TALAN

Positive innovation

Research and Innovation

Business Report *2024*

Summary

Preface

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PREFACE

We are pleased to present the Talan Group's Research and Innovation Annual Report 2023. As a consulting firm specialising in innovation, our mission is to support our customers in their digital transformation by prioritising sustainable, durable and ethical solutions.

We are convinced that research and innovation are essential for achieving these objectives. We also firmly believe that sustainability and social responsibility are crucial elements in the adoption of technologies such as Artificial Intelligence.

This Annual Report 2023 provides an overview of our achievements and prospects, confirming these convictions.2023 was marked by growing interest in the market for Generative Artificial Intelligence. In response to our customers' expectations and questions, we have extended the research we began in 2022 in this field. In particular, we have deepened our understanding of the ethical issues involved, developed objective evaluation techniques, and worked to identify and reduce the biases inherentin this AI.

In order to link our research work to real-life issues, we have also continued our studies into AI use cases and their impact. For example, we contributed to the national debate on the remuneration of right-holders when their content is used to train AIs. We are also aware of the need to use digital technologies sensibly, so we keep a constant watch and conduct projects to assess their environmental impact. These efforts have enabled us to increase the number of articles we publish in scientific and mainstream journals and conferences. This recognition illustrates our ability to produce significant results for the scientific community and beyond.

Lastly, we have submitted our organisation and our research approach to the European Commission to achieve its European Human Resources Strategy for Researchers (HRS4R) accreditation. This label, based on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, will recognise the excellence of our working conditions and the career development possibilities we offer our Research teams. We hope to obtain this official recognition in 2024.

Thank you for your interest in our work. We invite you to explore the pages of this report to learn the details of our commitment to research and innovation.

Nicolas RECAPET
Group Executive VP HR, CSR & Transformation

Laurent CERVONI
Research and Innovation Director

Introduction

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A. OBJECTIVES OF THE ANNUAL REPORT

Innovation and research are central elements of the Talan Group's DNA. In 2019, Talan concretised this value by creating its own Research and Innovation Centre. The Centre's mission is to encourage and support the group's technological and methodological initiatives, particularly in the fields of digital transformation, artificial intelligence, and data processing, as well as the environmental and societal impacts of the associated technologies. Its role consists in anticipating technological developments and enabling Talan to build new products that have a positive impact on society in the broadest sense. The Research and Innovation Centre focuses its actions on two main areas:

- Deploying and guiding technological projects by facilitating collaboration between Group entities and allocating the necessary human and financial resources. Our Research teams work with a wide range of academic and private-sector partners, particularly on issues intended to protect the environment and provide useful solutions for our customers and society as a whole.

- Advancing research and disseminating knowledge, particularly through an open source approach: our research projects are published in scientific articles and specialised journals.

This shows the Talan Group's ability to develop a differentiating product offering for its customers, taking into account current social and environmental changes.

In this annual report, we will present the following:

1/ Talan's Research and Innovation vision, along with a summary of the past year's achievements.

2/ The strategic objectives we have set ourselves for the current year and for the longer term, as well as a summary of the means used to achieve them.

3/ The organisation of the group's Research and Innovation teams, their working methods, the links between the various entities involved, and their roles in achieving the objectives.

4/ Details of the group's collaborations and partnerships and their nature.

5/ Publications (scientific or otherwise) our researchers published during the year and the context of their distribution.

6/ Events organised by the research teams, including "Research Tuesdays".

This report provides a comprehensive view of our objectives and how we have achieved them, highlighting both our commitment to research and our ability to meet the needs of our customers and the scientific community.

B. Our Research and Innovation teams

The group's research activities are mainly led by its Research and Innovation Centre, whose management is based in France. However, Research and Innovation also operates in the various countries where Talan is located, with dedicated teams in Belgium, Canada, and Tunisia.

1/ The Talan Research and Innovation Centre

The Talan Research and Innovation Centre was created in 2019 under the leadership of Dr. Laurent Cervoni. It is known for its outstanding multidisciplinary approach in cutting-edge fields such as Digital Transformation, Artificial Intelligence, Big Data, and the impact these technologies and the resulting changes have upon society. Drawing on the expertise of PhDs from a wide range of disciplines, the Centre is a literal melting-pot of innovation, working to improve and enhance the group's offerings.

Its objectives are consistent with Talan's CSR approach and commitments by focusing on environmentally responsible initiatives, reducing the digital divide and paying particular attention to the human factor. Consequently, the Centre is making its own contribution to forging a better, more sustainable future for everyone.

2/ Dataroots

Dataroots, a Talan Group subsidiary, specialises in end-to-end data solutions and is known for its expertise in artificial intelligence and cutting-edge technologies.

Its mission is to deliver unrivalled data-driven solutions built to have a long-lasting business impact for its customers. Actively contributing to numerous applied R&D projects, Dataroots ensures that its consultants have cutting-edge expertise in machine learning, AI and cloud technologies. Dataroots is also known for its commitment to AI4Good initiatives such as tracking the carbon footprint of cloud computing, monitoring the swarming of bees to prevent their death and creating federated learning platforms for analysing medical data..

3/ Talan Tunisia

Talan Tunisia is the group's nearshore development centre with more than 500 engineers from the best Tunisian and European engineering schools, all specialising in new technologies. It concentrates on fields such as artificial intelligence, blockchain, the cloud, and intelligent automation. The Tunisian team contributes to the group's innovation activities in projects including ones involving Generative Artificial Intelligence, the Metaverse, and Blockchain, led by Imen Ayari. The Centre's innovation team also organises or participates in events such as the Talan Global Hackathon and the Talan Summer Camp 2023, the third edition of which was on the theme of "Technolgical innovation as a lever for sustainable development". In 2023, it mainly published studies on blockchain (ICMLC 2023) and artificial intelligence (TRAMI 2023)..

4/ Talan Canada, INSUM & Createch

Createch is part of the Talan Group and renowned for its innovative simulation, space and process optimisation and virtual environment solutions. The Canadian company joined the group in 2022, combining the group's expertise with its own supply chain to deliver innovative and complex projects.

Createch's mission is to deliver cutting-edge technological solutions that perfectly match the requirements of its customers while also adopting a sustainable development and social responsibility approach.

Talan Canada's teams also include Insum, an Oracle solutions specialist. Both these Talan Canada business units offer companies their applied research expertise..

KEY FIGURES 2023

13 000 Days of research

37 Research publications

30 Current projects

12 PhDs recruited

Comparison 2022

11 000	27	22	10

To date, Talan's research teams include more than 40 PhDs throughout the group, 12 of whom were recruited in 2023 to join the Research and Innovation Centre. Talan promotes diversity and parity, with an equal gender balance and a workforce comprising more than eight different nationalities.

Strategic orientations

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A. Talan's Research and Innovation vision

The mission of the Research Centre and, more generally, the Research business it supports is to contribute to the group's global strategy along four main lines:

Helping increase added value.

- R&D projects are based on customer expectations and anticipate market developments.
- The projects are led by PhDs with at least three years of field experience in applied research who are then assigned to operational missions.

Instilling confidence in the technology and solutions the group offers customers.

- The tools, methods, and approaches Talan offers have all been tested, validated, and evaluated in its research and innovation projects.
- Talan's teams develop proofs of concept in synergy with customer use cases.

Dynamising Talan's teams and offerings

- Several hundred employees participate in research projects, acquiring new technical and methodological skills in the process.
- The Research and Innovation teams regularly contributes their work to the group's offerings.

Strengthening the group's positioning

- The group boosts its visibility through publications in conferences and peer-reviewed journals.
- Partnerships with publishers and the academic world enable us to keep a constant watch on technical and methodological developments.

The group's work is structured around three areas of research:

- Technology, mainly in artificial intelligence and all data processing and management approaches.
- The human and managerial dimension.
- The environment and the impact of technology.

RESEARCH AND INNOVATION CENTRE ADDED VALUE MODEL IN SYNERGY WITH THE TALAN GROUP

Helping increase perceived added value

Create R&D projects based on customer expectations and demonstrating Talan's expertise

Recruit graduates with 8 to 10 years'higher education (and three years of applied research experience)

Assignment deployment after 12 months

Building trust in technology

Validate technologies or methods prior to their deployment with customers

Building synergies between R&D projects and customer projects

Strengthening the group's positioning

Enable the group to anticipate technologies and methods

Publishing at international conferences

Establish partnerships with academic institutions or publishers

Dynamising Talan's teams and offerings

Increase the skills of employees when they are between contracts by integrating them into research projects

Improve or create new in-house offerings with commercial potential

1. Artificial intelligence and data processing and data management technologies

This area of research is crucial for the group and its customers. These technologies are central to industrial and societal change, transforming operations, business models, and markets rapidly and profoundly. By focusing on these areas, Talan can develop innovative solutions that exactly meet our customers' needs while anticipating future trends. These research projects enable us to propose cutting-edge strategies that optimise business processes and generate significant competitive advantage for our customers.

