Written Document 1: Graphics Proposal

1. Introduction

The user interface and speed of a Geographic Information System (GIS) influence how well information can be conveyed to the target users. By analyzing the user experience of three established GISs, we adapt three successful features that will make our GIS easy to use for university students living in cities: having a familiar interface, fast response time and clear labeling.

2. State of the Art Review (SAR)

2.1: SAR1 - Toronto Police Crime App

The Toronto Police Crime App provides geographic information on various kinds of crimes in Toronto. In terms of interface, the GIS gives users a window on the right for choosing different categories of crime (Figure 1). Each button is a colorful icon that is accompanied by a short description, making the function of each button clear. In contrast, the search window on the left is not self-explanatory, because it uses technical phrases like “[r]esult layer name” and some symbols at the top look similar to each other. Furthermore, having two control methods on the same web page may lead users into decision paralysis because “more options mean more struggle” [2].

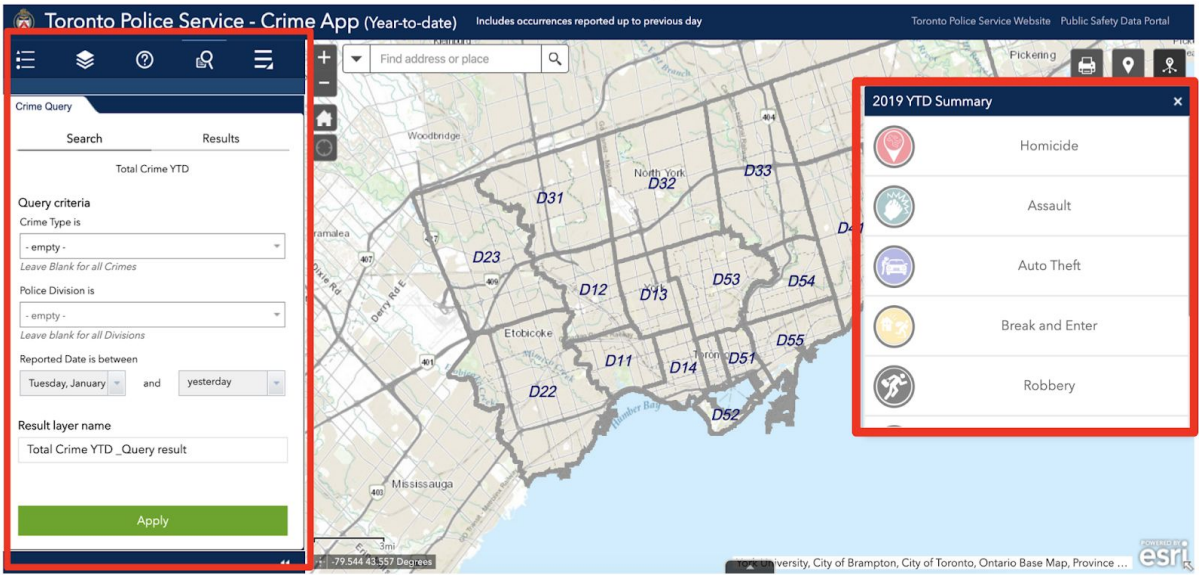

Figure 1: Two control methods in the same interface: a detailed one on the left and a simple one on the right.

Search results are presented in tabular form (Figure 2), which most users like according to geoinformatics professors Bernd Resch and Bastian Zimmer [1]. Clicking on the results directs users to the crime locations on the map, which is preferred for connecting searches with location information [1].

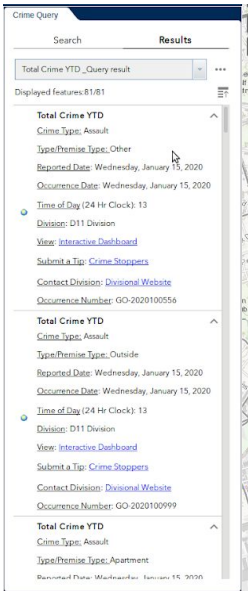

Figure 2: Search results are displayed in tabular form in the left panel, which is preferred by users.

2.2: SAR2 - Canada's Clean Energy Resources and Projects

Canada's Clean Energy Resources and Projects atlas (CERP) gives users who have some knowledge of power plants an overview of energy resources across Canada.

