European Commission

HORIZON EUROPE

New Projects in Robotics & AI 2022

Directorate-General for Communications Networks, Content and Technology

HORIZON EUROPE

New Projects in Robotics & AI 2022

TABLE OF CONTENTS

INTRODUCTION
HORIZON EUROPE: FIRST WAVE OF AI AND ROBOTICS PROJECTS

In the name of our unit, "Robotics and AI, Innovation and Excellence" at the European Commission, I am very proud to announce these 42 new projects in AI and Robotics launched between June and November 2022. This is the first wave of projects from Horizon Europe, resulting from the topics of the work programme listed below.

These projects will all work towards improving the society we live in, by tackling very important technological or application-driven challenges, as prioritised in the strategy developed by ADRA, the Public-Private Partnership (PPP) for AI, Data and Robotics (see ADRA Association and the Strategic Research Innovation and Deployment Agenda (SRIDA)).

The brochure presents the objectives and expected impact of each project, grouping them by their respective Horizon Europe topics:

- The two Coordination and Support Actions (CSA) under the topic "European coordination, awareness, standardisation & adoption of trustworthy European AI, Data and Robotics" aim to support the AI R&I community and improve the adoption of trustworthy AI in Europe.
    - The first CSA will support ADRA, the AI, Data and Robotics PPP, coordinate and establish links with all relevant initiatives in AI, data and robotics in the Horizon 2020, Horizon Europe, Digital Europe Programmes, and other programmes (Networks of excellence centres, DIHs, pilots, data platforms, and other projects). It will also support and encourage the adoption of AI technologies in all Member States and Associated Countries, promoting the adoption of trustworthy AI, data and robotics in procurement, and will work towards building a solid landscape for standardisation in support of the Commission's regulatory framework.
    - The second CSA will take the lead in the development of the AI-on-demand platform, building upon existing Horizon 2020 projects (ICT-26-2018, ICT-49-2020), with a focus on supporting the research community. The platform aims to become instrumental in boosting progress in the field, fostering sharing and re-use of resources, comparison, and constant improvement of results.
- The Research and Innovation Action (RIA) under the topic "European Network of Excellence Centres in Robotics" aims to join forces into a strong and tightly networked European research community in robotics, to become a world-class powerhouse for robotics excellence which fosters scientific and technology advances in the major robotics challenges which hamper its deployment.
- The RIA under the topic "European Network of AI Excellence Centres: Pillars of the European AI lighthouse" will develop mechanisms to reinforce the European network of AI excellence centres, mobilising researchers to collaborate on the key AI research challenges and to progress faster in joint efforts. In particular, the action will focus on safe and secure AI, addressing safety and security by design.
- The Innovation Actions (IA) under the topic "AI, Data and Robotics for the Green Deal" will integrate and optimise AI, data and robotics solutions showing direct contributions to the Green Deal, by addressing the following use-case scenarios: precision farming, minimisation of fertilizer

and pesticide use; resource and logistic optimisation in the food industry; water systems management and pipeline repair; inspection and maintenance of wind and solar renewable energy assets; recycling and material recovery in e-waste; and reduction of the environmental impact and optimisation of the metallurgy industry.

- The IAs under the topic "AI, Data and Robotics at work" will demonstrate how AI, data, robotics and automation solutions can support workers in their daily tasks, improving working conditions (both physical and social) and work performance/efficiency, while considering safety, security and resilience. Five projects focus on a new human-centered paradigm to keep people away from unsafe and unhealthy jobs via collaborative embodied (physical) AI, engaging and empowering end-users and workers, regardless of their gender, age or background. Two projects focus on human-centric AI supporting professionals in trustworthy hybrid decision-making, and optimising their tasks. The application sectors range from production, harvesting, surgery, medical diagnostics, hazardous healthcare and food handling, inspection of infrastructures, and climate services.

- The RIAs under the topic "Pushing the limit of robotics cognition" will develop the next generation of autonomous robots, with better perception and understanding of their environment, increasing their impact thanks to advanced capabilities to work without/with limited supervision; and the next generation of interactive robots, with greatly improved intuitive, safe and efficient cognitive, social and physical capabilities, to assist humans. The projects will develop various types of robots, such as mobile platforms, robotic arms, novel deformable manipulators, humanoids, wearables, prosthetics, miniaturised robots, drones, and multi-robot systems. They will demonstrate their potential benefit in a broad set of applications, such as agile production, assembly, manufacturing, logistics, cleaning, guiding, social interactions, healthcare (rehabilitation, support to disable), prosthetics, agri-food, water cleaning, edutainment and retail.

- The RIAs under the topic "Verifiable robustness, energy efficiency and transparency for Trustworthy AI: Scientific excellence boosting industrial competitiveness" will focus on building the next level of intelligence and autonomy while developing trustworthy AI technologies and demonstrating their benefits in particular applications. These projects address the following major research areas:

    - Novel or promising learning as well as symbolic and hybrid approaches to advance "intelligence" and autonomy of AI-based systems.
    - Advanced transparency in AI.
    - Greener AI, increasing data and energy efficiency.
    - Advances in edge AI networks.
    - Complex systems & socially-aware AI.

- The RIAs under the topic "Tackling gender, race and other biases in AI" will develop technologies and algorithms to evaluate and address bias in AI-based systems, and support the deployment of such bias-free AI-based solutions.

I invite you to discover all these projects in this brochure. Not only are they expected to have an impact within their respective application sectors, together, they will advance the field of AI and robotics throughout Europe, well beyond the completion of the individual projects.

In the unit, we all look forward to following these new projects and accompanying them in realising the potential of AI and robotics for the improvement of European society and economy.

Cécile Huet

Cécile HUET, PhD
Head of Unit Robotics & Artificial Intelligence Innovation and Excellence – A1

COORDINATION AND SUPPORT ACTIONS

ADRA-E

AI, Data and Robotics ecosystem

Call	*HORIZON-CL4-2021-HUMAN-01-02*
Duration	*1 July 2022 > 30 June 2025*
Project ID	*101070336*

OBJECTIVES

AI, Data and Robotics is omnipresent in our daily lives and key to addressing some of the most pressing challenges facing our society. While the essentials are present, European ADR is waiting for exploitation to achieve its full potential. The ARD ecosystem is inherently complex because many stakeholders at many different levels require a holistic strategy towards collaboration to be effective and efficient. This project is set up in close liaison with the Adra Association (private side of the ADR Partnership) and includes it as a partner, committed to sustain its outcomes. Adra-e should be seen as the operational arm of the partnership to foster collaboration, convergence and interoperability between communities and disciplines to advance European ADR while safeguarding the interest of European citizens:

- Support the update and implementation of the SRIDA
- Map the ADR landscape and infrastructures, Deliver services and build connections between structured initiatives.
- Raise awareness of the acceptability and trustworthiness of ADR for citizens, businesses, public administrators and educators.
- Increase innovation capacity and adoption of core ADR technology with applications
- Support the development of standards and regulations maintaining European technological sovereignty.
- Stimulate the onboarding of new technologies to alleviate roadblocks via cross-European collaboration and support delivering a strong ADR partnership by project end.

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ADRA – AI, DATA AND ROBOTICS ASSOCIATION
adr-association.eu/

CRO-AI – HRVATSKA UDRUGA ZA UMJETNU INTELIGENCIJU

EXPECTED IMPACT

IMPACT 1: SOCIETAL

1. A series of annual Convergence Events with different scope and audience to connect the entire ADR ecosystem and to facilitate a multi-stakeholder dialogue.
2. Increased awareness and understanding in order to remove the most significant obstacle to uptake of ADR technologies.

IMPACT 2: SCIENTIFIC

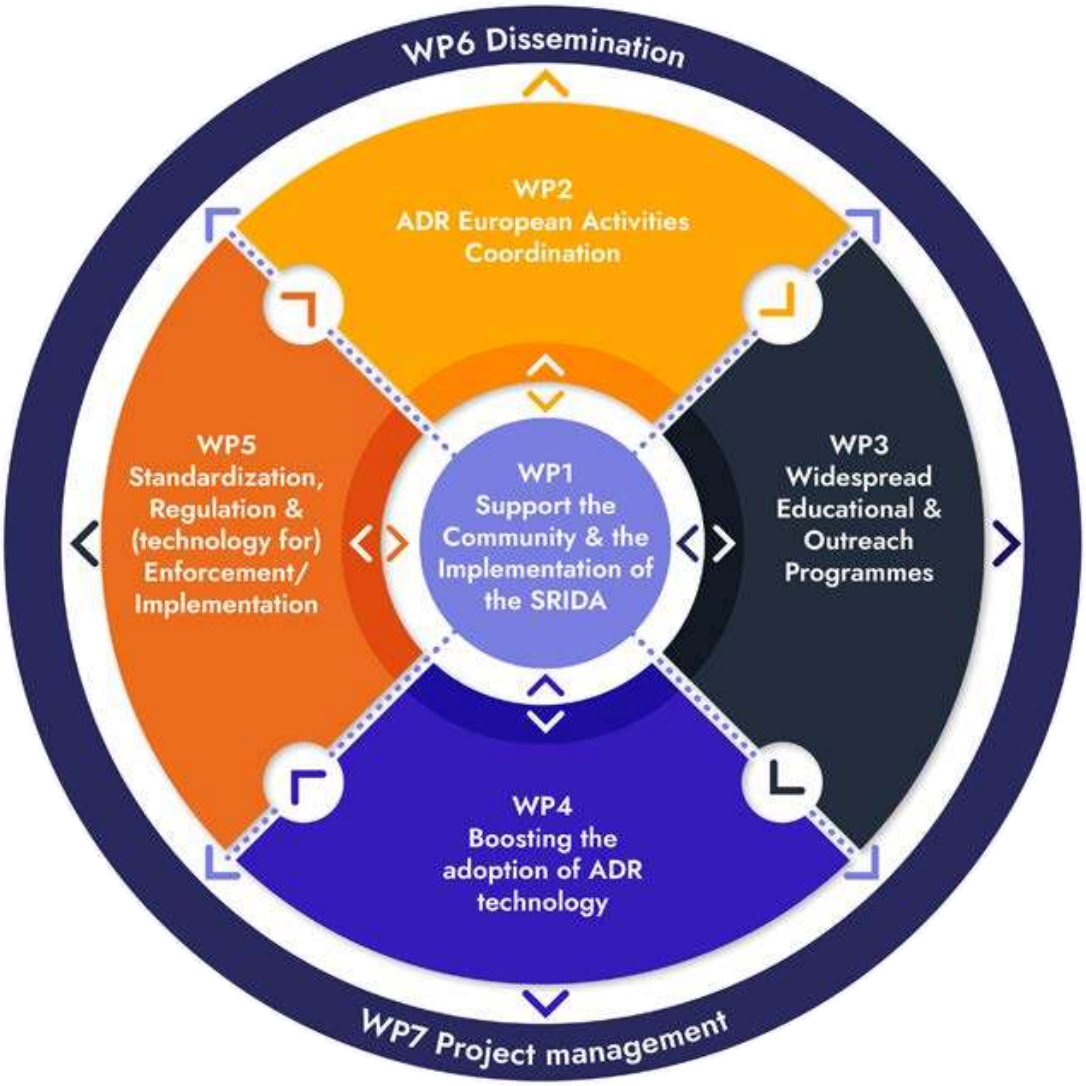
1. A series of Actionnable Recommendations to improve the update and implementation of the SRIDA.
2. Establishment of an AI, Data and Robotics Awareness Centre as an online and living repository for materials including cartographies, standards, and educational resources.

IMPACT 3: TECHNOLOGICAL

1. Develop an AI, Data and Robotics Observatory of standards and standardization activities.

IMPACT 4: ECONOMIC

1. Drive the synergies between policy developments, technological and cultural gaps to further drive alignment between EU Member States.
2. Support the spread of advanced technologies by high-tech SME via regional ecosystems.



AI4EUROPE

AI4Europe aims to develop and maintain the AI on-demand Platform (AIOD) ai4europe.eu, a resource for the research community, facilitating experimentation, knowledge sharing and the development of state-of-the-art AI solutions in Europe.

Call	*HORIZON-CL4-2021-HUMAN-01-02*
Duration	*1 July 2022 > 31 December 2025*
Project ID	*101070000*

OBJECTIVES

The **main objective** of AI4Europe is to support and facilitate a sustainable digital platform and experimentation environment through the creation of open research channels and mechanisms that foster the European AI research ecosystem, both academic and industrial, to maximize academic, social, and industrial impacts, while seamlessly integrating other projects, platforms, and solutions.

The **specific objective**s are to:

1. Ensure *platform support for the research community* fostering a cooperative and *transparent governance model* open to contributions from all stakeholders to address their needs.
2. Design and execute a *sustainability plan* that supports and ensures the *long-term viability of technical, financial, and legal features* of the AIOD platform.
3. Integrate *hardware resource provisioning* into the platform to provide underlying computational resources, establishing it as a place to carry out and disseminate AI research.
4. Advance the AIOD platform as an *open distributed tool* extendable by the community with new services and tools, and ensure interoperability with other strategic EU platforms.
5. Enhance the *accessibility and usability* of the excellence science of Europe's AI research community, and to ensure standard, secure, and executable reusable research assets.

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6. Embed mechanisms to facilitate the development and use of *Trustworthy AI* aligned with policy and regulatory developments in the European Union.
7. Foster the *uptake of AI in research communities*, industry, and society at large by mobilizing and enriching efforts in AI education, upskilling and reskilling.
8. Enhance *access, sharing, training and mobility* for all European nations, ecosystems, and communities, with special attention on young AI scholars, facilitating cooperation and matchmaking.
9. Ensure *cooperation with the AI, Data and Robotics PPP and other related Digital Europe initiatives*, to support them and to maximize the impact of the AIOD platform.
10. Support delivering a strong ADR partnership by project end.

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F6S
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SCIENTIFIC RESEARCH CENTER OF THE SLOVAK ACADEMY OF SCIENCES AND ARTS
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PARIS CITY UNIVERSITY
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UNIVERSITY OF LEIDEN
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EXPECTED IMPACT

IMPACT 1: SCIENTIFIC

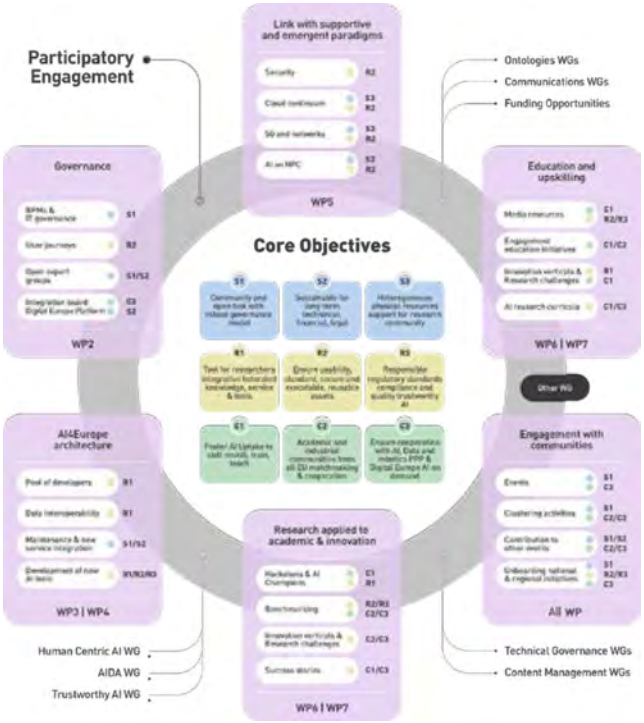
- An *AI platform* to provide researchers with a comprehensive, sovereign, and sustainable infrastructure following European values.
- Mitigate many *IPR challenges* that restrict the sharing of AI, datasets, and solutions.
- *An open governance model* owned by the community, driven by their needs, based on contribution and fair principles.

IMPACT 2: ECONOMIC/TECHNOLOGICAL

- An *EU-wide platform* for AI researchers to translate research into innovation.
- By making *online educational resources* accessible, AI4Europe will promote European values to create a seal of quality.
- A *sustainable platform* that ensures its technical, legal, and financial continuation after the finalisation of the project.
- *Easy-to-use set of services* used by all researcher institutions on AI.
- *Ease to access heterogeneous hardware*.

IMPACT 3: SOCIETAL

- *Increased inclusiveness*, by supporting a human-centered approach to technology development, aligned with European social and ethical values, as well as sustainability.
- Explicit and more *transparent connection of the EU's AI ecosystem with policy priorities*.



NETWORKS OF EXCELLENCE CENTRES

EUROPEAN NETWORK OF EXCELLENCE CENTRES IN ROBOTICS

EUROBIN

A Network of Excellence on Artificial Intelligence-driven Robotics seeking to bring together the robotics community and to benefit science, industry, and society while promoting European values. The network is a facilitator of knowledge transfer and exchange between research institutions and industry partners.

Call	*HORIZON-CL4-Digital-Emerging-2021-01-12*
Duration	*1 July 2022 > 30 June 2026*
Project ID	*101070596*

OBJECTIVES

The main vision of euROBIN is that of a European ecosystem of robots that share their data and knowledge and are able, based on their diversity, to jointly learn to perform the endless variety of tasks in human environments.

euROBIN's main goals are:

- Addressing the main scientific and technological challenges hampering the breakthrough and large-scale deployment of robotics: euROBIN focuses on making cognition-enabled Robotics solutions more transferable and reusable among scientists and by new industries. This is crucial to better join forces in Europe in this dynamic and very competitive field.
- Providing a stage for cooperation and exchange of scientific knowledge and talents between the most outstanding robotics labs in Europe in the areas of knowledge representation, physical interaction, robotic learning and human-robot interaction
- Generating a nucleus to which the community at large can adhere, enabling ground-breaking new applications in industrial, personal and outdoor robotics in Europe
- The euROBIN network proposes the novel concept of robot cooperative competition focused on the three main application domains defined in the robotics roadmap of

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www.cnrs.fr

ASSOCIACAO DO INSTITUTO SUPERIOR TECNICO PARA A INVESTIGACAO E DESENVOLVIMENTO
www.ist-id.pt

UNIVERSITA DI PISA
www.unipi.it

Horizon Europe:
- Robotic manufacturing for a circular economy
- Personal robots for enhanced quality of life and well-being
- Outdoor robots for sustainable communities

- The network will strongly interact with and benefit from other collaborative EU-initiatives such as the euRobotics association and the AI DATA Robotics Association (Adra), empowering the strength of AI & Robotics in Europe. It builds on and contributes to the assets on the AI-on-Demand platform.

EXPECTED IMPACT

IMPACT 1: *Scientific breakthrough:* A scientific and technological framework for transferable AI-powered and cognitively-enabled robots is the basis for an ecosystem of heterogeneous, jointly learning intelligent machines.

IMPACT 2: *Economic:* Increase the share of the European robotics industry at the international robotics market in the areas of interactive industrial manufacturing, personal/healthcare robotics, supply chain robotics.

IMPACT 3: *Long-Term economic:* In the areas industrial manufacturing, personal robotics, logistics supply chain, emerging mass-market robotics products benefit from the transferability concepts and/or the EuroCore.

IMPACT 4: *Societal:* Emergence of AI-powered robotics mass markets contribute sustainable solutions to the challenges of international industrial manufacturing competitiveness, demographic change, and cyclic supply chains.

The euROBIN network essentially contributes, through its focus on transferability, interoperability, cooperation, and its instruments including the EuroCore repository, **to international leadership of European robotics science and technology**.

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NETWORKS OF EXCELLENCE CENTRES

PILLARS OF THE EUROPEAN AI LIGHTHOUSE

EUROPEAN LIGHTHOUSE ON SECURE AND SAFE AI (ELSA)

Network of Excellence funded by the European Union

Call	*HORIZON-CL4-2021-HUMAN-01-03*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070617*

OBJECTIVES

ELSA is a virtual center of excellence that will spearhead efforts in foundational safe and secure artificial intelligence (AI) methodology research. As a large and growing network of top European experts in AI and machine learning, our goal is to promote the creation of a community that supports the development and deployment of cutting-edge AI solutions in the future and make Europe the world's lighthouse of trustworthy AI.

ELSA builds on and extends the existing, internationally recognized ELLIS (European Laboratory for Learning and Intelligent Systems) network of excellence. ELSA, like ELLIS, rests on three pillars: selected research programs, local research units, and a PhD and postdoc program.

ELSA will establish a fluid two-way communication between academic research and real-life application scenarios through the creation of the ELSA Innovation Lab. These dynamics will be strengthened and facilitated by new instruments (such as open calls or joint PhD supervision) that foster academia-industry collaboration. The ELSA innovation lab will provide a platform for driving and utilizing socially-beneficial innovation.

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We focus on the following key use cases of safe and secure AI: healthcare, autonomous driving, robotics, cybersecurity, media and document security. The network is addressing three major challenges: The development of robustness guarantees and certificates, privacy-preserving and robust collaborative learning, and the development of human control mechanisms for the ethical and secure use of AI.

