# Why Do People Take E-scooter Trips? Big Data and Unsupervised Machine Learning Insights on Temporal and Spatial Usage Patterns

**Nitesh R. Shah, Jing Guo, Lee D Han, Christopher R. Cherry**

University of Tennessee

Contact: Nitesh R. Shah: nshah12@vols.utk.edu | Jing Guo: jguo31@vols.utk.edu | Lee D Han: lhan@utk.edu | Christopher R. Cherry: cherry@utk.edu

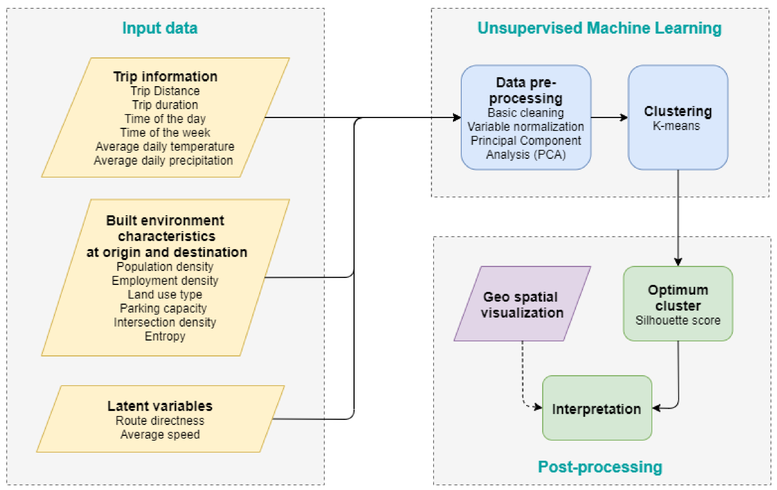
## Takeaways

- We identified five distinct purpose-oriented e-scooter usage patterns in Nashville
- ¾ of e-scooter trips were NOT tourist-oriented nighttime entertainment trips
- E-scooter usage pattern doesn't resemble commuting pattern in Nashville
- The number of e-scooter trips of each five distinct patterns increased over a year
- E-scooter ridership increases during weekends and summer months in general

## Abstract

Electric scooters (e-scooters) are becoming one of the most popular micromobility options in the United States [1]. Although there is some evidence of increased mobility, reduced carbon emissions, replaced car trips, and associated public health benefits, there is little known about the patterns of e-scooter use. This study proposes a framework for high-resolution analysis of micromobility data based on temporal, spatial, and weather attributes. As a case study, we scrutinized more than one million scooter trips of Nashville, Tennessee, from September 1, 2018, to August 31, 2019. Weather data and land use data from the Nashville Travel Demand Model data and scraping of Google Maps Point of Interest (POI) data complemented the trip data. The combination of Principal Component Analysis (PCA) and a K-Means unsupervised machine learning algorithm identified five distinct e-scooter usage patterns, namely daytime short errand, utilitarian, evening social, night-time entertainment district, and recreational trips.

## Research Design




**Study Area:** Nashville, Tennessee

**Study period:** September 1, 2018 to August 31, 2019

**Data Source:**

- E-scooter data: 1,072,430 trips from Shared Use Mobility Device (SUMD) data
- Land-use characteristics: Nashville Activity-Based Model and Point of Interest (POI) data from Google Maps
- Weather data: Global Historical Climatology Network (GHCN)

## Unsupervised machine learning methods can identify distinct purpose-oriented trip patterns of e-scooter use

## Results

Eleven principle components were used to identify 16 K-means clusters that are further grouped into five usage-grouped clusters based on general characteristics of individual K-means clusters such as trip distance, and origin and destination location. These usage-grouped clusters are daytime short errand, utilitarian, evening social, night-time entertainment district, and recreational trips.

