Modern Data Analytics: A Case Study

Mapping and Mitigating Noise Levels in Leuven

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Overview

The City of Leuven wants to tackle the noise problem in the Naamsestraat neighborhood.

Aim: To find a balance between vibrant nightlife and ensuring residents can enjoy a peaceful night's sleep.

Methodology: mapping of night-time noise levels Via sound monitors and implementing behavioral interventions; promotion of noise reduction strategies.

Problem Statement

ANALYSIS

Which factors contribute to the noise level of Leuven?

ANALYSIS

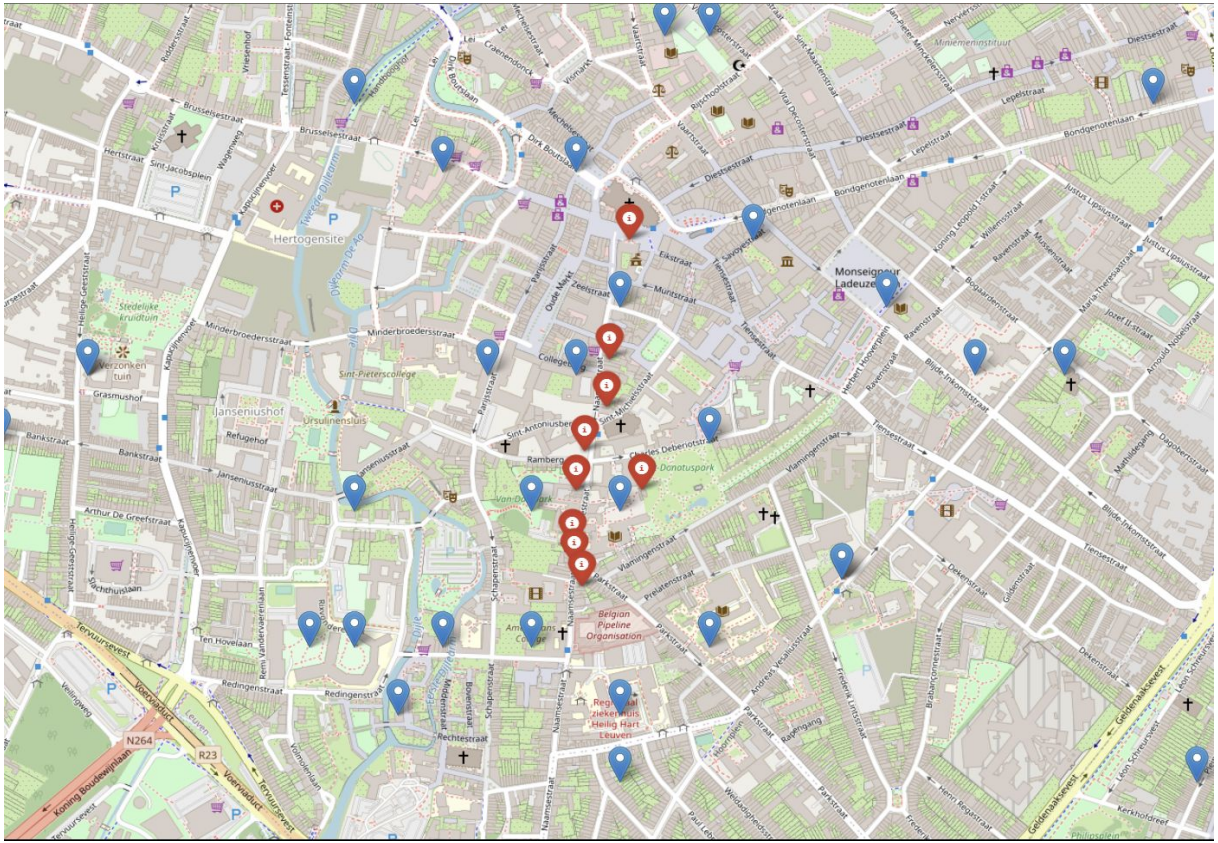
How can we identify patterns, trends, and potential correlations with various factors, such as weather conditions

APPLICATION

How to design transportation networks, impose restrictions in certain populated locations, coordinate event dates/locations, construction of the new properties/streets, etc.

