Can we predict why people travel within a city?: A study analysing the spatial and temporal characteristics of travel intention within Montréal, Canada between September and October 2017.

*This dissertation is submitted in part requirement for the MSc in the Centre for Advanced Spatial Analysis, Bartlett Faculty of the Build Environment, UCL.*

*A colour version of this dissertation is available online.*

Word Count:11,986

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*30th August 2019*

# Abstract

The prediction of why people travel across cities remains an area within the broader mobility studies without extensive investigation. Arguably, this has been hindered by:

(1) an absence of large datasets which details the activities that people’s travel to when they move across a city;

(2) the difficulty in accurately representing space and time within models used to predict why people travel across cities.

Regarding (1), in recent years, smartphones travel surveys have provided researchers a platform to study the attributes characterising travel within a city at increasingly fine temporal and spatial scales. This study makes uses of one such study: the *2017 MTL Trajet* app – a travel survey examining *how* and *why* its participants have moved across Montreal between 18th September 2017 and 18th October 2017. Regarding (2), this project builds upon a small body of research to uncover and categorise spatial and temporal interdependencies of the GPS data from the MTL Trajet before assessing the performance of three machine-learning classification models: Random Forest, Support Vector Machines and Multilayer Perceptron Neural Networks. Note, these models are built to classify *why* people travel based on spatial and temporal characteristics of individual trip.

**Key Words:** Travel intention classification, Mobility, Spatio-Temporal Investigation, Volunteered Geographic Information.

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# Declaration

I, Thomas Keel, hereby declare that this dissertation is all my own original work and that all sources have been acknowledged. It is 12,000 words in length

Signed:

Date: 28th August 2019

# Acknowledgments

I would firstly like to thank my family and friends for their thorough support during the planning and writing of this dissertation. A special thanks goes out to my flat mates James, James and George for putting up with me this year.

Secondly, I would like to thank my supervisor Huanfa Chen for his useful comments and advice during the development of this project.

Finally, I am extremely grateful to all the people I have met at CASA and I thank them for their enthusiasm and all the support they have given me throughout this year.

# Chapter 1. Introduction

## 1.1 Research Overview and Questions

The purposes by which people use transport networks on a large scale remains an area with a distinct lack of investigation within the broader mobility studies (Yazdizadeh *et al.,* 2019). In the past, this has primarily been due to an absence of data, at such a large scale, available to study the activities that people are travelling to, when they move around a city.

In recent years, however, improvements to GPS and processing power of smartphones has provided researchers a new opportunity to study and record the large scale geospatial movement of people (Zhao *et al.*, 2019). Travel survey apps created for smartphones require much less effort from their participants than traditional travel surveys (i.e. where a separate GPS device is required to record movement) (Li et al., 2016). Therefore, it has become increasingly easy to collect qualitative information about movement within a city – including information about *how* and *why* people travel.

The ability of smartphone users to create a large amount of geographically-referenced in these travel survey apps can help us generate unique insight into transport behaviour at much greater scales than ever before. This form of participatory data creation is known as Volunteered Geographic Information (hereafter, VGI) (after Goodchild, 2007).

Despite the potential to produce more VGI that can be used to generate insight into mobility within a city, there are many cities globally that have no form of formal research initiated within them (Attard *et al.*, 2016). One exception to this, is Montreal, Canada, where a number of mobile travel survey applications have been created to study *how* and *why* participants have moved within the city. This report makes use of the most recent available dataset from one of these studies: The *2017 MTL Trajet* travel survey project (Ville de Montréal, 2019). The *MTL Trajet* project was carried out between 18th September 2017 and 18th October 2017 and is used in this dissertation to following assess the following research questions:

**Main Research Question:**

Can we effectively classify the purpose of trips using spatial and temporal indicators?

**Sub-Questions:**

1. Which spatial and temporal indicators are most important for the classification of trip purpose?
2. Which type of classification model is most effective in the classification of trip purpose?