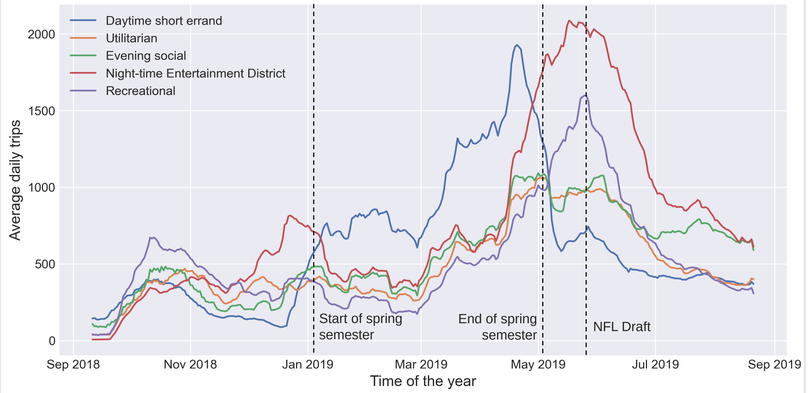
The summary of five usage-grouped clusters are as follows:

| | Daytime short Errand | Utilitarian | Evening social | Night-time Entertainment District | Recreat-ional |
|---|---|---|---|---|---|
| Percentage of trips by count | 20.4 | 16.8 | 18.9 | 26.1 | 17.8 |
| Percentage of trips by Vehicle-Miles Travelled | 13.3 | 20.5 | 20.9 | 25.4 | 20.0 |
| Percentage of trips by travel duration | 19.0 | 16.9 | 20.5 | 25.2 | 18.5 |
| **General Attributes (mean)** | | | | | |
| Route distance (miles) | 0.47 | 0.88 | 0.80 | 0.71 | 0.81 |
| Trip duration (minutes) | 15.2 | 16.5 | 17.8 | 15.9 | 17.0 |
| Route directness ratio | 0.58 | 0.64 | 0.53 | 0.54 | 0.48 |
| Percentage of weekend trips within the cluster | 17 | 4 | 56 | 35 | 48 |

*Note: Red color indicates lower values while blue color indicates higher values among clusters*

## Temporal Distribution

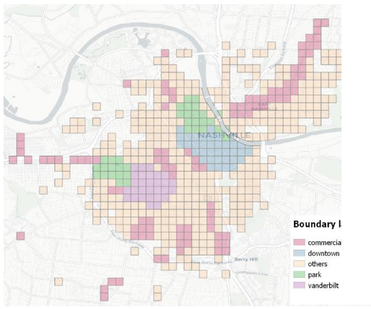
The analysis of full year data shows temporal change in usage-grouped clusters.



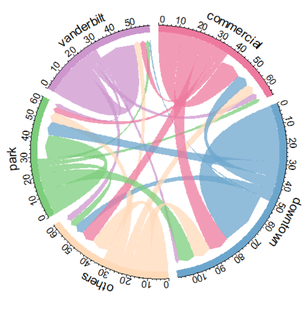

**21-days average of daily e-scooter trips of usage-grouped clusters**

## Spatial Distribution

The following diagrams illustrate the spatial distribution of e-scooter trip origin and destination of the three key usage-grouped clusters. The top left map shows the boundaries of the built environment categories (commercial, downtown, park, Vanderbilt University, and others, while the remaining diagrams are chord diagrams that illustrate the flow of e-scooter trips among these built environment categories for key usage-grouped clusters.




**Built environment classification**




**Daytime short errand trips**




**Night-time entertainment district trips**




**Recreational trips**

*Note: The unit of the value on the axis is thousands.*

## Key findings

- Eleven principle components explained 91.5% of variance in the data, where several variables such as trip start time, and downtown land use type at origin as well as destination had a strong effect on principle components
- Among usage-grouped clusters, the night-time entertainment district has the highest proportion of trips (26% of all e-scooter trips) followed by evening social (19% of all e-scooter trips)
- The daily average trips of all five usage-grouped clusters increase during summer months, although they are also influenced by other factors such as holidays, semester schedule of Vanderbilt University, and special events like NFL draft
- Some usage-grouped clusters, like night-time entertainment district trips, start and end within the same built environment categories, whereas others, like daytime short errand trips, are more evenly distributed among all built environment categories
- The general e-scooter pattern doesn't resemble bikeshare usage patterns, which shows some commuting trips

THE UNIVERSITY OF TENNESSEE KNOXVILLE

## REFERENCES

[1] NACTO. (2020). Shared Micromobility in the US: 2019. Retrieved from https://nacto.org/wp-content/uploads/2020/08/2020bikesharesnapshot.pdf

## ACKNOWLEDGMENT

The author would like to thank Colleen Herndon and her team at the Nashville Metropolitan Planning Organization for providing the e-scooter trip data.