CSCI 4210U - Information Visualization
Final Report - Problem-Driven Design Study

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Summary of Contributions:
Research & Proposal: Adwan Salahuddin Syed, Agilan Ampigaipathar and Jude Antony
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We, Adwan Salahuddin Syed, Agilan Ampigaipathar and Jude Antony certify that this work is our own, submitted for CSCI 4210U in compliance with the Academic Integrity Policy. All work contributed was done of equal proportion by each member.

Problem Statement

We have decided to do a problem-driven design study, for which we wish to examine a continuous issue which hasn't been illuminated in Toronto and still has not been solved by the City of Toronto. The issue we have chosen to contemplate is that certain wards in Toronto don't approach bike stops and parking locations in contrast with others so we might want to do a visualization which can be introduced to the City of Toronto featuring the numerous wards in Toronto which need cycling access.

There are additionally various parks with an expanding requirement for bike parking inside a large number of the inaccessible wards as well as the bordering wards, thus we have to all the more likely comprehend the present situation of bike parking corresponding to the parks of Toronto. In a perfect world, all the parks and even schools ought to have enough bike parking zones close by as these are areas we think has a high bike utilization populace particularly among the families biking around parks and wards outside of the core Toronto wards where public transit is more frequent.

We picked essential datasets in light of the fact that it contains the geospatial information we need inside Toronto including all the various wards there is bike parking and areas where there isn't accessible parking. By picturing this dataset according to different correlation combinations of the datasets such as street parking in conjunction with parks for example, we want to have the option to comprehend and distinguish wards with a requirement for expanding bike parking in certain locations. This visualization can serve us to eventually pinpoint the problem areas and present to City of Toronto policymakers the present circumstance, and our proposed solution(s) we derive from our visualization work. This project can be found in the Github repository Info_Vis_Final_Project and a zip folder is also provided with this report.

Data Preparation

In order to conduct this study we have found datasets which are updated regularly in Toronto's Open Data repository. The dataset we chose to start our study is Bicycle Parking - High Capacity (Outdoor). In correspondence with that dataset, we will additionally use Bicycle Parking Racks to map out the permanent and seasonal multiple-capacity bicycle parking racks installed and managed by the Cycling Infrastructure and Programs Unit. Additionally, we needed to correlate this bike parking with the accessibility zones. We found this data once again from Toronto's Open Data repository and chose the Parks and Toronto District School Board Locations datasets. Lastly, we needed to map all this data on a map of Toronto displaying all the wards which we found through the dataset Toronto Wards.

For the bicycle parking, school and Toronto wards datasets we were simply able to retrieve the GEOJSON format files which included all the data attributes in path elements so no manipulation was required outside of displaying the data through an SVG as an individual layer. Each svg layer was encoded with separate colour schemes such that they had high contrast against one another and users could see visual pop out.

Unfortunately, for the parks dataset there was only a SHP format file and this had to be manipulated in order for us to embed it into our visualization. To do this we utilized a tool called Map

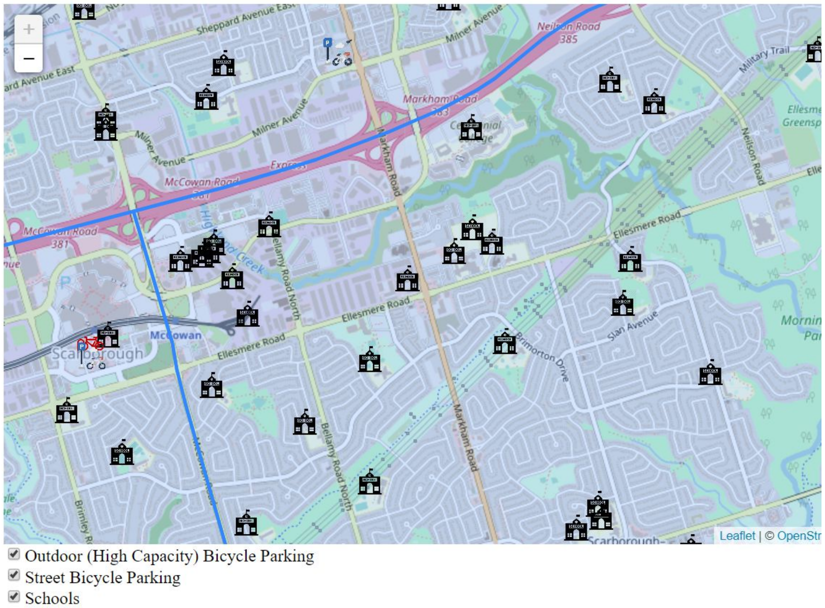
[Shaper](#) where we were able to convert from SHP format to GEOJSON so we could embed it as a layer like the other datasets we retrieved.