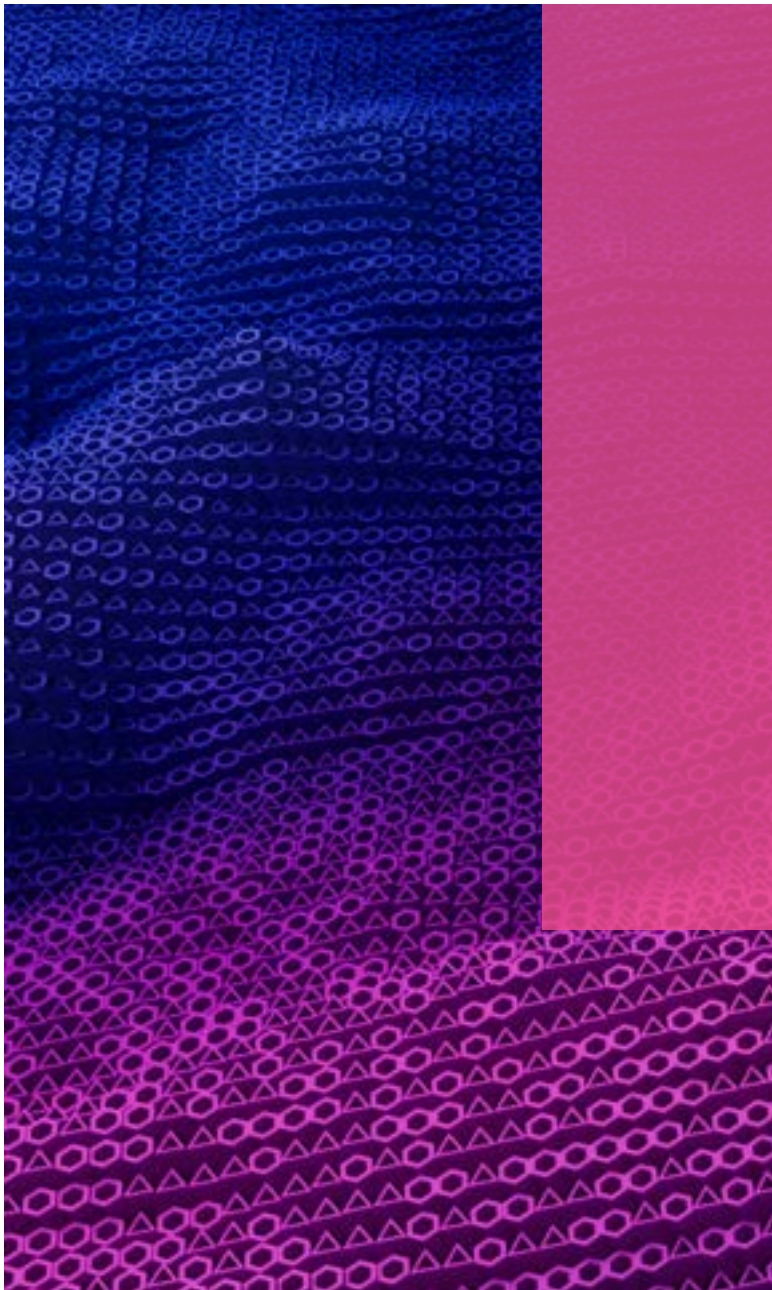
We conduct research and monitoring simultaneously on mature technologies (symbolic AI and digital AI), on developing technologies (such as generative AI), and on emerging approaches (hybrid AI, frugal AI, etc.)..

2. The human and managerial-dimension

Research into the human and managerial aspects is equally essential for a consulting firm specialising in digital transformation, such as Talan. This ensures that the technological innovations are adopted and integrated into organisations effectively. By better understanding the dynamics of organisational change, cultural resistance and the skills needed, we can help our customers to integrate technology-led change more effectively, ensuring that new technologies are deployed in a way that maximises employee commitment and improves internal collaboration. As a result, digital transformations become not only technically possible, but also socially and humanly feasible and acceptable.

3. The environment

Lastly, the fact that we include the environmental impact of these technologies in our R&D approach confirms our desire to take corporate social responsibility into account, including in the technological field. For Talan, conducting research in this area helps to understand and mitigate the potential negative effects of the technologies on the environment and human organisations. This approach can lead to innovations that promote sustainability, such as the development of energy-efficient solutions or reducing the carbon footprint of the technologies being deployed. By integrating sustainability into its proposals, Talan can not only meet growing regulatory requirements but also answer customers' concerns regarding ecology, environmental protection, and their social and societal responsibilities.



B. Summary of 2023

In 2023, the group continued to work on several research projects launched in 2022 and confirm its convictions, particularly regarding changes in certain emerging technologies or technologies adopted by the market. Our work on Large Language Models (LLMs), for example, provides a better understanding (and so, explanation) of their limitations, relevant use cases, and intrinsic weaknesses. We have looked at ways of complementing these algorithms to improve them and make interactions with them more reliable. In addition, we have continued our drive to promote less resource-intensive technologies, since LLMs and their bulky training databases consume large amounts of energy. Lastly, in view of the many generative AI tools and players now available, we have begun a process to evaluate these techniques.

The Research Centre has also offered training-courses on generative AI for the entire group since 2023, highlighting use cases and implementation examples. In summary, the key research projects for 2023 include the following:

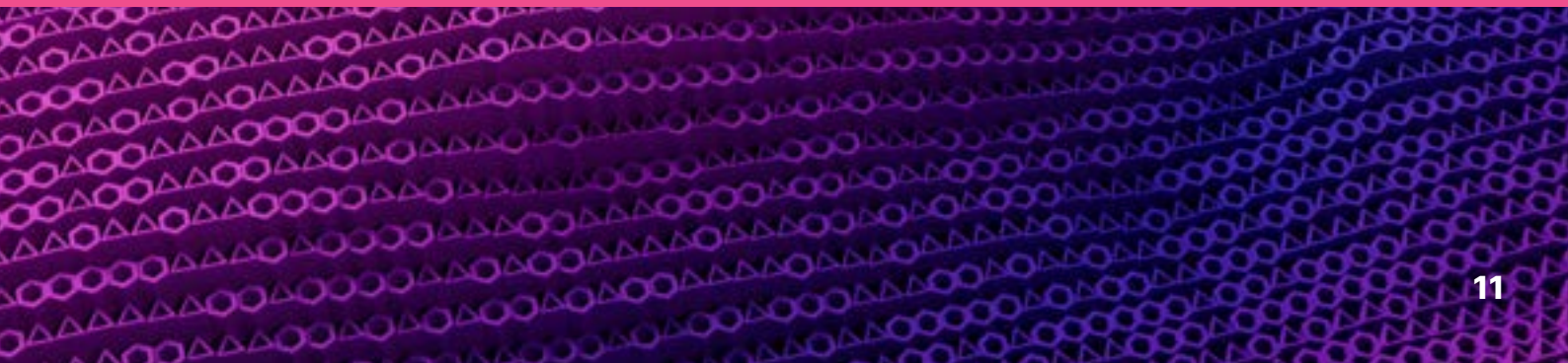
Generative Artificial Intelligence: As we said in our previous report, Talan launched several projects in 2022 implementing Generative AI techniques. We continued this work in 2023 with experiments on Large Language Models, multimodal generative AI, and their impact on businesses and organisations.

Advanced data processing: Synthetic data and data visualisation have been central to major research projects, answering the questions and expectations of customers needing to handle large quantities of important and/or sensitive data.

Artificial Intelligence in combating money laundering and preventing fraud: This use case examined the contribution of AI to fighting this global scourge and suggested ways of implementing innovative solutions.

The environment: We have continued to examine the impact of technology on the world around us and the way in which climate change is factored into corporate strategies.

In mid-2023, we also published our first business report on 2022. This report reflects our commitment to quality research and sustainable innovation. It provides an overview of our achievements and our prospects for the future. The year has seen us strengthen our Research teams and produce an unprecedented number of publications in recognised journals and conferences, and 2023 has shown we can produce recognised results by providing inspiration that makes a pragmatic contribution to the entire Talan Group ecosystem.



C. Objectives for 2024

In 2024, the Talan Group intends to further strengthen its research and innovation efforts. The group plans to significantly increase the number of days devoted to research, intensify its policy of recruiting highly qualified people to enrich its R&D team, and improve its integration of the innovations it develops into solutions it offers customers. The BUs will recruit PhD graduates to encourage the dissemination of research methods across all the group's entities. We will continue to focus on projects studying the impact of generative AI, business transformation, ways of limiting the emissions generated by the technologies, and ethical issues. To maintain an objective perspective detached from the effects of fashion, our research team is looking beyond generative AI by pursuing its analysis of hybrid and multimodal AI and by adopting a frugal approach whenever possible. Talan plans to expand its strategic partnerships with academic institutions and publishers. These actions are intended to strengthen Talan's strategic position and promote a culture of continuous innovation within the group.

D. Strategies for achieving objectives

To achieve its objectives, the Centre regularly recruits 'young PhDs' for a year's "post-doctorate" work and welcomes PhD students writing their thesis at the Centre on projects defined in agreement with the group's entities.

