Enhancing AIS Vessel Trajectories via Trip Detection

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Motivation

AIS trajectories provide a detailed picture of vessel behaviour at sea. There are two drawbacks to the available information in AIS messages. Firstly, it is difficult to automate the segmentation of AIS messages of a single vessel into the individual trips. Secondly, the messages do not contain information about the vessel's surroundings. These two drawbacks are tackled with this pipeline, easing the usage of AIS data for maritime research.

Pipeline

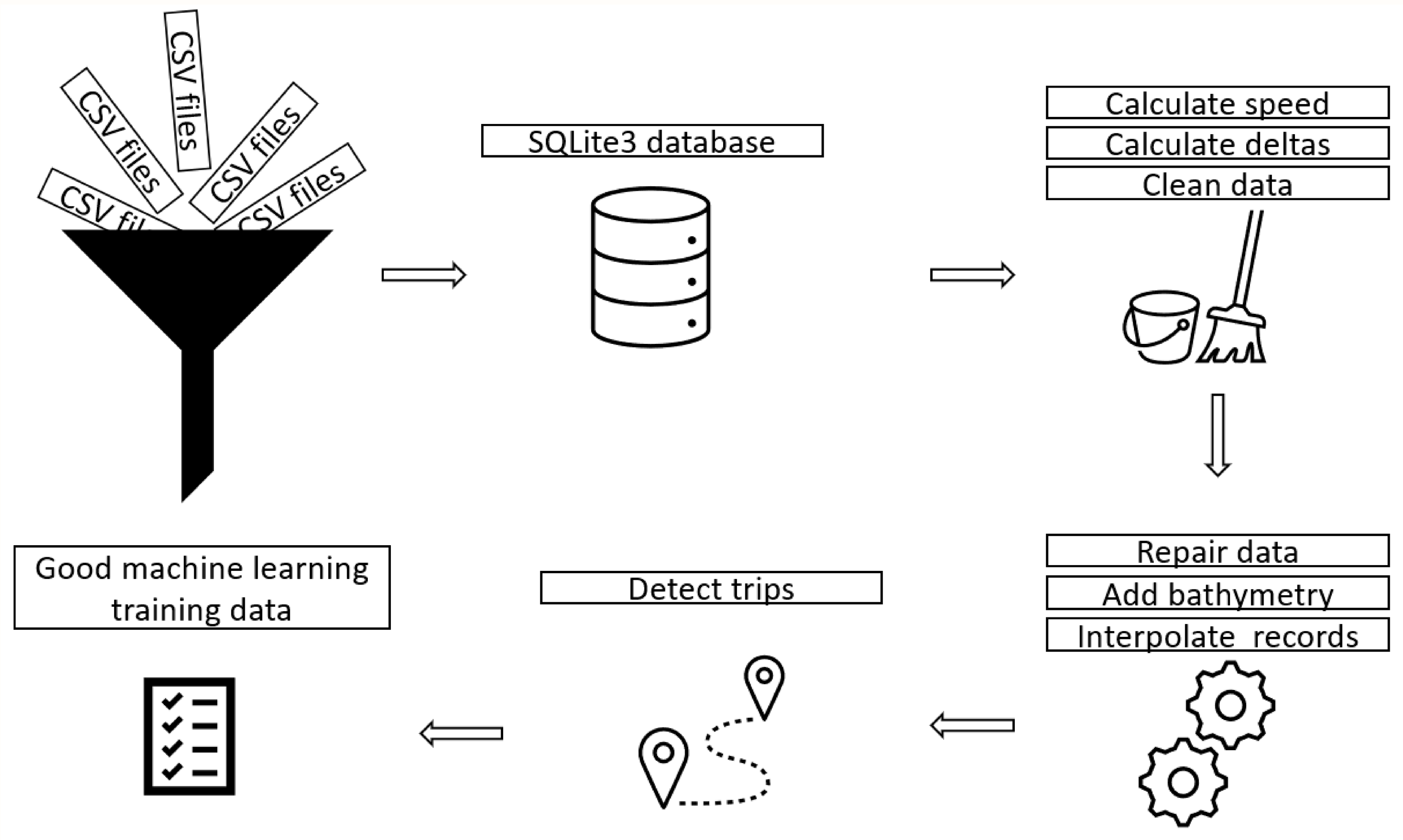

Figure 1: Schema of pipeline process

Figure 1 shows the processing steps of the pipeline. For faster computation the data is stored in a SQLite3 database. Further features are computed or attained using additional data sources. With the detected anchorages, the AIS trajectory is split into multiple trips, resulting in a well curated enhanced AIS data set.

Trip labeling

The detection of anchorages is necessary for trip labeling. For this, close to shore data samples are clustered using DBSCAN. For each cluster an anchorage is determined. With the anchorages detected, the nearest anchorage for every database entry is computed. In addition to the assigned anchorage the anchorageDelta is stored for the trip detection.

If the anchorageDelta of a data entry falls below the specified threshold, a flag is set, indicating that the vessel is at anchor. If the vessel remains in the anchorage area for a specified time and the vessel leaves the anchorage area, the tripCount is incremented by one.

Additional Features

Besides the trip segmentation the core benefit of the pipeline is the additional features added to every AIS message. Added features are:

- Distance to shore
- Spatial and temporal deltas
- Detected anchorage
- Trip label
- Water depth

Computing Features

In order to add the water depth to an AIS message, the bathymetric map supplied as a tif file by GFW [1] is used. Taking the Latitude and Longitude value of the AIS message, the exact water depth can be appended. This feature is of great value, for example, when predicting the fishing method performed by the vessel. [3] For computing the distance traveled between two GPS positions the Haversine formula is used. The distance delta and timestamp delta can be used for flagging inconsistent data samples and detect long periods of missing signal.

