SAFEROADS

Traffic management and road safety platform for the ATCLL infrastructure

M4 - Final Presentation

Project in Informatics 2022/23
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Group 7

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01. Context
Background

- Our project builds upon an existing **ATCLL project (Aveiro City Tech Living Lab)**, which involves a network of sensors scattered across Aveiro
- These sensors gather data for various types of analysis, forming a foundation for our work

01. Context
Objectives

- Develop a platform that can **showcase events and traffic flow** in Aveiro based on real-time sensor data and integrated data from external APIs (HERE and OpenWeather)

- **Identify new events** using cameras and radars, such as potholes and wrong-way traffic

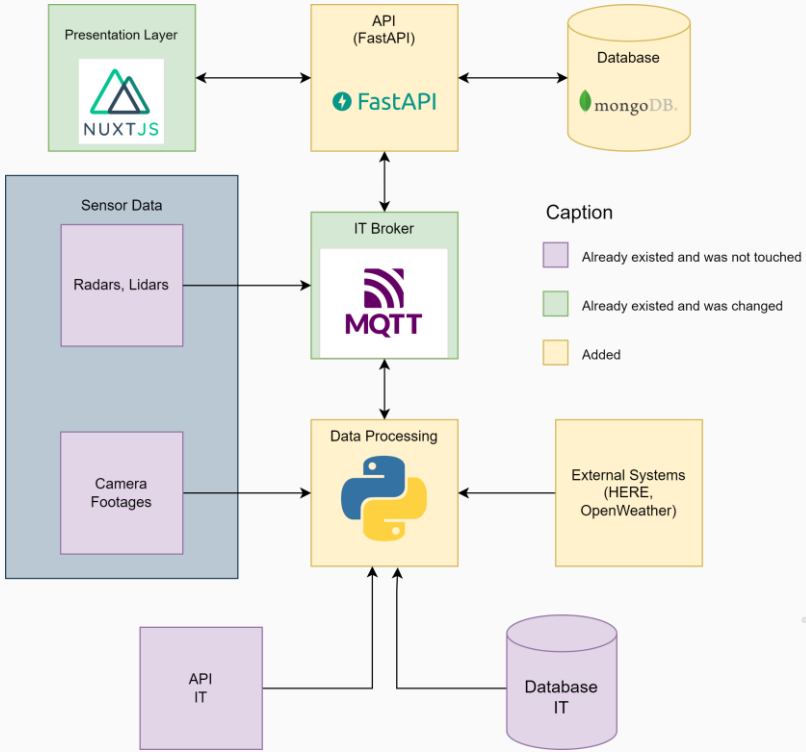
- Establish correlations with sensor data - taking into account factors like traffic flow, weather conditions, school periods, and weekdays - and **develop a traffic flow prediction model**

01. Context
Target Audience

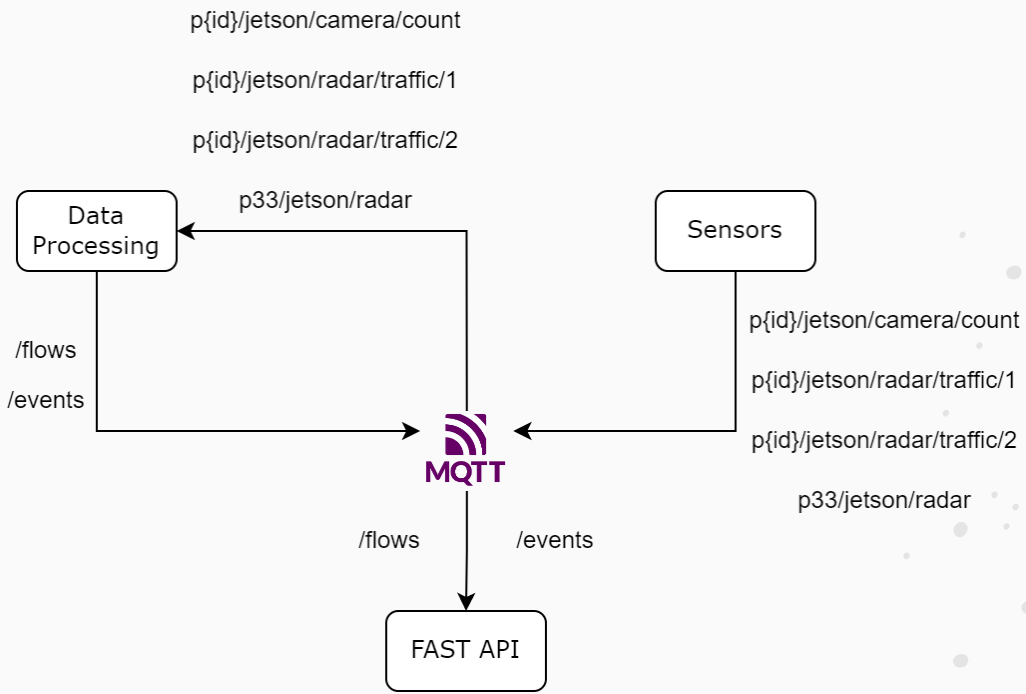
- **Municipal authorities** who wish to observe the city's behaviour in order to make informed strategic decisions and promote road safety

- **Citizens** who want to be up-to-date with road conditions, weather conditions and traffic in order to plan their journeys accordingly

