



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación

A photograph of a server room with three rows of server racks. The racks are filled with server units, and the top of the middle rack is open, showing a dense bundle of red and blue cables. The perspective is from a low angle, looking up at the racks.

AI and Supercomputing for Real Impact

AI Technologies from Barcelona Supercomputing Center



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About BSC

Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC-CNS) is Spain's leading supercomputing center and an international reference in Artificial Intelligence (AI) and High-Performance Computing (HPC). We design, build and apply advanced computing technologies to support science, industry and public decision-making globally, with a strong focus in Europe.

BSC works with a clear mission focused on impact:

- Supercomputing and AI services for Spanish and European researchers and entrepreneurs
- Scientific excellence and R&D in Computer Sciences, Life Sciences, Earth Sciences, Engineering and Social Sciences
- Technology transfer including knowledge transfer, education and public engagement

A public research consortium

BSC is a public consortium formed by:



Generalitat de Catalunya
**Departament de Recerca
i Universitats**



**UNIVERSITAT POLITÈCNICA
DE CATALUNYA**
BARCELONATECH

Scale and expertise

- More than 1,350 professionals
- Over 1,000 researchers
- More than 50 research teams
- Over 100 active research lines

Networks and ecosystems

BSC plays an active role in building deep tech research and innovation ecosystems, leading consortiums in several key strategic European projects as well as managing two of the R&D&I Networks in Catalonia:

- X4HPC, the High Performance Computing network that brings together over 400 researchers from approximately 41 research groups across several major Catalan institutions, bridging the gap between high-level scientific research and the commercial market.
- CLARIAH-CAT, the digital humanities network in Catalonia, focusing on the digital transformation of culture and heritage connecting data, tools and research communities of the Social Sciences, Arts and Humanities sector.

Through these networks, BSC connects technology, science and society, and helps research results reach real use.



BSC AI Factory in the European Context



Barcelona Supercomputing Center is in charge of one of Europe's AI Factories, part of a large-scale European ecosystem designed to support the development and deployment of European Artificial Intelligence technologies. This ecosystem brings together supercomputing centers that provide the needed computing power, large datasets and top experts' knowledge to enable advanced AI development across Europe, aligning with the strategic roadmap to strengthen its sovereignty.

More than access to computing

Most startups and small companies lack the computing power required for training resource-intensive models developed in modern AI's implementation. BSC AI Factory provides access to advanced resources and a safe environment to learn and innovate, lowering the entry barriers for the innovation ecosystem.

BSC AI Factory goes beyond access to MareNostrum 5, one of Europe's most powerful supercomputers. It operates as an Innovation Hub for applied AI, supporting organizations throughout the full process of building, testing and deploying AI solutions. The focus is on collaboration, practical use cases and real-world impact. It promotes cooperation between supercomputing centers, universities, startups, SMEs, industry, public institutions and financial actors.

Innovating to Build the Future Together

In recent years, artificial intelligence has moved from an emerging topic to a core part of how we work, plan and innovate. Today, the challenge is no longer access to data, models or computing power. The real challenge is turning AI into solutions that make a measurable difference in the real world.

This catalogue brings together a selection of AI and supercomputing technologies developed at the Barcelona Supercomputing Center to address real challenges across industry and ultimately in society. From advanced processors as AI infrastructure to applied solutions in agriculture, climate, health, mobility and the public sector, these technologies are designed to move beyond research and create tangible impact.

By promoting open, scalable, and future-ready solutions, BSC-CNS is shaping the next generation of digital and industrial transformation.

Artificial intelligence is quickly transitioning from testing to widespread use

Artificial intelligence is moving fast from testing to wide adoption. It is shifting from a value add tool to a core asset across most industries.

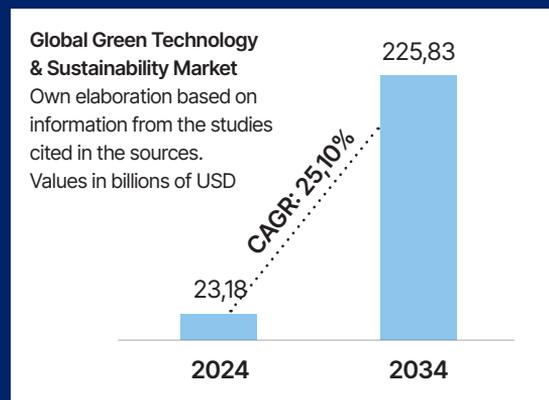
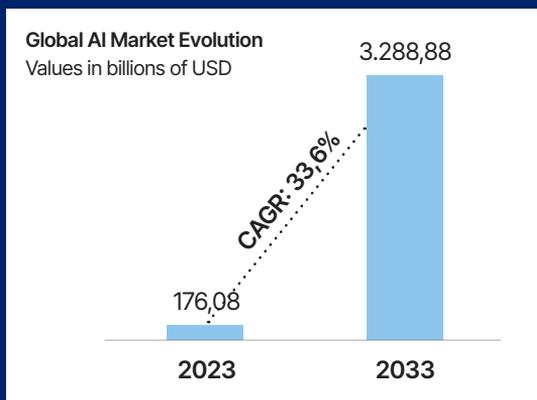
Companies rely on it not just for efficiency, but to innovate and stay competitive, as seen in rising investment and real use cases.

Stronger models, more data, better computing power, and cost pressure are pushing AI into both traditional sectors and public services.

How is AI impacting the different sectors

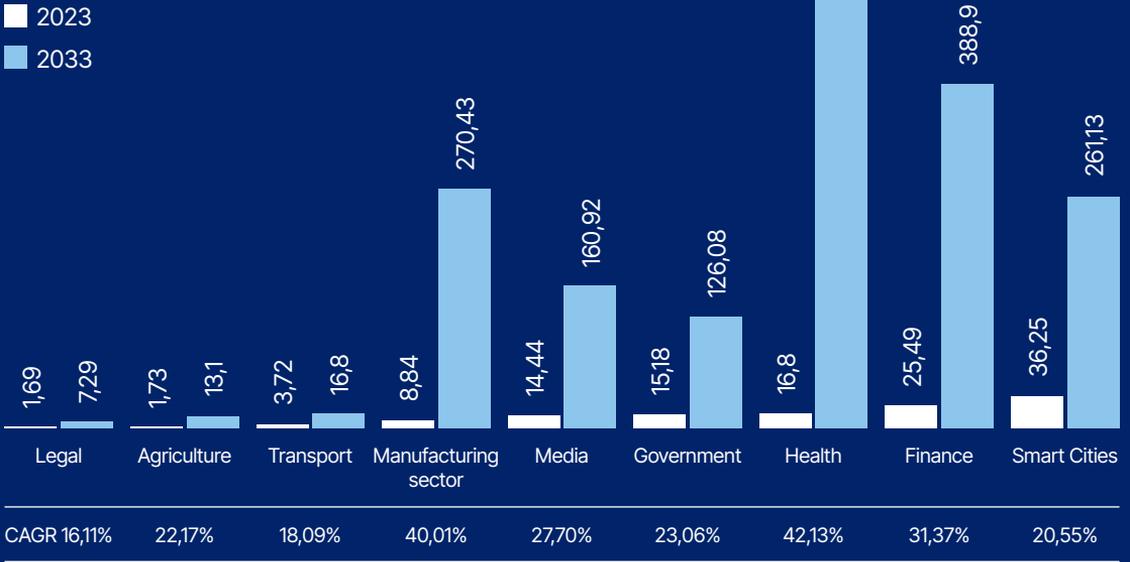
AI is affecting each sector in different ways, with some industries changing faster than others. Between 2023 and 2033, adoption is projected to speed up across industries, with several areas moving from optional use to essential reliance on AI.

(This graph complements the **Global AI market evolution by end-user sector** graph above, as **Global Green Technology & Sustainability Market** constitutes a sector category)



Global AI market evolution by end-user sector

Values in billions of USD



Current AI technologies are intended to address industry and societal issues, with a heavy emphasis on applicability, scalability, and collaboration. To comprehend the applications of AI in each area, it is necessary to break down the AI-based technologies that will benefit each sector:

		AI-based Technologies									
		ML	DL	NLP	Generative AI	Computer vision	Predictive AI systems	Algorithmic optimization	ASR	Big Data	Edge AI
Market sectors	Agriculture	✓				✓	✓				
	Transportation	✓	✓			✓	✓	✓	✓	✓	✓
	Finance	✓	✓	✓	✓		✓		✓	✓	
	Legal	✓		✓	✓				✓		
	Healthcare	✓	✓	✓	✓	✓	✓		✓	✓	
	Government	✓		✓			✓		✓		
	Smart Cities	✓				✓	✓		✓	✓	✓
	Media and Entertainment	✓	✓	✓	✓	✓			✓		
	Industry 4.0	✓	✓			✓	✓	✓	✓	✓	✓

At this point, success with AI is determined by impact. It is about implementing technologies that are dependable, intelligible, and in line with societal and industrial requirements. Control, responsibility, and trust have become equally crucial as performance. The sections that follow show how BSC technologies apply these concepts across several industries, transforming powerful AI and supercomputing technologies into practical, reliable solutions that add actual value.

