

DETECTION OF FALSE DATA INJECTION IN AIS VESSELS COMMUNICATION USING MACHINE LEARNING

Automatic Identification System (AIS)

AIS is an automatic identification and tracking system used in the maritime domain, to collect information and identify ships. It is used by ship crew and coast guards to monitor maritime activities. For this, ships must be equipped with a transceiver that can send and receive AIS messages. This equipment is mandatory for all vessels with more than 300GT and above, for all ships which are engaged into international journeys, and for all passenger ships. For all other vessels, cheaper and less powerful transmitters are suggested, but not required.

In AIS messages you can find identification number, position, speed, orientation and some other dynamic and static information.

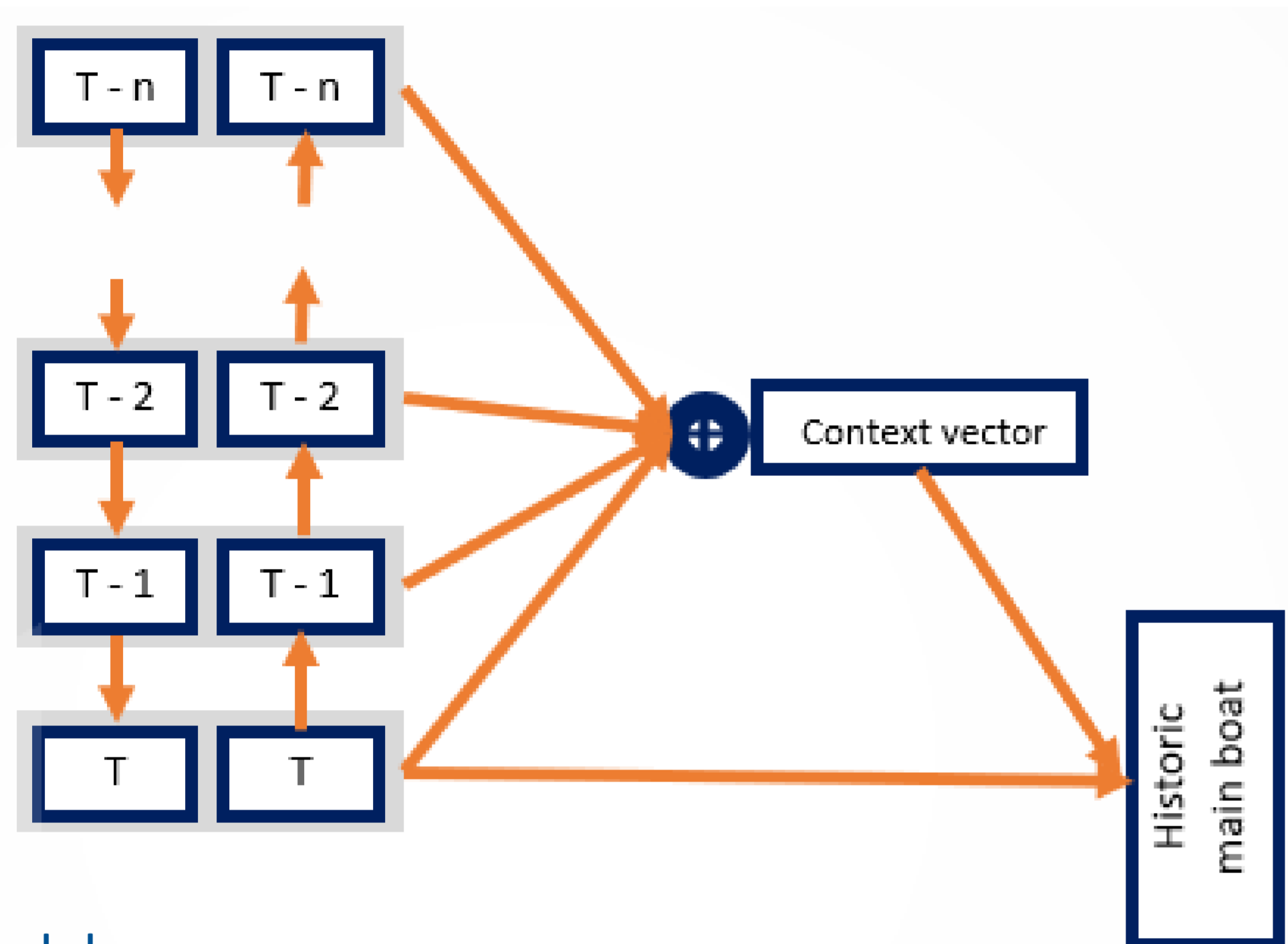


Fig 3. Attention model

Incomplete data problematic

One of the main problems is the quality and regularity of data :

- Each messages don't contain the same information
- Messages are missing because of a collision between them or because the satellite is not over the area. (Time, where satellite are not over a certain area, is variable)
- In one area the number of boat variate

A missing message is something common. Therefore, it's difficult for a model to use all the data available as input because if the input size is fixed, a large part of the input will be empty

Intentional shut down of AIS

It has been shown multiple times than some vessels deactivate AIS transmission in order to hide illegal fishing and it seems to be something common [1][2]. Boats lose connection regularly with the satellite and a large number of boats make difficult human surveillance.



