

# IVADO PRF3 Workshop 2024: Towards Resilient and Sustainable Supply Chains Through Machine Learning and Optimization

**Date:** April 22, 2024

**Place:** Amphitheatre | Rachele et Alain-Paris (A.335), [HEC Montréal downtown campus](#) (Hélène Desmarais Building)

**Description:** Recent developments in machine learning and optimization have the potential to enable supply chain decision-makers and practitioners to leverage data and deal with uncertainty in an effective and adaptive fashion. This scientific workshop presents various industrial realizations demonstrating how modern machine learning and optimization methods can effectively be applied in practice. Through academic-style talks from speakers in both academia and industry, they will present various use cases in supply chains and scientific approaches, as well as challenges and opportunities in the applications of learning and optimization methods. There will also be dedicated time for informal discussions among participants.

*The conference provides coffee, lunch and post-event cocktail reception with finger foods*

**Symbolic fee:** \$25

**Titles and speakers:**

Time	Title:	Speakers
8:30 - 8:50	Coffee & registration	
8:50 - 9:00	Opening speech	Erick Delage (HEC Montréal)
9:00 - 10:00	<a href="#">Practical Considerations for Decision Under Uncertainty in an Industrial Setting</a>	Marie-Claude Côté, Sacha Izadi, Nicolas Boez, Jean-François Landry (IVADO Labs)
10:00 - 10:45	<a href="#">Sample Efficient Algorithms for Urban Mobility Problems Through Physics-Informed Machine Learning</a>	Carolina Osorio (HEC Montréal and Google Research)
10:45 - 11:00	Coffee break	
11:00 - 11:45	<a href="#">Ship Route Optimization - Multi-Objective Approach</a>	Capt. Gurjeet Warya (True North Marine)
11:45 - 12:30	<a href="#">Humanitarian Supply Chain Analytics</a>	Marie-Ève Rancourt (HEC Montréal)

12:30 - 13:45	Lunch	
13:45 - 14:30	<a href="#">Operational Design and Data in Smallholder Farmer Supply Chains</a>	Joann de Zegher (PemPem)
14:30 - 15:15	<a href="#">Optimize-Then-Predict: An Imitation-Based Learning Framework</a>	Louis-Martin Rousseau (Polytechnique)
15:15 - 15:30	Coffee break	
15:30 - 16:15	<a href="#">Unlocking Decision-Making under Uncertainty: The Power of Industry-Academia Collaboration</a>	Emma Frejinger (Université de Montréal), Helen Glover (CN)
16:15 - 17:00	<a href="#">Leveraging Machine Learning and Optimization in Supply Chain Planning</a>	Yossiri Adulyasak (HEC Montréal)
17:00 - 18:00	Cocktail	

## Speakers' Information:

Marie-Claude Côté, Jean-François Landry, Nicolas Boez, Sacha Izadi

Marie-Claude Côté



Sacha Izadi



Nicolas Boez



Jean-François Landry



### **Affiliations:**

**Marie-Claude Côté:** Vice President, Data Science, IVADO Labs

**Sacha Izadi:** Senior Data Scientist, IVADO Labs

**Jean-François Landry:** Senior Data Scientist, IVADO Labs

**Nicolas Boez:** Senior Data Scientist, IVADO Labs

IVADO Labs (<https://ivadolabs.com/>)

**Presentation Title:** Practical Considerations for Decision Under Uncertainty in an Industrial Setting

**Presentation abstract:** Applying optimization and machine learning solutions to real-world industry

problems is often a challenging task, especially when dealing with uncertainty and limited data. Within this presentation, we will show some concrete examples of how these problems are tackled at Ivado Labs. First with the introduction of a general framework for decision under uncertainty. Secondly with the application of this framework to two use cases: A storage allocation problem in the context of a maritime container terminal, and a multi-echelon inventory management problem. Some key results will be presented to showcase the performance of the solutions, followed by some takeaways for solving such problems in an industrial setting.

### **Short bio of speakers:**

#### **Marie-Claude Côté**

Marie-Claude Côté specializes in artificial intelligence and operations research and has led several teams of scientists and developers delivering products and solutions to large enterprises. She is currently in IVADO Labs' executive team and is leading their data science team. Previously, she created and grew Element AI's AI core group, main group responsible for building the AI technology for the company's products, and led the JDA Labs' data science team. She is co-inventor of more than 10 patents and holds a PhD in applied mathematics from École Polytechnique de Montréal.