Over the course of this year, the PhDs and PhD students manage research projects with the objective of proposing innovative solutions matching market expectations. In these projects, 'young PhDs' manage group employees (not necessarily PhD holders), publish articles and ensure that the projects go smoothly from their design through to their end. At the end of this year, the PhDs recruited by the Centre will join the group's various entities and so bring their expertise.

In line with the group's purpose, the Research Centre promotes the dissemination of knowledge and, in particular, the results of its research work. Consequently, it has proposed a charter on the use of "open-source" tools. This charter was published in 2022 and is available to all group employees alongside our other recommendations on the use of digital tools.

The Centre also developed a research charter in 2022 to define the doctrine and principles applied to it. Among other things, this charter ensures the freedom of researchers to conduct research, along with their security and independence. It also confirms the special status of researchers, notably by providing for the implementation of the resources needed for the research to be conducted properly.

This charter forms part of the best practices recommended at the European level. It was distributed to everyone involved in research in 2023.

Reserch and innovation projects in 2023

04

Generative Artificial Intelligence (GenAI)

2023 was notable for the emergence of tools and assistants based on generative artificial intelligence (GenAI). GenAI is a branch of AI that specialises in creating new, original content such as text, images, music or voice from existing data. It opens up new opportunities for innovation, creativity, and business transformation, motivating Talan to explore and integrate this technology in various fields and sectors.

Three international Talan divisions have been particularly active in utilising GenAI. In France, the Research and Innovation Centre has focused on developing prototypes and studying the impact of generative AI on Talan's activities. In Belgium, Dataroots has explored the use of GenAI in an MLOps-based operational approach.

Talan Tunisia has developed several platforms for improving operational efficiency. The GenAI models that attracted most of the Centre's attention in 2023 were the large language models (abbreviated to LLM). The most popular models are GPT (OpenAI), LLaMA (Meta), Bard then Gemini (Google), and Mistral (MistralAI).

Initially, the Research and Innovation Centre studied the use of LLMs for the automatic extraction of information to create structured databases that can be queried more easily. **RFP Analyzer** is a tool that analyses requests for proposals in order to help draft the group's replies by providing easier access to information within Talan and ensuring they are consistently of high quality. **LexBrain** is a new-generation legal assistant designed specifically for Talan's counsels. This tool transforms natural language queries into usable legal information. The assistant instantly extracts crucial details on European regulations, directives and decisions affecting customer companies while citing its sources. **Talan Seeker** helps managers and salespeople to search for candidate profiles within Talan CVs, whatever their format. The three tools described are mock-ups currently being developed into Talan internal tools.

However, developing these tools based on LLMs and other forms of GenAI involves a challenge: evaluating them. Currently, LLMs are mainly developed to perform better than previous models on evaluation benchmarks, restricting the improvements made to the benchmark areas. Other shortcomings of this approach include the simplistic aggregation of results in leaderboards and the outdated fixed benchmarks. Consequently, the **EvalLLM** project aims to rethink the LLM evaluation approach by identifying new relevant tasks, designing benchmarks based on criteria sometimes neglected yet fundamental for users, such as energy consumption and ethics, developing upgradeable methods to eliminate obsolescence and creating benchmarks that reflect actual corporate use of LLMs. LLMs can be useful for development tasks because they share many similarities with natural language in terms of complexity and structure.

However, the objectives of writing code are different from those of composing text. The evaluation criteria currently used to evaluate code generation tools are partly inherited from NLP (Natural Language Processing) and do not take into account some key aspects of software development. The aim of the IAGen4Dev project is to develop an automated standard for evaluating the quality of AI-generated code, going beyond very simple criteria such as the result's accuracy and semantic closeness to code generated by developers.

In parallel, **the Porthos** project aims to study the impact of ChatGPT on idea creativity during brainstorming sessions. To provide a scientific answer to this question, a series of experiments was conducted in 2023 in which around thirty employees were asked to propose ideas for solving a problem with or without using chatGPT.

"The IAG opens up new opportunities for innovation, creativity, and business transformation, motivating Talan to explore and integrate this technology across various fields and industries."

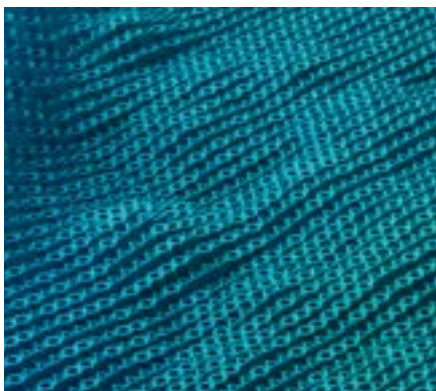
Generative AI is becoming increasingly powerful for generating text and images, and it is also emerging as an effective catalyst for digital transformation. Some progress is still needed in understanding a scene, however, to improve object segmentation and better understand the physical relationships between objects and the image's context. Implementing multimodal capabilities is one of the favoured future lines of development in generative AI. Certain pre-trained models, such as GPT4, already show multimodal capabilities. The multimodal AI project aims to explore the performance gains offered by existing **multimodal AI** and its potential applications. In a collaboration with a board game publisher/distributor, we are developing a GPT4-based chatbot capable of providing players with illustrated answers to help them understand the game rules, with photos of the boards and the strategies to use. Dataroots has explored the use of generative Artificial Intelligence (GenAI), and particularly LLMs, for integration into MLOps processes. The Automatic Spark Pipeline Testing with GenAI project aims to automate the generation of tests for **Spark pipelines by using GenAI**, with the aim of simplifying and accelerating the data pipeline validation and deployment process through the use of AI. In addition, the **AIDEN** (AI Driven Knowledge Enhanced Navigator) project aims to optimise information searches using a chatbot designed specifically for answering questions regarding human resources.

Talan Tunisia's AI teams have proposed several initiatives such as Lynx, TenderGen and RGate to meet certain recurring challenges.

The first, **Lynx**, is a platform that uses generative AI to fully automate internship management and optimise the process from start to finish. This solution includes an intern application tracking system that simplifies the evaluation of applications, as well as an intelligent matching mechanism – also based on generative AI – that enables students to be efficiently matched with available internships and offered the most suitable subjects.

Another platform, **TenderGen**, is designed to rapidly analyse frequently large and time-sensitive tender documents. TenderGen features a number of key functions: semantic extraction of information, conversational interaction with the content of calls for tender, multimodal information retrieval, generation of replies and content for reply packs, and Open API credit consumption tracking by call.

In addition to these platforms, Talan Tunisia's AI team has developed an innovative rights and access management solution. **RGATE** is a role-based management system designed for integration upstream of any generic AI model to ensure confidentiality and compliance with role-specific access rights, making the use of AI models more accessible and secure through the generation of simple prompts.



Artificial Intelligence Data processing

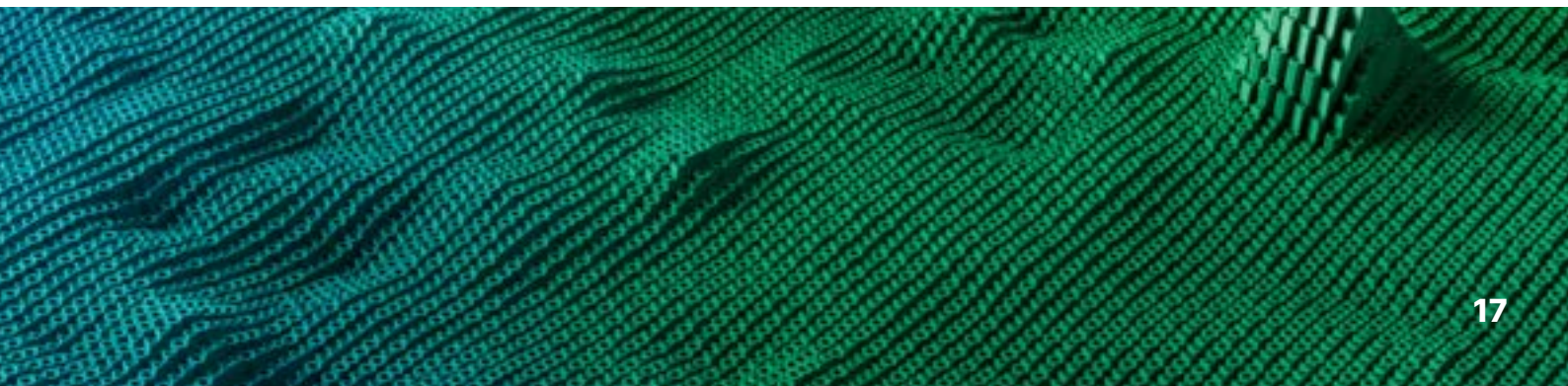
Artificial intelligence has undergone a major change in recent years with the arrival of generative AI. Nevertheless, the more traditional methods of artificial intelligence and data science are still highly useful in solving complex problems and creating value from data. They offer opportunities for developing useful creative applications in various sectors and provide levers for digital transformation and a competitive edge for businesses. At Talan, we are well aware of these advantages and strive to direct our research and innovation efforts towards these ambitions.

