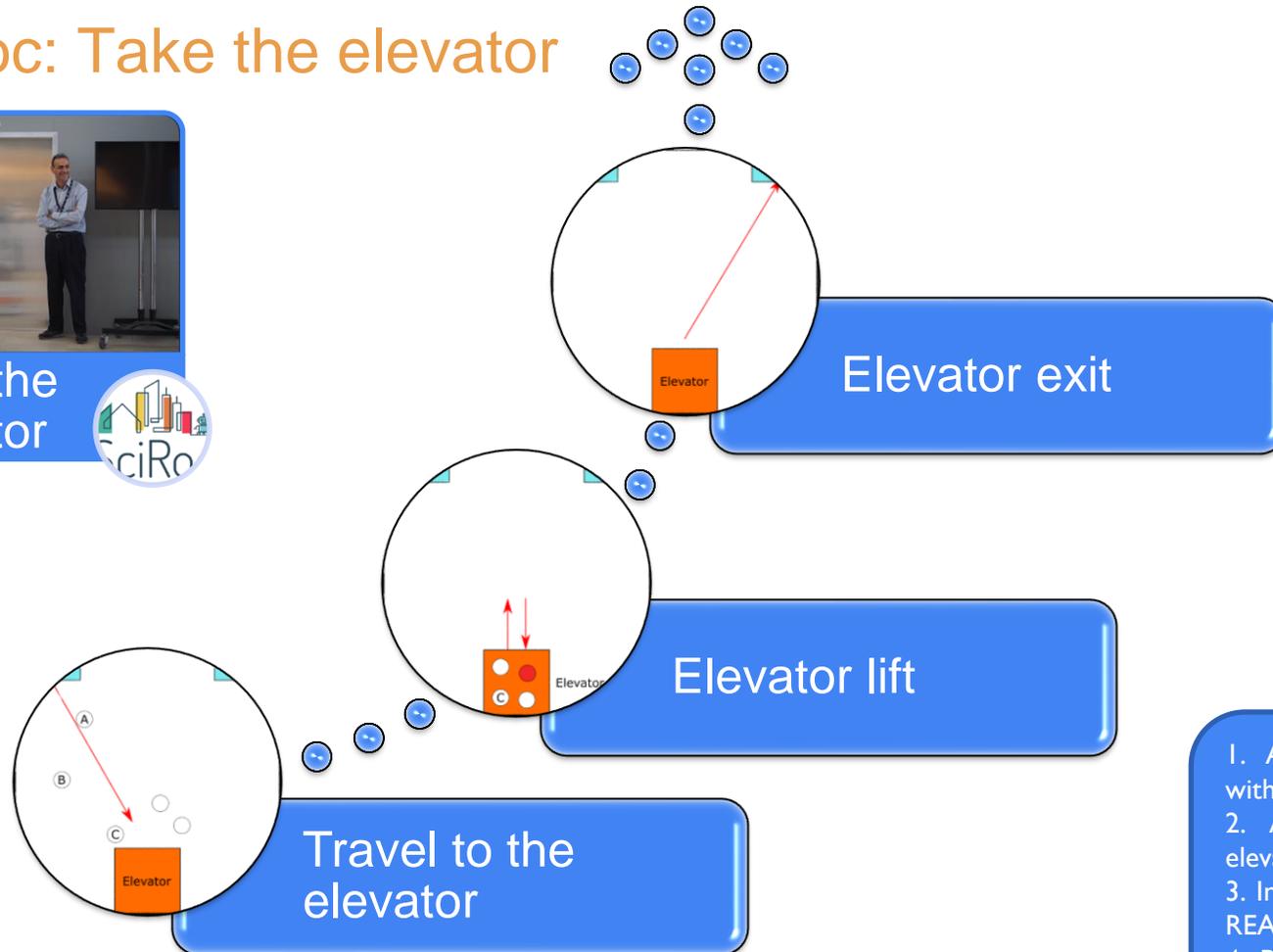
1. Request to the robot via Tablet
2. Navigation to user location
3. Interaction with the user and indication of object search, manipulation or monitoring

Target scenarios

SciRoc: Take the elevator



Take the elevator



1. Navigation to the departure approach checkpoint
2. Navigation to the final checkpoint
3. Indication of the end of the task

1. Obtaining floor via dataHub.
2. Navigation to checkpoint 1, user detection and no interaction
3. Navigation to checkpoint 2, user detection and interaction

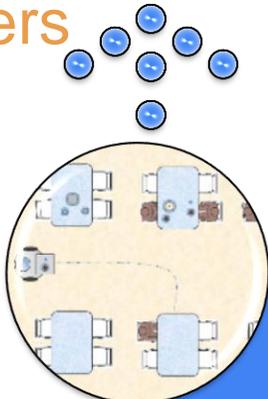
1. Approach the elevator, interaction with users
2. Allow passage and entry to the elevator
3. Indication of target plant and wait for READY
4. Priority to the user and exit of the elevator

Target scenarios

SciRoc: Deliver coffee shop orders



Deliver coffee shop orders



Transport of the petition

1. Wait for the "READY" commands to be issued
2. Navigation to the request checkpoint.
3. Wait for the reception of the "READY" commands
4. Navigation to the petition checkpoint



Cleaning/interaction with the client

1. Detection of the state of the table and cleaning
2. Taking orders from customers
3. Movement to the kitchen and indication of the requests



Movement towards the client

1. Wait for user petition: HELP, EXCUSE ME, SORRY, PLEASE ...
2. Localization of petition zone
3. Navigation to the petition checkpoint

Results of competitions

Results from ERL and SciRoc competitions



Visit my home

- Execution in simulation
- Execution in controlled environments
- Execution in real environments at IROS 2018
- Fulfillment of objectives and requirements
- Ranking 3rd position



Catering for granny Annie's comfort

- Execution in simulation
- Execution in controlled environments
- Execution in real environments at IROS 2018
- Fulfillment of objectives and requirements
- Ranking 3rd position



Take the elevator

- Execution in simulation
- Execution in controlled environments
- Execution in real environments at SciRoc 2019
- Fulfillment of objectives and requirements
- Continuous execution and failure recovery integrated in state machine



Deliver coffee shop orders

- Execution in simulation
- Execution in controlled environments
- Execution in real environments at SciRoc 2019
- Fulfillment of objectives and requirements





Results of competitions

Takeaways from ERL and SciRoc competitions

- Competitions as intermediate scenarios between “lab science” (academia) vs production and deployment (industry)
- Would be interesting to add robotic scenarios suitable for trends in end-to-end and/or Deep Reinforcement Learning solutions (e.g. simple tasks feasible to be formulated as an optimization problem)





Thank You!

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