IVADO
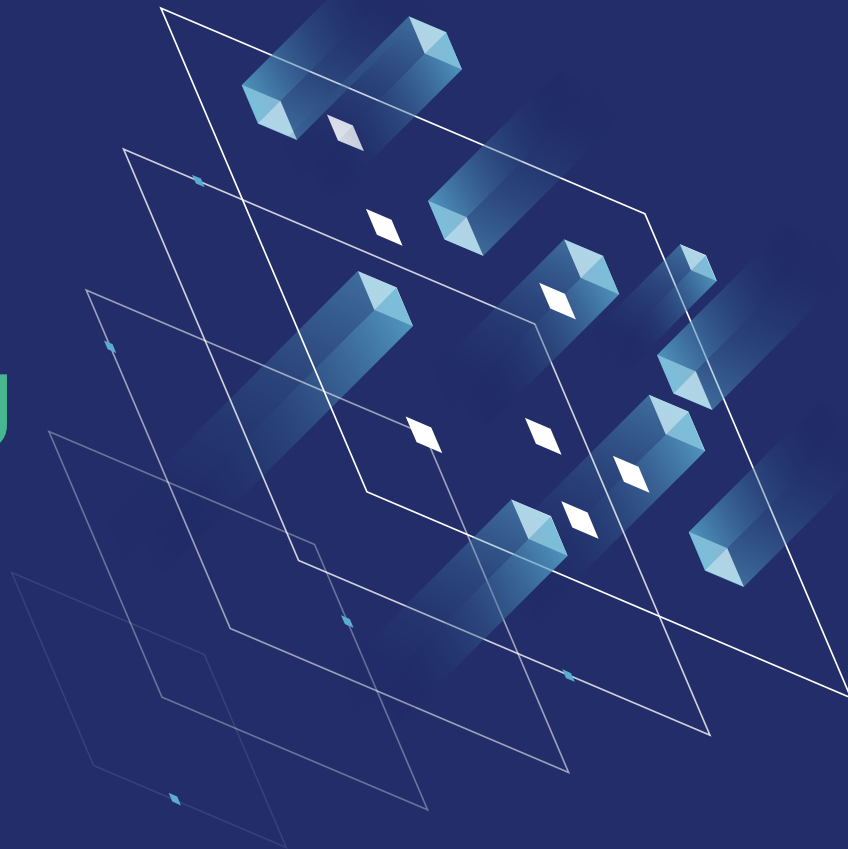
Accelerating the Digital Transition

2020-21 Activity Report

Université de Montréal

HEC MONTRÉAL

POLYTECHNIQUE MONTRÉAL

CANADA FIRST RESEARCH EXCELLENCE FUND | APOGÉE CANADA FONDS D'EXCELLENCE EN RECHERCHE

Québec

Contents

Words of Welcome

"In 2020, whether it was through videoconferencing or hosting online events, we experienced and observed the acceleration of the digital transition in society, made all the more necessary by the health situation. Against that backdrop and on our own scale, we are becoming increasingly vigilant, developing exemplary practices to support the growth of **responsible digital intelligence**. Ethics, equity, diversity and inclusion are integral to our thinking and actions aimed at ensuring that technological advances benefit all of society.

The **Canada First Research Excellence Fund program** midterm review was a chance to gauge the scope of our achievements since the Institute's inception. We have quickly ramped up capacity and brought together experts, the sum of whose knowledge has largely contributed to our strategic positioning within the digital intelligence ecosystem. Especially notable among those types of expertise is the alliance of two complementary research fields: **operations research** and **machine learning**. This "dynamic duo," which is the hallmark of the ecosystem we've developed in Québec, raises our international profile and ensures that IVADO has the assets it needs to respond to the longer-term challenges in society. Challenges to which digital intelligence can propose solutions in areas like smart supply-chain management and green economic conversion.

During the year, we also rolled out our new strategic plan and structured our operations around our four pillars: **Talent**, the starting point for all our activities; **Knowledge**, the indispensable raw material for research; **Transfer**, the point at which knowledge moves from academic insight to industrial application; and **Community**, the source of interactions and exchanges that opens the door to novel ideas and collaborations. This invaluable space of discovery and innovation is fertile territory for exploring potential solutions to the multiple challenges our society faces in the years to come."

Marie-Josée Hébert
Chair of the Board of Directors, IVADO
Vice-Rector of Research, Discovery, Creation and Innovation, Université de Montréal

"Under the shadow cast by COVID, the year 2020 was one of upheaval in many respects. Like all of you, we had to develop new ways of working, communicating and collaborating. Responding to the urgency of the situation, our community mobilized and, globally, we contributed to the crisis-management efforts, notably by supporting nine research projects focused on the development of concrete solutions to the many challenges brought about by the pandemic, and by making it possible for our staff and colleagues to continue their activities using adapted methods.

Driven as never before by our mission to accelerate the digital transition of society by mobilizing knowledge and talent in digital intelligence, we mapped out our new **strategic plan** and assisted in the hiring of ten new IVADO professors, along with four research professionals. We also supported the training of new digital intelligence talent by awarding more than $13 million in **scholarships and grants** as well as by organizing eight training sessions under the **"From Data to Decision"** program. And on the **collaborative research** side, we welcomed 12 new industrial members and initiated 133 new projects in addition to continuing the existing ones. In so doing, we succeeded in enriching our collaborations and **partnerships**, which are essential to harnessing knowledge and pursuing our operations. Despite physical distancing requirements, our indicators have remained positive, proving that digital transformation is gaining momentum in organizations. The pandemic context also presented us with opportunities to expand our talented team.

The year 2020 also saw IVADO reach an important stage of its history: the midpoint of our Canada First Research Excellence Fund term. Our combined efforts over the past few years were key to arriving at that milestone, achieving and indeed surpassing our initial goals. In conclusion, 2020 brought its share of challenges, but also successes and accomplishments, thanks to the steadfast commitment of our team, to whom I offer my sincere thanks, and our thriving community. This report is an opportunity to acknowledge the impact we have had over the past 12 months, and we are excited to roll out our strategic plan with the ambition of structuring and supporting the implementation of international-scale projects and propelling the **commercialization** and **transfer of research** and talent in digital intelligence for the benefit of our society."

