



# Traffic Flow Data Analytics: Waze vs Bluetooth

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## Introduction

As Waze, an GPS app provided by Google that provides turn-by-turn navigation information and user-submitted travel times and route details (**Figure 1**), is starting to be downloaded by millions of people worldwide in the recent years. Universities and Researches have started to use the data provided by Waze for research without testing whether the data coming from Waze is accurate.

Bluetooth, a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength radio waves, has been proven to be reliable through research done by other Researchers. Using Bluetooth data, which is collected by two Bluetooth detectors set up with a set distance between them (**Figure 2**), Waze data can be tested to confirm reliability by comparing the two.

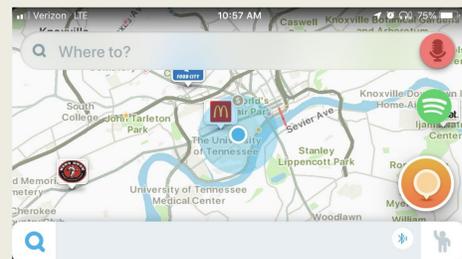


Figure 1: Waze GPS Map

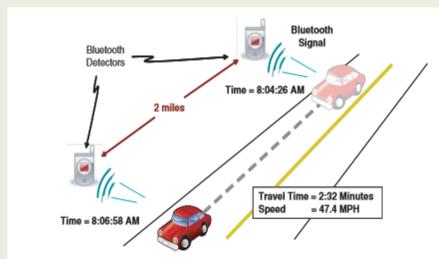


Figure 2: Bluetooth Data Collection

## Research Questions

- Is the Data from Waze reliable to be applied in traffic research?
- What day of the week is the Waze Data most reliable?
- What time of day is Waze Data most reliable?
- Which factors affect the reliability of Waze? (Traffic Value, Speed or Length of Segment?)

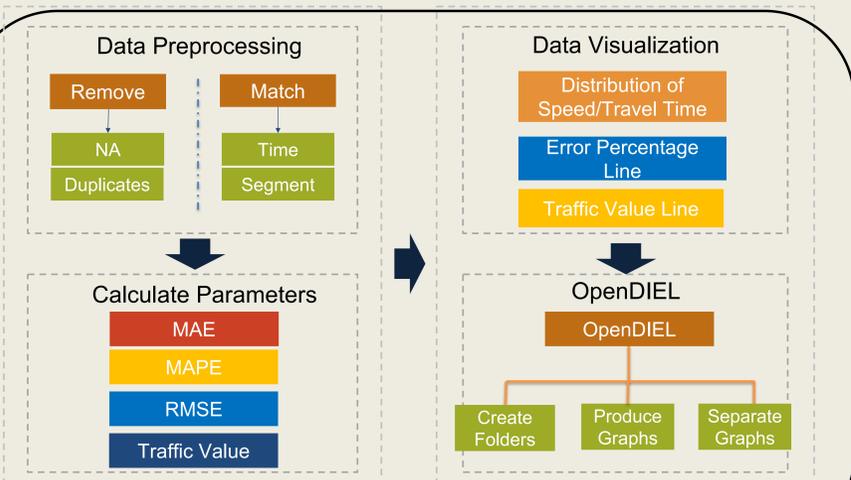


Figure 3: Process Summary

## Process

- Data preprocessing  
Code was written using the the language R in order to go through the data and removes unnecessary data. As well as Merge Bluetooth and Waze Data together into one data set.
  - Remove Duplicate Data
  - Remove Waze Historical Data
  - Merge Bluetooth and Waze Data in 24 hours
 Code was ran though Comet on OpenDIEL

- Calculate Parameters:

$$MAE = \frac{1}{N} \sum_{i=1}^N |y - \bar{y}|$$

We choose three error formulas as parameters:

MAE(Mean Absolute Error)

RMSE(Root Mean Standard Error)

MAPE(Mean Absolute Percentage Error)

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (y - \bar{y})^2}$$

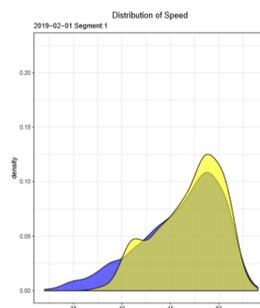
N=The number of Bluetooth/Waze speed samples in each hour

y =The value of each Bluetooth speed sample

$\bar{y}$  =The value of each Waze speed sample

$$MAPE = \frac{1}{N} \sum_{i=1}^N \left| \frac{y - \bar{y}}{y} \right|$$

- Data Visualization:



**Figure 4:** These graphs show the Distribution of the speeds between Waze and Bluetooth. The graph on the left shows a distribution that is similar between the two data set while the one the right shows a distribution that is not similar

