Project No.	Project Title	
2021-01-254	Analysis Framework and Advanced Mining of Multivariate Time Series Data	
Academic Advisor		**Co-Advisor**
Dr. Nir Nissim		
Team Members		
Gil Shenderovitz		
gilshend@post.bgu.ac.il		

Abstract

In recent years, computational advancements led to a significant increase in the abundance and availability of various types of data in a wide range of domains, particularly in the medical, and cybersecurity domains; Multivariate Time Series Data (MTSD) is one type of such data. This type of data is characterized as a sequence of discrete or continuous multidimensional time-stamped data points sampled from an entity over time.

Tremendous amounts of raw MTSD are collected, stored, and analyzed, as a wide variety of systems, devices, and services are continuously generating MTSD. As a result of the sampling procedure involved in generating MTSD, this particular type of data is notorious for being varied in sampling rate and temporal granularities, while usually consist of missing values and random noise. To analyze and learn from MTSD properly, a learning framework needs not only to cope with the abovementioned issues but also to accurately capture the temporal structure of the MTSD while providing interpretability and explainability of the taken decisions.

In the past, several learning frameworks based on Temporal Abstractions (TAs) and interval-based Temporal Patterns (TPs) have been proposed to learn from MTSD, overcoming existing issues and achieving state-of-the-art results on various tasks. Still, those methods are not sufficient for learning from MTSD.

In this research, we propose a new interval-based temporal feature, Inter-Rel-TP, which exploits the existing temporal reliance among interval-based Temporal Patterns, enhances the feature space and provides an additional explanatory ability. To evaluate the effectiveness and additional benefits achieved by using Inter-Rel-TP, we have designed and conducted several experiments to evaluate the additional qualities achieved by using Inter-Rel TPs for the task of Sepsis early detection in the intensive care unit (ICU), all of which resulted in superior results as compared to regular TPs.

Moreover, to leverage the prominent interpretability and explainability properties of TPs, and to elaborate the distilled knowledge for various tasks, an analysis and exploration framework has been developed. The framework provides additional task-supportive capabilities in production environments, helps stakeholders to examine a subject of interest, and reveals insights about the task in question.

In the near future, we wish to implement Inter-Rel TPs on different raw MTSD, where each holds different temporal characteristics, to further evaluate its qualities.

Keywords: Multivariate Timeseries Data, Machine Learning, Sepsis Prediction, Cybersecurity.