Gilles Savard
CEO, IVADO

2020-21 by the Numbers

The growth in IVADO's indicators is a measure of how its team and community are thriving. Here is a snapshot, organized by strategic pillar, of the Institute's key numbers for 2020-21, which speak to the many collaborations and initiatives implemented within our digital intelligence ecosystem.

Talent

5,258

person-days trained in 2020-2021 (excluding MOOC)

13,382 since 2016

7,500

new MOOC registrations

>15,000 registrations since the 1st MOOC went online

Knowledge

$13 M

in research scholarships and grants

$30 M since 2016

>$5 M

in fundamental research projects

>$12 M since 2016

Transfer

12

new industrial members

110 since 2016

133

new collaborative projects started

324 projects since 2016

Community

>1,400

scientist members of the IVADO community

>120

members and industrial partners

Operations Team

IVADO has more than quadrupled in size in four short years. Bringing together experts from various disciplines, all bound by a shared passion for the immense potential of digital intelligence, ours is a tight-knit and ambitious team firmly committed to changing society, one project at a time, thanks to data and algorithms.

Gilles Savard
CEO

Laurence Beaulieu
Deputy CEO

Yoshua Bengio
Scientific Director

Andrea Lodi
Scientific Co-Director

Jean-Marc Rousseau
Director of Technology Transfer

Guillaume Chicoisne
Scientific Advisor

Nancy Laramée
Director of Partnerships

Brian Moore
Scientific Programs Director

Elodie Palluet
Director – Digital Intelligence Talents

Peggy Jean-Baptiste
Head of Section – Administration

Lyne Lavoie
Administrative Assistant

Nathalie Sanon
Head, Training Program

Sira Maïga
Research Coordinator

Barbara Decelle
Health Research Advisor

Craig Cag
Administrative Officer - Scientific Programs

Alexandre Guertin-Pasquier
Student and Scientific Activities Coordinator

Nabila Ouchene
Coordinator, Online Training

Élisabeth Gosselin
Coordinator - Synchronous Training

Jean-François Connolly
Digital Intelligence Advisor

Vanessa Alarie
Partnership Advisor

Fabien Perineau
Partnership Advisor

Dany Plourde
Partnership Advisor

Lilia Jemai
Partnership Advisor

Zouheir Malki
Partnership Advisor

Guillaume Poirier
Partnership Advisor

Gabrielle Langlois
Partnership and Entrepreneurship Advisor

Jean-François Bruneau
Partnership Advisor (CIRRELT)

Mehdi Taobane
Partnership Advisor (CERC)

David Brieugne
Partnership Advisor (Tech3Lab)

Rheia Khalaf
Director, Collaborative Research & Partnerships (Fin-ML)

Sandra Estrela
Communications Coordinator

Camille Barrier
Communications Officer

Sophie Côté
Event Coordinator

Daniel Pelchat
Webmaster

Laurence Renault
Planning and Performance Advisor

Mariloue Daudier
Equity, Diversity and Inclusion Advisor
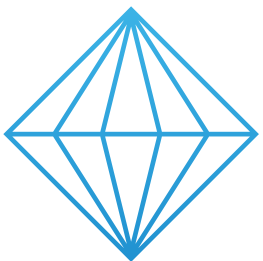
Christelle Molez
Administrative Technician

Gabriela Garcia Hernandez
Administrative Technician

Fernando Rodao Faz
Financial Management Advisor

Executive

Knowledge

Transfer

Communications, Project management and EDI

Administration

Digital Intelligence Talents

Talent

Training scientists, professionals, managers and the emerging talents of digital intelligence to drive better responses to organizations' growing needs.

5,258

person-days trained in 2020–2021 (excludes MOOCs)

13,382 since 2016

7,500

new MOOC enrolments

>15,000 enrolments since 1st MOOC went online

400

attendees at the 6th Mila/IVADO Deep Learning School

1,359 since the first edition

"From Data to Decision"

42

courses since 2016

Talent

A Range of Training

"This past year, we've worked hard to expand access to our online training content through the use of various platforms. We are privileged in that we can rely on a network of extremely qualified professionals to deliver a learning experience that is on the leading edge of knowledge in the various fields of digital intelligence."

– Nathalie Sanon,
Head, Training Program

IVADO is continually expanding its **training program** to support the increasing numbers of workers who are looking to appropriately use digital intelligence in their settings. Digital intelligence encompasses, among other things, **data science, operations research** and **artificial intelligence**, all of which are covered in the program. During 2020-21, we paid increased attention to development of **Massive Open Online Courses** (MOOCs) to improve **accessibility** for the entire Canadian and international learning community and to adapt to the health crisis.

Training for Professionals

In collaboration with its many academic members and partners, IVADO has developed the "From Data to Decision" continuous-training program, which aims to train professionals to foster improved adoption of digital intelligence in organizations. From schools to workshops and themed online courses, the program stands out for its content, which reflects the **cutting edge** of scientific and technological knowledge and is presented in a **non-partisan** manner and **interactively**, so as to equip learners with tools to make informed decisions in their projects.

Flagship Topics in 2020-21

Deep Learning: More than 400 attendees from Canada and internationally, 25% of whom were women, for the 6th IVADO/Mila school.

Data Science: workshops on Apache Spark and Paraview, given in collaboration with Calcul Québec.

Machine Learning Applied to Finance and Insurance: workshop presented in collaboration with Fin-ML.

Machine Learning online school: 4th edition of the school administered by Université Laval and the Institut Intelligence et Données.

Recommender Systems: MOOC initiated in collaboration with Université de Montréal and HEC Montréal, with Laurent Charlin (assistant professor, HEC Montréal) plus experts on Netflix and Microsoft.

Deep learning school

Nathalie Sanon, Head, Training Program

Talent

A Range of Training

"I am enthralled by artificial intelligence and what it can bring to oncology. With the Data.trek Challenge, I'm learning computational analysis while exploiting my own laboratory data!"

– Caroline Baril, Research Associate, Institute for Research in Immunology and Cancer (IRIC)

Customized Training for Executives

IVADO began development of digital intelligence training content specially adapted to the needs of executives. Among other things, this support and guidance helps identify promising projects in this field and assess their viability. The first training session was held in March 2021 and was well received.

"On behalf of the AI community of practice at Hydro-Québec, we thank you for last week's excellent training session. More than 110 people attended and we've had nothing but positive feedback so far. Thank you very much!"