All of the datasets that were used in this project can be found in our zipped codebase provided in the following directory: [Info_Vis_Final_Project/Bicycle Parking Vis/data/](#)

Design Description

The visualization design was a tabbed dashboard containing a glyph-based geospatial map and a ward-emphasized map. The design was optimal in order to best handle the Toronto open source data we found in regards to the bicycle parking data. Many of the datasets we found involved large sets of longitude and latitude values, and so the best approach to visualize this type of data is through the use of a map. The first default glyph-based geospatial map was designed with the aim of exploring. A user can interactively set filters onto the map using the checkbox filters in the bottom. These filters add glyphs representing the points from the different datasets shown visually using glyphicons. The first glyphicon shown below represents the Outdoor (High Capacity) Bicycle Parking. These high capacity bicycle parking are seen to be heavily prevalent in the most popular areas of Downtown Toronto where a large number of bicyclists are expected to be present. The second glyphicon represents the Schools. Many students use bicycles to get to school, and some would likely consider it an alternate means of commute, but without enough bicycle parking in these areas, it becomes evident the City of Toronto is currently inadvertently decreasing the number of student bicyclists. The aim is to show the discrepancy between the many schools within Toronto and the void of bicycle parking near these educational institutions. The third glyphicon represents the Street Bicycle Parking (as emphasized with the street sign). These street bicycle parking data was retrieved from a different dataset from Toronto Open Source Data as evidenced in the Data Preparation part of our report.

