

complAI

Collaborative Model-Based Process Assessment for trustworthy
AI in Robotic Platforms



Funded by FFG via „Ideenlab 4.0“

The FFG-Project complAI: Focus on Robot Interaction

Project Fact Sheet



www.boc-group.com



BOC Asset Management GmbH
<https://www.boc-group.com/de/>

JOANNEUM RESEARCH ROBOTICS
www.joanneum.at/robotics



UNIVERSITY OF VIENNA – INSTITUTE of PHILOSOPHY
<https://philtech.univie.ac.at/>



**Johannes Kepler University Linz –
Department for Criminal Law**
<https://www.jku.at/institut-fuer-strafrechtswissenschaften/>

Funding: *FFG – Austrian Research Promotion Agency*

Project Type: *Study*

Start: *01.02.2020*

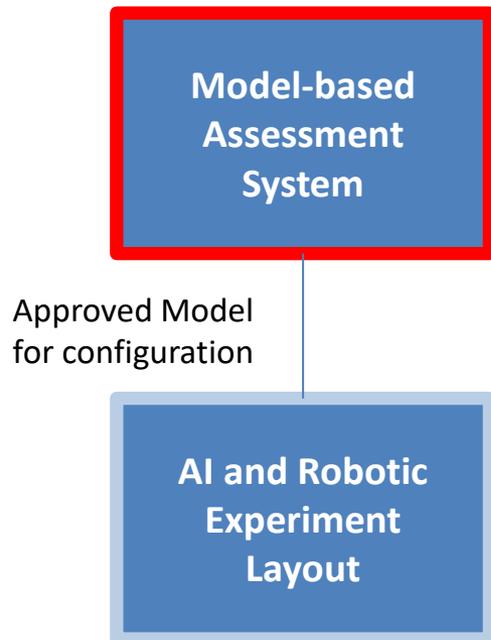
End: *31.01.2021*

Project Budget: *241.678 EUR*

Project Idea

Challenge:

How to model AI, Robotic and assess compliance

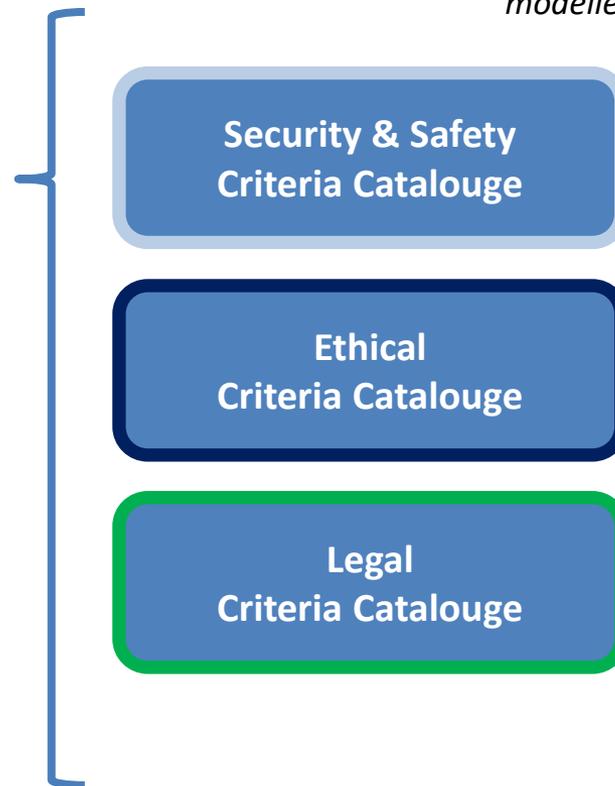


Challenge:

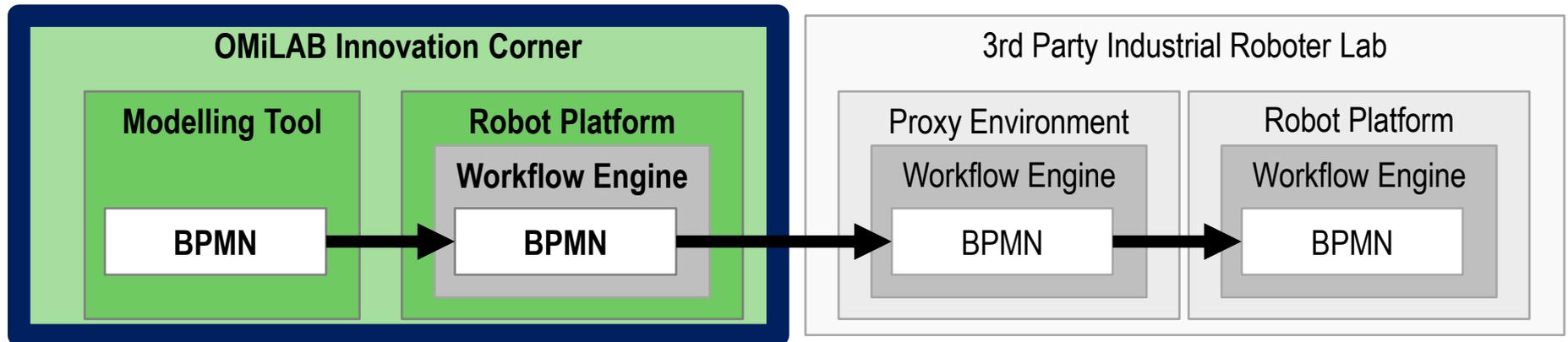
How to operate compliant model on robotic platform

Challenge:

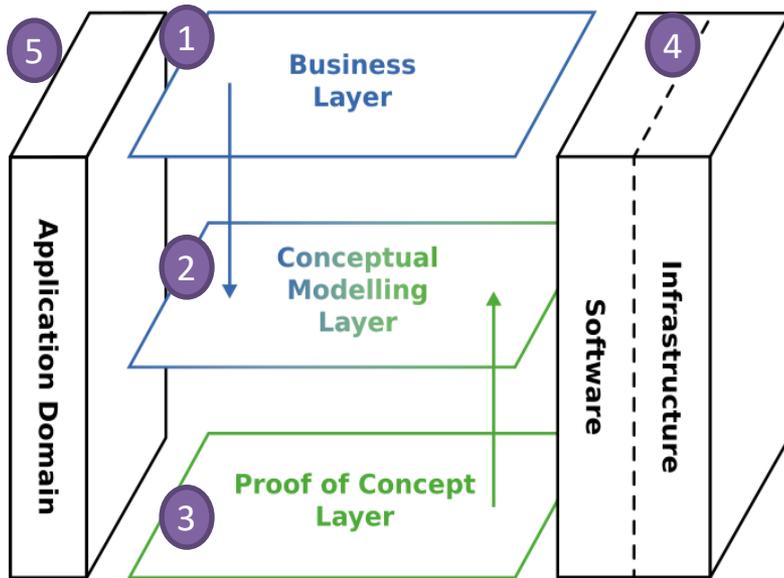
How to create criteria catalogues that can be modelled and assessed



