Collaborative Robotics, digital skills and re-humanization of the workspace

ResearchXchange
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FNSNF
SWISS NATIONAL SCIENCE FOUNDATION

77 NFP **Digitale Transformation**
Nationales Forschungsprogramm

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Collaborative robotics, an opportunity for the industry 4.0

WHY ARE COBOTS NOT AGILE ENOUGH?

- Online programming requires fixed environments and is limited to simple tasks

- Intuitive programming apps require a model of the workspace which is too time consuming/complex

- Sensor integration often requires expert knowledge and reduces reactivity/profitability

FUNDAMENTAL VALUES OF AGILE MANUFACTURING

empower the **worker**

BOTTOM-UP

AUGMENTED WORKERS

TULIP
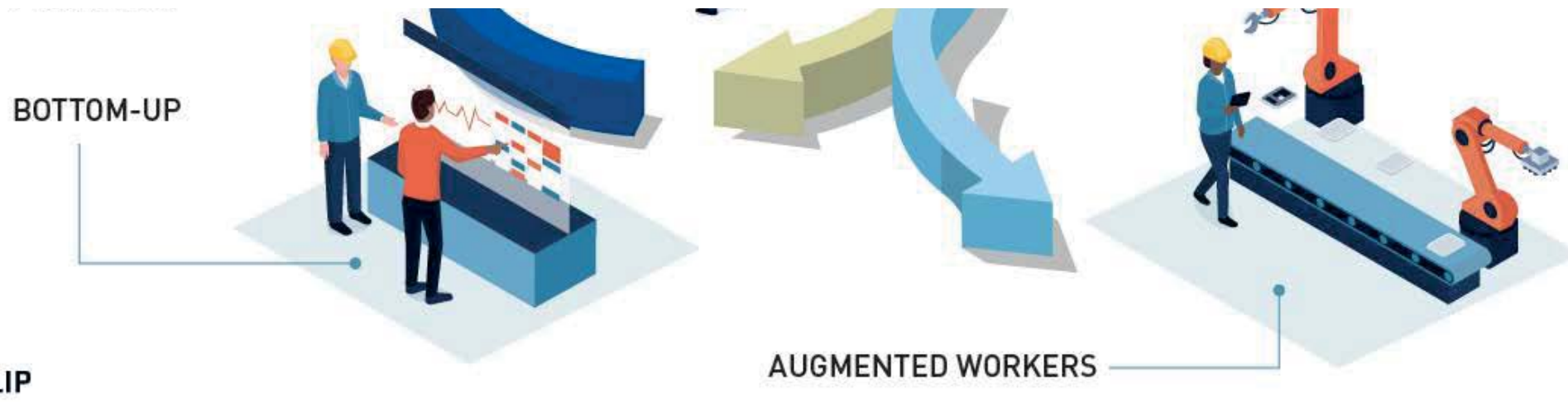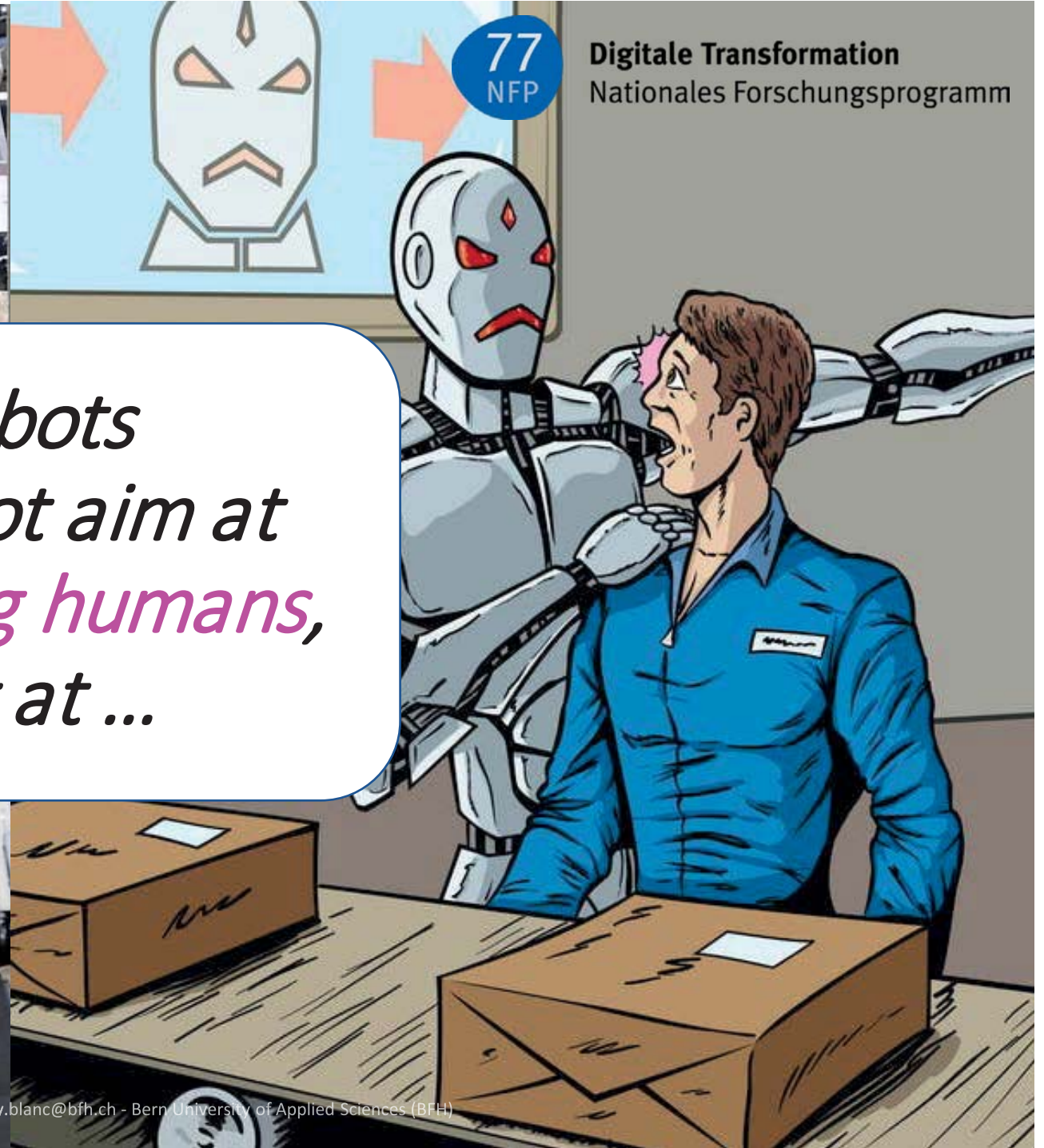
Robots
shall not aim at
replacing humans,
but at ...