02. Architecture Diagram



02. MQTT Messages



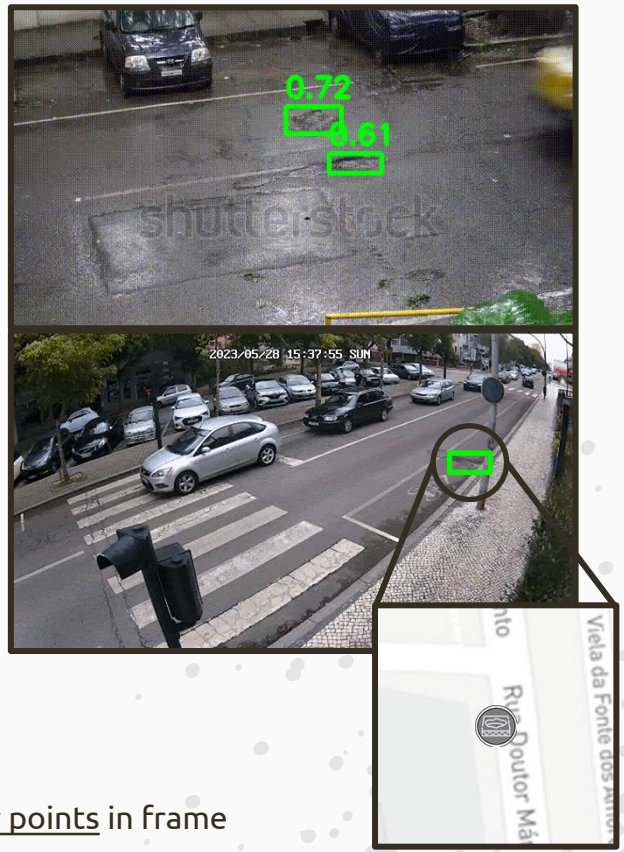
03. Event Detection - Potholes

- **YOLOv8 -** State-of-the-art object detection model

- **Trained a model** to detect potholes
  - Dataset with 665 annotated images
  - 100 Epochs (~8 hours 20 minutes)

- **Monitoring all cameras (5)**
  - P1, P25, P30, P33, P35
  - Everyday at 1 pm, for 10 seconds
  - 70% confidence threshold

- Algorithm translates to **geographical coordinates**
  - Know geographical coordinates of 4 non-linear coplanar points in frame



