



Human-centric algebraic machine learning

Exploitation and Outlook Plan - M18

Deliverable D8.7

WP8 - Dissemination, Exploitation and
Collaboration



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952091.

Consortium



ALGEBRAIC AI



Chantalimaud
Foundation



German
Research Center
for Artificial
Intelligence



Project

Title: ALMA: Human Centric Algebraic Machine Learning
 Acronym: ALMA
 Coordinator: Proyectos y Sistemas de Mantenimiento SL (eProsima)
 Grant agreement: 952091
 Call: H2020-EIC-FETPROACT-2019
 Program: Horizon 2020
 Start: 01 September 2020
 Duration: 48 months
 Website: <https://alma-ai.eu>
 E-mail: alma@eprosima.com
 Consortium: **Proyectos y Sistemas de Mantenimiento SL (eProsima) (EPROS)**, Spain
Champalimaud Foundation (CF), Portugal
ALGEBRAIC AI (ALG), Spain
German Research Center for Artificial Intelligence (DFKI), Germany
Inria (Inria), France
TU Kaiserslautern (TUK), Germany
FIWARE Foundation e.V. (FF), Germany
Technical Research Centre of Finland (VTT), Finland
Carlos III University (UC3M), Spain

Deliverable

Number: **D8.7**
 Title: **Exploitation and Outlook Plan - M18**
 Month: 18
 Work Package: WP8 - Dissemination, Exploitation and Collaboration
 Work Package leader: EPROS
 Deliverable leader: EPROS
 Deliverable type: Report (R)
 Dissemination level: Public (PU)
 Date of submission: 2022-02-28
 Version: v1.2
 Status: Finished

Version history

Version	Date	Responsible	Author/Reviewer	Comments
v1.0	21/02/2022	EPROS	Raúl Sánchez-Mateos Lizano	First draft
v1.1	21/02/2022	EPROS	Juan López Fernández	First Review (RV1)
v1.2	22/02/2022	EPROS	Raúl Sánchez-Mateos Lizano	Apply changes from RV1

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 D8.7 - Exploitation and Outlook Plan - M18* of the ALMA project. This deliverable covers the exploitation plan of the ALMA project, focusing on the AML technology and the integration platform referred to as Algebraic Machine Learning - Integrating Platform (AML-IP).

First, the joint exploitation plan is discussed, which applies to all members of the ALMA consortium. EPROS, as the project coordinator and WP8 leader, will guarantee that the exploitation plan presented in this document is agreed and conducted by all partners.

This deliverable concludes with the description of the individual exploitation plan of the partners, detailing the goal of their individual exploitation plan, their target audience, and the results and impact expected by each one of them.

Contents

Executive Summary	3
Contents	4
Acronyms	5
1 General exploitation plan	6
1.1 Project's mission and vision	6
1.2 Target customers and stakeholders	6
1.3 Strategic approach to materialize the vision	6
1.3.1 Algebraic Machine Learning (AML)	7
1.3.2 Algebraic Machine Learning - Description Language (AML-DL)	8
1.3.3 Algebraic Machine Learning - Integrating Platform (AML-IP)	9
1.3.4 AML Open Source Tools	9
1.4 Competition and SWOT analysis	10
1.5 Unique Selling Propositions (USPs)	12
1.6 Communication and dissemination strategy - revision of actions and priorities	12
1.6.1 Target communities and working groups	12
1.6.2 Project activities	13
2 Individual exploitation plan	15
2.1 eProxima (EPROS)	15
2.2 Champalimaud Foundation (CF)	15
2.3 Algebraic AI (ALG)	16
2.4 German Research Center for Artificial Intelligence (DFKI)	16
2.5 Inria (Inria)	17
2.6 TU Kaiserslautern (TUK)	17
2.7 FIWARE Foundation e.V. (FF)	17
2.8 Technical Research Centre of Finland (VTT)	18
2.9 Carlos III University (UC3M)	18
References	19

Acronyms

AI	Artificial Intelligence.
AML	Algebraic Machine Learning.
AML-DL	Algebraic Machine Learning - Description Language.
AML-IP	Algebraic Machine Learning - Integrating Platform.
CPU	Central Processing Unit.
DL	Deep Learning.
DNN	Deep Neural Network.
GA	Grant Agreement.
HCI	Human-Computer Interaction.
HW	Hardware.
HWA	Hardware Acceleration.
KPI	Key Performance Indicator.
ML	Machine Learning.
OEM	Original Equipment Manufacturer.
OMG	Object Management Group.
OS	Open Source.
R&D	Research and Development.
SEO	Search Engine Optimization.
SERP	Search Engine Result Pages.
SVM	Support Vector Machines.
SW	Software.
SWOT	Strengths, Weaknesses, Opportunities, and Threats.