EXPECTED IMPACT

IMPACT 1: Research programs provide targeted innovations in methodology on AI that are safe and secure by design. The expansion of the ELLIS and ELISE PhD and postdoc programs attract and develop experts, leaders and young talents that support and drive innovation on safe and secure AI. Our goals: the creation of new public benchmarks, dissemination of new software modules through the AI4EU platform, open publications, organisation of workshops in different scientific fields, and the setup of a competition platform.

IMPACT 2: We reach out to stakeholders, including policy-makers, to understand and discuss their needs and perceptions of risk and opportunities of AI, focusing on implications for the values of safety and human security. We aim to publish and provide advice to policy makers on integrated governance challenges arising from our research findings. We want to ensure orchestrated interaction between networks and related activities that exploit synergies and avoid duplication. We plan on providing methodology and educational materials that will also help reduce digital divide.

IMPACT 3: Development of demonstrators and software prototypes. Our goals: adoption of safe and secure AI technologies by companies that enable compliance with European requirements, open SMEe calls and academic and industry cooperations. AI is growing at a rapid rate, which is why we also contribute to the growing demand of leading experts in safe and secure AI.

INNOVATION IN AI, DATA AND ROBOTICS

AI, DATA AND ROBOTICS FOR THE GREEN DEAL

ALCHIMIA

Data and decentralized Artificial Intelligence for a competitive and green European metallurgy industry

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 >31 August 2025*
Project ID	*101070046*

OBJECTIVES

ALCHIMIA aims to build a platform based on Federated Learning (FL) and Continual Learning (CL) to help big European metallurgy industries unlock the full potential of AI to support the needed transformations to create high-quality, competitive, efficient and green production processes.

ALCHIMIA addresses specifically the challenges of the steel sector, creating an innovative system that automates and optimizes the production process dynamically with a holistic approach that includes scrap recycling and steelmaking.

As the name suggests, ALCHIMIA will find an optimal mix to reduce energy consumption, emissions and waste generation of the steelmaking process, while guaranteeing to obtain high-quality products. The replicability and scalability of ALCHIMIA will be enabled through the participation in the project of a complementary use case for the manufacturing of automotive parts.

The developed system will be used for prognostic optimization of the mix of inputs materials charged in the furnaces to obtain a certain product quality that matches the customers' specifications while reducing the environmental impact and the energy consumption of the process.

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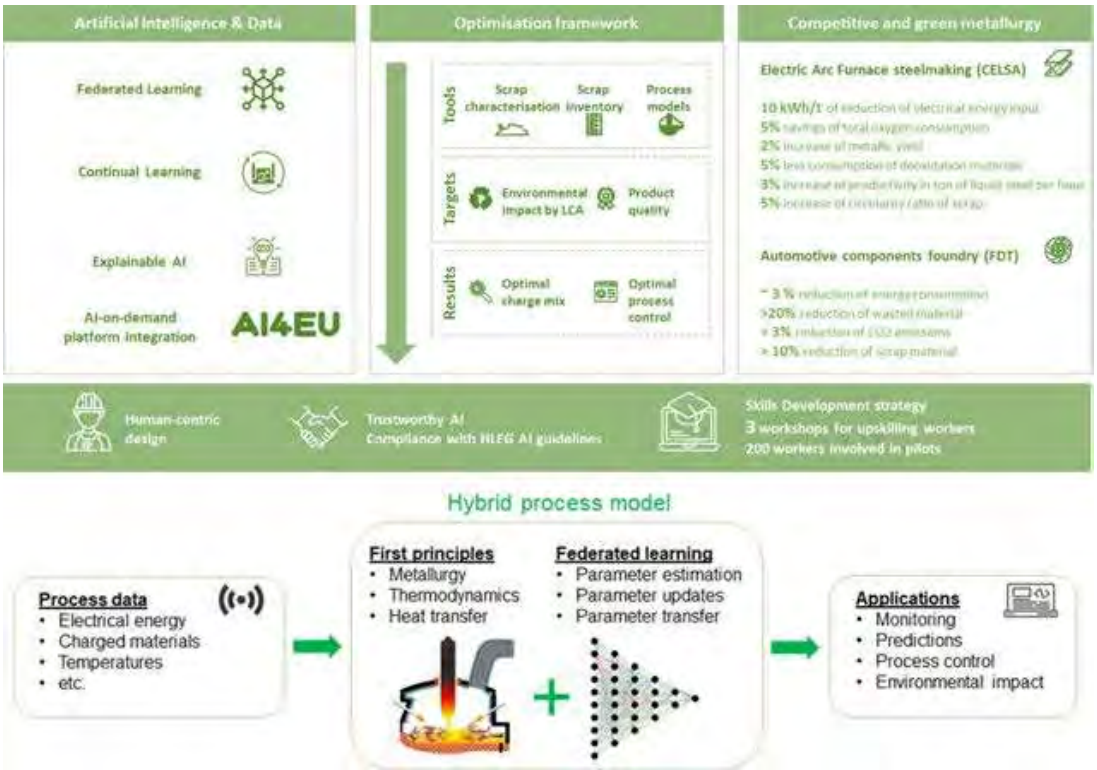
FONDERIA DI TORBOLE S.R.L.

EXPECTED IMPACT

The expected strategic impact of ALCHIMIA project focuses on:

- Optimizing the processes of Energy-Intensive Industries (EIIs) by reducing their environmental impact, in particular in terms of energy consumption, greenhouse gas emissions and waste generation.
- Reducing production costs by improving model-based plant control and regulation. As well as reducing production time, energy and resource consumption.
- Provide a new platform covering the Federated Learning and Continual Learning paradigms to support data-driven and first-principle models.
- Develop and formalize a comprehensive methodology for the application of ML-based and hybrid approaches for holistic process modelling to assess the main factors affecting their environmental performance.
- Favor the application of AI-based modelling and optimization solutions for the Green Deal in many industrial sectors, increasing confidence and trust.



CLARUS

Optimizing Production and Logistic Resources in the Time-critical Bio Production Industries in Europe

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070076*

OBJECTIVES

The CLARUS project aims to connect the Sustainable Paradigm in the food industry and AI-based applications, with the goal of developing a platform with high communications and processing capabilities, as well as the use of standardized open protocols and data models that will allow resource consumption assessment and traceability for food industry processes.

Currently, two pilots have been selected for validating the CLARUS solution. The first pilot focuses on the production of the frozen food, where energy and water consumption can be reduced using AI and data technologies. The other pilot focuses on the meat by-product production where the aim is to reduce the energy and maintain the quality of the products by optimizing the logistics of the by-products arrival.

CLARUS ambitions include not only contributing to resource and logistic optimization methods through the two pilot solutions, but also making a more general contribution through the creation of a Green Deal Index (GDI).

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gmmfinland.com

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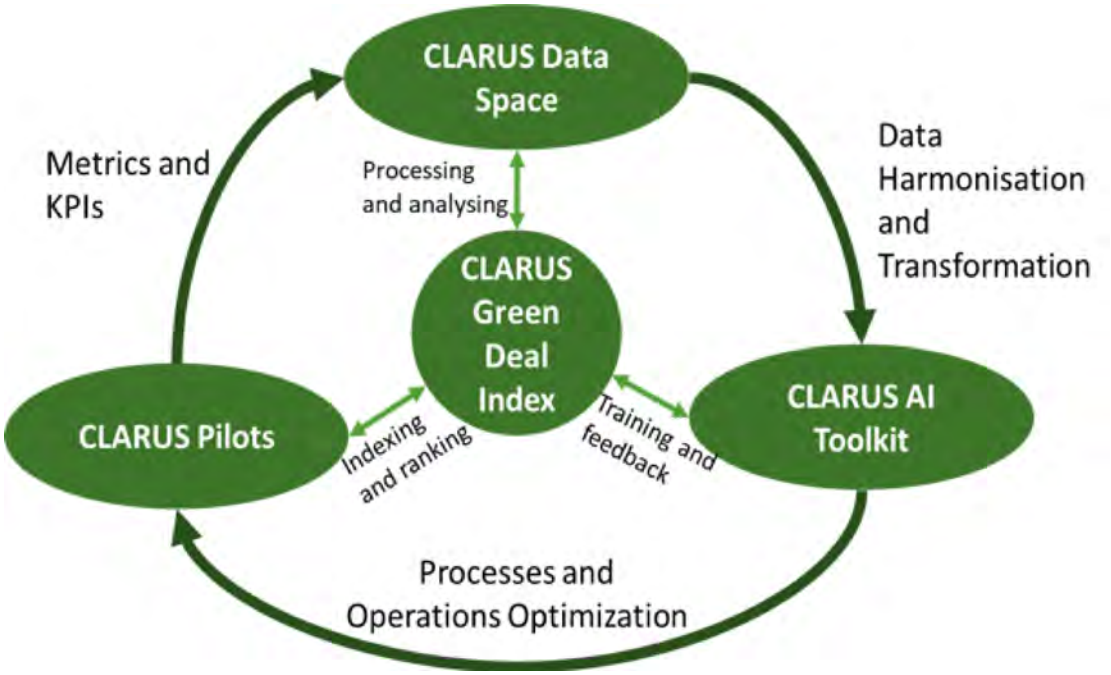
ardo.com/en

To demonstrate ithe impact on the green deal concept, the CLARUS project will provide three Tangibles Expected Outcomes which represents the Key Exploitable Results of the project:

- **CLARUS Green Deal Index:** methods, tools and data used to calculate the Green Deal Index (GDI)
- **CLARUS Data Space:** FAIR data models and Industrial Data Platforms tools that are developed and deployed for edge data management, cloud data management, and data harmonization, transformation and sharing
- **AI Toolkit:** AI algorithms and the trained models that are developed, tested, and validated in the project.

EXPECTED IMPACT

- **SCIENTIFIC:** creating new knowledge and experience in assessing the impact on the Green Deal plan, improving the adoptability of scientific outcomes in industrial demonstrations.
- **SOCIETAL:** providing clear metric on the impact of organization that present the friendliness with respect to the Green Deal Plan which will improve overall wellbeing.
- **ECONOMY:** CLARUS will transparently help in distributing the responsibilities of achieving the Green Deal Plans by providing proper ranking and indexing of companies, factories, cities, and countries. This will reduce the needed effort to determine the problem and help in reaching faster and more accurate results in improving the impact on the Green Deal.



DARROW

Driving the future of Water Resource Recovery Factories through data intelligence

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 March 2026*
Project ID	*101070080*

OBJECTIVES

The aspiration of DARROW is to build and demonstrate into an operational environment, an innovative, modular and flexible data-driven, AI-powered ecosystem of software services to make existing Wastewater Treatment Plants (WWTP) more autonomous, more energy efficient and better prepared for their transformation into Water Resource Recovery Facilities (WRRF). DARROW will take advantage of existing AI and Data analysis techniques with the ultimate goal of contributing to a greener planet by:

1. Saving energy costs;
2. Reducing Greenhouse Gas Emissions;
3. Increasing Resource Recovery; and
4. Improving water quality.

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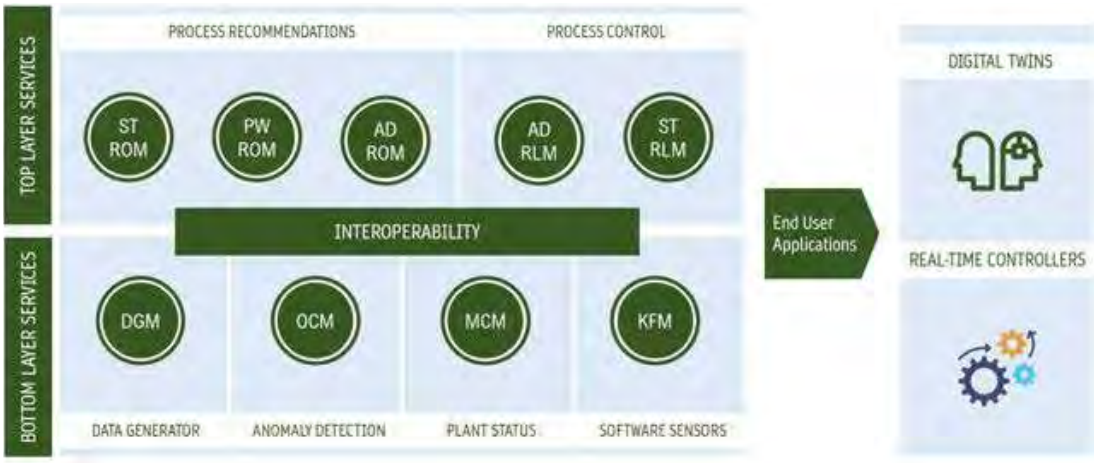
EXPECTED IMPACT

Plant optimization. DARROW will contribute to reduce OPEX and CAPEX in WRRFs, with the subsequent reduction in public budgets and/or customers' bills. Besides, DARROW will also demonstrate how digitalization of WRRFs can contribute to reducing the environmental impact of the water industry.

Trustworthy AI: DARROW will demonstrate the benefits of using advanced AI and Data solutions in the wastewater treatment sector and will demonstrate the level of maturity in facing and solving real operational problems, thus leveraging AI acceptance by plant managers and the future adoption of the proposed solution.



DIGIFOREST

Digital Analytics For Sustainable Forestry

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 28 February 2026*
Project ID	*101070405*

OBJECTIVES

With 43% of the EU covered by forests or woodlands, their well-being is essential for all Europeans. The European forestry industry has been tasked with achieving greater sustainability by the 2021 EU Forestry Strategy Targets include improved forest management, sustainable development of wood-based resources and improving the skills of forest workers.

In DIGIFOREST we choose an innovative novel approach to transform to large scale precision forestry management. It is centered on the collection of detailed and diverse forest data at tree level using mobile robots, its analysis with artificial intelligence and its presentation to forestry operators to support decision making and robotic selective logging/cutting. Specifically, will develop a heterogeneous team of robots to collect and update detailed maps of forest stands. We will evaluate the use of both rugged walking robots as well as aerial robots. The maps will be semantically labelled using artificial intelligence and our partner's advanced mapping technology. This will provide unprecedented detail down to individual tree level, which is impossible to achieve with current Aerial Laser Scanning from above the canopy.

This will allow to make more informed operation decisions. To act on this data, we will furthermore develop a Supervised Autonomous Harvester robot, a solution for robotic selective logging which could have a transformative impact on the economics and sustainability of selective cutting.

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MOOG BV
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EXPECTED IMPACT

IMPACT ON FOREST INVENTORIES The project will enable accurate tree-wise data collection at scale. Individual tree locations and their key attributes will be known and can be imported to decision support systems. Tree level data can then be aggregated to any desired resolution (grid or stand). Furthermore, temporal data can allow detecting tree growth, which enables creating site-specific growths models and monitoring of above ground carbon stocks.

IMPACT ON FOREST MANAGEMENT: Access to accurate tree-wise data will have a major positive impact on planning and implementation of any type of forest management, including a cost-efficient use of the resources. Thus, this project advances the Central EU forest strategy goal of moving away from clear cuts, and towards sustainable forest management, i.e. selective cutting in continuous cover forest management providing multiple services. This is further supported through high-resolution data that enable detecting valuable habitats for protection, and allow better estimating potential risks due to disturbances, such as insect damages or windthrows.

IMPACT ON LOGGING: Improved tree-wise data and traffic ability estimates will enable accurate planning of logging operations — to the extent that these operations can be automated. Eventually the automated harvester robot fleet would be able to perform automated logging operations cost-effectively by reducing operation costs, reducing harvesting losses and limiting the damage to environment. In addition, transition from heavy duty harvesters to light-weight harvester robots would reduce soil damage and damage to the remaining stands and enable more flexible operation in different seasons.

IMPACT ON AGRICULTURAL PRODUCTION: The developments of DIGIFOREST can cross-fertilise the field of robot-driven crop production. For example, building properly georeferenced image data in forest environments above and below canopy could – at a smaller scale – also be used in monitoring crops such as maize or horticultural crops for a full assessment. Similar aspects hold for the semantic interpretation with respect to analysing plant species. Techniques for detecting weeds and analyzing plant development from a semantic perspective are, from the core techniques point of view, similar to the semantic segmentation tasks in DIGIFOREST.

GRINNER

Improving waste management through an AI-powered detection system of batteries utilizing data from X-Ray detectors and pick-and-place robots

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070321*

OBJECTIVES

The Grinner project aims at commercializing an autonomous AI-enabled robotic sorting system capable of detecting and removing waste containing batteries from current waste streams before they enter inhospitable-to-battery machines that crush and consolidate waste. The system will comprise:

1. the fastest Energy-resolved X-Ray detectors in the market,
2. an ML-enabled software module that will analyse X-Ray data and effectively detect waste containing batteries while passing through the waste flow and vision-based pick and place robot(s) that will remove the flagged WEEE.

The objectives in Summary are:

- Build an X-Ray data set of WEEE scrap.
- Customization of the X-Ray system
- Develop the AI software module for detection of batteries within WEEE using X-Ray data.
- Deploy a vision-based robotic solution capable of Picking-and-Placing WEEE
- Develop, integrate and install a prototype system in a WEEE facility environment to conduct live trials and validate Grinner.
- Explore the potential exploitation of Grinner as an economically viable, stand-alone product for recycling facilities.

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GREENWEEE INTERNATIONAL SA
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ERION COMPLIANCE ORGANIZATION SCARL
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www.essex.ac.uk

EXPECTED IMPACT

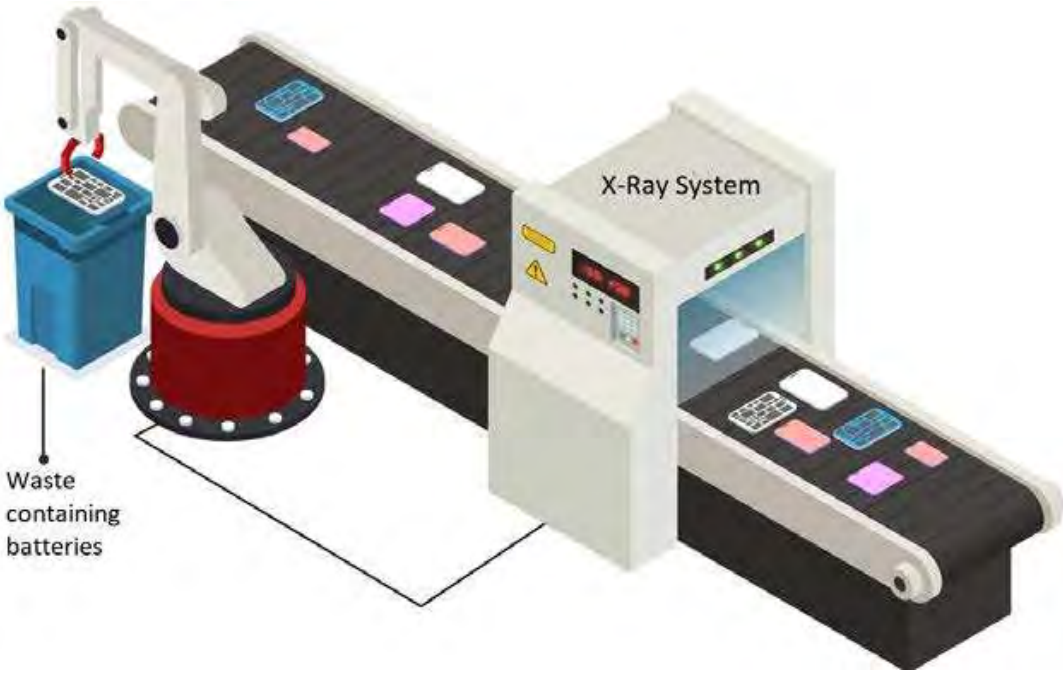
IMPACT 1: The waste management sector needs an effective solution that will address properly the issue of fires caused by WEEE containing batteries. Grinner, a combined AI, data and robotics solution, will help minimize:

- Ecological footprint (Toxic fluoride gas emissions) generated from battery fires
- the generation of waste due to burned materials on-site and the materials used for fire extinguishing
- the contamination of water (e.g., runoff water used for fire extinguishing may contain substances from burned WEEE).

IMPACT 2: Grinner will directly improve the environmental impact of electrical waste and its processing by eliminating hazardous toxic emissions – hydrogen fluoride (HF) and phosphoryl fluoride (POF3) – caused by battery fires

IMPACT 3: Replacing humans working in dangerous conditions.

IMPACT 4: Besides its environmental standpoint, Grinner will effectively enable European stakeholders (recycling operators) to save millions of Euros every year by eliminating the fires caused by the misuse of batteries and the economic implications in capital damage and recycling process interruptions that can vary from **€190k to €1.3m per incident**.