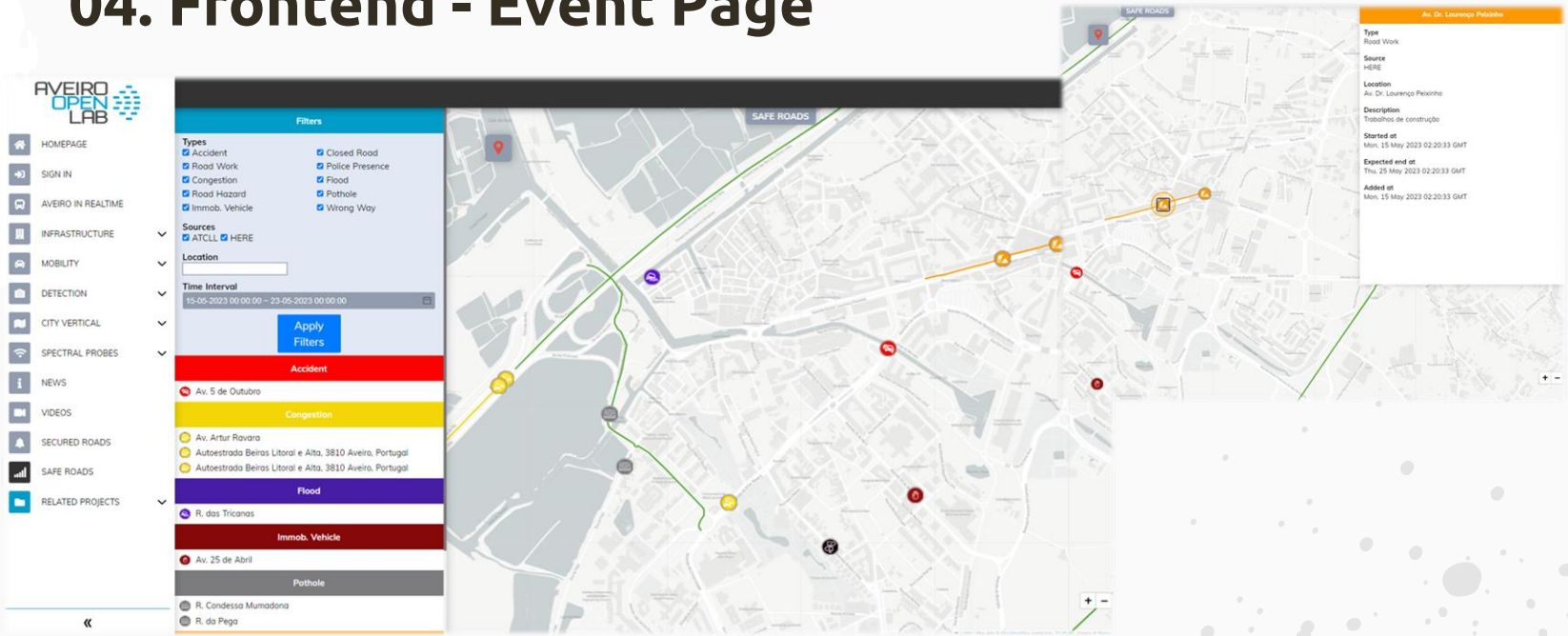
03. Event Detection – Wrong-way Traffic

- **Radar –** Vehicle positions

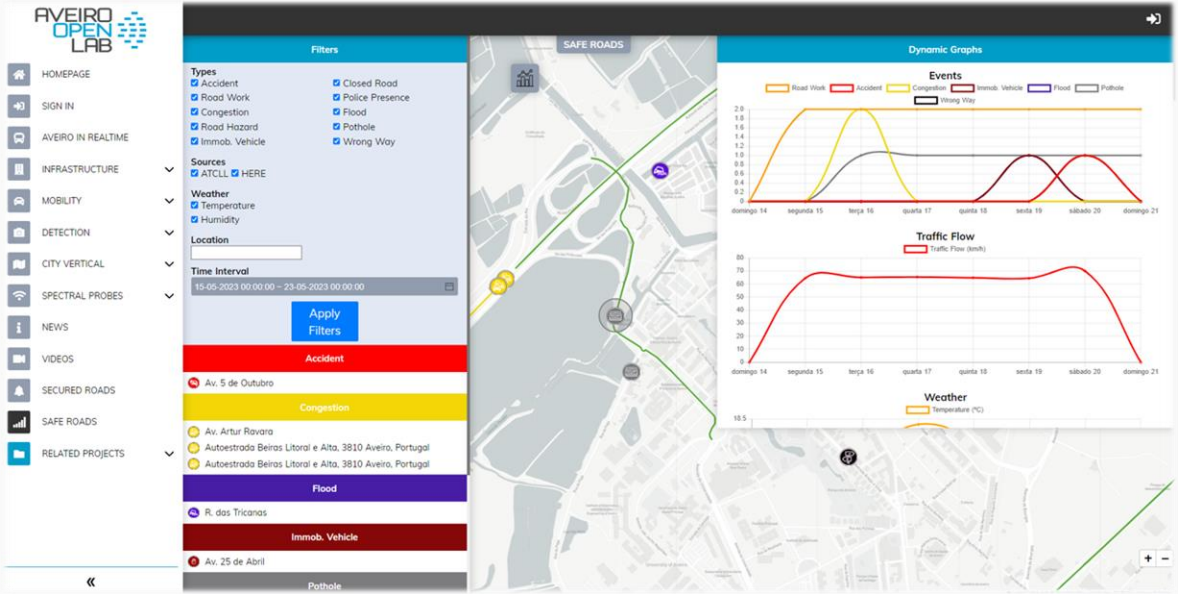
- **Developed an algorithm**
  - Line divides both ways of traffic
  - Shifts in position should move:
    - Right to left above the line
    - Left to right below the line
  - 5 consecutive detections threshold

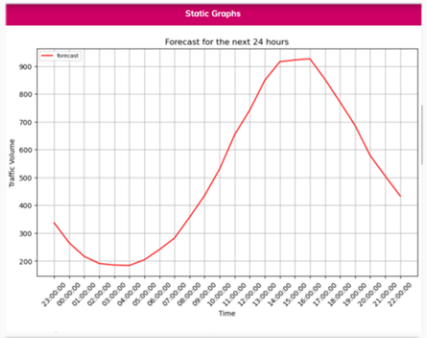
- **Implemented on P33**
  - Running all the time
  - Will be expanded to other posts

