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AIS trajectory classification based on IMM data

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About us

Introduction

Applied Artificial Intelligence Group

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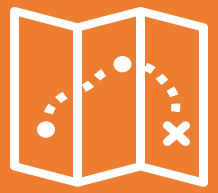
- Automatic Learning Techniques
- Data and Business Analysis
- Evolutionary Computation and Multi-objective Optimisation
- Computer Vision
- Internet of Things (IoT)
- Data Fusion Systems and Contextual Information
- Surveillance Systems & Air Traffic Control (ATC)
- Coastal Surveillance and Maritime Traffic
- Indoor localization systems
- Inference in adaptive, non-linear dynamic systems
- Unmanned vehicles
- People detection, tracking and action recognition

Objectives

Introduction

Useful information

To find useful information for maritime surveillance systems



Context information

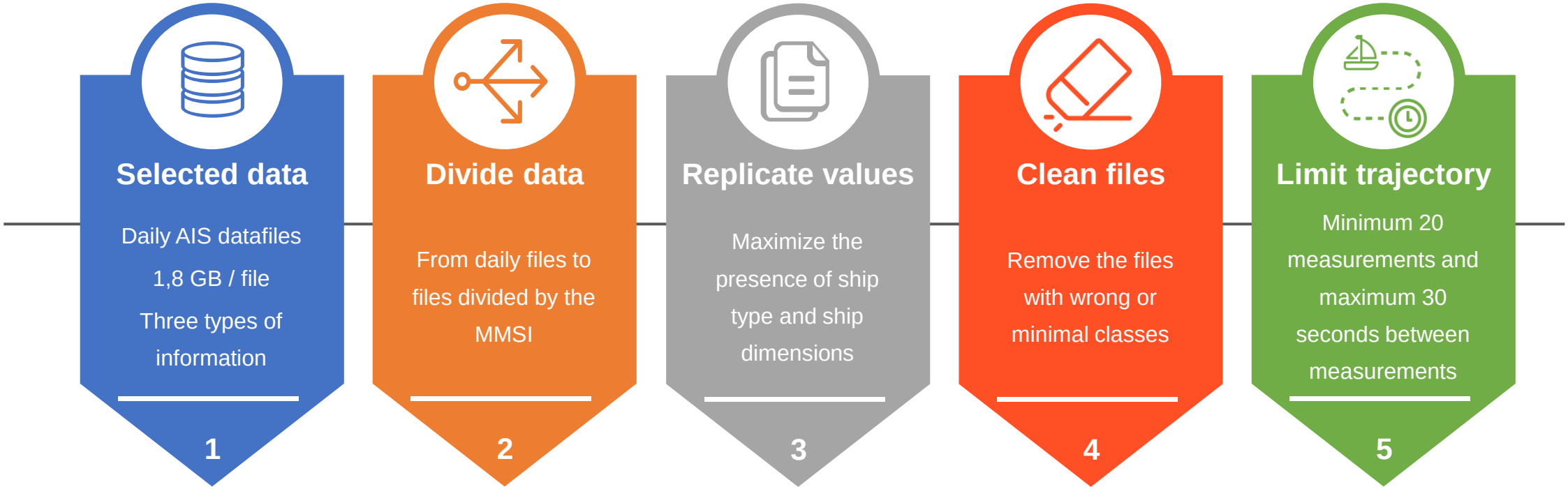
The main objective of the study is to use estimation data to extract context information

Trajectory classification

Obtain the ship type or the maneuver from the trajectory data

Data & preprocessing

System overview



Trajectory estimation

System overview

Estimation Filter

IMM Filter for its easy configuration and easy adjustment for the target movement