1 General exploitation plan

1.1 Project's mission and vision

Nowadays, the use of machine learning techniques is widespread in a multitude of sectors such as automotive, manufacturing, construction, marketing, etc. However, in many situations the machine learning algorithms utilized do not allow introspection when checking what the machine is actually learning, its learning state or how it learns. This is the black box phenomenon that is so common in neural networks by which the user no longer has control over what the machine is learning with the purpose of solving complex problems that a human cannot tackle.

AML is proposed as a new learning paradigm that builds on Abstract Algebra and Model Theory. Unlike other popular ML algorithms, AML is not a statistical method, but produces generalized models from embedded semantics of data in discrete algebraic structures.

Moreover, AML has the potential to seamlessly integrate unstructured and complex information contained in training data, with a formal representation of human knowledge and requirements. It also makes use of internal representations based on discrete sets and graphs, offering a good starting point for generating human understandable descriptions of what, why and how has been learned.

The mission of ALMA project is to provide a new ML paradigm easily understandable by users, eliminating the black box phenomenon of current algorithms and bringing this new paradigm closer to end users through an integration platform that allows exploiting AML in a wide variety of use cases.

1.2 Target customers and stakeholders

The main customers of AML and AML-IP are presented in the following list:

- Artificial Intelligence (AI) consulting companies
- Companies specializing in Machine Learning (ML) applications
- Human-Computer Interaction (HCI) companies
- Hardware acceleration Original Equipment Manufacturers (OEMs)
- AI engineers
- Software developers
- Researchers

Also note the relevance of this project in the AI research community, so new potential customers are expected to be added in future versions of this document.

Also please refer to the *D8.1 - Report on Communication and Dissemination* deliverable for more information on the target audience and the activities carried out to engage this group.

1.3 Strategic approach to materialize the vision

To materialize a reality in which AML is used to solve large real-life problems, it is necessary to provide a user-friendly library, as well as an infrastructure that exploits the capabilities and advantages of AML. In addition, it is required that the user's interaction with AML keeps complexity to the minimum in order to engage the developer community and facilitate its incorporation into target communities such as ROS or FIWARE.

In addition, an effort is required to build an AML ecosystem through well-defined standards and community building efforts. These efforts in particular will be the basis for the project to achieve the visibility and influence required for it to be adopted by a larger number of users and developers worldwide.

The keys to the success of the project lie in the development of the key results shown in Table 2:

Key result	Type	Contribution
AML	Brand	Novel ML paradigm based on Complex Algebraic Model Theory
AML-DL	Open source specification	Specification for encoding algebraic rules describing a problem in an embedding understandable by the AML engine.
AML-IP	Open source platform	Platform that exploits the capabilities of AML and allows it to be integrated into ROS 2 ¹ systems and FIWARE-compliant environments.
AML Open Source Tools	Open source tools	Tools that enable end-users to address ML problems using AML.

Table 2: Key result of materializing the vision

The activities corresponding to the realization of the ALMA project vision in order to achieve the key results appearing in Table 1 are based on the following fundamental principles:

- Commercial exploitation, with special focus on the European market.
- Alignment with activities that are being developed in related fields of research in the European Union, whether other projects of the Horizon 2020² programme or new projects of the NextGenerationEU³ programme.
- Acceptance of the results by the international community.

1.3.1 Algebraic Machine Learning (AML)

AML, as a Novel ML paradigm based on Complex Algebraic Model Theory, aims to solve common problems of traditional ML technologies such as independence of statistical data, combination of formal knowledge and training data, distributed and collaborative learning, and human-understandable learning.

Currently, all testing is carried out by DFKI, experts in the field of artificial intelligence. DFKI's use of AML generates feedback that allows for the improvement of AML and increases the knowledge regarding its use.