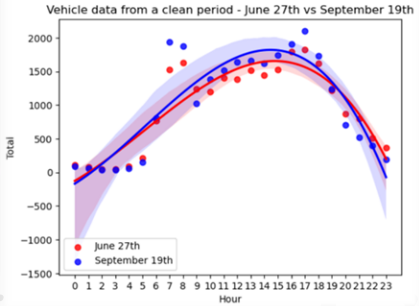
04. Frontend - Event Page



04. Frontend - Graphs Page



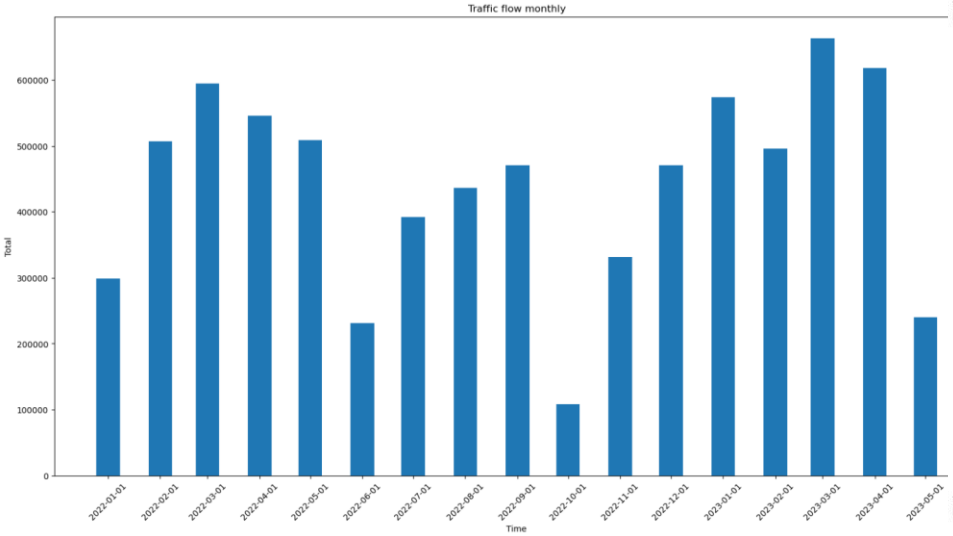


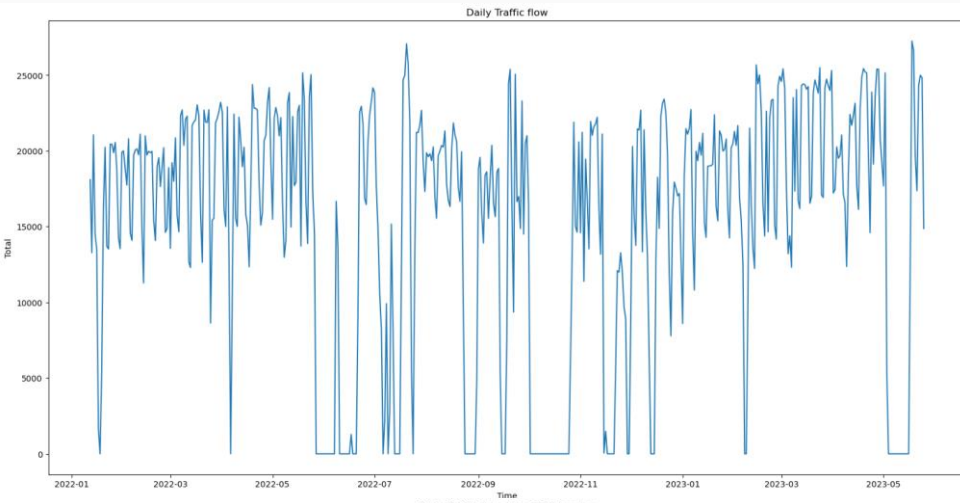


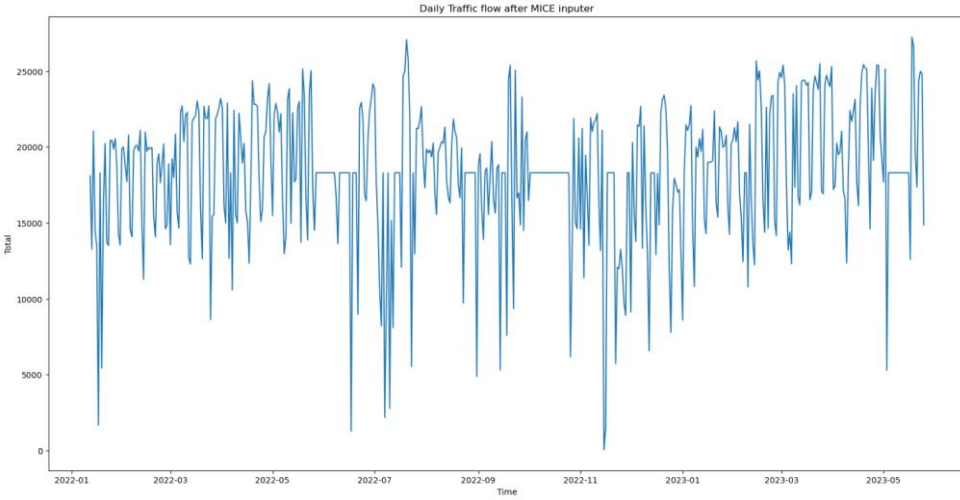
05. Traffic Flow Correlations and Forecast

- **Data analysis**
- **Exploring correlations**
  - Weekday - school vs no school
  - Weekend - school vs no school
  - Good weather - school vs no school
  - Adverse weather - school vs no school
  - School period - good vs adverse weather
  - No School period - good vs adverse weather
- **Exploring forecasting models**
  - **ARIMA** (AutoRegressive Integrated Moving Average)
  - **LSTM** (Long Short-Term Memory)

05. Data analysis







MICE (Multiple Imputation by Chained Equation)

05. Exploring Correlations

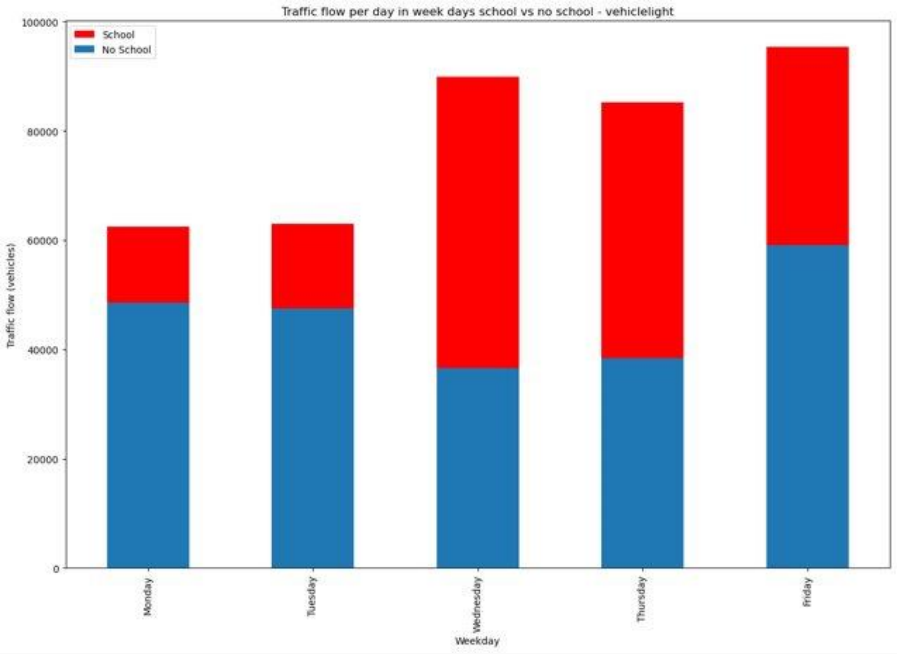
- Weekdays vs Weekends
- Good vs Adverse weather
- School periods vs no school periods

Conclusions?