OMiLAB Innovation Corner



Digital Transformation using OMiLAB – Open Innovation Corner



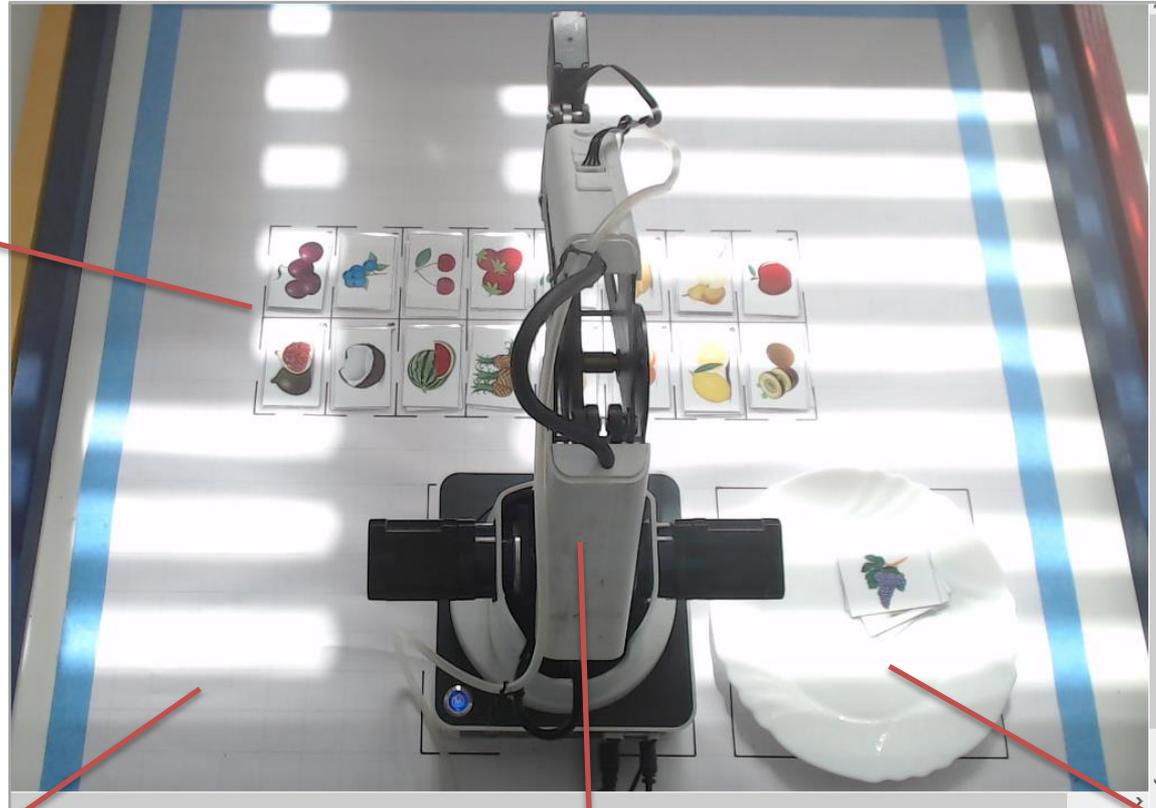
Innovate, Develop and Evaluate Digital Services considering:

1. **Scenario Layer** – using Scene2Model Environment
2. **Conceptual Model Layer** – using the Bee-Up Tool
3. **Run-time Layer** – using Dobot Magician, Makeblock mbot
4. **Software** – using ADOxx, OLIVE, ...
5. **Application Domain:** i.e. Factory of the Future

OMiLAB Innovation Corner Setting

Live-Stream to Dobot Magician in BOC-OMiLAB Innovation Corner:

https://lab.boc-group.eu/Dobot_Magician_1_onboard/



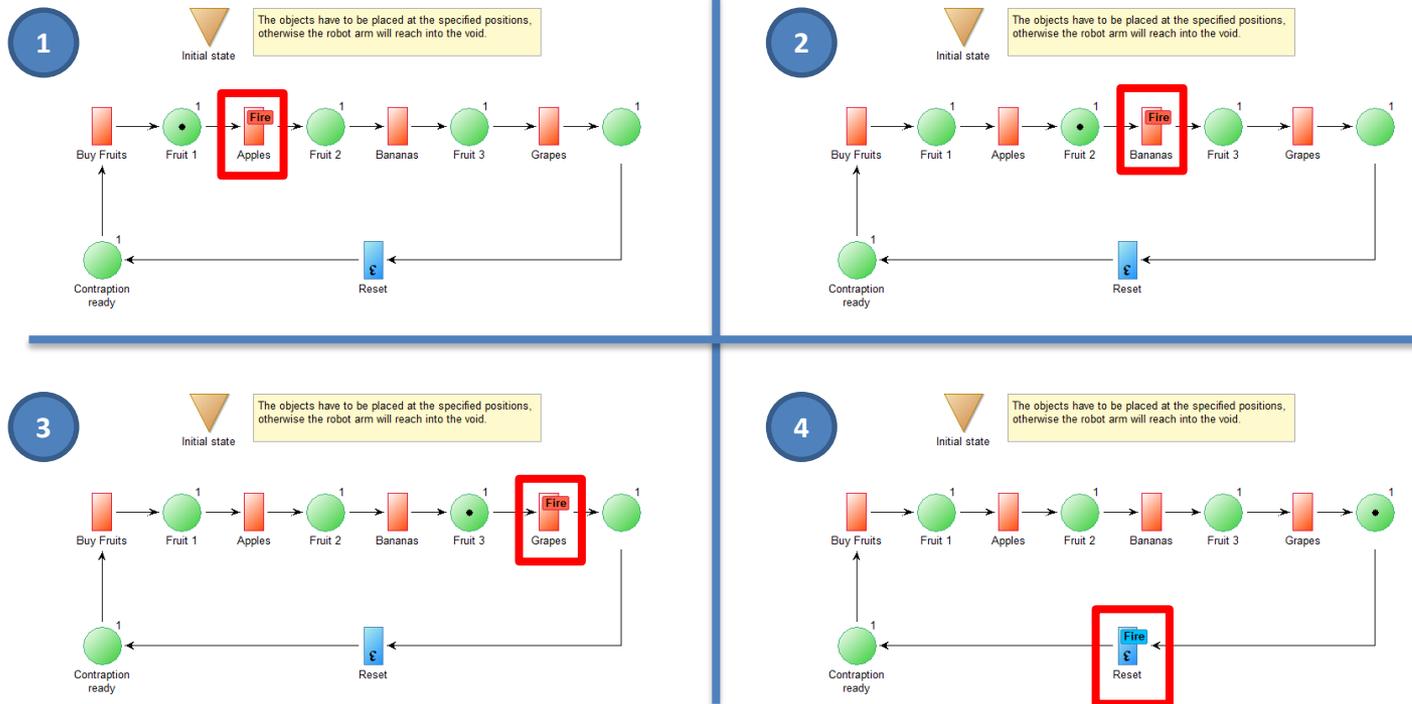
Product Range

Experimentation Environment

Robot Arm „Dobot Magician“

Shopping Basket

„Pick-and-Place“ of Fixed Sequence using Petri-Net



Characteristic:

- Fixed Sequence
- Robot-Arm API interaction is implemented in transitions
- Orchestration is performed by model changes

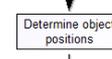
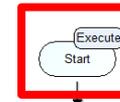
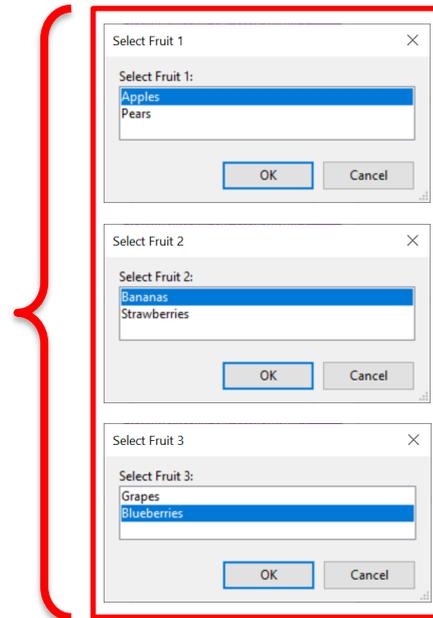
„Pick-and-Place“ of Fixed Sequence using Petri-Net

[Demo Video:
Fixed Sequence using Petri Net](#)

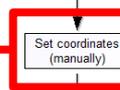
„Pick-and-Place“ of Variable Sequence using Flow Chart

```

Set coordinates (manually) (Operation (F) - Operation code)
# Selection Fruit 1
CC "AdoScript" LISTBOX entries:("Apples@Pears") toksep:("@" selection:("Apples") title:("Select Fruit 1") boxtext:("Select Fruit 1"))
IF (selection = "Apples") {
  SETL xFruit1:(yPos1)
  SETL yFruit1:(yPos1)
}
IF (selection = "Pears") {
  SETL xFruit1:(yPos2)
  SETL yFruit1:(yPos2)
}
# Selection Fruit 2
CC "AdoScript" LISTBOX entries:("Bananas@Strawberries") toksep:("@" selection:("Bananas") title:("Select Fruit 2") boxtext:("Select Fruit 2"))
IF (selection = "Bananas") {
  SETL xFruit2:(yPos3)
  SETL yFruit2:(yPos3)
}
IF (selection = "Strawberries") {
  SETL xFruit2:(yPos5)
  SETL yFruit2:(yPos5)
}
# Selection Fruit 3
CC "AdoScript" LISTBOX entries:("Grapes@Blueberries") toksep:("@" selection:("Grapes") title:("Select Fruit 3") boxtext:("Select Fruit 3"))
IF (selection = "Grapes") {
  SETL xFruit3:(yPos4)
  SETL yFruit3:(yPos4)
}
IF (selection = "Blueberries") {
  SETL xFruit3:(yPos7)
  SETL yFruit3:(yPos7)
}
958 characters
  
```



The objects have to be placed at the specified positions, otherwise the robot arm will reach into the void. (Requires Bee-Up 1.5 or newer.)