Leveraging on *human-machine complementarity*

Digitale Transformation
Nationales Forschungsprogramm

Agile manufacturing is about …

creativity
adaptability
flexibility
reactivity
continuous improvement

… and that is exactly what humans are good at

Humans are magnificent machines.

Real Intelligence.

Excellent visual context analysis.

Mobile articulated grippers.

tulip.co/agile-manufacturing

EFFECTIVE FLEXIBLE AUTOMATION

Sense → Gather Information about Surroundings
Vision System, Force Sensor, Laser

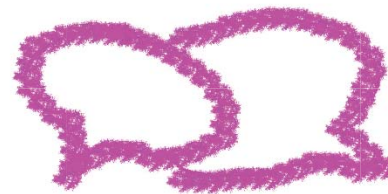**Think** → Using Known and Sensed Information
PC, Software — *Worker*

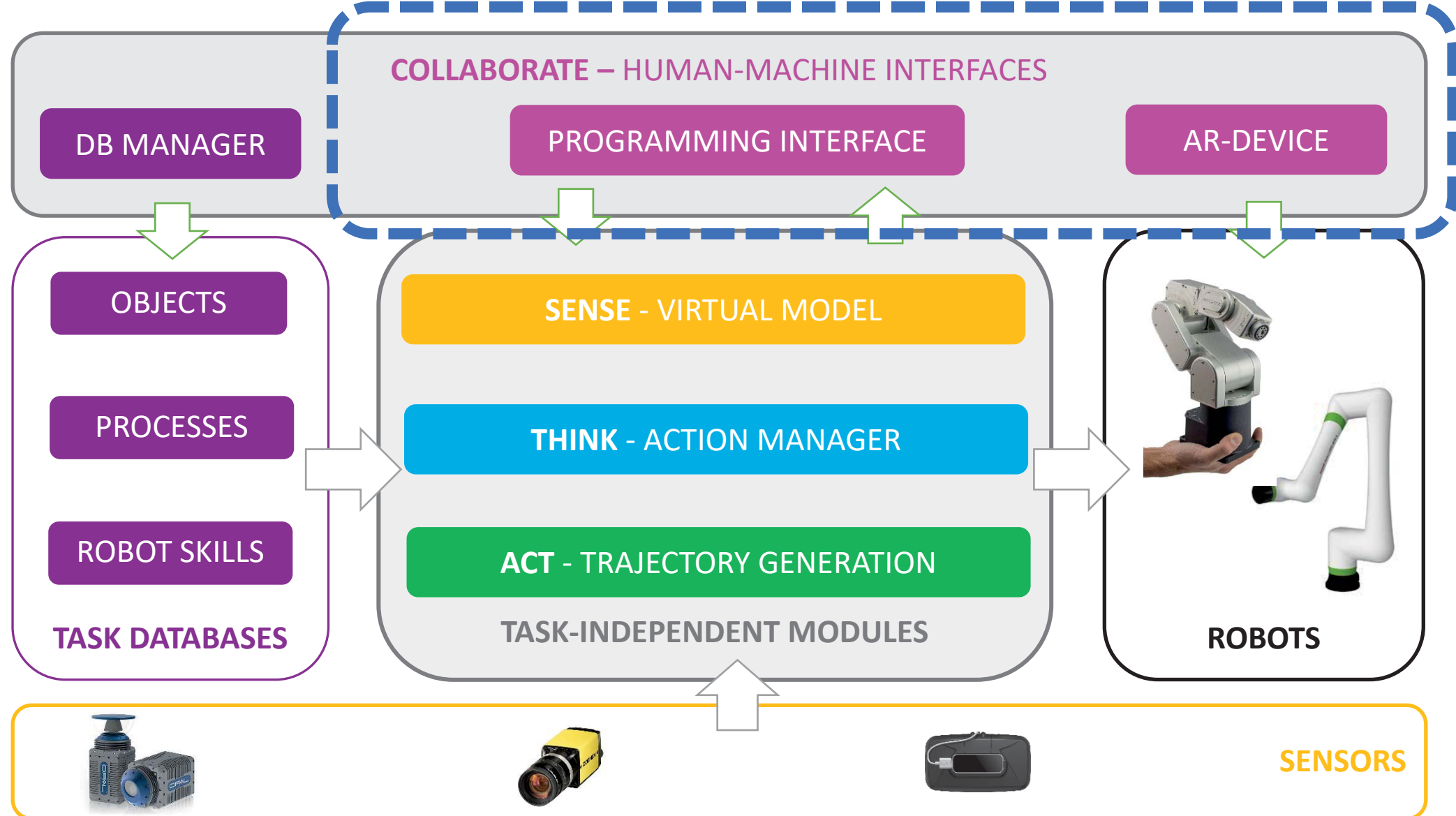**Act** → Complete Task
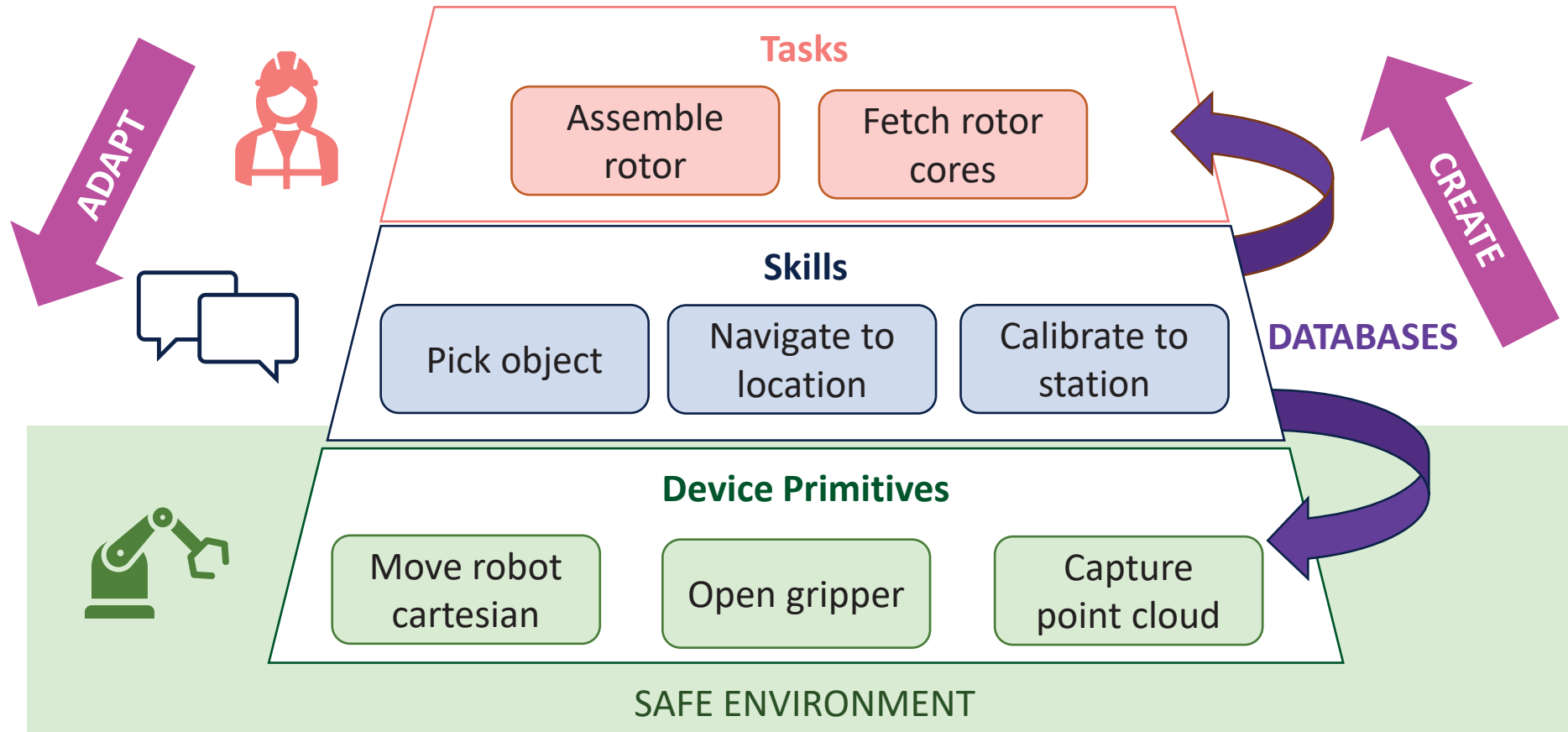Robot, Gantry, Gripper, Actuator