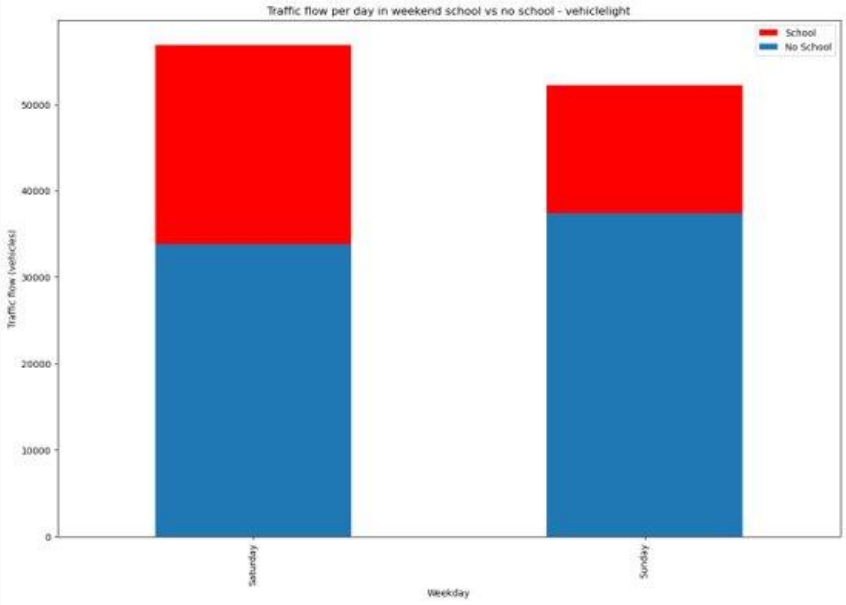
- Data analysis
- Exploring Correlations
  - Weekday - school vs no school
  - Weekend - school vs no school
  - Good weather - school vs no school
  - Adverse weather - school vs no school
  - School period - good vs adverse weather
  - No School period - good vs adverse weather
- Exploring forecasting models
  - **ARIMA** (AutoRegressive Integrated Moving Average)
  - **LSTM** (Long Short-Term Memory)

