Predictive Multimodal Trip Planner: A New Generation of Urban Routing Services

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Extended Abstract

Route planning in public transport receive an increasing interest in smart cities and particularly in metropolitan cities where crowded and jammed traffic is daily recorded in transportation network. The availability of digital footprints such as ticketing logs, or load on board the trains provide a relevant opportunity to develop innovative decision-making tools for urban routing of passengers in order to assist them to better planning their journeys. This planning must consider the forthcoming evolution of the traffic in order to adapt its response to the next state of the network and thus avoid unpleasant situations for the passengers.

In this paper, we present a system for individual trip planning that incorporates short and long terms forecasting of different indicators related to the station attendance, occupancy of the trains, and delays in train schedule. Few research works have focused on the integration and the combination of predictive indicators in existing route planners [1-3].

The proposed predictive indicators cover the entire journey of the passenger, and are updated according to traffic evolution. They are provided with the help of machine learning based models namely Random Forest [4] and Gradient Boosting [5] techniques, trained from different data sources such as ticketing data collected from automatic fare collection (AFC), train load given by onboard sensors, and the realized train schedule coming from automatic vehicle location (AVL). The proposed models consider both long and short term forecasting time horizons. The long term prediction aims to forecast the indicators one year in advance, whereas the goal of the short term prediction is to provide these indicators for the next train passage for the load, or within defined time interval for the attendance at station.

These indicators are translated into qualitative indicators such as comfort and occupancy in train, station and platform accessibility.

Furthermore, we expose the underling architecture and the integration between Navitia[1] as a trip planner and our forecasting model services.

[1] https://www.navitia.io/

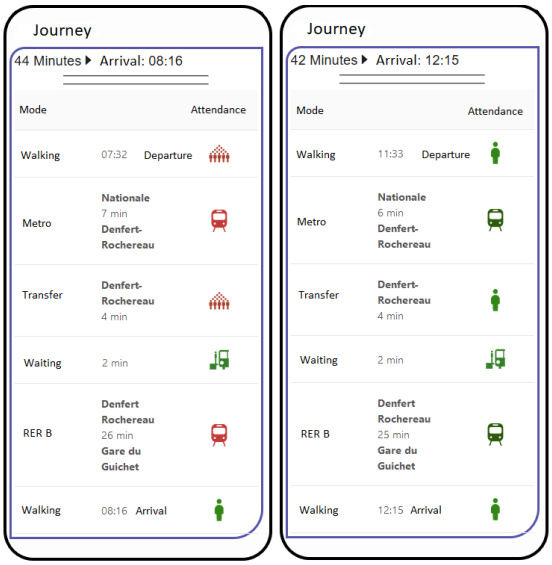

Figure 1 : User interface of the proposed predictive trip planner: The obtained journeys for two queries at rush and off-peak hours for the same couple of origin-destination. We can see in the capture at left, the train of the RER B is overloaded (pictogram in red color) at the station Denfert-Rochereau compared to the train of the midday at this station (pictogram in green color) as shown in the capture at right. We can also see the crowding level of the station when transfers are operated.

The Figure 1 shows the same journey given by the predictive trip planner at different moment of the day (rush and off-peak hours). It can be seen that, depending on the departure time, the predictive attendance at the stops of the journey differs, which impact the level of travel comfort. These predictive indicators allow the passenger to adapt his journey according to his own qualitative preferences ahead of time.

We demonstrate the interest of our approach for enhancing passenger travel experience as well as passenger information in multimodal system. We apply the predictive trip planner to a real-world use case in Paris metropolitan area, the test bed is carried out on data collected from 2016 to 2018 on a railway line operated by the French railway company SNCF, and from AFC validation logs provided by Île-de-France Mobilités, the organization authority that controls and coordinates the different transport companies in the studied area.

Future research should investigate the characterization of abnormal situations such as incidents and disturbances in the transportation network. The aim is to build new indicators, when traffic anomalies are detected. We could imagine, indicators such as anomaly severity, and time to return to a normal situation in terms of load in the trains and passenger flows at the station.

REFERENCES

[1]: Liebig, Thomas, Nico Piatkowski, Christian Bockermann, and Katharina Morik. "Predictive Trip Planning-Smart Routing in Smart Cities." In EDBT/ICDT Workshops, pp. 331-338. 2014.

[2]: Heppe, L., & Liebig, T. (2017). Real-Time Public Transport Delay Prediction for Situation-Aware Routing. In Joint German/Austrian Conference on Artificial Intelligence (Künstliche Intelligenz) (pp. 128-141). Springer, Cham.

[3]: Yu, L., Shao, D., & Wu, H. (2015, November). Next generation of journey planner in a smart city. In *2015 IEEE International Conference on Data Mining Workshop (ICDMW)* (pp. 422-429). IEEE.

[4]: Toqué, F., Khouadjia, M., Come, E., Trepanier, M., & Oukhellou, L. (2017). Short & long term forecasting of multimodal transport passenger flows with machine learning methods. In 2017 IEEE 20th International Conference on Intelligent Transportation Systems (ITSC) (pp. 560-566). IEEE.

[5]: Ding, C., Wang, D., Ma, X., & Li, H. (2016). Predicting short-term subway ridership and prioritizing its influential factors using gradient boosting decision trees. Sustainability, 8(11), 1100.