



Human-centric algebraic machine learning

Report on Collaboration - M36

Deliverable D8.5

WP8 - Dissemination, Exploitation and Collaboration



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Consortium



ALGEBRAIC AI



Chantalimaud
Foundation



German
Research Center
for Artificial
Intelligence



TECHNISCHE UNIVERSITÄT
KAISERSLAUTERN



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Executive summary

Algebraic Machine Learning (AML) is a novel machine learning technique based on algebraic representations of data. Unlike statistical learning, AML algorithms are robust regarding the statistical properties of the data and are parameter-free. AML systems can retain what they learn, including sociocultural ethical practices for human–artificial intelligence systems. The aim of the EU-funded ALMA project is to study the mathematical properties of AML and to leverage them to develop a new generation of interactive human-centric machine learning systems. These systems are intended to minimize bias in order to facilitate trust while better enabling distributed collaborative learning.

This report corresponds to *Deliverable D8.5 - Report on Collaboration - M36* of the ALMA project. This deliverable covers the main collaborations between ALMA consortium members and organizations, EU projects and communities external to the project.

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Acronyms

AI	Artificial Intelligence.
AML	Algebraic Machine Learning.
AML-IP	Algebraic Machine Learning - Integrating Platform.
HCI	Human-Computer Interaction.
ML	Machine Learning.
ROS	Robot Operating System.
TSC	Technical Steering Committee.

1 Introduction

This document details the collaborations with external entities to the ALMA consortium in order to ensure a proper research approach as well as to promote the reception of the project results by the target audience.

Collaborations with external entities were limited during this first phase of development due to the early stage of the project and the lack of results that can be proven and tested by a wider community of developers. This is expected to change in the next phases of the project given the encouraging results obtained by CF, ALG and DFKI in their research experiments. Special attention will be paid to the Robot Operating System (ROS) community, which is a key target audience for the adoption of AML technology through Algebraic Machine Learning - Integrating Platform (AML-IP).

Even so, a number of collaborations have been conducted by several partners with organizations out of the ALMA project. The main collaborations carried out during this first phase of the project can be categorized into research collaboration, involving VTT and Inria, and innovation collaboration, involving EPROS.

As we transition into the project's second phase, our primary focus shifts towards engaging the developer community. In this phase, the ROS 2 developers assume a pivotal role, driving the project's core development efforts.

Since this document is to be updated in the coming months, all resultant collaboration made within the ALMA project will be included in each of the revisions to follow.

2 Research collaborations

2.1 Karl Friston's extended research group

VTT has been collaborating with the Karl Friston's extended research group. This research group includes participants with a wide range of expertise including neuroscience, social science, and computer science. The multi-disciplinary group presents and discusses the latest work in addressing profound challenges in biosocial-technical systems.

The goal of this collaboration is to stay up-to-date with the latest applications of computer science based on first principles, which have been discovered through natural science research in, for example, theoretical biology. In particular, in relation to the latest developments in the world models construct.

The benefit resulting from their advice and revision of VTT's research is to have high level expert feedback on VTT's work during its development. Of particular relevance to VTT's work in WP5 is this research group's interest in world models. This interest encompasses human embodied psychomotor world models, organizational world models, and machine learning world models. World models are internal models of self in the world, and a major topic is how boundaries between internal states and external world can best be defined. A major related topic is how exchanges between internal states and external states can be represented. VTT's participation has included presentation, as well as participation in question and answer sessions with Professor Friston.

2.2 Center for Hybrid Intelligence

The Center for Hybrid Intelligence¹ is an interdisciplinary research team exploring digital interfaces that facilitate collaboration between humans and algorithms.

Inria has participated in a Round Table organized by the Center for Hybrid Intelligence, collaborating with Aarhus University professor Jacob Sherson.

2.3 Hybrid Human Artificial Intelligence (HHAI)

In June 2022, the The first International Conference on Hybrid Human-Artificial Intelligence² took place in Amsterdam. This Conference is dedicated to the study of Artificial Intelligence systems that cooperate synergistically, proactively, and purposefully with humans, amplifying instead of replacing human intelligence.

