# **ANOMALY DETECTION IN THE FIELD OF HEALTHCARE**

## ANOMALY DETECTION FOR EARLY DETECTION OF SEIZURES:

Epilepsy is a neurological disorder characterized by recurrent seizures, impacting millions worldwide. Predicting seizures is crucial for improving patient safety and quality of life. While traditional seizure prediction methods have primarily relied on electroencephalogram (EEG) data, recent research has begun exploring the use of electrocardiogram (ECG) data. This novel approach is significant because it leverages the potential of ECG to capture autonomic nervous system (ANS) alterations that precede seizures, offering a new avenue for early detection.

**Trends and Methods:**

A growing trend in the field of epilepsy management is the exploration of ECG data for seizure prediction. Unlike EEG, which directly measures brain activity, ECG monitors heart rate variability (HRV), which can reflect changes in the autonomic nervous system linked to seizure onset. This method is innovative because it opens the possibility of predicting seizures using a non-invasive, widely accessible technology that could be integrated into wearable devices. Here, we evaluated three anomaly detection techniques—Local Outlier Factor (LOF), Minimum Covariance Determinant (MCD), and One-Class Support Vector Machine (SVM)—to identify pre-ictal states using ECG data. These models aim to detect deviations in HRV patterns that occur during the period leading up to a seizure, thereby offering a potential early warning system.

**Challenges & Opportunities:**

* ECG data must be patient-specific to accurately detect anomalies indicative of seizures. This personalization is crucial because HRV patterns can vary significantly between individuals.
* Properly labeling ECG segments as pre-ictal or inter-ictal remains challenging due to the subjective nature of this task and the variability of physiological responses across different seizures.
* Ensuring these models can generalize across different patients and seizure types is a key challenge, given the novelty of this approach and the complexity of HRV data.
* The innovative use of ECG data for seizure prediction presents substantial potential in developing advanced wearable devices that continuously monitor HRV with high precision, providing the necessary data for these models.

## ANOMALY DETECTION TO DETECT FRAUDULENT CLAIMS:

Fraudulent claims in healthcare, particularly in the domain of prescription fraud, present a significant challenge for insurance companies and healthcare providers. Detecting such fraud is critical to maintaining the integrity of healthcare systems and ensuring that resources are appropriately allocated. Traditional methods of fraud detection rely heavily on domain experts manually reviewing claims, which is time-consuming and prone to errors. The rise of structured data and machine learning (ML) offers new avenues for automating fraud detection, leading to more efficient and accurate systems.

**Trends and Methods:**

Recent advancements in anomaly detection for fraudulent claims have focused on utilizing both supervised and unsupervised machine learning techniques. Traditional supervised approaches, such as logistic regression, have been widely used, but they are often limited by their reliance on labeled data and predefined assumptions about the nature of fraud. As a result, there is a growing interest in hybrid models that combine the strengths of supervised and unsupervised learning. We successfully applied supervised, unsupervised and a hybrid model combining an Autoencoder and a Random Forest classifier to real-world prescription data.

**Challenges & Opportunities:**

* Fraudulent claims represent a small fraction of the total claims, leading to a significant class imbalance. This makes it difficult for models to detect fraud accurately, as they may be biased towards the majority (non-fraudulent) class.
* Prescription fraud detection is complicated by the heterogeneity of healthcare data, including variations in billing practices across different providers and specialties. This complexity necessitates sophisticated models that can generalize well across different types of data.
* Ensuring these models can generalize across different patients and seizure types is a key challenge, given the novelty of this approach and the complexity of HRV data.
* Continued research and development of hybrid models that combine supervised and unsupervised learning could significantly improve fraud detection rates. These models can be tailored to specific types of fraud, such as prescription claims, and optimized for real-time processing.
* Building robust data infrastructure capable of handling large, complex datasets in real-time is essential for the effective deployment of these models. Investments in cloud-based platforms and advanced data processing tools would support the scaling of fraud detection systems.

## REFERENCES:

1. Karasmanoglou, Apostolos et al. “ECG-Based Semi-Supervised Anomaly Detection for Early Detection and Monitoring of Epileptic Seizures.” *International journal of environmental research and public health* vol. 20,6 5000. 12 Mar. 2023, doi:10.3390/ijerph20065000
2. J. Lu, B. C. M. Fung and W. K. Cheung, "Embedding for Anomaly Detection on Health Insurance Claims," *2020 IEEE 7th International Conference on Data Science and Advanced Analytics (DSAA)*, Sydney, NSW, Australia, 2020, pp. 459-468, doi: 10.1109/DSAA49011.2020.00060.
3. Matschak, Tizian, Christoph Prinz, Kristin Masuch, and Simon Trang. "Healthcare in Fraudster's Crosshairs: Designing, Implementing and Evaluating a Machine Learning Approach for Anomaly Detection on Medical Prescription Claim Data." \*2021\*.