Example of single vessel trajectory

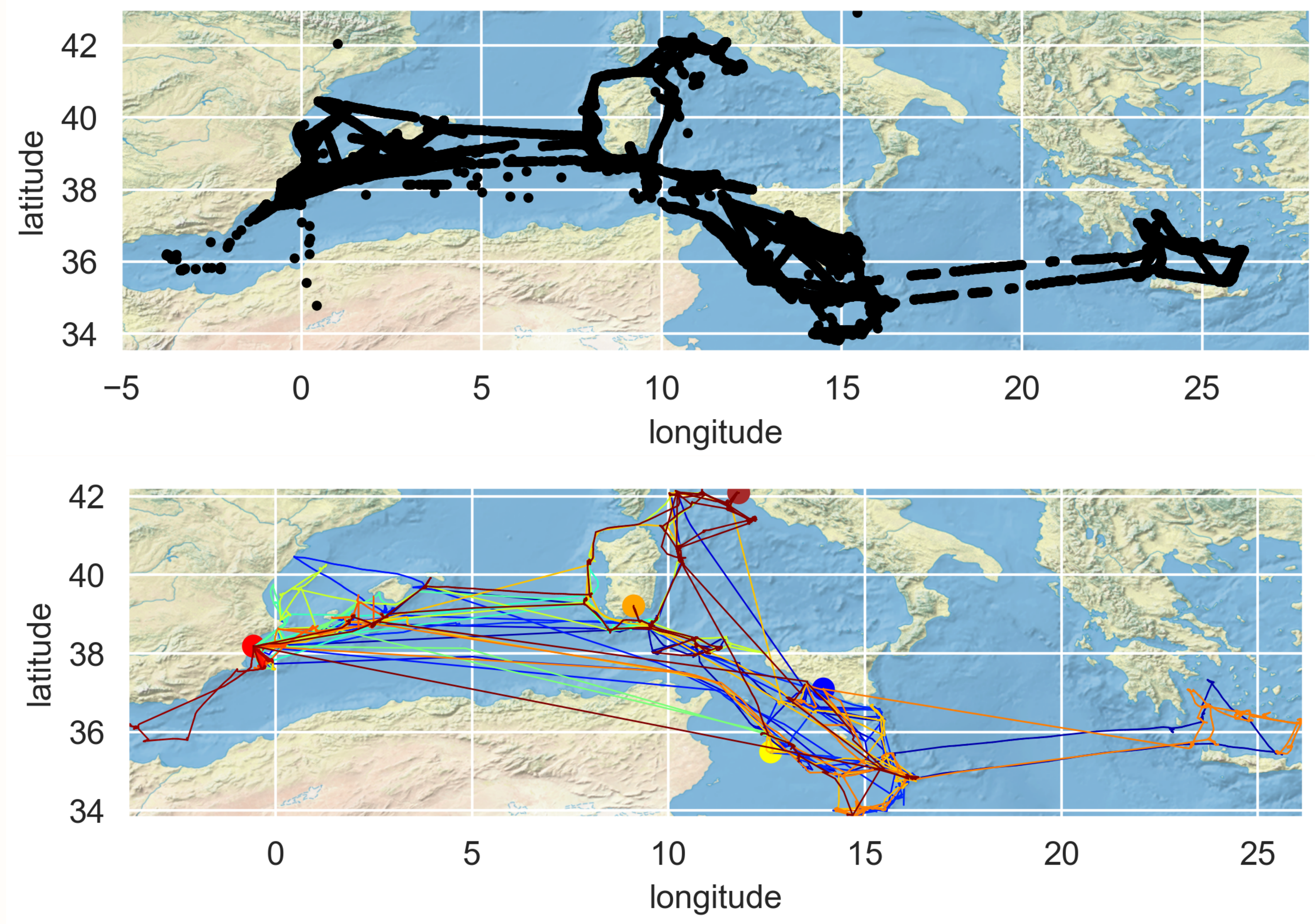

Figure 2: Top: Raw AIS messages of a single fishing vessel in the Mediterranean Sea during one year. Bottom: Processed vessel track of same vessel. Colored spots indicate the detected and labeled anchorages.

Figure 2 shows an exemplary output of the pipeline for a single trajectory. The colored spots visualize detected anchorages.

Conclusion

The added features are selected with the use case of mining fishing trajectories for fishing behavior in mind. By using flags the pipeline can be modified to accustom many different applications using just a terminal.

This is especially relevant for choosing the desired features. Whilst all features required for trip segmentation can be added to the AIS messages as they all contain additional behavioral and environmental information, it might be beneficial to limit them to small subset to reduce processing time. This pipeline is applicable to all standardized AIS messages. To broaden accessibility in the future we aim to publish the pipeline as a R package.

Further details can be found in the corresponding paper. For accessing the code scan this QR code leading to the GitHub repository [2].

Sources

[1] *Bathemetry Data Set*. Global Fishing Watch. 2023. URL: https://globalfishingwatch.org/data-download/datasets/public-bathymetry-v1.

[2] *open pipeline code*. Sören Dethlefsen. 2023. URL: https://github.com/miriskalt/AISFeatureEngineering.

[3] *Towards a Fixed-Gear AIS Trajectory Differentiation*. Bayer, M et al., In: Proceedings of the 18th International Symposium on Spatial and Temporal Data. (SSTD '23). Calgary, AB, Canada: ACM, 2023, pp. 61–64.