– Benoît Labonté, Hydro-Québec

Training for Emerging Talents

These initiatives are aimed at students and younger researchers interested in developing their skills and acquiring tools at key moments in their academic and professional journeys that will help them reach their full potential. These training modules aim at skills development through the following three streams:

Learning through projects

2nd edition of the Data.trek Challenge, January to April 2021, in partnership with the ÉIAS, Sentinelle Nord and the Université de Montréal Continuing Education department.
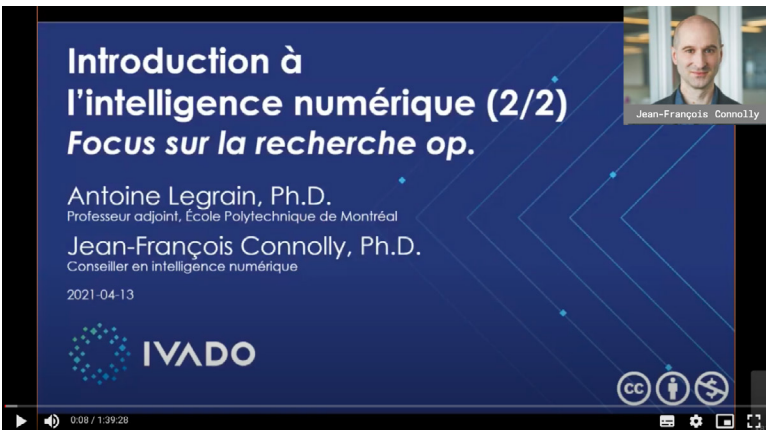
Development of cross-cutting skills

Writing a plain-language description of one's research project: new initiative, "My Research Project in 800 Words," launched in 2020.

Professional pathways

Alternatives to academic careers in digital intelligence, February 2021.

Start your teaching career on the right foot, February 2021.

Talent

Strategic Collaborations

"When organizations need coaching on their digital transformation, we are there for them, and training is the cornerstone. With Scale AI, we provide existing solutions to managers so that they can train their teams in the new needs raised by digital intelligence, right from the funding stage."

– Élodie Palluet, Director, Digital Intelligence Talents

MOOC Deep Learning Essentials

Scale AI + IVADO

In order to consolidate Canada's position in the artificial intelligence industry and to train tens of thousands of professionals for what is to come, Scale AI, offers financial support to help develop skills in digital intelligence. Canadian-based workers are eligible for discounts ranging from 50% to 85% of the cost of most IVADO training.

### Future Skills and NovaScience

Creation of online courses (MOOC) for the "From Data to Decision" program is made possible in part with the support of NovaScience and the Future Skills Centre. The latter will also enable development of professional certification, in collaboration with the Université de Montréal University Learning Centre and Faculty of Continuing Education. The project, which is among 30 being funded in Canada by the Future Skills Centre, will allow Canadian organizations to harness the power of digital intelligence.

"The three MOOCs I've worked on with IVADO have given me a very concrete and nuanced understanding of machine learning. These MOOCs provided me with the theory tools and conceptual imaging needed to set up an expert system for customer service at the Université de Montréal Distance Learning department."

– Vincent Laberge, Quality Control Assessor and Technopedagogical Advisor, Université de Montréal

Bias and Discrimination

The MOOC on Bias and Discrimination in AI presented by IVADO and Université de Montréal was named among the best online courses on the topic by The Good AI.
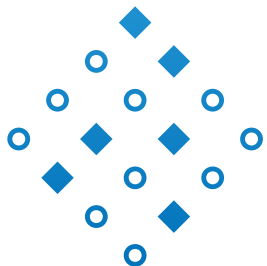
Knowledge

Supporting and promoting scientific research, while helping develop leading-edge expertise in digital intelligence.

26

new fundamental research projects funded (>$5 M)

69 since 2016 (>$12 M)

10

new IVADO professors

31 since 2016

174

scholarships and grants awarded, valued at $13 M

402 since 2016, total value $30 M

>$750,000

invested in research to combat COVID

Academic members

CENTRE DE RECHERCHES MATHÉMATIQUES

CIRRELT

CONSORTIUM SANTÉ NUMÉRIQUE

Université de Montréal

CANADA EXCELLENCE RESEARCH CHAIR — DATA SCIENCE FOR REAL-TIME DECISION-MAKING

GERAD

Mila

tech³lab

Knowledge

Academic Community, Scholarships and Grants

"This year we sensed a strong desire on the part of our academic community to mobilize in response to the health crisis, drawing on digital intelligence to seek solutions to the multiple challenges generated by COVID. Resilience, perseverance and collaboration were the watchwords of 2020, cementing the already strong ties among our professors, researchers and students."

– Brian Moore, Director of Scientific Programs

Welcome and congratulations!

Aishwarya Agrawal (1), Eilif Benjamin Muller (2), Elie Bou Assi (3), Gauthier Gidel (4), Guillaume Dumas (5), Pierre-Luc Bacon (6), Sarah Gagliano Taliun (7), Tomas Paus (8) (Université de Montréal), Antoine Lesage-Landry (9) and Moncef Chioua (10) (Polytechnique Montréal) brought the number of IVADO professors to 31.

A total of 111 scholarship awardees and four research professionals specializing in digital health joined the IVADO academic community.

Scholarships and Grants

In 2020, IVADO awarded 174 scholarships and grants with a total value of $13 million, broken down as follows:

65 Undergraduate Introduction to Research Scholarships, $325,000

15 MSc Excellence Scholarships, $600,000

22 PhD Excellence Scholarships, $2,200,000

9 "Data Storytelling" internship scholarships, $45,000

22 Postdoctoral Fellowships, $3,270,000

26 Fundamental Research Projects, $5,546,646

9 COVID projects with total support of $454,000

5 "Omics Data Against Cancer" (ODAC) research projects with total funding of $1,500,000 in collaboration with Génome Québec and Oncopole ($500,000 each)

1 OBVIA/IVADO postdoctoral fellowship, $50,000

"We are now supporting a total of 69 research projects led by multidisciplinary teams. In 2021, we will see new structure-enhancing projects focusing on a handful of subject areas that are key to the future of our societies."

– Guillaume Chicoisne, Scientific Advisor

An inspiring story

Olivia Gélinas and Sandrine Vieira were hired to form the data visualization team at Le Devoir, after doing their IVADO "Data Storytelling" internship there in 2019.