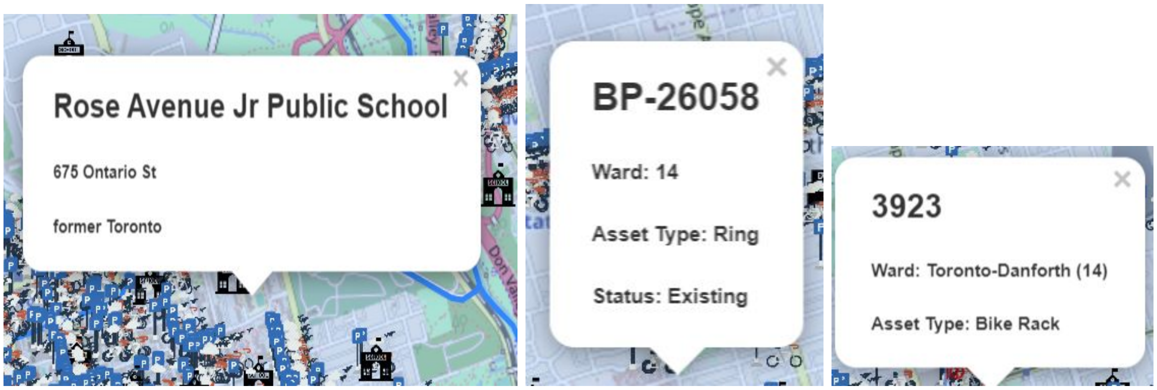

Many alternatives were considered including a third view (tab from the dashboard) to display a stacked bar chart for each ward with the number of Outdoor (High Capacity) Bicycle Parking and Street Bicycle Parking. This view was ultimately decided to be omitted due to the fact some of the datasets were missing the metadata for municipality/ward as well as some having outdated ward metadata (prior to the 2018 municipal ward changes) with wards that no longer exist or are merged with another ward. This made the process of ward identification for each of these bicycle parking points to be difficult to monitor. Each location would have to be manually searched and reconfigured to fit a ward in this case. The design also focused on the mapping visual representation to emphasize major areas lacking bicycle parking development, especially the areas outside of central Downtown Toronto where many schools and parks are located, yet are void of bicycle parking.



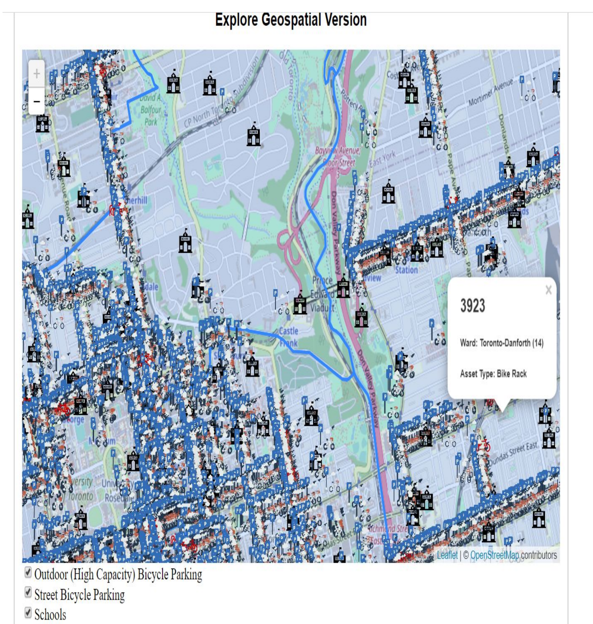
As seen here in the Scarborough area of Toronto, there are numerous schools, but very little bicycle parking available. The green areas of the geospatial map is greenery (parks). The geospatial map contains the topology of Toronto including the parks and bodies of water labelled.

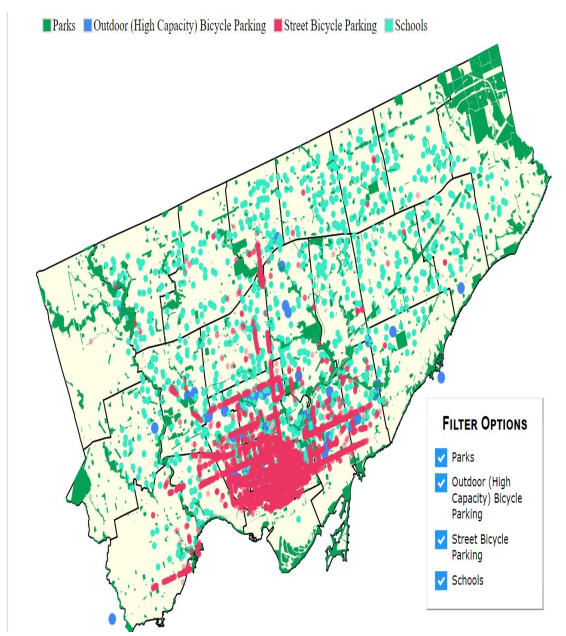
A few design features of the geospatial map involve the ability to pan and zoom, there are however, zoom restrictions in place to prevent over zooming in and over zooming out where Toronto is no longer the main focus of the visualization. These boundaries were placed to give the user the ability to interact and explore without being overwhelmed by showing the entire world and providing preset current zooming and to start the visualization near the centre of Toronto each time the vis is run

As seen here in central Downtown Toronto, the geospatial map succeeds in showing the expected logical patterns we see where many schools and parks are surrounded by numerous bicycle parking. There is usually more outdoor bicycle parking near parks, while popular biking streets are full of Street Bicycle Parking. This is the goal Toronto should aim for the rest of the city to increase the number of bicyclists.