COLLABORATE

Share information

Worker

https://medium.com/hausbots/what-is-a-robot-347fe2460db9

SOFTWARE ARCHITECTURE

COLLABORATE – HUMAN-MACHINE INTERFACES

DB MANAGER

PROGRAMMING INTERFACE

AR-DEVICE

OBJECTS

PROCESSES

ROBOT SKILLS

TASK DATABASES

SENSE - VIRTUAL MODEL

THINK - ACTION MANAGER

ACT - TRAJECTORY GENERATION

TASK-INDEPENDENT MODULES

ROBOTS

SENSORS

FLEXIBLE HMIs

Tasks

Assemble rotor

Fetch rotor cores

Skills

Pick object

Navigate to location

Calibrate to station

Device Primitives

Move robot cartesian

Open gripper

Capture point cloud

SAFE ENVIRONMENT

ADAPT

CREATE

DATABASES

Adapted from: Schou et al (2018) "Skill-Based Instruction of Collaborative Robots in Industrial Settings."
Robotics and Computer- Integrated Manufacturing 53

TASK BASED PROGRAMMING : EXAMPLE
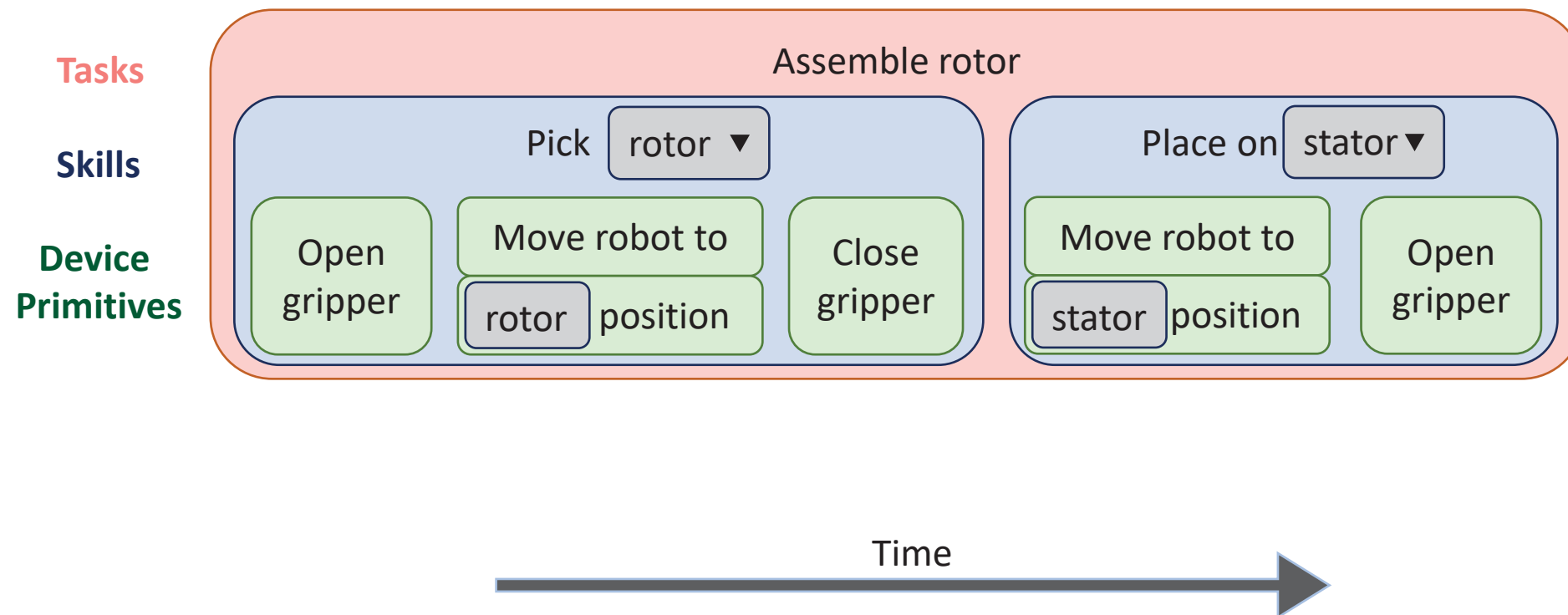
Tasks

Skills

Device Primitives

Assemble rotor

Pick [rotor ▼]

| Open gripper | Move robot to [rotor] position | Close gripper |

Place on [stator ▼]

