

Machine Learning-Based Classification of Fishing and Non-Fishing Vessel Activities Using AIS Trajectory Features

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Illegal, unreported, and unregulated (IUU) fishing poses a significant threat to marine ecosystems fisheries sustainability, and global food security. Conventional monitoring approaches largely rely on manual inspection of vessel movement patterns, which are time-consuming and often ineffective. The increasing availability of Automatic Identification System (AIS) data presents new opportunities for applying data-driven method for detecting fishing activities. However, accurately distinguishing fishing from non-fishing activities remains challenging due to overlapping movement patterns, variability in vessel behavior, and environmental influences. This study proposes a comparative machine learning approach for classifying fishing vessel activities using AIS trajectory features. A publicly available AIS trajectory dataset obtained from the Kaggle platform containing labeled fishing and non-fishing vessel activities was used. The dataset includes spatial, temporal, and behavioural features such as longitude, latitude, bearing, signed turning angle, time gaps, and distance to shore. Data preprocessing techniques, including missing value handling, normalization, and label encoding, were applied. Exploratory Data Analysis (EDA) was conducted to understand feature distributions and relationships, followed by feature engineering to derive meaningful behavioural indicators such as Euclidean speed, trajectory-derived vessel speed and directional changes. Four machine learning models such as Logistic Regression, Support Vector Machine (SVM), Random Forest, and Gradient Boosting were developed and evaluated using an 80:20 train-test split preprocessed dataset. Model performance was assessed using accuracy, precision, recall, and F1-score metrics. The results indicate that ensemble-based models, particularly Random Forest and Gradient Boosting, achieved superior performance with near-perfect classification accuracy among the evaluated models. Feature importance analysis revealed that distance to shore and temporal patterns are key predictors of fishing activity, while speed and directional features also contribute significantly. The findings demonstrate that integrating spatial, temporal, and behavioral features with machine learning enables effective automated vessel activity classification. Further validation using larger real-world AIS datasets is needed to confirm model generalizability. This approach supports intelligent maritime monitoring and efforts to combat IUU fishing and promote sustainable marine resource management.

Keywords: *Automatic Identification System (AIS), Fishing Vessel Classification, Illegal fishing, Machine learning, Marine resource management*