Data Exploration

Locations



Noise data

Weather data

Data Overview 2022

EXISTING DATA

Meteorological

- Wind strength
- Wind direction
- Rain
- Green coverage

Noise events

EXTRA DATA

Local events

- World Cup 2022
- Concerts
- Festivals

Nearby facilities

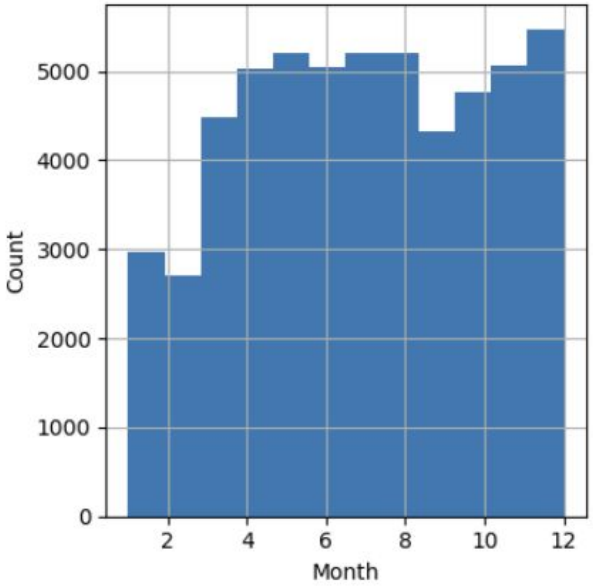
- Restaurants/ Cafes
- Bars
- Churches
- Bus stops
- Theaters