Manually entered coordinates

```

# Apples
SETL xPos1:(256)
SETL yPos1:(-158)

# Pears
SETL xPos2:(256)
SETL yPos2:(-107)

# Bananas
SETL xPos3:(256)
SETL yPos3:(-57)

# Grapes
SETL xPos4:(256)
SETL yPos4:(-9)

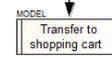
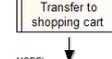
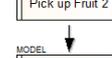
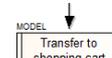
# Strawberries
SETL xPos5:(256)
SETL yPos5:(40)

# Cherries
SETL xPos6:(256)
SETL yPos6:(88)

# Blueberries
SETL xPos7:(256)
SETL yPos7:(135)

# Plums
SETL xPos8:(256)
SETL yPos8:(186)

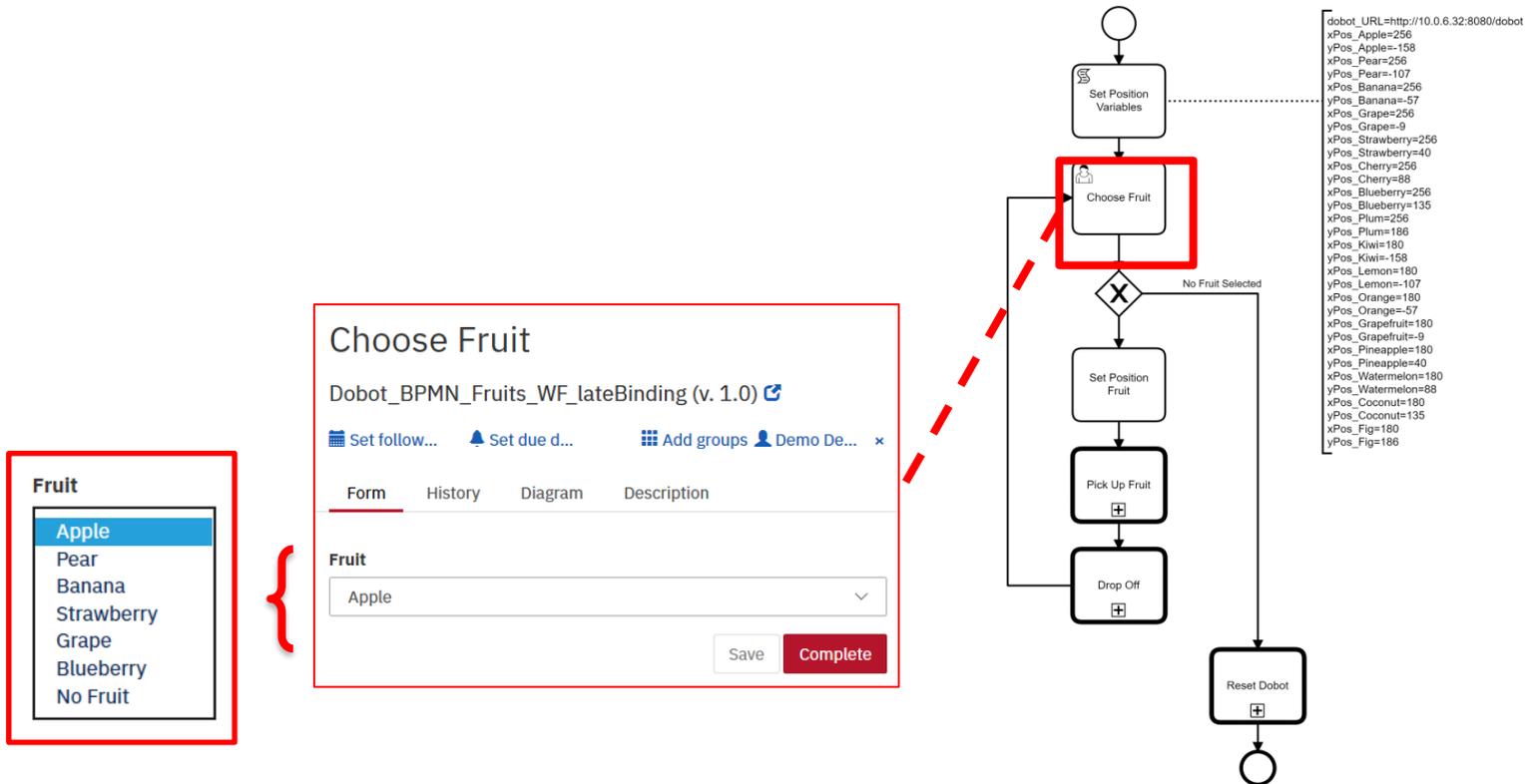
...
  
```



Characteristic:

- Fixed Sequence with variable „Picks“
- Robot-Arm API interaction is implemented in sub-processes
- Resource Allocation is performed by external service

„Pick-and-Place“ Adaptive Sequence with BPMN

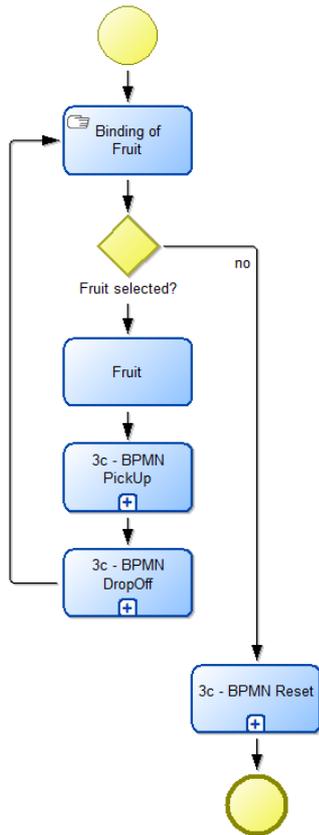


Characteristic:

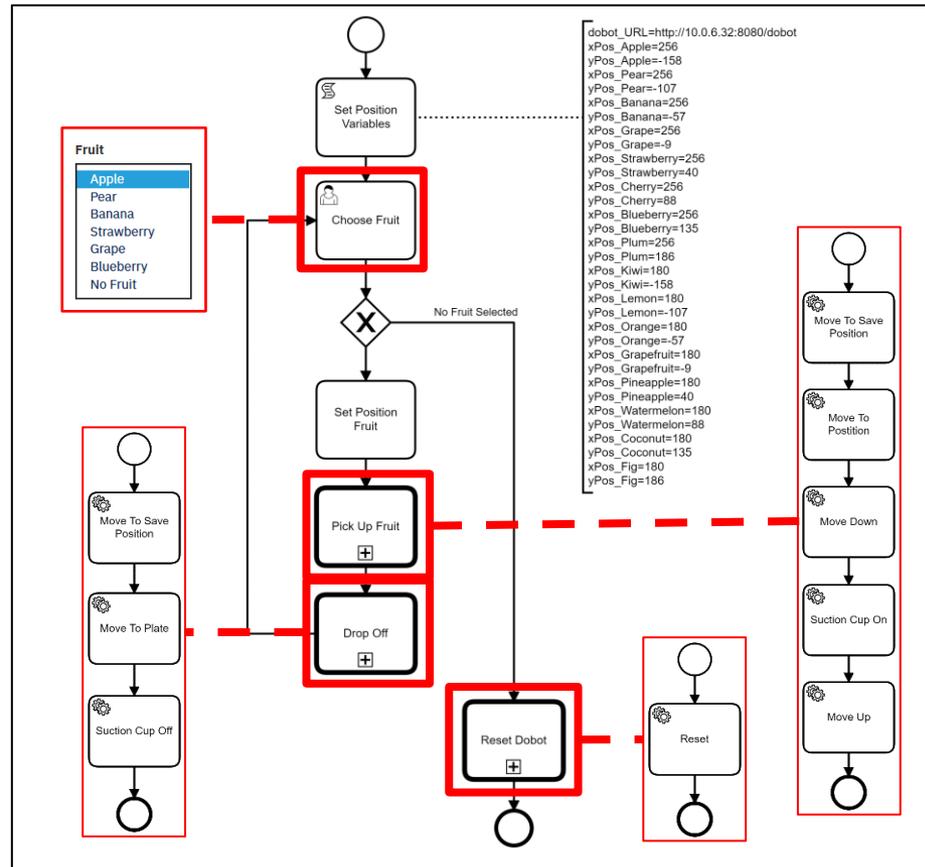
- Adaptive Sequence with variable „Picks“
- Robot-Arm API interaction is implemented in sub-processes
- Orchestration is performed by Workflow Engine using external services

