Knowledge representation of human centered automated manufacturing processes for Industry 4.0 and beyond.

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Human-centered Assistive Robotics

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Content

Introduction.

- The economic landscape is changing and is influenced by efficient automation, manufacturing technologies.

- Industry 4.0 represents the link between industrial production and information technology.

- FOON allows robots to interpret a task's goal.

- The industrial robot arm Franka Emika Panda" Was used to achieve the tasks.

Figure1: Panda arm

State of Art

FOON:

- FOON is a graph-based network used for encoding knowledge about manipulation tasks by encrypting the flow of actions coming one after another.
- The FOON network includes two kinds of nodes.
- A motion node could include more than one small movement.
- The motion node change the state of the input object.

State of Art

FOON:

- The functional unit describes a single atomic action that is part of an activity.

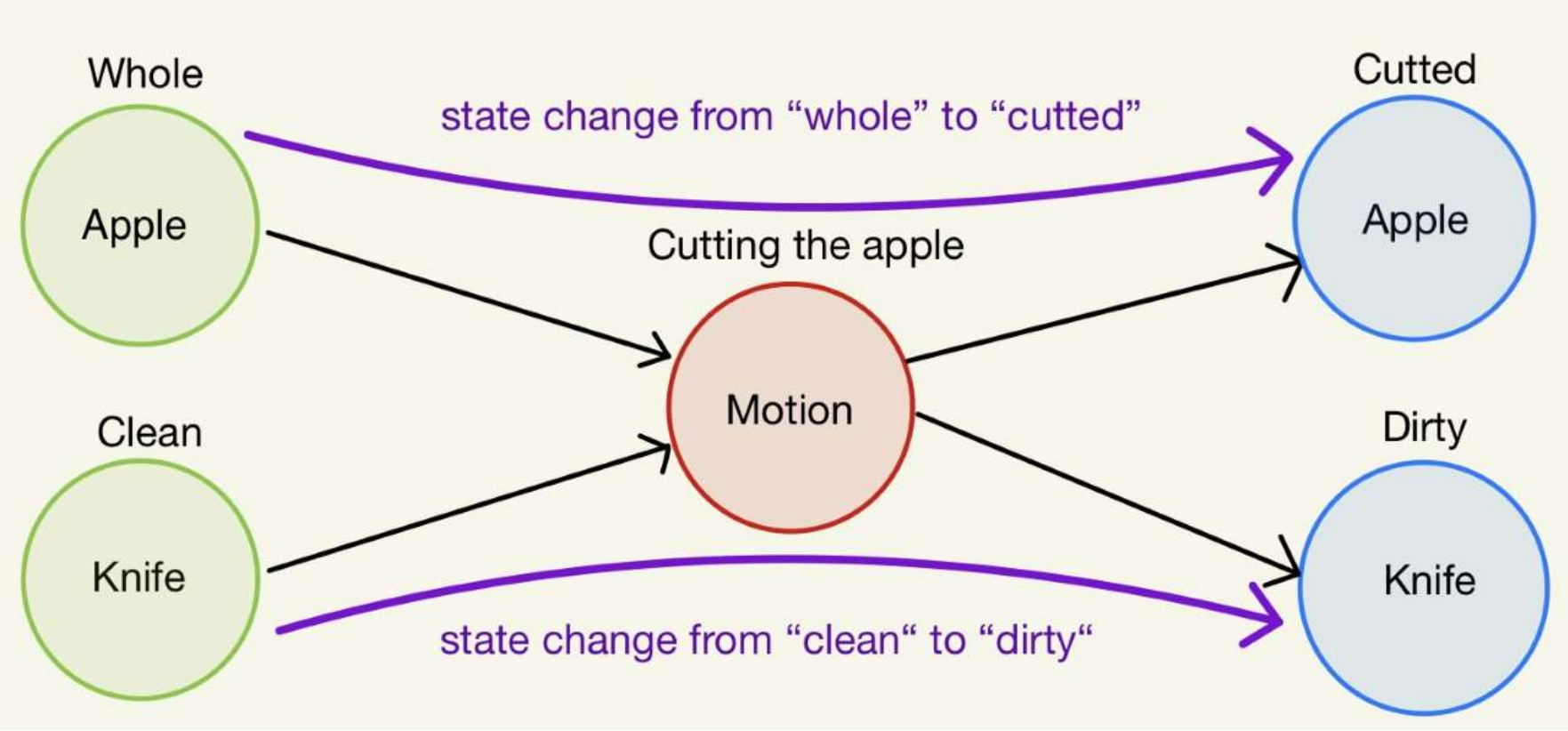


Figure 2 : A basic functional unit.