AI in Health

Healthcare systems are facing growing pressure due to aging populations, chronic diseases, rising costs and increasing demand for personalized care. Artificial intelligence is becoming a key tool to improve efficiency, accuracy and decision-making across the health sector.

AI supports better clinical and operational decisions by extracting meaningful insights from medical data at scale. By combining clinical data, medical images, biological information and real-time signals, AI systems support earlier diagnosis, better treatment selection and more efficient use of resources, while helping improve patient outcomes.

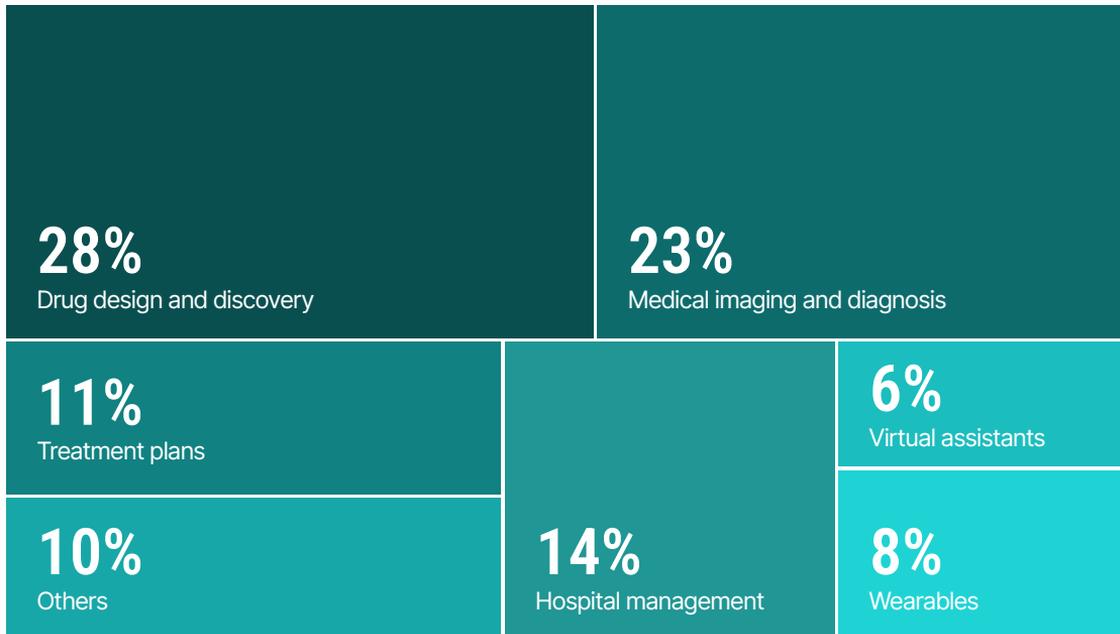
Current applications

	ML	DL	NLP	Generative AI	Computer vision
Drug design and discovery	✓	✓	✓		
Drug development (clinical trials)	✓	✓	✓		
Hospital management	✓		✓		
Predictive analysis and risk assessment	✓	✓	✓		
Support for clinical diagnosis	✓	✓			✓
Clinical treatment support	✓	✓	✓		
Clinical decision support	✓	✓	✓		
Wearables and monitoring	✓		✓		
Virtual assistants and telemedicine	✓		✓	✓	

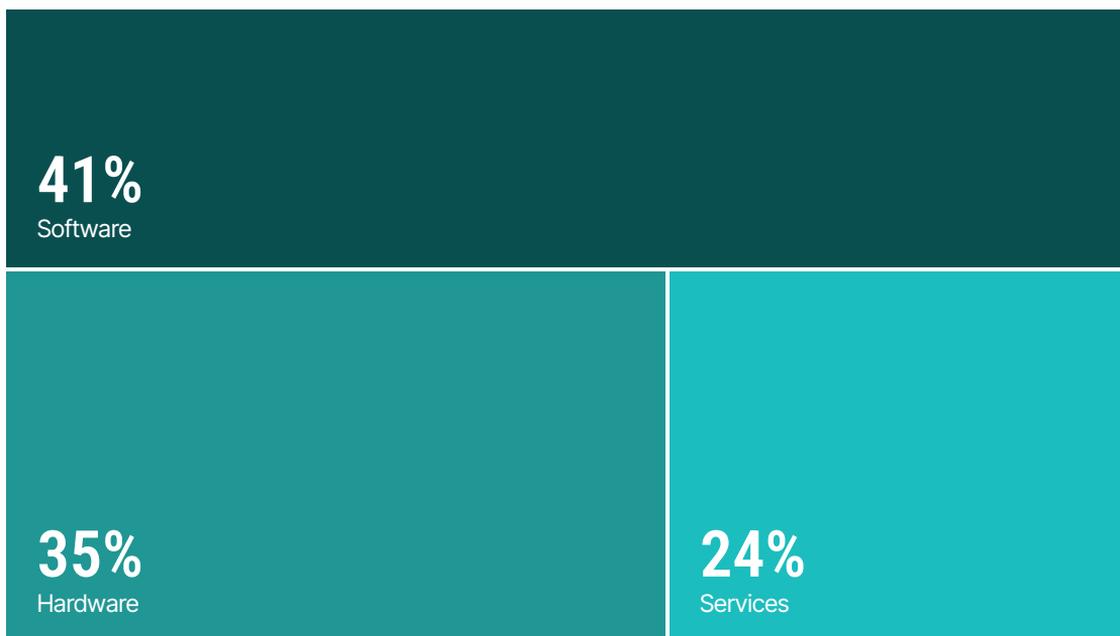
Applications

AI technologies

Market segmentation



By application type



By application solution

Krebstein: Synthetic data for Cancer Research

Krebstein is a project that uses generative artificial intelligence to create high-quality synthetic data for cancer research. By generating realistic but artificial patient data, the project helps researchers study cancer progression, identify rare patient groups and develop new insights, while respecting ethical and privacy constraints.



Problem

Cancer research depends on access to large and detailed clinical datasets. However, collecting and sharing this data is often limited by ethical, legal and privacy restrictions. As a result, researchers face data scarcity, which slows progress in studying disease evolution over time, especially for rare cancers and uncommon patient subgroups.

Solution

Krebstein addresses this challenge by using generative AI models to create synthetic cancer data that preserves the statistical and biological patterns found in real datasets, without exposing sensitive patient information. The system is trained on existing clinical and molecular data, such as gene expression profiles, and can generate new synthetic samples or realistic data trajectories that simulate how cancer evolves over time. These synthetic datasets can then be safely used for advanced analyses, including subgroup identification, cancer stage prediction and biomarker discovery, supporting research that would otherwise be limited by data availability.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Health



Pharmacology



Biotechnology



Research

Potential Clients

- Academia
- Big Corporation
- Small Companies
- Startups

Synthetic data unlocks new possibilities for cancer research while protecting patient privacy



Startum: 3D Decision Support Tool for Brain Tumor Surgery

STRATUM is an intelligent 3D support tool designed to help surgeons make safer and faster decisions during brain tumor surgery. By combining advanced medical imaging, artificial intelligence and high-performance computing, the system provides real-time guidance that supports more precise and informed surgical procedures directly in the operating room.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Health



Biotechnology



Research

Potential Clients

- Big Corporation
- Small Companies
- Startups
- Governmental Institutions
- Academia



Problem

Brain tumor surgery is extremely complex and requires surgeons to distinguish tumor tissue from healthy brain tissue with high precision. During surgery, large amounts of imaging and patient data are generated, but current tools struggle to process and integrate this information in real time. The lack of AI and high-performance computing at the point of care can lead to less cutting precision, longer surgeries and delayed decisions all of these increasing the risk for patients. Surgeons need reliable, real-time support to better interpret data and reduce uncertainty and errors during critical moments.