| Move robot to [stator] position | Open gripper |

Time →

TASK BASED PROGRAMMING : INTERFACE

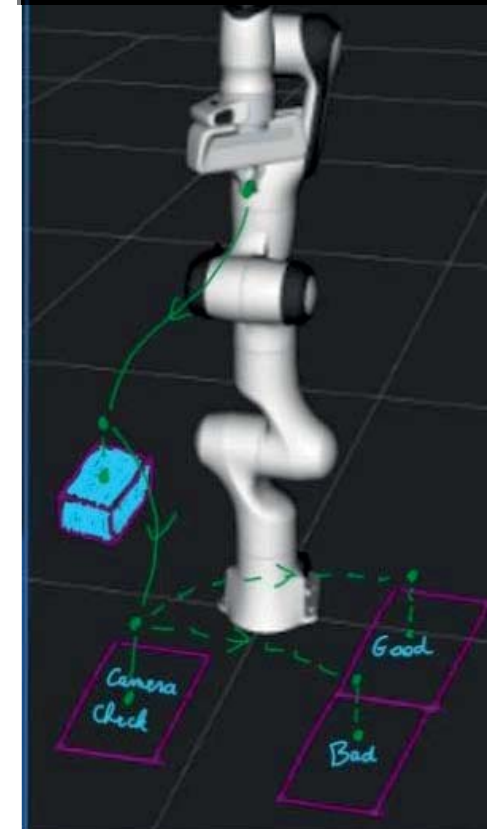# TASK BASED PROGRAMMING : EXECUTION

TUTORIAL PROGRAMMING

Pick and place
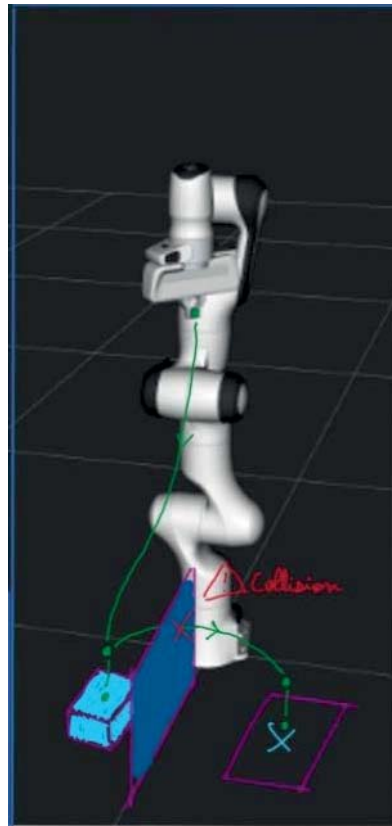(Concept of block and parameter)