RECLAIM

AI-powered Robotic Material Recovery in a Box

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070524*

OBJECTIVES

Recyclable materials recovery is a key element of the circular economy and the EU Green Deal. It is typically performed manually at large scale Material Recovery Facilities (MRFs) installed close to dense urban areas. Recent advances in AI and robotics have enabled the automation of several MRF activities. However, they target large waste volumes and are not cost-effective for smaller, less accessible areas.

To accommodate the latter, portable material recovery units can be deployed nearby. Despite the increasing demand for portable units, offerings lack intelligent, automated components that could significantly increase their productivity. To fill this gap, **RECLAIM** will develop a portable, robotic MRF (prMRF) tailored to small-scale material recovery. The proposal exploits well-tested technology in robotics, AI and data analytics which is improved to facilitate distributed material recovery.

RECLAIM adopts a modular multi-robot/multi-gripper approach for material recovery, based on low cost Robotic Recycling Workers (RoReWos). An AI module combines imaging in the visual and infrared domain to identify, localize and categorize recyclables. The output of this module is used by a multi-RoReWo team that implements efficient and accurate material sorting. Further, a citizen science approach will increase social sensitivity to the Green Deal. This is accomplished via a novel Recycling Data-Game (RDG) that enables and encourages citizens to participate in project RTD activities by providing annotations to be

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HELLENIC RECOVERY RECYCLING CORPORATION
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IRIS TECHNOLOGY SOLUTIONS, SOCIEDAD LIMITADA
www.iris.cat

ROBENSO P.C.
www.robenso.eu

ASOCIACION DE INVESTIGACION DE MATERIALES PLASTICOS Y CONEXAS
www.aimplas.net

AXIA INNOVATION UG
www.axia-innovation.com

INTERNATIONAL SOLID WASTE ASSOCIATION
www.iswa.org

PERIFERIAKOS FOREAS DIAXIRISIS STEREON APOVLITON IONION NISON ANONIMI ETERIA TON OTA
pin.gov.gr

used in deep learning for the retraining of the AI module. **RECLAIM** developments will be implemented and repeatedly assessed in three different demanding, real material recovery tasks.

EXPECTED IMPACT

IMPACT 1: RECLAIM integrates state of the art AI, data and robotic solutions for the development of the first prMRF which will accomplish material recovery in distant, geographically isolated areas not sufficiently covered by current waste management models. In full support to the Green Deal, enhanced material recovery will lead to a significant reduction in GHG emissions, since recycling of the sorted waste is enabled and thus emissions associated with the use of virgin materials are avoided.

IMPACT 2: The project adopts a highly modular approach by using multiple Robotic Recycling Workers (RoReWos) to compose a team that undertakes material recovery. RoReWos will be equipped with different grippers specialized to different types of materials, to improve recovery speed and reliability. **RECLAIM** aspires develop the solution with the highest "pick per invested euro" rate, to date, thus providing a new boost to the Green Deal and its objectives.

IMPACT 3: The project introduces new technologies on waste management and material recovery that contribute in keeping waste treatment and material recovery services running, being significantly less affected by unexpected challenges such as the ongoing pandemic or personnel shortages. Accordingly, **RECLAIM** contributes in making EU economy climate-neutral, zero polluting and globally competitive, through implementing breakthrough solutions and new business models on secondary material management.

IMPACT 4: RECLAIM increases social awareness to recycling via a novel Recycling Data-Game (RDG) that highlights the related challenges and encourages citizens to participate in project activities. The citizen science approach adopted by the project connects citizens with emerging social and environmental needs, thus improving societal adaptation in the green and digital transition.

Wind Turbine Blades Robotic Maintenance

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ROMAIN

Development Of A Robotic Maintenance System For Wind Turbine Blades

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070320*

OBJECTIVES

ROMAIN is a project closely directed to end-users. The measurable technological and operational objectives are broken down as follows.

Technological objectives

The first objective of the project is to design a compact robot capable of carrying and deploying the newly developed inspection and repair kit along the Wind Turbine Blade (WTB).

Subsequently, the inspection system will be optimised to detect subsurface defects within the WTB locally: this includes the implementation of advanced image processing algorithms with the objective of significantly increasing the inspection rate.

The project is also aiming at demonstrating advanced repair techniques using composite repair patches and heating and compaction curing and consolidation to repair the WTBs locally, with the support of the robot.

Furthermore, image processing and AI algorithms will be designed to fast process the images acquired with the procedures illustrated.

Finally, safety measures will be put into place throughout the demonstration phase to manage the robot and the integrated inspection and repair kit in case of malfunction.

Operational objectives

The project intends to demonstrate the functionalities of the integrated system in a real operating onshore wind farm, separately at first (the inspection kit separated from the repair one) and afterwards combined in a single system. The demonstration activities will always be performed according to the safety standards.

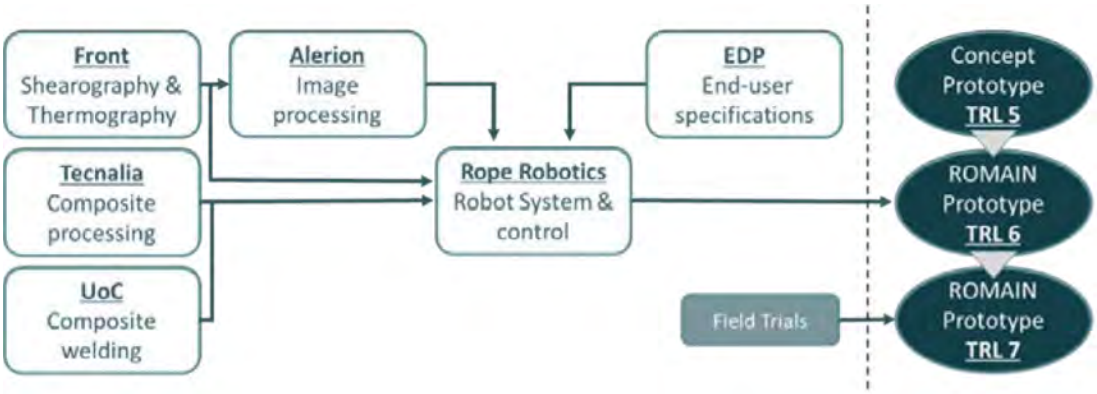
RopeRobotics robot in operation

EXPECTED IMPACT

IMPACT 1: Inspection and maintenance practices still rely strongly on technicians, exposed to a demanding and hazardous work environment. ROMAIN will enable to use a robotic system to perform WTB maintenance, totally removing the need for human access and consequently the associated safety risks.

IMPACT 2: Currently, inspections are limited to surface defect detection. Advanced optical inspection technique with subsurface defect detection will be developed and integrated with the robot in ROMAIN. The improved performance of the inspection will naturally lead to improved performance of the repair.

IMPACT 3: Data on WTB Inspection is primarily optical images acquired by conventional digital cameras and passive temperature images by thermal cameras. ROMAIN will produce different types of data by developing advanced lock-in shearography and thermography with laser heating. The new information collected will lead to advancement in gathering new physical intelligence about WTBs and hence to new analytical results.



ROMAIN consortium partners form a valuable workflow

SMART DROPLETS

Accelerating the achievement of EU Green Deal Goals for pesticide and fertilizer reduction through AI, data, and robotic technologies

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 28 February 2026*
Project ID	*101070496*

OBJECTIVES

Smart Droplets' main objective is to advance both hardware and software capabilities during chemical applications for resource optimisation and minimisation of chemical waste. It will use existing technologies (>TRL 7) developed within but not limited to the agricultural industry to accomplish this vision to deliver a complete system capable of translating large amounts of data from the field into meaningful information and impactful spraying commands to achieve the Green Deal goals. The road towards achieving the main objective consists of **four key objectives**.

1. **Innovate using intelligent Data infrastructure and Digital Twins.** Data interoperability, storage and exploitation of AI models are crucial to support, monitoring and refining of big amounts of field data. While Digital Twins and AI models play an instrumental role in analyzing field data to recommend spraying strategies.
2. **Introduce a robotic solution for autonomous spraying.** A retrofit (robotic) tractor and an advanced sprayer will be deployed in real farms to address the challenge of resource optimization and waste minimization, targeting chemical and nutrient over-application and natural resource exploitation during crop care tasks.
3. **Optimize technologies and demonstrate the Green Deal goals in real life environments.** Robotic and non- components will be tested and validated, and then progressively deployed in real farms where through data-driven decisions, will demonstrate its ability to attain its goals.

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FOODSCALEHUB
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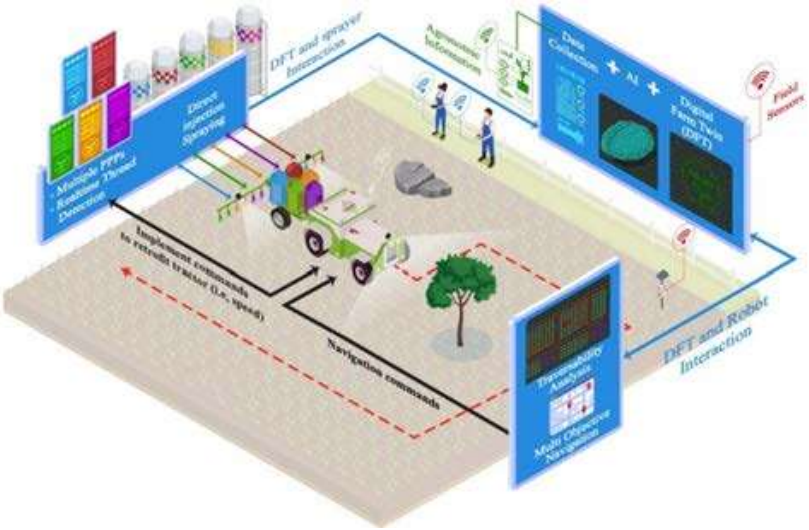
4. **Community building, synergies, and results exploitation.** Building a community around Smart Droplets is an integral part of the project as it ensures proper information exchange with relevant stakeholders, outreach to similar communities, and training programs for members while exposing technological and domain-specific constraints. While, result exploitation facilitates productization, adoption, and sustainability.

EXPECTED IMPACT

IMPACT 1: *Support Europe's open strategic autonomy by sustaining first-mover advantages in strategic areas including AI, data, robotics, and by investing early in emerging enabling technologies.* Smart Droplets will invest significant resources in technologies for sustainable and responsible agriculture. A strong IPR strategy will protect the EU's rights on the market and help shape a greener and fairer world. Digital Farm Twins, robotics, AI, and data are at the heart of Smart Droplets towards developing an innovative spraying solution for crop care tasks. Smart Droplets is creating added value in the agricultural industry and its supply chain, thus leveraging the first mover advantage to support Europe's open strategic autonomy, aligned with the EU mandate to reduce hazardous agrochemicals. Innovative and sustainable results of Smart Droplets will contribute to resilience and competitiveness of the EU economy while identifying early opportunities and bottlenecks on the IP and exploitation aspects of such technologies

IMPACT 2: *Reinforced European industry leadership across the digital supply chain.* Advances in robotic systems and the influx of AI and Data technologies have the potential to contribute to the Green Deal objectives across the European digital supply chain. Europe cannot afford to stay behind in the race of large-scale agriculture robotisation, so Smart Droplets offers the necessary test bench for exploring disruptive technologies that can offer global excellence and reduction of agrochemicals. The leading position of the European industry will be validated through benchmarking of all technological aspects during the project implementation. Moreover, real environment demonstrations will showcase the technological progress made within the project and validate their contribution towards the Green Deal. A comprehensive exploitation strategy will advance the adoption rate of robotic, AI and Data solutions, thereby reinforcing European industry leadership in the digital food supply chain.

IMPACT 3: *Robust European industrial & technology presence in key parts of a greener digital supply chain, from low-power components to advanced systems, future networks, new data tech. & platforms.* Smart Droplets takes a multi-layer complementary approach to tackle key parts of the supply chain, incorporating different components such as Digital Data Twins, robotics, AI, and Data Platforms to create an optimized spraying solution. This data-centric approach includes historic field data, 3rd party information services, and real-time sensory data of the deployed robotic system. Robust European industrial and technology presence requires strong engagement by stakeholders. Therefore, community and capacity-building activities will ensure proper transition and adoption of technologies.



TUBERS

Scalable and Modular robotic tools for pipeline inspection and repair

Call	*HORIZON CL4-Digital-Emerging-2021-01-09*
Duration	*1 September 2022 > 31 August 2026*
Project ID	*101070115*

OBJECTIVES

The European water network distribution is plagued by leaks that cause a staggering 20% of drinking water to go wasted.

TUBERS sets forth a new paradigm by creating the world's first combination robotic platforms allowing for 24/7 inspection and targeted in-situ repairs, greatly reducing the costs of inspection and maintenance.

The system will comprise:

1. A snake-like resident robot which can operate over long distances and negotiate pipeline-junctions to navigate large parts of the water network,
2. A modular soft-robotic platform capable of moving using an "inchworm" technique, for inspections and repairs of pipe segments featuring a novel repair deployment mechanism,
3. A High-accuracy inspection system that can detect leaks and measure corrosion based on coded excitation, an advanced technique that greatly improves Signal-to-Noise ratio,
4. A Decision Support System powered by Explainable Machine Learning algorithms incorporating a Multi-Criteria Decision Analysis framework for holistic planning of inspection and maintenance.

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The TUBERS solution will be validated in real water network pipelines operated by 3 of the most prominent water utility companies in the Netherlands. Once it reaches the market, our solution will provide the operators with powerful tools to eliminate waste, facilitating savings of an estimated 158GWh of energy and 79.000 tonnes of CO2 emissions within a 5-year period.

EXPECTED IMPACT

IMPACT 1 SCIENTIFIC: Development of a new ecosystem of digital tools, systems and processes connected through network and positioned towards the prevention of water loss through leakage, aiming for a more sustainable water management process.

IMPACT 2 ECONOMIC: Maximizing the value of existing water infrastructure by increasing utilization and ensuring better recovery from damages/ leakages by 50%.

Balancing supply and demand, while preventing unnecessary water waste.

IMPACT 3 SOCIETAL: Increased sustainability and circularity of water management, economically-viable and eco-friendly solutions to reduce/eliminate water leakage causing contamination and underground pollution.

IMPACT 4 CLIMATE CHANGE: initiative to contribute to help to exploring solution to deal with the climate change challenge.

INNOVATION IN AI, DATA AND ROBOTICS

AI, DATA AND ROBOTICS AT WORK

EARASHI

Embodied AI/Robotics Applications for a Safe, Human-oriented Industry

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 28 February 2026*
Project ID	*101069994*

OBJECTIVES

Despite a decrease since the 90s, 3.1M non-fatal accidents still happen at work, with at least four days of justified absence. Among these, around 3 300 fatal accidents take place in the EU-27. These work-related accidents and illnesses cost the EU economy EUR 460 billion in 2019, i.e., 3.3% of GDP annually.

In 2021, the EC proposed a new strategic framework for Health and Safety at Work (HSW) to protect the health and safety of its 170 million workers and achieve sustained decent working conditions for all human resources, especially related to industry 5.0, e;g. introduction of robots, AI and remote work to reduce the risks of dangerous tasks and increases productivity.

However, cognitive overload, digital fatigue, mental exhaustion, and various forms of 'techno-stress' are also increasing and shall be tackled to ensure HSW.

EARASHI aims to improve working conditions, trust, and acceptance of collaborative embodied AI in robotic systems. This will be achieved by supporting Industry, especially start-ups and SMEs, in the uptake of advanced digital and eco-responsible technologies (in particular AI, data, and robotics).This approach will help employees in their daily activities and improve their working conditions, leading to a productivity increase.

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ST MICROELECTRONICS
www.st.com/content/st_com/en.html

EARASHI adopts a worker-centric approach by considering workforce well-being and health (e.g., MSD and stress), design thinking methodology of production machines, worker acceptance, and ethics.

Selected through two open calls, beneficiaries will get access to EARASHI leading-edge technologies and test facilities from RTOs and industrial partners, business support, mentoring by industrial pairs, support in ethics, system integration, and user acceptance, thus lowering both their technical and business barriers.

EXPECTED IMPACT

In line with the Horizon Europe Strategic Plan, EARASHI aims to contribute to Europe's needs to be able to autonomously source and provide crucial services and technologies that are safe and secure for industry, and people. Thus, it will help shape secure, trusted, and competitive technologies as well as enable eco-responsible production and consumption for the production machines/tools sector.

EARASHI will also promote an open strategic autonomy by leading the development of key digital emerging technologies, sectors, and value chains, making Europe the first digitally-enabled circular, climate-neutral and sustainable economy.

Thanks to the Financial Support to Third Parties structure, through investments in early discovery and industrial uptake of new technologies EARASHI will contribute to strengthen Europe capacities in key parts of Digital and future supply chains in production machine, enabling agile responses to urgent needs and open strategic autonomy in digital and future emerging enabling technologies.

By investing early in and sustaining competitive emerging enabling technologies, EARASHI will contribute to accelerating an eco-responsible digital transition by 2030.

FAIRWORK

Decision Support to optimize processes and ensuring trustworthy usage of AI.

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101069499*

OBJECTIVES

Current automated and hierarchically structured production processes can only insufficiently deal with the upcoming flexibilization. We foster the "democratization" of decision-making in production processes, hence the participation of all involved stakeholders, by introducing a decentralized AI system. Our Democratic AI-based Decision Support System (DAI-DSS) democratically finds the appropriate decision for a concrete situation during production. Each human or technical actor is represented by an agent who negotiates based on the current status provided by the digital shadows and twins. The future situation is predicted by AI algorithms for each individual actor considering the modelled knowledge base that defines each negotiation strategy. A multiple optimization algorithm finds the most appropriate solution considering the needs of all involved human and technical stakeholders.

FAIRWork brings "Human, AI, Data and Robots" together, (a) by introducing Design Decision Models and assessing if those models are "appropriate / fair", (b) decentralizes the decision-making, by representing each involved – human or technical – actor within a Multi Agent System and configuring each agent with previously approved decision models, and (c) broadens the view to optimize the production process, by also introducing social and operational-related parameters, like energy consumption, in addition to the existing technical and business-related aspects. These will be identified and evaluated in user-centred decision making.

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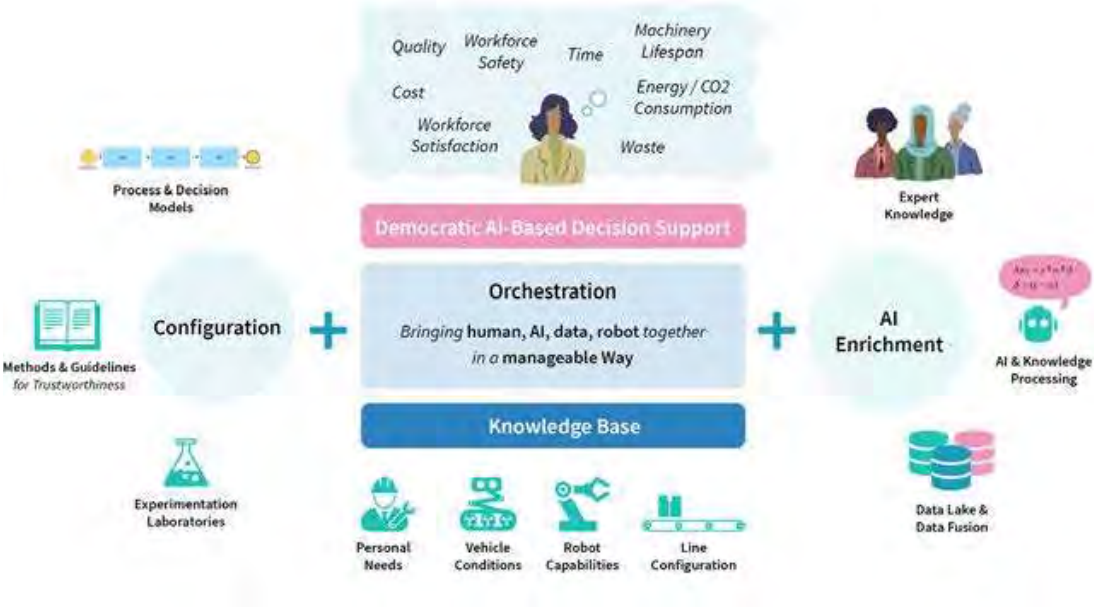
EXPECTED IMPACT

IMPACT 1: Improve optimization of the production processes. Raise efficiency through faster and more precise decision-making, integrating digital twins from all involved process stakeholders. Raise energy efficiency by configuring process management techniques, so that digital twins concerning energy-efficiency of business processes can be managed. Improve co-creation capabilities and strengthen compliance by using a transparent model-based approach that enables the collaboration with relevant stakeholders during decision-making.