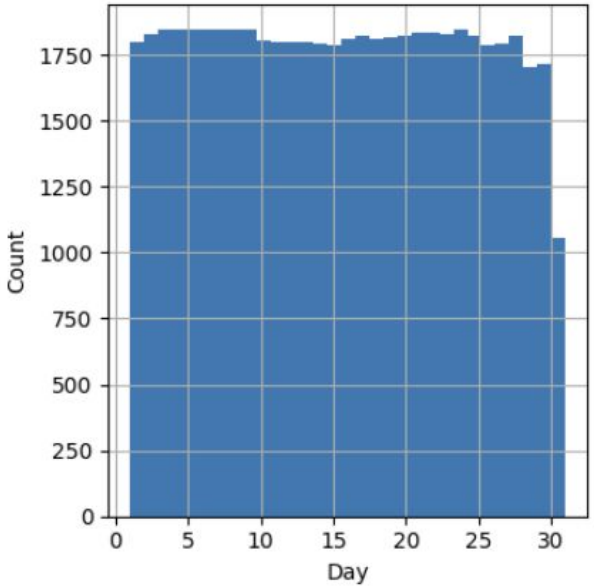
Noise level at 6 locations in Leuven

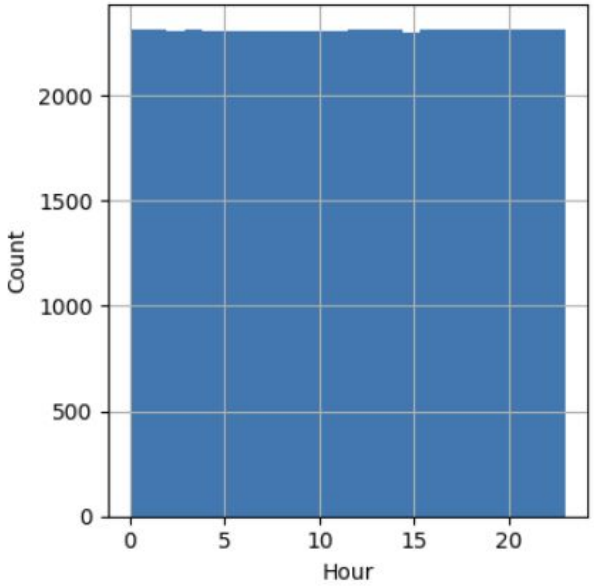
Shape of data
XX

Data Exploration

Distribution of noise data over month, day and hour

