



R&D IN ARTIFICIAL INTELLIGENCE AT THE UPC

2024



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH



Generalitat
de Catalunya



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01 THE UPC

The Universitat Politècnica de Catalunya (UPC) is a public institution of research and higher education in the fields of engineering, architecture, sciences and technology, and one of the leading technical universities in Europe.

The UPC participates in the innovation system of Catalonia with projects and contracts for research, development, valorization of knowledge and commercialization of technology.



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RESEARCH, DEVELOPMENT AND INNOVATION ACTIVITY AT THE UPC IN 2023



02

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is defined as the set of technologies (from the development of Machine Learning algorithms to natural language processing) that enable intelligent decision-making and carry out tasks that would normally require human intelligence, enabling machines to perform human-like cognitive processes, including the abilities to learn, understand, reason and interact.

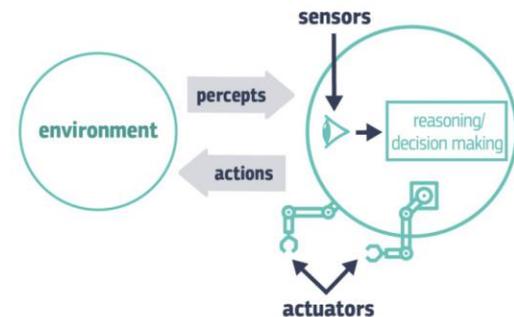


Figure 1. Schematic infographic of a system based on LA. Source: A Definition of AI for the European Commission.

Examples of activity I

Analysis, design and implementation of Artificial Intelligence techniques and methodologies to support the management, control or modeling of systems and/or real domains of great complexity, in different domains of application.

Supervision, security and automatic **control of critical systems** and infrastructures.

Development of **personal voice assistants**.

Facial recognition using AI facial filters to detect and identify people to provide secure access to devices.

Generation of a **digital twin of a wind turbine** to predict future failures/events, calculate the remaining useful life of the asset and make informed decisions.

Design of **failure-tolerant diagnosis and control systems** that are resilient and safe.

Creation of **Intelligent housing systems** and automation.

Examples of activity II

Modernization of geolocation, navigation and GPS systems for vehicles.

Planning of trajectories and guidance of **autonomous vehicles**.

Comparative study of **deep learning technologies** and solutions for the diagnosis of faults in **wind turbines**.

Creation of **cybersecurity** incident response tools and analysis of malware type software used by attackers implementing AI.

Application of **Artificial Intelligence in agriculture** to identify defects and nutrient deficiencies in the soil through applications of computer vision, robotics and machine learning.

Designs of intelligent structures based on monitoring systems and damage identification with application in aeronautics and wind plants.

Development of an intelligent control system applied to a **sequential batch reactor (SBR)** for the removal of **organic matter, nitrogen and phosphorus**.

Examples of activity III

Creation of intelligent content and digitization of content such as video classes, guides and textbooks in the educational field.

Creation of a computational system using AI for the **diagnosis of acute leukemias and lymphomas** from peripheral blood images.

Implementation of continuous learning strategies applied to the predictive control of **HVAC systems in tertiary sector** buildings to save energy.

Combination of **historical data and medical Artificial Intelligence** for the discovery of new drugs.

Early disease diagnosis and chronic disease analysis using laboratory data and AI-generated and ordered data.

Evaluation and Analysis of the potential of NIR photonic technology and mathematical techniques based on artificial intelligence applied to quality control in industrial processes in the textile and fashion sector.

Automation of detection, diagnosis and failure tolerance in systems with uncertainty and in **distribution systems** to improve efficiency.

03

RESEARCH AND INNOVATION



R&D

Through the research groups distributed by its Schools and Faculties, the UPC has facilities and resources to provide its own services, in the areas of diagnosis, advice, development, demonstration, training, promotion and support to industry, the public sector and civil society in the promotion and deployment of architectural innovation technologies.



UPC RESEARCH GROUPS AND CENTERS – ARTIFICIAL INTELLIGENCE

RESEARCH GROUPS, RESEARCH SUBGROUPS AND LABORATORIES

IA-DAIS, GREC, KEMLG, SOCO, GPI,
GPLN, VEU, CBA, CoDAIab, ANCORA,
GRCM, SAC, RAIG, SIR-OPE, MCIA

SPECIFIC RESEARCH CENTERS



04

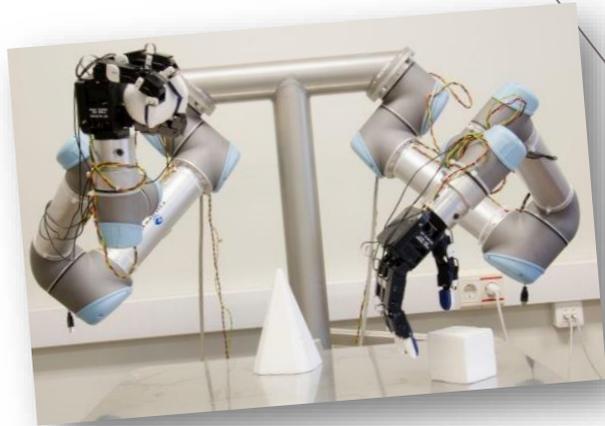
UPC EXCELLENCE PROJECTS

In this document are considered excellence projects those in which:

- The scientific process is rigorous and complex with high quality standards.
- They are strategic and tractors.
- They acquire a commitment to both social aspects and to great scientific and socioeconomic impact.
- They have repercussions on the territory.
- They comprise the different entities participating in the quadruple helix, so that the projects remain multidisciplinary.



UPC EXCELLENCE PROJECTS



Research group involved: [IOC](#)

CaRo: Core capabilities for co-workers Robots

Nowadays, the concept of co-worker robot has appeared, being a sufficiently intelligent and autonomous robot, destined to work as a collaborator of humans, who are the ones who have the necessary knowledge and capabilities to find solutions and solve tasks in certain situations, since fully autonomous robots have not been developed in many tasks yet.

For this reason, CaRo will develop information processing tools to understand the environment and the current situation, dynamic methods for flexible and rapid adaptation to the environment, will develop robust strategies for bimanual manipulation, and will exploit new communications technologies, such as 5G, to improve communication between the operator and the robot, between robots or between a robot and a distributed computing system.

The proposed solutions will be validated through a real experiment system, including a bi-armed robot with manipulation capability that will be used as a co-worker robot.

UPC EXCELLENCE PROJECTS



WINC - Wireless Networks within Next-Generation Computing Systems

The WINC project envisages a revolution in computer architecture, thanks to the integration of wireless networks within computer systems and Artificial Intelligence. The main hypothesis is that terahertz wireless technology will lead to at least a tenfold improvement in the speed, efficiency and scalability of both quantum and non-quantum systems.

With a transversal approach, WINC aims to validate the hypothesis

- (i) revealing the fundamental limits of wireless communications within computing packages,
- (ii) developing antennas and protocols that operate close to these limits while meeting the strict constraints of the scenario, and
- (iii) developing new architectures that translate the unique benefits of wireless vision into order-of-magnitude system-level improvements.

Research group involved: Department of Computer Architecture

UPC EXCELLENCE PROJECTS

MERIDIAN - Flexible distribution grid management for maximum decarbonisation using Artificial Intelligence

The challenge of a carbon-neutral economy in Europe leads to an increasingly integrated and electrified energy system, increasing the interaction between different actors in the energy sectors.

Digitization is key to linking the different actors in a clean, affordable and reliable energy system. In this sense, it is interesting to apply Artificial Intelligence (AI) to solve the associated challenges due to the ability of AI to identify patterns and knowledge in the data and learn to do it more accurately and effectively.

This project focuses on AI machine learning applications in the distribution and consumption domains and, in particular, its orientation towards improving operational procedures to find optimal operation to minimize emissions and maximize capacity 'accommodation of renewable energies in the distribution system.

Research group involved: [CITCEA-UPC](#)



HOSPITALES 4.0 - Machine learning for a more effective management

HOSPITALES 4.0 seeks to achieve a more effective management system to resolve the current situation existing in the hospital sector and to provide a solution to its requirements. It aims to be an intelligence and prediction system that allows to have decision-making tools in the face of possible critical situations, or simply to optimize and improve the use of available and limited resources.

The project includes the realization of a pilot on a real installation in which the concordance and functionality of several enabling technologies within Industry 4.0 are validated, including system simulation, digital twins, Machine Learning, artificial intelligence, the Internet of Things (IoT) and the interconnection of systems.

Research group involved: [MCIA](#)



FloWinTurCoM - Development and validation of intelligent monitoring systems, pitch control and structural damping strategies for floating offshore wind turbines

The final aim of the project is the development and validation of intelligent monitoring systems for the prediction, detection and localization of faults/damages in floating offshore wind turbines, together with the design of control systems and active and semi-active control systems with specific structural damping devices suitable for light floating wind turbines.

The project integrates fundamental research with the development of algorithms that include practical aspects of its real applicability.



