Towards Visually Understanding Commuter Behaviour

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Abstract—Too many people drive cars for commuting to work. If people used more active and sustainable transportation options this would reduce the impact on the environment and likely increase people's physical activity and well being. In this paper we visually explore commuting behaviour of people from workplaces based in the city of Calgary using data from a non-for-profit organization. Our goal is to raise awareness of commuting behaviour via visualizations to help organizations such as city councils and local governments to improve their business decisions when making investment into sustainable transportation infrastructure.

Index Terms—Business Visualization, Commuting, Sustainable Environment, Transportation, Visual Analytics.

1 Introduction

Many people drive cars for commuting. If people used more active and sustainable transportation options this would reduce the impact on the environment and likely increase people's physical activity and well being [2].

The Commuter Challenge[1] is a week-long event held during the annual Canadian Environment Week. The challenge is organized by volunteers from the Sustainability Alberta Association and is hosted by city coordinators who support workplaces from all over Canada. The challenge is a friendly competition between cities and workplaces that encourages Canadians to leave their cars at home. The purpose of the challenge is to celebrate active and sustainable transportation options. The challenge rewards walking, cycling, carpooling, transit, and telecommuting. The goal of the challenge is to raise awareness of commuting behaviour to help workplaces, councils, and local governments to improve their decision making with respect to sustainable transportation infrastructure investment.

The Commuter Challenge started in 1991 and was launched nationally across Canada in 2000. Data has been collected from participants and workplaces since 1999. The challenge in 2014 took place 1–7 June and involved over 1800 work places and 26000 individuals across Canada.

During May 2014, members from the Calgary Data For Good Meetup[2] came together to participate in a datathon to visually explore the challenge datasets. During the datathon one team explored some historical datasets and created a suite of visualization prototypes using various information visualization techniques and tools. This paper describes these prototype visualizations.

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1. http://commuterchallenge.ca/
2. http://www.meetup.com/Data-for-Good-Calgary/

2 Benefits of Active and Sustainable Transportation

The Commuter Challenge promotes a number of benefits for active and sustainable transportation. Some people participate for their health benefit, while others participate for the many issues around climate change.

Economic. By driving less money will be saved instead of purchasing gas. Health care will be reduced as people will be more healthier. Less tax dollars will be required for road construction and maintenance.

Health and Personal. Active and sustainable transportation enhances physical, mental, and emotional health. These facets of our lives are interconnected and significantly affect our well-being. This benefit will increase daily physical activity of people, engage people more with the community, save time rather than sitting in traffic, and allow people to relax on public transit [2].

Community. Active and sustainable transportation makes communities safer by reducing the risk of vehicle-pedestrian accidents, and can reduce traffic jams, traffic noise, and parking hassles.

Environmental. Active and sustainable transportation keeps air clean by improving air quality and reducing greenhouse gas emissions. This can help to reduce toxic air pollution, reduce the threat of climate change, conserve natural habitats, reduce the need for non-renewable fossil fuel resources, and reduce ozone layer destruction.

Workplaces. Active and sustainable modes of transportation can enhance employee productivity, health, and job satisfaction. Costs can be reduced by not having fewer demands on parking. Teleworkers can increase productivity as they will not need to waste time commuting. Healthy commuters are more relaxed at the workplace, take fewer sick days off, and are more alert and adept at work which can reduce workplace accidents. Employers who promote and facilitate the well being of employees, communities, and the environment enjoy greater loyalty and respect.