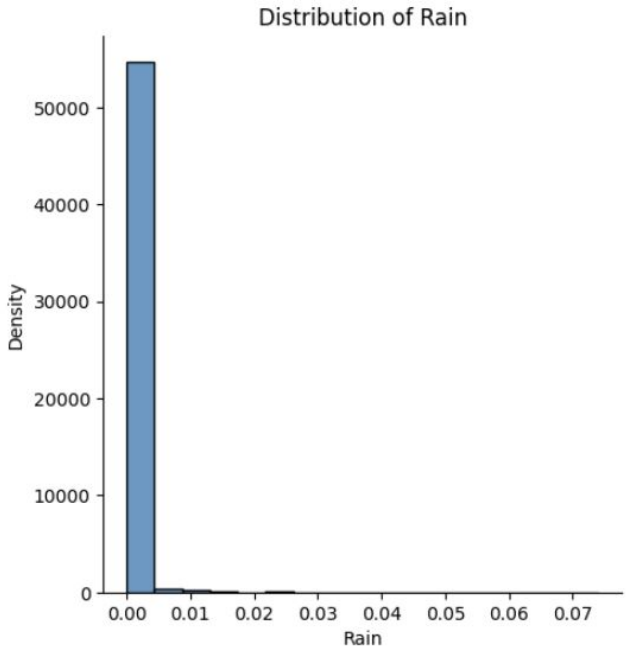


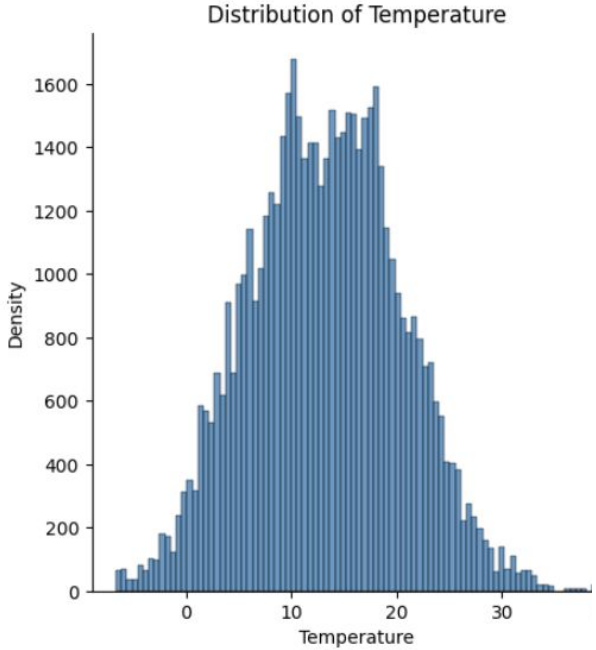


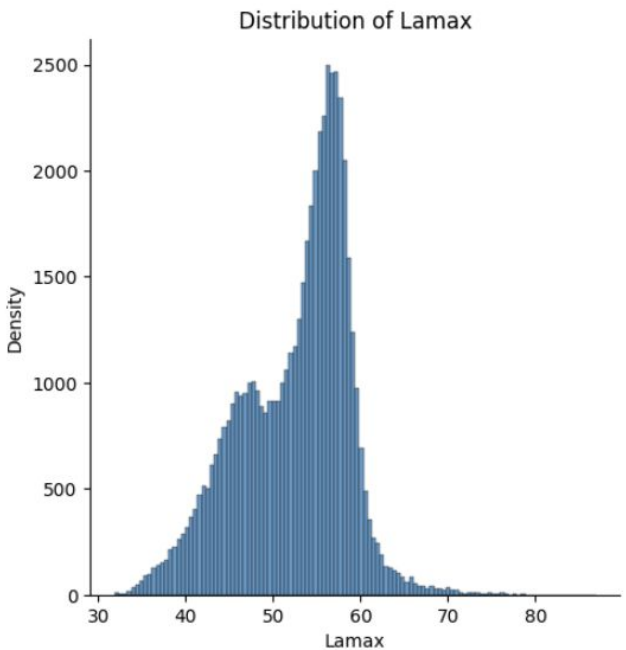


Data Exploration

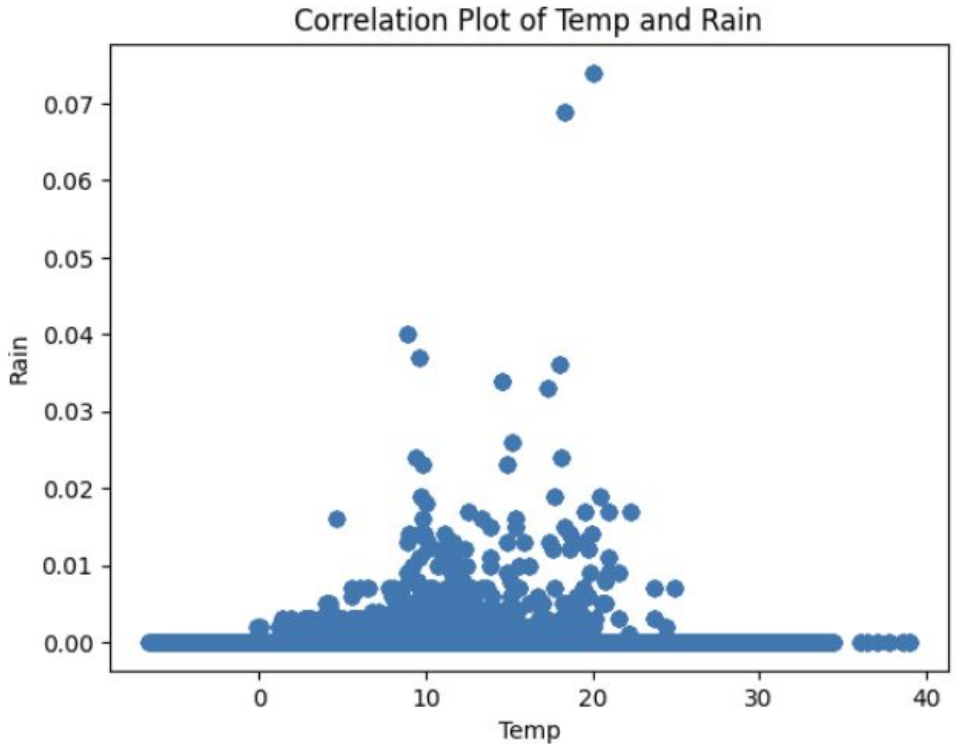
Distribution of Rain, Temperature, and Maximum Sound Level