Knowledge

Mobilizing in Response to COVID

In March 2020, as the health crisis began, IVADO issued a call for projects to its community, and the response was swift. Nine projects aimed at finding solutions to various problems caused by the pandemic received funding and logistics support.

Full article

>$750,000 invested in research

Digital Clinical Trials to Accelerate the Evaluation of Colchicine Therapy
Team: Jean-Claude Tardif (Université de Montréal) and Frédéric Lesage (Polytechnique Montréal).
IVADO funding: $125,000
Scale AI: $100,000
TransMedTech Institute: $50,000

Accelerating the Search for a Drug for COVID-19
Team: Yoshua Bengio (Université de Montréal) and Mike Tyers (IRIC).
IVADO funding: $100,000
Scale AI: $125,000
CERC: $25,000

Genomic Genetic Profiling of SARS-CoV-2 in Québec
Project undertaken by Julie Hussin (Université de Montréal).
IVADO funding: $100,000

Modelling of Animal Reservoirs of Pathogens
Team: Timothée Poisot (Université de Montréal), Colin Carlson (Georgetown University).
IVADO funding: $45,000

COVID-19 Critical-Care Digital Visualization Board
Team: Philippe Doyon-Poulin (Polytechnique Montréal) and Philippe Jouvet (Université de Montréal).
IVADO funding: $30,600

Identifying the Achilles Heel of SARS-CoV-2
Project undertaken by François Major (IRIC).
IVADO funding: $17,500

### Monitoring the Emergence and Expansion of SARS-CoV-2 on a Large Scale
Team: David Stephens (Université McGill) and Luc Villandré (HEC Montréal).
IVADO funding: $15,000

Developing a New Diagnostic Tool for COVID-19
Team: Frédéric Leblond (Polytechnique Montréal) and Dr Dominique Trudel (CHUM).
IVADO funding: $11,000
TransMedTech Institute: $33,100

Interconnecting COVID-19 Data
Team: David Ardia (HEC Montréal) and Emanuele Guidotti (Université de Neuchâtel).
IVADO funding: $10,000
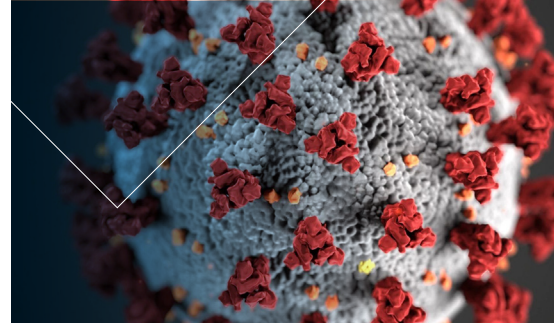
"I want to congratulate the IVADO team for their orderly and timely execution of the COVID-19 call for projects and initiatives. I feel very pleased to have played a part in this process, which has supported a number of major initiatives that will benefit our collective health. Through its actions and support, the IVADO team has shown itself to be proactive in a context of novelty and unknowns. Challenges such as these will likely recur in different forms in the future and, as we are now seeing, digital intelligence has a prominent role to play not only in delivering innovative solutions, but also in managing the delicate balance of life in a pandemic context."

– Yves Joanette, Director, Consortium Santé Numérique

Knowledge

Health, Life Sciences and Media

Spotlight on a selection of inspiring projects

"Thank you very much for your excellent work. Your support for the quest for a research method that can be validated in practice is essential!"

– Margarida Carvalho, IVADO Professor

A neurodevelopmentally-informed computational model of flexible human learning and decision making

The adolescent period is characterized by significant neurodevelopmental changes which impact on reinforcement learning and the efficiency with which such learning occurs. Using data from a large longitudinal study of 4000 Montreal students assessed annually, the team used a bayesian reinforcement learning framework to model reinforcement learning. They now aim to expand and validate this computational model to better measure neuropsychological age/delay (1), to understand how these learning parameters contribute to high-order human decision making processes on more complex learning tasks (2), to simulate better learning scenarios to inform development of targeted neuropsychological training paradigms to **boost human learning and decision making** (3); and to demonstrate how the cognitive processes modelled allow for better-performing automated reinforcement learning agents in low information environments (e.g., uncertainty), while still performing adequately, to inform next generation AI models of lifelong learning (4).

Team: Patricia Conrod, Irina Rish and Sean Spinney (Université de Montréal)

Ecosystemic Bioethics and Big Data: Health, Agriculture and Ecology

Today's problems are global, linking society, economy and the environment to health. Antibiotic resistance, for example, stems from misuse of antibiotics in health and agriculture that reduces their efficacy. Broader collaborations among physicians, farmers and environmentalists are needed to tackle this problem, but they are constrained by a host of **technical and ethical challenges**. This thesis aims to investigate these issues affecting the **flow of data** across the health, agriculture and ecological communities, so as to propose a model of data governance that maximizes access and protection to support research, monitoring and action while sustaining the trust of data providers.

Team: Antoine Boudreau LeBlanc (IVADO PhD scholarship awardee), Bryn Williams-Jones, Cécile Aenishaenslin (Université de Montréal)

The Pandemic Online: Contagious Conspiracy Theories

The Radio-Canada *Décrypteurs* team's inbox overflowed during the pandemic. The research team analyzed its contents and observed that anxiety over COVID-19 has created a climate conducive to the spread of conspiracy theories on social media platforms. The full article (in French) is available on the Radio-Canada website.

Team: Jérémie Tousignant and Marc Boulanger (Université de Montréal), IVADO "Data Storytelling" scholarship awardees, 2020 cohort

Knowledge

Transportation, Logistics and Trade

Spotlight on a selection of inspiring projects

"I really appreciate your support and the effort you have made to start the project with the Banques alimentaires du Québec in such a short time. Thanks to the funding you have organized with Mitacs and the Fondation de l'Hôpital du Sacré-Coeur de Montréal, I will be able to fully invest myself in this research that is very close to my heart!"

– Imène Abid, MSc in Data Science and Business Analytics (HEC Montréal)

Modelling Transit Mode Interactions by Integration of Differing Data Sources

This research, part of a **multimodal mobility** context, i.e., combining the use of various transit modes, aims to detect correlations of use and situations of **complementarity** or **competitiveness** between modes. Since it requires cross-referencing a large number of databases, the project poses challenges of data integration and merging. Specifically, passive and longitudinal data streams, such as counts and transactional data, are used to track ridership of various transit modes over time. Different models are developed to predict and explain the interactions between modes and their impacts on travel demand. Among other things, they are based on time series theory and relate the dimensions of time and space, e.g. through repeated observations nested in spatial units (multilevel modeling).