Solution

STRATUM brings high-performance computing and artificial intelligence directly into the operating room to support surgeons while the operation is taking place. The system collects and combines data from multiple medical imaging sources into a single platform and analyzes it in real time using AI. Tumor tissue and critical brain areas are automatically identified and highlighted, and the results are displayed as clear, easy-to-understand 3D visual guidance. This real-time support helps surgeons locate tumors more accurately, avoid sensitive areas of the brain and make faster, safer decisions during surgery.

Using HPC and AI in the operating room to support safer, faster and more precise brain tumor surgery

RapidAIM: Rapid detection of heart attacks from ECG images

RAPID AIM is an artificial intelligence tool designed to quickly detect heart attacks by analyzing images of electrocardiograms (ECGs). It supports fast diagnosis in emergency situations by allowing medical staff to identify signs of acute myocardial infarction within seconds, even when specialist expertise is not immediately available.

Problem

Detecting a heart attack as early as possible is essential to saving lives, but delays are common in emergency rooms, ambulances and low-resource settings. ECGs are often printed or shared as images, and their interpretation usually requires a cardiologist or trained specialist. When this expertise is not available, diagnosis can be delayed, slowing treatment and increasing long-term risks for patients.

Solution

RAPID AIM addresses this challenge by using artificial intelligence to automatically interpret ECG images. A photo or scan of an ECG, whether printed or captured with a smartphone, can be securely analyzed by the system. The AI detects patterns associated with heart attacks within seconds and immediately returns the result to healthcare professionals. This enables faster clinical decisions and earlier treatment, without waiting for specialist review.



Status

In research

Functional prototype

Validated in real-world

Target Industries

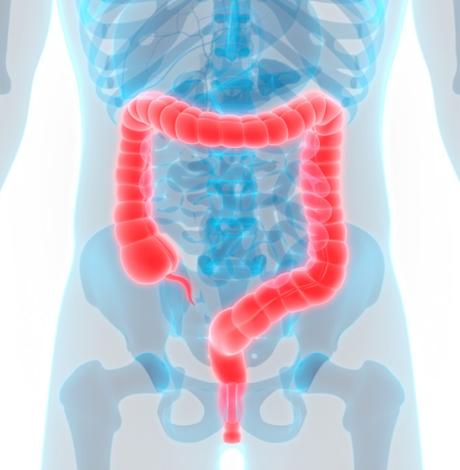


Health

Potential Clients

- General Public
- Governmental Institutions
- Hospitals

RAPID AIM helps detect heart attacks from simple and accessible ECGs, so treatment can start sooner and more lives can be saved



MiCRC: Early detection of colorectal cancer using microbiome data

MiCRC is a project that uses artificial intelligence to support the early detection of colorectal cancer through the analysis of microbiome data. By studying the composition of microorganisms in a simple fecal sample, the system helps identify individuals at higher risk of colorectal cancer or pre-cancerous lesions which supports earlier and more targeted diagnosis.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Health

Potential Clients

- General Public
- Big Corporation
- Small Companies

Problem

Colorectal cancer is one of the leading causes of cancer-related deaths worldwide. Detecting the disease at an early stage is critical to improving survival rates and reducing healthcare costs. However, many current screening methods are invasive, expensive and can result in unnecessary procedures, including follow-up colonoscopies, increasing the burden on both patients and healthcare systems. This creates a strong need for accurate, less invasive tools that can better identify which patients require further clinical examination.

Solution

Artificial intelligence is used to analyze the microbiome composition obtained from a fecal sample. After its collection with a standard device, microbial DNA is sequenced to create a detailed microbiome profile. AI models then identify patterns associated with colorectal cancer risk, detecting individuals who may have tumors or high-risk pre-cancerous lesions. Based on this risk assessment, a colonoscopy is recommended only when necessary, enabling more targeted, efficient and less invasive screening.

Early prediction of colorectal cancer through non-invasive microbiome analysis

PCarTrials: Heart Digital Twin for Atrial Fibrillation

PCarTrials creates a virtual digital twin of a patient's heart using clinical data. This digital heart model allows doctors and researchers to test different treatment options on a computer before applying them to the real patient, supporting more personalized and effective care in cardiology.

Problem

Heart diseases are among the most common causes of illness and death worldwide. However, many treatments are still designed based on average patient responses and do not fully account for how differently each person's heart behaves. This makes it difficult to select the most effective therapy for individual patients and increases the risk of suboptimal treatment outcomes.

Solution

PCarTrials uses patient-specific clinical data, such as medical scans and diagnostic tests to build a detailed virtual model of the heart that reflects how it functions in reality. This digital twin can then be used to simulate and compare different therapies, medical devices or drug effects in a virtual environment. By testing treatment options in advance, clinicians can identify which approach is most likely to work best for a specific patient, reducing uncertainty and supporting more precise and safer medical decisions.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Health



Pharmacology



Biotechnology



Research

Potential Clients

- Big Corporation
- Small Companies
- Academia

Digital heart twins help personalize treatment and improve outcomes for the world's leading cause of death

AI in Green Technologies and Sustainability

The sustainability industry is changing fast. Climate change, energy transition goals, biodiversity loss and pollution are no longer future concerns, they are daily challenges that require better understanding and faster action. Both governments and companies face increasing pressure to cut emissions, use natural resources more responsibly and meet stricter environmental regulations. At the same time, organizations must find ways to protect the environment while remaining economically efficient, making sustainability decisions more complex than ever.

Artificial intelligence is becoming a powerful ally in this effort. AI helps make sense of the vast amounts of environmental data generated by sensors, satellites and monitoring systems, revealing patterns and trends that are hard to detect with traditional tools. In sustainability, AI supports more accurate climate and environmental forecasts, continuous monitoring of ecosystems and air quality, smarter use of energy and resources, and better assessment of environmental risks. When combined with high-performance computing and modern data infrastructures, AI enables organizations to move beyond static reports and take more proactive, data-driven actions toward long-term resilience.

AI applications

	ML	DL	Computer Vision	Predictive AI	Optimization	Big Data	Edge AI
Climate & environmental modeling	✓	✓		✓	✓	✓	
Energy Optimization	✓			✓	✓	✓	✓
Renewable energy forecasting	✓	✓		✓	✓	✓	
Air quality monitoring	✓	✓		✓		✓	✓
Water management & hydrology	✓			✓	✓	✓	✓
Biodiversity & ecosystem monitoring	✓	✓	✓			✓	✓
Climate risk & resilience planning	✓			✓	✓	✓	
ESG reporting & impact assessment	✓			✓		✓	

Applications

AI technologies

The Sustainability Market

38%

North America

Strong public and private investment, established tech ecosystem, large corporations

28%

Europe

Strict regulation, European Green Deal, focus on renewables and smart cities

5,5%

Latam

Climate adaptation, agriculture, water access, impact investment

25%

Asia-Pacific

Rapid urbanization, energy transition, government-led climate initiatives

3,5%

Africa & MEA

Climate adaptation, agriculture, water access, impact investment

Market segmentation by region

Resilience: Climate Prediction for Strategic Decision-making

Resilience is a climate intelligence tool that provides predictions weeks, months and years in advance to support better decision-making to adapt to the strong effects of climate change. The project transforms complex climate data into actionable forecasts that organizations can use to support everyday operations, reduce risk and improve long-term planning.



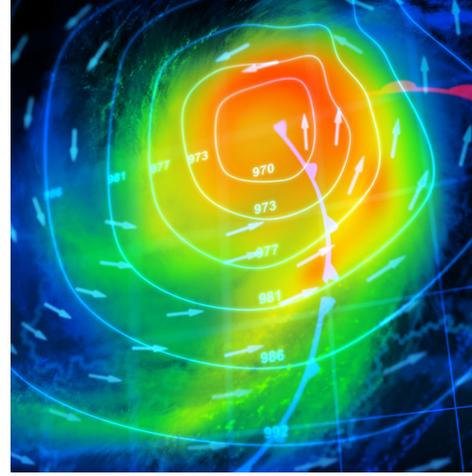
Resilience

Problem

Climate variability and uncertainty have become a major challenge for businesses and public institutions. Weather patterns are changing, traditional seasonality is no longer reliable, and many forecasting methods do not take longer-term climate signals into account. As a result, many organizations plan operations without enough foresight, which increases exposure to risk, inefficiency and waste.