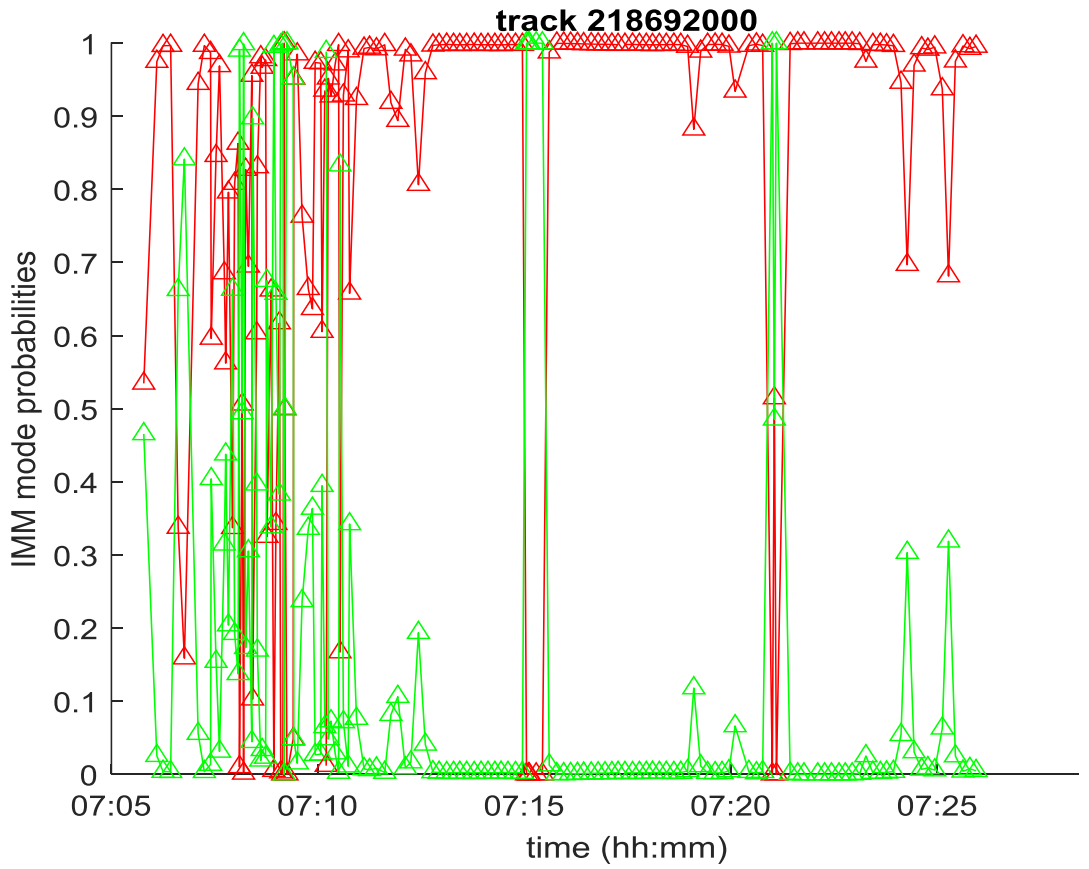
IMM Filter Modes

Configured by two modes, linear and maneuver movement

Filter data

Estimated kinematic values

IMM Probabilities to represent the type of movement



Proposed attributes

System overview

Kinematic data

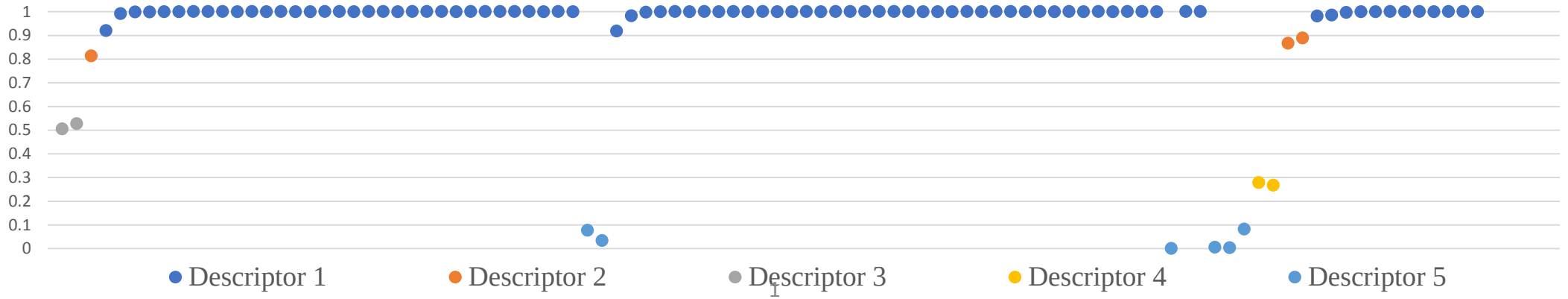
use statistical information about the trajectory kinematic values to achieve information of all the trajectory.