Team: Élodie Deschaintres (IVADO PhD scholarship awardee), Catherine Morency, Martin Trépanier (Polytechnique Montréal)

Bridging Data-Driven and Behavioural Models for Transportation

Transportation data is traditionally collected through travel surveys and fixed sensors, mostly on the roadways: such data is expensive to collect and has limited spatial and temporal coverage. In recent years, more and more transportation data has become available on a continuous basis from multiple new sources, including users themselves. This has fed the rise of machine learning methods that can learn models directly from data. Yet, such models often lack robustness and may be difficult to transfer to a different region or period. This can be alleviated by taking advantage of domain knowledge stemming from the properties of the flow of people moving in transportation systems for their daily activities. This project aims to develop **hybrid methods** relying on transportation and data-driven models to predict flows for several modes at different spatial and temporal scales using multiple **sources of heterogeneous data**.

Team: Nicolas Saunier, Catherine Morency, Francesco Ciari, Martin Trépanier (Polytechnique Montréal) and Lijun Sun (Université McGill)

Retail Innovation Lab: Data Science for Socially Responsible Food Choices

In this research program, the team will investigate the use of artificial intelligence techniques to efficiently provide higher convenience for retail customers while being socially responsible. In particular, they will study, implement, and validate systems for guiding customers to make **healthy food choices** in a convenience store setting, while being cognizant of privacy concerns, both online and in a brick-and-mortar store environment. A distinguishing feature of this research program is that it will make use of a unique asset – a new "living-lab," the Retail Innovation Lab (RIL) at McGill University. It houses a fully functioning retail store operated by a retail partner with **extensive sensing**, data access, and customer monitoring. The RIL will be an invaluable source of data to use in developing and validating our approaches as well as a perfect site for running field experiments.

Team: Saibal Ray, AJung Moon, James Clark, Maxime Cohen (McGill University)

Knowledge

Natural Resources, Energy and Theory

Spotlight on a selection of inspiring projects

Modelling the Energy Sector in Mexico

This project consists of an in-depth analysis of the various energy sectors in Mexico with a view to obtaining a suitable energy model for all of North America. It involves research and compilation of data on Mexico's energy sectors, analysis of the available studies on the energy future of the country, and comparison of those studies' outcomes with results obtained from the NATEM mathematical model. The main objective is to successfully model the energy sector of Mexico so as to observe the effects of its **energy and environmental policies** on the energy sector.

Team: Martine Francoeur (IVADO undergraduate scholarship awardee), Olivier Bahn (HEC Montréal)

Paths to a cleaner Northeast energy system through approximate dynamic programming

Achieving a **sustainable** and decarbonized **electricity system** requires new methodologies for long-term planning in the face of deep uncertainties related to technological developments, shifts in load patterns and the **weather-dependent intermittency** of **renewable energies**. The main research question in this project is the design of such greener energy systems for the American Northeast: the Canadian provinces from Ontario to Newfoundland, and the northeastern states of the U.S.A.

The subquestions are numerous. How can renewable energy penetrate the markets? Are supplementary power transmission lines necessary? Can energy storage improve the intermittency problems of wind and solar power? Which greenhouse gases (GHG) reductions are achievable? What is the cost of such changes? Crucially, what is the path to a better system?

Team: Michel Denault, Dominique Orban, Pierre-Olivier Pineau (HEC Montréal)

Optimization Algorithms for Machine Learning and Deep learning

Modern artificial intelligence and machine learning rely heavily on large-scale optimization problems. This project focuses on the design, complexity analysis and **high-performance computing** implementations of scalable nonlinear optimization algorithms for large problems. One of the goals is the development of provably convergent algorithms for solving structured convex optimization problems. Since the methods used for **deep neural networks** are not well understood theoretically, the project also aims to design provable, adaptive optimization algorithms with good generalization properties. Finally, the team members combine their expertise with game theory to solve the next generation of AI involving adversarial formulations.

Team: Nicolas Loizou (IVADO postdoc scholarship awardee), Ioannis Mitliagkas (Université de Montréal)

Learning to Select Cutting Planes in Integer Programming

Solving mathematical optimization problems is of dramatic importance for many applications. While astonishing progress has been done in the last decades, these problems remain usually extremely hard. General-purpose solvers make limited use of the very rich structure of the problem because they are designed to be highly generic. On the other hand, specialized approaches require experts to manually design an algorithm, which is time consuming. This project objective is to **automatically detect the problem structure** and adapt general algorithms using machine learning tools to outperform general-purpose solvers.

This project directly feeds Ecole, the Extensible Combinatorial Optimization Learning Environment.

Team: Antoine Prouvost (PhD scholarship awardee), Andrea Lodi (Polytechnique Montréal), Yoshua Bengio (Université de Montréal)
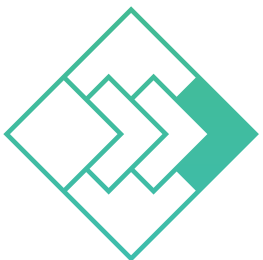
Transfer

Supporting learning about digital intelligence by companies and the community, technology transfer to industry and entrepreneurship.

>70 new professors involved in IVADO collaborative research projects

12 new industrial members

110 since 2016

133 new collaborative research projects started

324 projects since 2016

>$61 M value of IVADO collaborative research projects involving:

>150 companies, 220 researchers and 19 universities

>20 network and international partners

Transfer

Transportation, Logistics, Health and Life Sciences

Spotlight on a selection of inspiring projects

"Our best investment in digital intelligence has been our IVADO membership. IVADO has put us in touch with highly qualified researchers to make our in-house innovation projects a reality, meet inspiring industry professionals, and initiate collaborations with high-potential students who could become valuable talent for our organization."