State of Art

MoveIt:

- MoveIt is a state of the art software for manipulation.
- MoveIt setup assistant is a Graphical User Interface (GUI).
- Generating a Semantic robot description format (SRDF) by using the Universal Robot Description Fromat (URDF).

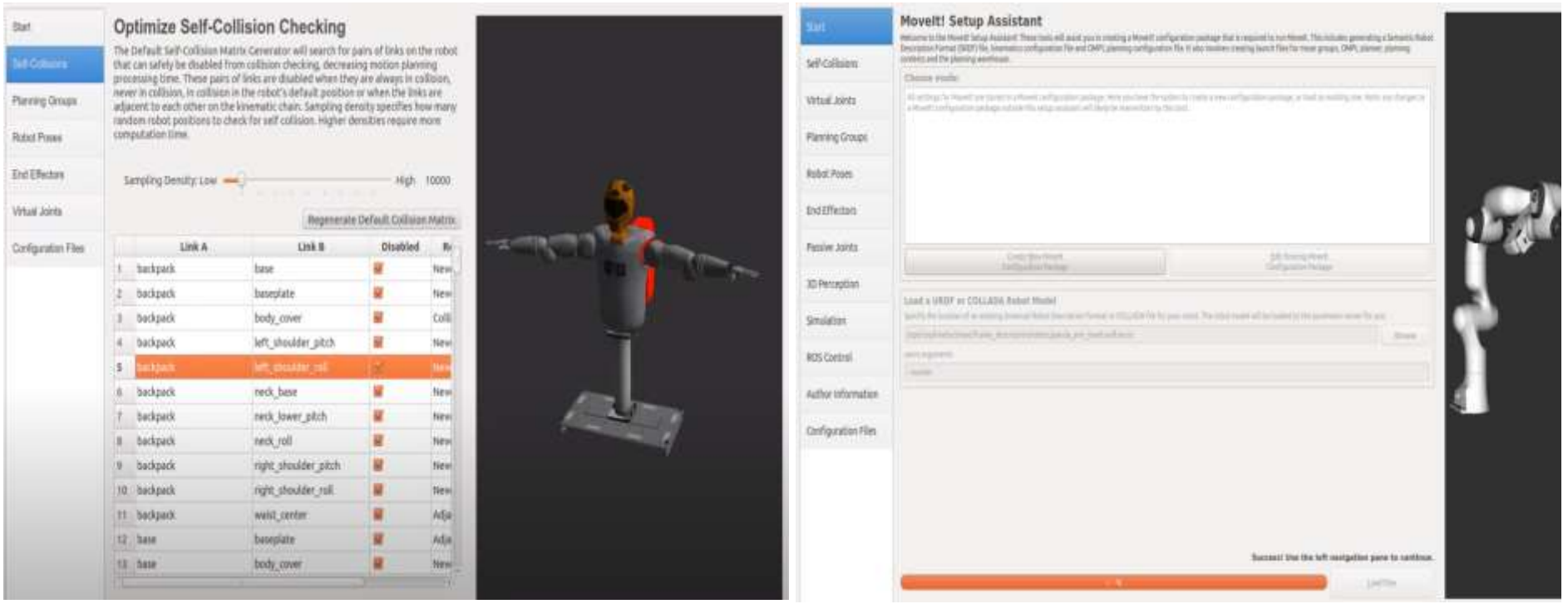


Figure 3 : MoveIt setup Assistant examples.

Implementation

Goal:

- The goal of the implementation was to make the robot acting human-like.
- The robot decides which functional unit to use through the user input command.
- we created an environment that includes two kinds of beer.
- The robot uses the FOON to sort the required or all kinds of beer bottles in its box.