05. School vs no school

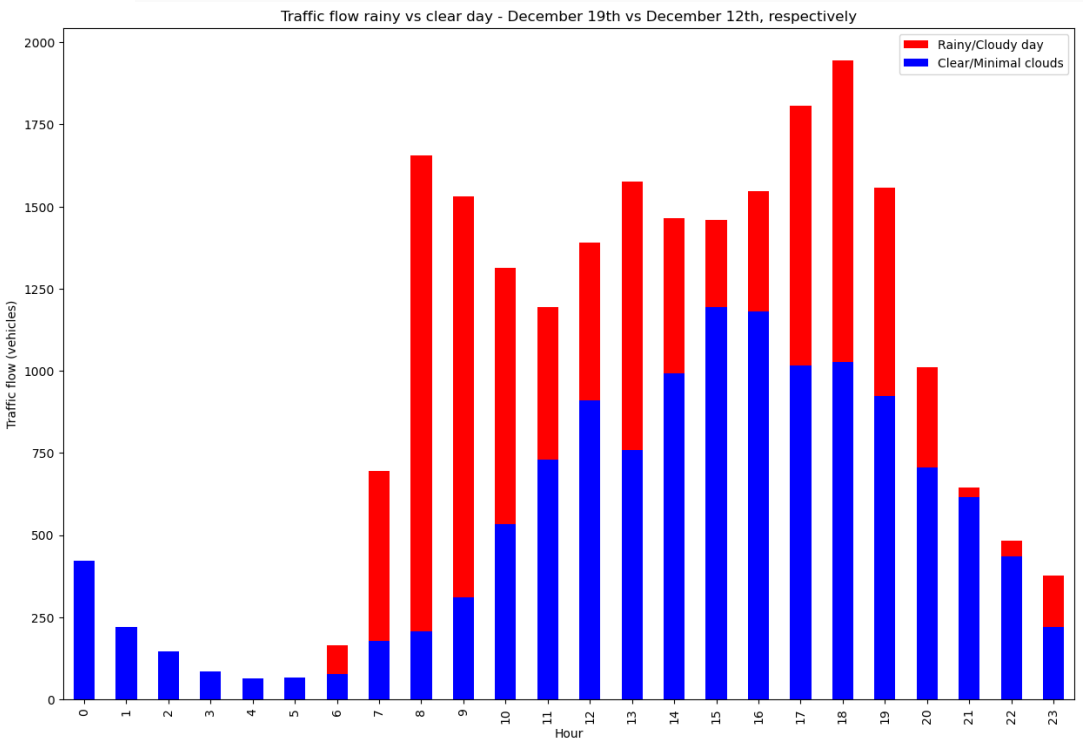
Weekdays

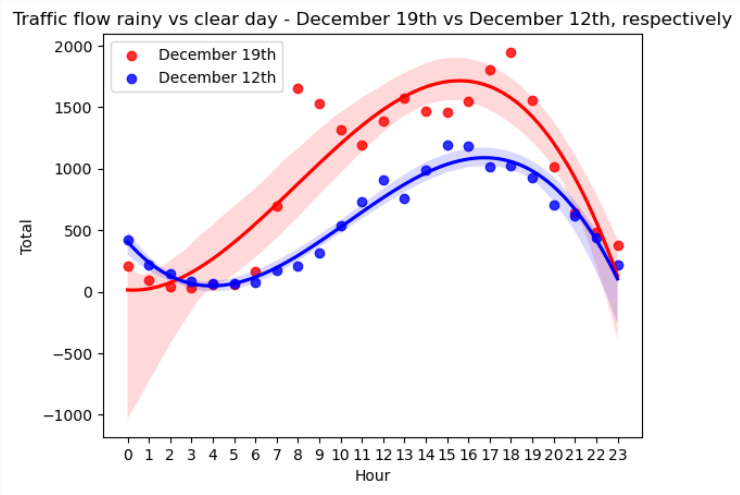


Weekend

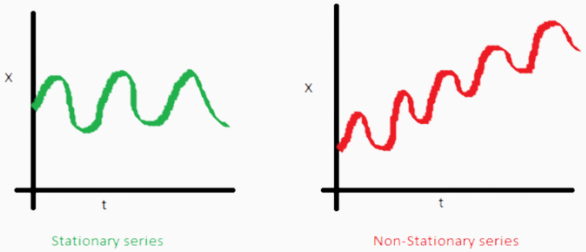


05. School period - good vs adverse weather





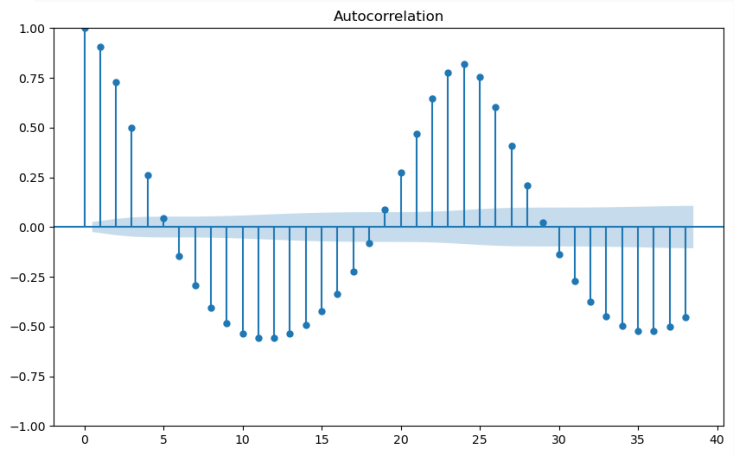
05. Forecasting Model - ARIMA

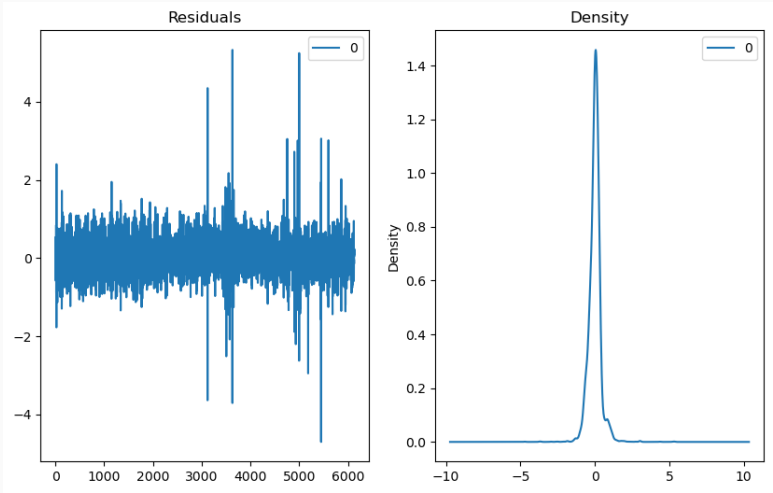


AR + I + MA

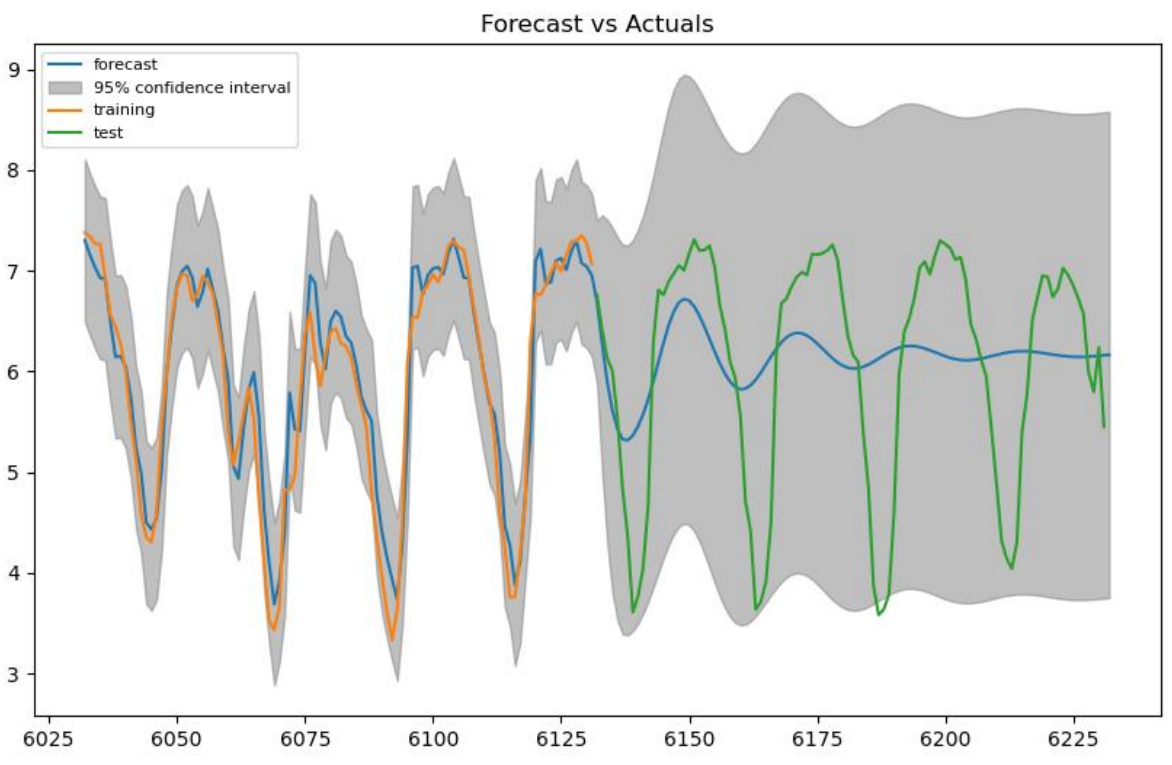
(**A**uto**R**egressive + **I**ntegrated + **M**oving **A**verage)