– Noël Grospeiller, Vice-President, Customer and Employee Experience, Centres vétérinaires DMV

Natural Language Processing for Automated Classification of Aviation Safety Reports

The International Air Transport Association (IATA), a trade association of the world's airlines, has been striving to integrate the aviation safety reports from various sources and generate insights for data-driven global safety risk identification. These reports offer valuable information about past incidents and operational hazards, however, the ever-growing stream of the reports which now reached more than 2 million records written in plain text by various personnel and with aviation domain acronyms, made the manual processing of these dataset time-consuming and challenging. The objective of this project is to develop a custom Natural Language Processor model that **classifies accident and incident reports** under the data-driven taxonomy. The project will greatly support IATA in organizing aviation safety reports, which leads to the efficient and effective data-driven safety risk analysis, ultimately supporting the global aviation safety community and bringing **socioeconomic benefits** of ensuring safe and secure air transport to public.

Team: Hyuntae Jung, Olena Vasylchenko (IATA), Philippe Langlais (Université de Montréal).

Decision-Support Tools for Planning and Delivering Home Care and Services

This innovative project aims to develop decision-support tools to improve delivery of home care and services, such as continuity of care and more optimal use of caregivers. It is built around two principal research topics. First, **optimization of supply** (caregivers) and **demand** (users) management. Second, optimization of complex, multi-criteria vehicle routing. The work in progress relies on data science and combinatorial optimization techniques to solve complex, large-scale problems and arrive at the **best decisions**.

Team: Louis-Martin Rousseau, Maria-Isabel Restrepo-Ruiz, Nadia Lahrichi (Polytechnique Montréal), Jonathan Vallée (AlayaCare)

Transfer

Ressources naturelles, énergie, finance et commerce

Spotlight on two of our innovative projects

"Twelve organizations joined our IVADO community this year as industrial members, and several of our members have won local and international acclaim for their innovation in digital intelligence. We can be proud of our robust partnerships with industry, which are laying the groundwork for the digital society of tomorrow!"

– Nancy Laramée, Director of Partnerships

False Data Injection Attacks on AC Power System State Estimation Using Cosimulation

The secure and reliable operation of an electric power grid is critical to national security. Power grid components such as the state estimator used to monitor the operating state of a power system are subject to **cyber-attacks**. Previous works show that an intruder can compromise the state estimation by injecting pre-designed false data into meters without being detected, if detailed knowledge of a transmission grid is available. This project shows that false data injection attacks (FDIA) on AC state estimation can be successfully launched using phasor measurement unit (PMU) data without knowing the topology and line parameters of a power grid. The designed FDIA attack will be implemented using a cosimulation platform (with both a power system simulator and a communication network simulator) to evaluate its impacts on power systems. The project will provide a better understanding of the attack's impact on generic AC state estimation and important guidance regarding the design of mitigation measures to ensure the secure operation of power systems.

Team: Marthe Kassouf, Rawad Zgheib (Hydro-Québec), Xiaozhe Wang (McGill University)

Automated Reading of Climate-Related Disclosures with Views Towards the Understanding of ESG Metrics for Responsible Investments

Environmental, Social and Governance (ESG) factors are crucial in the investment decision process of a company, considering the **sustainability** and **societal impact** underlying those factors. Asset managers and other financial institutions are increasingly relying on ESG rating agencies to assess, measure and compare the ESG performance of companies. However, there is not yet a methodological standard for measuring ESG performance of projects, companies, or investment/debt portfolios. The information necessary to understand the ESG impact of a company is in an unstructured relational format, and artificial intelligence can be used in these efforts. There are several sources of information to extract ESG ratings for companies. For instance, company-disclosed information, news sources, public data sources, surveys, media reports, annual reports, and sustainability reports. As a first step for ultimately improving ESG performance metrics, the researchers have explored data sources available about climate change risk disclosures and reports, and developed and used Natural Language Processing (NLP) methods to extract and categorize relevant information. In addition to climate-related indicators, other ESG indicators can be included, such as pollution, waste, product safety, human capital development, business ethics, etc. These indicators can be used to calculate quantitative ESG ratings.

Team: Alexis Hannart (Axionable), Elham Kheradmand, Manuel Morales (Université de Montréal)

Transfer

Spotlight on one of our innovative projects **in agriculture** + **2020-21 initiatives**

"We are fortunate to be supporting the co-development of multiple innovations in digital intelligence. To make sure these advances are leveraged for the long term, we work hand-in-hand with the organizations that adopt them to ensure they assimilate the key knowledge needed to take advantage of the technologies in question."

– Jean-Marc Rousseau, Director of Technology Transfer

Classification of Time Series Beehive Data

nectar Nectar is an agriculture technology company that makes beehive sensors, analytic tools, and management software for commercial beekeepers and pollination dependent agriculture. A third of the food that we grow depends on honeybee pollination. Nectar's mission is to help the beekeeping industry ensure honeybee health to secure our food supply. By leveraging sensor data with manually labelled data on numerous aspects of beehive conditions, the goal of this project is to develop time series algorithms to classify various aspects of beehive health using in-hive sensors, such as estimating bee population and detecting thermoregulation behaviors which correspond to different health states. Nectar's in-hive sensors collect temperature, humidity, sound, and position data every 15 minutes. The dataset was built from approximately 1000 sensors that were installed at research centers, commercial beekeeping operations, and urban hives throughout North America during the summer of 2018. One of the models developed in the project has become the first hive population model deployed on the platform.

Team: David Stephens, Zayd Omar (McGill University), Evan Henry (Nectar)

Flagship initiatives: It's 2020-21, we're adapting!

Continuation of IVADO webinars

Launch of the Midis Santé IID-IVADO webinars

Two Digital intelligence internship and job faires that reached over 2000 students.

Fourth edition of the IVADO Data Philanthropy Hub on social inclusion, in partnership with Synapse C, the Chief Scientist of Québec, and the Fonds de recherche du Québec.

Climate and digital intelligence: $840,000 award from the Ministère de l'Environnement et de la lutte contre les changements climatiques to Mila, IVADO and two Québec universities to support a major project in Morocco.

Development of a tool for research and monitoring by fields of expertise of professors in the IVADO community, to further networking between academia and industry.

Support for the creation of the IA-Agrosanté platform, an innovative interface for artificial intelligence services in the fields of agri-food and animal health being rolled out by the Université de Montréal Faculty of Veterinary Medicine, made possible thanks to the Prompt *Propulsion des universités* program.

Transfer

Entrepreneurship

In 2020, IVADO refined its entrepreneurship approaches to:

Promote development of data science companies by students and faculty;

Bring academic expertise to the entrepreneurial ecosystem (accelerators and incubators);

Unite talents in the entrepreneurial ecosystem.

