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Forecasting Vessel Trajectory based on AIS Data using Generative Adversarial Networks.

ABSTRACT - Masterthesis

Vessel tracking and collision avoidance has been a significant problem in the marine navigation for a long time. Since the advent of radar technology this problem has been addressed considerably. The Automatic Identification System (AIS) was originally developed as a collision avoidance tool. It achieves this by broadcasting the position, identity, speed and course of a vessel along with additional relevant information to other AIS-equipped vessels which are in its vicinity. The main motivation for proposing forecasting method is to perform anomaly detection. Historical AIS data of the path traversed by the vessel is used here to forecast the future trajectory and any odd deviation from it can be detected early and be notified to the corresponding authorities.

Forecasting has been in existence for a long time and used for various tasks like weather prediction, sales prediction, traffic estimation etc. Traditionally it has been done using techniques like moving average, exponential smoothing and auto regression. These methods are successful in many contexts but generally fail to capture the intricacies of highly non-linear patterns.

Since the advent of machine learning, the complexity of addressing many non-linear problems in tasks like classification, regression, probabilistic modelling etc. has reduced considerably. The method proposed here is a combination of probabilistic modelling and regression problem, which can be approached using generative models like variational recurrent neutral networks (VRNNs) or more successfully, by generative adversarial networks (GAN).

Using GANs, aim is to model the probability distribution of multi-step ahead predictions, xt+1, xt+2, xt+3,..., xt+k ('k' is the size of a prediction window) given the historical conditional data. Since we are using time series data, our generator and discriminator both consists of recurrent neutral networks which can appropriately model the temporal dependencies in the data. Initially the generator is fed a noise vector which is sampled from a Gaussian distribution with $\mu = 0$, $\sigma = 1$ and it forecasts a series of predictions of size 'k' with regard to a conditional window. The discriminator takes this series and inspects whether it is the valid value to follow the conditional window value or not. By training this model, the optimal generator models the full probability distribution of prediction series for a given condition window. With having the full probability distribution in hand, we can extract information regarding any possible outcome and the probability of their occurrence by sampling. This sampled sequence can be taken as basis for anomaly detection of vessel trajectories.