The **AI and Neuroscience** project aims to draw inspiration from the cognitive sciences and the computation performed by biological neural networks to identify new learning approaches for use in artificial neural networks. In seeking to improve deep learning, this project is investigating potential all-pervasive improvements. Several of the Centre's projects also highlight the application of AI in specific areas of businesses. The AI and Social Networks study seeks to use machine learning techniques to predict the popularity of Talan's communications with the aim of optimising their impact on the group's reputation. Our AI and budget forecasting project explores the possibility of making budget corrections or forecasts for a group entity from year N to year N+1, using AI techniques.

We are also convinced that AI can be extremely useful in the security and risk prevention fields. Consequently, we worked on two projects: **AI and Cybersecurity**, which aims to develop a machine learning model capable of detecting malicious URLs and so protect businesses better against external attacks, and **AI and Anti-Money Laundering**, which uses AI algorithms to detect money-laundering activities. These two projects are based on our Artificial Intelligence expertise and aim to reinforce security measures for the benefit of our environment and that of our customers.

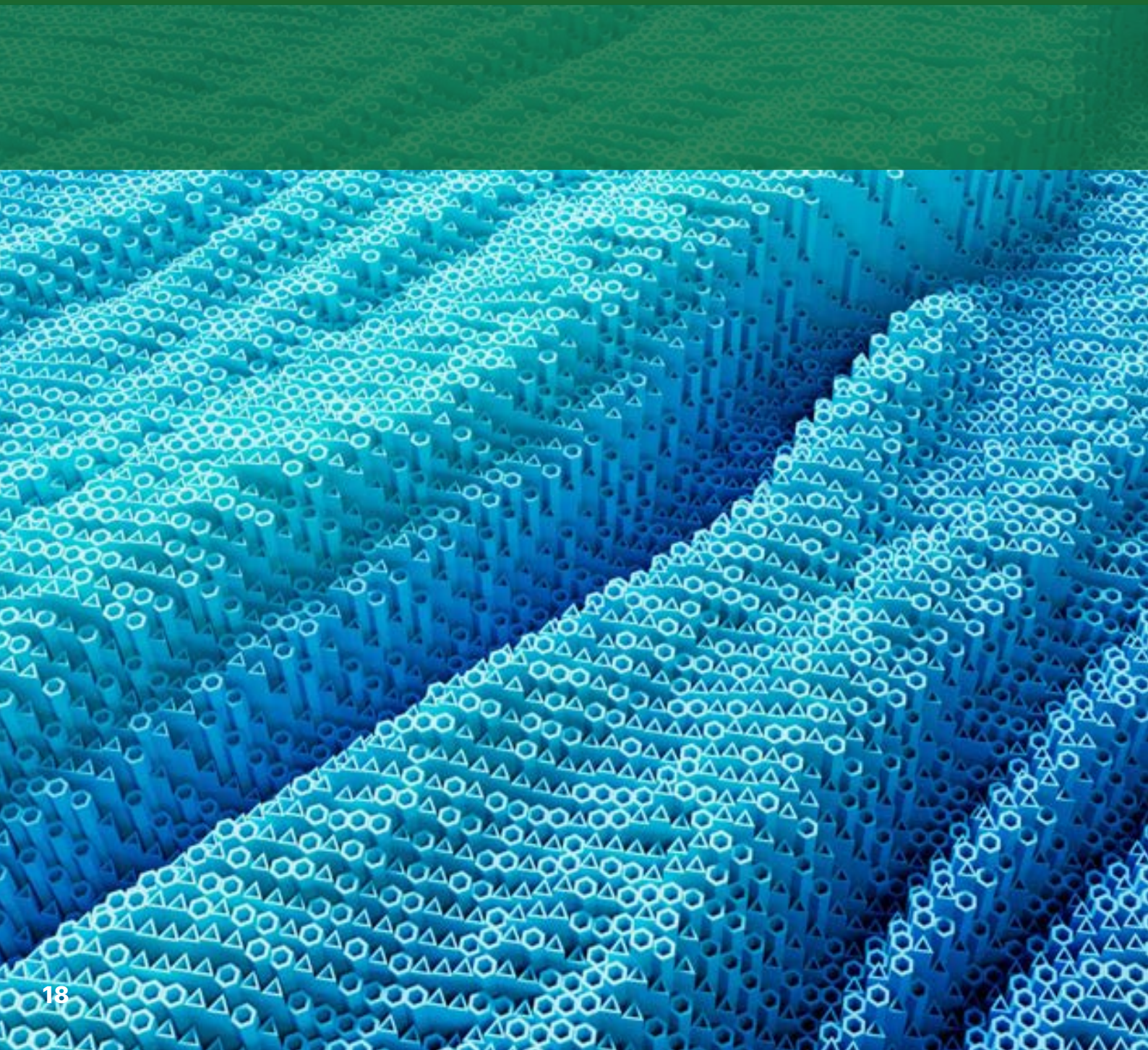
Talan's teams are also involved in computer vision, a fundamental area of artificial intelligence. Our Dataroots teams are working on two such projects in particular. The first, **CHIP**, aims to develop a high-performance model using computer vision methods to detect chip fabrication defects and so help chip manufacturers with their quality processes.

The second, **Farad2Sort**, aims to support this initiative by developing a framework for automating, simplifying and accelerating the deployment and monitoring of computer vision models directly on data capture tools. This highly innovative project could significantly benefit production lines in all industries.



Lastly, other projects are exploring many other possibilities, in terms of both data visualisation and algorithm research. This is particularly true of the Synthetic Data project, which is investigating the possibility of using a synthetic data generator to generate data supposed to capture the properties of real data without reproducing them as an alternative to long-term data retention, restricted by the GDPR. The Data Quality project, for its part, is proposing to develop an interface providing real-time visibility of the reliability of the information being handled, to help companies make informed decisions.

Next, the Dataviz project aims to better evaluate data visualisation techniques in order to develop a generative AI model capable of suggesting relevant visuals. Lastly, we should also mention the Whitebox project, which is intended to propose approaches and techniques that improve the explainability of AI models to ensure trust in these models, make user adoption easier and enable potential errors to be detected and corrected, thereby providing support for all the other projects. All these projects increase Talan's expertise in the key field of artificial intelligence and data science.



Management and Corporate organisation

Innovation and the organisation

It is vital for businesses to innovate as this enables them to maintain their competitive advantage, satisfy the constantly changing needs of their customers and adapt to market changes. Consequently, the Research Centre is interested in the link between the corporate organisation and internal innovations. Among other things, we are studying Talan's communities to see how they organise themselves and support innovative projects.

Caring leadership

The aim of this CIFRE ("Industrial Agreements for Training through Research") PhD thesis is to define caring leadership in a hybrid working context, i.e. alternating between face-to-face and remote working. It utilises a mixed methodology. Firstly, employee perceptions of caring leadership are characterised by means of interviews. Secondly, a quantitative methodology is used to develop and validate a psychometric scale. This tool will be used in quantitative analyses of the impact of caring leadership on other organisational variables.

Cultural transformation and climate change

In the face of climate change, companies are adapting, changing their business models and anticipating changes in their markets. Talan is interested in these changes and the consequences for companies based on several criteria. We are supplementing our knowledge on this subject by organising interviews that we combine with academic research. The purpose of this project is to be able to propose a model that can suggest adaptation strategies based on a company's characteristics. This project is correlated with the sustainable model project.

Turnover commitment and weak signals

Based on the resources-work requests model, the aim of this research is to identify the factors causing employees to be committed to their work and those encouraging them to leave. This involves doing a cluster analysis (latent profiles) to identify and compare typical profiles. An industrial R&D partnership was signed with the Consumer and Digital branch of the La Poste group on 12 April 2023.

Environmental and societal issues

The environment is a key subject for Talan, as it represents a major issue for the future of the planet and mankind. The environment is also a key subject for Talan because it represents a major issue for the future of our society. Talan wishes to be a responsible player committed to sustainable development, reducing its environmental impact and supporting its customers in their ecological transition. Talan also encourages innovation and creativity among its employees, who propose original, effective technological solutions in response to environmental issues. To support moves to combat climate change and ecological disruption, Talan's Research and Innovation teams also focus on environmental projects.

Firstly, some projects propose innovative ideas for creating tools enabling people to directly monitor and reduce their carbon footprint, mostly in the form of apps. For example, the TEFO project and its "My Carbon Footprint" application developed by the Research and Innovation Centre enables our employees to calculate the carbon impact of their business travel. Similarly, the HOPE project, also developed by our Research and Innovation Centre, aims to estimate the carbon impact of Talan employee assignments, the group's main business activity. This application, a response to growing customer demands, uses our tenders and the information they contain to estimate the amount of CO2 emitted during the assignment.

Talan Tunisia's teams too are working on innovative platforms. **MyCarbon Check** makes it easy for a person to track and calculate their carbon footprint via a multimodal conversational assistant (text and audio) powered by generative AI. It organises challenges and shares best practices, enabling its users to improve their scores.