Barriers and risks of AML Due to the current status regarding the progress of the mathematical theory on which AML is based, it is not possible to offer a developer the possibility to test it, so it is not possible to receive feedback from the community at this time.

²<https://ec.europa.eu/programmes/horizon2020/en/home>

³https://europa.eu/next-generation-eu/index_en

One of the main barriers of AML is the need for mathematical knowledge to use it, which makes the learning curve steep. This is intended to be softened by the open source development tools that will be developed throughout the project.

In addition, DFKI is already experimenting with AML and trying to solve real-life problems obtaining promising results. Moreover, in the coming months, AML will be used by the rest of the partners and later by the target communities.

Input from users Current AML users are consortium member partners (CF, ALG and DFKI) who have the knowledge necessary for the application of AML to specific problems.

Roles of the partners Since the whole project focuses on AML, all partners have a fundamental role to play in relation to this key outcome.

- CF and ALG are in charge of the development of the mathematical foundations of AML,
- DFKI researches world, cultural and ethical models that can be embedded in AML,
- Inria explores new paradigms and models of human interaction with AML,
- TUK develops a prototype for AML acceleration,
- EPROS develops the AML integration platform,
- UC3M applies AML to real-world use cases in robotics,
- VTT explores how AML addresses ethical issues, and
- FIWARE is in charge of providing compatibility of the integration platform with its product ecosystem.

1.3.2 Algebraic Machine Learning - Description Language (AML-DL)

The Algebraic Machine Learning - Description Language (AML-DL) is a specification that dictates the patterns for describing a problem so that a subsequent embedding of the problem can be generated and understood by the AML engine. This is still under development and is intended to be improved throughout the ALMA project.

Barriers and risks of AML-DL The main risk of AML-DL is the problem that a user requires the mathematical knowledge to be able to write a problem in AML-DL format correctly. This can be a major entry barrier for new AML users who do not have a mathematical background, such as software developers or AI experts.

This risk is intended to be mitigated with the development of open source tools for working with AML and the AML-IP.

Input from users Currently, AML-DL is not available to the wider public. Therefore, it is not possible to obtain feedback from the target audience that will eventually use AML. However, thanks to the research carried out by DFKI, it is possible to foresee the problems that can be generated by writing problems under the AML-DL specification framework depending on one's mathematical or AML knowledge.

Roles of the partners In this case, ALG and CF are the developers of the specification and the partners responsible for disseminating the knowledge to the rest of the partners so that they can define actual problems using the specification.

1.3.3 Algebraic Machine Learning - Integrating Platform (AML-IP)

The integration platform aims to exploit the benefits of AML such as collaborative learning, model-parallelizable learning on computational nodes working on smaller problems in parallel, and integration of AML into robotic systems (ROS 2) and the FIWARE ecosystem.

Barriers and risks of AML-IP The AML-IP is a completely new concept in which the user is provided with a platform that allows to connect all their own AML nodes, or even connect with other users working on the same problem in order to obtain a final ML model without suffering any bias.

There may be a reluctance on the end-users to start using AML and this would be the main barrier to the use of the AML-IP. That is why the integration platform intends to start by solving the problems of deployment and communication of conventional ML techniques in order to engage the user and subsequently offer new possibilities for this platform besides AML.

In addition, this risk is mitigated by the compatibility of AML-IP with ROS 2, since this is a community in which many early adopters can be recruited to test the product and share their opinion with the rest of the community.

Input from users This integration platform has already been presented to the ROS 2 community and to the ROS 2 TSC⁴, who have given feedback taking into account the current ROS 2 systems and AI user needs within the ROS 2 ecosystem.

Roles of the partners The AML-IP will be fully developed by EPROS taking into account the needs and advantages of AML to be exploited, and which are provided by ALG and CF.

1.3.4 AML Open Source Tools

To mitigate the AML learning curve, open source tools will be provided to the user to allow solving ML problems using AML in a user-friendly manner. The development of these tools is planned for a later phase of the project, when AML will present a stable and robust engine, along with a specification that can be used by a wider and non experienced community.

Barriers and risks of the open source tools As a new development framework, these tools compete against other well-established and widely used ML frameworks such as Tensorflow or Pytorch.