IMPACT 2: Strengthening the perception of trust and fairness. Improve workforce wellbeing and raise competence via transparent and co-creative configuration of decision-making, encouraging the consideration of the heterogeneous needs of relevant stakeholders. Raising attractiveness for skilled people by introducing novel technologies like AI, digital twins or smart devices.

IMPACT 3: Improve flexibility of European Industry. Cooperative decision-making has the potential to be extended with the vision that conveyor belt-oriented production moves towards cooperating robots. Collaborative decision-making can be applied between different actors within a production process including robots and operators. Support companies in offering "low-lot size" production capabilities that are especially relevant for start-ups. Intended time-reduction in prototyping raises the overall flexibility and reduces barriers by improving "low lot size" production.



FEROX

Fostering and enabling AI, data and robotics technologies for supporting human workers in harvesting wild food

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070440* — FEROX

OBJECTIVES

The FEROX project will design a fully-automated, wild-berry harvesting solution to support safer working conditions for pickers. Our main goals are to:

- Develop innovative solutions based on AI, computer vision and drones to monitor and support harvesting activities, incorporating improvements in working conditions and mitigating risks/threats to wild fruit picker safety.
- Identify and respond to short and longer-term needs, hazards, and occupational challenges that will make berry collection faster and more efficient.
- Develop flexible technical services (i.e. equipment, acquisition systems, software applications and human-computer interfaces) that are prime for exploitation.
- Validate the design and engineering approaches for monitoring berries and pickers, navigating through wildernesses to quickly locate ripe berry patches, to help with logistics optimizations and provide physical assistance if requested.
- Evaluate the impact of FEROX technologies on workers, measuring their improvements to health and their productivity vs effort spent collecting.

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SPARKD
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EXPECTED IMPACT

IMPACT 1: Generate new knowledge about the effects and benefits of using AI/drones to help workers in forest related tasks.

IMPACT 2: Improve trust in and acceptance of AI/drones at work, trying to expand commercial activities to locals too.

IMPACT 3: Create new business opportunities for EU's AI/drone SMEs and to extend the EU's lead in wild berry markets.

GEYEDANCE

AI Guidance For Robot-Assisted Eye Surgery

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070443*

OBJECTIVES

Retina indications are the leading cause of visual impairment in industrialized countries and posing a big unmet socio-economic challenge. Performing surgical actions directly at the retina - one of the most delicate and sensitive areas of the human body - with ultra-thin microsurgical instruments and with a limited view makes retina surgery a very challenging discipline with surgeons working at the limit of what is possible, requiring years of training and experience to reach proficiency.

GEYEDANCE is directly addressing this need by translating methods from Artificial Intelligence to the area of surgical robotics, together to be used for an advanced user support for reducing the mental and physical load of the surgeon. This AI-based surgical platform ideally connects novel sensing for an improved view of the surgical field with robotic technology that facilitates safe steering of the surgical instrument and thus helps to increase reproducibility and finally leads to less surgical trauma, improved safety margins, and better surgical outcomes.

Project objectives are as follows:

- Robust, reliable, and safe real-time, intraocular AI-based measurement of retinal geometry
- AI-based robotic assistance for safe and efficient surgery
- GEYEDANCE robot platform for eye surgery including clinical validation
- Preparation of successful exploitation of the GEYEDANCE robot platform

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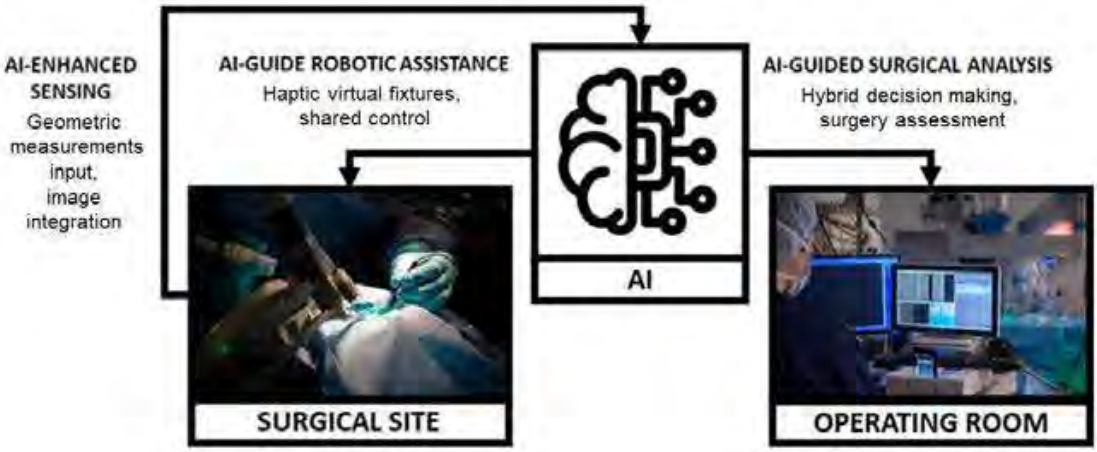
EXPECTED IMPACT

In GEYEDANCE, we will combine micro precision robotic tele manipulation with AI functionalities - two converging, mutually enabling technologies. This liaison will deliver significant value to retinal surgery by (1) making current procedures easier and safer, and (2) enabling new treatment procedures due to the improvement of dexterity and safety in instrument handling.

In addition, wider scientific, economic and societal effects can be expected, such as:

- Breakthrough integration of AI methods and medical robotics to provide more reliable tools for eye surgery
- Availability of relevant real-world data sets via open-access platforms
- Establishment of a best-practice platform for the integration of AI methods and medical robotics in a wider context
- Improved positioning of the European medical robotics industry in international competition
- Decreased number of people suffering from severe visual impairment and reduction of corresponding (in)direct societal and medical costs



HACID

Hybrid Human-Artificial Collective Intelligence In Open-Ended Decision Making

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070588*

OBJECTIVES

HACID aims at harnessing the hybrid collective intelligence of human experts and AI systems to address open-ended problems—i.e., problems in which the solutions are not constrained to a (predefined, limited) set of alternatives. We aim to develop a general methodology and apply it to medical diagnostics and climate services.

In medical diagnostics, the identification of a disease from a set of symptoms may be particularly complex, as it deals with a large variety of possible diseases. Climate services represent a relatively new area of decision-making but already supported by large formal and informal bodies of knowledge, demanding the integration of multiple knowledge domains into local contexts.

A promising way to improve decision making in complex open-ended problems is exploiting collective intelligence (CI). HACID aims at developing a hybrid collective intelligence decision support system capable of providing support to evidence-based decision-making, and aggregating and expanding the solutions provided by multiple experts, ultimately providing higher efficacy and efficiency, as well as higher user satisfaction, explainability and trust. The proposed system leverages complementarities between domain expertise from humans and the AI ability of reasoning on and analyzing vast amounts of data. Using a participatory approach, HACID aims at deploying an AI system capable to deal with complex, high stakes application domains and decision-making contexts.

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MET OFFICE (UK)
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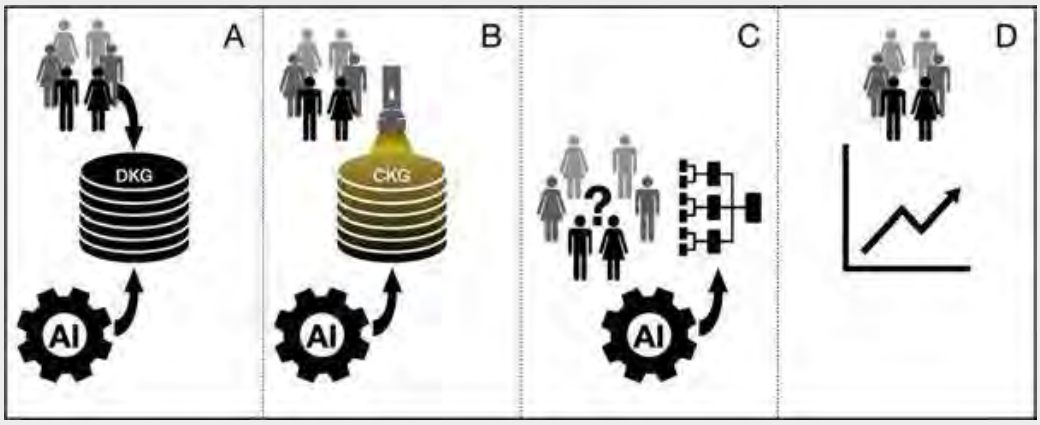
EXPECTED IMPACT

SCIENTIFIC IMPACT: HACID proposes a novel methodology to harness hybrid collective intelligence in open-ended domains. Being a rather uncharted territory, the project will lay new grounds for further research, especially for what concerns (i) the automatic information extraction approaches from large evidence databases, (ii) the user experience aspects related to interacting with heuristic knowledge systems, and (iii) the effects of social information and social influence on performance of hybrid collective intelligence systems.

IMPACT ON MEDICAL DIAGNOSTICS: Decision-making in medical diagnostics cannot currently count on technologies that can support professionals in their daily tasks, especially for general clinical settings. AI is conquering new grounds in diagnostics, for instance in supporting radiologist in spotting the most urgent cases. Very often, AI-based diagnostic systems are tailored to very specific diseases and are based on some image classification software. However, actual deployment is very limited due to lack of trust and medical ethics issues. The hybrid collective intelligence approach proposed in HACID can have a concrete impact because it addresses a wider domain than current AI technologies, and because it is designed to exploit the complementary abilities of human experts and AI systems, hence improving trust in the system.

IMPACT ON CLIMATE SERVICES: Climate services for supporting climate change adaptation management currently lack technologies that can support navigating an already very large evidence base. The potential impact of HACID is therefore very large, considering that a competing service does not exist to date. National and international agencies in Europe and worldwide would benefit from a more structured, unbiased and evidence-based decision process. Additionally, the evaluation research that will be conducted within the project can help measuring the quality of the proposed or implemented policies in a reliable way.



HACID foresees four phases to enable hybrid human-artificial collective intelligence in open-ended domains. (A) A domain knowledge graph (DKG) is created by integrating top-down knowledge engineering methods to grasp expert knowledge and bottom-up AI-generated knowledge obtained from the analysis of large bodies of evidence (e.g., scientific literature). (B) For every specific case (e.g., a patient with given symptoms), a case knowledge graph (CKG) is generated by collective tagging of relevant concept and knowledge enriching by both human experts and AI systems. (C) Solutions to the given case are provided by domain experts, and aggregated/expanded by reasoning on the concepts of the CKG. (D) Evaluation of the solution is performed with respect to efficacy, efficiency and trustworthiness exploiting a participatory evaluation approach.

SIMAR

Safe Inspection and Maintenance supporting workers with modular robots, Artificial Intelligence, and Augmented Reality

Call	*HORIZON-CL4-Digital-Emerging-2021-01-10*
Duration	*1 September 2022 > 31 August 2025*
Project ID	*101070604*

OBJECTIVES

Objective 1: Multipurpose aerial/ground robotic system to keep workers away from dangerous situations for a safe, robust, and trusted inspection.

Objective 2: Artificial Intelligence and Augmented Reality systems to reduce human workload and level of stress.

Objective 3: Human-centered robotics inspection system.

Objective 4: TRL7 validation and demonstration on an operational petrochemical facility, taking into account end-users requirements.

EXPECTED IMPACT

IMPACT 1: Reduce the risk and therefore increase the safety of personnel when collecting inspection data. By using this novel solution to remotely inspect, human workers do not have to access all inspection locations in person anymore. They can avoid hazardous working at heights or with high temperatures. Therefore, the exposure to risk is decreased, and human safety is improved.

IMPACT 2: Increase the quality of the data by reducing human factors that affect their performance. Performing inspection remotely, avoiding working in difficult and dangerous and uncomfortable locations (at heights, high temperature) will reduce the human factors that can lead to human

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errors in collecting inspection data. More reliable inspection data is key to ensuring asset integrity and avoiding future (catastrophic) asset failure.

IMPACT 3: Reduce current inspection costs and outage time. Errors or poor inspection data quality will have severe implications, including fatalities, injuries, and health effects on the public and plant staff. It may also allow for leaks and the release of dangerous compounds into the environment, resulting in clean-up and remediation costs. It will also cause equipment damage, resulting in unplanned repairs and replacements, downtime, and equipment unavailability for production. The use of robotic technologies in SIMAR will importantly decrease the cost and time of inspection and maintenance operations in Oil&Gas facilities.

SIMAR proposes a new type of inspection robot that is composed of an aerial system with advanced navigation capabilities that will allow it to safely land on pipes, even if they are located in complex and cluttered locations and deploy untethered and light-weight crawlers that integrate either adapted X-ray or PEC (Pulsed Eddy-Current) sensors to perform complete inspections of insulated pipes.

This will be done by applying the MOVE, SUPPORT and UNDERSTAND functionalities, integrated into a unique system, validated in a controlled environment, and finally demonstrated in a real operational industrial facility of the SIMAR end-users.

MOVE will be implemented by robots with flying and crawling locomotion, SUPPORT by the application of Augmented Reality, and UNDERSTAND by means of Artificial Intelligence.

SIMAR project will further develop inspection robots from previous H2020 projects. In the image, a prototype from the HYFLIERS H2020 project (H2020-ICT-25-2017-1, GA:779411)

SOFTENABLE

Towards Soft Fixture-Based Manipulation Primitives Enabling Safe Robotic Manipulation in Hazardous Healthcare and Food Handling Applications

Call	*HORIZON CL4-Digital-Emerging-2021-01-10*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101070600*

OBJECTIVES

The project proposes a new framework for manipulation actions involving deformable delicate objects based on the notion of soft fixture-enabled manipulation primitives. While fixtures by means of robotic grasps or specifically designed workpiece fixtures are routinely applied in industrial robotics applications involving rigid objects such as metal parts, there is a need to generalize these robotic methods to materials and situations that require the robust manipulation of soft or fragile items.

The goal of the project is to extend existing robotic grasping and manipulation techniques based on a novel soft fixture-based framework that generalizes the notion of caging grasps together with the co-development of a soft fixture-optimized robotic manipulator and tooling for this purpose.

Fresh food processing and preparation requires complex and sophisticated manipulation that is comparatively labour intensive.

These manipulation challenges are in principle well-suited for robotics, but the handling of delicate items such as meat and fish requires new types of robotic manipulation primitives to secure the manipulated object safely.

In addition to the fresh food handling use case, the project will focus on the healthcare sector that shares the same manipulation

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challenges, where the project will demonstrate how soft fixtures can be utilized by a robotic system assisting health care workers by reducing stress and risk exposure during the handling, preparation, dressing, undressing and safe disposal of personal protective equipment (PPE).

EXPECTED IMPACT

IMPACT 1: Increased Robotic Handling of Fresh Produce.

In this project, we focus on addressing key challenges associated with the manual processing of fresh produce such as fish and meat, which typically has an associated labour intensity that makes it hard to offer commercially. We put the needs of the worker at the forefront and aim to create robust autonomous solutions for selected processing stages that employ the proposed methodological advancements of robotic manipulation. For this, we take into account specific requirements to handle and manipulate delicate food produce aiming to reduce the manual work load resulting from food processing.

IMPACT 2: Impact on the public health sector: Freeing Human Resources as a Human-Centered Paradigm to Improve Health Facility Efficiency.

The health sector is still a traditional one, where technologies based on robotics have reached key applications in surgery, but are still far from making an impact on many aspects of the hospital's daily tasks. The project focusses on the labour intensive challenges surrounding dressing, undressing and safe disposal of personal protective equipment (PPE) as a novel area for the application of robotics in the healthcare environment. In this setting, trust by professionals is crucial, and this project aims to bring such technology closer to hospitals and health professionals. We focus in particular on a close integration of requirements and feedback from healthcare professionals in the development of the proposed technologies with the goal of increasing overall health facility efficiency in a human-centered manner.

IMPACT 3: Impact on sectors that involve robots in a shared environment: Building confidence for professionals to work in a shared environment with robots.

An overall key challenge for humans to collaborate with robots is the reliability of robotic systems. The low-level manipulation methodologies based on the concept of soft fixtures developed in this project all aim to improve the reliability of robotic manipulation actions in novel application scenarios and will likely extend to human-robot interaction tasks beyond the specific scenarios considered in the project.

TOMORROW'S DEPLOYABLE ROBOTS: EFFICIENT, ROBUST, SAFE, ADAPTIVE AND TRUSTED

AGIMUS

Next generation of AI-powered robotics for agile production

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*1010700165*

OBJECTIVES

Industrial robots are currently designed for specific tasks, often rigidly fixed to the ground floor. They are manually programmed each time the production line changes, because of their limited perception and adaptation capabilities, which is costly and time-consuming. This prohibits robotization of small batch production. **What if we could enrich the shop floor with general-purpose robots, faster to set up, more autonomous and versatile to the manufacturing process?** This way, we could drastically simplify the design of manufacturing lines and cost-efficiently robotise small batch production, providing the EU manufacturing industry with flexibility and competitiveness.

However, such a level of autonomy is not yet possible on the shop floor because of the limited perception and learning capabilities of current robots. AGIMUS aims to deliver open-source breakthrough innovation in AI-powered agile production, enabling general-purpose robots to be quick to set up, autonomous and to easily adapt to process changes. We leverage cutting-edge technologies and go beyond the state-of-the-art to equip current mobile manipulators with a combination of (i) an advanced task and motion planner that can learn from online available video demonstrations; (ii) optimal control policies obtained from advances in reinforcement learning based on efficient differentiable physics simulations of the manufacturing process; as well as (iii) advanced perception algorithms able to handle objects and situations unseen during initial training. The AGIMUS solutions will be demonstrated and thoroughly stress-tested in 3 testing zones, as well as 3 industrial pilots in Europe, under numerous diverse real-world case studies and scenarios.

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EXPECTED IMPACT

IMPACT 1: AGIMUS is expected to bring breakthrough innovation in versatile and autonomous industrial robotics for agile production by pushing the limits of AI-powered solutions for mobile manipulators in agile manufacturing. This starts with the delivery of next-generation perception algorithms and advanced learning capabilities, which will enable general-purpose robots to deliver multiple diverse tasks without requiring resource-intensive programming and training activities. On top of that, high-accuracy visual and haptic feedback will further enrich the capacity to understand and interact with the robot surroundings, leading to more accurate, faster, and safer (re-)actions.

IMPACT 2: AGIMUS brings forth, integrates and advances award-winning technologies to transform current industrial robotics solutions into a versatile arsenal of smart capabilities that can evolve further after its initial deployment. Building upon advanced perception and improved learning features, AGIMUS introduces a new generation of task and motion planning, with optimal control and reinforcement learning, that exploits multimodal feedback to handle situations that the robot has not or cannot be trained for.

IMPACT 3: AGIMUS leverages on existing testbeds and incorporates them into its core activities to deliver dedicated and focused testing zones that can highlight the potential of the envisioned framework through realistic operating environments while promoting collaboration and ensuring a sustainable transfer of knowledge among not only consortium members but also next generation of AI, Data and Robotics experts, empowering current and future European open strategic autonomy.

IMPACT 4: AGIMUS paves the way towards flexible and reconfigurable machinery by carefully designing the core principles (including ethics, trustworthiness, security, safety, etc.) that will act as the foundation for next-generation AI-powered versatile and autonomous industrial robotics. These principles will act as guidelines for the new generation of capabilities introduced (perception, learning, planning, manipulation, etc.) towards accelerating industrial uptake and significantly expediting the transformation of small-batch industrial players.

CONVINCE

CONtext-aware Verifiable and adaptIve dyNamiC dEliberation

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 31 March 2026*
Project ID	*101070227*

OBJECTIVES

The goal of CONVINCE is to advance the capabilities of robots to perform complex tasks robustly and safely within unstructured environments via autonomous and unsupervised adaptation to the environment and operational context. The key contribution is to develop and verify cognitive deliberation capabilities that ensure safe robot operation over extended periods of time without human intervention. These capabilities will be integrated into a model-driven software toolchain to allow developers to build application-specific deliberation systems able to:

1. Determine robot's behaviors required to fulfill a given task, also taking into account the context in which the robot operates and the experience gained during previous executions of the same task.
2. Deploy and configure the components that are required to execute these behaviors.
3. Automate the analysis of behaviors to ensure that they are safe and secure, leveraging on formal models and tools for design-time and run-time verification.

Results of CONVINCE will be validated on three different real-world use cases: Robot Vacuum Cleaner (UC1), Assembly Robot (UC2), Robotic Museum Guide (UC3).

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To summarize, the objectives of CONVINCE are:

- To develop a safe adaptive, cognitive deliberation system capable of detecting unexpected situations and provide contingency plans to handle them;
- To develop formal tools that ensure correct execution of behaviors and contingency plans instantiated by the cognitive deliberation system both at design time and run time;
- To integrate the tools developed in the project in an open-source software toolchain for behavior developers.

