1st International Workshop on Actionable Knowledge Representation and Reasoning for Robots (AKR³)

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Keywords
Knowledge Representation, Reasoning, Cognitive Robotics, Web Knowledge, Actionable Knowledge

1. Introduction

The "**A**ctionable **K**nowledge **R**epresentation and **R**easoning for **R**obots (AKR³)" workshop is dedicated to Knowledge Representation and Reasoning (KRR) in the area of cognitive robotics, with the focus on acquiring knowledge from the Web and making it actionable for robotic applications in the sense that robots can use acquired knowledge for action execution and understand what they are doing. We aim to bring together the European communities specialising in KRR and robotics to increase collaboration and accelerate advancements in the field.

Household robots are still not able to autonomously prepare meals, set or clean the table or do other chores besides vacuum cleaning. Much of the knowledge needed to refine vague task instructions and transfer them to new task variations is contained in instruction web sites like WikiHow, encyclopedic web sites like Wikipedia, and many other web-based information sources. We argue that such knowledge can be used to teach robots to perform new task variations, similarly to how humans can use Web information.

Given the availability of a plethora of sources and datasets of common sense knowledge on the Web (e.g. ConceptNet [1] or OMICS [2]) as well as recent advances in language modelling, it is a timely research question to investigate which methods and approaches can enable robots to take advantage of this existing common sense knowledge to reason on how to perform tasks in the real world. The main issue to be addressed in particular is how to allow robots to perform tasks flexibly and adaptively, gracefully handling contextually determined variance in task execution. We expect this line of research to contribute to better generalizability and robustness of robots performing in every-day environments.

For this first edition of the workshop we received 6 submissions, which were all accepted and presented. We had roughly 20 participants, not including the organisers and the invited speaker.

2. Program Overview

The workshop began with a short introduction by Philipp Cimiano, focusing on the motivation for organising a workshop at the intersection of the knowledge representation and reasoning for robotics domain. He also presented the Best Paper Award and introduced the invited speaker: Lars Kunze[1].

ESWC 2024 Workshops and Tutorials Joint Proceedings, May 26-27, Heraklion, Greece
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Afterwards, Lars Kunze held his invited talk on the topic of **Making Robots Explainable and Trustworthy**. In his talk, he introduced three current challenges with actionable understanding: i) Mastering everyday tasks, ii) Dealing with change and iii) Explainability and trustworthiness. For each challenge, he focused on aspects for potential solutions, showing what has been done and what still needs to be done. For the first challenge he focused on the understanding of tasks, robots and the environment, for the second challenge the talk focused on lifelong learning (focused on understanding objects) and lastly, he focused on the semantic interpretation of spatio-temporal observations to generate contextualised explanations.

After the Invited Talk, the Best Paper winning paper **Towards Improving Large Language Models' Planning Capabilities on WoT Thing Descriptions by Generating Python Objects as Intermediary Representation** was presented by Lukas Kinder. Their work focused on equipping LLMs in planning tasks with domain knowledge through WoT thing descriptions. These descriptions are translated into Python classes using LLMs before generating action sequences based on the task description and participating things.

After the coffee break, Michaela Kümpel presented the paper **Steps Towards Generalized Manipulation Action Plans - Tackling Mixing Task** on behalf of her colleagues. In this work, the authors present a theoretical model for guiding the creation of adaptable action plans using the CRAM cognitive architecture. Each model consists of an action designator, pre- and postconditions as well as task-specific requirements. Their theoretical model is exemplified for the task of *Mixing*.

The third paper **The SPA Ontology: Towards a Web of Things Ready for Robotic Agents** was presented by Michael Freund and also focused on WoT thing descriptions by presenting the SPA ontology that enhance these descriptions by also modelling preconditions and interaction effects. Based on these enhanced descriptions, a PDDL problem description can be derived and solved before mapping the created plan back to create suitable WoT plans.

In the fourth paper called **Towards a Knowledge Engineering Methodology for Flexible Robot Manipulation in Everyday Tasks**, Jan-Philipp Töberg presented a knowledge engineering methodology and its application on the concrete manipulation task of cutting fruits and vegetables. The methodology is semi-automatic and focuses on dispositions & affordances, task-specific object properties as well as action groups & their operational properties.

Afterwards, Diego Reforgiato Recupero presented the paper **Towards Seamless Human-Robot Dialogue through a Robot Action Ontology**, which enables a robot to listen to speech instructions and either perform an action or answer a posed question using ChatGPT. For perforing the action, an ontology is used to decide whether the robot can and should perform the action.

In the last presentation, Lobna Joualy presented the paper **KB4RL: Towards a Knowledge Base for automatic creation of State and Action Spaces for Reinforcement Learning**, which uses a knowledge base to support the creation of the state and action space in reinforcement learning tasks based on the task to learn and the robot type.

Acknowledgments

The workshop is organized by the SAIL Network in collaboration with the Joint Research Center on Cooperative and Cognition-enabled AI (CoAI JRC).

References

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