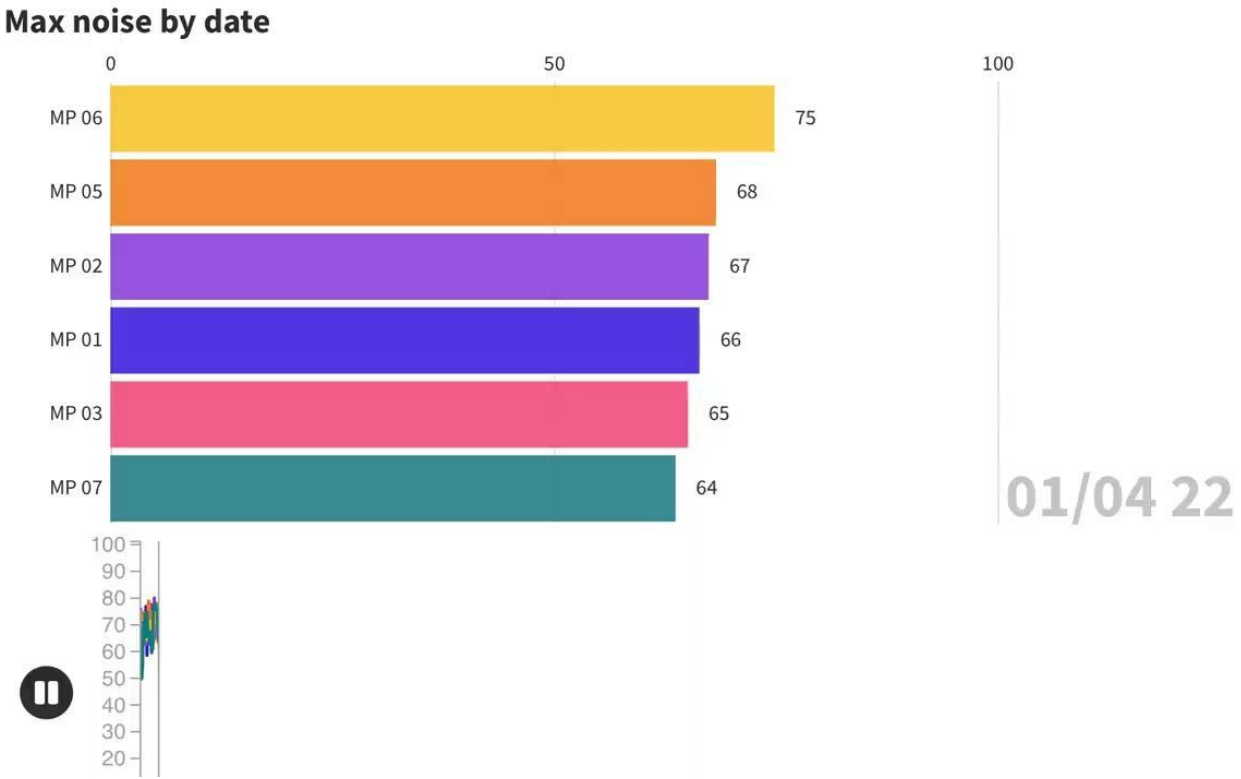




Data Exploration



Data Visualization



Data Preprocessing

- The weather data was combined with noise using relative distance
- Noise aggregated on hour-date basis
- Two locations with almost no data were removed

Modelling

Random Forest Regression Model

Model description

Random Forest Regression: a supervised learning algorithm and bagging technique that uses an ensemble learning method for regression in machine learning.

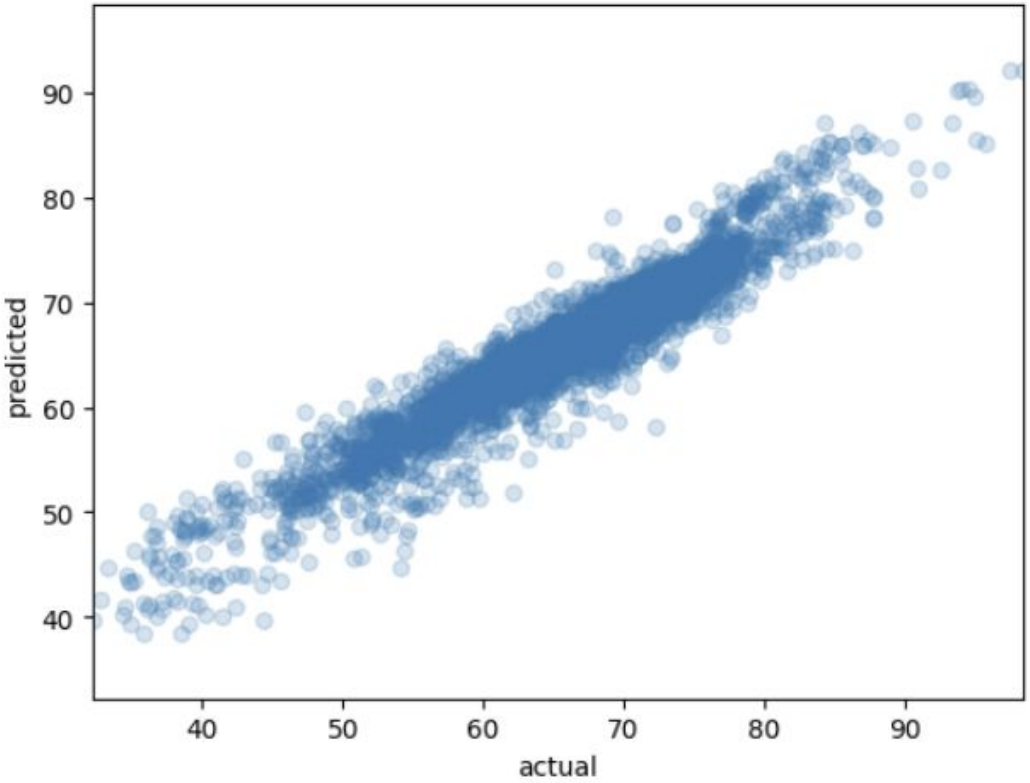
SHapley Additive exPlanations (SHAP): an explanation technique used to predict noise levels for a single location, based on the available features