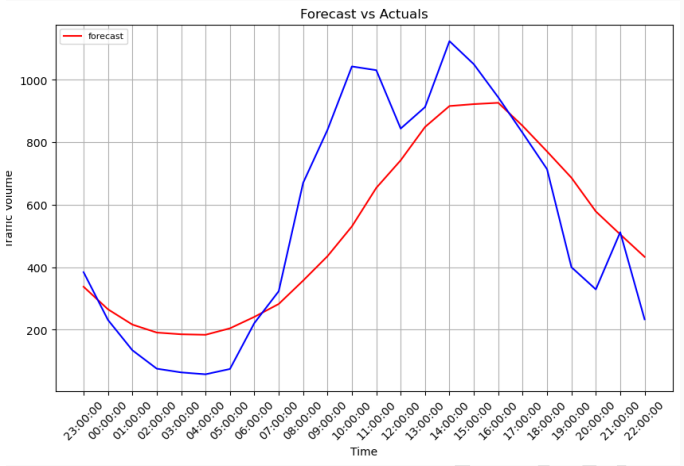
statsmodels





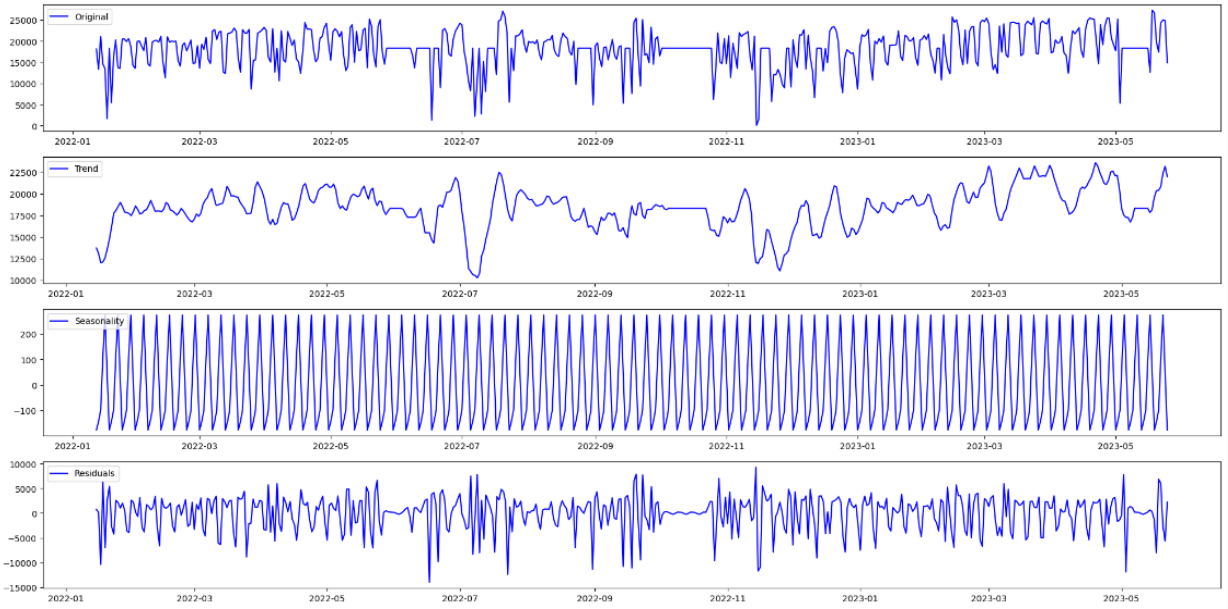
05. Forecasting Model - ARIMA

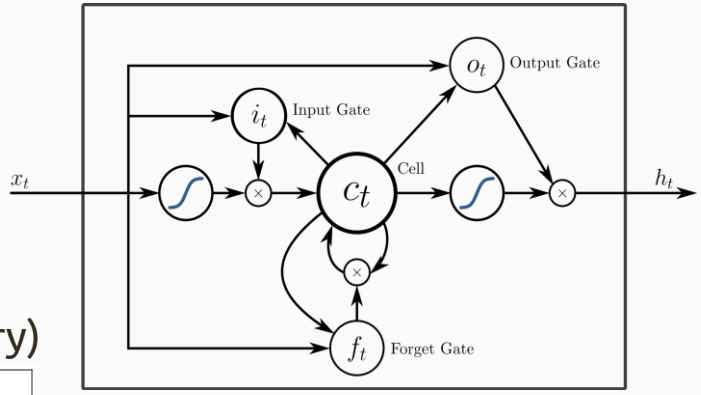




05. Forecasting Model - LSTM

LSTM
(Long Short-Term Memory)