Implementation

FOON:

- Build list of objects and sub-motions.
- Implement The needed Classes such as Thing, Object, Motion, FunctionalUnit and TreeNode.
- Build the functional units from the objects and motion.
- Save functional units in the TreeNode class.
- Visualize the FOON structure with Networkx draw libraray.

Implementation

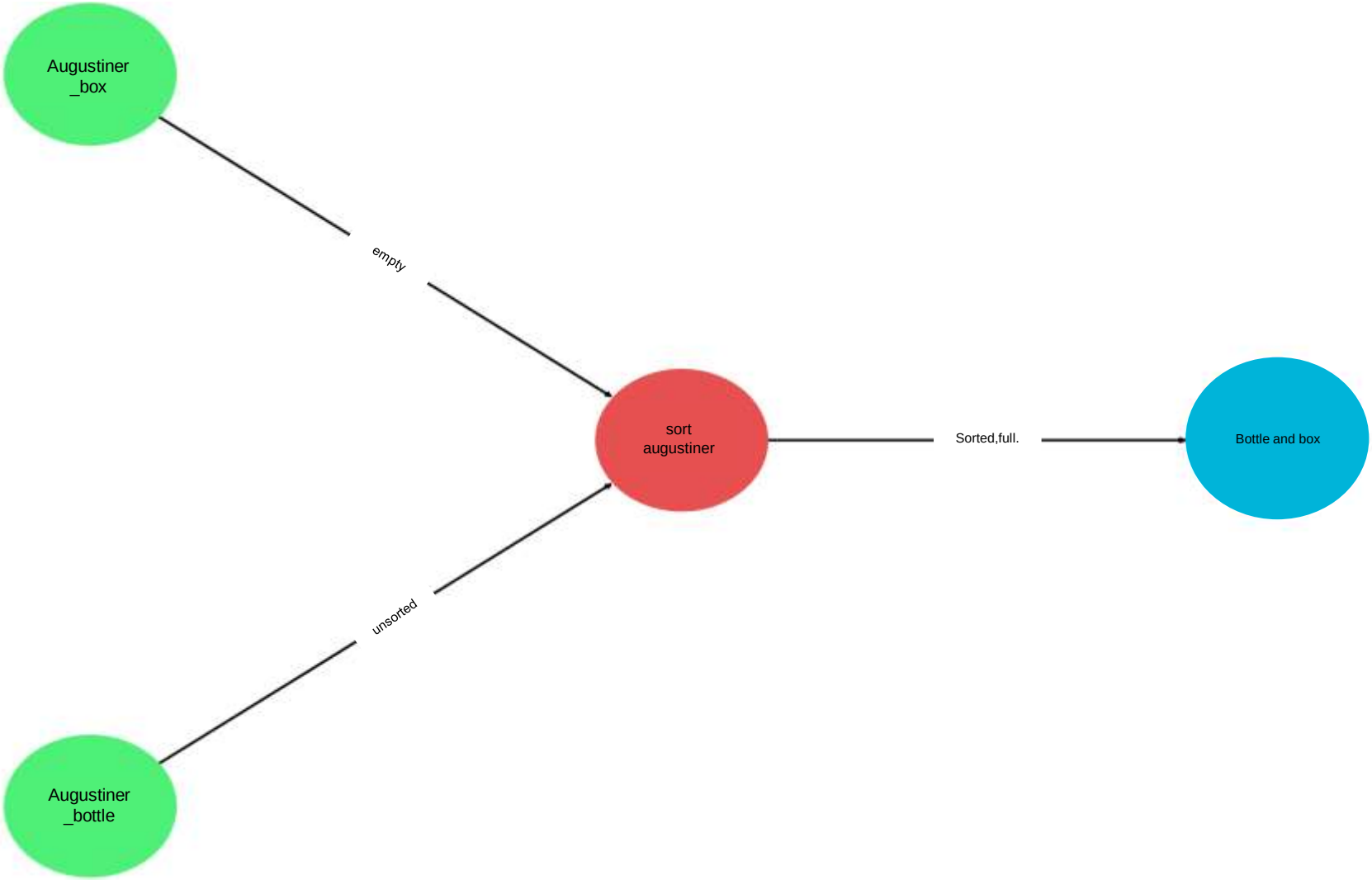


Figure 4: The "augustiner" functional unit (Implementation's output).

