

Applicability of image-based error classification and explanation methods on time series data

(Master Thesis)



BICH NGUYEN

Motivation

At this chair algorithmic solutions have been investigated, using collected time series data from Intensive Care Units (ICUs), to detect complications in patients or support physicians in the diagnosis process. However, faulty recordings occur from time to time and need to be detected automatically as manual annotation is time-consuming. In recent years, machine learning methods like neural networks have become important in the development of such algorithms. Since methods based on pure time series data are limited, imaging the data allows using well researched image-based approaches and possibly improving error detection. However, as the learned relationships of those models are hard to understand, the research field of explainable AI (XAI) aims to make the decisions of the methods explainable. This is particularly important in the medical field to create transparency in the decision-making process.

State of the Art

So far distance-based and deep learning methods for anomaly detection on time series data in the ICU have been investigated in previous theses. To apply image-based classification methods like Convolutional Neural Networks, researchers have used methods such as Gramian Angular Field or Markov Transition Field for the image conversion of time series data, where the angular relationships of the polar coordinates of each data point and the transition probability of the discretised states of the data are represented in an image respectively. In the field of XAI, there exist methods such as LIME, SHAP or Grad-CAM to determine the importance of each input features to a output, where LIME calculates a simpler model for the relation of a specific input and output pair, SHAP calculates the contribution of each input and Grad-CAM makes use of the gradients of a convolutional layer. This information can be used to highlight the important areas of the input image accordingly.

Objective

The aim of this thesis is to investigate image-based error classification and explanation methods on time series data in the ICU. For this purpose, image conversion methods are applied to available time series data and methods for error detection in images are considered. In addition, image-based explanation methods are implemented and visualized. To evaluate the usefulness, these approaches are compared and evaluated with previous approaches that only use time series data.

Planned Procedure

First, a literature review is conducted and the available ICU data is analyzed to identify suitable image conversion methods and possible approaches for error detection and explanation methods on images. Subsequently, the image-based approaches will be implemented. To evaluate their performance and usefulness, they will be compared with error detection and explanation methods for time series data from previous theses.