#### **Sacha Izadi**

Sacha Izadi is a Senior Data Scientist at IVADO Labs, specializing in the development of products and systems blending machine learning with operations research. With a background that includes five years in AI consulting, Sacha has delivered bespoke AI solutions for large corporations, from proof-of-concept to full-scale industrialisation. His expertise lies in the development of large-scale optimization engines for supply planning, marketing portfolio management, and pricing promotions across various sectors such as consumer goods and B2B operations.

#### **Nicolas Boez**

Nicolas Boez is Senior Data Scientist at Ivado Labs, where he has been scientifically leading and delivering projects for 5+ years. His expertise lies in combining the fields of Operations Research (OR) and Machine Learning (ML) to create powerful AI solutions. Specializing in stochastic optimization, Nicolas has developed 10+ AI components mainly applied to maritime container terminals. These modules support operational, tactical and strategic decisions about operations and assets scheduling, routing, answering customer requests, etc. His work simplifies complex tasks and improves decision-making, proving invaluable in the maritime industry. Nicolas is known for his ability to tackle challenging problems with AI, making operations smarter and more efficient.

#### **Jean-François Landry**

Jean-François is a Senior Data Scientist at Ivado Labs with over 15 years of experience in optimization and AI. He has in-depth knowledge of scheduling problems, having worked for several years in the airline crew member scheduling industry as well as on pickup and delivery routing problems. In recent years at Ivado Labs, his work has been focused on finding solutions to a wide variety of problems ranging from inventory management problems to black-box optimization and flow maximization problems within a stochastic framework. Within his current role, he applies his expertise to bring projects from inception (proof of concept) to full scale deployment, developing the scientific approach and ensuring its scalability and feasibility.

## Carolina Osorio



### **Affiliation:**

**Carolina Osorio:** Scale AI Research Chair in Artificial Intelligence for Urban Mobility and Logistics, Professor at HEC Montréal and Staff Research Scientist at Google Research (<https://www.carolinaosorio.net/>)

**Presentation Title:** Sample Efficient Algorithms for Urban Mobility Problems Through Physics-Informed Machine Learning

**Presentation abstract:** This talk presents various physics-informed methods to search high-dimensional continuous spaces in a sample efficient way, with a focus on urban mobility applications. We present advances in three areas: (i) variance reduction methods for gradient estimation, (ii) sample-efficient dimensionality reduction methods, (iii) sample-efficient simulation-based network optimization algorithms. We present case studies based on various metropolitan areas. We identify and discuss research opportunities and challenges in the fields of optimization and machine learning as applied to urban mobility problems.

**Short bio of speaker:** Carolina Osorio is a Full Professor in the Department of Decision Sciences at HEC Montreal, where Osorio holds the SCALE AI Research Chair in Artificial Intelligence for Urban Mobility and Logistics. Osorio is also a Staff Research Scientist at Google Research. Her work focuses on the design of AI and simulation-based optimization algorithms to tackle high-dimensional optimization problems. Osorio has collaborated with top private and public sector urban transportation stakeholders, including Ford Motor Company, and New York City Department of Transportation. Osorio was recognized as one of the outstanding early-career engineers in the US by the National Academy of Engineering's EU-US Frontiers of Engineering Symposium, and is the recipient of a US National Science Foundation CAREER Award, an MIT CEE Maseeh Excellence in Teaching Award, an MIT Technology Review EmTech Colombia TR35 Award, an IBM Faculty Award and a European Association of Operational Research Societies (EURO) Doctoral Dissertation Award.

## Capt. Gurjeet Warya



**Affiliation:**

**Capt. Gurjeet Warya:** Vice-President, Business Development and Operations at True North Marine (<https://tnmservices.com/>)

**Presentation Title:** Ship Route Optimization - Multi-Objective Approach

**Presentation abstract:** This presentation covers the efforts of True North Marine (TNM) a Montreal-based consulting firm offering services on route selection and analysis to ocean-going ships using advanced multi-objective Route Optimization tools. This powerful routing tool is the result of a collaboration between TNM and IVADO which initiated a R&D project among three Quebec universities in 2019. The project developed a DSS consisting of several modules which include diagnostic analytics to identify the performance functions based on historical route and weather data, predictive analytics to generate the route network and solve the optimization problem, prescriptive analytics to support and manage the multi-objective features. The methodologies developed include machine learning, inverse optimization, shortest path, data quality analytics, and big data management to convert data into information for decision making. The project was successfully commercialised as OPTINAV, an online Route Optimization Software, during the Fall of 2022.