Solution

Resilience provides decision-making support by combining large amounts of climate and environmental data with powerful prediction models. The system collects and curates the relevant data, calibrates prediction models, and evaluates forecasts with both historical and real-time data. Different data sources are then combined and processed to provide information on the time scale and the specific geographical space that users need. Forecasts are delivered through APIs that connect directly to business systems, making it possible to easily integrate climate predictions into daily operations as well as long-term planning processes.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Retail



Energy



Logistics



Sustainability



Climate



Agriculture



Transport or Automotive

Potential Clients

- Big Corporation
- Small Companies
- Governmental Institutions

Predicting climate to support better decisions



Scan QR
and learn more



AI4Land: AI-based Land and Vegetation Mapping to Improve Climate Studies

AI4Land is a project that uses artificial intelligence to generate detailed digital maps of Earth's landscapes and plants. By combining satellite photos and environmental data, the project creates high-resolution representations of how land and ecosystems are structured today and how they can change in the future. These maps help climate scientists understand how the Earth's surface evolves over time and how it influences future climate scenarios.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Sustainability



Climate



Energy



Public Safety



Research



Government



Agriculture

Potential Clients

- General Public
- Governmental Institutions
- Policy Makers
- Academia

Problem

Many climate studies still use static or low-resolution maps of the Earth's surface. These maps fail to portray how landscapes and plants change over time, and they frequently lack the precision required to adequately represent real-world situations. As a result, climate models and carbon cycle forecasts contain significant uncertainty. Without precise and dynamic land information, it is difficult to estimate future climate scenarios and develop effective environmental and mitigation solutions.

Solution

AI4Land addresses this issue by using artificial intelligence to turn low-resolution environmental data into high-definition digital twins of the Earth's surface. The project collects and standardizes data from satellite images, soil parameters, and global climate scenarios, and merges it into a unified digital library designed for large-scale computation. AI models are trained to identify the complex patterns that cause changes in landscapes and vegetation over time. Using this data, the system reconstructs past land conditions and predicts how land use and ecosystems will change in the future, allowing scientists to improve climate models and environmental strategies.

High-resolution digital landscapes give the necessary data to better understand environmental change and build more effective mitigation solutions

RespireAire: Improving Air Quality Analysis Through Artificial Intelligence

RespireAire develops artificial intelligence tools and data resources to improve how air quality is monitored, analyzed and managed. By combining large volumes of observations with advanced AI models and atmospheric simulations, the project provides precise, high-resolution air quality information to benefit public health, environmental research and policy-making.

Problem

Air pollution has major consequences for both human health and ecosystems, but its efficient control is constrained by the limited information used to monitor air pollution and the high computing cost of modern air quality models. Due to the gaps in data, unreliable measurements and expensive simulations, it is difficult to accurately evaluate air quality conditions and design effective mitigation strategies at local and regional scales.

Solution

RespireAire improves how air quality is assessed across Spain by combining air quality measurements, advanced atmospheric models and artificial intelligence. The project starts by collecting and checking monitoring data to ensure it is reliable. Since full atmospheric simulations are computationally expensive, RespireAire trains AI models to approximate the simulations' behavior and produce similar results, much faster. By combining real measurements and fast AI models, RespireAire creates detailed air quality maps and analysis that help authorities and researchers better monitor pollution and plan actions to reduce it.



Status

In research

Functional prototype

Validated in real-world

Target Industries

-  Public Health
-  Research
-  Sustainability
-  Climate

Potential Clients

- General Public
- Policy Makers
- Academia
- Governmental Institutions
- Big Corporation
- Small Companies
- Startups

Better data and AI tools to support cleaner air and informed public decisions



SeasGen: Seasonal Predictions with Generative AI

SeasGen is a project that uses generative artificial intelligence to predict climate conditions one season ahead. By learning from large climate simulation datasets, the system delivers fast and efficient seasonal forecasts that help organizations plan ahead in sectors affected by climate variability.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Climate



Sustainability



Logistics



Agriculture



Energy



Health

Potential Clients

- Big Corporation
- Policy Makers
- Governmental Institutions
- Academia

Problem

Many sectors, such as agriculture, energy, logistics and public planning, depend on knowing how climate conditions may change months in advance. However, current state-of-the-art climate prediction systems rely on traditional numerical models that require very large computing resources. This makes forecasts expensive to run and limits how often they can be produced and used in real operational settings.

Solution

SeasGen tackles this challenge by training generative AI models on large collections of climate simulations. These simulations are collected, cleaned and combined into a unified dataset suitable for deep learning. The AI model learns the patterns that cause seasonal climate anomalies and uses observations of the current climate state to generate predictions for the coming months. The results are presented through intuitive maps and visual summaries, allowing decision-makers to access seasonal climate information quickly and at a fraction of the computational cost of traditional models.

Efficient climate predictions can be made with generative AI methodologies

Alya4Fusion: Nuclear Fusion: A new era of green energy on Earth

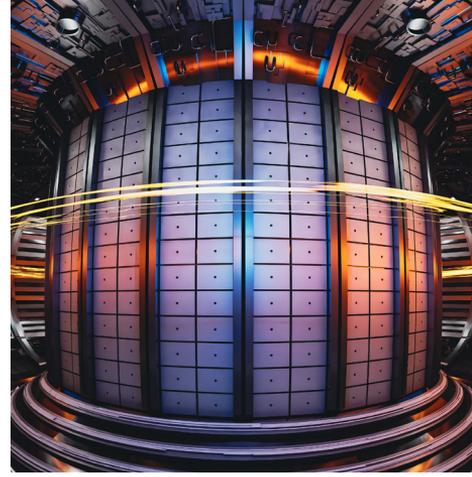
Nuclear fusion is the primary objective for sustainable power, a process that provides a virtually inexhaustible supply of clean energy. Alya4Fusion is a simulation platform designed to help develop nuclear fusion reactors, providing a 3D simulation tool that models both the plasma inside the reactor and the surrounding engineering components. By supporting different reactor designs, Alya4Fusion helps improve reactor performance, safety and durability before physical systems are built, allowing it to iterate fast.

Problem

Developing nuclear fusion reactors is extremely complex, expensive and time-consuming. Building and testing physical prototypes requires large investments and long development cycles. Without advanced simulation tools, it is difficult to test different designs, predict performance and identify potential risks early in the development process.

Solution

Alya4Fusion enables researchers and companies to test and improve fusion reactor designs using computer simulations instead of costly physical experiments. The platform uses detailed physical models to simulate how plasma behaves and how reactor components respond under different operating conditions. These simulations are run on high-performance computing systems, allowing users to explore many design options, evaluate safety and performance and reduce the risks and costs associated with building real reactors.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Energy



Sustainability



Research



Government

Potential Clients

- Startups
- Academia
- Big Corporations building or investing in reactors

Simulating fusion reactors to accelerate clean energy innovation

AI in Agriculture

Agriculture is undergoing a major transformation driven by data, automation and artificial intelligence. Growing demand for food and its traceability, climate variability and pressure on natural resources are pushing the sector to adopt more precise, efficient and resilient approaches.

AI allows farmers, companies and public institutions to move from reactive decisions to predictive and data-driven strategies. By combining data from satellites, sensors, drones and weather models, AI systems can monitor crops, anticipate risks and support better planning across the agricultural value chain.

