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Analysis and Visualization of Brno Traffic Data

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Abstract

The escalating issue of urban traffic congestion poses significant challenges not only for commuters but also for municipal authorities tasked with efficiently managing urban traffic flows. In response, there has been aim to develop a tool with purpose of analysis and visualization of traffic data from datasets provided by the Waze navigation application: Traffic Delays and Traffic Events. The developed web-application meant to be usefull for both types of users: commuters and municipal authorities, with its practical functionalities such as interactive city maps and intuitive dashboard. Moving forward, the next phase involves further exploring of traffic analysis to unveil underlying patterns and trends.

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1. Introduction

Traffic affects everyone living in the city, commuting by a car. Everyone wants to get to their desired location as fast as possible, so that means spending less times in traffic. Modern navigation application collects so many information about traffic delays and incidents, but in this format it is useless for ordinary users.

Waze, in cooperation with municipalities in project called **Waze for Cities**, provides data collected from its users to cities, but it is responsibility of each municipality how they choose to utilize this data. The objective is to develop a solution capable of effectively utilizing provided data to benefit the general public, aiding in their comprehension of city traffic dynamics along their daily routes. Additionally, the solution aims to assist municipal authorities in discerning traffic patterns for the purpose of enhancing urban traffic management strategies.

Numerous municipalities already tried analyzing data from Waze, for example Prague[1] or Washington DC[2]. What these and many other solutions share is usage of pre-existing tools for data analysis, which may not necessarily be tailored specifically for traffic analysis. For instance, Prague utilizes PowerBi, primarily focusing on statistical data and summaries while neglecting map-based analysis and visualization. On the other hand, Washington DC uses ArcGis, which besides all the statistical information visualize the data on map base. None of the solutions accessible to the general public currently prioritize in-depth analysis and visualization of specific streets or routes.

The proposed solution prioritize traffic data analysis from user perspective – its main focus is on user experience, and mainly how commuters travel through the city, while working with map base – using simple routing algorithms to define user routes and analyze traffic only on this part. Furthermore, the solution leverages spatial data attributes for visualization purposes, enhancing the representation of traffic dynamics over a map.

Created web application is available to wide public in testing mode, succesfully analyzing and visualizing Waze data up to one year in the past.

2. Design of the Solution

Waze currently offers municipalities access to two datasets, serving as the foundational elements for the analyzed and visualized data:

- **Traffic Delays** – consisting of automatically generated traffic jams data based on GPS from user's mobile devices
- **Traffic Accidents** – consisting of data mostly from users and municipalities, about 4 main types of traffic alerts - delays, hazard, accidents and closed road.

[1] https://golemio.cz/data/doprava
[2] https://bit.ly/washington-dc-dashboard

The proposed solution has three main parts. First is data preparation consisting of cleaning, filling in missing values and transforming data, described in section 2.1. The next part consist of user interaction with map and visualization of analysed data within it, detailed in section 2.2. Lastly, section 2.3 offers of brief description of data visualized in Dashboard.

2.1 Data preparation

Each dataset contains almost half a million records, and this records are not further processed by the City of Brno and is provided to users in the same format as Waze its providing it to the municipalities. Therefore, this data needs to be processed before further use – cleaned, missing values filled in, transformed, etc.

Cleaning data primarily involved addressing encoding issues with street names, as certain names are unreadable and useless for further analysis. Additional aspects addressed in this step included the elimination of duplicate entries and the rectification of inconsistencies present within the dataset. This issues has been effectively resolved within the proposed solution.

Filling-in missing values can be categorized into two main issues:

- Filling-in missing street names – the street was missing for some records. This was filled in based on its geospatial attributes.
- Filling-in missing categories – each traffic alert should have defined main category and subcategory, if subcagetory was missing – it was filled based on multiple other attributes, eg. traffic jam subcategory was filled based on attribute `level` from `Traffic delays` dataset.

Transformation takes care of preparation of data, so that it can be easily used in application, eg. aggregating data for visualization by hours and days.

2.2 Interaction with map

The primary functionality of this application is controlled through its map-based interface. Its functionality can be described by two main features:

- User interaction with map – map, implemented using the `Leaflet` library, enables users to interact with specific streets and select routes by choosing individual waypoints across the map.
- Visualization of traffic delays and alerts on map – based on user selection, traffic delays are depicted on the map from one intersection to another, while traffic alerts are clustered into larger groups. However, each alert remains visible and provides basic information about the incident.

2.2.1 User selected route

Upon user selection of origin and destination points on the map, the algorithmus firstly calculate the route. For this calculated route, it needs to determine which streets the route intersects, but the intersection needs to be at least 2 points. Finally, it calculates traffic delays on the route (from one intersection to another) and, if user selected, it also visualize traffic incidents within the route. This whole process can be see in Figure 1.

2.3 Dashboard

Another functionality is covered by dashboard, which visualize more detailed data using different types of charts. The main focus is on multiple line charts, which visualize the development of different attributes describing traffic delays in time – number of delays, average level of delay, total lenght of delay and more.

Another charts visualize the number of different categories and subcategories of traffic alerts and most critical streets by number of delays or alerts, in selected time frame.

3. Results

The proposed solution in form of web application, as can be seen in Figure 2, succesfully analyzes and visualizes traffic data sourced from the Waze navigation application, covering the entirety of Brno city up to one year in the past.

The web application enables users to seamlessly choose different streets or routes for visualization of traffic delays and alerts directly on the map. In the absence of a selection, the application automatically displays this information across the entire city, providing users with a comprehensive overview of the traffic situation in Brno.

Furthermore, the developed web application offers users detailed charts illustrating how various aspects of traffic delays have evolved over time. This information is accessible via the Dashboard.

Future plans involve conducting more extensive analyses of traffic, exploring various traffic patterns, and examining the correlation between weather conditions and traffic dynamics.

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