# Title Page:

Title: Examining the spatio-temporal dynamics of the presence, and purpose, of movement across the region of Montréal, Canada in 2016-2017. OR A space-time deconstruction of the travel patterns and the purpose of travel across the region of Montréal, Canada 2016-2017

# Abstract

* 300 words max

Quantifying the ways in which people travel across a city, and for which purpose they travelling, remains an area within broader mobility studies without extensive investigation. Arguably, this form of investigation has been hindered by: (1) an absence of relevant data which details how and why people travel in a city and (2) a lack of consistency in the metrics used when quantifying the space-time dynamics of travel. In recent years, mobile phones have fuelled an eruption in sources of volunteered geographic information (VGI) provided by Open Data Initiatives at a city level. As such, we now have a unique opportunity to study cities in more detail than ever before. This study makes uses of

It also proposes a new framework for this form of investigation.

This study serves as a spatio-temporal investigation into movement across Montréal and proposes a new methodology for understanding spatio-temporal information within network data.

This study provides a spatially informed data science project containing relevant visualisation techniques (i.e. MSc SDSV)

Key Words: Networks, Machine Learning, Spatio-Temporal Investigation

# Declaration

I 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

# Table of Contents

# List of Figures and Tables

# List of acronyms and abbreviations

VGI – Volunteered Geographic Information

# Acknowledgments

# Introduction

* 500 words

First paragraphs:

* Movements can be similarly viewed as spatial interactions between an origin and destination.(Murray et al. 2012)
* ﻿Another reason is that goods are produced in one location, perhaps a factory or farm, then shipped to consumers at other locations. Of course, interaction could also be viewed as trade flows, as considered between towns, cites, regions, states, and countries. (Murray et al. 2012).
* ﻿Sometimes the movement patterns that result are understandable or explainable, like birds migrating south for the winter, but often times they are not obvious (Murray et al. 2012)
* Studying these geographical flows important
* Insight into which activities occur on which days and times (similar to Zhang & Cheng, 2019). -> (lead onto Batty, 2013)

Other Ideas:

* Also an examination of where to people drive (and relation to parking spaces) -> this is flawed however as only subset
* Which modes are used for which activities
* big data allows for us to not only study the spatial and temporal interactions but also interactions of socio-economic factors [this is what this research aims to do] (Cheng *et al.*, 2017)
* Wireless portable devices are carried by humans, exhibit the same mobility behaviour of their human carriers and their movements (Jahromi *et al.*, 2016).
* ESSENTIAL: Smart City with interacting networks and GPS signals (Jahromi *et al.*, 2016)
* Also EMBED research questions the study poses

Actual:

*Opener*

The way in which people move across space and the reason for their movement on a large scale, still remains an area with a distinct lack of investigation. This somewhat owes to a lack of data and . Primarily the movement of people is of concern to time-space analysis. Something about Montreal. Real time data gives us ability to study real-time processes within a city Goodchild (2013).

Smartphones capable of environmental geospatial information at an unprecedented level (Li et al., 2016).

[VGI and smartphones useful in] transport in revealing people’s preferences for mobility and therefore be useful for decision-making. (Attard *et al.*, 2016).

﻿GPS-enabled devices that record people’s everyday movements, gives us opportunity to understand human phenomena (Kwan & Neutens, 2012)

Understanding mobility through mobile phone has kicked off (Zhao *et al.*, 2019)

*Objectives*

The objectives of this dissertation, are as follows:

1. WHICH MODES FOR WHICH ACTIVITIES
2. Deciphering the space-time signal of a city
3. Directionality of travel and modes

*Motivation*

*What movement is, what transport is*

Murray *et al.* (2012) suggests that the moment of people is spatial interaction between origin and destination. It is these two points that interrelate and, as such, the study of the purpose of the flow between these connections underpins our understanding of transport and behaviour of populations in a city. Theoretically, one can propose that different categories of movements have differing spatio-temporal profiles. Research carried out by Zhang & Cheng (2019) discover expected difference in the profiles of people travelling within London based on their employment status. In general, finding regularity in full-time transport patterns compared with those who are un-employed. While, this information is of use to transport authorities, there is still a lack of investigation into more of the local impacts of transport as well as the veracity. Indeed, the very same principles that ‘big data’ is defined by (i.e. Volume, Velocity, Veracity, Variety), so too is our understanding of transport. In Economic terms transport is a derived demand (Golledge & Gärling, 2001).

* demand for transport is a derived demand i.e. for people to do other things (Golledge & Gärling, 2001) -> thus important to study transport like this

Murray *et al.* (2012) suggests that the moment of people is spatial interaction between origin and destination. It is these two points that interrelate and, as such, the study of the purpose of the flow between these connections underpins our understanding of transport and behaviour of populations in a city. Theoretically, one can propose. The dataset forming the backbone of this report provides a look into the way that people move.

with smartphones enormous potential to collect location data for many purposes, hence ﻿Itinerum platform created (Patterson *et al.*, 2019)

*Current modelling and the state of Big Data in time-space understanding*

Big data measurement and influx has extended to the extent that it is real-time, which gives us a unique opportunity to study geographical phenomena (Goodchild, 2013)

Mathematical models being employed without regard of space, often including problems that are inherently tied to spatial considerations (O'Sullivan & Manson, 2015)

*Smart phones and new ways of studying space-time*

Smartphones capable of environmental geospatial information at an unprecedented level (Li et al., 2016; etc. (i.e. Patterson)).

Also, space-time methods and smart cities

*Why Montreal*

Smart cities [i.e.] the instrumentation of cities which are now providing vast amount of real-time data (from Li *et al.*, 2016). Increase in the amount of geo-tagged/geo-referenced data

*Approach*

*MTL Trajet*

This study makes use of data from the MTL Trajet survey (citizen science) originally collected by XXX at McGill University (ref). This dataset provides a unique insight into the

The dataset forming the backbone of this report provides a look into the way that people move.

This study also concerns itself with the modelling through classification on purpose of the movement. It is hoped, in combination with a spatio-temporal investigation, this analysis presented can infer something about movement at a higher scale within a city. Although, it must not be forgotten that this study primarily focusses in on Montréal and this may not be transferred to other cities (Ergodoic and Ecological Fallacy).

This study attempts to break away from its data-driven approach to provide more context

Montreal itself poses an interesting problem, and warrants further investigation

This following examine the related literature and reviews the philosophy of the metrics introduced in 2. After this, in 3 detail is provided on the data . Results (4) first create a ESTDA before modelling.