Active Learning for targeted data annotation and model training in intensive care data

(Master Thesis)

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Motivation

Recent development in machine learning has led to breakthroughs in solving complex problems. However, modern machine learning architectures are increasingly complex and require a large amount of labeled training data for proper learning. In the field of medical computer science, obtaining such labeled data is particularly costly due to the need for expert knowledge from medical professionals.

The Novelty Detection Analysis System (NDAS) developed at the Informatik 11 enables manual data annotation for intensive care datasets. However, the current annotation process is cumbersome and leaves opportunity to be improved in terms of efficiency. Hereby, active learning techniques can assist the researcher during the annotation of data points.

State of the Art

In the field of machine learning, active learning focuses on selecting a subset with the most informative data points for the annotation process, while maintaining the information content of the entire dataset. In these cases, the resulting model represents the same or a very similar function as a model trained on the entire data set. There are various methods for selecting these datasets, such as uncertainty sampling or diversity sampling. Another technique is query-by committee, which combines multiple models and selects data points where the disagreement is the highest. Various approaches combine active learning with deep learning to improve the training process of the underlying model. To our knowledge, there exists no active learning approach used for annotation and automatic detection of inconsistencies in intensive care data.

Objective

The goal of this work is to develop an active learning approach for targeted annotation of data points in medical informatics. To achieve this, several active learning techniques are implemented and integrated into NDAS. This aims to increase the process efficiency of the data annotation itself and reduce the biases that the labels may contain. In addition, supported annotation of data points is expected to improve existing novelty detection methods, while not being the main focus of this work.

Planned Procedure

First, a literature review is conducted to determine the current state of the art in the development of active learning techniques. Subsequently, an analysis is performed to evaluate the suitability of the different approaches for application in a medical context. Suitable approaches will then be implemented and integrated into NDAS. The labeling of the data is simulated on the one hand with the help of existing labels and on the other hand performed by physicians using the implemented active learning concept. In addition, the underlying models for detecting data inconsistencies will be extended and evaluated with the new annotations.

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05.05.2023

Informatik 11
Embedded Software
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