Since these tools are open source, they allow the community of developers, researchers and mathematicians to contribute and apply their knowledge in their development in order to make them more robust and easily adopted.

Input from users Since the development of these tools has not yet begun, there is no input from users.

Roles of the partners These tools will be developed by ALG, authors of AML, FIWARE, experts in the standardization of open source products, and EPROS, with great knowledge in the field of open source software and the possibility to reach a large community such as ROS 2.

⁴<https://discourse.ros.org/t/ros-2-tsc-meeting-minutes-12-16-2021/23541>

1.4 Competition and SWOT analysis

AML is a novel ML paradigm that aims to break into a collapsed market and industry of ML solutions such as:

- supervised learning techniques like neural networks, Support Vector Machines (SVM), decision trees, etc.;
- unsupervised learning like k-means clustering and association rules; and
- semi-supervised learning.

However, AML presents great benefits and strengths that none of the aforementioned technologies exhibit. Exploiting these strengths will allow AML to find a niche in the market for collaborative learning applications or applications that require understanding of the learning process.

The following Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was presented in *Section 2.2.1.1 Exploitation* of the ALMA Grant Agreement (GA) 952091.

- Strengths
 - Innovative ML paradigm based on simple, demonstrable and elegant mathematical principles.
 - Radically new capabilities (reduced dependence on training data statistics, capability to combine formal knowledge and training data and distributed learning).
 - Auditable and certifiable knowledge representation.
 - Experienced partners.
 - ROS 2 and FIWARE compatibility.
 - Open source licences.
- Weaknesses
 - AML still has to demonstrate that is practical for resolving large, real-life problems.
 - Advanced skills required in mathematics and programming makes finding core developers hard.
 - A high performance engine to compete with neural network GPU implementations is still missing.
 - Unforeseeable risks inherent to new technologies.
- Opportunities
 - Many new potential and emerging markets.
 - No competitors with the same technology.
 - Good platform for researchers.
 - Increased investments in AI research and development by the EU.
 - Good channels for dissemination and exploitation including the large ROS 2 and FIWARE communities.
- Threats
 - A competing technology (Deep Learning (DL)) supported by strong competitors such as Google.

- Commoditization of ML methods (and accompanying libraries) based on Deep Neural Network (DNN), for example TensorFlow⁵ or PyTorch⁶.

As stipulated in the GA, the previous SWOT analysis has been reviewed by the consortium and some significant changes have been applied. The opinions and feedback received by each of the partners in the multiple meetings of the ALMA project have been taken into account, resulting in the following new SWOT analysis (**bold text** indicates additions while ~~crossed-out text~~ denote deletions):

- Strengths
 - Innovative ML paradigm based on simple, demonstrable and elegant mathematical principles.
 - Radically new capabilities (reduced dependence on training data statistics, capability to combine formal knowledge and training data and distributed learning).
 - ~~Auditable and certifiable~~ **Human understandable** knowledge representation.
 - Experienced partners.
 - ROS 2 and FIWARE compatibility.
 - Open source licences.
 - **Enhanced privacy and security of user data.**
- Weaknesses
 - AML still has to demonstrate that is practical for resolving large, real life problems.
 - Advanced skills required in mathematics and programming makes finding core developers hard.
 - A high performance engine to compete with neural network GPU implementations is still missing.
 - Unforeseeable risks inherent to new technologies.
- Opportunities
 - Many new potential and emerging markets.
 - No competitors with the same technology.
 - Good platform for researchers.
 - Increased investments in AI EU research and development.
 - Good channels for dissemination and exploitation including a large ROS 2 and FIWARE communities.
 - **New HCI paradigms and methodologies for AI systems.**
 - **Embedding knowledge of world models, culture and ethics.**
- Threats
 - A competing technology (DL) supported by strong competitors such as Google.