These are the different tooltip types to be seen from user interaction of the geospatial glyphicon map. The first tooltip is for Schools and features the school name, the address, and the municipality (some of the metadata is outdated as seen with this example). The second tooltip is for the Street Bicycle Parking and features the ID number, the ward number, the type of parking (Ring/Rack), and the status whether it is “Existing” or “Temporarily Removed”. The third tooltip is for the Outdoor (High Capacity) Bicycle Parking and features the ID, the parking type (Bike Rack/Angled Bike Rack/Bike Corral), and the ward. These tooltips allow for a variety of user interaction functionality during the exploration of this problem through the vis when clicking these glyphicons positioned according to their relative longitude and latitude positions. The parks can be seen in the background when zoomed in closer and the glyphicons are sized in a way to compliment the natural topology of Toronto, while providing additional information.





This is the second mapping focused on a ward-level view of the datasets (can be seen on the second tab of the dashboard). This provides a top-level approach of the datasets and is easier to view the intricacies of the parks, schools, street bicycle parking, and the outdoor (high capacity) parking. The Outdoor (High Capacity) Bicycle parking was intentionally mapped out to be larger considering these are high capacity and to also appear more relevant among the many street parking in that congested area of central

Downtown Toronto. The parks are polygon shaped and mapped using the coordinates provided from its respective dataset. The schools make up most of the plotting onto the map simply because there is just such a massive amount of schools in Toronto, many without bicycle parking in proximity as seen from this vis.

Scenario/Use Case

The principal focus of the visualization is to present to the city of Toronto highlighting the many wards in Toronto which lack cycling access. However, it is possible for anyone to interact with the vis and interpret in their own way (not only limited to city officials). An example of an informal use case of such interaction with the visualization has been provided below.

The viewer is interested in studying the areas in Toronto with the best access to bicycle parking. Upon accessing the url, the system directs the user to the Toronto Bicycle Parking visualization. The user reads the problem statement definition and understands the motive of the vis. The user explores the geospatial map provided by Open Street Map and uses the zoom feature to locate their school. The user then clicks on the 'ward map' tab and the system navigates the user to the map representation of City of Toronto plotted using geojson data. The user checks the 'outdoor' and the 'street bicycle parking' checkbox options to view the discrepancy in bicycle parking. The system displays the bicycle parking spots as points (marks) corresponding to their positions (channels) on the map. The user wants to view the outdoor bicycle parking (high capacity) spots in relation to parks. The user unchecks the 'street bicycle parking' checkbox and checks the 'parks' box instead. The system reloads and updates the vis with the park geojson data applied to the wards map in conjunction with the previously applied outdoor parking dataset. The street bicycle parking data is entirely removed from the vis.

Conclusion

Although the visualization serves its purpose as its supposed to, there are additional optimization features which we could've implemented with more time. We tried adding the tooptips on ward map to view totals, however all the datasets don't have metadata for wards/municipality. Several of them follow the old ward scheme, as a result those might have to be manually looked at by location and then figured out for ward fitting. The other possibility is to do a count of the points on the map layer, but it may not be accurate because of scaling and translations. We can further extend the filter functionalities to filter tooltip with filters from ward map to only show totals for filtered criteria, filter by parking type for bicycle_parking_map_data.geojson (Bike Rack/Bike Corral/Bike Shelter) and filter based on ward name.

Moreover, we can upgrade the vis with a new view to the dashboard with a bar chart for wards as well as a stacked bar chart with the different bike parking types representing the total bike parking available for the wards. There is also the opportunity to add more interactivity components; Examples include: clicking on ward to focus on that ward, replacing the vis with an enlarged/scaled version of the ward to produce a clear view on the details and a button to reverse/undo the zoom.