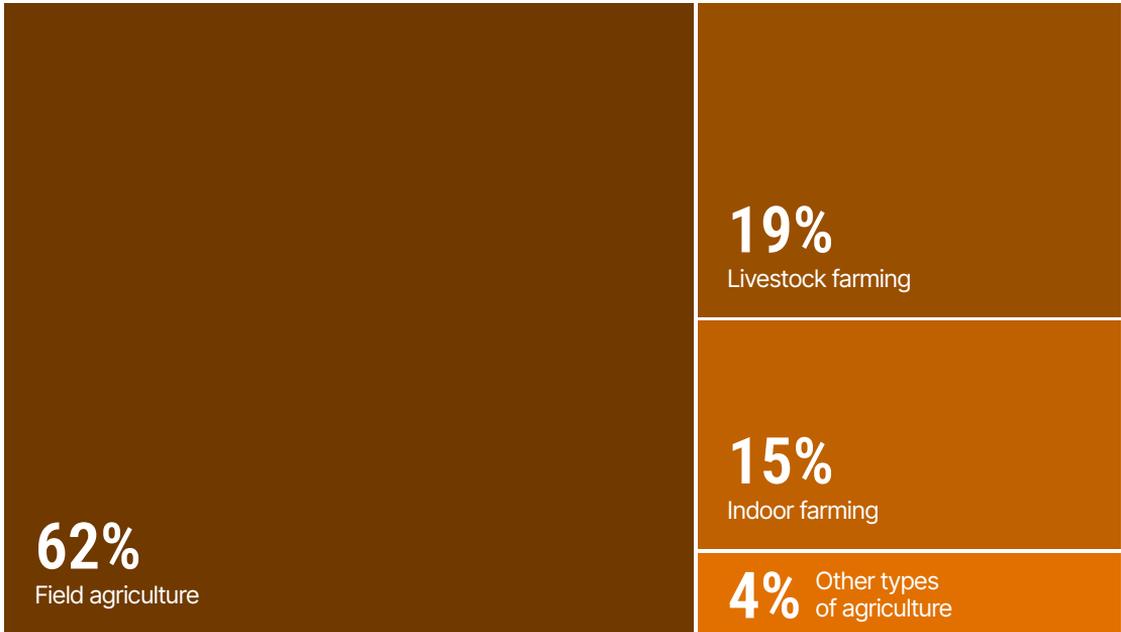
Current applications

	AV	NLP	ML	RPA	Predictive models	IoT sensors	Genetic algorithms
Optimization of intelligent irrigation systems	✓		✓		✓	✓	
Pest and disease detection	✓		✓		✓		
Livestock health monitoring	✓		✓		✓	✓	
Precision agriculture and predictive analysis			✓		✓	✓	
Autonomous agricultural machinery	✓		✓	✓			
Genetic improvement of crops			✓		✓		✓
Optimization of the agricultural supply chain			✓		✓	✓	
Climate-smart agriculture			✓		✓	✓	
Intelligent pesticide application	✓		✓	✓			
Classification of harvested products	✓		✓	✓	✓	✓	

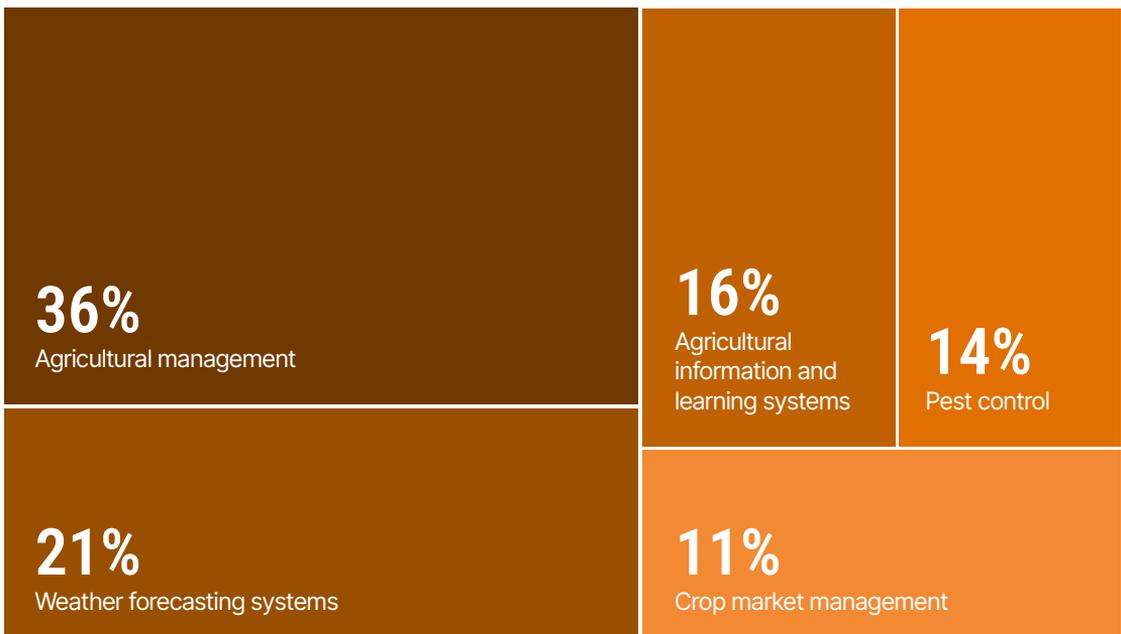
Applications

AI technologies

Market segmentation



By type of crop

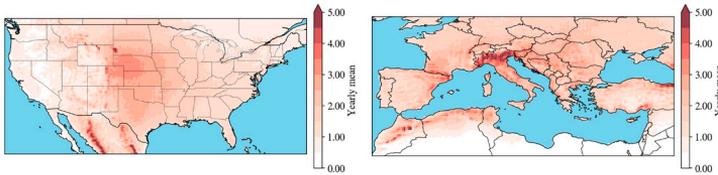


By type of application

HailStorm: Hail Hazard Mapping with Machine Learning

HailStorm is a research project that uses artificial intelligence to better understand where and how often hailstorms occur. By analyzing historical weather data together with reported hail events, the project produces maps that show hailstorm risk across large regions in Europe and the United States. These maps help stakeholders better understand and manage one of the most damaging types of extreme weather.

Average yearly hailstorms 2004-2023

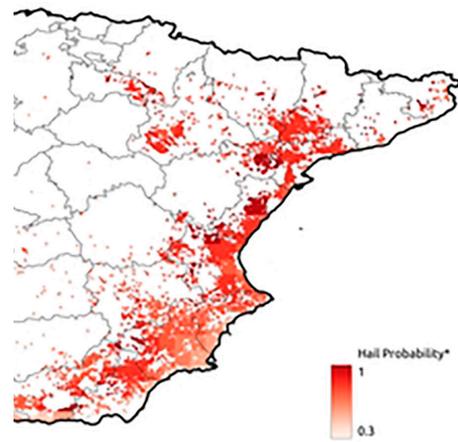


Problem

Hailstorms cause significant damage every year, especially to agriculture, energy infrastructure and insured assets. Despite their high impact, hailstorms are difficult to quantify and predict. They are caused by complicated atmospheric processes, and reliable observations are frequently rare or unevenly distributed, especially across wide geographic areas. The lack of consistent data makes it difficult to estimate risk and create effective mitigation strategies.

Solution

HailStorm addresses this challenge by using machine learning to identify patterns in past weather conditions and reported hail events from Europe and the United States. The AI model is carefully designed, trained and calibrated to recognize the meteorological conditions that cause hail production. Users can select a region and a time period of interest, and the system automatically generates maps and visual summaries showing where and when hailstorms are most likely to occur. This method allows for the creation of consistent and comparable hail risk maps, even in areas with limited observations, thus facilitating better planning and decision-making for agriculture, insurance, and public agencies.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Potential Clients

- General Public
- Small Companies
- Startups
- Big Corporation
- Policy Makers
- Academia
- Governmental Institutions

Hailstorm risk maps allow decision-making for the agriculture industry, insurance, and communities vulnerable to severe weather damage



3DgrainsML: Grain Shape Analysis to Determine Crop Growing Conditions

3DgrainsML is a technology that combines artificial intelligence and high-resolution 3D scanning to study the shape of cereal grains. By analyzing grain shape, the project can determine the environmental and farming conditions under which crops were grown. This provides a non-destructive and low-cost way to study agriculture, climate impacts and food production strategies, using grains that are widely available today and in historical records.

Status

In research

Functional prototype

Validated in real-world

Target Industries

-  Sustainability
-  Biotechnology
-  Research
-  Agriculture
-  Climate
-  Archaeology

Potential Clients

- General Public
- Small Companies
- Startups
- Governmental Institutions
- Academia

Problem

Understanding how crops react to growing conditions such as water availability, soil management and climate is essential for agriculture, sustainability and food quality. However, many existing phenotyping methods are expensive, destructive or difficult to apply at scale. This limits their use in agronomy, food provenance, quality control and long-term studies of past agricultural and climate conditions.

Solution

3DgrainsML combines high-resolution 3D scanning of grains and AI to classify grains according to their growing conditions. Each grain is scanned and digitally aligned so shapes can be compared consistently. The system then translates grain shape into numerical features using mathematical techniques that capture even small differences in form. Machine learning models use these features to classify grains according to growing conditions, such as water use, fertilization practices and climate-related factors. Because the approach does not harm samples, it may be used on both present and historical grain collections, enabling the study of previous agriculture and climate.

Grain shape can be used to learn about climate and food production strategies

AI in Transportation

Transportation systems are under increasing pressure as cities grow, mobility patterns become more complicated and complex logistics demand continues to rise. A growing share of the population now lives in large urban areas, where limited space must be shared by private vehicles, public transport, cyclists and pedestrians. At the same time, sustainability goals, safety regulations and the need to reduce congestion and emissions are forcing transport systems to operate more efficiently and with greater coordination than ever before.

Artificial intelligence is becoming a key enabler in this transformation. AI allows transport operators, manufacturers and public authorities to move beyond static planning and manage mobility in a dynamic, real-time and predictive manner. AI systems optimize traffic flow by merging data from vehicles, sensors, cameras, traffic infrastructure, and logistics platforms. As multiple transport systems increasingly coexist in the same physical space, AI also plays a critical role in improving safety, risk management and decision-making, helping cities and transport networks become more adaptive, resilient and secure.