⁵<https://www.tensorflow.org/>

⁶<https://pytorch.org/>

- Commoditization of ML methods (and accompanying libraries) based on DNN, for example TensorFlow or PyTorch.
- **Vendor lock-in: low acceptance of AML by companies that cannot change to other ML vendors without incurring significant cost.**

1.5 Unique Selling Propositions (USPs)

ALMA offers a unique value proposition in the AI sector, and more specifically in the field of ML, by proposing a new machine learning paradigm based on the Theory of Abstract Model Algebra. This new ML paradigm referred to as AML offers benefits such as: *a)* reduced dependency on statistics in training data, *b)* combination of formal knowledge and training data, *c)* distributed and parallelizable learning, *d)* collaborative learning independent of the original training data, *e)* enhanced security of user data, *f)* greater mathematical transparency, *g)* understandable and traceable learning process for the user. This is enhanced by the presence in the ALMA consortium of experienced partners in the AI industry that allow for the exploitation of all the aforementioned benefits. Moreover, the presence of experienced partners in the robotics business guarantees the compatibility of AML with ROS 2 systems, as well as other members that will elaborate use cases with the purpose of demonstrating how to use AML in cases of greater applicability.

The partners' experience with the use, distribution and exploitation of open source products should also be positively considered, valuing the needs of the community so that these can be included in the project road map.

1.6 Communication and dissemination strategy - revision of actions and priorities

Besides the materialization of the vision, the main dissemination and communication activities conducted during the lifetime of the ALMA project are included, as they constitute part of the exploitation strategies.

1.6.1 Target communities and working groups

Table 3 shows the list of target communities as well as the partners in charge of raising awareness of the project results among these communities.

Target community	Partner(s) involved
ROS 2 TSC	EPROS
ROS / ROS 2 community	EPROS
Open Robotics Foundation	EPROS
FIWARE	FF
OMG	EPROS
International Data Spaces Association	FF
Finnish Center for AI	VTT/DFKI
Finnish AI Accelerator	VTT/DFKI
Computer Science community	ALG/CF/DFKI
Mathematics researchers	ALG/CF
ROS 2 Hardware Accelerator WG	TUK

Table 3: ALMA target communities and partners responsible for raising awareness

1.6.2 Project activities

Table 4 defines the goal, marketing actions and target Key Performance Indicators (KPIs) for the communication activities according to *Section 2: Communication and dissemination strategy* of *Deliverable D8.1 - Report on Communication and Dissemination* of the ALMA project. As explained in *Section 3: Communication and dissemination activities* of the aforementioned deliverable, the main efforts are focused on the publication of research papers and participation in events to disseminate the ALMA project and research results.

Activity	Target goal	Defined actions	Target KPIs
ALMA website	Provide general information about the project	Frequent updates of ALMA website and Search Engine Optimization (SEO)	ALMA website within the five first Search Engine Result Pages (SERPs)
Participation in technical conferences and workshops	Raise awareness on technical and scientific communities	· Presence at ROS World/ROSCon; · Presence at FIWARE Summit; · Presence at HumanE AI Network; · Presence at relevant HCI, ML, ROS and Hardware Acceleration (HWA) conferences and workshops	(end of year 1 / year 2 / year 3) · > 5/15/20 technical presentations (uploaded on SlideShare) · > 125/375/500 attendees in total · > 12/37/50 downloads from SlideShare
On-site demonstrations and presentations to customers/users	· Attract customers; · Raise awareness	Presentations and or demonstrations to target customers/users	35 performed by end of project

Scientific publications	Scientific dissemination	Publication to journals and magazines	> 10 publications by end of project
Presence at major trade fairs	· Market awareness; · Go-To market	Presence with dedicated space within eProxima's or some partner's booth	≥ 2 large trade fairs by end of project
Production of marketing material	Dissemination of ALMA brand and results of Research and Development (R&D)	Flyers, brochures, promotional material	A flyer, a brochure and an infographic
Active presence on social networks	Raise awareness of AML and AML-IP among developers and end-users	Regular posts through eProxima and other partners channels starting from the second phase of the project	· > 3 posts/month (Twitter, LinkedIn, Facebook) · 1 video/year on YouTube · > 10 average likes/share per post
One-to-one communication	Raise awareness on target audiences thought targeted information	Newsletter	Featured articles in FIWARE monthly newsletter

Table 4: Communication and dissemination activities - revision of actions and priorities

2 Individual exploitation plan

This section describes the individual exploitation plan of each of the ALMA consortium members, as well as the target audience, expected results and impact of each of them.

It is worth mentioning that according to *Section 2.2.1 Dissemination and exploitation of results* of the ALMA GA 952091, "while an individual Exploitation will be developed by each partner, the main exploitation effort will be carried by the two SMEs involved in the ALMA project, EPROS and ALG".

