SMART BUOY TRAJECTORY PREDICTION AND ANOMALY DETECTION

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A major environmental problem of fishing is that of ghost fishing. Ghost fishing occurs when fishing gear that is abandoned or lost at sea drifts into open water, entangling and killing fish with it. The dead fish, along with the fishing gear sinks to the ground, where scavengers feed on the corpses of the fish. As the weight frees up, the fishing gear rises back up to the surface where it can entangle more fish, continuing this horrible cycle. Blue Ocean Gear, a California-based company, helps commercial fleets track fishing gear by embedding GPS sensors to buoys, which are floating objects that are used to identify the fishing gear they are attached to. The GPS transmissions from buoys provide real-time coordinates of the fishing gear, which can help reduce ghost fishing.

However, due to lifespan limitations of the sensors' batteries, smart buoys cannot transmit hourly GPS coordinates, which can pose a problem, as commercial fleets need more regular updates, especially if the smart buoys have been separated from their gear due to an anomalous event. For Blue Ocean Gear to provide these regular updates, the Clinic team at the UChicago Data Science Institute (DSI) developed predictive models to estimate locations of the fishing gear and a rule-based algorithm to determine if a buoy trajectory can be considered anomalous.

The DSI team built three prediction models - two models built off of Blue Ocean Gear readings and interpolated sea current and wind data, and one model built from a physics-based simulation model. The team collected data from the Copernicus open action hub and created a model around the current direction and magnitude of the ocean currents and ocean winds at that point in time. A linear model fit to these features resulted in a mean absolute error of 0.16 nautical miles and a simple deep learning model resulted in a mean absolute error of 0.15 nautical miles. The physics-based model produced accurate predictions within 0.5 nautical miles, and fed results into a visualization that outlines the probability that a buoy lies in a particular area based on a heat map. The heat map can be created using any set of predictions and associated variance and will be a useful visualization tool for fishermen looking to retrieve long-line buoys.

Fig. 1: Physics-Based Simulation of Buoy 680 on 29th July 2022 with Probability Heatmap

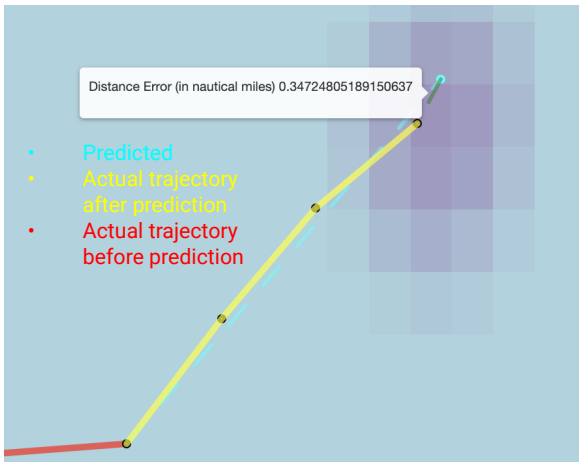

Fig. 2: Trajectory Prediction Neural Network