IVADO Entrepreneur Postdoc Fellowships

Congratulations to the two 2020 awardees, Marco Bonizzato and Yann-Seing Law-Kam Cio!

Marco Bonizzato, supervised by Marina Martinez (Université de Montréal) for his project **NeuralDrive**, a medical-device start-up with a revolutionary view on AI-based neurostimulation therapy for people with spinal cord injury. The device applies neurostimulation of the brain, nerves and muscles to improve the efficiency of motor training, reverse paralysis and help people walk again.

Yann-Seing Law-Kam Cio, supervised by Sofiane Achiche (Polytechnique Montréal) for his project **DesignBot Inc.** (formerly Metatronic), which aims to develop a software solution aimed at alleviating the burden on engineers and designers moving from product ideas to functional proof of concept. The software guides engineers via a methodology, tested

using research and artificial intelligence (AI) algorithms, that allows them to identify the key functionalities, properties and means needed to ensure their technology product is functional.

Start-ups **Gray Oncology** (Marc-André Renaud, 2018 awardee), **Blue City Technology** (Asad Lesani, 2018 awardee) and **LinguAI** (Selçuk Güven, 2019 awardee) will soon join the IVADO community as industrial members (at the conclusion of the program, businesses that are created can now benefit from a free IVADO membership for two years).

Datapreneur program

Support of $100,000 for the Datapreneur program of the Université de Montréal Entrepreneurship Centre. There were eight finalist start-ups: Antisense, Helis, Braindlab, Connektica, Drône Des Champs, LatenceTech, MedOClock® and Pill0.

Flagship events

Webinar in collaboration with the Embassy of Canada to Japan, Tokyo, September 2020.

Participation in the Forum Croissance Numérique with Montréal International, November 2020.

Participation in the 5th Big Data World Meeting: Disruptive Technologies at the Service of Humanity, Bogota, November 2020.
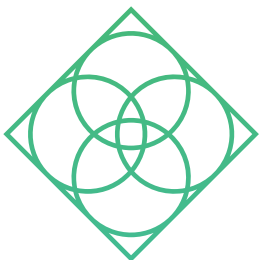
Participation in the World Manufacturing Forum, Italy, November 2020.

IVADO was a sponsor of the AIxSpace event, January 2021.

Organization and moderating of the panel "Être ou ne pas être une licorne" with IVADO academic partner 4POINT0, February 2021.

IVADO was a sponsor of the Effervescence 2021 event, March 2021.

Community

Making Montréal the hub of a strong international network of excellence in digital intelligence.

110
industrial members

15
academic partners

7
academic members

11
network partners

14
international partners

1
new IVADO intersectoral student committee

Community

The IVADO community

"Though we are physically distanced, we've stepped up our creativity to energize exchanges within our team and our community, maintaining the quality of our collaborations as best we can. They are key to our ability to collectively harness the full socio-economic potential of digital intelligence!"

– Laurence Beaulieu, Deputy CEO

ACADEMIC MEMBERS
PARTNERS
INDUSTRIAL MEMBERS

As of May 3, 2021

Community

Propelling student research in digital intelligence into the future

"The members of the IVADO student community hail from diverse backgrounds and are united by their keen interest in digital intelligence. In addition to recruiting, our mission is to provide support and training to this diversified new generation so that they may flourish and become an asset to the society of tomorrow."

– Alexandre Guertin-Pasquier, Student and Scientific Activities Coordinator

Objective 1

Support development and transfer to industry of digital intelligence research produced by students

First edition of the IVADO Digital October symposium, which attracted more than 350 participants.

Implementation of the programs "My Research Project in 800 Words," with five articles published, and "My IVADO Research Project in 180 Seconds."

Objective 2

Support the professional development of students

Launch of the IVADO **science cafés** introducing the labs and chairs of the IVADO ecosystem.

Development of **18 training** modules on ethics, EDI, science communication, media relations, project management, entrepreneurship, career development coaching, including with Sentinelle Nord, ACFAS and the Association des communicateurs scientifiques du Québec.

>1,300

student participants in IVADO activities during 2020

Objective 3

Foster, consult and support a dynamic, inclusive and multidisciplinary student community

Publication of a reference framework for the IVADO student community.

Major consultation on student services provided by IVADO.

Establishment of a roundtable with representation by the main student groups in digital intelligence from the Campus.

Creation of the SOUtien aux Regroupements IVADO (SOURI) program, providing logistical and financial support for student-run events in digital intelligence.

Creation of a student-dedicated newsletter and Facebook group.

Profile of our 2019 cohort of AIMS-IVADO fellows.

Creation of the IVADO Intersectoral Student Committee

1. Franck Benichou – Double Master's degree in Management, Data Science and Business Analytics, HEC Montréal

2. Chloé Bourquin – Doctorate in Biomedical Engineering, Polytechnique Montréal

3. Joëlle Cormier – Master's Degree in Management Science, HEC Montréal

4. Laura Gagliano – Doctorate in Biomedical Engineering, Polytechnique Montréal

5. Vincent Mai – Doctorate in Robotics/IA, Mila, Université de Montréal

6. Sébastien Paquette – Postdoctorate in Psychology, Université de Montréal

7. Léa Ricard – Master's Degree in Computer Science, Université de Montréal
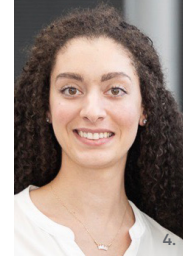
Community

Equity, Diversity, Inclusion (EDI)

"We work cross-functionally with a number of internal and external partners to ensure that digital intelligence is more equitable, diverse and inclusive. We do this in different ways, including introductory digital intelligence activities for underrepresented groups and training and awareness initiatives for all to help reduce unconscious and algorithmic bias."

– Mariloue Daudier, Equity, Diversity and Inclusion Advisor

Priority 1: Talents

The key actions taken over the past year to attract new digital intelligence talent from all backgrounds are as follows:

- Involvement in the QISEA Québec Indigenous Science Fair, which reached 50 young people from various Indigenous communities;

- Support for the Prompt 2020 Camp Découverte Techno: introduction to coding for 230 young people, 31% of whom were girls;

- Parité Sciences: equipping and raising awareness among teachers to stimulate enrolment by young women in undergraduate programs in science;

- Support for the second cohort of 30 women attending the AI4Good Summer Lab.