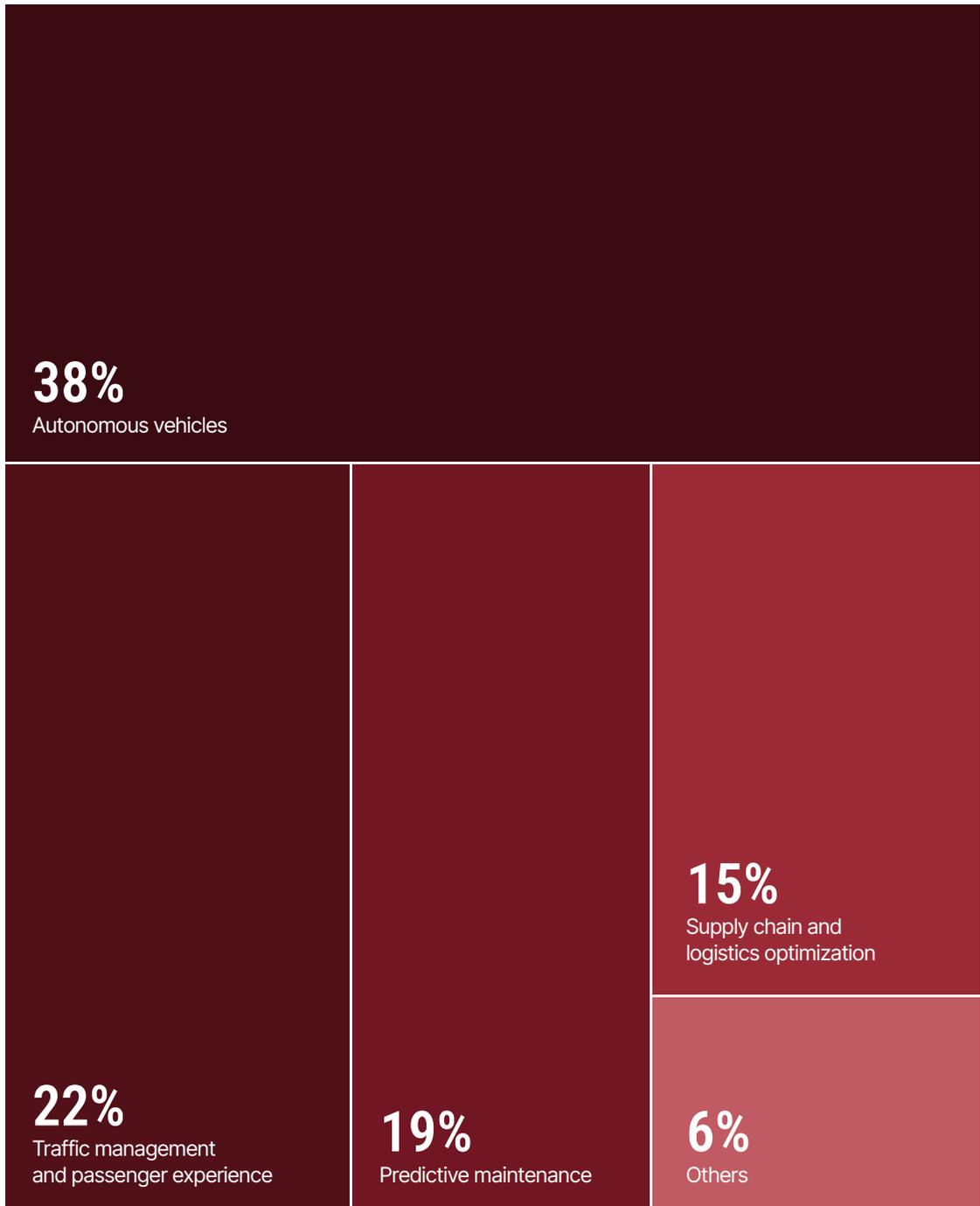
Current applications

	Computer vision	Biometric sensors	Deep neural networks	Optimization algorithms	Predictive analysis	IoT sensors
Monitoring and analysis of driver behavior	✓	✓	✓			
Pattern detection	✓		✓			
Traffic management and smart traffic lights	✓		✓	✓		
Traffic incident detection	✓				✓	
Predictive maintenance	✓		✓		✓	✓
Route and travel time optimization	✓			✓	✓	
Road condition monitoring	✓				✓	✓
Automated license plate recognition	✓		✓			
Smart parking management	✓			✓		✓
Autonomous vehicles	✓		✓		✓	

Applications

AI technologies

Market segmentation



By application type

SafeExplain: Safe and explainable AI for Autonomous Systems

SafeExplain helps organizations use artificial intelligence safely in autonomous systems such as vehicles, robots, satellites and industrial machines. The project provides methods and software tools that allow AI to be integrated into systems where safety is critical, while meeting both regulatory and engineering requirements.



Safe and Explainable
Critical Embedded Systems based on AI

Problem

AI systems are developed very differently from traditional safety-critical software. They learn from data, can behave unpredictably and they often do not follow fixed rules defined in advance. This creates a mismatch with safety-critical development processes, which require strict verification, clear requirements and evidence that systems behave safely in all situations. As a result, using AI in autonomous systems such as cars, aircraft or space missions poses a certain risk if there aren't new methods in place to address these differences.

Solution

SafeExplain provides software technologies that make AI suitable for use in safety-critical autonomous systems by combining explainable AI with built-in safety mechanisms. The approach starts by clearly defining the operating conditions and limits of the AI, then uses this information to guide how data is selected, models are trained and behavior is evaluated. Throughout development, the system is continuously tested and validated to collect evidence of safe and reliable behavior. Safety functions such as monitoring, supervision and redundancy are integrated directly into the system architecture, allowing the AI to detect and respond to unsafe situations at runtime. This combination of explainability, validation and runtime safety enables AI systems to operate reliably in real-world environments while meeting safety and legal requirements.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Transport or Automotive



Aerospace



Industry 4.0



Robotics

Potential Clients

- Big Corporation
- Small Companies
- Startups

AI can be safely deployed in autonomous systems while meeting safety regulations

AI in Public Sectors

Public administrations are increasingly adopting artificial intelligence to improve how decisions are made, how resources are managed and how public services are delivered. The growing volume of administrative data, more complex regulatory environments and rising demands on public systems are pushing governments to look for tools that help them operate more efficiently. At the same time, structural trends such as increased mobility, higher population concentration in urban areas and greater exposure to climate and environmental risks are adding pressure to public services and infrastructure.

In this context, AI supports a shift from reactive to predictive and data-driven governance. By combining administrative records with data from transport, energy, environment, health and real-time sensors, AI systems help public institutions anticipate incidents, plan interventions and allocate resources more effectively. Predictive models are used to improve emergency response, energy and environmental management, and disaster preparedness, while big data analytics and optimization techniques support more efficient management of waste, mobility and urban infrastructure. Together, these capabilities contribute to more resilient, sustainable and transparent public services, particularly in smart city and metropolitan environments.