Implementation

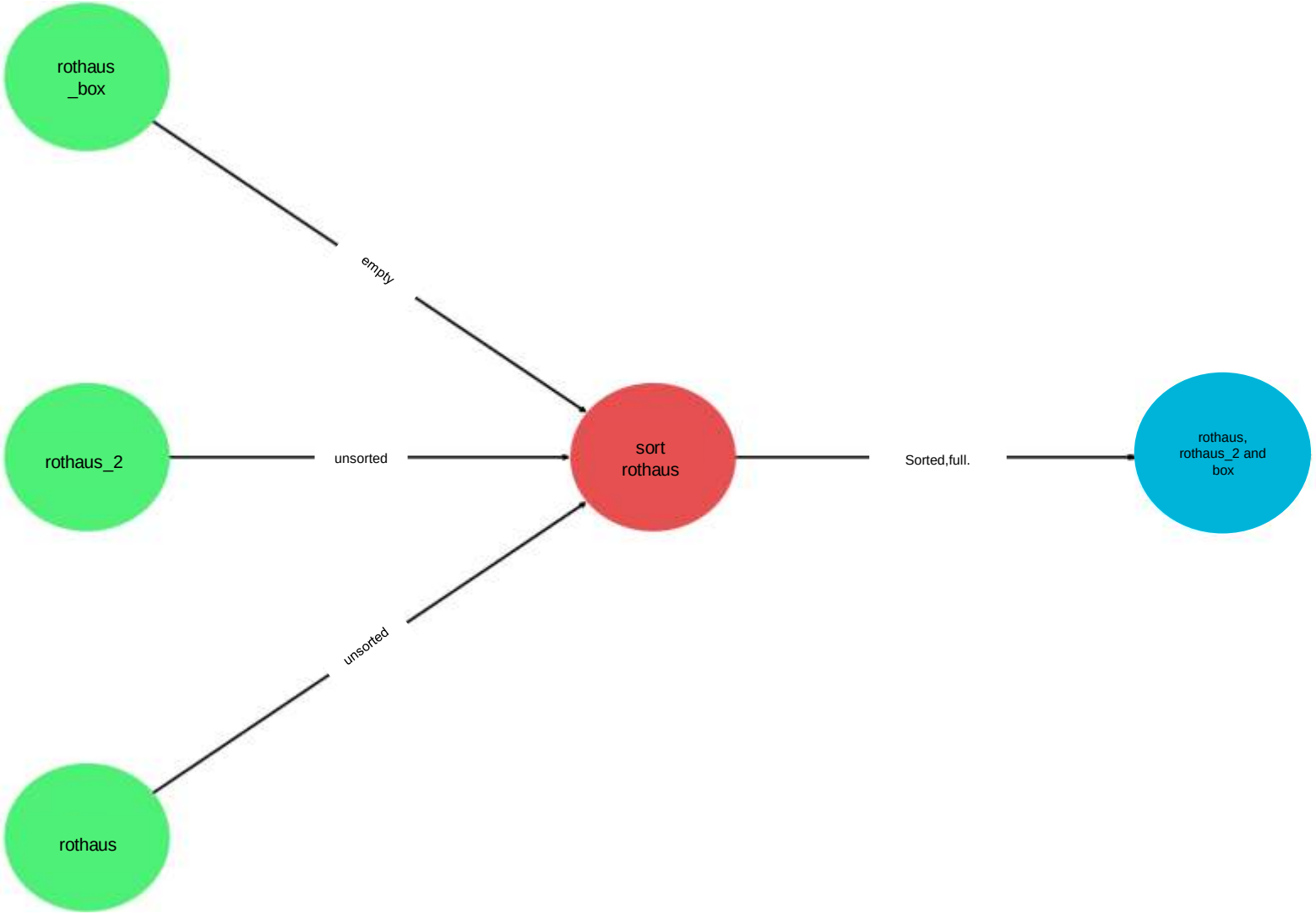


Figure 5: The "rothaus" functional unit (Implementation's output).