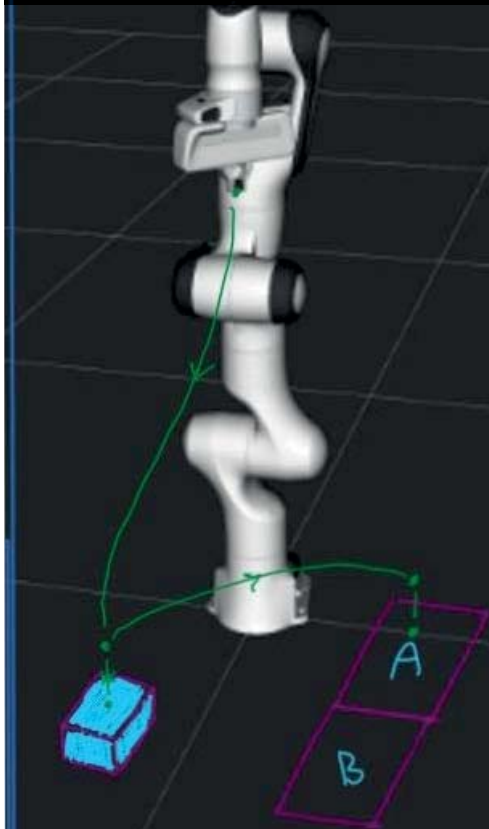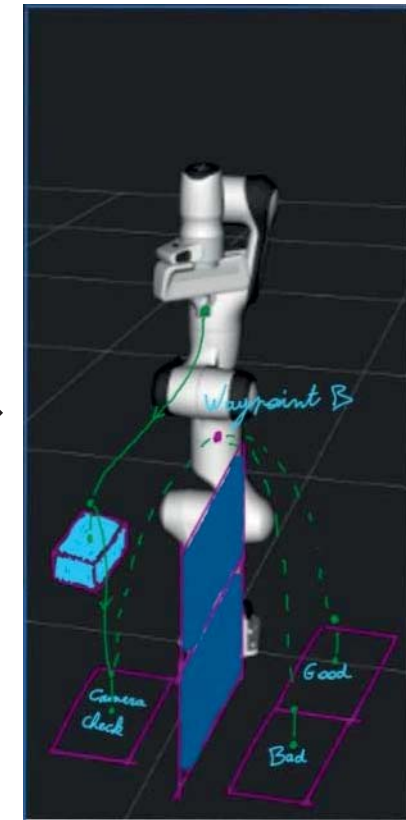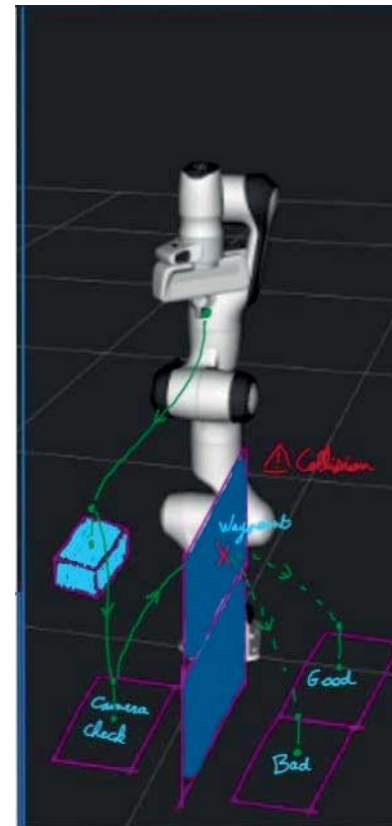
Paletizing
(Concept of loop)
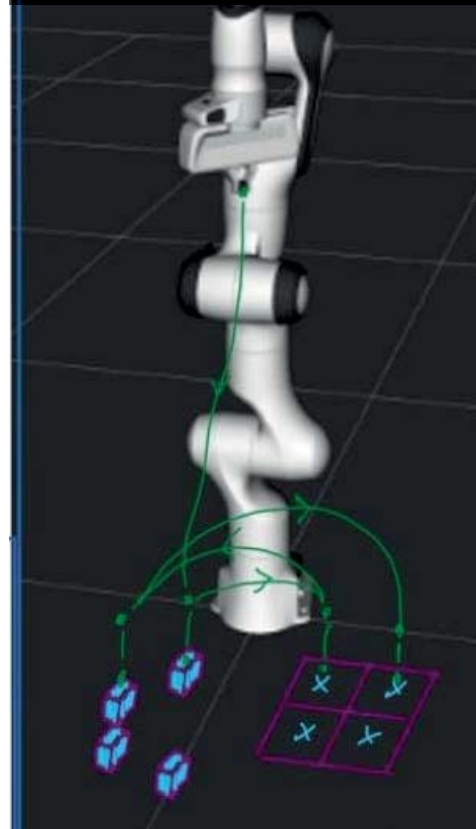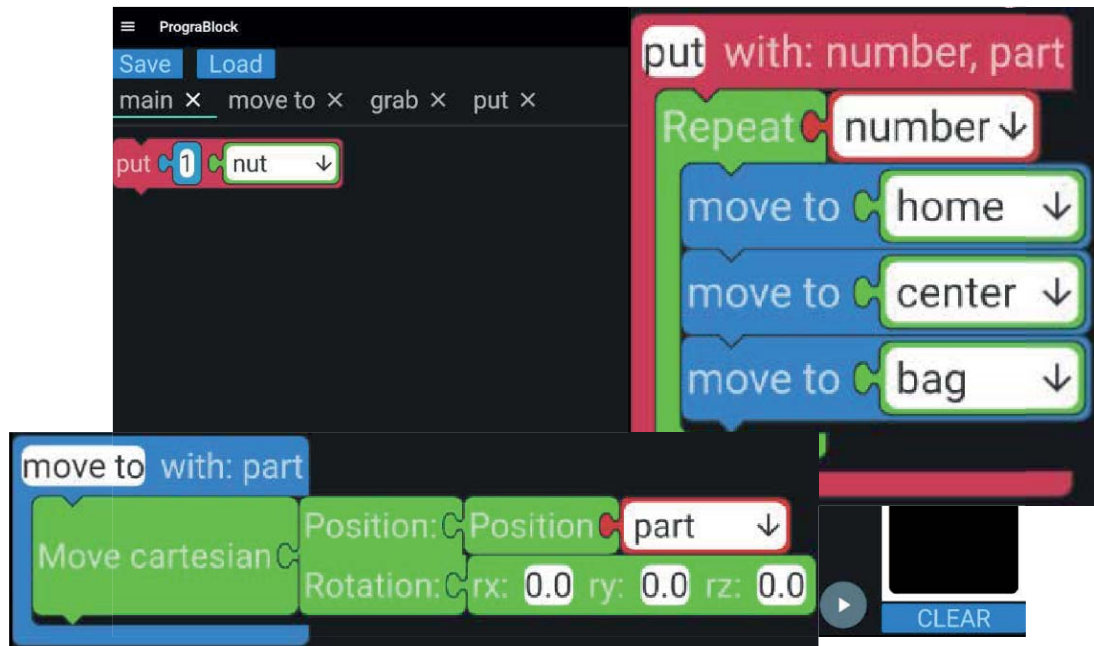
Sorting
(Concept of conditions)

TUTORIAL ROBOTICS
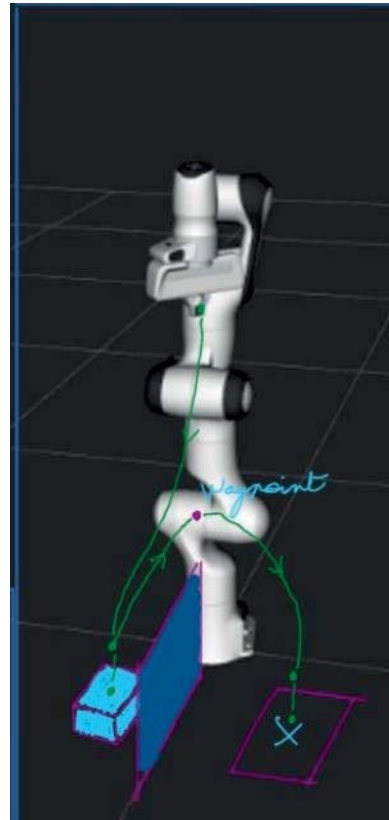
Pick, navigate to and place
(Creation of waypoint)