Fig 2. Plotting in red position where boat disappear more than 4h

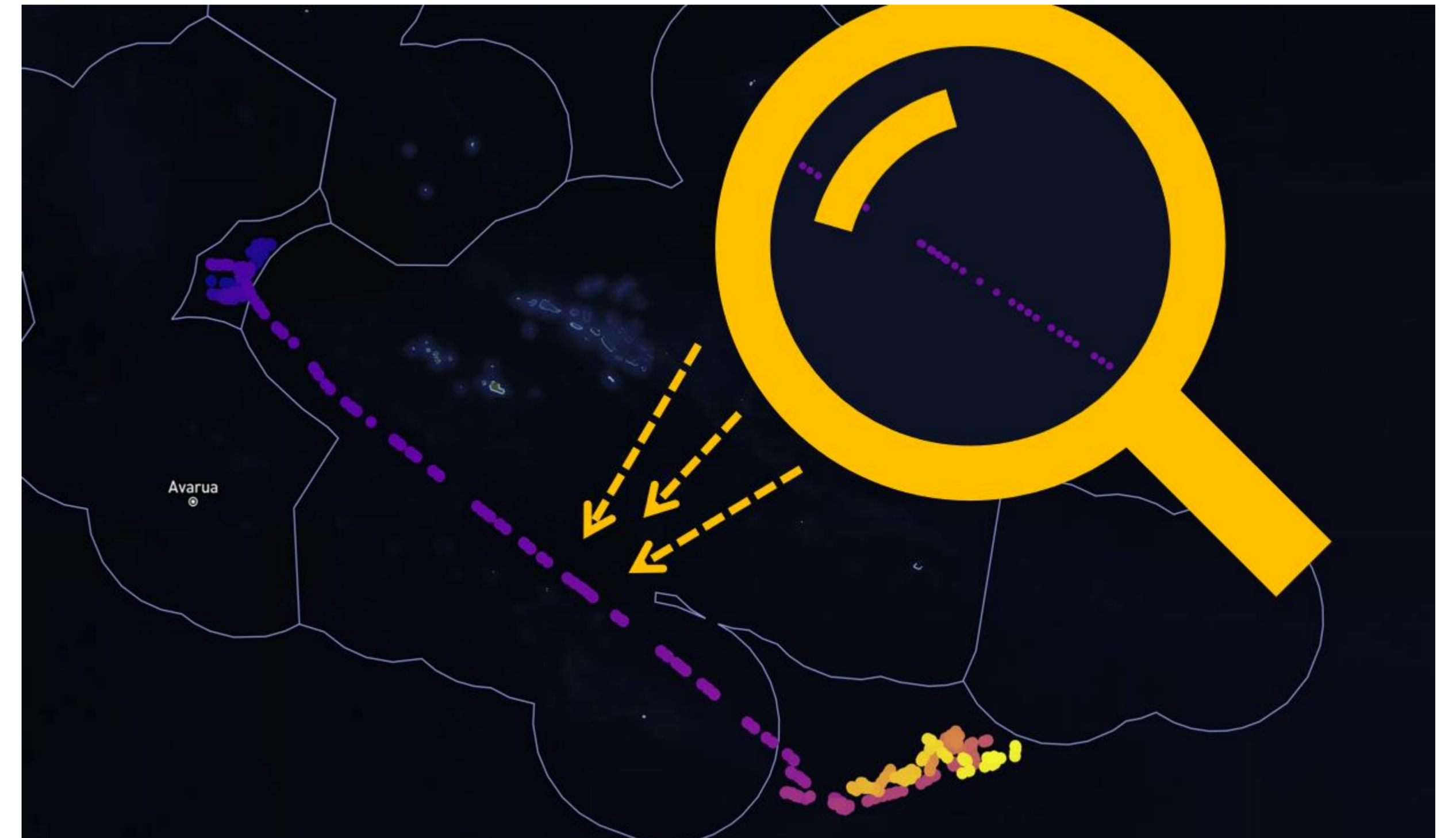


Fig 1. Example of position data got by vessel over 2 weeks

Attention Neural Network

The attention mechanism [3] is an attempt to implement selectivity concentrating on a few relevant things while ignoring others in a large deep neural network.

This showed significant progress in Neural Language Processing (NLP) so people expected widespread in time series problems but the application in time series are still limited. Some promising result has been published recently.[4]

In our case the goal is to create a context vector of a fixed size that could be used as a root for other networks with different goals.

Future directions :

Using a multiple attention layer to create a context vector that will contains :

- The historic of the main boat
- The historic of the neighboring boat
- Map context

Doing multi-task learning on the context part of the network to force the genericity

- Predict next message
- Complete removed message

Using this pretrain attention network as a root for other network that will detect:

- Intentional shutdown
- Strange trajectory
- Wrong status (fishing, etc.)

[1] Oceana, <https://oceana.org/publications/reports/avoiding-detection-global-case-studies-possible-ais-avoidance>

[2] Henri Weimerskirch, Ocean sentinel albatrosses locate illegal vessels and provide the first estimate of the extent of nondeclared fishing, 2020,

[3] Dzmitry Bahdanau, et al. Neural machine translation by jointly learning to align and translate, 2016,

[4] Shun-Yao Shih, et al. Temporal Pattern Attention for Multivariate Time Series Forecasting, 2019,

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