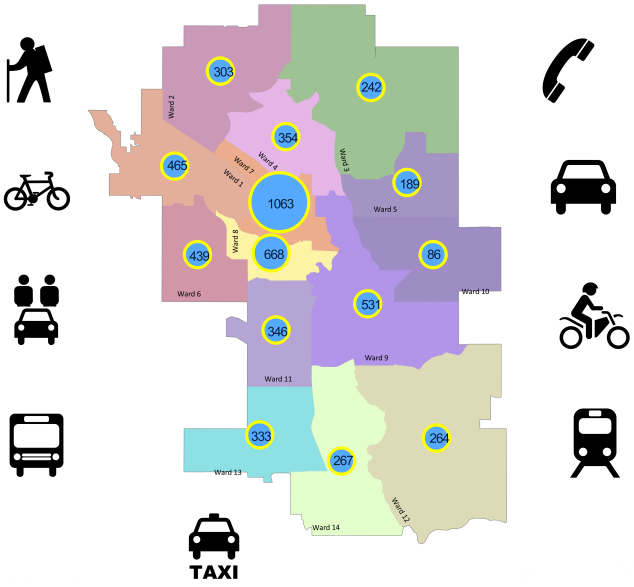
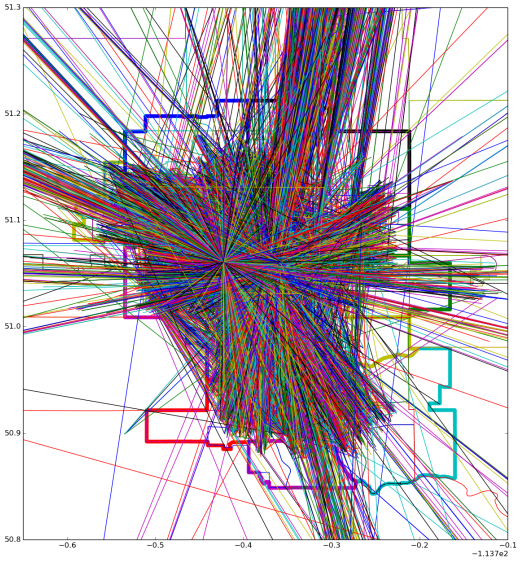
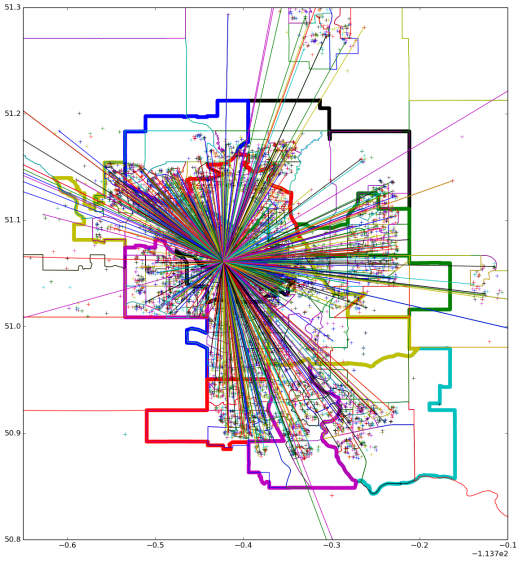


Fig. 1. Commuting behaviour in Calgary from 14 political wards with number of commuters per ward.



(a) Commuters in Calgary by wards.



(b) Commuters to the University of Calgary (centre point) by wards.

Fig. 2. Commuting Behaviour in Calgary from 14 different political wards.

3 Commuter Visualizations

We created different visualization prototypes using various toolkits [1], [3] to investigate the following research questions. The questions aim at helping city councils and local government understand where people commute from to discover trends and make better business decisions on where to invest in public sustainable transport infrastructure.

RQ1 Can you visually analyze where people commute from within a city?

RQ2 How does commuting behaviour vary by political wards of a city?

RQ3 Is there a correlation between improved commuting behaviour and participation in Commuter Challenge?

RQ4 How do factors like gas prices, weather, and time of day impact commuter behaviour?

RQ5 How has commuter behaviour changed over time?

RQ6 How much of an impact does transit (e.g., train and bus) and bike paths have on commuter behaviour?

Figure 1 shows 14 political wards of Calgary with the total number of commuters during the 2013 Commuter Challenge for each ward. Wards have a total number of commuters represented in a blue circle. The two largest wards are 7 and 8 which contain parts of downtown plus regions just North and South of downtown. Ward 7 contains 1063 commuters and Ward 8 contains 668 commuters. The least number of commuters come from wards 10, 5, and 3 (86, 189, 242 commuters respectively) in the North East.

Figure 2(a) shows wards represented by thick coloured lines and thinner edges for the location of where people commute from within the city. People commute from all parts of the city and most work downtown. A number of people commute from just North of the city, North West, and South East where there are some small commuter towns. There are no commuters from the South East.

Figure 2(b) shows a subset of Figure 2(a) with people commuting to the University of Calgary, which is the centre point. All students have transit passes provided. Most people commute from the North West where the university is located, then the South West, and some from the South. The least available transit options, however, are in the far South East and North East quadrants which has the least amount of commuters.

Figure 3(a) shows an interactive visualization of the city wards of Calgary represented as a chord diagram. Each ward is a segment in numerical order in the outer circle. The larger the segment the more people that commute to that ward. A user can select a ward and it highlights the edges. This visualization shows people commuting from *wards to work*. People commute from all wards to downtown as there are edges from all wards to ward 7 (orange colour). Many people live and work downtown, represented by the orange edge from ward 7 back into ward 7. Some people that live downtown in ward 7 work in ward 8 which is where the University is located (i.e., orange edge from ward 7 to ward 8 at the bottom of the visualization).

