NHH

NHH Norwegian School of Economics

# Joint Workshop Centres for Shipping and Logistics & Energy, Natural Resources and the Environment

Bergen, 24-25 May, 2023

Forskningsrådet

Evaluation of the Social Sciences in Norway (SAMEVAL)

# CSL/ENE Workshop, NHH Norwegian School of Economics

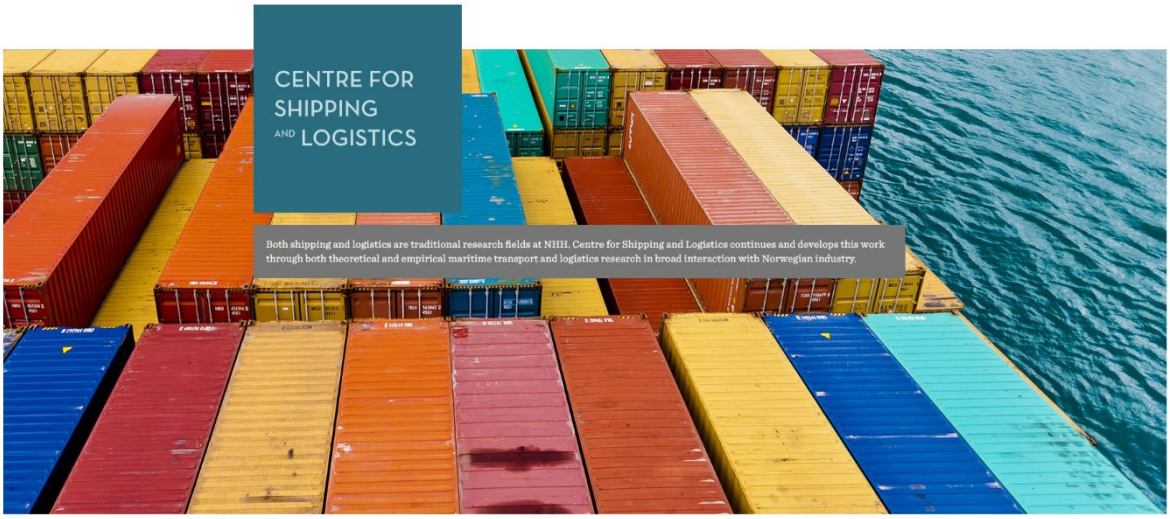
**Bergen, 24-25 May, 2023**

The CSL and ENE research centres are pleased to organize this joint workshop, as part of the SAMEVAL project “Transportation, logistics, energy and green business finance”. The main aim of this project is to enhance our international portfolio of contacts and activities and developing future projects, including projects from EU and other relevant calls.

Both shipping and logistics are traditional research fields at NHH. The Centre for Shipping and Logistics continues and develops this work through both theoretical and empirical maritime transport and logistics research in broad interaction with Norwegian industry.

ENE (Energy, Natural Resources and Environment) is a cross-disciplinary area covering and combining research in several core topics such as energy markets, management of renewable and non-renewable resources and the environment and climate change.

The purpose of this joint workshop is to discuss ideas in the intersection of both centres, including applications in relevant problems, and the development of methodological approaches on optimization, empirical analysis, and data handling, among others.




**PROGRAMME**

**Wednesday 24th May**

**9.45 - 11.00 SESSION 1 (Aud. P - "Finn Kydland") Chair: Julio C. Góez**

9.45 – 10.00 Welcome/Introduction

10.00 – 10.30 Julie Schasler (Dataloy): *Integrated chartering and vessel operations*

10.30 – 11.00 Etienne Dunn-Sigouin (NORCE): *A short overview of climate futures, focusing on 3 projects: insurance, shipping and agriculture*

**11.00 – 11.30 COFFEE BREAK**

**11.30 – 13.00 SESSION 2 (Aud. P - "Finn Kydland") Chair: Leif K. Sandal**

11.30 – 12.00 Francesca Maggioni (University of Bergamo): *Robust and Distributionally Robust Optimization Models for Classification Problems*