Inria was invited to this event, where they gave a talk on the subject of *Reimagining the Future of Interaction: Towards Human-Computer Partnerships*, with focus on explainability and controllability of Machine Learning (ML) approaches.

This public speech in an Artificial Intelligence (AI) and ML friendly scenario helped AML to take the first steps into the Human-Computer Interaction (HCI) community.

¹<https://hybridintelligence.eu/>

²<https://www.humane-ai.eu/event/the-first-international-conference-on-hybrid-human-artificial-intelligence-hhai/>

3 Collaboration with ROS community

The partnerships with the Robot Operating System (ROS) community are intended to bring the developers of the ROS community closer to the ALMA technology. The methodology to be followed in this collaboration is based on the use of three major channels:

- ROS Discourse
- ROS 2 Technical Steering Committee (TSC)
- AI Integration Working Group

These are explained below in a section dedicated to each of them.

3.1 ROS Discourse

ROS Discourse serves as a dynamic forum within the ROS community where users are able to share use cases, announcements and other news related to ROS, rather than technical questions. It is a place for users to interact with each other by showing the progress of their implementations, proposals for new working groups and research results in order to improve the ROS ecosystem.

EPROS is actively engaged in this channel, committed to providing regular updates on developments performed within the ALMA project, with a specific focus on the AML-IP. Our collaboration with the ROS community aims to ensure that the roadmap of new ROS-compatible technologies is useful and potentially exploitable by ROS end-users and developers.

In the initial stages of the project, forum activity has been limited, as outlined in *Deliverable 8.1 - Report on Communication and Dissemination*. The phase of engaging the ROS community to use AML in their systems is scheduled for the upcoming project phase, when proven innovation results and stable and testable products resulting from the innovation will be made available.

In the current mid-term stage of our project, the ROS 2 community is gradually embracing the array of tools provided by the AML-IP. Notably, tools such as the DDS Monitor for debugging and the DDS Router, the core component of AML-IP, have been crafted with AML in mind. Crucially, because they are built on the Fast DDS framework, these tools have the adaptability to broaden their application scope, addressing a wide range of tasks and needs.

3.2 ROS 2 Technical Steering Committee (TSC)

The ROS 2 Technical Steering Committee (TSC)³ is the organism comprising representatives of companies, organisations, and ROS 2 community in charge of setting the guidelines for the development of ROS 2. These organisations are committed to collaborate in the development of ROS 2, and have the responsibility to define the direction of the project.

EPROS as a member of the ROS 2 TSC has the right to vote on actions taken affecting the governance of ROS 2. Therefore, EPROS has a privileged position to promote the ALMA project at dedicated TSC meetings and hence reach the ROS 2 community.

Moreover, because the representatives of the organisations that comprise the ROS 2 TSC have a wide experience in the robotics industry, and especially in ROS 2, it is possible to get first-hand feedback on all the results of the ALMA project.

³<https://docs.ros.org/en/rolling/Governance/ROS2-TSC-Charter.html>

3.3 AI Integration Working Group

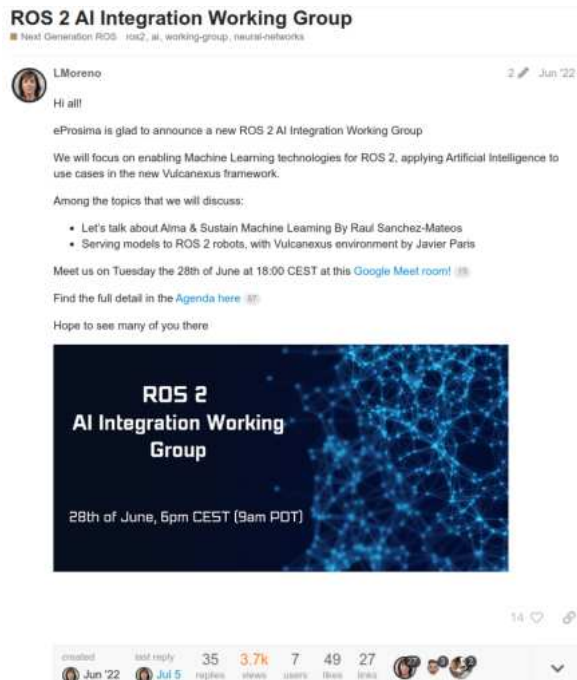
A proposal has been submitted for the creation of a new working group led by EPROS that aims to create a community of ROS users who apply ML technologies in systems developed with the ROS 2 framework. Thus, it would be possible to closely monitor the use cases of AI in robotics in order to present AML and the AML-IP as an alternative solution that has a number of benefits compared to traditional ML technologies.

