

# Detection of process errors in temperature-monitored deliveries

## Student



Kai Erdin

**Initial Situation:** For industries like pharmaceuticals or food production, temperature monitoring during transportation is a crucial aspect to ensure the quality and safety of their products. Using ELPRO's temperature loggers shipped with the product, the receiver can review the historical temperature data during transportation to verify that there were no temperature excursions (alarms) which could have harmed the products. However, for failed shipments, interpreting the temperature data to detect the root cause of the failure during transportation requires expertise and is not universal for all customers. Therefore, this evaluation has either not been done or for only a few cases by an expert of the receiver company.

**Approach / Technology:** ELPRO provided a real world dataset containing more than 450'000 temperature time series and their alarm thresholds, collected over multiple years from a logistics company. Since the data is unlabeled, neither failure types, the intervals of a failure nor its root causes are known. The thesis addresses the problem by creating methods to group similar, time- and amplitude invariant patterns together to simplify the analysis of the data. Since a pattern can occur multiple times in the same delivery, the methods should be able to find arbitrary patterns both locally and globally.

**Result:** The developed solution is a FCOS-based algorithm redesigned for one-dimensional signals, which is able to detect arbitrary patterns in multiple signals, both amplitude and width invariant. Should the pattern occur multiple times in the same delivery, the algorithm is able to find all occurrences of the pattern. The final model was successfully able to find patterns which it was not trained on. To demonstrate the capabilities of the final model, a

web application was created which allows the receiver of a failed delivery to find other occurrences of the same anomaly in past deliveries, to help them find the root cause of the failure to improve the quality of the delivery.

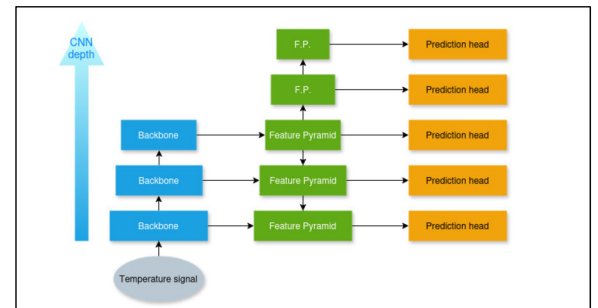
## ELPRO temperature loggers

<https://www.elpro.com/en/libero-cx-single-use>

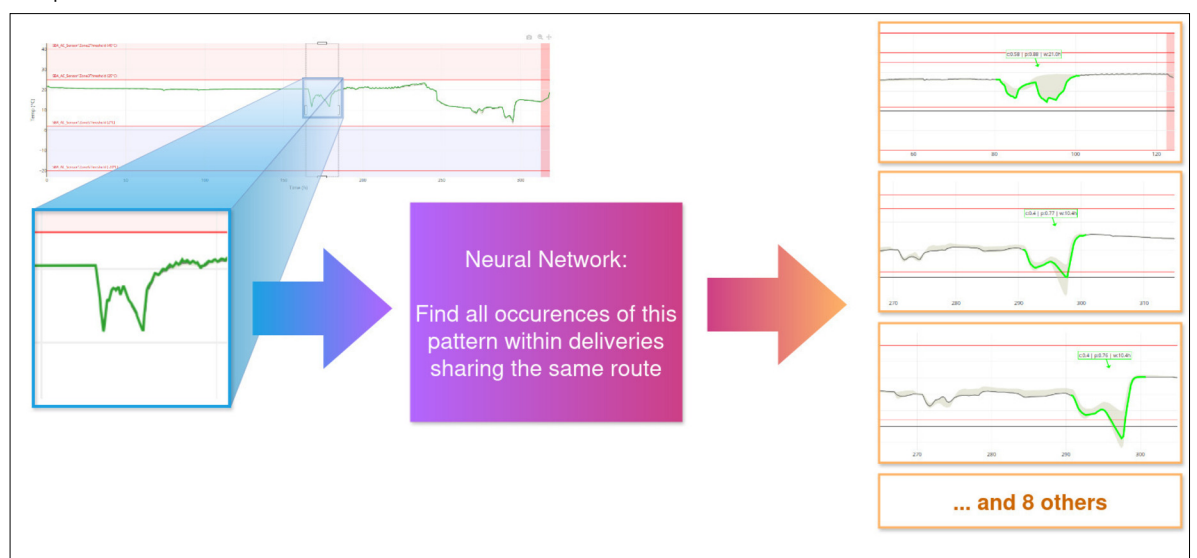


## FCOS (Fully Convolutional One-Stage Object Detection) model to detect patterns of different sizes

Own presentation



## Example process of finding candidates having similar patterns to find out the root cause of this event



**Advisor**  
Hannes Badertscher

**Subject Area**  
Data Science, Electrical Engineering

**Project Partner**  
ELPRO, Buchs, St. Gallen