Similarly, **LeafSpace** is investigating the gamification of the problem to raise awareness and help employees adopt sustainable and responsible practices through the combined use of augmented reality and artificial intelligence.

The teams are also working on applying the most advanced algorithmic and artificial intelligence techniques to environmental protection. For example, the Dataroots teams are developing the **IOBees** project, an automatic system for detecting early swarming of bees, a phenomenon potentially resulting in their death, to assist beekeepers. Also at Dataroots, the **Cloud Carbon Footprint Tracking** project estimates the Carbon Footprint of cloud computing for Talan's projects, providing an accurate picture of the impact of the group's activities and those of its customers.

Next, since effective sustainable development is as much about the environment as it is about the economy, Talan Tunisia's teams have been working on the **Joud** project, the aim of which is to explore the use of NFT technologies to design a more environmentally friendly online market platform. The Dataroots teams have also proposed an innovative solution, **Automatic Trading Bot for Energies**, in the form of an energy market trading robot, since improving energy distribution is vital to a successful ecological transition.

Healthcare

Talan conducts R&D projects in the Healthcare field, using new technologies as a lever for innovation and transformation. Thanks to its expertise, the group can help healthcare professionals make the most of their data, improve their processes and create new services while complying with the industry's ethical, legal and health standards.

The Recov'Up project is a striking example of our work. This application, developed by SkeewAI, focuses on the prevention and treatment of musculoskeletal disorders (MSDs). For this project, we provided a logical inference engine that facilitates diagnosis and support for patients. Following this project, we continued our collaboration with SkeewAI in the MOCA project, which enables physiotherapists to assess patient performance remotely by analysing videos of functional tests.

Other projects already presented in the previous annual report were finalised this year. The Re-training for Exercise project is one example, studying how to combat sedentary lifestyles and their impact on personal health. The Talan Research and Innovation Centre helped analyse the results and build a model capable of predicting the VO2 max values of patients. Similarly, the Aiintense project aims to assist doctors in conducting their neurological assessments of patients by improving the quality of their diagnosis, decision-making and implementation of an appropriate therapeutic approach.

Healthcare is closely linked to sport. Through our FIVE project developed jointly with IRMS2, we have designed a random-forest-based machine learning model for predicting the risk of injury during five-a-side football matches.

Lastly, Dataroots' teams have drawn on Talan's data expertise in creating Flash, a secure learning platform for analysing medical data. In compliance with data protection regulations and standards, this platform enables researchers and healthcare professionals to access data without sharing it between different institutions, thereby making it easier to discover therapies for rare diseases while ensuring medical data security and confidentiality.

Communication, collaboration and outreach

05

A. Publications

1/ Artificial Intelligence – Peer-reviewed journals and conferences

Types	Journal/Conference	Author	Title/Subject
Scientific article	Journal of sports traumatology	D. Jacob, R. Tievant, L. Cervoni, M. Roudesli	Prediction of 5-a-side football injuries using a machine learning method.
Scientific article	HAL open archives	H. Canever, X. Wang	Network traffic classification using Unsupervised Learning: a comparative analysis of clustering algorithms
Scientific article	TPAMI 2023	R. Friji et al.	Geometric Deep Neural Network Using Rigid and Non-rigid Transformations for Landmark-based Human Behavior Analysis.
Scientific conference	ACFAS 2023	L. Cervoni	Opening conference
Scientific conference	AIME 2023 Slovenia	L. Cervoni, R. Sleiman, D. Jacob	Explainable artificial intelligence in response to the failures of musculoskeletal disorder rehabilitation
Scientific article	Springer	L. Cervoni, J. Brasseur	Simultaneously teaching Mathematics and Prolog in School Curricula: a mutual benefit
Scientific conference	PFIA 2023 APIA	L. Cervoni, J. Brasseur	Use of artificial intelligence to assist in the prevention and self-rehabilitation of osteoarticular pathologies

Scientific conference	RJCIA 2023	X. WANG, P. Kuntz, F. Meyer	Classification Multi-Labels en flux : Formalisation et Applications
Scientific conference	APIA - Strasbourg	D. Jacob, R. Tievant, L. Cervoni, M. Roudesli	Prédiction des blessures au Foot 5 à l'aide d'une méthode de machine learning.
Scientific conference	KI 2023	J. Gonzalez, F. Dama, L. Cervoni	A novel incremental learning strategy based on synthetic data generated from a random forest
Scientific article	HAL open archives + Arxiv	D. Jacob, D. Abboud	Mise en place d'une habilitation : D'une solution monolithique vers une architecture en microservice
Scientific article	Polish Journal of Aesthetics	A. Allaire, L. Cervoni	Magical simulacra and magic simulation : a Baudrillardian perspective on the recognizing and creating of magic using generative artificial intelligence

2/ Artificial Intelligence – Other publications

Type	Journal/Conference	Author	Title/Subject
Article	1024 - Bulletin de la SIF, Novembre 2023	H. Canever	Reflections on the creation of secure synthetic data that comply with the regulations
Conference	Télécom ParisTech Thursday seminar	H. Canever	Synthetic data, a challenge for AI and privacy
Article	Actu IA, volume 11	Y. Arnaud	AI and the search for exoplanets: how algorithms help characterise new worlds
Conference	Technology conferences EPITA	H. Canever	Synthetic data, a challenge for AI and privacy
Article	Zenodo	L. Cervoni, T. Farès	MICA: Medical Intelligent Conversational Agent
Article	The Conversation	Y. Arnaud	Why is AI neither benevolent nor malevolent?
Article	ActuIA	T. Calvi (uncredited contribution by S. Fayad)	I-JEPA: an AI model close to human intelligence based on Yann LeCun's vision
Conference	MBA Devinci Executive Education	H. Canever	Prompt Engineering

Types	Revues / Conférences	Auteurs	Titres - Sujets
Article	ActuIA, Issue 12	F. Dama	The use of AI in Anti-Money Laundering.
Article	ActuIA online	F. Dama	The use of Artificial Intelligence in Anti-Money Laundering - State of the art
Article	ActuIA online	S. Fayad	Can artificial intelligence see like human beings?
Editorial	Orthopaedics & Traumatology : Surgery & Research	T. Jacques, R. Sleiman, M. I. Díaz, J. Dartus	Artificial Intelligence: Emergence and possible fraudulent use in medical publishing
Article	Talan website	F. Dama	Anti-Money Laundering and the Financing of Terrorism (AML/CFT): AI leads the investigation.
Article	ActuIA, Issue 13	A. Benamar	What is the political orientation of the text generators?
Article	Talan website	S. Fayad, L. Cervoni	Generative AI: what if it were a massive job creator?
Article	Talan website	A. Benamar, D. Jacob	Generative AI: does the future of DataViz lie in image generation?
Article	ActuIA en ligne	A. Benamar	Is it possible to learn to unlearn an LLM?
Article	ActuIA Numéro 14	A. Benamar	Controlled image generation with ControlNet
Article	ActuIA Numéro 14	A. Allaire et W. Babonnaud	ChatGPT, Llama 2 and Mistral 7B walk into a bar... Humour and large language models

3/ Organisation, Management, Architecture, Blockchain

*revues scientifiques à comité de lecture
**conférences scientifiques à comité de lecture

Types	Revues / Conférences	Auteurs	Titres - Sujets
Scientific conference**	European Business Ethics Network Conference	Y. Arnaud	Benevolent leadership in contexts of mobility and hybrid despatialization of workplaces: An early-stage thesis project
Scientific conference**	22nd AIPTLF Congress	Y. Arnaud	The perception of quality of life at work and the employee experience: the case of a consultancy firm with a quality label
Scientific conference**	90th ACFAS Congress	D. Jacob, Y. Arnaud, O. Chelbi, L. Cervoni	Study of the performance of idea creativity in real and virtual brainstorming contexts.
Scientific conference**	R&D Management conference	O. Chelbi, Y. Arnaud, D. Jacob	Experimental investigation of creativity's performance: A comparative analysis of three collaborative brainstorming tools
Article scientifique*	Degrowth Journal	Y. Arnaud	Toward the degrowth of the Economics of Orbital Space and Space Debris : A preliminary theoretical application in low-Earth orbit
Scientific conference**	IPDMC	O. Chelbi	Business model innovation building on data : a process mixing both innovation and tension management
Scientific conference**	ICMLC 2023, International Conference on Machine Learning and Cybernetics	B. Boussofara, I. Ayari et al.	DeFL: A Novel Blockchain Fully Orchestrated Federated Learning Framework

Types	Revues / Conférences	Auteurs	Titres - Sujets
Conference	Aquility 2023	B. Gauthier, Y.Arnaud	Exploring and characterising caring in agile contexts: a qualitative analysis
Round table	Festival Astr'Auvergne	Y. Arnaud, C. Toussaint, S. Rouillon	What are the prospects for the sustainable management of orbital space?
Public conference	InfiniSciences	L. Poulet, A. Beth, Y. Arnaud, N. Laporte	Latest news about the Universe
Webinar	Ad Hoc Solutions	T. Préault, Y. Arnaud, A. Dean	Corporate Social Responsibility: What are we talking about?