During the second phase of the project, eProxima has been leading the AI Integration Working Group. The primary objective is dedicated to empowering Machine Learning technologies for ROS 2 and applying Artificial Intelligence to various use cases. Through collaborative synergy and the exchange of insights, the group is dedicated to showcasing the transformative potential of AML and the AML-IP in the ROS community, ushering in a new era of innovation.

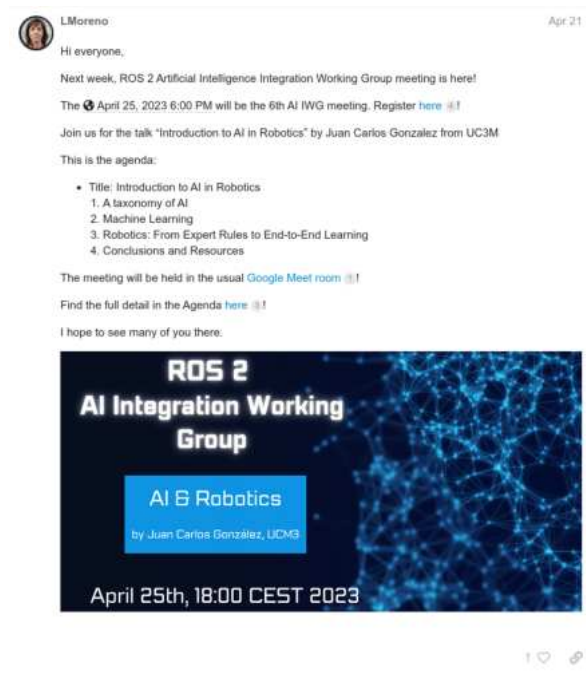
For detailed information regarding the working group agenda, open public Google Meet meeting room, and meeting discussions, please visit eProxima's ROS Discourse post ⁴.

For a comprehensive overview of the group's topics and interactions, please refer to Figure 1.

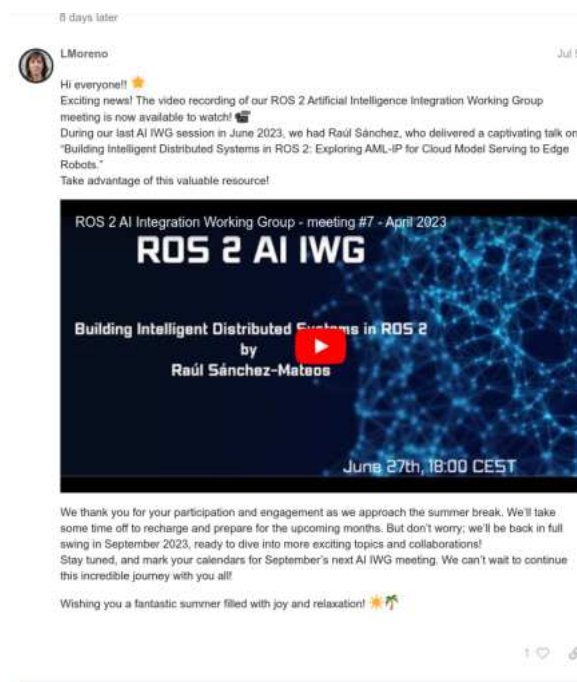
⁴<https://discourse.ros.org/t/ros-2-ai-integration-working-group>



(a) AI Integration Working Group first post



(b) AI Integration Working Group - meeting #6



(c) AI Integration Working Group - meeting #7

Figure 1: ROS Discourse posts