

AI for Sustainable Ship Operations

Research Questions

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The Challenge

Sea levels are rising and putting millions of people at risk.

Shipping carries **80%+ of global cargo** ³; we can't live without it.

Shipping accounts for up to 1B Kg CO₂/year, 3% of greenhouse gas emissions globally. ^{1,2}

This is up 20% over the last decade according to the International Maritime Organisation). ³



The Opportunity

- Operational controls, including speed / trim adjustment and route optimisation are the **most cost-effective solutions**.
- These tactics depend on **accurate Ship Fuel Consumption (SFC) prediction**.
- An **ship-specific** (heterogenous), causal framework could lower carbon emissions by 10%.

Motivating Question

How can we build explainable AI to guide captains' decisions?

The Homogeneity Assumption

Current models treat ships as a **single homogeneous system**, ignoring real life diversity such as sea conditions, port operations, ship design, age, and hull condition (biofouling).

The Explicability Problem

Advanced ML models achieve accuracy but reveal **correlations, not causes**. Captains use experience and instinct in the absence of explanation. Ship safety regulations require decision justifications.





Research Questions

RQ1: How can the intrinsic heterogeneity of ship operational states be systematically identified, modelled, and interpreted to develop more accurate and robust SFC prediction frameworks?

RQ2: How can we move beyond correlation to establish the true causal relationships between key operational, navigational, and environmental factors and SFC to inform ship captains, owners and IMO regulations?

Research Goal

Develop an **AI-powered, interpretable, and causally informed framework** for ship fuel consumption prediction that is: **accurate** (robust predictions across diverse operational conditions), **interpretable** (a clear understanding of causal mechanisms), and **applicable** (trustworthy, actionable insights for captains and owners).

Why It Matters

Industry adoption of trustworthy systems that operators will actually use, leading to an **environmental impact** of reduced shipping carbon emissions.

Thank you

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References

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