Maritime transport of cargo is the most cost-efficient method of transportation. However, it accounts for near 2% of global greenhouse gas (GHG) emissions. In recent years, we have seen initiatives set out by the International Maritime Organization (IMO) and the United Nations to reduce and ultimately eliminate the marine transport's carbon footprint as an effort to limit climate change. In 2018, IMO set out a road plan, titled *'The IMO Initial Strategy for Reducing Greenhouse Gas(GHG) Emissions, and its Follow-up Actions Towards 2050'*, and again updated in July 2023 with an objective of reducing emissions by at least 20% by 2030 and at least 70% by 2040, compared to levels 2008.

The IMO also outlined different approaches to achieve the above-mentioned goals, such as improving the Energy Performance Index of existing ships, developing a speed optimization mechanism, developing carbon-neutral fuel sources, and alternative propulsion methods. Projects such as fitting sails and utilize wind energy, however this requires long development time and retrofitting the current fleet.

An immediate, and relatively cheap class of solutions that can help achieve such goal set out by the IMO is called *Weather Routing*. Weather Routing is an umbrella term for the optimization algorithms that utilize current/forecasted meteorological data (e.g., winds, currents, etc.) to our advantage to reduce fuel consumption and emissions. We can also use meteorological data in conjunction with other data sources to identify and avoid pirate activity zones, ecological sensitive and protected zones, and adverse weather conditions. With a well-designed and well-optimized Weather Routing algorithm, we can save up to 30% of fuel consumption on a single voyage, which can reduce the fuel costs for shipping companies which in turn reduce carbon emissions and reduce the carbon footprint of the maritime transport sector, it can also improve voyage safety and secure both sailors on board, the ship, and the cargo.

In this talk we propose a class of optimization methods of 3 different solutions: *Hybrid Search*, *A^* Search*, and *CMA-ES Genetic Algorithm*, and compare their performances with real world metrics. Each of these solutions approaches the problem from a different area of mathematics, insights from differential equations, graph theory, and evolutionary genetic algorithm respectively. We will discuss the principles behind them, and validaty of results.