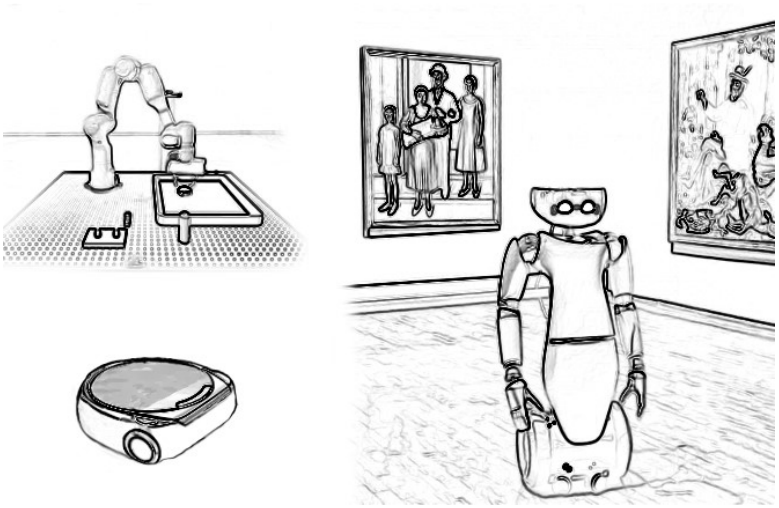
EXPECTED IMPACT

Better Perception and understanding of the world, efficient cognitive capabilities beyond the state-of-the-art. CONVINCE specifically advances the state-of-the-art in perception and situation understanding that integrate representation of situation models, methodologies for classifying observations and compare them against predictions. Overall, this will provides robots not only with a better understanding of the world, but also effective internal models that allow broader and deeper decisional autonomy, longer interactions in more complex operating environments.

Safe cognitive capabilities, safety and reliability. CONVINCE will develop novel methodologies for modelling complete robot software architectures, model checking tools to enable design-time verification and run-time monitors to assessing safety properties of robot applications thus increasing their reliability and ensuring AI safety.

New generation of AI-powered robotics and smarter robots. CONVINCE advances state-of-the-art in task and motion planning able to cope with uncertainty in the environment. The key contribution is a deliberation system which allows robots to face complexity of unstructured environments by detecting discrepancies between expected and perceived unfolding of the mission and perform contingency actions toa avoid failures. CONVINCE will make a step change towards the realization of AI-powered robotic applications that are compliant by design with legal standards, reducing debugging time, development cost and time-to-market.

Addressing real-world problems. CONVINCE will develop an open-source toolchain that will support robot developers in the modeling, verification and implementation of robot behaviors. All methods and tools will be validated in three use cases, selected not only to represent real-world problems with unpredictable and unknown environments, but also to demonstrate applicability of the technology in domains spanning consumer robots, industrial manufacturing and service robotics.



CORESENSE

Theory and Technology of Understanding for Autonomous Robots

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101070254*

OBJECTIVES

Cognitive robots have higher autonomy, enabling them to deployments in increasingly open-ended environments. This offers enormous possibilities in human economy and wellbeing. However, it also poses strong risks that are difficult to assess and control by humans. The essence of the problem can be traced to robots suffering from a lack of understanding of what is going on and a lack of awareness of their role in it. This is a problem that Artificial Intelligence approaches based on machine learning are not addressing well. Autonomous robots do not fully understand their open environments, their complex missions, their intricate realizations, and the unexpected events that affect their performance. An improvement in the capability to understand of autonomous robots is needed.

The objective of this project is to provide a comprehensive solution to this need in the form of four elements: 1) a formal, systemic theory of understanding, 2) a theory of awareness for autonomous systems, 3) reusable software assets, such as architecture and components, to apply these theories in real robots using state of the art software, and 4) three complete demonstrations of its capability in real robots. These demonstrations address a wide spectrum of needs: a) augment resilience of drone teams, b) augment flexibility of manufacturing robots, and c) augment human alignment of social robots. In summary, this project will develop a cognitive architecture for autonomous robots -and systems in general- based on a formal concept of understanding, supporting value-oriented situational awareness and self-awareness to improve robot flexibility, resilience and explainability.

CORESENSE

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EXPECTED IMPACT

The CORESENSE project addresses the development of a theory and technology of understanding that have a vocation of universality. This implies that the potential impact is enormous.

In the more modest, concrete developments of the project, the paths to expected impact have four dimensions: theory, technology, bussines and social.

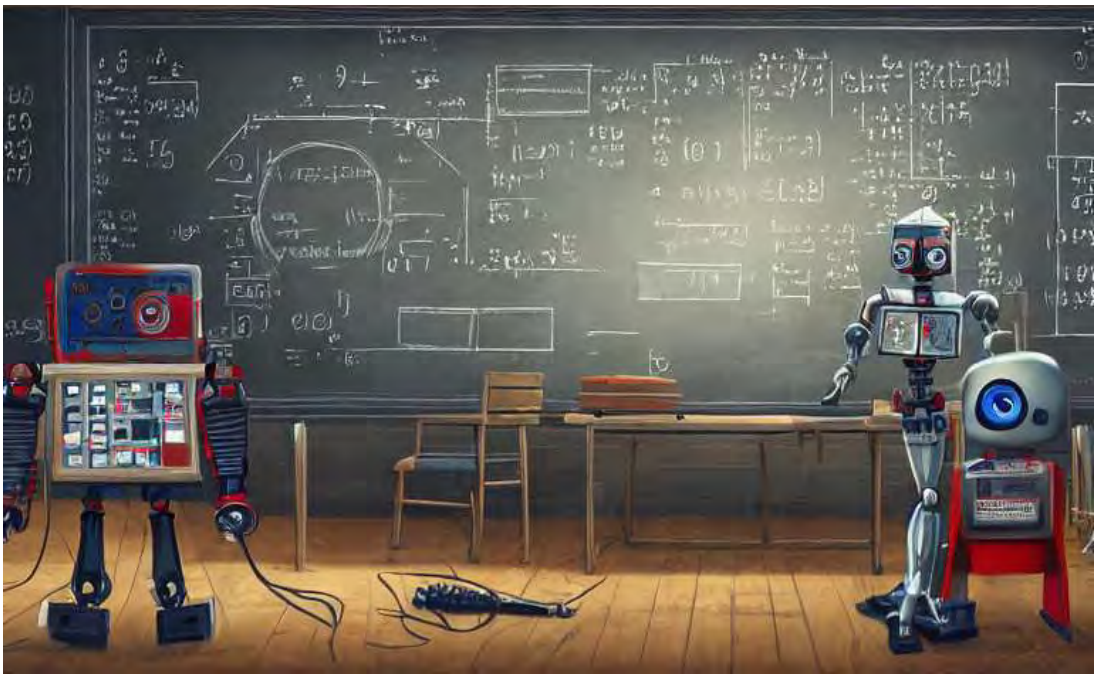
IMPACT 1: Theory. The project will address the challenging theme of machine understanding. This has been well talked-about in AI and cognitive science but no consolidated theory is yet available. The scientific impact of the theories will be achieved through academic channels. This means a) publications in mainstream journals, and b) the preparation of a book on the theory.

IMPACT 2: Technology: Some of the core technological assets produced in the project -a software-intensive control system architecture and a collection of functional components- will be released as open-source through the ROS ecosystem to obtain feedback, application use cases and contributions to development of the codebase. This will set a community-driven software asset basis for the next class of impact.

IMPACT 3: Business: We plan to create a company to deliver applied aspects of this technology to industrial customers using a services approach based on a) the open-source assets and b) company-owned software assets to address domain specific, high-value applications. This means that not all software products of CoreSense will be released as open source and they will enable the realization of targeted economic impact for Europe.

IMPACT 4: Social: We will explore the potential use of the CoreSense value-centric mechanisms in the context of the current efforts to standardize and regulate AI impacts. This will be done in three scopes: EU regulation on AI, IEEE standardization on AI and autonomous robots, and CoE establishment of policies on AI.

In summary, the expected CORESENSE impacts cover a wide spectrum of possibilities aligned with the Horizon Europe vision on robotics and Artificial Intellligence.



HARIA

HUMAN-ROBOT SENSORIMOTOR AUGMENTATION

Wearable sensorimotor interfaces and supernumerary robotic limbs for humans with upper-limb disabilities

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101070292*

OBJECTIVES

HARIA re-defines the nature of physical human-robot interaction, laying the foundations of a new research field, i.e., **human sensorimotor augmentation**. The idea is to study how to integrate humans and **AI-powered supernumerary robotic limbs** to perform complex manipulation tasks with both biological and artificial limbs under the direct control of the human.

A fundamental challenge in HARIA will be to find the right trade-off between motion task parameters that are controlled by the user, and the level of robot autonomy. The enabling core technology of this interplay is the **wearable sensorimotor interface** that establishes a connection between the human sensorimotor system and the system of actuators and sensors of the robot, allowing for reciprocal awareness, trustworthiness, and mutual understanding. The sensorimotor interface captures signals from human body motion, or muscle activation, that are mapped onto commands for the robot limbs using a novel approach that exploits the redundancy of the human sensorimotor system. This will lead to the simultaneous control of natural and artificial limbs. Interfaces will also exploit combinations of somatosensory stimuli to convey haptic sensations related to the task at hand, further improving users' control accuracy and level of engagement in the collaboration.

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TWENTE MEDICAL SYSTEMS INTERNATIONAL B.V.
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HOSPITAL NACIONAL DE PARAPLÉJICOS, SESCAM
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HARIA sensorimotor augmentation will be applied to assist people with upper-limb disabilities, focusing on **two target populations**: chronic stroke and spinal cord injured patients.

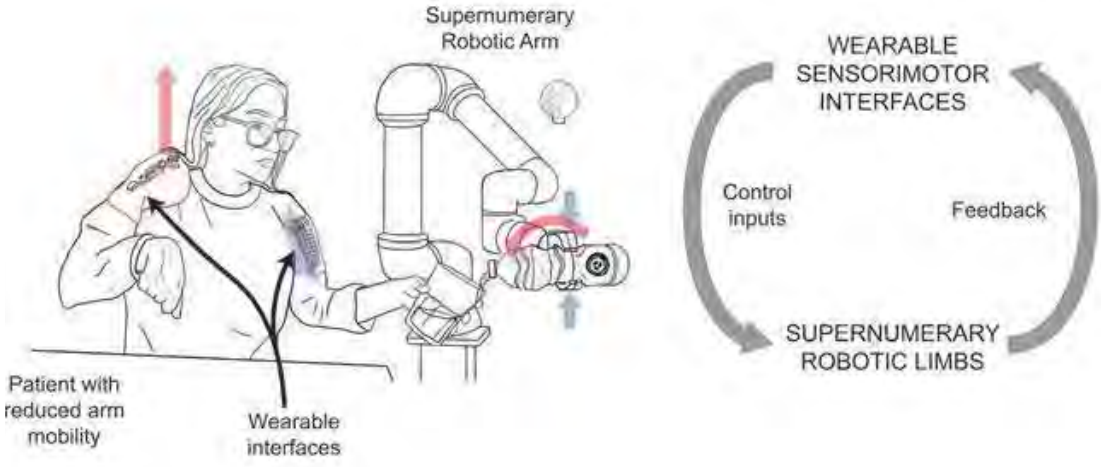
EXPECTED IMPACT

AI-powered enabling technologies for human sensorimotor augmentation. HARIA will develop robotic systems with improved manipulation capabilities and dexterity, together with novel sensorimotor human-robot interfaces combining input and feedback devices to establish a connection between the human user and the robotic limb.

Advanced controllers for human sensorimotor augmentation. HARIA will devise novel methodologies to combine bio-signals and human body motions captured by the wearable interfaces together with scene understanding and intelligent role assignment to generate the control of the robotic supernumerary limbs. Information on task execution captured by the robot sensors will be fed back to the human through haptic signals for enhancing the human perception of supernumerary limbs, their agency, and task execution awareness.

Supernumerary limbs for people with disabilities. So far, wearable extra limbs have been mainly used to augment healthy humans' capabilities, while collaborative arms and grippers have been mainly applied to industrial assembly tasks. HARIA focuses on applying these technologies as assistive devices and targets a large set of end-users with upper-limb disabilities. HARIA systems will be integrated in three different scenarios involving activities of daily living to be performed by selected stroke survivors and spinal cord injured individuals. Thanks to the sensorimotor interfaces, users will be actively in charge of controlling the robot. This will represent a strong motivation for using HARIA devices, ensuring their long-term adoption.

Long term impact on the healthcare domain and beyond. The societal mid-term impact on life after stroke and spinal cord injury will be evident in the recovered autonomy in the execution of daily activities, leading also to a positive consequence for caregivers and rehab facilities. A societal long-term impact is expected in domestic rehabilitation and homecare thanks to the possibility of exploiting remotely, at home, the HARIA technologies. In addition, the outcomes of the project will impact other domains of the service robotics field, defining novel paradigms for human-robot communication.



INTELLIMAN

AI-Powered Manipulation System for Advanced Robotic Service, Manufacturing and Prosthetics

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 September 2022 > 28 February 2026*
Project ID	*101070136*

OBJECTIVES

A key challenge in intelligent robotics is creating robots that are capable of directly interacting with the world around them to achieve their goals. On the other hand, robot manipulation is central to achieve the promise of robotics, since the definition of robot requires that it has actuators that it can use to change the world.

Learning will be central to such systems to become autonomous, as the real world contains too many variations for a robot to have an accurate model of human requests and behaviour, of the surrounding environment, the objects in it, or the skills required to manipulate them, in advance. The main objective of the IntelliMan project is focusing on the question of "How a robot can efficiently learn to manipulate in a purposeful and highly performant way". IntelliMan will range from learning individual manipulation skills from human demonstration, to learning abstract descriptions of a manipulation task suitable for high-level planning, to discovering an object's functionality by interacting with it, to guarantee performance and safety.

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IntelliMan aims at developing a novel AI-Powered Manipulation System with persistent learning capabilities, able to perceive the main characteristics and features of its surrounding by means of a heterogeneous set of sensors, able to decide how to execute a task in an autonomous way and able to detect failures in the task execution in order to request new knowledge through the interaction with humans and the environment. IntelliMan further investigates how such AI-powered manipulation systems are perceived by the users and what factors enhance human acceptability.

EXPECTED IMPACT

IMPACT 1: Develop platform-independent knowledge transfer between different domains and robotic systems, reducing need of training.

Reusability and composability of AI modules both in the operational context of a wide range of actions and use cases.

IMPACT 2: Developing novel AI-powered manipulation systems with persistent learning capabilities and transferrable knowledge, able to decide how to execute a task in an autonomous way and to detect failures in the task execution.

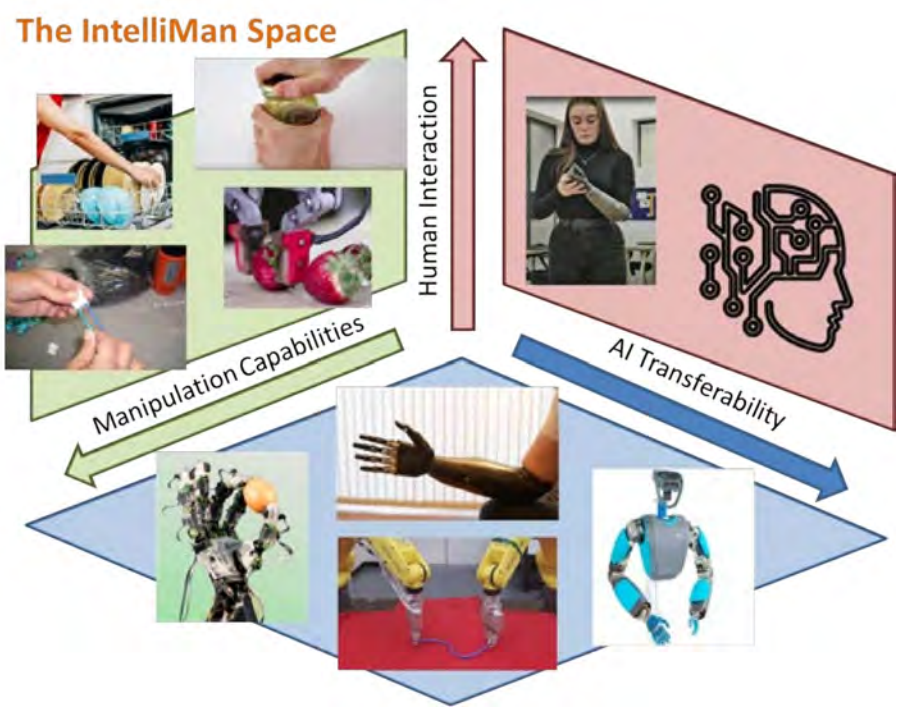
Learn individual manipulation skills and abstract descriptions of manipulation tasks from human demonstration suitable for high-level planning.

IMPACT 3: Increase robot acceptance through sliding and shared autonomy, by handling adequately both human and robotic actions, with human-centric, advanced behavioral and elaborated planning models.

Multidisciplinary approaches including SSH to ensure end-user involvement in the design of AI-powered robotic systems addressing human factors and interaction will be adopted.

IMPACT 4: Develop novel AI-powered robotic solutions and advanced control tools for dexterous and safe manipulation for different environments and applications.

Increase performance, portability, deployability and safety of robotic manipulation.



MOZART

MORPHING COMPUTERIZED MATS WITH EMBODIED SENSING AND ARTIFICIAL INTELLIGENCE

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101069536*

OBJECTIVES

The MOZART project aims to advance the state-of-the art in robotic handling and manipulation of soft and heterogeneous objects. The approach we take is a radical departure from existing manipulator approaches as we will develop a new concept for manipulation using deformable manipulation surfaces supported by AI-powered control and learning tools. The manipulation surface can change its curvature locally and through this manipulates objects on its surface.

Automation of food packaging has continuously evolved in the last few decades. However, it remains heavily dependent on the manual handling of fragile and fresh food items. As a result, the workers' occupational health and injuries are critical, and so is the non egligible economic impact: handling of the product is tightly related to product quality control, food waste, and hygiene safety issues. EU Mozart project investigates the latest robotic technologies and system solutions to impact the most essential industry to sustain human life, food handling. We aim at pushing the boundaries of the food industry to be more economically, socially, and environmentally sustainable.

For demonstration we have chosen three target demonstrators in the food handling industry which are descaling fish, sorting of chicken and presentation of chicken.

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ASSOCIATION DE L'AVICULTURE, DE L'INDUSTRIE ET DU COMMERCE DE VOLAILLES DANS LES PAYS DE L'UNION EUROPEENNE
www.avec-poultry.eu

The final pillar of the project is an integrative-interdisciplinary social sciences and humanities approach that tackles the transition of the role of the operators today to more high-skilled jobs in the future. It also addresses the general ethical challenges surrounding food production to ensure sustainable technology development in terms of social and ethical as well as ecological consequences.

The core research is complemented by a comprehensive dissemination and communication package that targets all relevant stakeholders. Finally, a clear exploitation plan including standardization is described which will transition the AUTOMATs from TRL 5 at the end of the project to a product ready to impact the food packing industry four year after the end of the project.

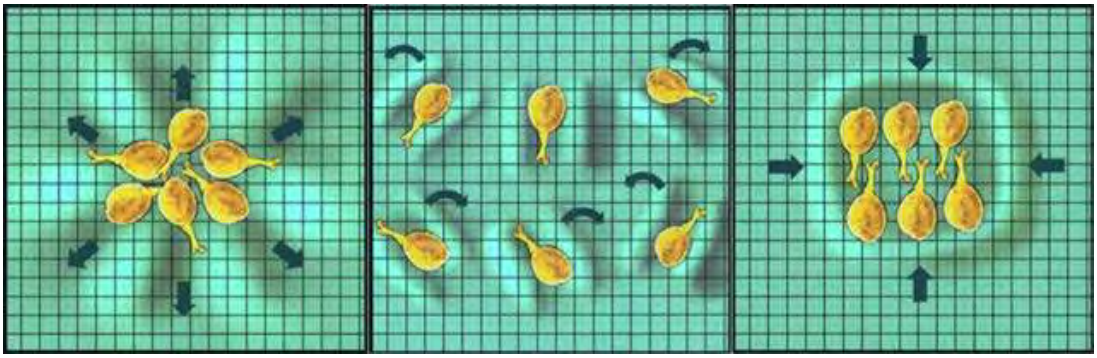
EXPECTED IMPACT

The MOZART project aims to make radical improvements to automation in the food processing industry through scientific research and innovation coupled with a sensitivity to the societal and the broader impacts of the work.

IMPACT 1: Scientifically, the spearhead is surface-based manipulation through breakthroughs in soft sensing skins and origami-based actuation combined with the distributed control and learning toolbox based on AI. Individually, after the project each of these scientific elements will have a significant impact in the relevant communities based on the publications and dissemination efforts of the project. However, the most significant scientific breakthrough is probably the AUTOMAT concept of surface-based manipulation, which is likely to open a new field of research in the years to come.