B. Events

2023 saw three Research Tuesdays meetings organised by the Research and Innovation Centre, with leading figures in the AI world:

Antoine Couret was Marketing Director at Bouygues Télécom before co-founding IT4PME and Geo4Cast. In 2017, he became Chairman of Hub France IA, an association promoting French AI. In early 2021, he created Aleia. Aleia is the first European AIaaS platform to offer an environment for developing models and deploying them in production. It accelerates the implementation of AI projects by freeing data scientists from IT issues and simplifying the transformation of algorithms into APIs to speed up integration into information systems.

Françoise Soulié has over 40 years' experience in artificial intelligence, particularly in the fields of neural networks, machine learning and social network analysis. A École Normale Supérieure graduate and holder of a PhD from Grenoble University, she has also been a university lecturer and supervised numerous theses. She founded a startup before working for companies such as Atos and Business & Décision, and she has also held key positions on European and international committees such as the European Commission's high-level AI expert group and co-chair of the working group on innovation and commercialisation within the GPAI (Global Partnership on AI).

Juliette Mattioli is a recognised artificial intelligence expert and represented France at the G7 Innovators Conference in 2017. She has headed the "Data Sciences & Artificial Intelligence" Hub in the Systematic Paris-Region competitiveness cluster since 2019. Its reputation stems from its deep understanding of the industrial challenges associated with AI, and it plays a crucial role in algorithm engineering for the industrial deployment of reliable AI-based solutions, especially in critical systems.

At the Everyday AI exhibition organised by Dataiku (November 2023), the research team presented a demonstration of the reproduction of published research results, illustrating how Dataiku can be a powerful tool for generating synthetic data.

At the 4th AI France Summit organised by NUMEUM (July 2023), the Research Centre unveiled its GenAI-based chatbot prototype, called Talan Seeker, which assists staffing.

Forum de l'IA

The Talan Innovation Factory team in Tunisia organised the Talan Global Hackathon 2023, an AI innovation event focusing on social impact.

In addition, Insum and Talan worked together in the first half of 2023 to create a virtual environment in order to host a beta event for the Oracle APEX community by using the Owniverse platform developed by the Talan Innovation Factory team. Participants were able to join in the event via their Oculus VR headset and a web application. They were able to share content in the metaverse, communicate via chat, interact with each other and celebrate the community's unity.

C. Courses and training

Écoles	Responsables	Sujets
EPITA	S. Fayad, R. Sleiman	IA et Sciences Cognitives
Devinci Executive Education	L. Cervoni	Intelligence Artificielle et Data Innovation
SummerCamp'23 at Talan	A. Journe	AI and Research
IMT	L. Cervoni	AI and the Environment
ESSCA	Y. Arnaud	Introduction to Research
ESIEA	L. Cervoni	The value of combining logic and imperative programming
ESIEA	D. Jacob	IAGen, LLM et RAG
Telecom Paris	H. Canever	Prompt Engineering
Telecom Paris	H. Canever	Synthetic Data
ESIEE	A. Allaire	IA Frugale
IAE de Bordeaux	Y. Arnaud	Human resources project management

D. Collaborations and partnerships

Talan works with universities on many training courses and research projects:

- **University of Sherbrooke, Canada:**

Talan worked with researchers from the University of Sherbrooke on a thesis studying industry's adoption of augmented reality technology for assisting frontline workers. Talan's Metaverse team has developed a real-time augmented reality simulation of the interaction between workers and industrial machines, complete with historical information.

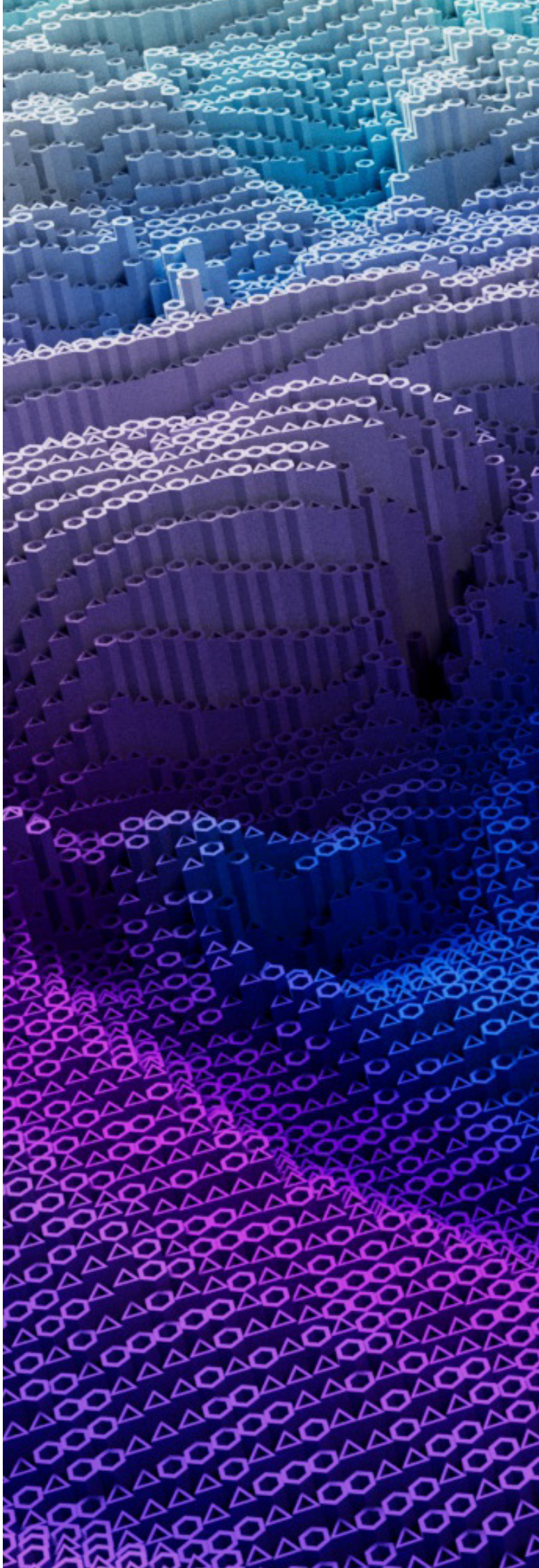
- **DeVinci Executive Education (formerly Institut Léonard de Vinci):**

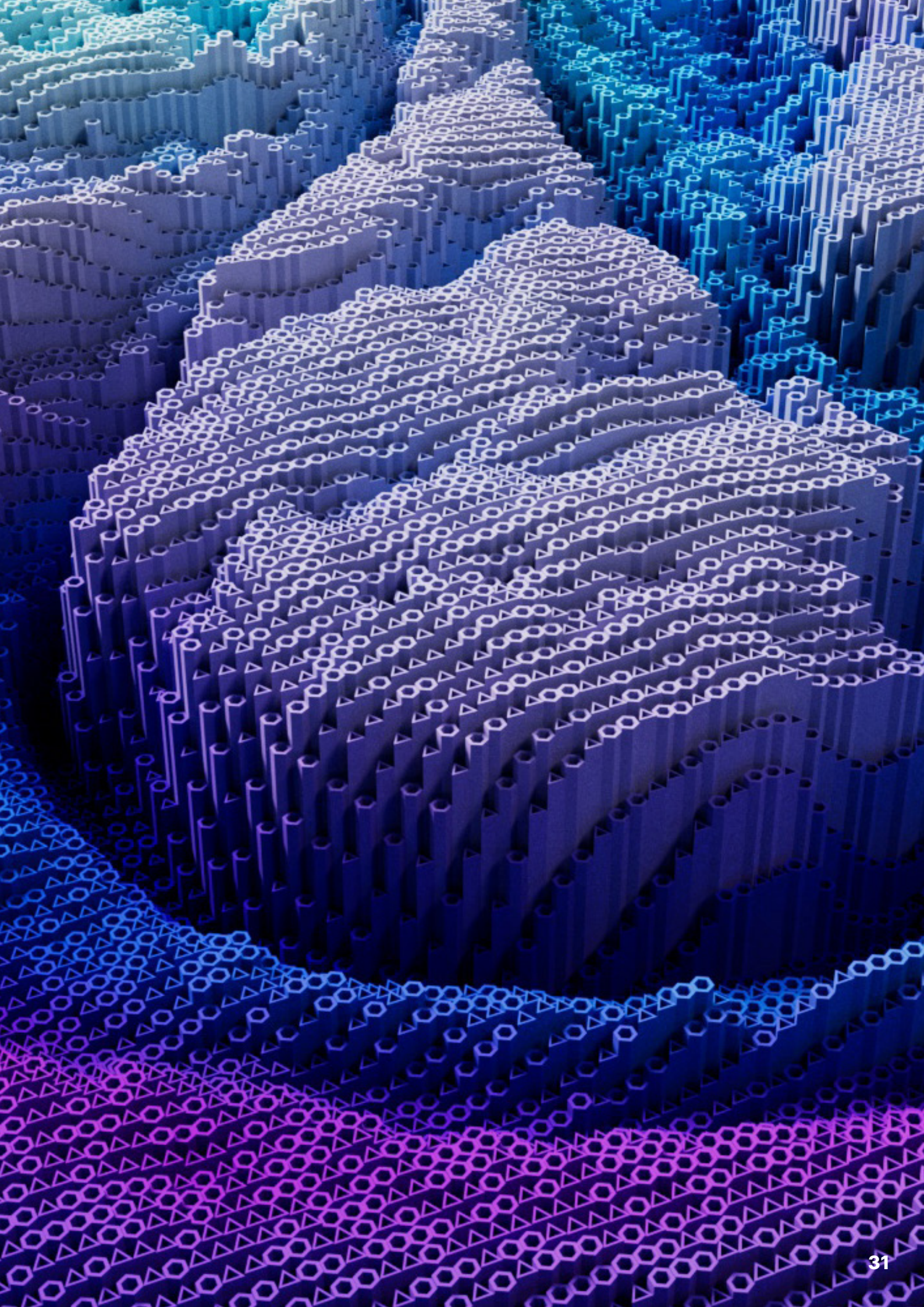
Talan is one of the Artificial Intelligence MBA programme's main facilitators after helping to develop it in 2019 and continued to do so until 2023.