2.1 eProsima (EPROS)

Exploitation plan The exploitation strategy pursued by eProsima aims to increase the company's competitiveness and presence in the robotics industry. This is achieved by offering not only a communication middleware for robots, but also solutions that make it possible to apply AML to robots developed with ROS 2 development framework. By exploiting the compatibility of AML-IP with the ROS 2 ecosystem - mainly thanks to the fact that both make use of eProsima's Fast DDS as middleware for communications - eProsima is able to reach and engage a large community of robotics developers thus facilitating the exploitation of AML in the robotics sector.

Moreover, eProsima has experience when it comes to facing the many challenges that exploiting Open Source (OS) software entails, following a commercially successful strategy based on offering consultancy as well as freemium services. The company is committed to Open Source software and open standards (such as Object Management Group (OMG), to which it contributes) and thereby a similar approach is planned for the exploitation of the AML-IP.

Target group / audience / stakeholders eProsima's target audience are software developers, the ROS 2 community, and end-users of ML applications who would benefit from exploiting the capabilities of AML by integrating this new ML technology into their developments through the AML-IP.

Expected results / impact The expected outcome of the exploitation activities carried out by eProsima is that of making the ROS community aware of the AML technology, so that they would start to integrate it into their projects through the use of AML-IP. Also, aside from the robotics sector, it is intended that those developers applying ML technologies to real problems will be able both to interconnect their different computational nodes to exploit the distributed learning capabilities of AML, and to connect with other users working on the same problem to exploit the collaborative learning capabilities of AML. All these possibilities would be enabled by the AML-IP.

2.2 Champalimaud Foundation (CF)

Exploitation plan Champalimaud's deliverables correspond to the publication of formal analyses of Algebraic Machine Learning. They are interested in the mathematical foundations of the technology so that other researchers are able to expand and apply it in the near future.

With these results, Champalimaud will train several researchers with expertise in this new technology and will be able to apply for other grants.

Target group / audience / stakeholders Champalimaud has set as their target researchers in ML and more broadly in Computer Science and Mathematics interested in learning problems. They believe their technology can be the basis for a highly transparent learning framework, and expect other researchers to make use of it.

Expected results / impact Champalimaud's immediate results consist of the publication of arXiv reports and journal manuscripts with proofs and illustrations of AML. They expect that these results will help the community see the advantages of this new technology. They also hope that their results contribute to the development of software and hardware in Algebraic AI (ALG) pushing the computational limits of the approach.

2.3 Algebraic AI (ALG)

Exploitation plan The goals of the Algebraic AI exploitation plan are:

- Provide solid theoretical foundations for AML. A foundations manuscript on AML (already available) [1], a thorough study of Atomized Semilattices (already available) [2], a paper on Semantic embeddings on Semilattices (ready for publication, to be uploaded to arXiv imminently) and a fourth paper on machine learning using algebraic models (in progress, to be submitted by summer 2022).
- Develop an AML engine for scientific and industrial applications. They plan to make the engine available to ALMA partners in 2022 and to launch the first commercial AML engine in 2023 with a freemium exploitation model.
- Design hardware to compute AML models more efficiently. They expect to sell hardware accelerators by 2024.
- Engage in an aggressive campaign to popularize AML. They plan to start with this effort as soon as the engine and the aforementioned papers are ready. They foresee that this effort may start by the end of 2022.
- Develop an open network for distributed computation of AML. Unlike neural networks, AML models can be efficiently trained in parallel. They plan to leverage this unique capability of AML by creating a world-wide decentralized network that will allow for the collaborative training of AML models. They expect to sell usage tokens, software, hardware and consultancy to the network users.

Target group / audience / stakeholders Algebraic AI's main target group is Machine Learning scientists and engineers.

Expected results / impact Algebraic AI have the ambitious goal of bringing AML to a state of development sufficient to replace Deep Learning in many practical applications.

2.4 German Research Center for Artificial Intelligence (DFKI)

Exploitation plan DFKI is in charge of modeling use cases of real-world problems with AML, focusing on connecting activity monitoring sensors with the AML computational engine. Furthermore, they aim to represent complex human concepts in AML. The goal is to exploit these research results through Human-AML co-creation of complex domain models.