Statistical values
Mean
Mode
Standard deviation
Maximum
Minimum
The 3 quartiles

Kinematic values
Speed
Speed variation
Distance
Direction variation
Time

Type of movement

use a set of descriptors to identify the state of the IMM filter mode probabilities



Segmentation & classification

System overview

Trajectory segmentation

Create inputs with the same number of measurements

Classification algorithms

- Decision trees
- Support Vector Machines

Classification approximation

- Using all the classes values
- Using only the majoritarian classes in a binary classifier

Classes values

Ship type values		
Anti-pollution	Cargo	Dredging
Fishing	HSC	Law enforcement
Medical	Military	Passenger
Pilot	Pleasure	Port tender
Reserved	Sailing	SAR
Tanker	Towing	Towing long/wide
Tug		

Navigational Status values		
At anchor	Constrained by her draught	Engaged in fishing
Moored	Restricted manoeuvrability	Under way sailing
Under way using engine		

Previous experiments and results

Study experiments

IMM configuration

35.4125% Ship type

69.1483% Maneuver

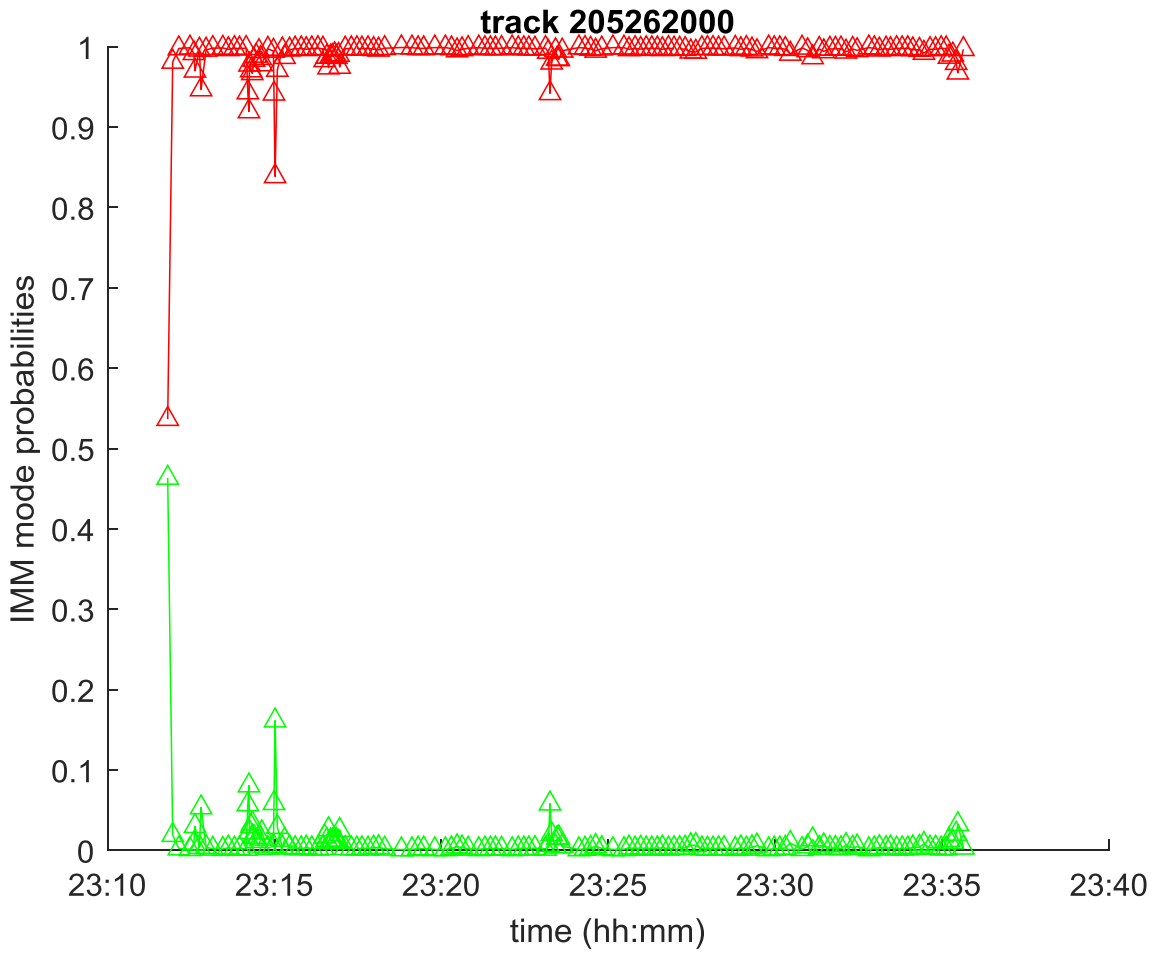
Kinematic and statistical values

The **time**, the **speed variation** and the **direction variation** seem to give more information than other variables.

