Essence Neural Network for Explainable Error Detection in Intensive Care Medical Data

(Bachelor Thesis)

CORNELIU PASA

Motivation

Within the clinical use case ASIC (Algorithmic Surveillance of ICU patients) technologies and tools are developed that help with early detection and diagnosis of ARDS (Acute Respiratory Distress Syndrome). For correct diagnoses high quality medical data is necessary.

However, due to machine errors and measurement inaccuracies, medical data is prone to be inconsistent and erroneous. These errors can be detected using various algorithms, however understanding the decisions of these tools is non-trivial, because the data often comes from many sensors. An important problem consists in making it clear why the tool classified an error as such.

State of the Art

There are many tools and algorithms for novelty detection in time series. Some of the more popular methods use SVMs, k-nearest-neighbors or autoencoders to find anomalies. In the master thesis of Jan van Essen, a novelty detection method based on a sliding window and nearest neighbor for medical data was implemented and tested in NDAS (novelty detection analysis system). However, this method isn't explainable. There are several popular methods used to introduce explainability in AI methods and some of these have also been tested for outlier detection, such as applying DeepLog with Shapley features or Robust and Explainable Autoencoders. However, research in this field using medical data is lacking.

Objective

The objective of this thesis is to implement and adjust an Essence Neural Network in the context of novelty detection in medical data from ICU patients. The goal is to train this network such that it is both accurate and explainable. Then, based on several examples, the internal weights of this network have to be analyzed and described to evaluate its interpretability. Ultimately, the algorithm has to be integrated in NDAS.

Procedure

After an initial literature research, the available data will be analyzed and we will decide how to use it for training. The Essence Neural Network (ENN) will be implemented and trained to detect novelties in our training data. The performance of the ENN will be compared to other novelty detection algorithms. Then the weights of the network will be analyzed on several examples to explain how the algorithm came to the result. Finally, the algorithm will be integrated into NDAS.

Betreuer: Alexander Kruschewsky
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RWTH AACHEN UNIVERSITY