IMPACT 2: From an industrial perspective, four years after the end of the project, the AUTOMAT will be integrated into commercial manipulation mats and will have been tested both for compliance with existing regulations and for durability. It is expected that the first commercial manipulation mats will be sold as pilot solutions to key industrial players initially in the chicken handling industry. Thereafter, the product will be marketed globally across the entire food processing segment.

IMPACT 3: From a societal perspective, development in the automation of food processing directly contributes to several of UN sustainability goals. Furthermore, when fully developed, the AUTOMAT technology has the potential to transform dull, unskilled, and low-paying jobs into better-paying knowledge-based jobs.



AUTOMATS manipulating drumsticks to be ready for packaging

PILLAR ROBOTS

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PILLAR-ROBOTS

Purposeful Intrinsically Motivated Lifelong Learning Autonomous Robots

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101070381*

OBJECTIVES

PILLAR-Robots aims at developing a new generation of robots endowed with a higher level of autonomy. These robots will be able to determine their own goals and establish their own strategies, creatively building on the experience acquired during their lifetime to fulfil the desires of their human designers/users in real-life application use-cases.

To this end, the project will operationalize the concept of purpose, drawn from the cognitive sciences, to increase the autonomy and domain independence of robots during learning. Purposes will guide the acquisition of knowledge and skills that are actually relevant for operating in real target applications. In particular, the project will develop algorithms for the acquisition of purposes, to bias the perceptual, motivational and decision systems of the robots' cognitive architectures towards those purposes, and strategies for the learning of representations, skills and models that will allow purpose-related deliberative and reactive decisions.

PILLAR-Robots will implement and validate demonstrators of purposeful lifelong open-ended autonomy using the resulting Purposeful Intrinsically Motivated Cognitive Architecture within three different application fields characterized by different types and levels of variability: Agri-food, edutainment, and unstructured industrial/retail.

Finally, PILLAR-Robots will carry out a complete evaluation of the possibilities and impacts of purposeful lifelong open-ended autonomy in these realms from an operational, a market-oriented and societal (socio-economic, ethical and regulatory) perspective.

EXPECTED IMPACT

IMPACT 1: PILLAR-Robots will provide a path towards the design of more autonomous and multifunctional robots. In this line, and from a scientific viewpoint, PILLAR-Robots will operationalize purposeful open-ended learning producing visual and speech-based algorithms for purpose acquisition as well as a motivational structure to support them. In the long term, the algorithms proposed will be applied in large scale demonstrations and in deployments. Also, the extensive inclusion of the algorithms in other cognitive-based systems or architectures is expected.

IMPACT 2: PILLAR-Robots will develop a novel cognitive architecture for lifelong, open-ended learning. This architecture will integrate new mechanisms for both acquiring and managing motivations and addressing the problem of contextual memory-based decision processes. It will also contemplate the automatic acquisition of representations when generalizing. In the long term, the adoption of the proposed architecture and software components in large scale demonstrations and in deployments, as well as the extensive hybridization of the architecture and components in other systems, is expected.

IMPACT 3: From a practical application perspective, the project will have a direct impact on three fields of application: agri-food processing, edutainment and industry/retail. In the long term: the applications and sectors involved will scale up with experimentation in close to market environments, leading to productivity gains in relation to current robotic solutions, providing new market opportunities for the partners and third parties, and opening up new application fields for robotics.

IMPACT 4: The socio-economic, ethical, and legal studies that will be carried out on the main concepts of the project will impact future regulatory actions to facilitate the safe and secure adoption of robots with higher levels of autonomy.

RĚGO

Cognitive robotic tools for human-centered small-scale multi-robot operations

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2026*
Project ID	*101070066*

OBJECTIVES

RĚGO proposes an innovative set of **AI-powered, modular, microsized swarms of robots**. They are wirelessly steered by electromagnetic fields as well as able to react to other external stimuli, and then naturally controlled by humans through intuitive dexterous interfaces and interaction techniques. Taking advantage of AI multi-robot control strategies, **these robots can team up and collaborate to fulfill complex tasks in a robust and unprecedented flexible way**. By exploiting multisensory interaction techniques and cognitive shared control, **the operator will achieve an unparalleled level of seamless interaction and continuous collaboration with the robotic team**.

According to the application at hand, the robotic team will feature different task-specific characteristics (e.g., biocompatibility for medical procedures, biodenitrification for cleaning water, ability to carry drugs to fight infections) and be dispatched through various delivery systems, including a stimuli-responsive milli-scale wireless robotic carrier developed within the project.

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To achieve this revolution, RĚGO will develop magnetic multi-robot motion control systems, autonomous swarm control techniques for micro-sized robots, human-robot haptic-centered interfaces, and cognitive shared-control techniques. **RĚGO enables the next generation of AI-powered interactive small-size multi-robots systems**, with increased capabilities to work with each other and their human operators.

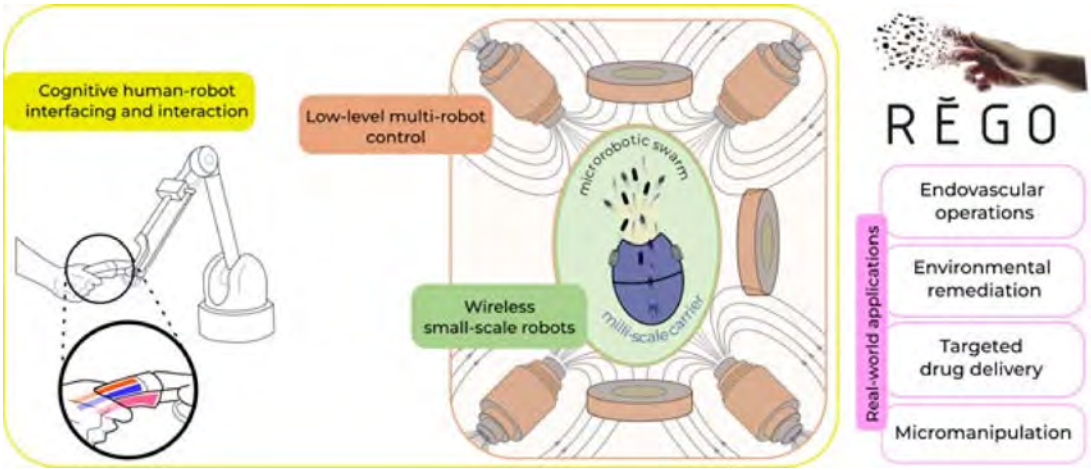
EXPECTED IMPACT

Wireless small-scale robots: Explore multi-robot systems including milli-scale carriers and swarms of microrobots. They will be responsive to a combination of endogenous and exogenous stimuli, thus enabling the implementation of shared control strategies and superior awareness and responsivity to the working environment.

Multi-robot electromagnetic field control: Introduce a novel class of actuation systems based on Distributed Magnetic Actuation, which uses a large number of low-power miniaturized electromagnetic elements distributed within the target workspace or in its close vicinity. The resulting systems offer unparalleled field-shaping capabilities and provide magnetic field gradients that are orders of magnitude higher than conventional systems.

AI-based shared control: Lead a new generation of shared-control teleoperation systems, producing advancements in how to best share the load for executing a task between the operator and an AI robot autonomy, with possible flexible levels of autonomy that can be adapted online depending on the operator's performance and confidence.

Cognitive haptic human-robot interaction: Combine kinesthetic and cutaneous cues to provide rich information to the operator through an innovative multisensory haptic handle and corresponding rendering techniques.



SESTOSENSO

PHYSICAL INTELLIGENCE FOR SMART AND SAFE HUMAN-ROBOT INTERACTION

Call	*HORIZON-CL4-Digital-Emerging-2021-01-11*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070310*

OBJECTIVES

Sestosenso develops technologies for the next generations of collaborative robots capable of self-adapting to different time-varying operational conditions and capable of safe and smooth adaptation from autonomous to interactive when human intervention is required either for collaboration or training/teaching. The project proposes a new sensing technology from the hardware and up to the cognitive perception and control levels, based on proximity and tactile sensors embedded in the robot body, providing a unified proxy-tactile perception of the environment, required to control the robot's actions and interactions, safely and autonomously.

Sestosenso is motivated by the industrial need to integrate workers with robots and the need for robots that could operate safely without out-of-the-robot infrastructure, thus reducing robot setup times and costs and increasing the flexibility of the shopfloor configuration.

The **Sestosenso** technology is demonstrated by three Use Cases of industrial interest:

1. Automotive manufacturing application, concerning Human-Robot Cooperation for assembly tasks in dynamic and narrow environments;
2. A warehousing application, to perform safe whole-arm manipulation for lifting large, heavy and bulky objects;
3. Agricultural application, requiring wearable devices and collaborative mobile manipulators for harvesting in presence of unmodelled and delicate obstacles.

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EXPECTED IMPACT

Sestosenso develops technologies at HW and SW level to exploit data-driven machine learning methods typical of AI for new generations of self-standing robots with great capability to interact with humans and with the environment in safe and reliable way.

In particular, the project aims at the development of solutions for:

IMPACT 1: New generation of AI-Powered Robotics

Sestosenso will endow autonomous and interactive robots with a better perception and understanding of the world as well as increased capabilities to work without/with limited supervision, and intuitive, safe and efficient cognitive, social and physical capabilities to assist humans.

IMPACT 2: Smarter robots with improved capabilities, functionalities and increased level of autonomy

Sestosenso will provide the tools necessary to address real-world problems, such as the manipulation of delicate, irregular, dynamic and deformable objects, the navigation in dynamic, harsh and challenging environments, the continuous physical interaction with humans.

IMPACT 3: Safe and efficient Human-Robot Collaboration

Sestosenso will develop embedded proxy-tactile sensing technology enabling the implementations of synergic, reliable and safe Human-Robot Collaboration based on advanced reactivity and mutual human-robot action understanding.

LEADERSHIP IN AI BASED ON TRUST

VERIFIABLE ROBUSTNESS, ENERGY EFFICIENCY AND TRANSPARENCY FOR TRUSTWORTHY AI: SCIENTIFIC EXCELLENCE BOOSTING INDUSTRIAL COMPETITIVENESS

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HUMAN-COMPATIBLE AI WITH GUARANTEES

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TECHNION
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WORKABLE
workable.com

DATEIO
dateio.eu

AUTOFAIR

Human-compatible AI with guarantees

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070568*

OBJECTIVES

The AutoFair project seeks to address needs for trusted AI and user-in-the-loop tools and systems in a range of industry applications through:

- Comprehensive and flexible **certification of fairness**. At one end we can consider risk averse a priori guarantees on certain bias measures as hard constraints in the training process. At the other end, we can consider post hoc comprehensible but thorough presentation of all of the tradeoffs involved in the design of an AI pipeline and their effect on industrial and bias outcomes.
- **User-in-the-loop** in continuous iterative engagement among AI systems, their developers and users. We seek to both inform the users thoroughly in regards to the possible algorithmic choices and their expected effects, and at the same time to learn their preferences in regards to different fairness measures and subsequently guide decision making bringing together the benefits of automation in a human-compatible manner.
- **Toolkits** for the automatic identification of various types of bias, and their joint compensation by automatically optimizing various and potentially conflicting objectives (fairness/accuracy/runtime/resources), visualizing the tradeoffs, and making it possible to communicate the tradeoffs to the industrial user, government agency, NGO, or members of the public, where appropriate.

USE CASES

Use Case 1: workable.com is the world's **leading hiring platform**, where companies find, evaluate and hire better candidates, faster. Clearly, individual and group fairness among the candidates is crucial for their continued custom.

Use Case 2: IBM Watson Advertising helps scale **advertising campaigns** with AI and machine learning and addressing unwanted bias in advertising. Unwanted bias in advertising has the potential to negatively impact consumers, who may miss out on an economic opportunity or feel targeted based on stereotypes, while also negatively impacting brands that may experience poor campaign performance.

Use Case 3: dateio.eu is a **fintech** running a card-linked marketing platform delivering targeted cashback offers to banks' clients. We will also work on credit risk decisions under the guidance of experts from Nationwide Building Society and BNP Paribas (pending further approvals).

EXPECTED IMPACT

IMPACT 1: The availability of human-compatible tools for detecting bias will both spur companies to **detect biases in-house**. It will also spur third-party researchers to detect bias in the data of said companies.

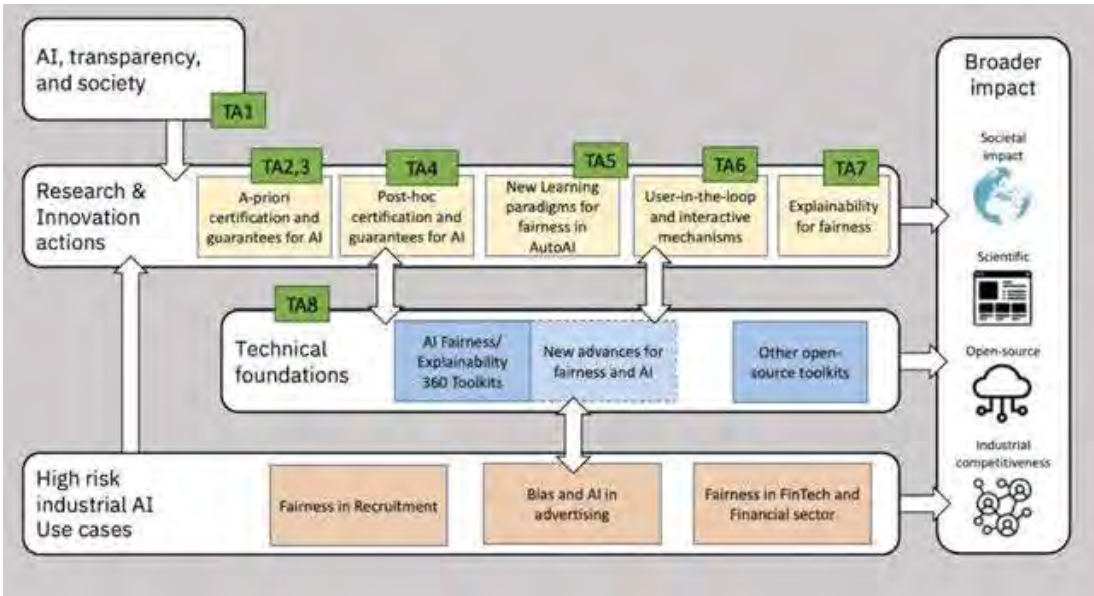
IMPACT 2: Removing some of the risks of violating European Regulation of Artificial Intelligence while using AI will **make European businesses more likely to use AI** and become more efficient and more competitive.

IMPACT 3: Advances in fairness in human-resources automation and explaining fairness-related aspects thereof will **improve fairness in hiring**.

IMPACT 4: Improved **policy recommendations** for the regulation of AI will lead to more efficient uses of AI.

IMPACT 5: Better public understanding of AI and the tradeoffs involved will reduce the risk of backlash against AI.

IMPACT 6: A cohort of **early-career researchers** is trained to focus on fairness aspects of AI.



ENEXA

Efficient Explainable Learning on Knowledge Graphs

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070305*

OBJECTIVES

Knowledge graphs (KG) are a flexible knowledge representation paradigm intended to facilitate the processing of knowledge for both humans and machines at Web scale. They are widely regarded as a key enabler for a number of increasingly popular technologies, including Web search, question answering, personal assistants and AI across most sectors including Industry 4.0, personalized medicine, legislation, economics and more. That machine learning (ML) on knowledge graphs is amenable to explainable AI is a well-established result. However, current ante-hoc explainable machine learning approaches for knowledge graphs fail to deal with the idiosyncrasies of real data, especially scale, inconsistency, and incompleteness. Addressing the challenge of using ML for KGs on real data is the challenge tackled by ENEXA.

In ENEXA, we focus on efficient explainable ML on polymorphic knowledge graphs. We aim to develop scalable, hybrid and symbolic ML algorithms for large, real-world, noisy knowledge graphs able to achieve precise and explainable predictions. The rationale behind the ENEXA concept lies in exploiting the polymorphy of knowledge graphs, especially the fact that KGs can be represented as using several representations, e.g., tensors and formal logics. These different representations allow for different types of ML algorithms to be implemented on KGs and used as proxies for each other.

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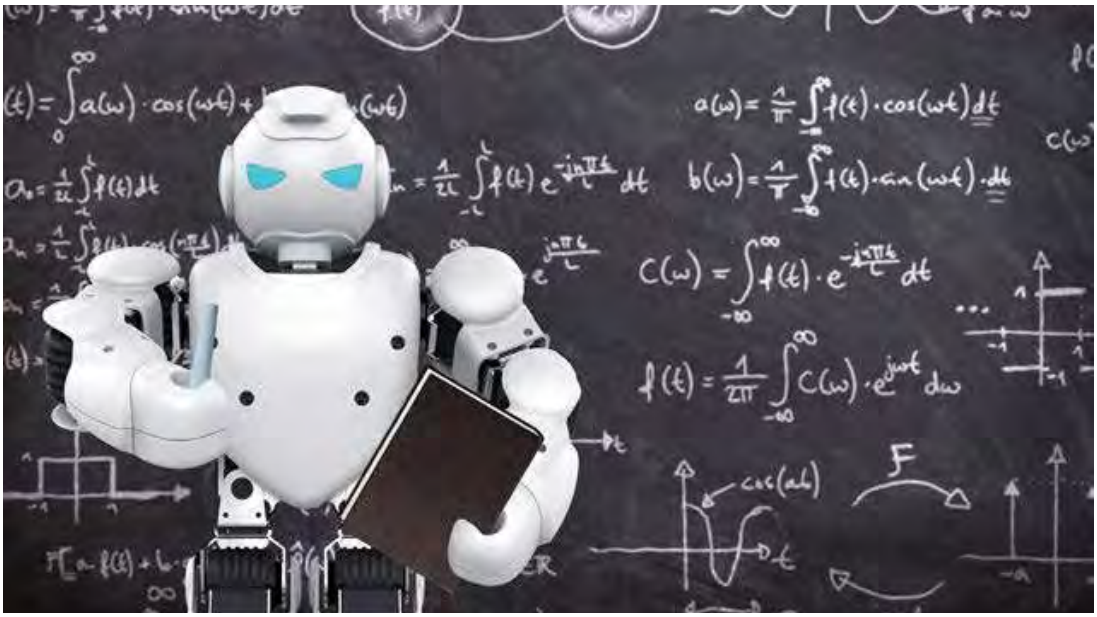
EXPECTED IMPACT

IMPACT 1: ENEXA aims to develop world-class explainable machine learning algorithms for knowledge graphs. Exploiting the numerous representations available for knowledge graphs will make ante-hoc globally explainable machine learning amenable to real KGs. To this end, we will focus on tackling the problems of scalability, efficiently search space traversal, data inconsistencies and exploitation of semantics. Tackling these problems will be carried out by the intelligent selection and switch of fitting representations during learning processes.

IMPACT 2: ENEXA's advances of transparency in AI are grounded in its approach to explainability being based on a user-centered paradigm. Our paradigm aims to include users into the construction of explanations in such a way that the explanation process is first completed when the explainer and the explainee agree upon the explanandum to a degree sufficient for the explainee. This new take on explainable AI will be made possible by the algorithms we aim to develop and represents a significant advance in transparency and explainability.

IMPACT 3: ENEXA will support European citizens in the digital transition. European citizens are confronted with an increasing number of machine learning results, especially on the Web. Hence, machine learning algorithms must be explainable to address the need of non-AI experts for explanations when confronted with AI-driven decisions. By addressing knowledge graphs and ante-hoc explainable machine learning with the important advances discussed in impacts 1 and 2, ENEXA will contribute to empowering citizens with the tools necessary to act in the digital transition.

IMPACT 4: ENEXA implements a human-centered approach to the development of technologies. Our explanation process is a widely applicable, human-centered approach to explaining machine learning results to humans independently of their background. Our approach is ethical by means of making all decision processes of our AIs completely transparent. We go beyond the classical take on transparency by not only explaining decisions, but by even being able to explain how the decision process came about by making the sequence of decisions taken by the AI to compute the model available for inspection by the end users.



EVENFLOW

Robust Learning and Reasoning for Complex Event Forecasting

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070430*

OBJECTIVES

EVENFLOW will develop hybrid learning techniques for complex event forecasting, which combine deep learning with logic-based learning and reasoning into neuro-symbolic forecasting models. The envisioned methods will combine (i) neural representation learning techniques, capable of constructing event-based features from streams of perception-level data with (ii) powerful symbolic learning and reasoning tools, that utilize such features to synthesize high-level, interpretable patterns of critical situations to be forecast.