IMM descriptors

35.9279% Ship type

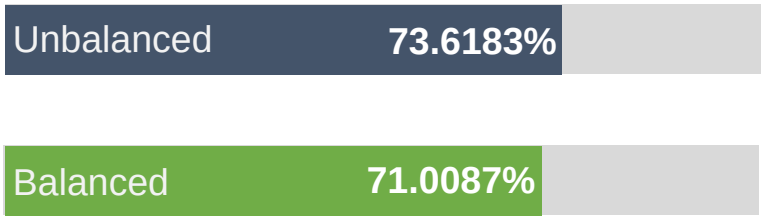
68.9883% Maneuver

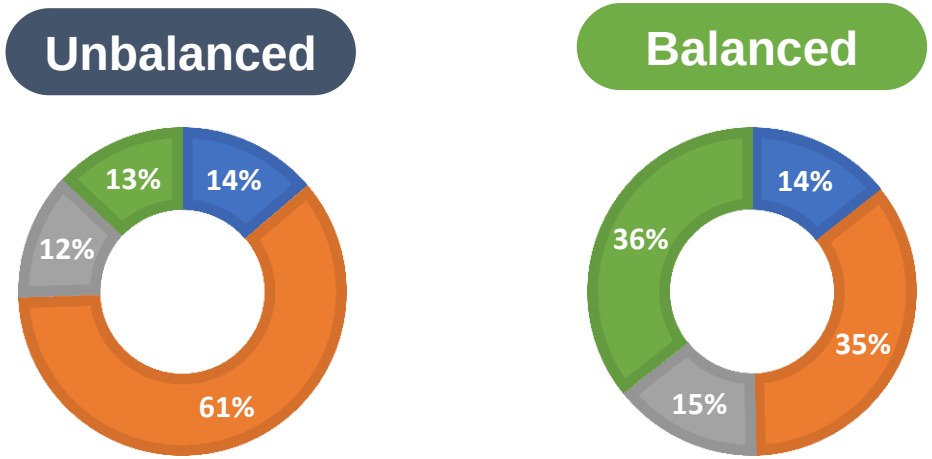


Binary classification

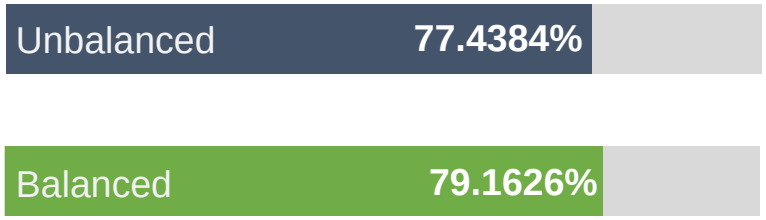
Study experiments

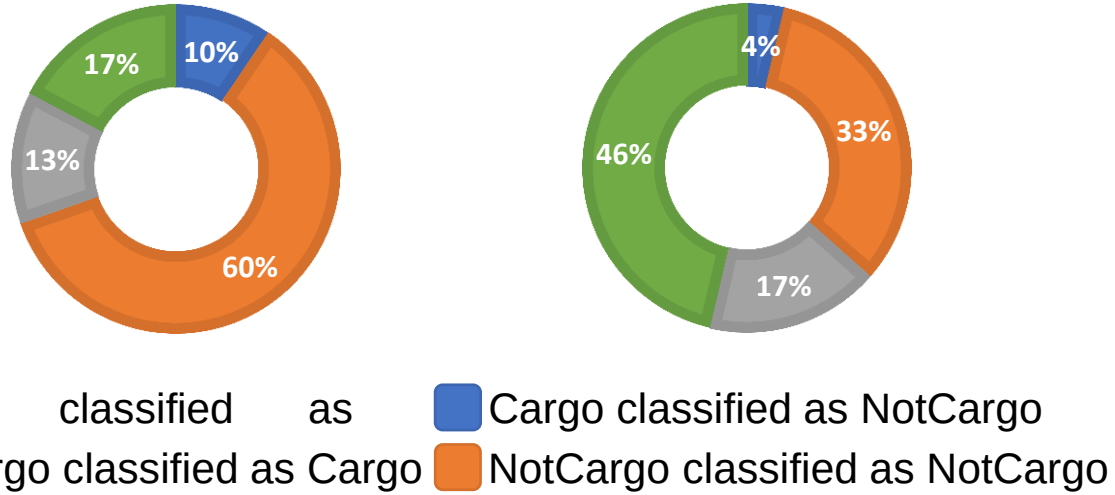
Decision trees





Support Vector Machine

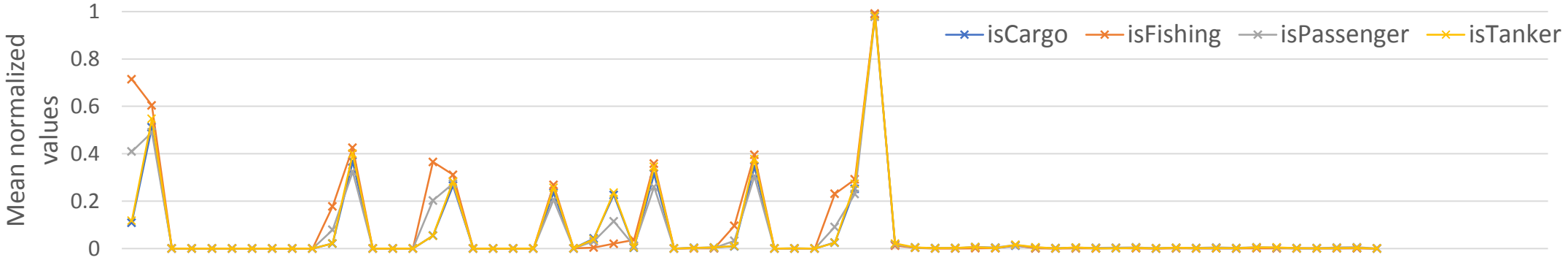




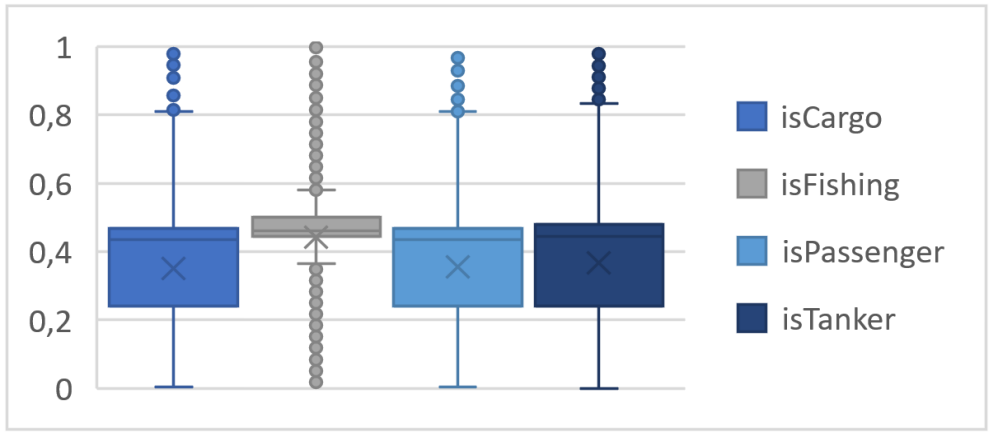
Attributes visualization

