# Railway Track Laboratory

Degree programme: BSc in Industrial Engineering and Management Science
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The SBB plays a crucial role in Switzerland's transportation system, transporting over a million passengers daily. To mitigate railway noise, SBB has installed measurement systems along a specific track section. The aim of this thesis is to analyze how weather conditions, such as temperature, humidity, and air pressure, affect sound propagation and the resulting noise pollution. Building on a pre-study and report, the focus is on systematically analyzing noise peaks.

## Introduction and Objectives

The SBB play a crucial role in Switzerland's transportation system, transporting over a million passengers daily. To mitigate railway noise, SBB has installed comprehensive measurement systems along a track section, which is displayed int figure 1. The aim of this thesis is to analyze how weather conditions such as temperature, humidity, and air pressure affect sound propagation and the resulting noise pollution. Building on a pre study and report, the focus is on systematically analyzing noise peaks and improving model accuracy through feature engineering techniques. The inclusion of winter data is intended to provide an understanding of the seasonal fluctuations in noise levels, give a comprehensive insight into the effects of weather conditions on railroad noise and provide explanations for the observed noise peaks.

## Research Design

The analysis begins with cleansing the data records and checking them for possible errors. Exploratory data analysis (EDA) is then performed using descriptive statistics and visualizations to identify patterns and anomalies. Feature engineering techniques are used to create new variables to improve model performance. Various modeling strategies, including linear regression and random forests, are used to capture both linear and non-linear relationships. The variables used for the linear model were selected using forward selection and lasso. Finally, the results are analyzed to determine the significance of the different factors influencing noise levels.

## Results

The environmental factors have only a minimal influence on noise measurements. The model results show that train type, speed and location have the greatest influence on the noise level. There are indications that the stream next to the rail could influence the noise levels, as the noise levels vary depending on which side of the track the stream flows. Exactly on every 5th or 6th of the month, the noise rises for inexplicable reasons, as you can see in figure 2 with the blue lines. The speed-normalized Transit Exposure Level (TEL80) is a measure of noise and was used as the target variable. Despite being speed-normalized, velocity features remain highly dominant. This raises questions about the accuracy of the TEL80 value.

## Implications and Recommendations

In a follow-up study, it would be valuable to analyze in detail what exactly happens on the 5th and 6th of each month that causes these noise peaks. It could be something specific to the measurement location or something particular related to rail operations. In addition, some variables that were not considered in this study could be important for feature development and be useful in conjunction with the new stream data.

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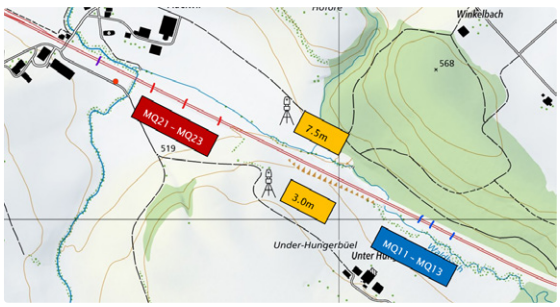


Figure 1: Map of the railway line showing the setup for monitoring stations

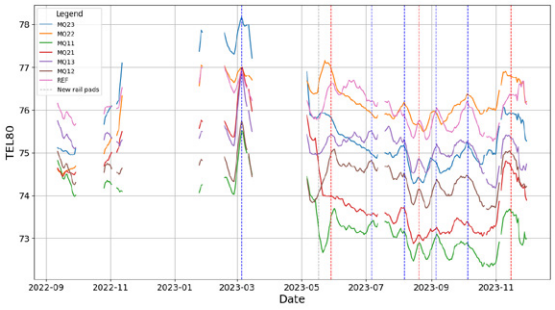


Figure 2: 7-day moving average of TEL80 values per location with marked peak values