**Short bio of speaker:** Gurjeet Warya is the VP Business Development and Operations at True North Marine since 2013. Prior to True North Marine, Gurjeet spent 17 years at sea, sailing on ocean-going vessels, in various capacities, the last 4 of which were as a captain. Aside from the certificates of competency as a ship captain, Gurjeet holds a master's in economics and an MBA from HEC Montreal. Gurjeet is passionate about data-driven insights to inform strategic decision-making and is a strong advocate of digitalisation of shipping industry to bring efficiencies to the supply chain ecosystem.

## Marie-Ève Rancourt



**Affiliation:**

**Marie-Ève Rancourt:** Canada Research Chair in Humanitarian Supply Chain Analytics and Associate Professor at HEC Montréal (<https://crc-analytique-logistique-humanitaire.hec.ca/>)

**Presentation Title:** Humanitarian Supply Chain Analytics

**Presentation abstract:** This presentation seeks to present decision-making problems inherent in humanitarian supply chains, emphasizing their distinctive features. We explore specific network analysis and design problems unique to humanitarian contexts, such as relief item prepositioning and evacuation planning. Recognizing that each problem demands an ad hoc solution approach, we discuss the intuition behind the implemented OR-based methodologies such as stochastic programming and statistical modeling. Applied quantitative research hinges heavily on data collection and processing to delineate problems and parametrize optimization models. We illustrate the use of both unstructured information and formal data to devise well-defined problems. Real-life examples and solution validation techniques will be also discussed, along with an exploration of integrating machine learning techniques to enhance proposed optimization frameworks. The presentation follows the principles of a bottom-up research design, from challenges encountered by humanitarian organizations on the field to solution propositions.

**Short bio of speaker:** Marie-Ève Rancourt is an Associate Professor in Logistics and Operations Management at HEC Montréal, holding the Canada Research Chair in Humanitarian Supply Chain Analytics. Specializing in humanitarian logistics, supply chain design, and transportation management, her research centers on optimization methodologies to enhance data-driven decision-making and policy formulation. Collaborating with organizations globally, including the World Food Programme, Red Cross Societies, the Caribbean Disaster Emergency Management Agency, the World Bank, and the Quebec Food Bank, she develops analytical methods for managing relief supply chains and supporting vulnerable populations in locations such as Kenya, Liberia, Haiti, Madagascar, and Canada. Her work has received recognition, including the AACSB Innovations That Inspire Challenge, and has yielded award-winning articles, such as the SEIO-BBVA Foundation Prize and POMS HOCM Best Paper Awards. She has contributed to top-tier journals like *Production and Operations Management* and *Operations Research*.

## Joann de Zegher



**Affiliation:**

**Joann de Zegher:** Founder and CEO of PemPem (<https://www.pempem.io/>)

**Presentation Title:** Operational design and data in smallholder farmer supply chains

**Presentation abstract:** This talk will introduce the operational innovations implemented by [PemPem](#) to advance traceability and sustainability in global commodity markets supplied by hundreds of millions of smallholder farmers. In this talk, I will also share ML/optimization opportunities and lessons learned from our work in Indonesia.

**Short bio of speaker:** Joann de Zegher is Founder and CEO of PemPem, which develops mobile supply chain management software for micro-enterprises in agricultural commodity supply chains. Joann is also a Mulago Fellow (2022) and has been the Maurice F. Strong Career Development Professor at the MIT Sloan School of Management from 2018-2024. Joann has a PhD in Earth Systems Analysis and Operations Management from Stanford University.



## Louis-Martin Rousseau



**Affiliation:**

**Louis-Martin Rousseau:** Canada Research Chair in Analytics and Logistics of Healthcare, and Professor at Polytechnique Montréal (<https://hanalog.ca/en/person/louis-martin-rousseau/>)

**Presentation Title:** Optimize-Then-Predict: An Imitation-Based Learning Framework.

**Presentation abstract:** Predictive models are playing an increasingly pivotal role in optimizing decision-making. This talk introduces an innovative approach based on optimize-then-predict, wherein a series of (possibly) stochastic sequential decision problems are initially solved offline, and subsequently, a predictive model is constructed based on the offline solutions to facilitate real-time decision-making. The applicability of this methodology is demonstrated through two use cases: patient radiation therapy where managers need to preserve capacity for emergency cases and a novel dynamic employee call-timing problem for the scheduling of casual personnel for on-call work shifts.