Implementation

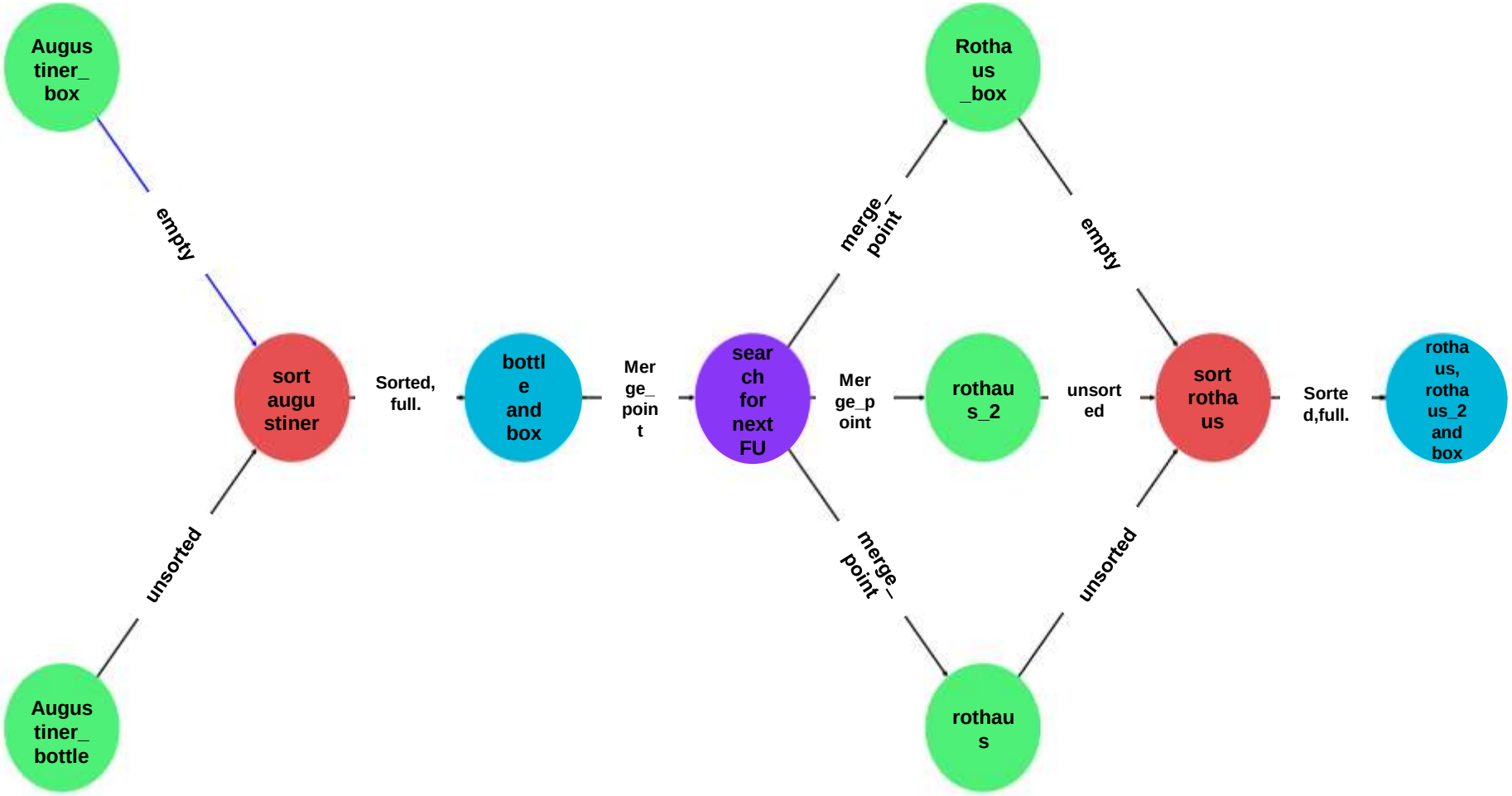


Figure 6: The TreeNode includs all functional unit (Implementation's output).