Priority 2: Institutions

To promote inclusion of under-represented groups in **STEM education and careers**, IVADO is piloting medium-term consultation and consensus-building efforts with its community, including, among others:

- Launch of a survey on EDI polling professors, research professionals and students from the seven IVADO academic members;

- Publication of the English version of the Unconscious Bias and Recruiting pamphlet.
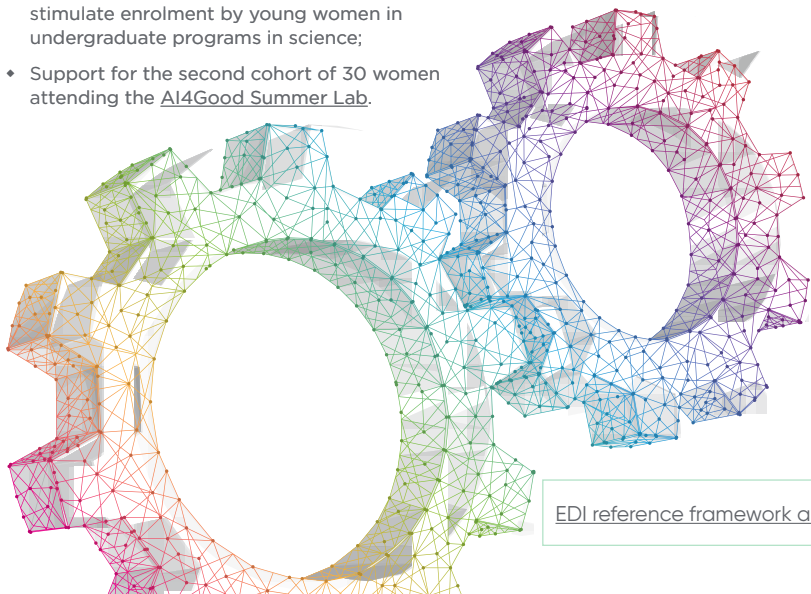
EDI reference framework and resources

>2,500
participants reached through awareness and training activities

60%
of students in the FRQ-IVADO Research Chairs in EDI self-identify as members of designated equity groups (women, members of visible minorities, Indigenous peoples, persons with disabilities)

Priority 3: New knowledge production

To create levers for facilitating contributions from people from minority groups and to further develop work on EDI topics in digital intelligence, IVADO:

- Funded the OBVIA/IVADO postdoctoral fellowship involving study of challenges of power, inequality and discrimination in AI (awardee: Sylvain Munger);

- Held workshops on EDI in Digital Intelligence and Ethics and EDI in Digital Intelligence;

- Held a roundtable on women and diversity in digital intelligence in collaboration with the IVADO Intersectoral Student Committee.

Community

Ethics

"It is not tomorrow that we will be able to discard our moral and political responsibility on machines."

– *Faire la morale aux robots*, published by Flammarion, 2021.

Martin Gibert, AI ethics researcher (Université de Montréal)

As part of efforts to ensure a responsible and sustainable future for digital intelligence, IVADO and its community were involved in several key initiatives:

◆ Participation in the second edition of the Montréal Speaker Series in the Ethics of AI;

◆ Organization of a study day on the ethics of algorithms in collaboration with OBVIA;

◆ Publication of the book Faire la morale aux robots: *une introduction à l'éthique des algorithmes* by Martin Gibert, AI and big data ethics researcher (IVADO, Université de Montréal Centre for Research on Ethics);

◆ Joint support, with the Fonds de Recherche du Québec and OBVIA, for creation of the Humaniteq podcast, which invites listeners to think about the societal issues raised by new technologies;

◆ Creation of a dedicated page and posting of available resources on the IVADO website.

Initiatives and considerations are continuing with an eye to raising awareness within the digital intelligence ecosystem about the **ethical impacts** of the growth of digital intelligence tools in our societies.

"Outstanding presentations on the current state of research and best practices in ethics and AI for capitalizing on innovation through promotion of inclusion and diversity."

– Catherine Feuillet, Director of Development, SKEMA Canada (webinar on Ethics + EDI, December 2020)

WEBINAIRE | WEBINAR

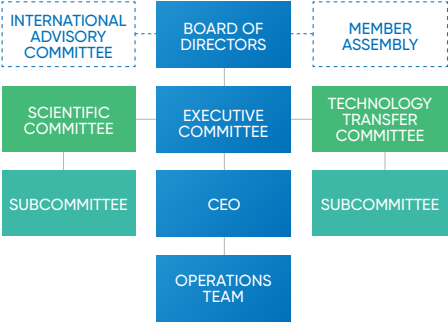### Équité, Diversité et Inclusion en intelligence numérique

Equity, Diversity and Inclusion in Digital Intelligence

Par | By Vanessa Cherenfant et Mariloue Daudier

Governance

IVADO's governance structure is guided by the administrative management agreement signed by our three founding universities (HEC Montréal, Polytechnique Montréal and Université de Montréal) and dictates the implementation of our various committees.

INTERNATIONAL ADVISORY COMMITTEE

BOARD OF DIRECTORS

MEMBER ASSEMBLY

SCIENTIFIC COMMITTEE

EXECUTIVE COMMITTEE

TECHNOLOGY TRANSFER COMMITTEE

SUBCOMMITTEE

CEO

SUBCOMMITTEE

OPERATIONS TEAM

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Chair of the Board
Vice-Rector, Research Discovery, Creation and Innovation, Université de Montréal

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Alain Lavoie
President, LexRock AI

Alexandre Le Bouthillier
Co-founder, Imagia

Natacha Mainville
Senior Research Program Manager, Google Brain

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Maxime St-Pierre
Managing Director, Digital Media, Radio-Canada

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Head, Expertise - Data Science and High Performance Computing, Hydro-Québec

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Jean-François Larochelle
Senior Director, DataLab R&D, Intact

Natacha Mainville
Senior Research Program Manager, Google Brain

Philippe Molaret
Technical Director, Thales Canada

Pierre Nader
President, SPN Consultants

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Senior Data Scientist, Desjardins

Pape Wade
Co-founder and CEO, Airudi

Nada Zogheib
Executive Director, Centre d'entrepreneuriat Poly-UdeM

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IVADO

We thank the entire IVADO community, which contributes directly to accelerating the digital transformation of our society!

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