Talan also supports several startups through its StartUp Network (SUN).
In the Research field, Talan works with two SUN companies in particular:

- **AiiNTENSE,** whose business consists of optimising medical care, the prognostic assessment and hospital stays of patients through decision-support cognitive assistants, tele-expertise and tele-assistance services and a platform for clinical and neuroscientific research, in the AiiNTENSE project.

- **SKeeWAI,** a company committed to providing care for osteoarticular pathologies and particularly lumbago or ankle sprains, with the Recov'Up project.





The teams

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Laurent Cervoni,
Research and Innovation Director:

An engineer from the École Supérieure d'Ingénieurs en Électronique et Électrotechnique (ESIEE) and a PhD in Computer Science from the University of Rouen, Laurent's career has included the use of digital/connectionist AI and symbolic AI technologies, largely contributing to the ISO standardisation of the Prolog language, an essential link in symbolic AI.

He began his career with an AI solutions provider and then became CapGemini/ITMI's Technical Director responsible for AI projects. He then headed the new media development department at EDS France before setting up and running his own consulting firm to support companies in their digital transformation.

He was an advisor to a ministerial office (Victim Assistance Secretariat) before taking over as General Manager of Docaposte Localeo (La Poste group), before joining Talan.

He is also a Board member of the Association des Docteurs de France (ANDès) and a Board member of the Regional Institute of Sports and Health Medicine in Normandy. He heads the scientific committee of ActuIA, a journal specialising in Artificial Intelligence, and is Lead Professor of the MBA in AI and Data Innovation at DeVinci Executive Education.

He is convinced that AI must be frugal, hybrid, multimodal and available to all (via Open Source in particular).

A. PhDs participating in research projects in France

Andres Ladino

Andrés holds a Master's degree in Electronic Engineering from the Pontificia Universidad Javeriana (Colombia) and a PhD in Automation and Production from the University of Grenoble Alpes (obtained in 2018). He obtained his PhD in collaboration with CNRS and INRIA as part of the European SPEEDD (Scalable Proactive Event-Driven Decision-making) project. His thesis focuses on topics related to the estimation (reconstruction) and prediction of road traffic variables on large-scale networks. He has also extended his research in the field of intelligent transport, focusing on the development of different types of transport network simulation and methodologies for measuring the impact of new technologies on transport.

Angélique Allaire

Angélique Allaire holds a PhD in the History of Art, specialising in digital humanities, which she obtained in 2023 at Sorbonne University in partnership with the Sorbonne Center for Artificial Intelligence. During her thesis, Angélique worked on a comparative archaeological epistemology of the Greek world in France and Germany between 1870 and 1915, utilising an automatic analysis of a large multilingual corpus of documents.

Angélique works on a range of issues relating to generative AI and its evaluation, as well as its environmental impact.

Antoine Garçon

A graduate engineer from the Ecole Polytechnique Fédérale de Lausanne, Antoine Garçon obtained his PhD in Atomic and Molecular Physics in 2020. He later completed a post-doctorate in Machine Learning and Deep Neural Networks. During his research, Antoine focused on developing new metrology tools based on nuclear magnetic resonance. He is also an expert in the processing of data from laboratories, specialising in the modelling and detection of weak signals in rich and complex data sets.

Alexandra Benamar

Alexandra Benamar obtained her PhD in Computer Science with a specialisation in artificial intelligence and natural language processing in 2023 from the University of Paris-Saclay in partnership with the CNRS and EDF, as part of the CIFRE scheme. Her thesis focuses on the evaluation and suitability of word embedding in various fields, using syntactic and semantic knowledge. Alexandra's projects focus on a number of topics, including generative AI, multimodal AI, data quality and machine unlearning.

Arnaud Deleruyelle

Arnaud Deleruyelle holds a PhD in Computer Science and graduated from the University of Lille in 2022 with a thesis specialising in artificial intelligence. During his thesis, Arnaud worked on computer vision, specialising in the segmentation of cellular microscopy images using deep learning in highly unsupervised contexts.

Arnaud participates in research projects on several subjects related to generative AI, computer vision and data augmentation and anonymisation.

Axel Journe holds a Polytech'Nantes engineering degree in Computer Science, as well as a PhD in Computer Science obtained in a CIFRE collaboration with Engie. His thesis focuses on the learning of Bayesian networks, using probabilistic graphical models in the field of artificial intelligence. His projects cover a wide range of applications such as communications, human resources management and IT development.

Damien Jacob

Damien Jacob holds a PhD in Earth and Environmental Sciences with a specialisation in Geophysics, obtained in 2021 from the University of Strasbourg.

His thesis focuses on the dual-media modelling of the karstic aquifer system in Qatar. Damien works on a range of topics relating to generative AI, multi-agent systems and virtual reality.

Fatoumata Dama

An engineering graduate of ENSIMAG (École Nationale Supérieure d'Informatique et de Mathématiques Appliquées de Grenoble), Fatoumata Dama obtained her PhD in Computer Science in 2022. She is a machine learning, deep learning and probabilistic modelling specialist. Since 2023, she has been an R&D Engineer at Talan, where she manages R&D projects on AI subjects. She is currently working on fraud detection and generative AI.

Helena Canever

Helena Canever obtained her PhD in Physiology and Physiopathology in 2021 with a thesis project on the analysis and modelling of the spatial-temporal migratory behaviour of epithelial cells. At Talan, she works on AI projects related to synthetic data generation as an alternative to canonical storage and to the influence of digital and AI solutions on the carbon footprint of business practices. She is also interested in the issue of data protection in relation to new technologies, particularly generative AI. As part of Talan's CSR policy, she has developed the Hope application for simulating the carbon footprint of the group's missions serving its customers.

Jordan Gonzalez

Jordan Gonzalez obtained his PhD in Computer Science from the ESIEA engineering school in 2022 with a specialisation in supervised and semi-supervised incremental learning. Jordan has extensive expertise in the deployment of generative AI. At Talan, Jordan has worked on generative AI and its use in information retrieval systems.

Manuel Díaz

Manuel Díaz graduated from the École Normale Supérieure (ENS) in 2023 with a PhD in Physics, specialising in quantum physics. During his PhD, Manuel worked on mathematical modelling of the behaviour of electrons in strongly interacting quantum materials.

Manuel participates in research projects on a variety of GenAI-related subjects, including its evaluation and impact as well as quantum computing.

Mounir Lahlouh

Mounir Lahlouh holds a PhD in Computer Science, specialising in artificial intelligence, which he obtained in 2023 from the University of Reims Champagne-Ardenne in partnership with Basecamp Vascular (BCV) as part of the CIFRE scheme. His thesis focused on the use of deep learning for the segmentation, classification and geometric characterisation of blood vessels.

Mounir is involved in a variety of fields, focusing mainly on generative AI, studying its evaluation and identifying biases and ethical issues as well as examining sport-related subjects.

Rita Meziati Sabour

An engineer specialising in Signal and Image Processing, Rita Meziati worked on the recognition of emotions and social stress based on the variability of the calculated, non-contact heart rate in her PhD thesis. Her studies involved the acquisition and analysis of physiological signals. In her thesis, she applied statistical methods and machine learning algorithms to the descriptors read from these signals for the targeted emotion/stress recognition tests. She also used Recurrent Neuron Networks to segment the cardiac signals in order to define their noisy portions.

Rita Sleiman

Rita Sleiman graduated from Centrale Lille university in 2022 with a PhD in Computer Science, specialising in artificial intelligence. During her thesis, Rita worked on trend detection and demand forecasting for fashion items using Big Data and AI.