„Pick-and-Place“ Adaptive Sequence with – whole BPMN Stack

BPMN



BPMN for Workflow Engine



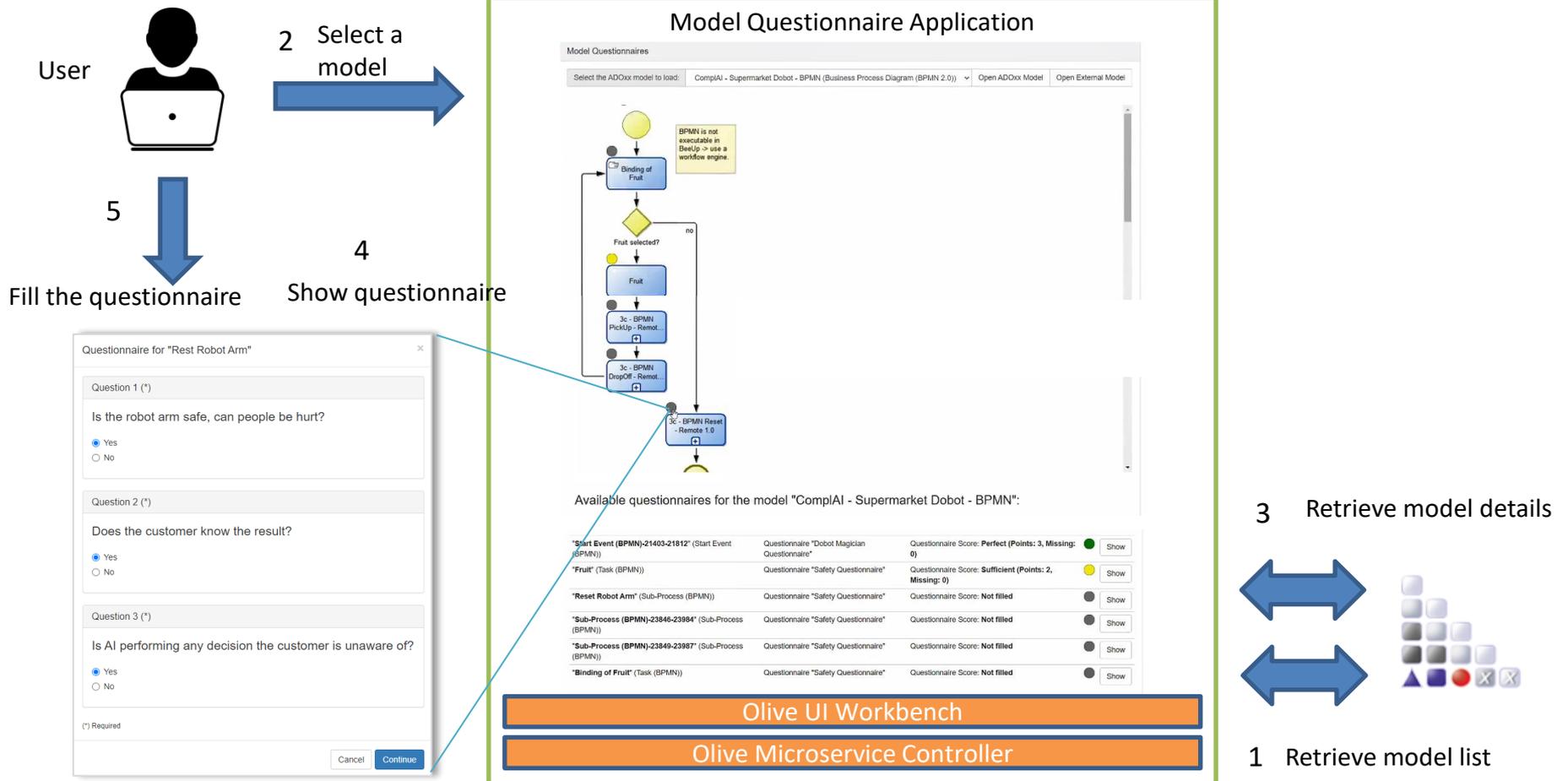
Robot Arm



„Pick-and-Place“ Adaptive Sequence with BPMN

[Demo Video:
Adaptive Sequence with BPMN](#)

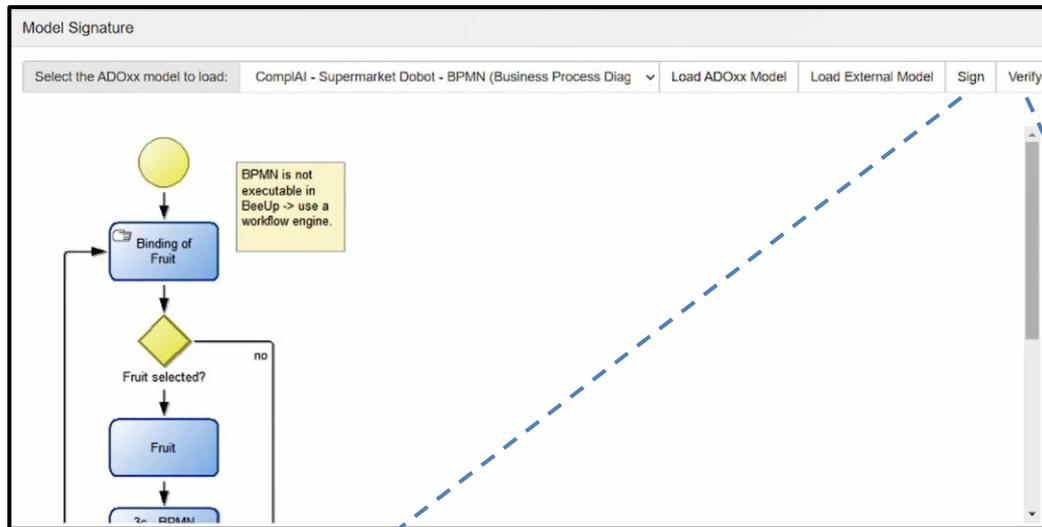
Legal, Ethical and Security Assessment of the Workflow using Questionnaires



Legal, Ethical and Security Assessment of the Workflow using Questionnaires

[Demo Video:](#)
[Assessment Questionnaire](#)