**Short bio of speaker:** Louis-Martin Rousseau has been a professor at Polytechnique Montreal for 20 years, where his research explores the frontier of artificial intelligence (AI), operations research (OR), and management science (MS). His work focuses on combinatorial optimization, solving problems from transportation logistics, personnel scheduling, and healthcare resource optimization. Since 2016, he has held the Canada Research Chair in Healthcare Logistics (HANALOG)., which focuses on developing a new generation of optimization algorithms to solve descriptive, predictive and prescriptive analytic problems in healthcare. Louis-Martin has published over 200 scientific publications, some in prestigious journals, such as Management Science, INFORMS Journal on Computing, and Transportation Science.

## Emma Frejinger and Helen Glover

**Emma Frejinger**



**Helen Glover**



**Affiliations:**

**Emma Frejinger:** Canada Research Chair in Demand Forecasting Optimization of Transport Systems, CN Chair in Optimization of Railway Operations, and Professor at Université de Montréal (<https://www.emmafrejinger.org/>)

**Helen Glover:** Manager of Innovation Management at CN

**Presentation Title:** Unlocking Decision-Making under Uncertainty: The Power of Industry-Academia Collaboration

**Presentation abstract:** The COVID-19 pandemic exposed the fragility and complexity of global supply chains, creating unprecedented challenges and opportunities for decision makers moving our vital goods and commodities. In this context, rail transportation plays a critical role in ensuring the resilience and efficiency of supply chains, but also faces significant variability in demand, capacity, and operating environment. How can rail operators cope with these challenges and optimize their operations under uncertainty? In this presentation we will discuss challenges through the lens of a successful academic-industry partnership between Canadian National Railway, the largest rail network in Canada, and the Chair in Optimization of Rail Operations at Université de Montréal. The collaboration has developed and advanced analytics and operations research modelling techniques to support decision-making across large networks. We will present how these techniques can help rail operators take their operational performance and sustainability to new levels and the value of industry-academia partnerships to solve the hardest problems.

**Short bio of speakers:**

**Emma Frejinger**

Emma Frejinger is a professor in the Department of Computer Science and Operations Research at Université de Montréal where she holds a Canada Research Chair and an industrial chair funded by the Canadian National Railway Company. Her research is application-driven and focuses on innovative combinations of methodologies from machine learning and operations research to solve large-scale decision-making problems. Emma has extensive experience working with industry, predominantly within the transportation sector. Since 2018, she also works as a scientific advisor for IVADO Labs developing AI solutions for the supply chain industry.

**Helen Glover**

Helen Glover is the Manager of Innovation Management at CN, a leading North American railway company. She has a background in geomatic engineering and has been working at CN since 2012, where she has led various innovative technology projects. Helen has also played a critical role in taking CN's groundbreaking Autonomous Track Inspection Program from concept to reality. She is passionate about innovation management, designing technology strategies, and applying AI and automation to build the Supply Chain of the future.

## Yossiri Adulyasak



**Affiliation:**

**Yossiri Adulyasak:** Canada Research Chair in Supply Chain Analytics and Associate Professor at HEC Montréal (<http://yossiri.info/>)

**Presentation Title:** Leveraging Machine Learning and Optimization in Supply Chain Planning

**Presentation abstract:** A recent study showed that approximately 98% of firms do not believe they have the necessary tools to help them face a future disruption. Traditional supply chain planning models that rely on simplistic assumptions with respect to uncertainties are far from being effective in such a circumstance. This talk covers our recent research in supply chain analytics which leverages various stochastic optimization and machine learning methods for decision-making under uncertainty in the areas of demand forecasting, production planning, inventory management, and distribution planning in supply chains. We will present notable results, key takeaways and potential research directions based on the projects and case studies.

**Short bio of speaker:** Yossiri Adulyasak is the Canada Research Chairholder in Supply Chain Analytics, an associate professor at HEC Montréal. Prior to joining HEC, he was a postdoc at MIT and then a data scientist at JDA (now Blue Yonder). To date, he has co-authored more than 40 research articles in the areas related to supply chain management, AI/analytics and optimization which appeared in prominent research journals in Operations Research, Artificial Intelligence and Supply Chain Management. Yossiri serves as a scientific consultant for multiple industrial initiatives with firms and start-ups to integrate modern predictive and prescriptive analytics in various supply chain applications. He is also a co-inventor of five patent applications in retail and supply chain analytics, and has been awarded several prizes from academic and industrial organizations during his tenure.