Target group / audience / stakeholders The target audience of DFKI are AI researchers and developers of AI applications.

Expected results / impact The expected results are:

- Represent basic ethical ideas with AML.
- Define world models in terms of ecosystem culture and ethics.

- Human-AML co-learning of cultural pluralism and cultural hybridization.
- Embed complex human concepts in a language understandable to the AML interpreter.

If these objectives are met, it would be of high benefit for the exploitation of AML as a new ML technology that aims to solve problems not achievable by traditional ML technologies.

2.5 Inria (Inria)

Exploitation plan Inria's goal is to include AML models in creative interactive software for situated typing.

Target group / audience / stakeholders Inria expects to reach *a)* the general public, as the situated typing application will be designed for them, and *b)* the creative professionals, as the system will include personalized types designed by professional typographers, which can be extended or adapted by a creative audience.

Expected results / impact The expected results are:

- Running software applications using AML.
- The publication of scientific papers.
- The potential commercialization of the results obtained from the project.

2.6 TU Kaiserslautern (TUK)

Exploitation plan TUK plans to release a first version of Hardware (HW)/Software (SW) accelerator architecture and implementation to ALG in order to speed-up the processing of AML in their environment.

Target group / audience / stakeholders ALG is the company that will benefit the most from TUK developments, designs, and optimizations. By achieving both HW and SW acceleration algorithms for the AML computation engine, the target audience of ALG can be more easily engaged to incorporate AML in their projects.

Expected results / impact TUK expects performance speed-ups as compared to a standard CPU of 5-10x. This will have large impact on the scaling possibilities and potential of AML.

2.7 FIWARE Foundation e.V. (FF)

Exploitation plan FIWARE's exploitation plan aims at achieving compatibility between AML-IP and the products present in their ecosystem, paying special attention to the Context Broker. In this way, AML and AML-IP can be exploited by the FIWARE community.

Moreover, as with EPROS, FIWARE is highly experienced in exploiting Open Source products and technologies by providing freemium services and contributing to the dissemination and exploitation of open products and standards.

Target group / audience / stakeholders FIWARE's main target audience is their own community, with a special consideration for the FIWARE community dedicated to the development of AI technologies.

Expected results / impact AML-IP is expected to be compatible with the FIWARE ecosystem, thus enabling the exploitation of AML by FIWARE users.

2.8 Technical Research Centre of Finland (VTT)

Exploitation plan VTT aims for an exploitation at three levels: basic, use-inspired, and applied. At the basic research level, VTT will publish in natural science journals. Already one paper has been published in the physics journal Entropy. At the use-inspired research level, VTT will publish in bridging scientific journals. Already one paper accepted for publication in Behavioral and Brain Sciences. At the applied research level, VTT aims to publish in applied science journals as soon as results from the application of AML become available towards the end of the project.

Target group / audience / stakeholders In accordance with the tasks present in WP5, VTT's work will be directed to communities with interest in Artificial Intelligence that are working at the intersection of natural sciences, social sciences, and action science. These can include Finnish Center for AI⁷ and Finnish AI Accelerator⁸.

Expected results / impact Increasing awareness and adoption of AML in the context of communities working at the intersection of natural sciences, social sciences and action science.

2.9 Carlos III University (UC3M)

Exploitation plan UC3M's research on robot planning and control will showcase valid use cases and comparisons using AML applied to humanoid robots. All results will be published in renowned scientific journals and conferences.

Target group / audience / stakeholders UC3M's target audience is composed of ML researchers as well as software and hardware developers in the robotics industry to include AML as the primary ML technology to be included in their developed robots.

Expected results / impact The impact that UC3M expects to have is that developers and researchers will be able to learn from the application of AML to the humanoid robot use case and thus achieve the spread of AML to more scenarios and use cases in the industry.

⁷<https://fcai.fi/>

⁸<https://faia.fi/>

References

- [1] Fernando Martin-Maroto and Gonzalo G. de Polavieja. *Algebraic Machine Learning*. 2018. arXiv: 1803.05252 [cs.LG].
- [2] Fernando Martin-Maroto and Gonzalo G. de Polavieja. *Finite Atomized Semilattices*. 2021. arXiv: 2102.08050 [math.RA].