Features taken into account:

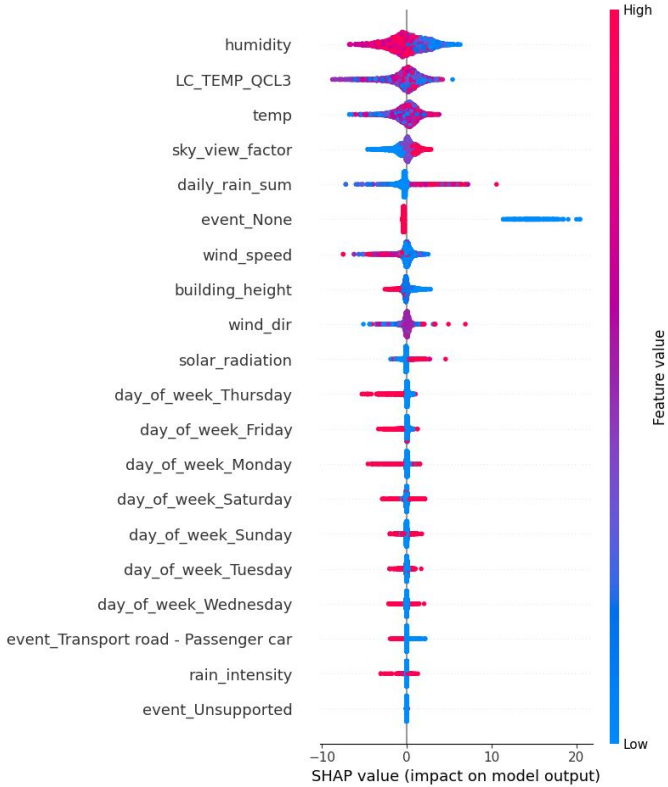
- Location
- Time
- Noise Level
- Weather Factors
- Events

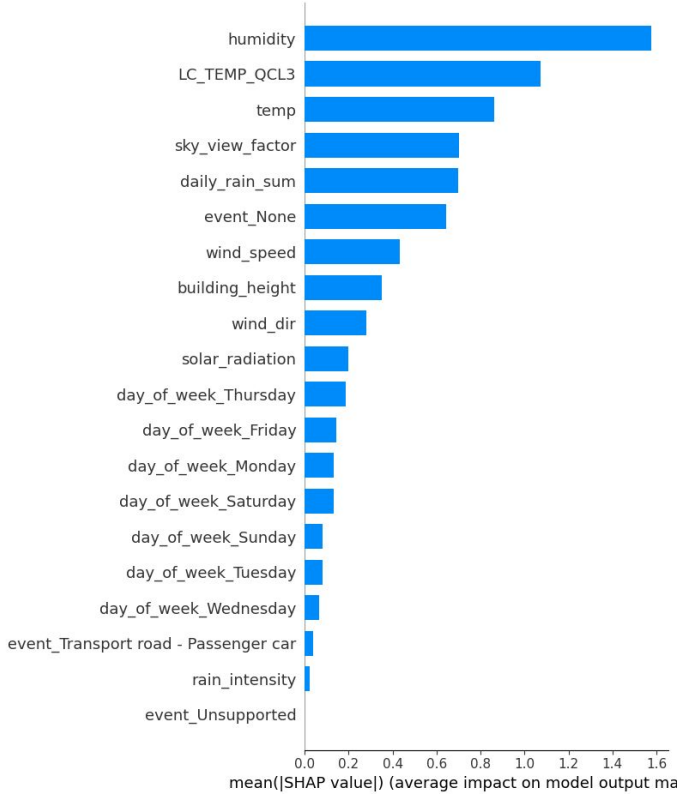
Model MSE: 49.32860170698673
R-squared: 0.3460532176391878 4