12.00 – 12.30 Eduardo Moreno (Adolfo Ibáñez University/Google France): *Benders Adaptive-Cuts Method for Two-Stage Stochastic Programs*

12.30 – 13.00 Vincenzina Messina (University of Milano-Bicocca): *Graph Embedding: Representing and Analyzing Complex Networks*

**13.00 – 14.00 LUNCH**

**14.00 – 15.00 SESSION 3 (Aud. P - "Finn Kydland") Chair: Mario Guajardo**

14.00 – 14.30 David Van Bulck (Ghent University): *Choosing the right algorithm: an application to sports timetabling*

14.30 – 15.00 Jiehong Kong (SINTEF Energy Research): *Integrating Machine Learning Techniques into the Decision-making Process for Hydro Scheduling*

**15.00 – 15.15 SHORT BREAK**

**15.15 – 16.15 SESSION 4 (Aud. P - "Finn Kydland") Chair: Haiying Jia**

15.15 – 15.45 Lang Hao (Hong Kong Polytechnic University): *Green Energy Transaction Policies in the Shipping Industry: The Case of Substitute Versus Complementary Green Energy Goods*

15.45 – 16.15 Ning Lin (Centre for High North Logistics, Nord University): *Review of environmental risks and impact due to shipping activities in the Arctic*

**19.30 DINNER at Zachariasbryggen**

**Thursday 25th May**

**10.00 - 11.00 SESSION 5 (Aud. P - "Finn Kydland") Chair: Gabriel Fuentes**

10.00 – 10.30 Mikael Rönnqvist (Université Laval): *Maritime Vessel Weather Routing with Multiple Objectives Under Uncertainty*

10.30 – 11.00 Peter Ellevseth (Safetec): *Causal analysis on weather implications on collisions and forecasting models for early recognition of high-risk areas*

**11.00 – 11.30 COFFEE BREAK**

**11.30 – 13.00 SESSION 6 (Aud. P - "Finn Kydland") Chair: Stein W. Wallace**

11.30 – 12.00 Paolo Migliari (Global Supply Chain Management MSD): *Blockchain-Based Solutions for Healthcare: Enhancing Trust, Security and Efficiency*

12.00 – 12.30 Wu Zhenming (UiT The Arctic University of Norway): *Tracking Liquid Bulk Volume in Storage Tanks Using Interferometric Synthetic-Aperture Radar (SAR)*

12.30 – 13.00 Jaikishan Soman, Stein W. Wallace (NHH Norwegian School of Economics): *CITYFREIGHT project & final remarks*

**13.00 – 14.00 LUNCH / FAREWELL**

**ABSTRACTS**

***Integrated chartering and vessel operations***

Julie Schasler (Dataloy)

We will briefly introduce Dataloy and our software for integrated chartering and vessel operations. Then we will discuss development areas we are interested in and interesting research questions from our practical perspective.

***A short overview of climate futures, focusing on 3 projects: insurance, shipping and agriculture***

Etienne Dunn-Sigouin (NORCE)

Climate Futures is a centre for research-based innovation (SFI) whose goal is to develop solutions for reducing climate risk. Led by the Norwegian Research Centre (NORCE), we aim to make weather and climate forecast information not only useful but usable in real-life applications. Our approach focuses on collaboration between academics and public and private organisations, where we embed our researchers within our partner institutions. Here, I will give a short overview of Climate futures, some example pilot projects in the shipping, insurance and agricultural sectors as well as some lessons learned from our ongoing collaborations.

***Robust and Distributionally Robust Optimization Models for Classification Problems***

Francesca Maggioni (University of Bergamo)

In this talk we present novel data-driven optimization models for Support Vector Machines (SVM). To handle uncertainty in data measurements, robust optimization models are proposed both in the linear and non linear cases. Besides, a moment-based distributionally robust optimization model enforcing limits on first-order deviations along principal directions in the linear case is presented. All the formulations reduce to convex programs. The new classifiers are evaluated on real-world databases and compared with the corresponding deterministic ones.