## 1.2 Motivation

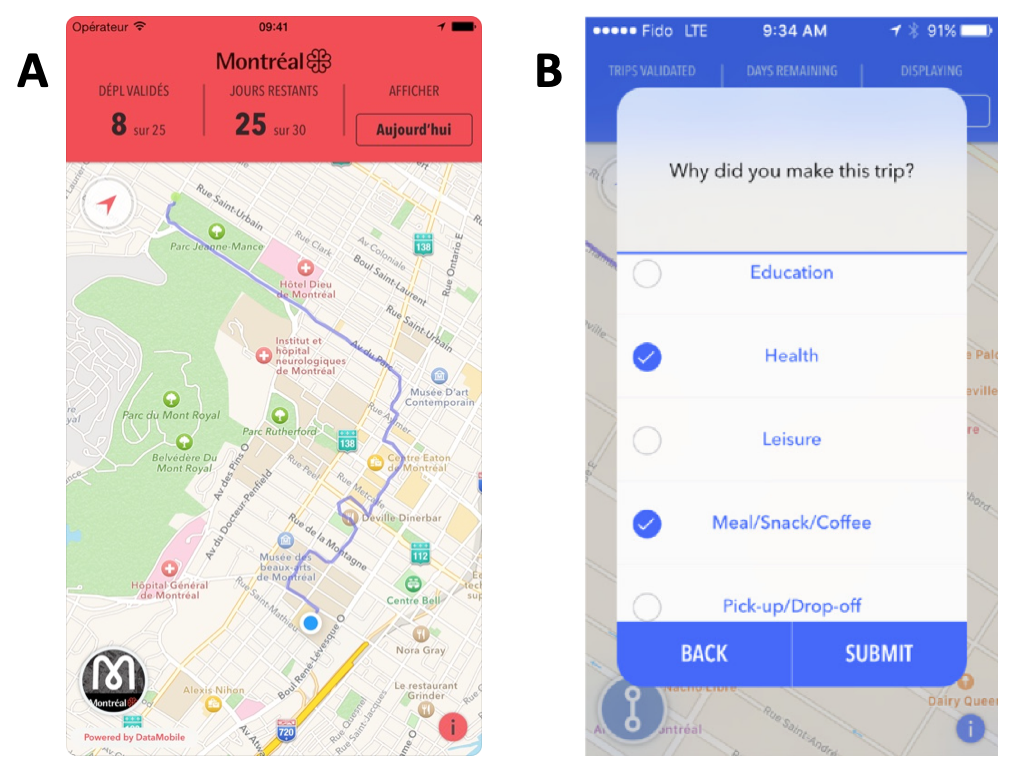
Movement can be thought of as an interaction between an origin and destination (Murray *et al.*, 2012). People move across space and through time to go from where they are to where they want to be (Murray *et al.*, 2012). Transport, is the by-product of the interaction between an origin and destination, and can thus is best considered a ‘derived demand’ for a given destination (Golledge & Gärling, 2001). Studying the patterns in the types of destinations that people demand to travel to, thus, underpins our comprehension of behavioural patterns within a city (Kwan & Neutens, 2012).

If we are able to discern the activities for which individual’s make movements (hereafter, their ‘*trip purpose’*), we may be able to use this information to inform policy and account for demand in essential (e.g. health & educational services) and non-essential (e.g. leisure & commercial) services throughout a city (Attard *et al.*, 2016).

To better understanding and classify trip purpose (or intention of movement), we first need to understand the temporal and spatial scales at which people are travelling at for certain activities. The motivation of this study is thus to evaluate whether we can use spatial and temporal dependencies discovered within different categories of trip purposes to model and classify them.

## 1.3 Approach

This study makes use of data from the *2017 MTL Trajet* survey originally collected by researchers at the Transportation Research for Integrated Planning (TRIP) lab, Concordia University (Patterson & Fitzsimmons, 2017a). This survey was part of the 2015-2017 Montréal Smart and Digital City Action Plan and was created to study travel behaviour across the city (MTL Trajet, 2017). Data collection for this survey was carried out through a mobile app (available on both iOS and Android platforms) which automatically recorded a location trace using GPS provided from a user’s phone (**Figure 1.1A**; Patterson & Fitzsimmons, 2017a). When users were stopped in a given location for more than intervals of 120 seconds the app would prompt the user to end the trip and input a travel mode and travel purpose for the trip (see **Figure 1.1B**).

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***Figure 1.1*** *(A) Screenshot from the MTL Trajet app showing recorded GPS trace (source: Patterson, 2017a). (B) Example of prompt similar to one used in the MTL Trajet app (source: Patterson et al., 2019).*

Data from the *MTL Trajet* forms the backbone of the information used to test three types of classification models that look to characterise the purpose of movement:

1. Random Forests

2. Support Vector Machines

3. Artificial Neural Networks

Temporal and spatial clustering techniques will be used to generalise about the space and time trends seen within the data before being input into the models.

## 1.4 Outline

The following chapters of the report are organised as follows:

*Chapter 2* reviews literature relating to trip purpose classification, the use of VGI in mobility studies and existing travel surveys based in Montreal.

*Chapter 3* details the steps carried out in the data pre-processing and collection, the development of space and time metrics from the MTL Trajet data, and the set-up for each trip-purpose classification model.

*Chapter 4*, presents the results from the analysis procedure and compares the performance of the classification models.

*Chapter 5* discusses the extent to which the research objectives (set out in 1.1) have been achieved in the results and highlights uncertainty within them the analysis procedure.

Finally, *Chapter 6,* draws conclusion from the research carried out in this project and suggests areas of further research.