Study results

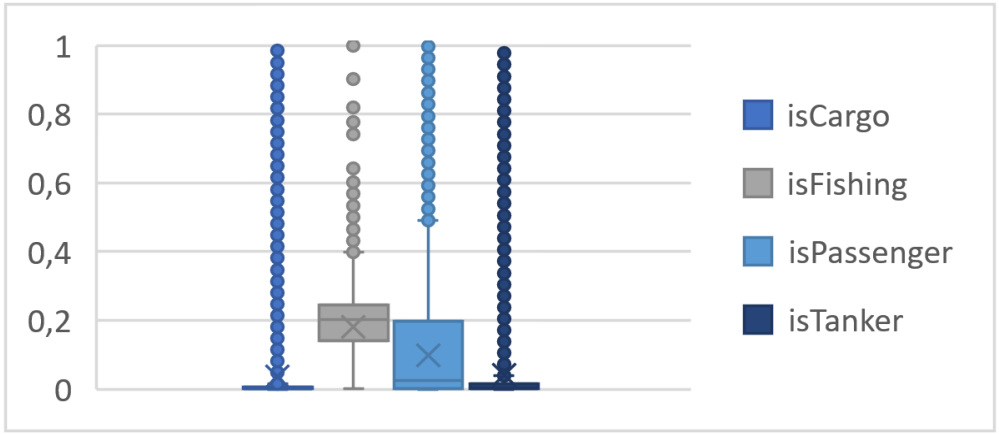
Mean vectors are proposed to represent the attribute variation between classes



With the results of both classification approaches we have found three kinematic variables (**time, speed variation and direction variation**) with most of the information to make distinctions between classes



Time variable box-plotting

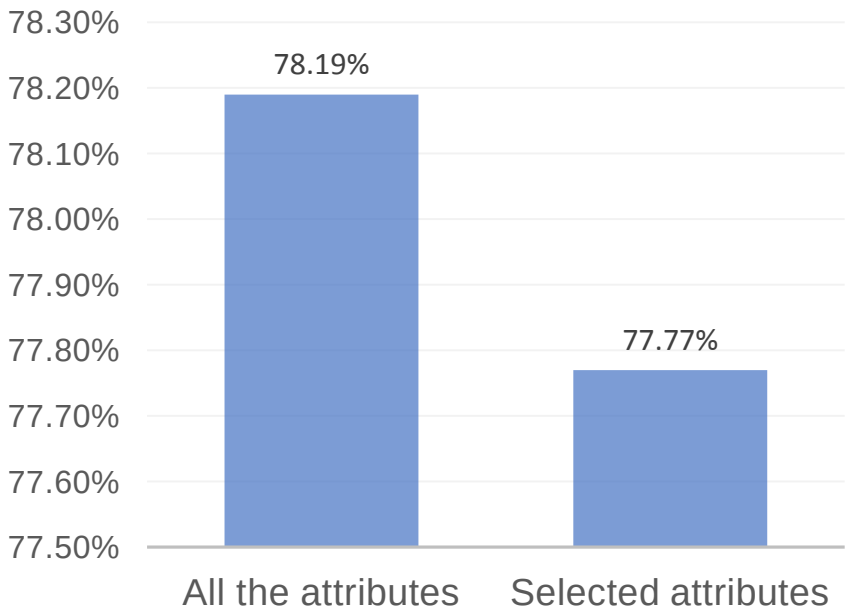


Direction variation variable box-plotting

Conclusions

Kinematic variables of time, speed variation and direction variation with enough information to achieve a useful classification

Final classification results



Future lines of investigation

Find new attributes extracted from the trajectories to improve the classification results

Use new data mining techniques or classification algorithms


Thank you!