Rita participates in research projects on several subjects including generative AI, neuroscience and explainability of AI systems.

Rym Salhi

Rym Salhi holds a PhD in Applied Mathematics from Le Mans University, which she obtained in 2019. Rym worked as a Lecturer-Researcher and subsequently as Research and Innovation Project Manager at the Le Mans Institute of Risk and Insurance. Her research focuses on the building of random models for financial and energy risk management.

Sophie Fayad obtained her PhD in Neuroscience from Sorbonne University in 2019. After writing a thesis on the neural bases of neuropathic pain, she completed a post-doctorate on inter-individual variability in behaviour and addiction, utilising data science and AI methods. She joined Talan's Research and Innovation Centre in 2023, where she works on a range of topics relating to generative and multimodal AI and the interplay between AI and neuroscience.

Tonie Farès

After completing a Master's degree in Fundamental Mathematics at the University of Lille, Tonie Farès prepared and defended her thesis at the Lens Mathematics Laboratory in the field of functional analysis. The title of her thesis: "P-summing composition operators on weighted Bloch spaces". She continued her research and lectured to students (in Mathematics and Computer Science) as a temporary teaching and research associate (ATER) at the Université d'Artois for two years. She joined Talan in September 2021 as an R&D Engineer at the group's Research and Innovation Centre. She participates in various research projects in fields ranging from identification to implementation and operational monitoring.

William Babonnaud

William Babonnaud holds a PhD in Computer Science with a specialisation in computational linguistics, awarded by the University of Lorraine in 2022. His thesis focuses on lexical semantics, compositionality and coercion and explores the theoretical foundations of semantic types. After a postdoc in Computational Linguistics, William joined the Talan teams, where he participates in research projects on several subjects relating to generative AI, including its evaluation, the detection of ethical biases and abuses, along with its impact.

B. PhD students supported by Talan in 2023

Yann Arnaud

Yann Arnaud is writing his Management Sciences thesis at the Institut de Recherche en Gestion des Organisations (University of Bordeaux) and Talan's Research and Innovation Centre. He is also a research assistant at CIRANO (Montreal, Canada) working on several healthcare economy-related subjects. His latest work at Talan focuses on human resources management (caring leadership, commitment and turnover), generative AI and the metaverse (idea creativity in brainstorming contexts) and space debris (the common good and space policy).

Olfa Chelbi

Olfa Chelbi is conducting her Management Sciences research in collaboration with the Management Research Centre (CRG-I3) at the Institut Polytechnique de Paris. She is particularly interested in how business models work and the mechanisms for collaboration between large companies and startups in the banking sector. Her work also focuses on the impact of the metaverse upon consultant creativity in brainstorming contexts.

C. The Talan Tunisia team

Imen Ayari

Head of the Research and Business Development (R&BD) department in Talan Tunisia's Innovation Factory, Imen Ayari is a qualified engineer, holds an Executive MBA and has more than 20 years of experience in Information and Communication Technologies. Her experience covers a wide range of sectors including banking, industry, retail, e-government and insurance. Imen is a firm believer in open collaboration and synergy between professionals, academics and students. For example, she coordinated testing of metaverse-related development during 2022.

Racha Friji

Racha Friji is Head of AI Research and Development at the Talan Innovation Factory in Talan Tunisia, holds a PhD in Artificial Intelligence – Cristal lab/ENSI, teaches at INSAT (including in Computer Vision) and is a member of the Scientific Committee of the journal ActuIA. She wrote and published several articles on deep learning and action recognition in 2022.

Conclusion

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Conclusion

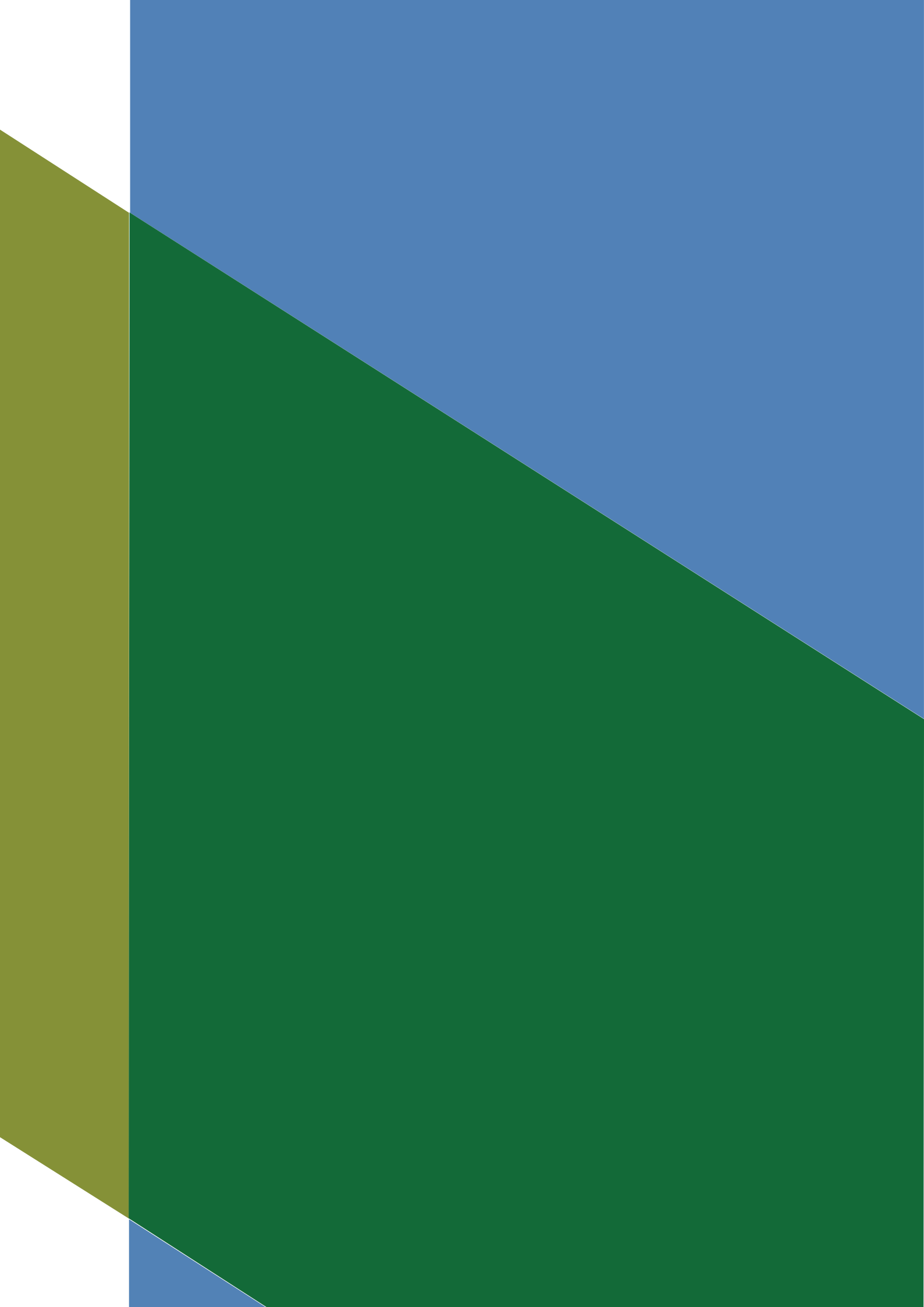
2023 highlighted Talan's strong commitment to research and innovation, with a significant increase in the number of days devoted to this business and in the number of scientific publications and popular articles. The quality of the group's research work is underlined by the variety of conferences in which our researchers have participated. Our publication on the use of AI to support patients in their rehabilitation of osteoarticular pathologies was selected as one of the top three publications at the Application of AI conference in Strasbourg (PFIA Conference – APIA 2023).

For 2024, Talan plans to further increase the number of research days and employees involved. This indicates the group's continued strengthening of its commitment to research and innovation, particularly in France, Canada, Tunisia and Belgium. This expansion is expected to strengthen Talan's expertise in generative AI and its applications while increasing the proportion of customer projects in the group's R&D portfolio.

The group plans to support this strategy by recruiting highly qualified people (with 8 to 10 years' higher education and experience in applied research) to join its R&D team. Targeting the recruitment of these profiles in this way is designed to increase our internal research capacity and improve the application of innovations by our customers. The group places particular emphasis on creating R&D projects based on customer expectations. Talan aims to improve the integration of innovations developed in R&D into the solutions it offers its customers, thereby enhancing added value, the relevance of its research and trust in the solutions it deploys.

We are maintaining our commitment to the ethical development of AI and to transparency, including our evaluation of the environmental and societal impact of the technologies we develop and our choice of explainable technologies. This reflects our move towards greater social responsibility in our R&D activities.

This outlook demonstrates our strategic aim of making research and innovation a core aspect of all group activities, in all countries and in all our activities, to strengthen our strategic position in the market and provide our customers with the best possible support in adopting technological developments.



“By truly embracing a humanist approach to technology, we believe we can make the next digital age an era of progress for all.”

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