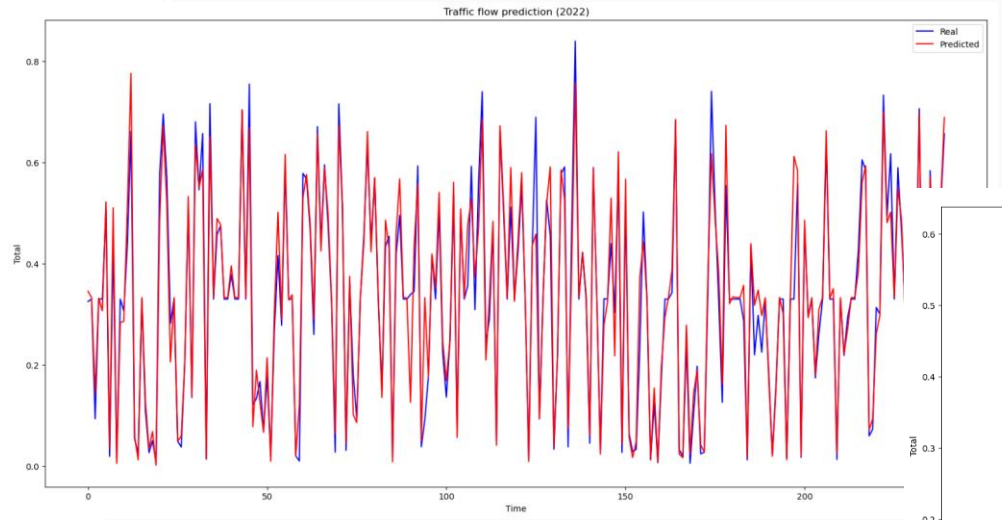


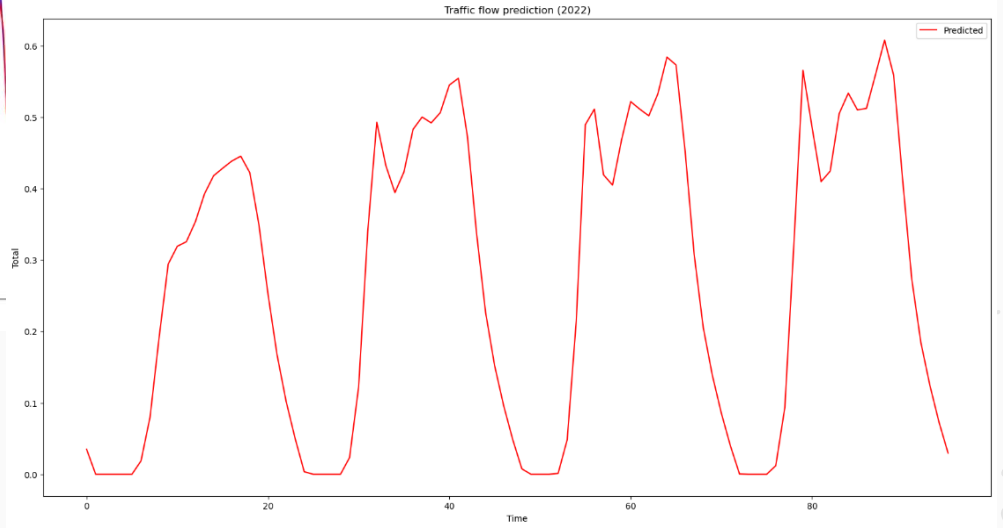


LSTM - architecture

- 2 LSTM layers with 64 units each
- a fully connected dense layer with 1 unit

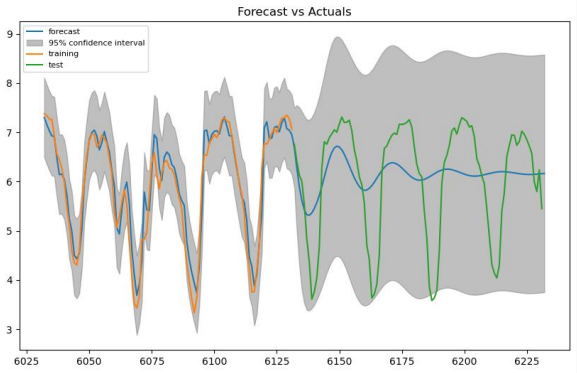
05. Forecasting Model - LSTM



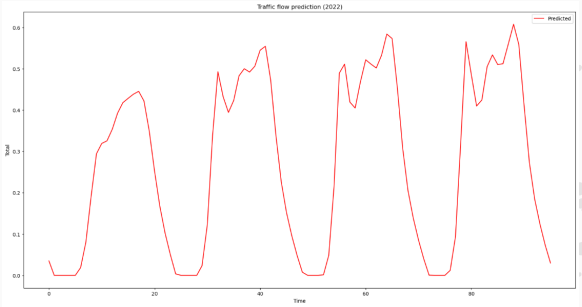


05. Forecasting Model - ARIMA vs LSTM

ARIMA



LSTM



06. Summary

- **Platform** to visualize events and traffic flow in Aveiro
- Integration with data from **external APIs** (HERE and OpenWeather)
- Detection of **new events** (potholes and wrong-way traffic)
- **Correlations** and **traffic flow prediction** model

06. Future Work

- Fetch data from more **external APIs** (Waze)
- Detect more types of **events** using YOLOv8 (floods, armed people,…)
- Integrate **traffic forecast** results in the frontend

Thank you!