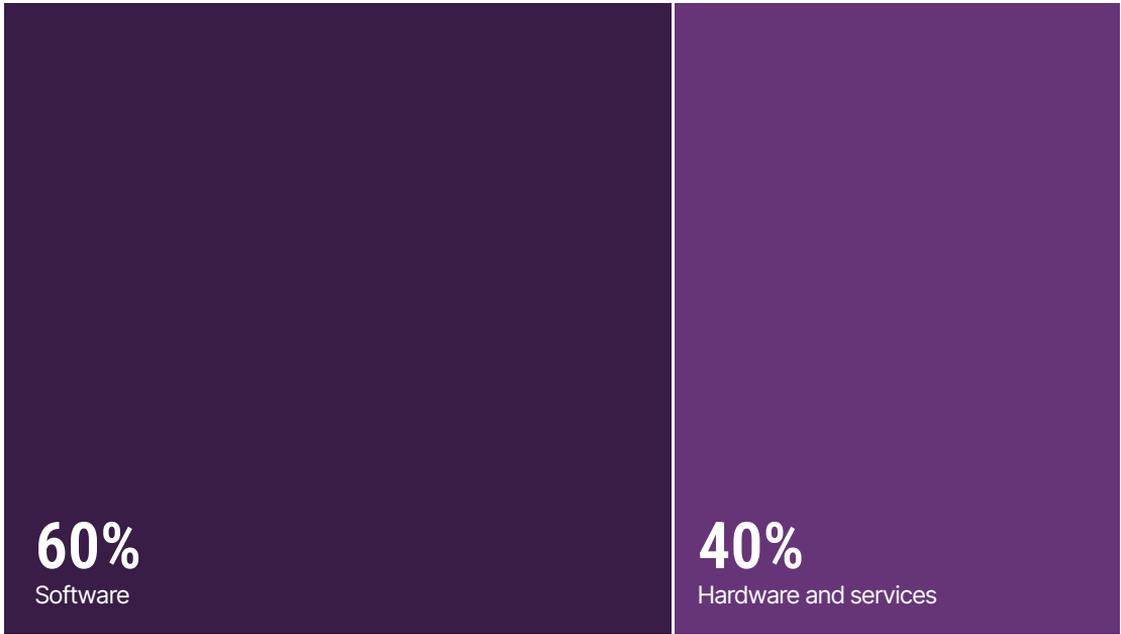
Current applications

	ML	DL	NLP	Generative AI	Computer vision
Detection and Prevention of Fraud	✓				✓
Administrative Process Automation	✓		✓		
Public safety and surveillance	✓	✓			✓
Predictive analysis and risk management	✓				
Automated citizen service			✓	✓	
Public health management	✓				
Cybersecurity and data protection	✓	✓			
Emergency prediction	✓				
Management of critical infrastructures	✓				✓
Monitoring of disinformation and electoral security	✓		✓		

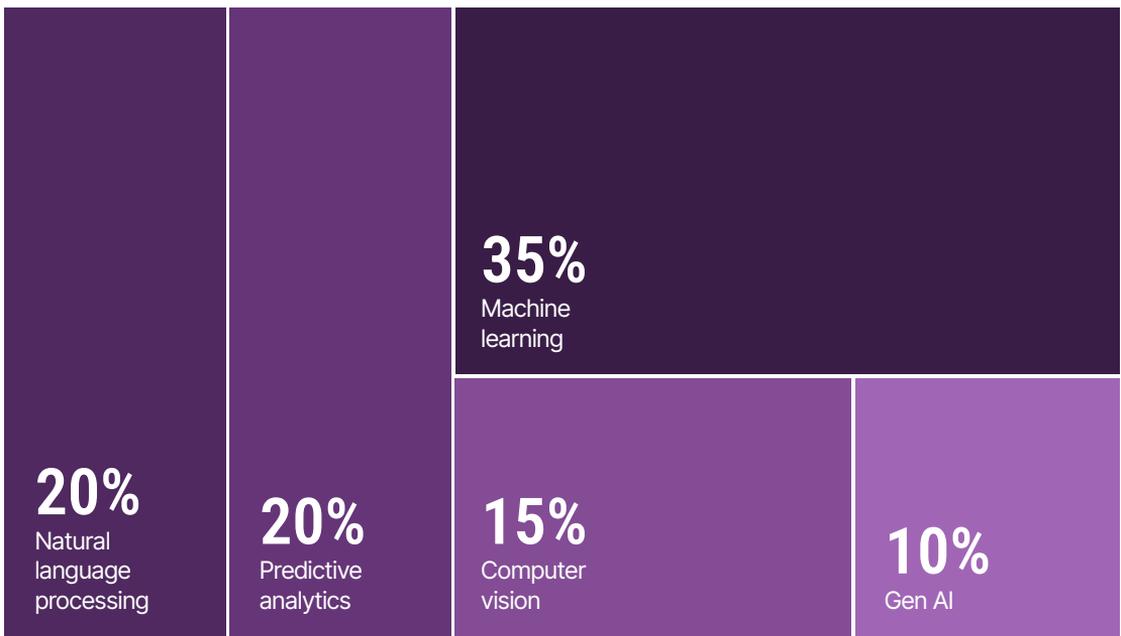
Applications

AI technologies

Market segmentation



By solution type



By technology type

ENDcast: Forecasting Disease Outbreaks Driven by Climate

ENDcast is a climate-driven disease forecasting platform that provides early warnings of infectious disease outbreaks up to six months in advance. The platform assists local, national, and regional decision-makers in anticipating disease risks to plan interventions needed to protect public health.

Problem

Many infectious diseases are strongly influenced by climate conditions such as temperature, rainfall and other large-scale weather patterns. However, health authorities often lack practical tools that translate climate variability into useful disease forecasts. Without early warnings, responses to outbreaks are mostly reactive, which can increase health impacts and translate into additional pressure on public health systems.

Solution

ENDcast estimates disease outbreak risk by combining climate indicators, historical disease data and seasonal patterns within a single modeling framework. The system analyzes climate signals together with geographic and seasonal factors to produce monthly forecasts with an outlook of one to six months. The results are delivered through an interactive web platform where users can explore past disease trends, assess how well the models performed in previous situations and visualize the probability of outbreaks in the coming months.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Climate



Sustainability



Health

Potential Clients

- Big Corporation
- Policy Makers
- Governmental Institutions
- Academia

Turning climate signals into early warnings that help prevent disease outbreaks



MLESmap: AI models to Assess the Impact of Earthquakes

MLESmap is an artificial intelligence-powered system that creates near-real-time maps of earthquake impacts to help with emergency response and disaster management. The project provides quick and accurate maps and graphs on ground shaking right after an earthquake using high-performance computing, physics-based models, and machine learning.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Government



Public Safety



Research



Reinsurance

Potential Clients

- Big Corporation
- Policy Makers
- Governmental Institutions
- Academia

Problem

Earthquakes are one of the most dangerous natural disasters because they are unpredictable. In the minutes following an earthquake, emergency services and civil protection organizations require quick and precise information to determine which areas are most damaged. However, early assessments of earthquake consequences are sometimes unclear or slow, reducing the effectiveness of response activities in the vital early phases.

Solution

MLESmap addresses this challenge by running a large number of realistic, physics-based earthquake simulations ahead of time using high-performance computing. These simulations cover a wide range of earthquake scenarios and are used to train machine learning models that understand the relationship between earthquake characteristics and ground motion. When an actual earthquake happens, the system uses basic event information, such as location and magnitude, to quickly estimate ground acceleration using pre-trained models. This enables decision-makers to receive accurate estimates of shaking strength in near real time, as well as clear maps and visual summaries.

The combination of high-performance computing and Machine Learning improves our ability to understand and respond to natural hazards such as earthquakes in near-real-time

vCity: Urban Digital Twins for Smarter Cities

vCity is a digital platform for creating and managing urban digital twins that enables cities to simulate, analyze, and visualize complex urban scenarios. Developed by the Barcelona Supercomputing Center, the platform integrates data from multiple sources to support evidence-based urban planning and policy making through a comprehensive, data-driven view of the city.

Problem

Cities are facing increasingly complicated challenges with transportation, sustainability, access to public services, environmental quality, and citizen well-being. Decision-making is frequently focused on fragmented data and isolated analysis, making it difficult to comprehend how may affect urban aspects interact and how policies may effect the city as a whole.

Solution

vCity addresses this challenge by providing a multidimensional digital twin of the city that brings together heterogeneous urban data in a single environment. The platform allows users to simulate hypothetical scenarios, analyse interdependencies between urban systems, and visualize outcomes in an intuitive way. The platform follows a human-centric and responsible approach, with an emphasis on transparency, traceability, and auditability of information.



Status

In research

Functional prototype

Validated in real-world

Target Industries



Government



Public Safety



Research

Potential Clients

- Policy Makers
- Governmental Institutions
- Academia

Digital twins allow cities to simulate change and plan smarter, more sustainable futures

AI Infrastructure & Enabling Technologies

As AI systems scale and become embedded in critical services, the focus is shifting from isolated models to the foundations that make AI reliable at scale. The next stage of AI development will be shaped by advances in computing hardware, distributed software architectures, optimization techniques and shared AI resources. The demand for AI-ready infrastructure is accelerating due to larger models, real-time requirements and energy constraints, which pushes innovation in specialized processors, edge-to-cloud coordination and automated optimization of AI workloads. At the same time, language technologies and public AI infrastructures are becoming strategic assets, especially in regions that aim to reduce dependence on external providers and ensure linguistic and cultural representation.

This expansion also presents significant risks that are redefining priorities in the sector. Organizations increasingly identify model inaccuracy, cybersecurity threats, regulatory compliance, explainability and data privacy as important concerns, yet many lack effective mechanisms to address them. As AI influences high-impact decisions, the challenge is no longer just performance, but control, accountability and trust. Future AI infrastructure must therefore embed governance, transparency and efficiency by design, enabling AI systems that are auditable, secure and aligned with societal values. Technologies that support sovereignty, responsible deployment and efficient operation will be essential to turn AI adoption into long-term, sustainable impact.