Legal, Ethical and Security Approval of the Workflow using Digital Signature



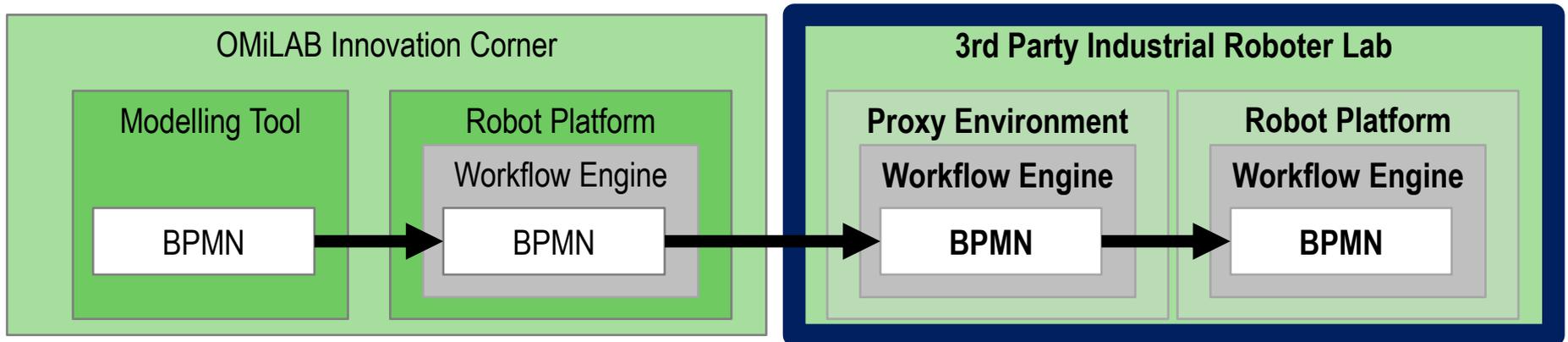
The 'Log-in' dialog box contains two input fields: 'Username:' with the value 'model_owner' and 'Password:' with masked characters '*****'. At the bottom right, there are 'Cancel' and 'Continue' buttons. A dashed blue line connects the 'Continue' button to the 'Valid signatures for the model' table.

Valid signatures for the model	
Users: "domain_advisor"	Applied on "2020-08-10 17:33:49"
Users: "model_owner"	Applied on "2020-08-10 17:33:26"
Users: "technical_advisor"	Applied on "2020-08-10 17:33:37"

Legal, Ethical and Security Approval of the Workflow using Digital Signature

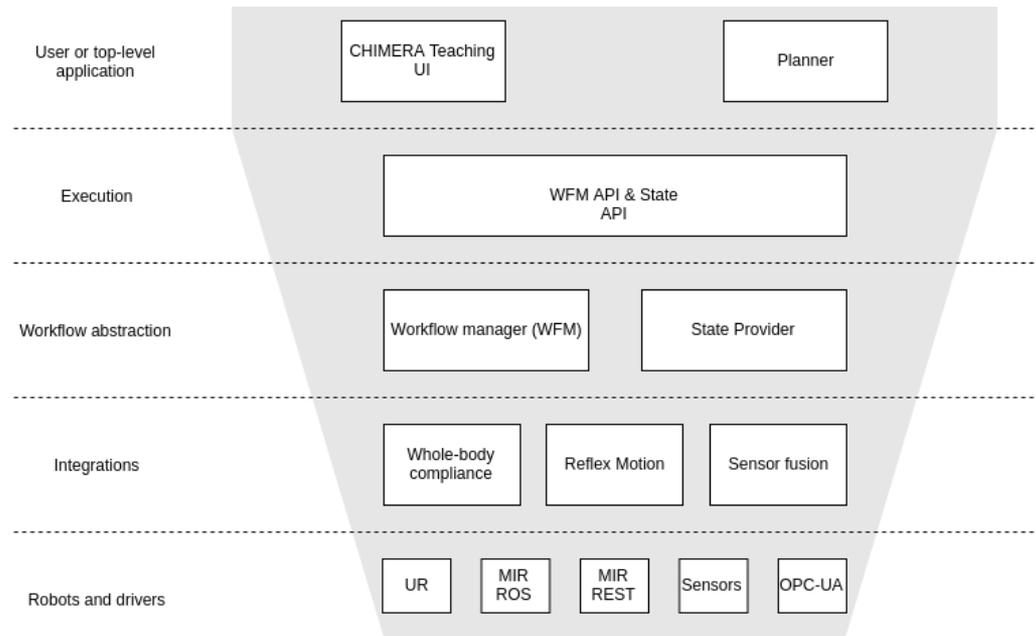
[Demo Video:](#)
[Digital Signature](#)