Sorting with viapoint modified
(Modification of waypoint)

PAPER PROTOTYPE

WORK IN PROGRESS : LEARNING SKILLS

2 co-design workshops:
- Interface design with technicians from our industrial partners
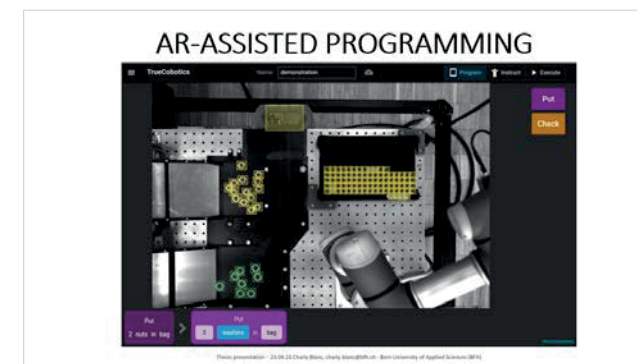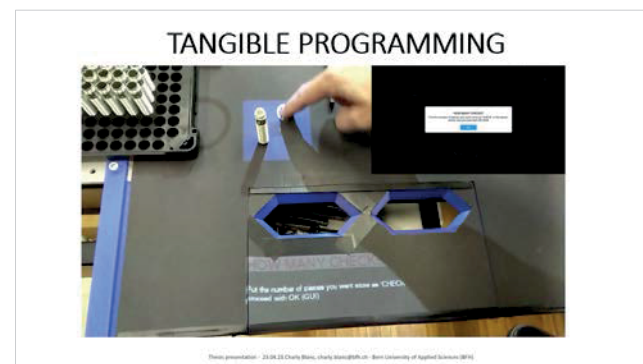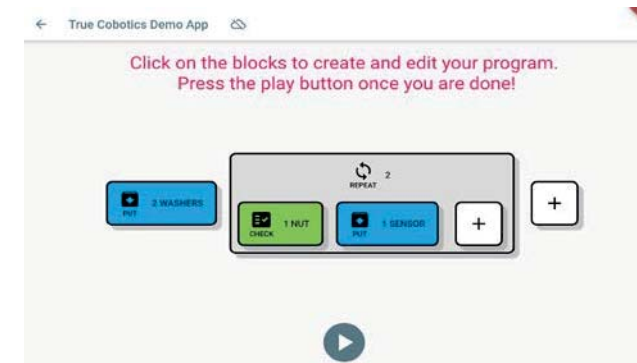- Interface usability with target users (with the support of UNIA)

In collaboration with BFH – Soziale Arbeit

USE CASE : SENSOR PACKAGING

HOW TO IMPROVE THE INTERACTION

GUIDANCE

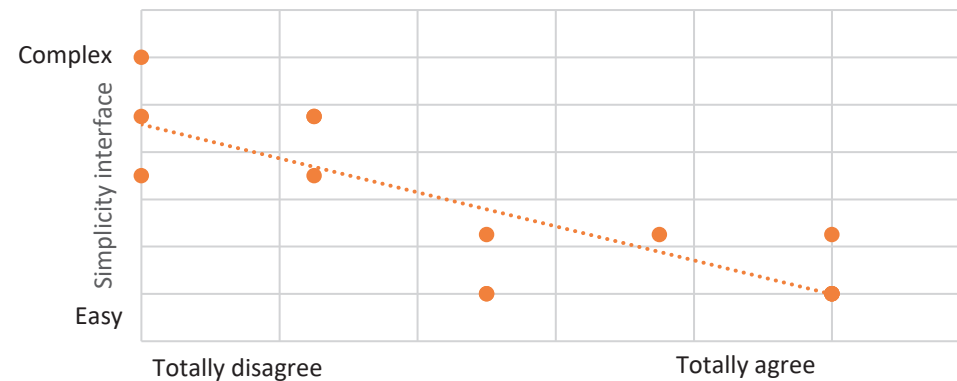contact: Valentin.Roesler@sipbb.ch

NATURAL LANGUAGE PROGRAMMING

Try the demo yourself:
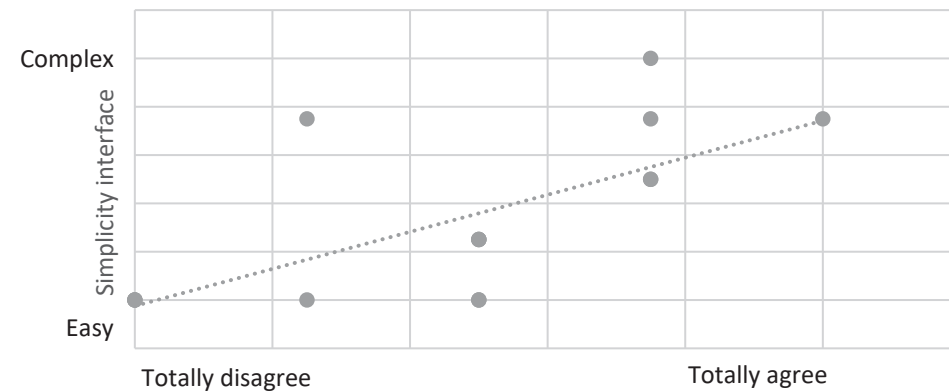https://urfree-robot.web.app