Implementation

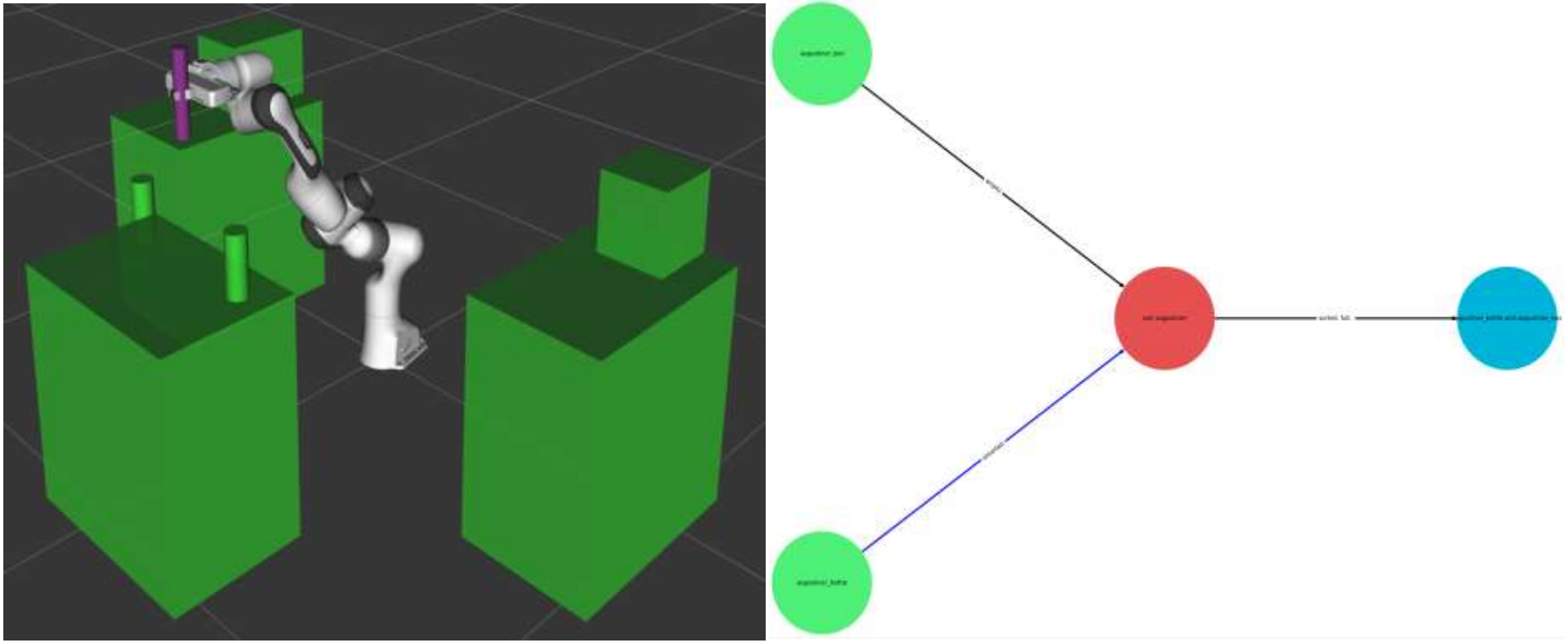


Figure 7: Synchronization between robot movement and FOON visualzation (Implementation's output) .