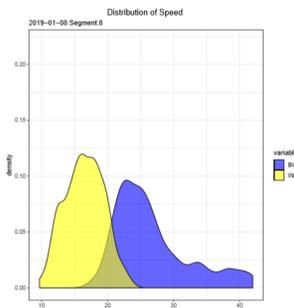
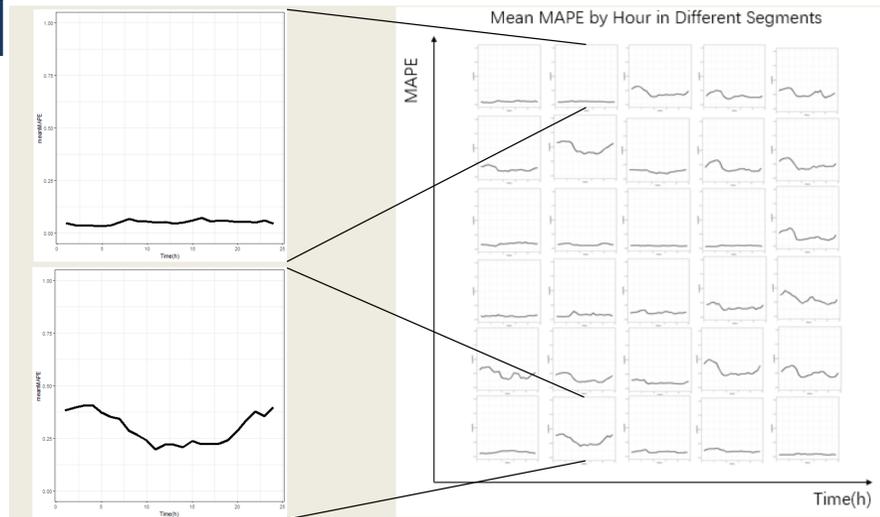
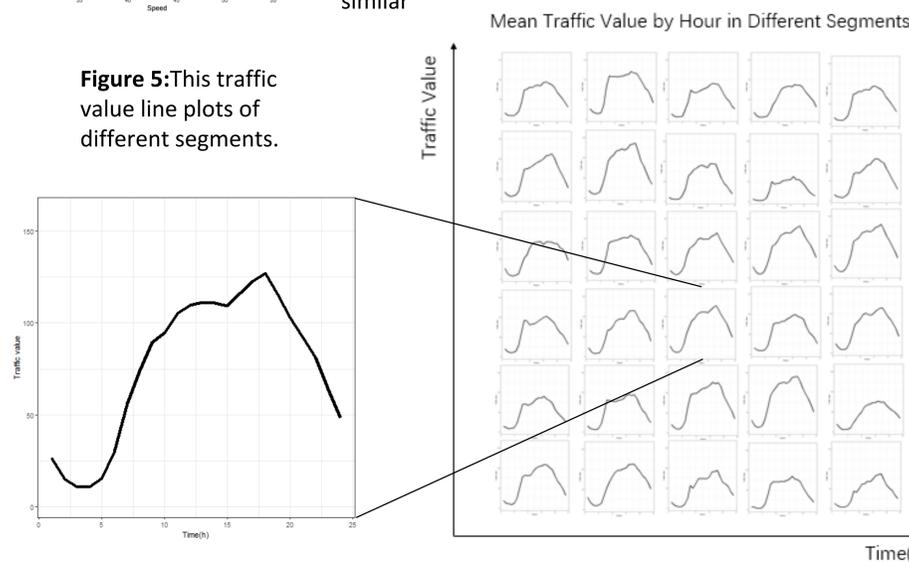


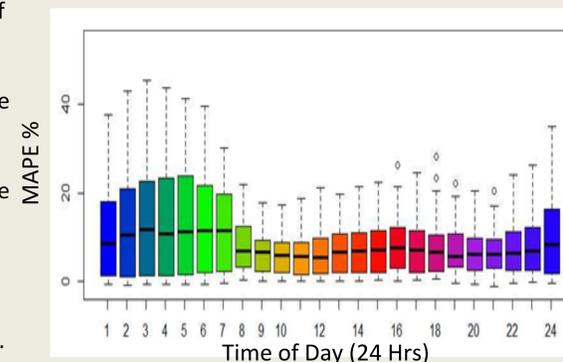
Figure 5: This traffic value line plots of different segments.



MAPE (31 Segments)

**Figure 6:** This MAPE line plots of different segments. The segment that has a lower error between two data sets will have average error in 24 hours. The segments with higher errors between two data sets will have a line with similar curves.

Figure 7: Box plot showing the Mean Absolute Percentage Error (MAPE) for each segment.



## Conclusions

- There is no significant difference in the day of the week
- During Peak hours MAPE is typically Lower
- MAPE is related to traffic congestion/flow

## Future Work

- Traffic Values, Speed, and the Length of the Segments will be checked to see how it affects the Waze data.
- Try to predict Traffic patterns for a day in the future

## Acknowledgements

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### References:

- Ding, F., Chen, X., He, S., Shou, G., Zhang, Z., & Zhou, Y. (2019). Evaluations of Wi-Fi Signal Based System for Freeway Traffic States Monitoring: An Exploratory Field Test.
- Haghani, A., Hamed, H., Sadabadi, K. F., Yound, S., & Tarnoff, P. (n.d.). Data Collection of Freeway Travel Time Ground Truth with Bluetooth Sensors.
- Yang, S., Brakewood, C., Nicolas, V., & Sion, J. (2019). Bikeshare Users on Budget? Trip Chaining Analysis of Bikeshare User Groups in Chicago. doi:10.1177/0361198119838261