Industrial Roboter LAB



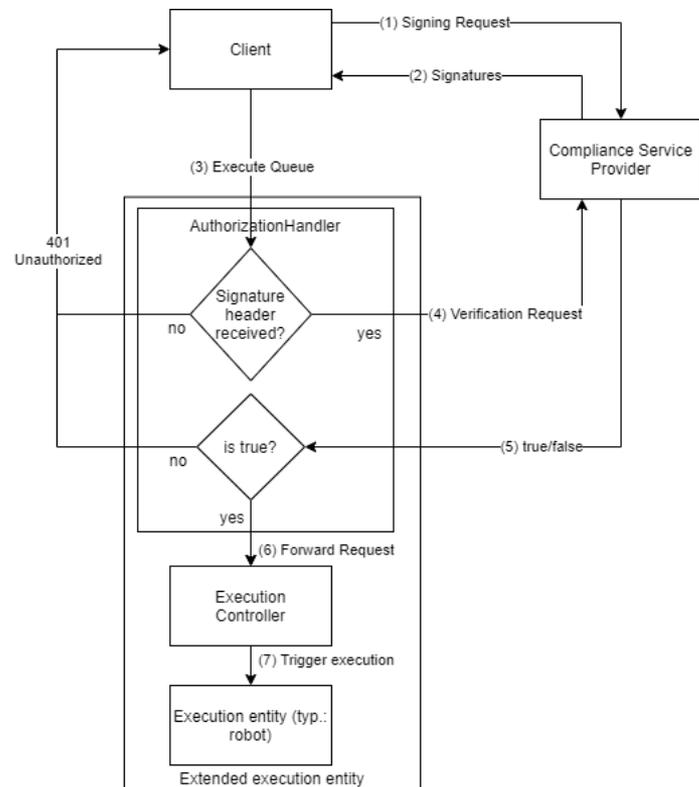
JR ROBOTICS Software Stack

- ▶ Layered approach for executing workflows on a robotic platform



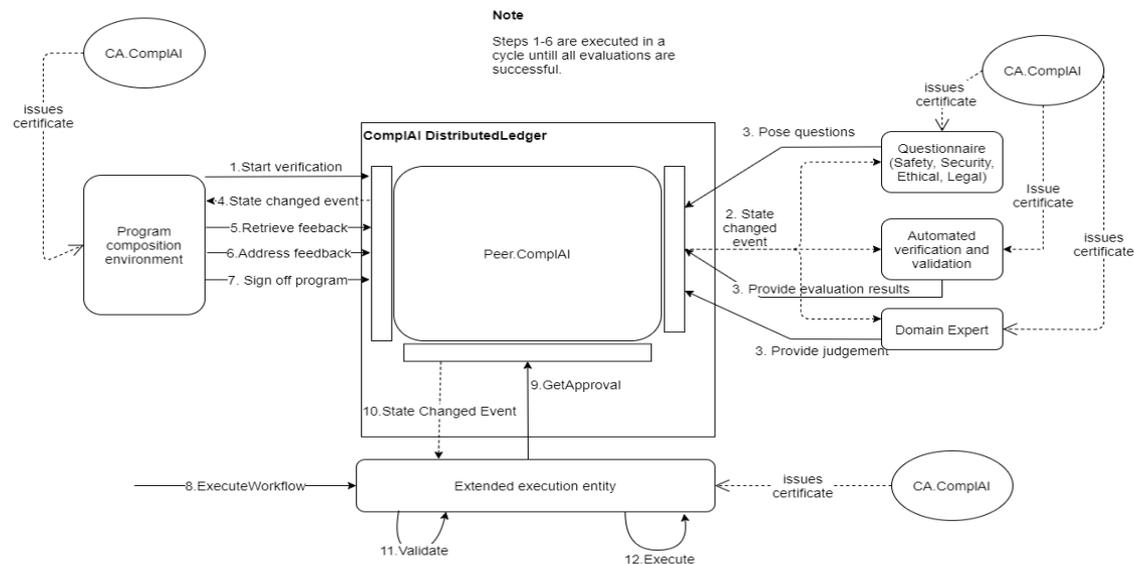
Workflow Engine Extension

1. Workflow engine receives a queue of workflows including a signature
2. Workflow engine sends a verification request to the Compliance Service Provider
3. If the verification fails the engine aborts and sends back an error message
4. If the verification succeeds the workflow queue is executed on the robot



Verification Process - Concept

- ▶ Distributed Ledger maintains workflow verification procedure
- ▶ Operations are signed by the corresponding entity and stored in a blockchain
- ▶ Workflows are executed only if they are verified and signed by the verification authority



Reflection and Project Results

Project: Recap

Challenge:

How to model AI, Robotic and assess compliance

Business Domain Model

- *BPMN-Business Processes*

Technical Robot Model

- *Petri-Net*
- *Flow Chart*
- *BPMN Workflows*

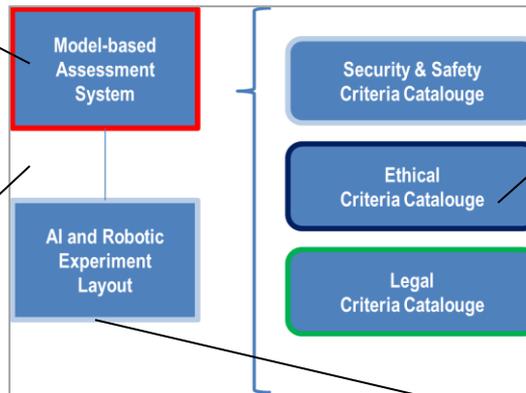
Artificial Intelligence

- *DMN-Rules*
- *CNN for image recognition*

Challenge:

How to create criteria catalogues that can be modelled and assessed

- *Questionnaire and Threshold Model*



Approved Model for configuration:

Questionnaire Model

- *Associating Questionnaire Model with Technical Robot Model*
- *Signing the Model*

Challenge:

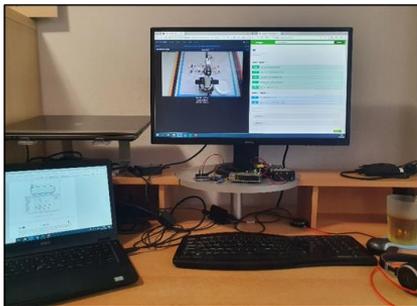
How to operate compliant model on robotic platform

Workflow Engine

- *„Verified“ BPMN Processes*

Accessing Experiment in OMiLAB Innovation Corner

- BOC OMiLAB-Innovation Corner:
<http://olive.innovation-laboratory.org/lab-reservation-service/>
- Deploying „Reservation and Virtual Access Service“ for local testing:
<https://git.boc-group.eu/olive/lab-reservation-fast-deployment-package/-/releases>
- Integration „Reservation and Virtual Access Service“ in your Modelling Tool using Bee-Up as sample:
<https://git.boc-group.eu/olive/lab-reservation-beeup-integration>
- Deploying „Reservation and Virtual Access Service“ for Production:
<https://git.boc-group.eu/olive/lab-reservation-service>
- Improving Source Code of „Reservation and Virtual Access Service“:
<https://git.boc-group.eu/olive/lab-reservation-service-docker>



Remote
Connection



Access to Results










Welcome
Download
Tutorial
Frequently Asked Questions
Developer Community
Documentation
Contact