EXPERIMENT : MUSEUM EXPO RESULTS

I would like to better understand how the robot works (15 participants)

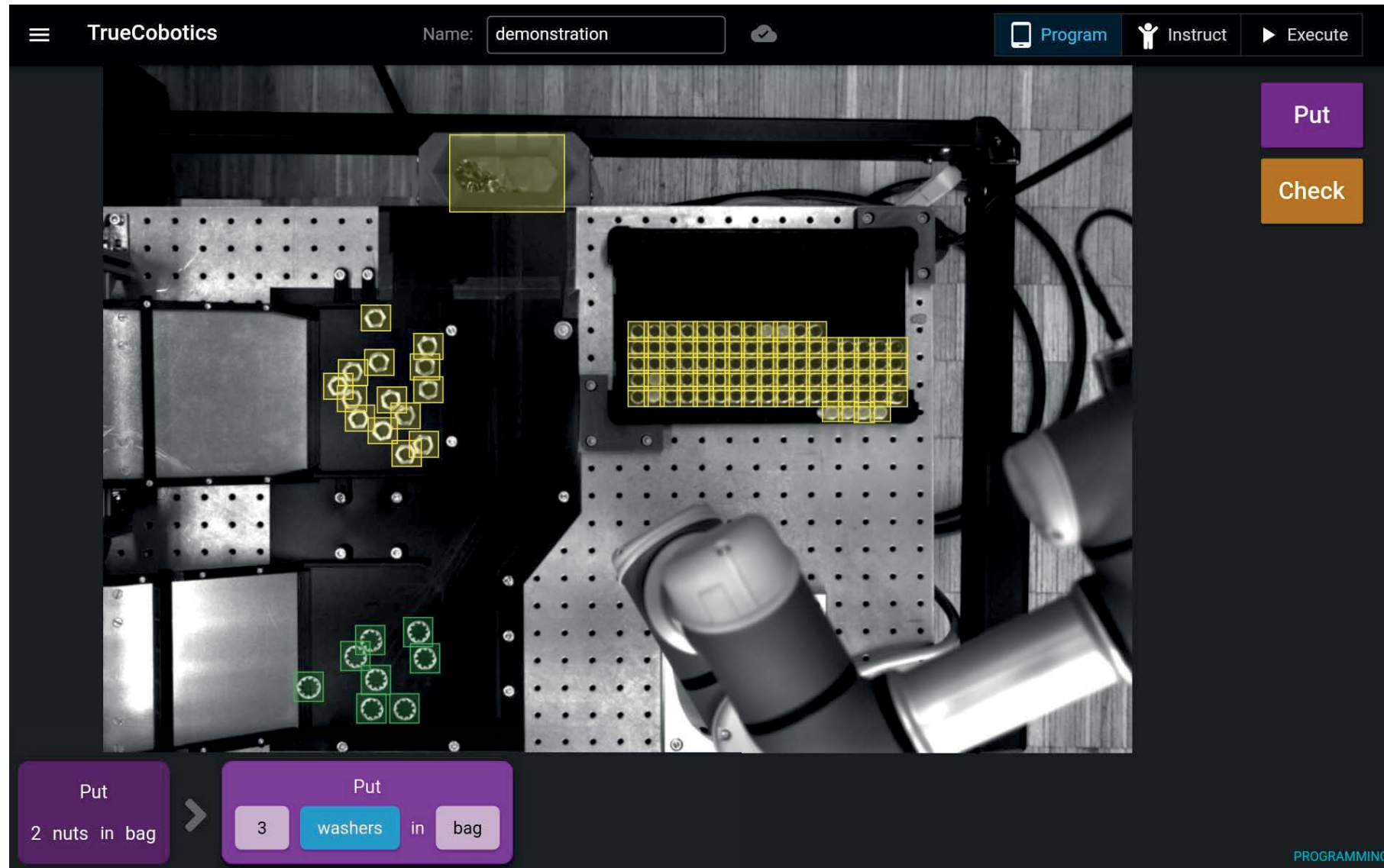I would be afraid to damage the robot while using it (15 participants)

Simple interface :
- Feeling of safety and control over the machine
- Willing to go futher in the learning process

TANGIBLE PROGRAMMING

AR-ASSISTED PROGRAMMING

Questions

- How to empower the user?

- What is the best approach to acquire autonomy in robotic programming, between group exercises (Problem-Based Learning) and individual guided tutorials (Didactic Learning)?

- What are the advantages of using tangible programming?

- What are the benefits using AR/VR for robot programing?

Thank you for your attention!

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With the contribution of

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