Model performance



SHAP value


humidity
LC_TEMP_QCL3
temp
sky_view_factor
daily_rain_sum
event_None
wind_speed
building_height
wind_dir
solar_radiation
day_of_week_Thursday
day_of_week_Friday
day_of_week_Monday
day_of_week_Saturday
day_of_week_Sunday
day_of_week_Tuesday
day_of_week_Wednesday
event_Transport road - Passenger car
rain_intensity
event_Unsupported
−10
0
10
20
SHAP value (impact on model output)
High
Feature value
Low


humidity
LC_TEMP_QCL3
temp
sky_view_factor
daily_rain_sum
event_None
wind_speed
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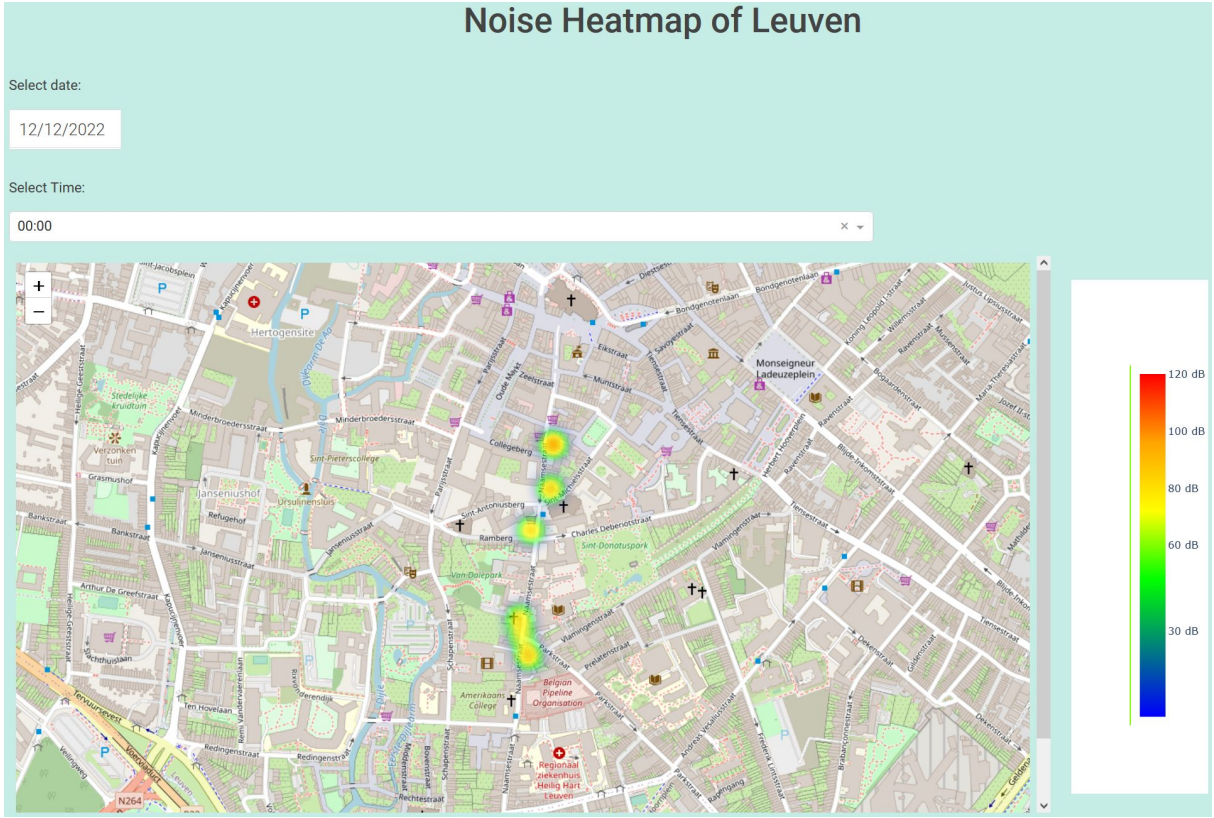
day_of_week_Thursday
day_of_week_Friday
day_of_week_Monday
day_of_week_Saturday
day_of_week_Sunday
day_of_week_Tuesday
day_of_week_Wednesday
event_Transport road - Passenger car
rain_intensity
event_Unsupported
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
mean(|SHAP value|) (average impact on model output ma