Crucial in the EVENFLOW approach is the online nature of the learning methods, which makes them applicable to evolving data flows and allows to utilize rich domain knowledge that is becoming available progressively. To deal with the brittleness of neural predictors and the high volume/velocity of temporal data flows, the EVENFLOW techniques will rely on novel, formal verification techniques for machine learning, in addition to a suite of scalability algorithms for federated training and incremental model construction. The learnt forecasters will be interpretable and scalable, allowing for fully explainable insights, delivered in a timely fashion and enabling proactive decision making.

EVENFLOW will be evaluated on three challenging use cases related to (1) oncological forecasting in precision medicine, (2) safe and efficient behavior of autonomous transportation robots in smart factories and (3) reliable life cycle assessment of critical infrastructure.

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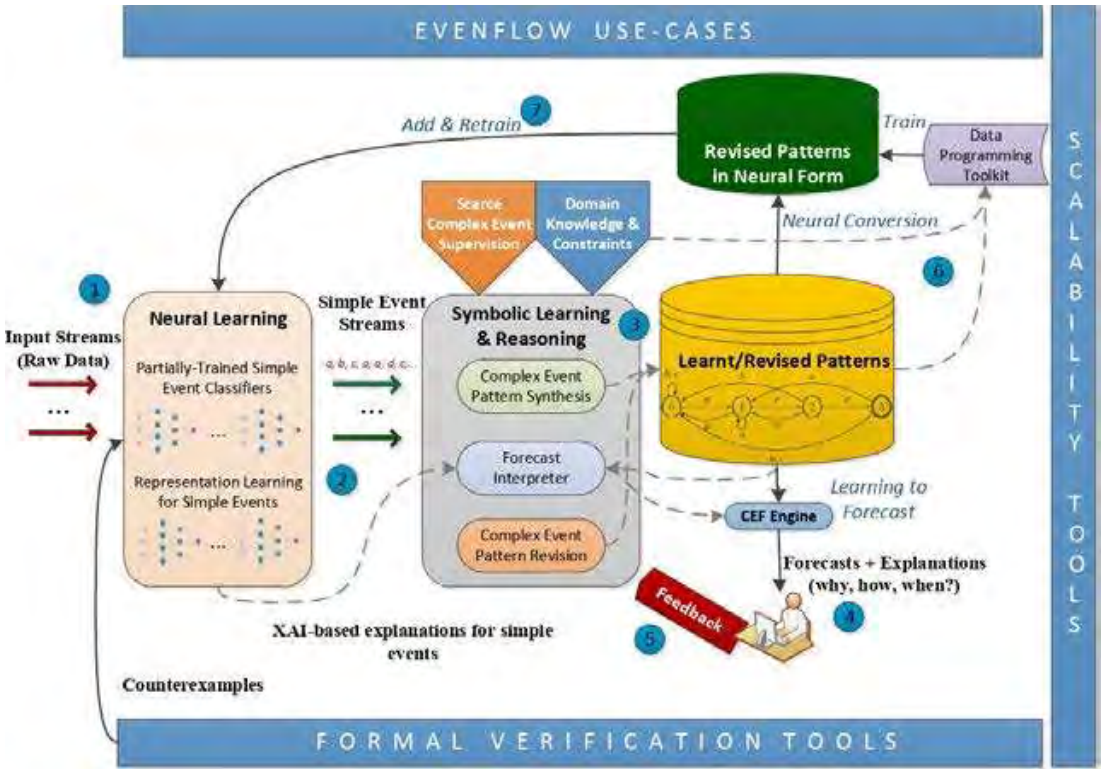
EXPECTED IMPACT

- New scientific horizons in integrating machine learning and machine reasoning, neural, statistical and symbolic AI.
- Breakthroughs in verification, interpretability and scalability of neuro-symbolic learning systems.
- Interpretable, verifiable and scalable ML-based proactive analytics and decision-making for humans-in-the-loop and autonomous systems alike.
- Robust, resilient solutions in critical sectors of science and industry.
- Accurate and timely forecasting in vertical sectors (healthcare, Industry 4.0, critical infrastructure monitoring).
- Novel FAIR datasets for scientific research
- Novel resources and approaches for verifiable, interpretable, scalable and knowledge-aware machine learning.



REXASI-PRO

To design a novel framework in which safety, security, ethics, and explainability are entangled to develop a Trustworthy Artificial Swarm Intelligence solution. The framework will make a trustworthy collaboration among a swarm formed by autonomous wheelchairs and flying robots to allow a seamless door-to-door experience for people with reduced mobility.

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070028*

OBJECTIVES

Objective 1: Trustworthy by construction. We will design new human-centric solutions based on imitation learning and the adaptation of bio-inspired solutions to develop trustworthy-by-construction AI systems.

Objective 2: Robust, Safe, Secure, and Reliable AI-based autonomous wheelchair. We will provide a formal demonstration of the reliability of the fleet. Specifically, we will focus on making trustworthy on the following aspects:

1. planning algorithms,
2. obstacle detection and avoidance,
3. communication among swarms.

Objective 3: Green AI solution. We will develop two novel solutions: an AI-based orchestrator layer for managing the fleet of AI-based swarms and a topology-based dataset optimization for ML algorithms.

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Ethical Objective: Create an AI ethical risk framework tailored to the class of use-cases represented by the REXASI-PRO's use-cases. Defining a multi-phase tool system for assessing ethical issues of a Multi-Robot Systems and Data Collection Platform supporting people with mobile disabilities gap.

Business Objective: Definition of a roadmap for the certification and commercialization of autonomous wheelchairs.

EXPECTED IMPACT

The greatest ambition of the REXASI-PRO project is to deliver a framework that will ensure a safe collaboration among a swarm formed by autonomous wheelchairs and flying robots, in order to enable a seamless door-to-door experience for people with reduced mobility. This goal will result in benefits for these people, their families, caregivers, scientific community, industry, and environment, creating a scientific, economic, technological and social benefit.

IMPACT 1: World-class transparent, explainable, accountable and trustworthy AI, based on smarter, safer, secure, resilient, accurate, robust, reliable and dependable solutions.

IMPACT 2: Improved AI solutions aiming to meet the industrial requirements in terms of autonomy, accuracy, safety, repeatability, robustness, resilience and security.

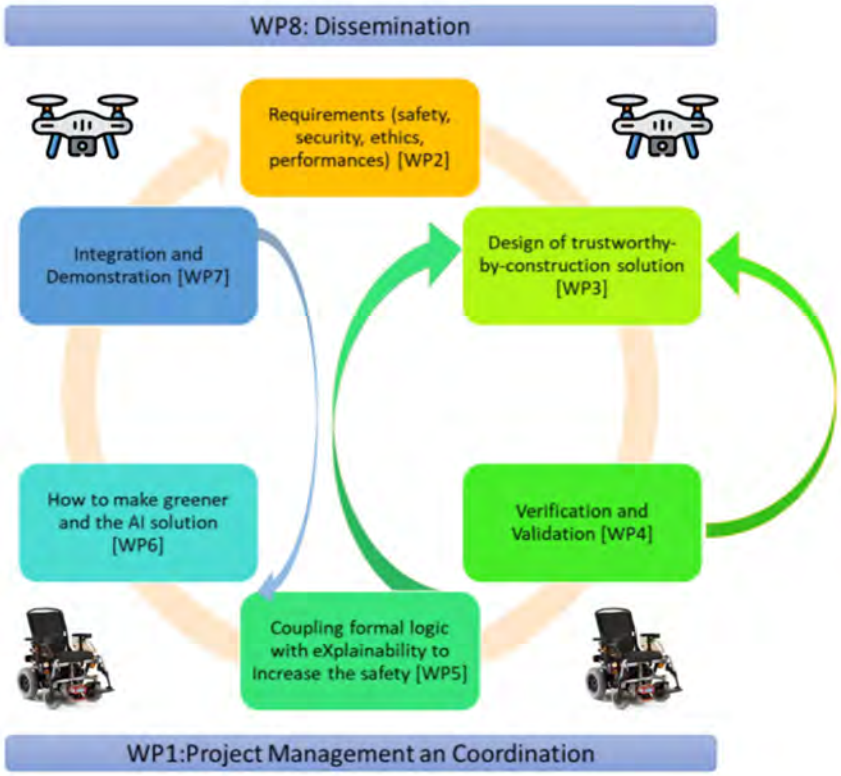
IMPACT 3: Greener AI models.

IMPACT 4: Next level of AI-based solutions, exploiting the intelligence embedded in the edge-to cloud infrastructure.

IMPACT 5: Advances in complex systems & socially aware AI.

IMPACT 6: Increased inclusiveness, by supporting a human-centred approach to technology development that is aligned with European social and ethical values, as well as sustainability.

IMPACT 7: Sustainable, high-quality jobs by targeting skills mismatches, the need to empower workers, and ethical considerations relating to technological progress [[2019 CIGI-Ipsos Global Survey on Internet Security and Trust.



SAFEXPLAIN

Safe and Explainable Critical Embedded Systems based on AI

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SAFEXPLAIN

SAFE AND EXPLAINABLE CRITICAL EMBEDDED SYSTEMS BASED ON AI

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101069595*

OBJECTIVES

Deep Learning (DL) techniques are at the heart of most future advanced software functions in Critical autonomous AI-based Systems (CAIS). Advanced software functions are likely the most competitive factor in all CAIS. Hence, the **economic success of CAIS industries (e.g., automotive, space, railway) depends on their ability to design, implement, qualify, and certify DL-based software products under bounded effort/cost**. However, there is a fundamental gap between Functional Safety (FUSA) requirements of CAIS and the nature of DL solutions needed to satisfy those requirements. The **lack of explainability** and traceability, and the **data-dependent and stochastic nature of DL software** clash against the need for **deterministic, verifiable and pass/fail test-based** software solutions for CAIS.

SAFEXPLAIN tackles this challenge by providing a novel and flexible approach to allow the certification – hence adoption – of DL-based solutions in CAIS by (1) architecting DL solutions that allow explaining why they satisfy FUSA requirements, with end-to-end traceability, with specific approaches to explain whether predictions can be trusted, and with strategies to reach (and prove) correct operation, in accordance to certification standards. SAFEXPLAIN will also (2) devise alternative and increasingly complex FUSA design safety patterns for different DL usage levels (i.e. with varying safety requirements) that will allow using DL in any CAIS functionality, for varying levels of criticality and fault tolerance.

SAFEXPLAIN (or "safe-expl**AI**n", from **SAFEty**, **EXPLAINability**, and **AI**) brings together a highly skilled and complementary consortium to successfully tackle this endeavour. The technical expertise in the three disciplines involved in the challenge: AI expertise, FUSA expertise, and platform/performance expertise, is covered by three research centers (RISE, IKR and BSC respectively). The technical viability of the approach is assessed against three CAIS case studies: automotive (NAV), space (AIKO), and railway (IKR). The economic viability of the approach is assessed in the context of a prototype of a commercial toolset (EXI). Finally, to prove that explainability and traceability levels achieved are fully compliant with FUSA, SAFEXPLAIN will rely on internal certification experts that provide certification reviews as a service (EXI), and external ones subcontracted for an independent assessment.

EXPECTED IMPACT

IMPACT 1: SAFEXPLAIN will provide scientific and technical solutions to the European industry that enable fully-autonomous CAIS (e.g. cars, trains, satellites) with certified and economically viable solutions.

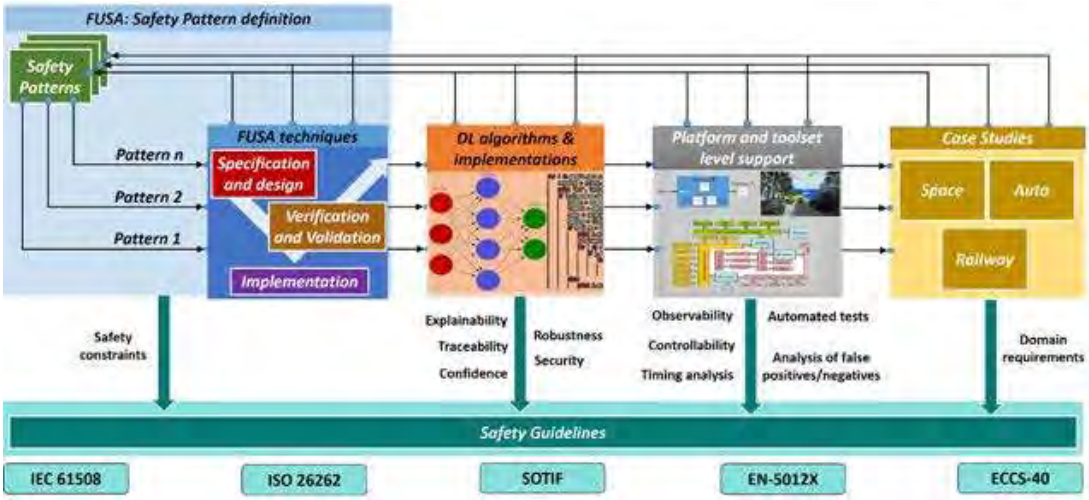
IMPACT 2: SAFEXPLAIN will bring increased efficiency of CAIS systems because safe DL solutions reduce CO2 emissions (up to 80% for different types of vehicles according to informed predictions).

IMPACT 3: SAFEXPLAIN solutions will allow European CAIS benefit from DL functionalities and remain competitive in the future, while still being trustable.

Those impacts will be acheived building on the main outcomes of SAFEXPLAIN:

- Incorporation of SAFEXPLAIN safety guidelines into the domain-specific certification process.
- Use of SAFEXPLAIN DL libraries, components and API to develop safety-critical software in CAIS.
- Higher trust on DL-based solutions for FUSA related systems.
- Contribute to SRIDA's "safety-by-design" approach among other SRIDA's objectives.

All in all, SAFEXPLAIN provides a novel and flexible approach to allow the certification – hence adoption – of DL-based solutions in CAIS.



SUSTAINML

Application Aware, Life-Cycle Oriented Model-Hardware Co-Design Framework for Sustainable, Energy Efficient ML Systems

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070408*

OBJECTIVES

This project is based on the insight that in order to significantly reduce the CO2 footprint of ML applications power-aware applications must be as easy to develop as standard ML systems are today. Users with little or no understanding of the tradeoffs between different architecture choices and energy footprint should be able to easily reduce the power consumption of their applications.

We envision a sustainable, interactive ML framework development for Green AI that will comprehensively prioritize and advocate energy efficiency across the entire life cycle of an application and avoid AI-waste.

1. Model the requirements of specific ML applications.
2. Resource aware optimization methods based on models from previous objectives.
3. Footprint and AI-waste transparent interactive design assistant that guides the developers through the entire process.
4. Collection of efficient methods and cores as catalogs and libraries of energy optimized parameterized ML models.
5. Dedicated toolchain implementation.

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EXPECTED IMPACT

The SustainML framework will address the carbon and resource footprints of ML models and offer multiple pathways to avoid AI-waste from the very early stages of AI life-cycles. This will not be a limiting factor for the rapid growth of both AI research and AI adoption, but rather an enabling tool focused on sustainable growth.

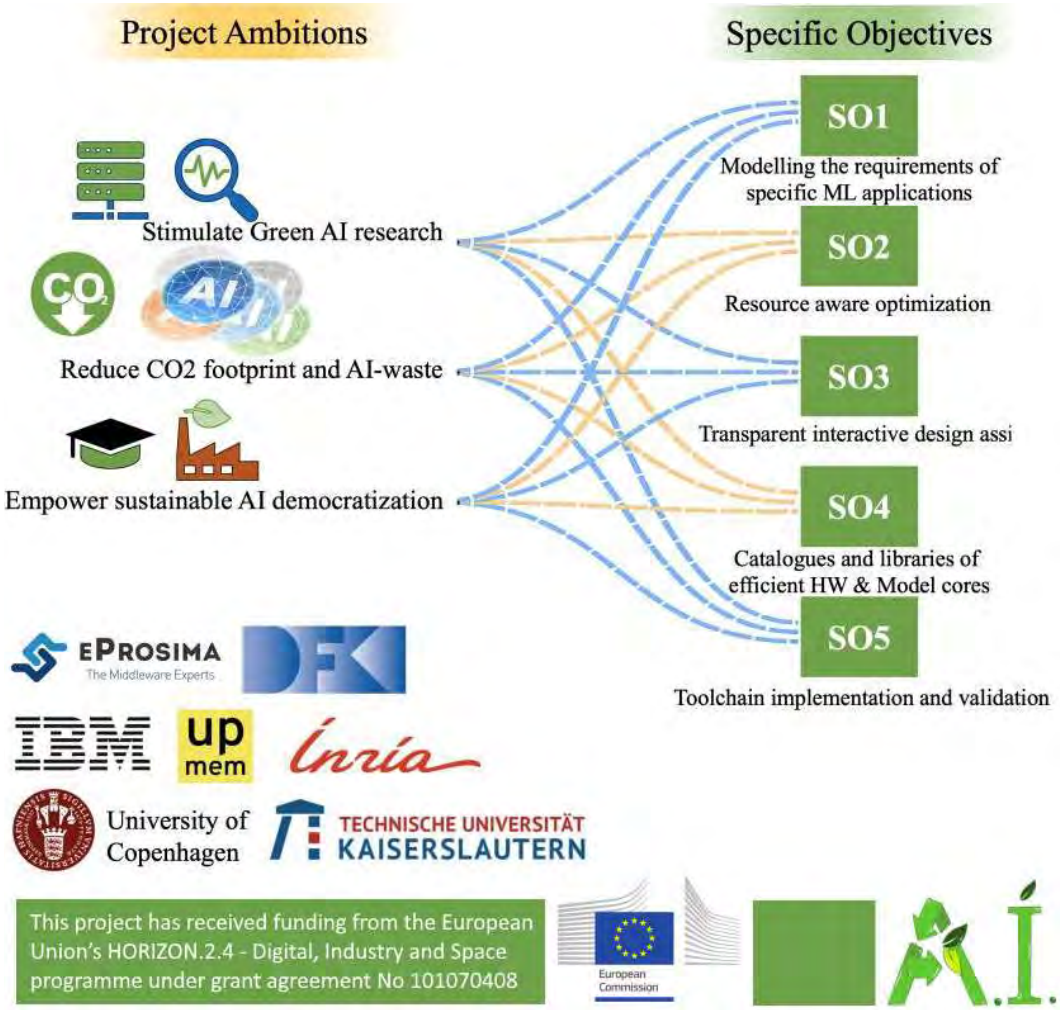
IMPACT 1: On a global level reducing AI waste through the entire life cycle to a wide spectrum of application domains targeting all AI developers from novice to expert. Ultimately lowering the global consumption of data centers and the energy/carbon footprint of AI, with the potential to accelerate AI research and adoption.

IMPACT 2: While AI will not solve all problems by itself, the ability to greatly expand AI into all industry sectors and use its means of optimizing resource consumption more widely, without AI itself being a major CO2 emission and financial cost factor, will be hugely impactful.

IMPACT 3: Transition from the "democratization of AI" to the "democratization of Green AI" that will allow especially SMEs, private enthusiasts, NGOs, and individual innovators to develop and use AI in a sustainable way.

IMPACT 4: Cultivating trust in AI for the general public, and insight into AI for non-expert practitioners through systematic, transparent, and explainable taxonomy and knowledge recycling approaches.

IMPACT 5: Being a nexus to spread new technologies/hardware such as PIM that can offer a sustainable alternative to current HW.



TALON

Autonomous and Self-organized Artificial Intelligent Orchestrator for a Greener Industry 4.0

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070181*

OBJECTIVES

Next-generation industrial systems promise to deliver unprecedented excellence not only in terms of performance, but also explainability, trustworthiness and transparency.
To achieve this new objectives, state-of-the-art concepts of artificial intelligence (AI), edge-to-cloud (E2C) computing, blockchain, and visualization need to be de-risked and applied.

Motivated by this, TALON aims at sculpturing the road towards the next Industrial revolution by developing a fully-automated AI architecture capable of bringing intelligence near the edge in a flexible, adaptable, explainable, energy and data efficient manner. TALON combines the benefits of AI, edge and cloud networking, as well as blockchain and Digital Twins, optimized by means of:

a) new key performance indicators that translate the AI benefits into insightful metrics;
b) novel theoretical framework for the characterisation of the AI;
c) blockchain used to deliver personalized & perpetual protection based on security, privacy and trust mechanisms;
d) AI approaches for automatically and co-optimizing edge and cloud resources as well as the AI execution nodes;
e) semantic AI to reduce the learning latency and enhance reusability; and
f) digital twins that visualize the AI outputs and together with human-in-the-loop approaches. All the technological breakthroughs are demonstrated, validated and evaluated by means of proof-of-concept simulation and four real-world pilots.

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EXPECTED IMPACT

IMPACT 1: By increasing the explainability and regulatory compliance of complex AI systems, TALON will foster their faster adoption by the European industry, leading into cost savings and increased enterprise competitiveness.

IMPACT 2: TALON will enable a new way of autonomous, high performance AI systems, which are based on the deployment of smart objects (e.g., UAVs, industrial Robots) in complex industrial settings and use cases. Such deployments will unlock the technological potential of autonomous systems in high-value applications, which will lead to tangible economic savings.