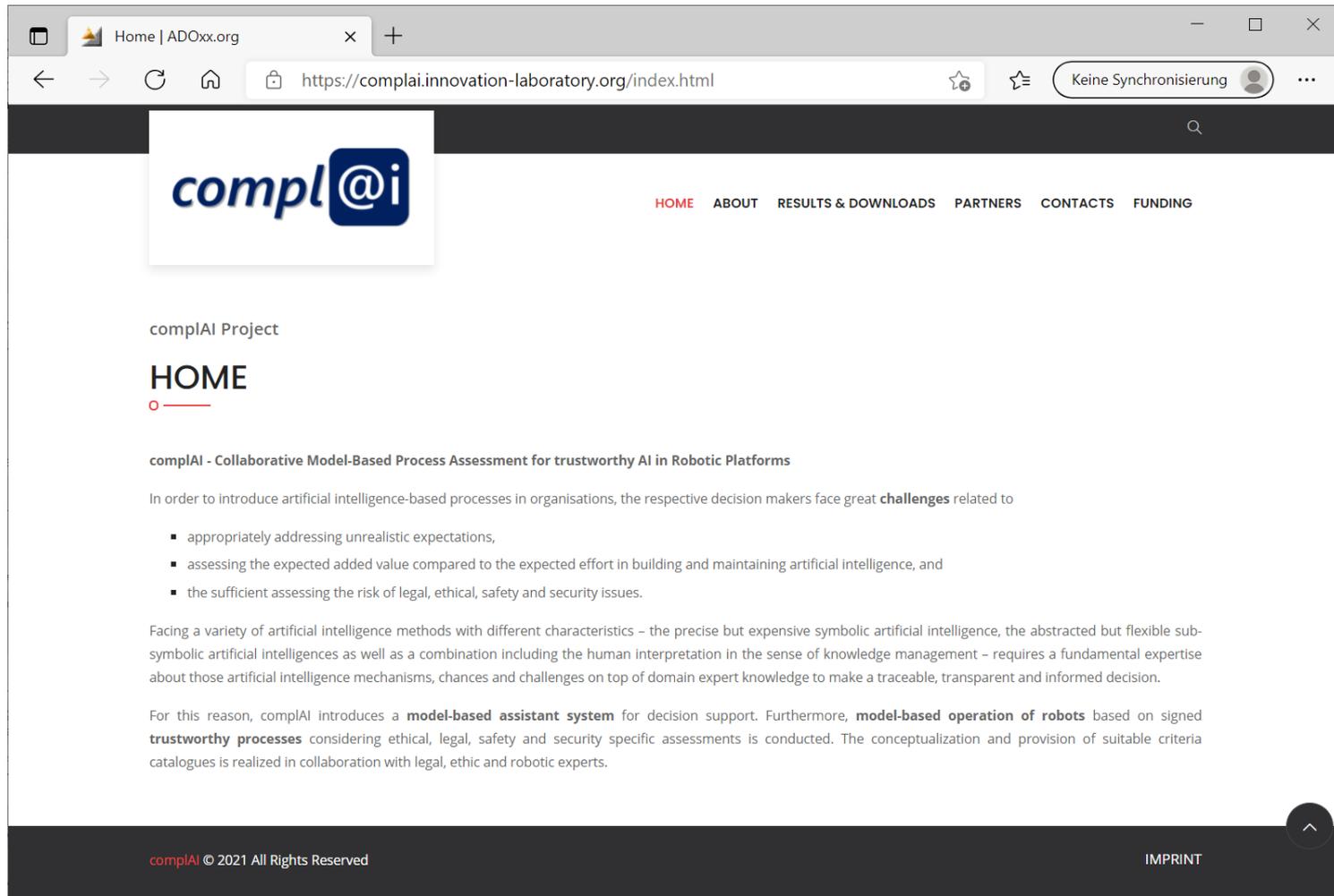
Overview
Downloads

Groups	Items	Description	Technology	Version	Introduction Video	Technical Explanation Video	Slides & Documentation	Download
2. Sample Models to smartly Operate a Robot Arm		showing different kinds of interaction with the robot arm: (a) manual interaction or (b) interaction via a workflow engine using three different modelling languages: (i) Petri-Net, (ii) Flowchart, (iii) BPMN.						
	2.1 Processes with fixed bound resources	A starting setup is provided, introducing the three different modelling languages - (i) Petri-Net, (ii) Flowchart, (iii) BPMN - and how they interact with the robot arm. Those models introduce also the different abstraction layers that can be observed when interacting with a robot.				Process with fixed binding using Petri Net and Process with fixed using Flowchart and Process with fixed binding using BPMN	Processes with Fixed Binding of resources using different Modelling Approaches	Sample Models of Processes with Fixed Binding of Resources (OMLAB internal) and Sample Models of Processes with Fixed Binding of Resources (OMLAB external)
	2.2 Processes with pre binding of resources	In addition to the process with fixed bound resources, those sample models introduce two actions where AI is needed, (1) a sensor identifies which resources are available, (2) a knowledge base decides, which resources to select. Both AI interactions are simulated with manual interactions by the modeller to explain where to interact with AI. Smart sensors or decision making is introduced before the process starts.				Process with pre binding using Petri Net and Process with pre binding using Flowchart and Process with pre binding using BPMN	Processes with Pre Binding of resource using different Modelling Approaches	Sample Models of Processes with Pre Binding of Resources (OMLAB internal) and Sample Models of Processes with Pre Binding of Resources (OMLAB external)
	2.3 Processes with late-binding of resources	In addition to the process with pre-binding of resources, this late-binding introduces now a time issue, where the sensor information and the decision making needs to be performed during execution.				Process with late binding using Petri Net and Process with late binding using Flowchart and Process with late binding using BPMN	Processes of Late Binding of Resources using different Modelling Approaches	Sample Models of Processes with Late Binding of Resources (OMLAB internal) and Sample Models of Processes with Late Binding of Resources (OMLAB external)

<https://adoxx.org/live/web/complai/downloads>

Webpage

<https://complai.innovation-laboratory.org/index.html>



The screenshot shows a web browser window with the URL <https://complai.innovation-laboratory.org/index.html>. The browser's address bar shows the URL and a search icon. The website's header features the complAI logo on the left and a navigation menu with links for HOME, ABOUT, RESULTS & DOWNLOADS, PARTNERS, CONTACTS, and FUNDING. The main content area includes the text "complAI Project" and "HOME" with a red underline. Below this, the text reads "complAI - Collaborative Model-Based Process Assessment for trustworthy AI in Robotic Platforms". A paragraph follows: "In order to introduce artificial intelligence-based processes in organisations, the respective decision makers face great challenges related to". This is followed by a bulleted list of three challenges: "appropriately addressing unrealistic expectations," "assessing the expected added value compared to the expected effort in building and maintaining artificial intelligence, and" and "the sufficient assessing the risk of legal, ethical, safety and security issues." Another paragraph states: "Facing a variety of artificial intelligence methods with different characteristics - the precise but expensive symbolic artificial intelligence, the abstracted but flexible sub-symbolic artificial intelligences as well as a combination including the human interpretation in the sense of knowledge management - requires a fundamental expertise about those artificial intelligence mechanisms, chances and challenges on top of domain expert knowledge to make a traceable, transparent and informed decision." A final paragraph explains: "For this reason, complAI introduces a model-based assistant system for decision support. Furthermore, model-based operation of robots based on signed trustworthy processes considering ethical, legal, safety and security specific assessments is conducted. The conceptualization and provision of suitable criteria catalogues is realized in collaboration with legal, ethic and robotic experts." The footer contains the copyright notice "complAI © 2021 All Rights Reserved" and a link to "IMPRINT".