Results

- The model provides a good prediction input considering all the data
- R-squared is fairly low
- Traffic and public transport surprisingly unimportant
- Most important features in the prediction:
  - Humidity, location, temperature, time
  - Higher level of humidity lead to higher noise levels
  - Higher levels of temperature lead to higher noise level

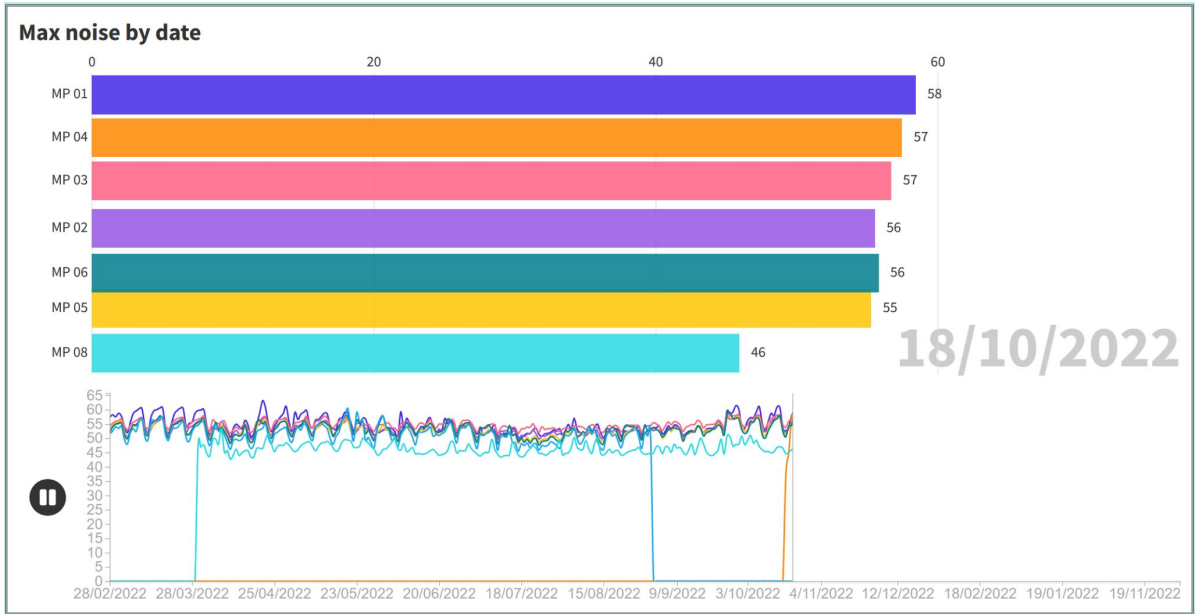
Noise Mapping App

App



The app displays a heatmap of max noise levels in the locations. It accepts user input and displays the heatmap according to that input.

App



A changing bar plot allows to visualize how the max noise levels change with the days.

The app has been deployed with AWS Elastic Beanstalk:

http://mydashapp-env.eba-egg3ihi2.eu-north-1.elasticbeanstalk.com/