Decarbonizing Maritime Operations: A Data-Driven Revolution

NeurIPS 2023 Workshop: Tackling Climate Change with Machine Learning

Authors : Ismail Bourzak[1], Sara El Mekkaoui[2], Abdelaziz Berrado[2] and Loubna Benabbou[1]

[1]University of Quebec at Rimouski, Rimouski, Canada
[2]Mohammadia School of Engineers / Mohammed V University in Rabat, Rabat, Morocco

Presented by :
Ismail Bourzak

UQAR

جامعة محمد الخامس بالرباط
Université Mohammed V de Rabat

ECOLE MOHAMMADIA D'INGÉNIEURS

The maritime industry serves as a crucial conduit for global trade and commerce.

Urgent need for the maritime sector to reduce its carbon footprint as part of the global decarbonization challenge.

International Maritime Organization regulations have instituted stringent rules aimed at emission reduction.

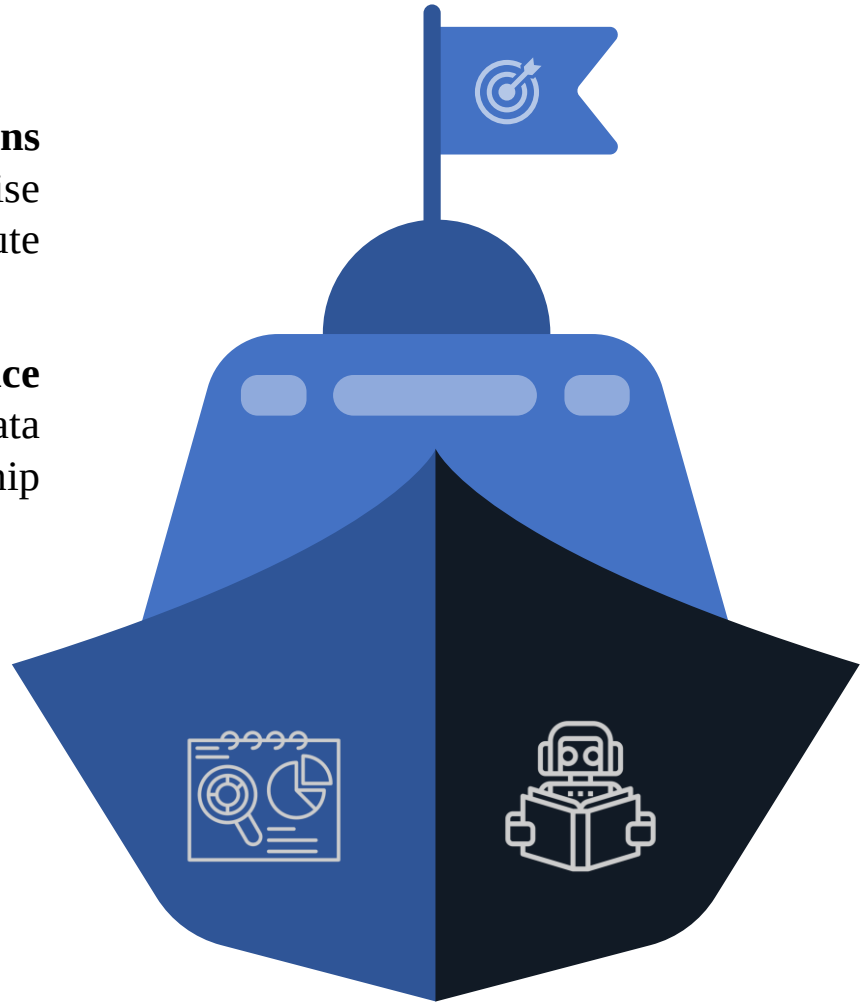
The advent of Maritime 4.0 marks an era characterized by digitalization, automation, and optimization.

Machine learning and artificial intelligence are pivotal tools that are facilitating the achievement of sustainability goals.

Maritime CO2 Emissions:
More than 2% of Global Total in 2018

Data Analytics Approaches

- **AIS data analysis for emissions estimation:** Utilizing AIS data for precise emissions estimation and route optimization.
- **Big data analytics for ship performance monitoring:** Employing Big Data techniques to monitor and enhance ship performance.



Machine Learning Models

- **ML-based estimators for fuel consumption:** ANNs optimize fuel efficiency in diverse conditions for greener operations.
- **ML for ship performance prediction:** Statistical and ML models enhance ship performance prediction and operational efficiency.
- **Data-driven approaches for sustainable shipping:** ML frameworks analyze AIS/weather data for energy-efficient routing.
- **ML and statistical analysis for fuel efficiency:** ML and statistical analysis jointly optimize routing and fuel efficiency considering environmental data.

Ship speed optimization

01

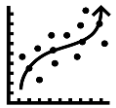
Data collection

- Historical Voyage Data
- Ship Specifications Data
- Real-time Environmental Data
- Operational Data

02

Machine Learning

- Regression Models for predicting optimal speed settings
- Reinforcement Learning for real-time speed control adjustments



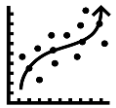
03

Output

- Optimal speed and route recommendations

- **Significantly reduces fuel consumption, directly cutting down emissions.**
- **Provides a benchmark for environmental efficiency in maritime operations.**

Ships' Arrival Times Estimation



01 02 03

Data collection

- AIS Data
- Port Schedules
- Historical Performance Data
- Environmental Data

Machine Learning

- Time Series Models for forecasting arrivals
- Classification Models for estimating arrival probabilities

Output

- Accurate predictions of ships' Estimated Time of Arrival

- **Reduces unnecessary idling emissions by optimizing port arrival schedules.**
- **Lowers the overall carbon footprint of maritime voyages.**

Quayside Planning

01

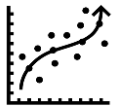
Data collection

- Port Operation Data
- Cargo Data
- Logistical Data

02

Machine Learning

- Predictive Modeling using supervised ML for berth allocation
- Clustering Algorithms for resource allocation patterns



03

Output

- Predictions of berthing times and durations

- **Decreases emissions from ships by reducing idle time at the port.**
- **Enhances air quality around ports by enabling faster turnaround.**

Resource Allocation and Scheduling

01

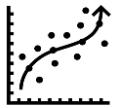
Data collection

- Resource Inventory Data
- Labor Schedules Data

02

Machine Learning

- Deep Neural Networks for complex, multi-resource scheduling
- Reinforcement Learning for dynamic and adaptive scheduling



03

Output

- Schedules and allocation plans for port resources to minimize idle time

- **Diminishes emissions from port machinery through improved scheduling.**
- **Cuts down on indirect emissions by reducing the operational footprint.**

Supply Chain Monitoring

01

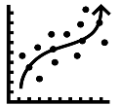
Data collection

- Tracking Data
- Transportation Schedules Data

02

Machine Learning

- Graph Neural Networks for optimizing supply chain networks



03

Output

- Predictive insights on cargo flow and inventory

- **Aids in preventing emissions spikes by smoothing supply chain operations.**
- **Facilitates lower emissions through improved logistical efficiency.**

Decarbonizing Maritime Operations: A Data-Driven Revolution

NeurIPS 2023 Workshop: Tackling Climate Change with Machine Learning

Thank You

Contact Details:

Ismail Bourzak : ismail.bourzak@uqar.ca
Sara El Mekkaoui : saraelmekkaoui@research.emi.ac.ma
Abdelaziz Berrado : berrado@emi.ac.ma
Loubna Benabbou : loubna_benabbou@uqar.ca

UQAR