***Benders Adaptive-Cuts Method for Two-Stage Stochastic Programs***

Eduardo Moreno (Adolfo Ibáñez University/Google France)

Two-stage stochastic programs (TSSP ) are a classic model where a decision must be made before the realization of a random event, allowing recourse actions to be performed after observing the random values. For example, many classic optimization problems, like network flows or facility location problems, became TSSP if we consider, for example, a random demand.

Benders decomposition is one of the most applied methods to solve TSSP with a large number of scenarios. The main idea behind the Benders decomposition is to solve a large problem by replacing

the values of the second-stage subproblems with individual variables, and progressively forcing those variables to reach the optimal value of the subproblems, dynamically inserting additional valid constraints, known as Benders cuts. Most traditional implementations add a cut for each scenario (multi-cut) or a single-cut that includes all scenarios.

In this paper we present a novel Benders adaptive-cuts method, where the Benders cuts are aggregated according to a partition of the scenarios, which is dynamically refined using the LP-dual information of the subproblems. This scenario aggregation/disaggregation is based on the Generalized Adaptive Partitioning Method (GAPM). We formalize this hybridization of Benders decomposition and the GAPM, by providing sufficient conditions under which an optimal solution of the deterministic equivalent can be obtained in a finite number of iterations. Our new method can be interpreted as a compromise between the Benders single-cuts and multi-cuts methods, drawing on the advantages of both sides, by rendering the initial iterations faster (as for the single-cuts Benders) and ensuring the overall faster convergence (as for the multi-cuts Benders).

Computational experiments on three TSSPs validate these statements, showing that the new method outperforms the other implementations of Benders method, as well as other standard methods for solving TSSPs, in particular when the number of scenarios is very large.

***Graph Embedding: Representing and Analyzing Complex Networks***

Vincenzina Messina (University of Milano-Bicocca)

Graphs provide a powerful way to represent complex networks in a wide range of domains, from social networks and recommendation systems to biological and transportation networks. However, analyzing and processing large-scale graphs can be a computationally expensive and challenging task. In recent years, graph embedding has emerged as a promising approach to address this challenge, by representing graphs as low-dimensional vectors that capture their structural and semantic features.

In this talk, we will discuss the key challenges and opportunities of graph embedding, and present some applications in different domains.

***Choosing the right algorithm: an application to sports timetabling***

David Van Bulck (Ghent University)

In today's society, timetables are essential to keep economies and societies running. However, due to the growing availability of algorithms and the increasing complexity of timetabling requirements, selecting an appropriate algorithm to construct the timetable can be challenging. This talk presents different strategies for selecting the most suitable algorithm for an optimization problem, focusing on sports timetabling as an example.

Until not so long ago, the lack of a common benchmark of problem instances made it difficult to assess the performance of sports timetabling algorithms. In this regard, we recently organized the International Timetabling Competition 2021 (ITC2021) on sports timetabling, inviting researchers to develop broadly applicable sports timetabling algorithms. The first part of this talk discusses the generation of a set of artificial yet challenging, realistic, and diverse problem instances for ITC2021. We present a set of features describing the structure of the problem instances, and use these features

to construct the so-called instance space for sports timetabling. Several gaps in this space hint that existing problem instances from the literature are not very diverse.

ITC2021 demonstrated that it is possible to move away from competition-specific algorithms to more generally-applicable solvers. However, using a single algorithm for all types of applications is not the best choice, as different algorithms tend to work best on different types of problem instances. The second part of the talk presents how machine learning techniques can be used to predict which ITC2021 algorithm is expected to work best, when given the features of a sports competition. An analysis of these recommendations provides insights into when and perhaps even more importantly why some algorithms work better than others.