Implementation

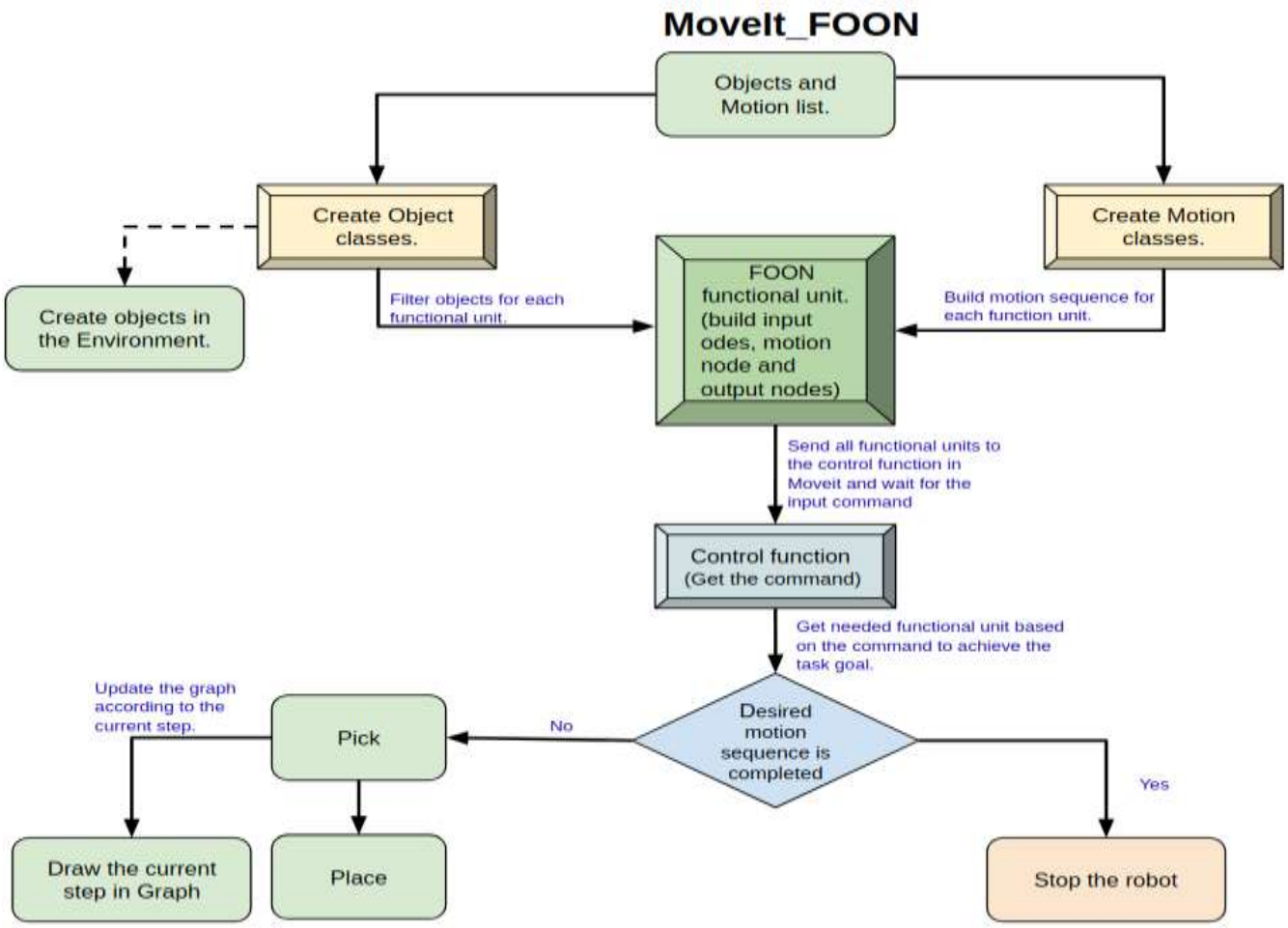
MoveIt:

- Create Semantic Robot Description Format for Panda_arm to use it in Rviz
- move the robot arm to "start" position. (kinematic singularity).
- Build the pick and place functions for the Panda_arm
- Build the open and close gripper functions for the Panda_hand
- Calculate the path orientations (joint angles) from the Euler equation using Roll, pitch and yaw.
- A sequence of motions in the moveIt for example:
    1. Go to the start position
    2. Pick the box then place the box on the table.
    3. Pick the beer then place the beer on the box.

can be presented as one node in the FOON graph with name "organize the beer".

Implementation

MoveIt_FOON workflow:



Conclusion:

- An approach was developed to construct functional units using a list of different objects.

- Future work:
  - Improve network structre.
  - Implement a visoin recognition system.

References

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Thank you for your Attention!