The impact of weather on transit demand

Conference Poster

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D-BAUG Lighthouse Project: E-Bike City Subproject B

The impact of weather on transit demand

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1 Introduction

This work studies the influence of weather on travel demand in Zurich, with a focus on public transport ridership. The weather conditions induce a change in travel demand, depending on spatial and temporal factors, such as time, day, transit line and location in the network [1]. With the use of statistical and machine learning techniques, this work aims to identify the relationships between the weather and the ridership of different modes.

2 Data

Long-term data of ridership: passenger counting data from the public transport agencies (VBZ), on boarding at several stops of different lines; bike counting stations; car traffic data.

Long-term weather data: 10 minutes samples collected from the Institute for Atmospheric and Climate Science (ETH Zurich), containing information on amount of rain, temperature and wind.

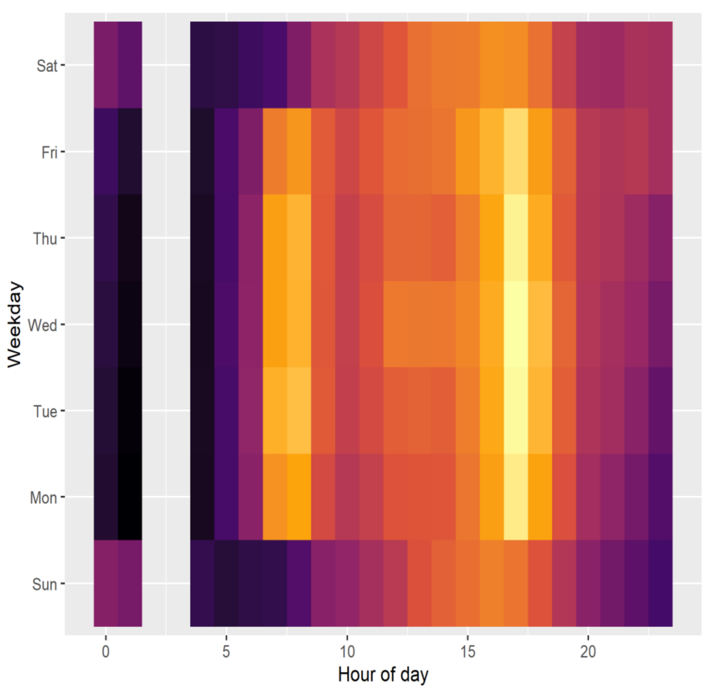

Fig 1:Public transport occupancy

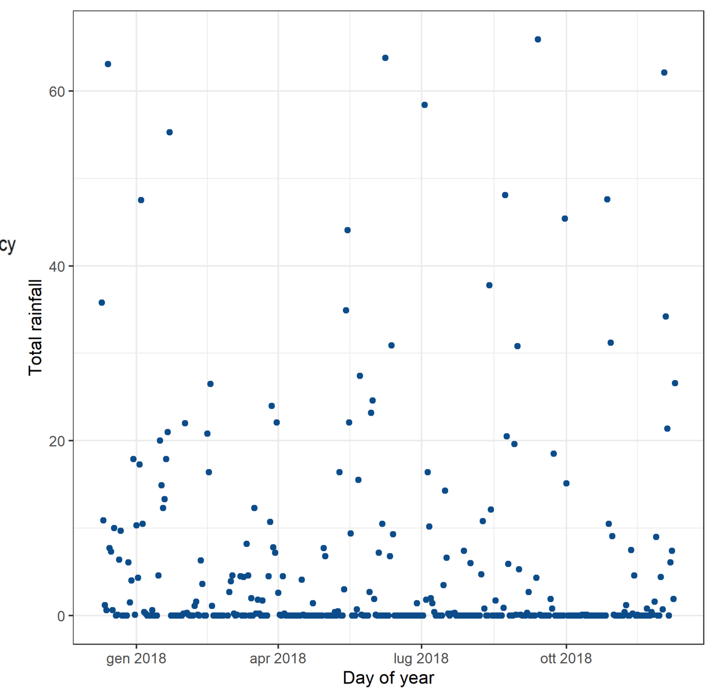

Fig 2: Rainfall during the year

3 Methods

A forecasting model is developed to predict the usage of different modes, based on Machine Learning techniques. The model is trained on historical data of ridership and makes extensive use of information on weather and the network (e.g. location and transit stops). The prediction model has a twofold function: it can be used to predict the expected increase of ridership of the different modes in case of specific weather conditions; it shows how much different factors, such as the weather and the network location, contributes to a variation of ridership in case of adverse weather conditions.