***Integrating Machine Learning Techniques into the Decision-making Process for Hydro Scheduling***

Jiehong Kong (SINTEF Energy Research)

During the past half-century, numerous optimization models have been developed to help hydropower producers to determine the optimal power generation schedules. Nevertheless, the producers must manually set up the executive commands before running the optimization models. Limited by human analytic competence, the producers usually use the default setting. The value of the optimization tools could be further carried forward if the commands are dynamically determined according to the specific operating and market conditions. In this paper, we propose a framework and methodologies to facilitate the decision-making process for hydropower producers by realizing the automatic setup of executive commands. This automation is achieved by integrating machine learning (ML) techniques with a comprehensive understanding of the hydro systems and the hydro scheduling tools. It is demonstrated that nonphysical spills from reservoirs can be 100% avoided using the command setting predicted by ML compared to the result obtained by the default setting. The calculation time can reduce by 45% compared to the robust setting.

***Green Energy Transaction Policies in the Shipping Industry: The Case of Substitute Versus Complementary Green Energy Goods***

Lang Hao (Hong Kong Polytechnic University)

To mitigate global warming by reducing GHG emissions, the shipping industry is actively looking for green energy sources. A defining feature of these green energy goods is that they may be complements or substitutes. For example, electricity is a main green energy source, part of which photovoltaic cells are complemented by the development in battery technology. However, it competes with and thus is a substitute to both hydrogen and methanol. It is unclear how energy providers with complementary or substitute green energy goods would collaborate or compete in the green energy market (Jacobsson and Lauber, 2006; Bergek et al., 2008; Bergek et al., 2015; Normann, 2017). This is important for the green energy transaction in the shipping industry because energy providers may be too reluctant to take the initiative to advance the development in green energy without preferential policies. This study aims to address this question and provide policy recommendations from the social welfare viewpoint.

***Review of environmental risks and impact due to shipping activities in the Arctic***

Ning Lin (Centre for High North Logistics, Nord University)

Global warming and continued reduction in sea ice cover will result in longer open water duration in the Arctic. In the regions north of the Bering Strait (north of 70 degrees N), future open-water duration may shift from a current 3-4 months to a projected near 5 months by 2040, which is important for the shipping industry and may lead to an increasing number of vessels navigating through the Arctic shipping routes. However, this trend also comes with a range of environmental and operational challenges.

One of the primary impacts of increased shipping activities in the Arctic is the increased risk of accidents and environmental damage. As ice melts and sea routes become more accessible, more ships are entering the region, increasing the risk of collisions and spills. The impact of Arctic shipping also extends to indigenous animals, shipping activities can disrupt migration patterns (Halliday et al., 2017), alter feeding grounds (Derocher et al., 2013), and contribute to increased noise pollution (Pirotta et al., 2012), which can interfere with communication and hunting. In addition, the potential for oil spills (de La Fayette, 2008) or other accidents (Sarkisov et al., 2017) during shipping operations can have severe and long-lasting impacts on local wildlife, including damage to their habitat and food sources.

The purpose of this paper is to review the literature on the environmental impacts and risks of shipping activities in the Arctic. This literature review research helps synthesize and summarize existing research findings in the field of environmental impacts of shipping in the Arctic, providing a comprehensive overview and insights to the readers. This research will also identify gaps in the existing knowledge base and highlight areas that need further research.

***Maritime Vessel Weather Routing with Multiple Objectives Under Uncertainty***

Mikael Rönnqvist (Université Laval)

True North Marine (TNM) is a Montreal based consulting company offering services on route selection and analysis to ocean-going vessels, operators and owners. The need for optimized routing has gained relevance in the age of JIT arrivals, fluctuating fuel costs and tightening emission standards. The efficient route requires a deep understanding of the interplay between fuel consumption, vessel speed and safety depending on the weather. Today, there are many high accuracy sources on ocean currents and seas and winds, the three primary weather elements that go towards route planning. Other important information that affects a voyage planning include among others; storm locations and movements and their historical tracks, wind speed and direction, sea currents, wave height and frequency. The weather condition is vital in the route planning. The IMO (International Maritime Organization) has implemented new regulations, as of January 1st 2020, requiring vessels to burn fuel with much lower sulphur content (drop from 3.5% to 0.5%) with anticipated effect that fuel costs for vessel operators will significantly rise. Hence, new vessel routes must better balance operational cost, fuel and greenhouse gas (GHG) emission cost, and weather-related safety issues. True North Marine is working together with Université Laval, HEC Montreal and UQTR (University Quebec Trois-Rivieres) in a project funded by IVADO, Prompt and MITACS to develop advanced analytics tools to support the planning process. More specifically, these tools allow analyzing many routes in order to determine the optimal speed / fuel consumption setting and best route option based on forecast weather data, historical weather data, vessel characteristics and data obtained from monitoring past performance of vessels. In this presentation, we provide an insight in the practical planning process and analytics tools developed so far to support the planners which will go towards more precise and dynamic routing.