What is driving AI infrastructure evolution

- Larger models – growing demand for compute and memory
- Distributed AI – edge, cloud and on-device coordination
- Public AI resources – shared models and platforms
- Energy constraints – efficiency and sustainability pressures

What future AI infrastructure must enable

- Efficient execution of AI workloads
- Built-in governance and security
- Scalable and adaptive systems
- Technological independence and openness

Key risks organizations face with AI

	Organization considers risk relevant	Organization working to mitigate risk
Inaccuracy	56	32
Cybersecurity	53	38
Intellectual property infringement	46	25
Regulatory compliance	45	28
Explainability	39	18
Personal/individual privacy	39	20
Workforce/labor displacement	34	13
Equity and fairness	31	16
Organizational reputation	29	16
National security	14	4
Physical safety	11	6
Environmental impact	11	5
Political stability	10	2
None of the above	1	8

Barcelona Zettascale Laboratory: European Chips for AI and Supercomputing

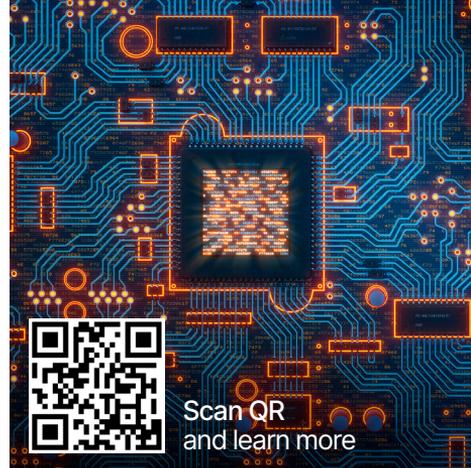
The Barcelona Zettascale Laboratory develops advanced computer chips, designed in Europe, for artificial intelligence and supercomputing. The project focuses on creating and testing new processors based on RISC-V, an open and flexible hardware architecture. These processors are designed to support future European supercomputers and advanced industrial systems, helping Europe build its own high-performance computing technology.

Problem

Europe relies heavily on computer chips designed and manufactured outside the region. This limits control over key aspects such as performance, security and long-term availability. Additionally, there is a lack of local expertise covering the full chip development process, from initial design and testing to manufacturing using the most advanced technologies. This dependency affects not only supercomputing, but also critical areas such as artificial intelligence, autonomous systems and essential digital infrastructure.

Solution

The project addresses this gap by designing processors in-house, focusing on architectures optimized for AI and high-performance computing workloads. The full development process is carried out within Europe, including architecture design, implementation, verification and physical design, followed by fabrication through an industrial partnership with Intel, using Intel 3 and Intel 18A processes. Once manufactured, the chips are brought up, tested and demonstrated in real systems, creating a complete and repeatable pipeline that builds European expertise.



Status

In research

Functional prototype

Validated in real-world

Target Industries

-  Telecommunications & Mobile
-  Transport or Automotive
-  Health
-  Energy
-  Government
-  Research

Potential Clients

- Big Corporation
- Governmental Institutions
- Academia

High-performance computing chips designed in Europe to power the future of AI, academy, government and industry



Scan QR
and learn more



Status

In research

Functional prototype

Validated in real-world

Target Industries



Health



Climate



Transport or Automotive



Agriculture



Industry 4.0



Energy



Public Safety



Logistics



Aerospace



Government

Potential Clients

- Big Corporation
- Small Companies
- Governmental Institutions

Colmena: Self-organizing Software for Efficient Edge and Cloud Operation

COLMENA is a technology that lets many different devices work together as one intelligent, self-organizing system to run applications efficiently and reliably without central control.



Colmena

Problem

Modern digital services run across a mix of edge devices, data centers and cloud platforms. These systems are typically owned and maintained by multiple entities, making cooperation challenging. Developers must work with many complex technologies, operators need to deploy and adapt services efficiently, and infrastructure owners want to keep control over how their devices are used. At the same time, users expect services that are reliable and trustworthy. Managing all this together typically requires specialized expertise, manual intervention and high operational effort.

Solution

COLMENA develops software that converts individual devices into autonomous agents that work together to create a unified computing platform. The system continuously analyzes the performance of deployed services and reacts to changes based on each device's capabilities, ownership limits, and service quality requirements. COLMENA also has built-in methods that help developers coordinate multiple components of an application, reducing complexity and simplifying service operation throughout the edge-to-cloud continuum.

More efficient, robust and cost-effective service operation across edge and cloud is possible without increasing software development complexity

AIRE for Industry: Trustworthy AI Governance for High-risk and Regulated Systems

AIRE for Industry helps organizations use artificial intelligence in situations where mistakes can have serious consequences. These include sectors such as finance, healthcare, mobility and public services. The project supports companies and public institutions by connecting advanced AI techniques with regulation, ethics and governance, making it easier to deploy AI systems responsibly in real-world complex environments.

Problem

Artificial intelligence is increasingly used to automate important decisions that can affect people's lives, finances and safety. In regulated and high-risk sectors, these decisions can carry legal, economic, reputational and social consequences. While AI can improve efficiency and accuracy, many organizations struggle to ensure that their systems are compliant, transparent and trustworthy once deployed. Governance, risk management and ethical considerations are frequently considered separately from the technical systems, making accountability difficult to implement.

Solution

AIRE works with organizations to understand how AI systems are used in practice, which decisions are automated and where technical, legal, ethical and operational risks may arise across the full AI lifecycle. It applies scientific methods such as uncertainty analysis, explainability and causal assessment to identify system limitations, potential failures and decision reliability. These technical results are then translated into clear governance and regulatory guidance, supporting organizations deploy and operate AI systems in a way that is transparent, accountable and aligned with legal and ethical requirements.

The real challenge of AI today is not performance but control, accountability and trust



Status

In research

Functional prototype

Validated in real-world

Target Industries

-  Health
-  Industry 4.0
-  Energy
-  Finance
-  Pharmacology
-  Public Safety
-  Aerospace
-  Transport or Automotive
-  Government
-  Media & Communication
-  Biotechnology

Potential Clients

- Big Corporation
- Small Companies
- Governmental Institutions
- Regulated industry



Cocoon: Using AI to automatically optimize AI

Cocoon is a research project that uses artificial intelligence to automatically optimize other AI systems. Instead of relying on human experts to manually fine-tune code and models, Cocoon combines evolutionary algorithms and AI techniques to make systems such as large language models run faster and more efficiently. This reduces computing time, energy use and operational costs.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Research



All Industries that use big data in their software

Potential Clients

- Big Corporation
- Small Companies
- Startups

Problem

Modern AI models, particularly large language models, require massive computational resources to train and deploy. Optimizing their code and execution is difficult, time-consuming, and typically performed manually by professionals. This reduces performance gains while increasing expenses, energy consumption, and development time.

Solution

Cocoon uses an evolutionary optimization process in which AI systems optimize themselves by automatically exploring, evaluating and refining alternative implementations of code and model components. Starting from a defined optimization goal, the system generates candidate solutions, tests them using a performance evaluation framework, and iteratively improves them based on measured results. This process enables AI models and their deployment pipelines to become faster and more efficient without manual tuning, making advanced AI more scalable and cost-effective.

AI that automatically improves AI performance, efficiency and cost

Public AI Infrastructure: Language Technologies

The Barcelona Supercomputing Center is developing Public AI Infrastructure focused on language technologies including text processing, speech recognition and machine translation. This infrastructure provides open and reusable AI models that can be adopted by different ecosystems, from public institutions to small and medium-sized companies. The models are trained using the MareNostrum 5 supercomputer and built on the expertise of the Language Technologies Lab within BSC AI Institute.

Problem

Most major language models are built and trained primarily in English, giving little support to Spanish co-official languages. This causes challenges for public services, businesses and startups who require solutions that are compatible with local languages, cultural contexts, and legal requirements. In addition, many organizations lack access to affordable AI models adapted to their needs that can be deployed locally.

Solution

The Public AI Infrastructure develops large language models (LLMs) specifically trained with carefully curated data in Spanish and co-official languages. The training process places strong emphasis on reducing bias, addressing ethical concerns and ensuring proper representation of social and cultural values. These models can be integrated into existing systems and deployed either locally or online, enabling broader and more responsible adoption of language AI across different sectors.

Status

In research

Functional prototype

Validated in real-world

Target Industries



Transversal

Potential Clients

- Governmental Institutions
- Startups
- Small Companies

Open language technologies aligned with local languages and values





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