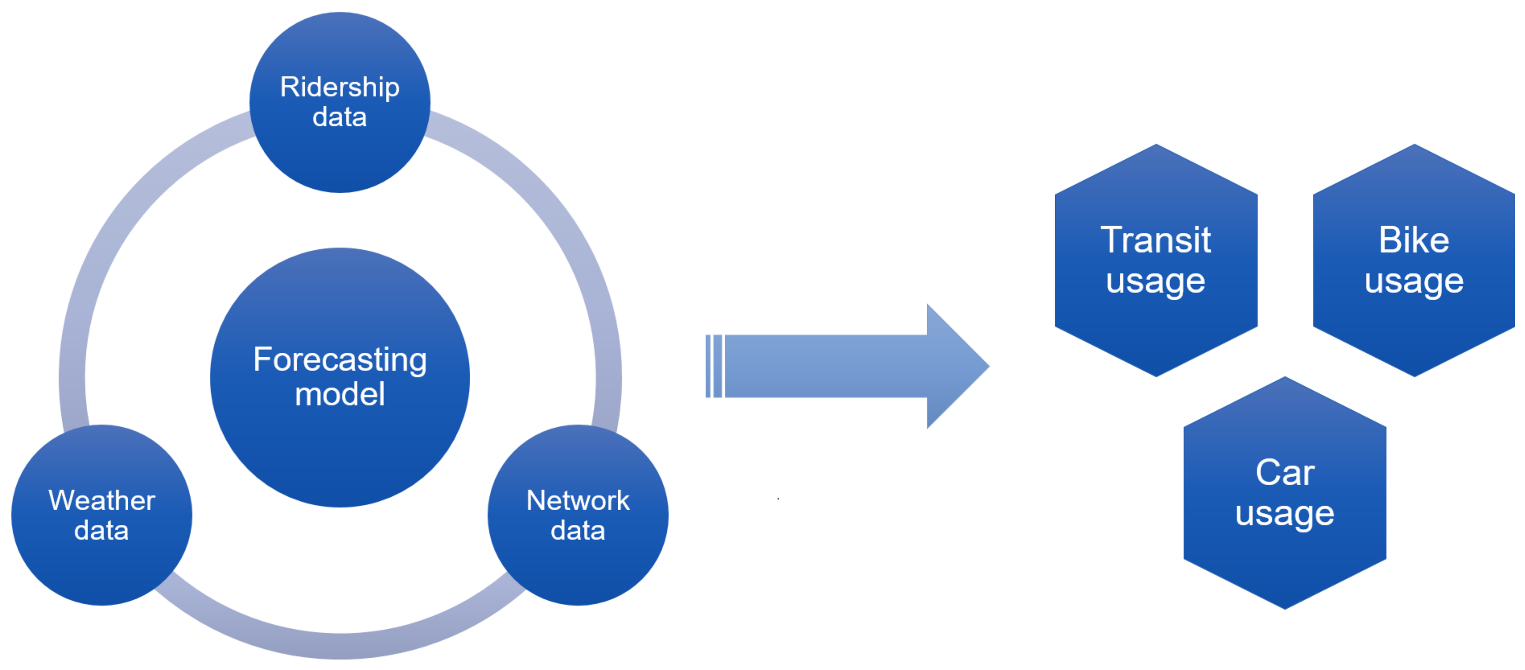

Fig 3: Schematic representation of the methodology

The weather effect is evaluated as percentage increase of ridership, between two conditions (e.g. rain and no rain):

$$\Delta^r_{i,j} = \frac{R_j - R_i}{R_i} 100$$

The change of ridership is evaluated for different combinations of weather, time and space features. For instance, light and heavy rain are compared, but also working and non-working days, and different areas of the city.

4 Results

The analysis of public transport occupancy in Zurich in case of rain shows significant variations, distributed unevenly in the network (Figure 4). An occupancy increase is observed in the city center or areas with an high concentration of offices. On the other hand, a decrease is observed in leisure areas of the city, like the Zoo.