UPC EXCELLENCE PROJECTS

OMEGA-X - Orchestrating an interoperable sovereign federated Multi-vector Energy data space built on open standards and ready for GAia-X

The objective of OMEGA-X is to implement a data space (based on common European standards), which includes a federated infrastructure, a data market and a services market, which implies the exchange of data between different interested parties. It demonstrates its value for cases and real needs and concrete needs of energy, while guaranteeing scalability and interoperability with other initiatives in the field of energy.

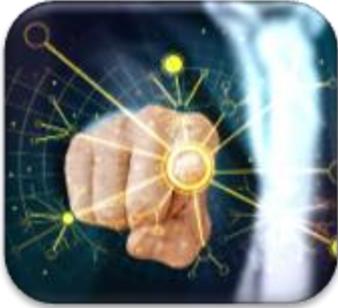
Research group involved: [CITCEA-UPC](#)



05
EDUCATION



EDUCATION – BACHELOR'S DEGREES



[Bachelor's degree in Artificial Intelligence](#)



[Bachelor's degree in Informatics Engineering](#)



[Bachelor's degree in ICT Systems Engineering](#)



[Bachelor's degree in Mathematics](#)

[More information on UPC bachelor's](#)

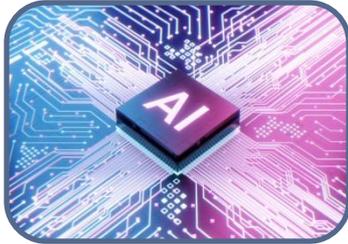


EDUCATION – MASTER'S DEGREES



- [Master's degree in Artificial Intelligence](#)
- [Master's degree in Data Science](#)
- [Master's degree in Informatics Engineering](#)
- [Master's degree in Automatic Systems and Industrial Electronics Engineering](#)
- [Master's degree in Automatic Control and Robotics](#)

DOCTORAL PROGRAMMES



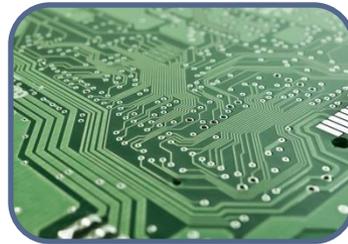
[Artificial Intelligence](#)



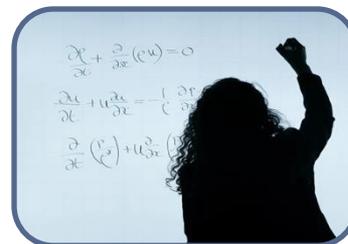
[Computing](#)



[Automatic Control,
Robotics and Vision](#)



[Network Engineering](#)



[Applied Mathematics](#)



UPC SCHOOL – MASTER’S DEGREES OF CONTINUING EDUCATION

- [MASTER IN JOURNALISM AND ARTIFICIAL INTELLIGENCE](#)
- [MASTER IN 4.0 INDUSTRY](#)
- [MASTER IN ADVANCED PROGRAMMING FOR AAA VIDEO GAMES](#)
- [MASTER IN CYBERSECURITY MANAGEMENT](#)
- [MASTER IN BLOCKCHAIN](#) (SEMIPRESENCIAL O ONLINE)
- [MASTER IN MBA IN BUSINESS ANALYTICS](#)
- [MASTER IN ADVANCED PROGRAMMING FOR AAA VIDEO GAMES](#)



UPC SCHOOL - POSTGRADUATES

- [ARTIFICIAL INTELLIGENCE WITH DEEP LEARNING](#)
- [MATERIALIZATION OF MODELS AND TECHNOLOGIES IN INDUSTRY 4.0](#)
- [CLOUD COMPUTING ARCHITECTURE](#)
- [DIGITAL TRANSFORMATION LEADERSHIP](#)
- [FINTECH TECHNOLOGIES AND APPLICATIONS](#)
- [QUANTUM ENGINEERING](#)
- [SMART MOBILITY: INTELLIGENT TRANSPORT SYSTEMS](#)
- [SPORTS ANALYTICS](#)
- [DIGITAL HEALTH LEADERSHIP](#)

UPC SCHOOL – COURSES OF CONTINUING EDUCATION

- [COURSE OF CONTINUING EDUCATION IN BUSINESS PROCESS MANAGEMENT \(BPM\)](#)
- [COURSE OF CONTINUING EDUCATION IN BLOCKCHAIN FOR BUSINESS \(PRESENCIAL\)](#)
- [COURSE OF CONTINUING EDUCATION IN BLOCKCHAIN FOR BUSINESS \(ONLINE\)](#)
- [COURSE OF CONTINUING EDUCATION IN URBAN MOBILITY 4.0 \(SEMIPRESENCIAL](#)
• [O ONLINE\)](#)

[More information about master's, postgraduates and courses of continuing education at at UPC](#)





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