***Causal analysis on weather implications on collisions and forecasting models for early recognition of high-risk areas***

Peter Ellevseth (Safetec)

Risk is determined by the probability of an event happening and the potential impact it may have on human life, the environment, or private property. The objective of this study is to quantify this risk and identify the factors (weather and operational) that have contributed to reported vessels' collisions over the past 40 years in the Norwegian waters. Understanding these causes will inform the development of a forecasting model, which will provide early warnings for high-risk navigational areas where extra caution should be exercised.

***Blockchain-Based Solutions for Healthcare: Enhancing Trust, Security and Efficiency***

Paolo Migliari (Global Supply Chain Management MSD)

The healthcare industry is facing numerous challenges in terms of data management, privacy, and security. Traditional systems are often siloed and fragmented, which can lead to inefficiencies, errors, and data breaches. Blockchain technology offers a promising solution to these challenges by providing a secure, decentralized, and transparent way to manage and share data. In this talk, I will explore the principles and techniques of blockchain-based solutions for healthcare, and their potential to enhance trust, security, and efficiency in the healthcare industry. During the presentation, I will present real-world use cases from the Pharma industry to illustrate both the challenges and opportunities of blockchain-based solutions in healthcare.

***Tracking Liquid Bulk Volume in Storage Tanks Using Interferometric Synthetic-Aperture Radar (SAR)***

Wu Zhenming (UiT The Arctic University of Norway)

Liquid bulk commodities play a vital role in various industries, and their storage involves cylindrical tanks with floating or fixed roofs. The roof height of these tanks varies based on the stored volume and can cause deformation of the tank walls. Traditional geodetic instruments are used to assess these structural deformations, ensuring safe operation and determining maintenance needs. However, measuring large tanks with traditional instruments can be challenging, and the height differences measured are not considered indicators of liquid volume storage due to low spatial coverage and temporal resolution.

Here, we will present an innovative approach using differential interferometric synthetic aperture radar (DInSAR) to track variations in the volume of liquid bulk stored in terminals. We hypothesize that changes in liquid bulk volume are associated with the movement of the tank's roof. Persistent Scatterer Interferometry (PSI), a DInSAR algorithm, is utilized due to its effectiveness in monitoring sub-centimeter ground deformation over large areas. PSI has been successfully applied to various applications, such as subway tunnels, airports, mining areas, and cultural heritage sites.

In this study, we selected a port in Singapore - Bukom port with cylindrical tanks, and historical Sentinel-1 radar imagery is used to retrieve long-term deformation of fixed tank roofs through PSI. By comparing changes in the ports with AIS data, we aim to establish a link between liquid bulk volume

and roof displacement measurements derived from PSI. This approach has the potential to revolutionize liquid volume monitoring using space technology, thereby improving resource allocation, stocking decisions, demand estimates, and production planning.

***CITYFREIGHT project & final remarks***

Jaikishan Soman, Stein W. Wallace (NHH Norwegian School of Economics)

CITYFREIGHT is a project in which we study how can freight transportation be organized in a smart sustainable small city to reduce energy and space use. The primary objective is to provide public authorities in smaller, topologically complicated, cities and initially the City of Bergen, with a toolbox for realistically planning for a city that is energy efficient and sustainable in terms of freight transportation. This talk presents an overview of the latest developments of the project.