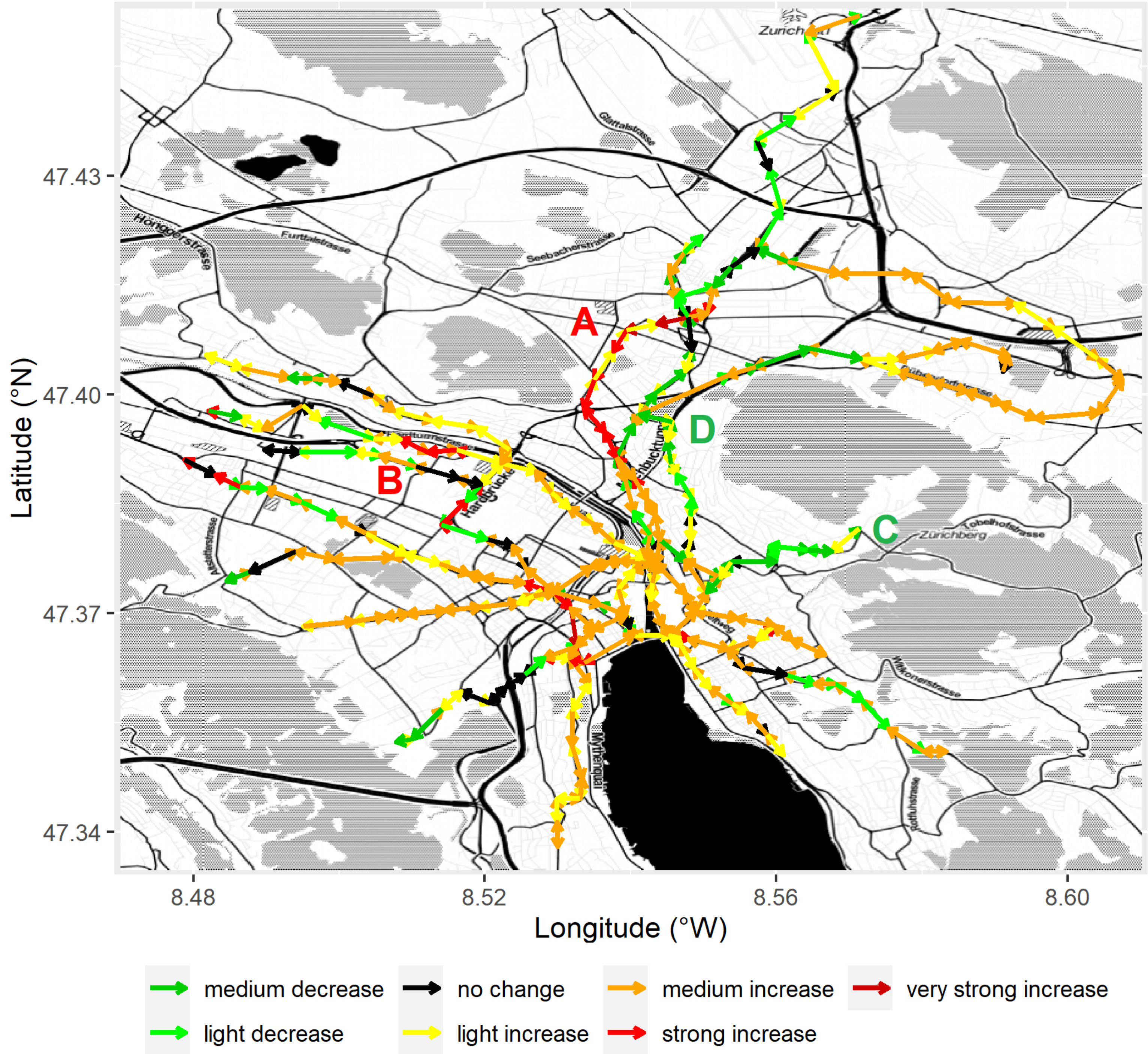

Fig 4: Occupancy variations in the Zurich public transport network, in rainy days compared to non-rainy days. Dark green refers to -5%, yellow to 5%, red to 30%.

On days of heavy rainy the average occupancy in public transport is 7.4% higher than on non rainy days (Table 1). Moreover, distinguishing between light and heavy rains shows that more intense rainfalls lead to an higher occupancy. Significant differences are identified between working and non-working days in case of rain (Table 2). The occupancy increases in working days, while it decreases in non-working days.

Table 1: Average occupancy variation between no, light and heavy rain.

Rainfall (mm)	$\Delta^r_{0,1}$%	$\Delta^r_{0,2}$%
{no;<=0.2;>0.2}	4.6	7.4
{no;<=0.5;>0.5}	5.0	8.0
{no;<=1.5;>1.5}	5.0	9.8

Table 2: Average occupancy variation per day type, 7:00 - 9:00 am.

Rainfall	$\Delta^r_{no,rain}$%	$R_{rain} - R_{no}$
Working	6.4	3.4
Non-work.	-6.5	-1.0

5 Future

The preliminary analyses showed a significant effect of weather on transit ridership. In the next steps, this works aims to develop a forecasting model able to predict the effects of weather on ridership and identify the main contributing factors.
A similar analysis will be repeated for bikes and car ridership, to have a complete overview on the impact of weather on travel demand.

References

[1] S. Tao, J. Corcoran, F. Rowe, and M. Hickman, "To travel or not to travel: 'weather' is the question. modelling the effect of local weather conditions on bus ridership," *Transportation Research Part C: Emerging Technologies*, 2018.

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