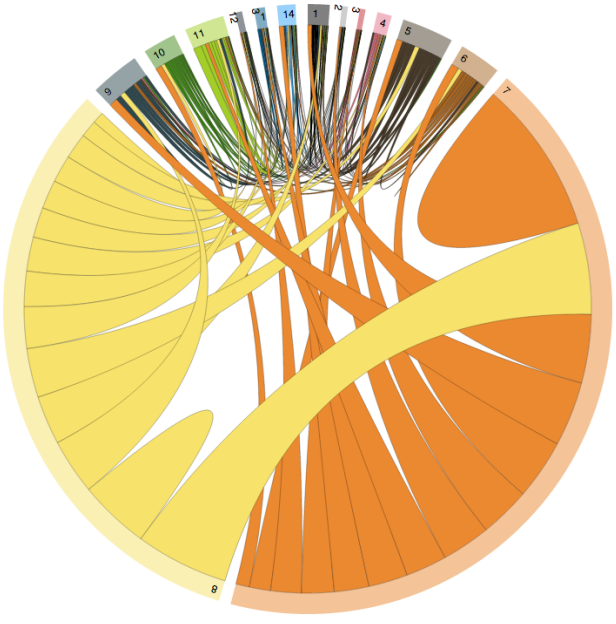
Figure 3(b) shows another interactive visualization of the city wards of Calgary represented as a chord diagram. This visualization shows the opposite of where people commute from *work to wards*. The visualization clearly shows that many people leave downtown (ward 7 orange) to go home in all other wards including ward 7. Ward 8 (yellow) also has people commuting back home to all wards in the city. What is interesting is that besides ward 7, ward 8 also have people that live downtown (i.e., ward 7).

Figure 4(a) shows the *usual* commuting behaviour of people ordered by each ward left to right (e.g., 1–14). When people signed up to the challenge they specified how they usually commute to work. The encoding is as follows: grey = drive alone, yellow = car pool two people, green = carpool three people, pink = transit, blue = bike, red = walk, and aqua = telecommute. Many people usually drive alone or take transit. Very few people car pool greater than two people. For wards 1–6 and 10–14 most people take transit and then drive alone. People in wards 7–9 which are closest to downtown travel by transit about the same amount as walking, and travel by bike too.

Figure 4(b) shows the commuting behaviour of people during the *challenge* by each ward as opposed to what they usually do. What is noticeable is that walking, car pooling with two people, and telecommuting increased. Figure 4(c) explicitly shows the differences in commuting behaviour between *usual* and *challenge*. People drove alone less and car pooled more with either two or three people. During the challenge people increasingly chose to walk and telecommute instead of transit.

Figure 5(a) shows the amount of fuel costs (gas at $1.19 CAD) saved per industry sector during the challenge. The fuel costs are calculated as follows: Fuel saved = Total KM / 100 * Fuel Factor. The Fuel Factor is – Drive: 0, Carpool (2 people): 3.17, Carpool (3+): 4.75, Scooter: 7.5, Transit: 8.9183, and All other modes: 9.5. Utilities, Arts, Entertainment, Professional, Scientific, and Technical Services, and Information and Cultural Industries sectors were the more efficient. Mining, Quarrying, and Oil and Gas Extraction, Transportation and Warehousing, and Educational Services were the least efficient industry sectors and had negative savings. The more efficient workplaces are likely to be located down town with better access to public transport whereas the least efficient are likely to be spread among the city hence people will have to travel further. Possibly

(a) Commuting from *wards to work*.

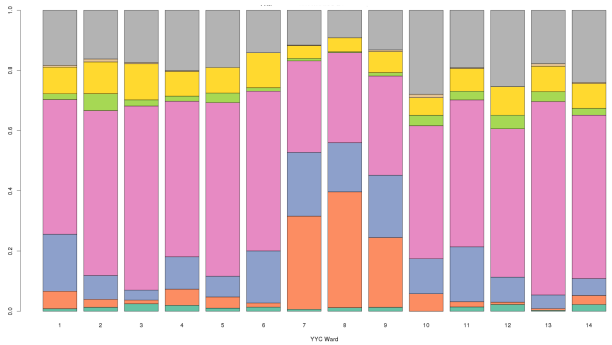


(b) Commuting from *work to wards*.

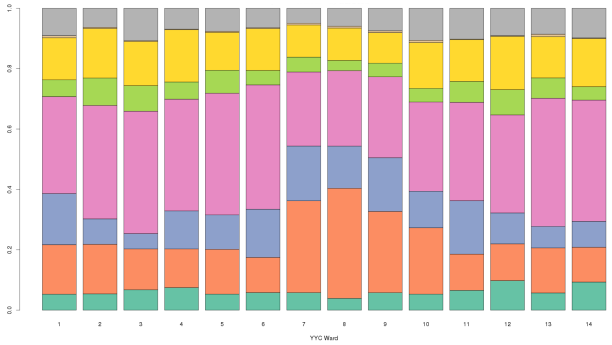
Fig. 3. Chord Diagrams of commuting behaviour from political wards to and from work.

for the least efficient sectors people still relied quite heavily on driving as their office locations were not close to public transport.