IMPACT 3: TALON will boost the environmental performance and twin (i.e., green+digital) transformation of European enterprises that leverage AI as part of their industrial applications. This will result in economic savings for enterprises. Likewise, TALON will enhance the technological capacity of AI innovators and AI solution providers, through enabling them to create greener offerings.

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IMPACT 4: TALON will have a positive impact on industrial adopters and users of AI technology, through enabling them to fully leverage the benefits (i.e., energy efficiency, low latency, privacy and data protection) of edge computing. The project will therefore help European enterprises to adopt AI solutions that are in-line with European values like data sovereignty and compliant to the emerging regulatory environment.

TUPLES

BUILDING TRUSTWORTHY AI SYSTEMS FOR PLANNING AND SCHEDULING

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070149*

OBJECTIVES

Task planning and scheduling has always been at the heart of AI and of problems related to robotics, defense, space exploration, manufacturing and logistics. Unfortunately, current methods, whether model-based or data-driven AI, do not inspire enough confidence to be massively adopted and have the expected impact: the former due to a lack of efficiency and adaptability to non-modelled situations, and the latter due to a lack of transparency, robustness, and safety guarantees. TUPLES (TrUstworthy Planning and scheduling with Learning and ExplanationS) is a 3 year project aiming to obtain scalable, yet transparent, robust and safe algorithmic solutions for P&S. It will contribute to a more integrated and human-centered approach to the development of P&S tools, in order to increase confidence in these systems and accelerate their adoption.

The cornerstones of our scientific contributions will be:

- combining symbolic P&S methods with data-driven methods to benefit from the scalability and modelling power of the latter, while gaining the transparency, robustness, and safety of the former;
- developing rigorous explanations and verification approaches for ensuring the transparency, robustness, and safety of a sequence of interacting machine learned decisions. Both of these challenges are at the forefront of AI research.

We will demonstrate and evaluate our novel and rigorous methods in a laboratory environment, on a range of use-cases in manufacturing, aircraft operations, sport management, waste collection, and energy management.

Tuples
TRUSTWORTHY AI

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EXPECTED IMPACT

OUTCOME 1

To **develop hybrid planning and scheduling methods** that combine the efficiency, flexibility, and adaptability of data-driven learning approaches with the robustness, reliability, and clarity of model-based reasoning methods. This will require the ability to integrate learned models into the core of current planning and scheduling approaches that rely on constraint satisfaction, combinatorial optimization, and heuristic search algorithms. These hybrid methods are starting to be developed in other areas of AI, but are still in their infancy in the planning domain.

OUTCOME 2

To develop **verification and explanation methods** capable of reasoning about the properties of the solutions produced by planning and scheduling systems, in particular when these are represented by neural networks. Currently, neural network explanation and verification is gaining momentum in computer vision for example, but existing methods only consider isolated decisions. Planning on the other hand requires explaining plans, i.e. sequences of decisions that interact and affect possible futures, which is much more difficult.

OUTCOME 3

To **demonstrate these approaches on real practical case studies**, from airplane pilot assistance, to soccer team recruitment, and waste collection.

GENERAL IMPACT

TUPLES will release some software tools and a testing environment to enable the human-centered development and assessment of trustworthy P&S systems.

If enhanced trustworthiness ends up driving mass adoption of P&S the expected outcomes will include increased productivity, decreased environmental footprint and the empowerment of workers in the above sectors. These could translate into huge economic, environmental and social impacts.

ULTIMATE

mUlti-Level Trustworthiness to IMprove the Adoption of hybrid arTificial intelligencE

Call	*HORIZON-CL4-2021-HUMAN-01-01*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070162*

OBJECTIVES

Artificial Intelligence (AI) has entered the business mainstream, opening opportunities to boost productivity and innovation but suffer limitations hindering wider adoption in industrial settings. Both model and data-driven AI approaches naturally complement each other. However, **hybrid AI** does not fully address the issue of **trustworthiness** (validity, explaina-bility and ethics).

ULTIMATE will pioneer the development of **industrial-grade hybrid AI** based on 3 stages to ensure trustworthiness and promote the widespread adoption of hybrid AI in industry. Main objectives are the following:

- Develop data representation / visu-alisation models, and propose **innovative architectures** to construct and train hybrid AI algorithms.
- Design **rigorous evaluation methodologies** with appropriate properties (e.g. accuracy. robustness, safety) to strengthen their trustworthiness.
- Implement the developed hybrid AI algorithms under **operational conditions** (Robotics and Space) and fully assess them.
- Ensure the **ethical compliance** and **trustworthiness** through qualitative / quantitative approaches.

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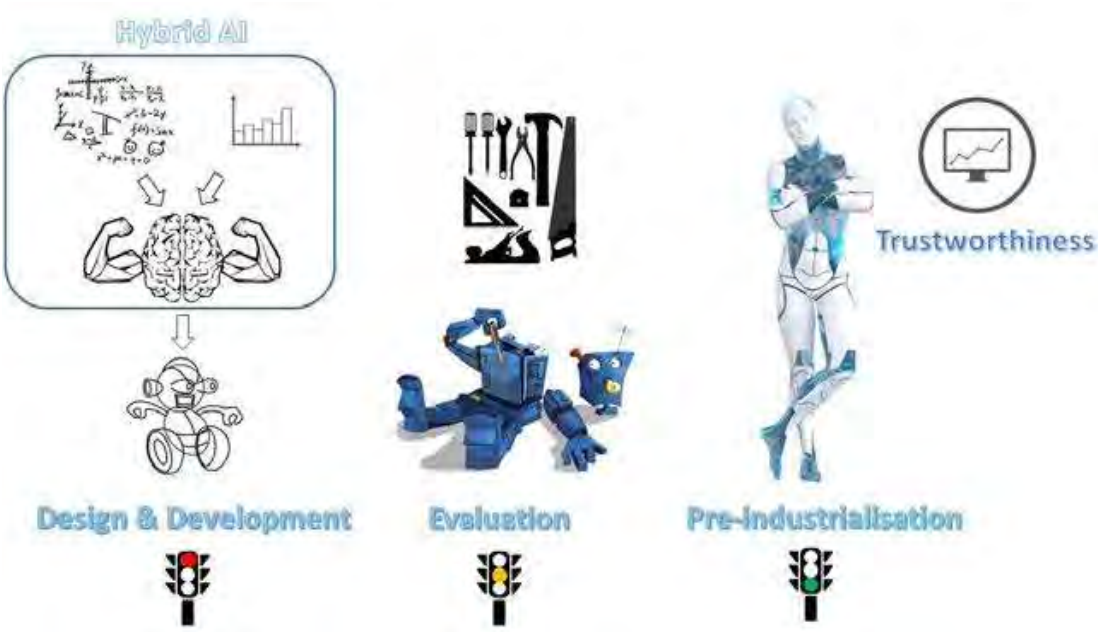
EXPECTED IMPACT

IMPACT 1: advance the current knowledge on the design, development, and deployment of **production-grade hybrid AI** and on rigorous evaluation methodologies (e.g. confidence estimation methods) to signi-ficantly increase the trustworthiness.

IMPACT 2: go beyond some existing **standards** as a reference in AI solutions to **meet industrial requirements** (related to safety for instance) to cover AI systems trustworthiness more adequately including **social and ethical** issues.

IMPACT 3: ensure that AI development and implementation is **human-centric** and is a force for good in society whilst evaluating the consequences taking into account the criteria of people (compliance with appropriate legal, ethical and societal foundations) and the machine's criteria.

IMPACT 4: support the creation of **high-quality jobs** where humans are making informed decisions using AI outputs rather than simply executing tasks they do not understand.



LEADERSHIP IN AI BASED ON TRUST

TACKLING GENDER, RACE AND OTHER BIASES IN AI

AEQUITAS

ASSESSMENT AND ENGINEERING OF EQUITABLE, UNBIASED, IMPARTIAL AND TRUSTWORTHY AI SYSTEMS

Call	*HORIZON-CL4-2021-HUMAN-01-24*
Duration	*1 October 2022 > 30 September 2025*
Project ID	*101070363*

OBJECTIVES

Our society is facing a dramatic increase in inequalities and intersectional discrimination. In this context, AI-based decision support systems are becoming ubiquitous in the public and private sectors. We need to prevent these AI systems from amplifying this phenomenon but rather mitigate it. To successfully adopt these systems, society needs to understand and trust the decisions. Fairness stands as one of the main principles of Trustworthy AI promoted at EU level. How these principles translate into technical, functional, social, and lawful requirements in the AI system design is still an open question. One of the key questions is how to test if a system is compliant with these principles and to repair it in case it is not and how to obtain a compliant-by-design system.

The aim of AEQUITAS is to address and tackle the multiple manifestations of bias and unfairness in AI by proposing a controlled experimentation environment for AI developers to create controlled experiments for

- assessing the bias in existing AI systems
- providing practical methods to repair, remove, and mitigate bias
- providing fairness-by-design methodologies and techniques to design new bias-free systems

AEQUITAS will foster the overarching principle and broad notion of AI fairness and will raise social awareness, particularly among LGBTQI and women and other fragile groups at risk of AI bias and unfairness, as well as among socio-economically vulnerable groups at risk of digital inequality, such as children and the elderly.

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ASOCIACION PARA EL DESARROLLO ECONOMICO Y SOCIAL RAYUELA
asociacionrayuela.com

EXPECTED IMPACT

To increase availability and deployment of unbiased AI solutions across a wide range of industrial and digital sectors: releasing AEQUITAS both as a service via the AI-on-demand platform and as an on-premise tool will boost innovation of EU companies (including both SMEs and start-ups) in the adoption of fair AI systems.

To provide AI-based solutions for enhancing digital equality and social inclusion for groups at risk of discrimination: implementation of fair AI-based solutions for the management of human resources, for the health sector, and for education domains – starting from the use cases of the project.

To increase the involvement of underrepresented groups in the design, development, training, and deployment of AI: the AEQUITAS methodology will proceed through a participatory design process including underrepresented social groups (via associations) in the design and development of AI systems.

To increase awareness, knowledge, and skills about trustworthy, bias-free and socially responsible AI in the industry and scientific community: dissemination campaign including awareness, education courses, and training on the one side for industries and scientific community and on the other side for the general public and associations for groups at risk of discrimination.

BIAS
Mitigating biases of AI in the labour market

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BIAS

Mitigating Diversity Biases in the Labour Market

Call	HORIZON-CL4-2021-HUMAN-01-24
Duration	1 November 2022 > 31 October 2025
Project ID	101070468

OBJECTIVES

The project will investigate the use of Artificial Intelligence in the labor market and how biases in hiring and promoting processes based on personal characteristics are potentially reproduced with AI-based systems. In an employment context, this can involve analyzing text created by an employee or recruitment candidate in order to assist management in deciding to invite a candidate for an inter-view, training and employee engagement, or monitoring for infractions that could lead to disciplinary proceedings. It is therefore necessary to identify and mitigate biases that occur in applications used in a Human Resources Management (HRM) context. The project will:

1. investigate this from a technical perspective by identifying how current AI systems are biased and propose solutions to make them less biased
2. investigate from a social scientific perspective by conducting extensive ethnographic fieldwork concerning the lived experiences of employees, Human Resource managers, and technology developers
3. provide substantial training for HR managers and technology developers regarding the responsible development and implementation of AI

EXPECTED IMPACT

Develop trustworthy, novel tools for bias identification and bias mitigation in AI/NLP systems that can be deployed across multiple applications in a wide range of industrial and digital sectors.

Empower underrepresented citizen communities through extensive co-creation activities that informs technology development and industry training activities.

Empower the AI and HRM community through capacity building to develop better technology and institute better practices by integrating concerns about bias into their everyday workflow and strategic considerations.

Advance the field of worker studies through a richly detailed understanding of bias in recruitment and HRM, especially as it relates to the use of AI and technology.

Inform future trajectories of NLP and AI research with increased involvement of underrepresented persons in the design, development, training, and deployment of AI.

Make hiring practices less biased through the development of a proof-of-concept system that can be further developed into a commercially viable product to reduce bias in AI systems used in recruitment.

FINDHR

FAIRNESS AND INTERSECTIONAL NON-DISCRIMINATION IN HUMAN RECOMMENDATION

Call	*HORIZON-CL4-2021-HUMAN-01-24*
Duration	*1 November 2022 > 31 October 2025*
Project ID	*101070212*

OBJECTIVES

Algorithmic hiring is the usage of tools based on Artificial Intelligence (AI) for finding and selecting job candidates. As other applications of AI, it is vulnerable to perpetuate discrimination.

Considering technological, legal, and ethical aspects, the EU-funded FINDHR project will facilitate the prevention, detection, and management of discrimination in algorithmic hiring and closely related areas involving human recommendation.

FINDHR aims to create new ways to ascertain discrimination risk, produce less biased outcomes, and meaningfully incorporate human expertise. Moreover, it aims to create procedures for software development, monitoring and training. On completion, the project's publications, software, courseware and datasets will be made freely available to the public under free and open licenses.

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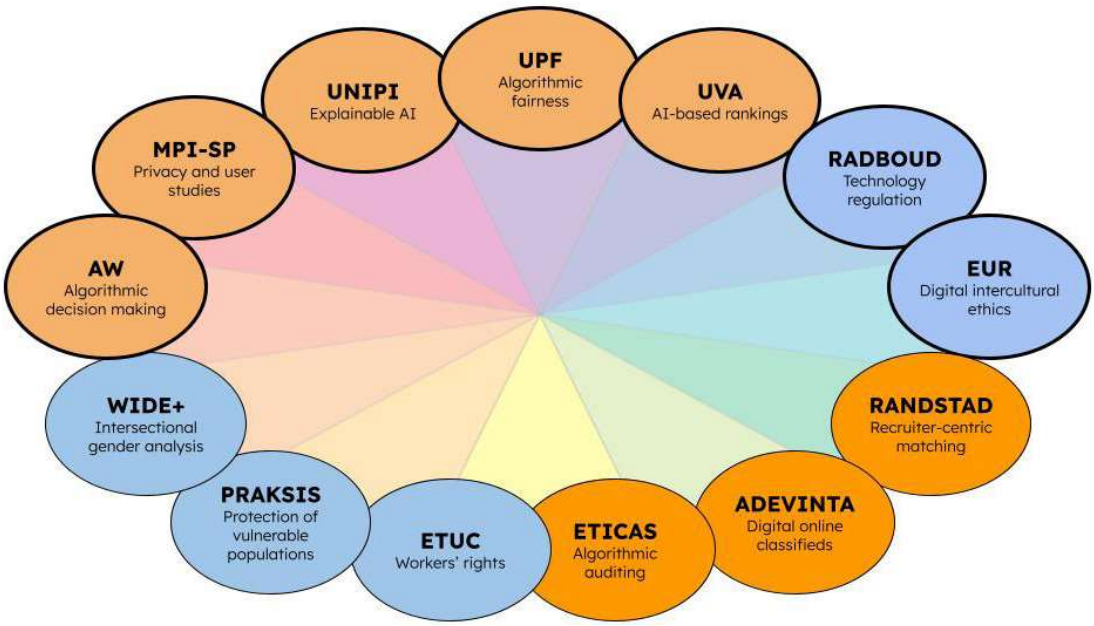
EXPECTED IMPACT

IMPACT 1. Methods: Open technical designs, open-source software, and open datasets are the most important output of our project. We will provide methods for discrimination risk assessment, a protocol for equality monitoring, and a software development guide that, complemented with our training, provide the relevant know-how and guidance necessary to effectively integrate bias detection and mitigation technologies in the AI industry, particularly in human recommendation and algorithmic hiring services.

IMPACT 2. Frameworks and policy inputs: Improvements in equal access to work are advances in social inclusion. Our project centers discrimination protection needs of workers, particularly women and vulnerable groups. By developing and demonstrating a framework for impact assessment and auditing and an equality monitoring protocol for human recommendation systems in the context of recruitment, we will provide tools that anti-discrimination groups and government regulators can use to gather quantitative evidence to evaluate inclusion advances and make them long-lasting.

IMPACT 3. Training: We will develop and deliver specialized training in high-risk applications of AI for human recommendation and recruitment, and more accessible by offering it to a broad spectrum of researchers and practitioners. A strong multiplying effect is foreseen by making all materials available as OpenCourseware, including video recordings of lectures, worksheets for case studies, and programming notebooks for data analysis, reducing entry barriers to people seeking these skills.



MAMMOTH

Multi-Attribute, Multimodal Bias Mitigation in AI Systems

Call	*HORIZON-CL4-2021-HUMAN-01-24*
Duration	*1 November 2022 > 31 October 2025*
Project ID	*101070285*

OBJECTIVES

MAMMOth focuses on multi-discrimination mitigation for tabular, network and multi-modal data. The project intends to address bias in AI through the following objectives:

- Redefine bias on the basis of multiple (protected) characteristics instead of a single attribute.
- Create standardized AI solutions to address bias across all phases of the development of AI systems.
- Develop and advance new technologies to evaluate and mitigate AI bias.
- Ensure reliability, traceability and explainability of AI solutions in order to address different types of bias.
- Integrate and prototype bias-preventing AI solutions into an open source suite in order to increase their availability and deployment.
- Increase awareness and skills preventing AI bias and the uptake of the MAMMOth solutions by involving affected communities and stakeholders across Europe and worldwide.
- Advance the European approach to excellence in trustworthy AI.
- Study AI biases on use cases – providing insights on high-risk applications of bias, in finance, face recognition and research.

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EXPECTED IMPACT

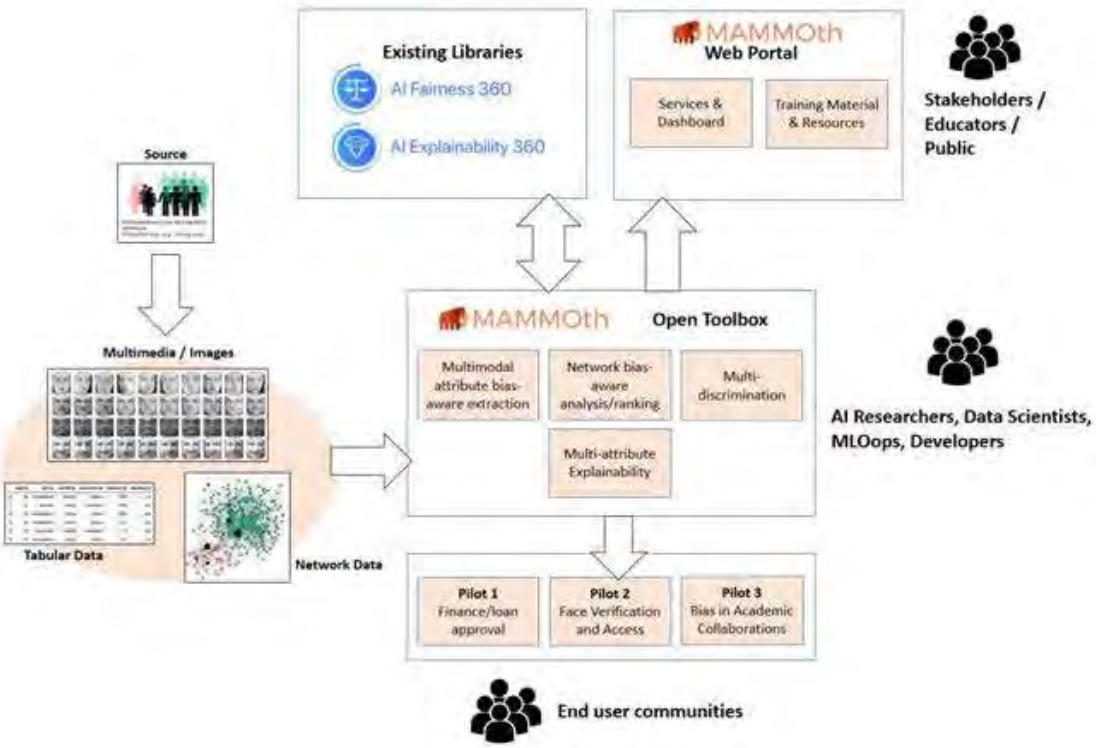
MAMMOth's contribution is summarized as follows:

IMPACT 1: Increased availability and deployment of unbiased and bias-preventing AI solutions across a wide range of industrial and digital sectors through the MAMMOth toolkit.

IMPACT 2: AI-based solutions for enhancing digital equality and social inclusion for women, girls and other groups at risk of discrimination, such as ethnic minorities and the LGBTIQ community.

IMPACT 3: Increased involvement of under-represented persons in the design, development, training and deployment of AI, as a means to contribute towards the solution of socially responsible AI.

IMPACT 4: Increased awareness, knowledge and skills on trustworthy, bias-free and socially responsible AI in the tech industry and scientific community.



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