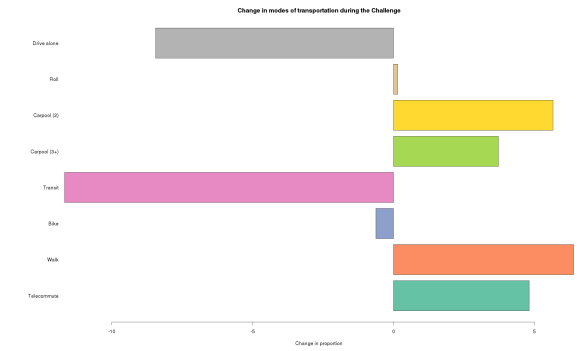
Figure 5(b) shows the amount of calories burned per industry sector during the challenge. The calories are calculated as 55 calories burned per KM. Mining, Quarrying, and Oil and Gas Extraction, and Arts Entertainment, Professional, Scientific, and Technical Services burned the most amount of calories. This is likely due to more people participating in the challenge were from workplaces in these sectors. Some industry sectors burned very few calories.



(a) Usual commuter behaviour by wards.

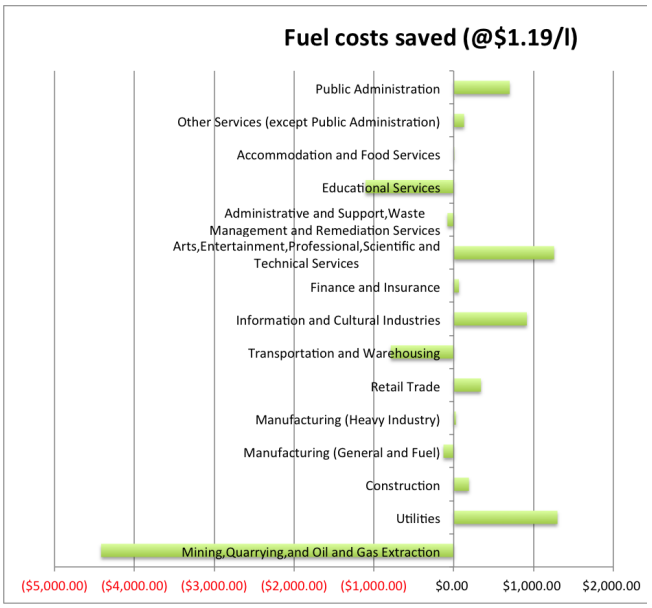


(b) Commuter behaviour during the Commuter Challenge by wards.

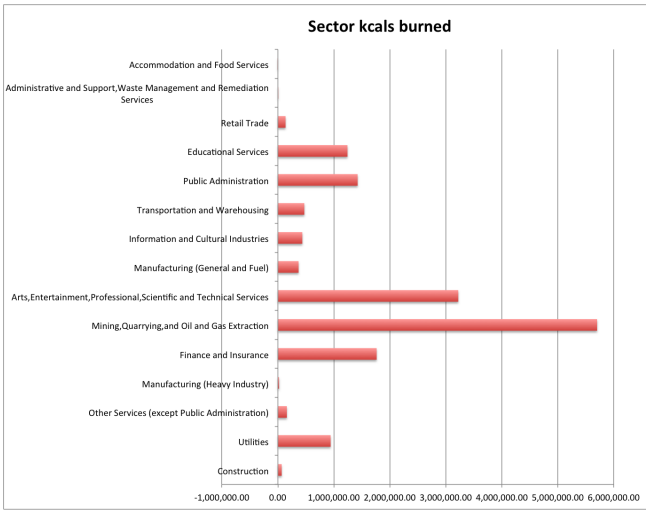


(c) Commute Changes during the Commuter Challenge.

Fig. 4. Commuting behaviour by wards in Calgary. Grey = drive alone, Yellow = car pool 2 people, Green = carpool 3 people, Pink = transit, Blue = bike, Red = walk, Aqua = telecommute.



(a) Fuel costs per industry sector.



(b) Calories burned per industry sector.

Fig. 5. Industry sector fuel costs and calories burned.

4 Summary

Many people drive cars for commuting to work. If people used more active and sustainable transportation options then there would be reduced impact on the environment and likely increase in people's physical activity [2]. In this paper we created visualization prototypes to understand commuting behaviour in the city of Calgary, Canada. We are currently developing an application that will integrate these visualizations and others to address the research questions in more detail by being able to drill down into the industry sector, company, and participant levels. We are also creating visualizations of the data from other cities within Canada. Once our application is more complete we will deploy it during the next Commuter Challenge to make reporting more effective for the organizers of the event and workplaces participating, and to help inform city councils and local governments.

Acknowledgments

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References

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