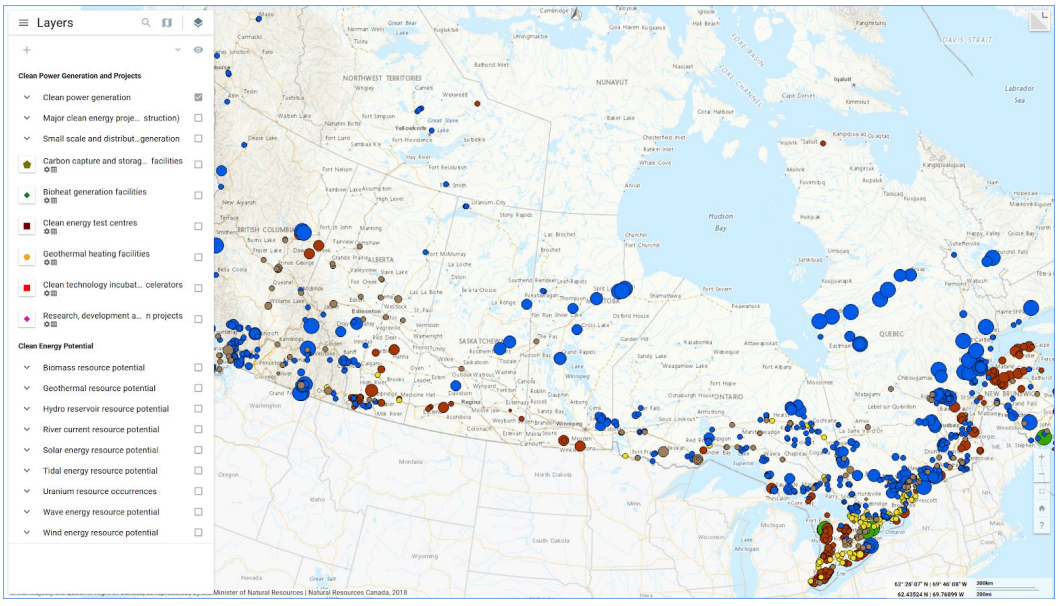

Figure 3: CERP's initial interface, which resembles Google Map's interface.

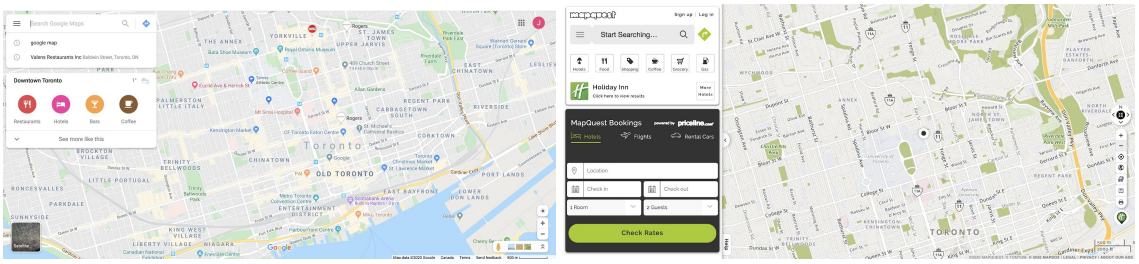

Figure 4: Popular interfaces on the web. Left to right: Google Map, MapQuest

CERP's interface and button placement (Figure 3) resembles popular GISs such as Google Maps (Figure 4). According to Jakob Nielsen, a user experience researcher, adopting a familiar interface reduces training time because users need not remember new rules that govern this system [3:227]. This design decision likely allows CERP to be usable for the widest range of users.

CERP's left panel (Figure 5) is full of technical-sounding options without explanation: for example, "biomass resource potential" highlights forests. CERP should accompany these buttons with meaningful icons so that users can visually understand the buttons' functionalities [3:125].

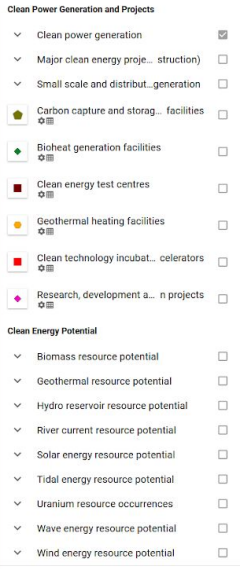

Figure 5: CERP's left panel contains buttons that toggle different data. The options are technical-sounding and have no icons, which may make novice users unsure about their functionalities.

CERP takes 1 second to zoom; in contrast, Nielsen finds that a system should respond in 0.1 second in order to feel instantaneous to the users [3:125]. We hypothesize that poorly-optimized code forces the computer to calculate extraneous information.

2.3 SAR3 - Condos.ca

The GIS displays a map of the prices and locations of different condos on sale in the Great Toronto Area (GTA) for potential buyers.

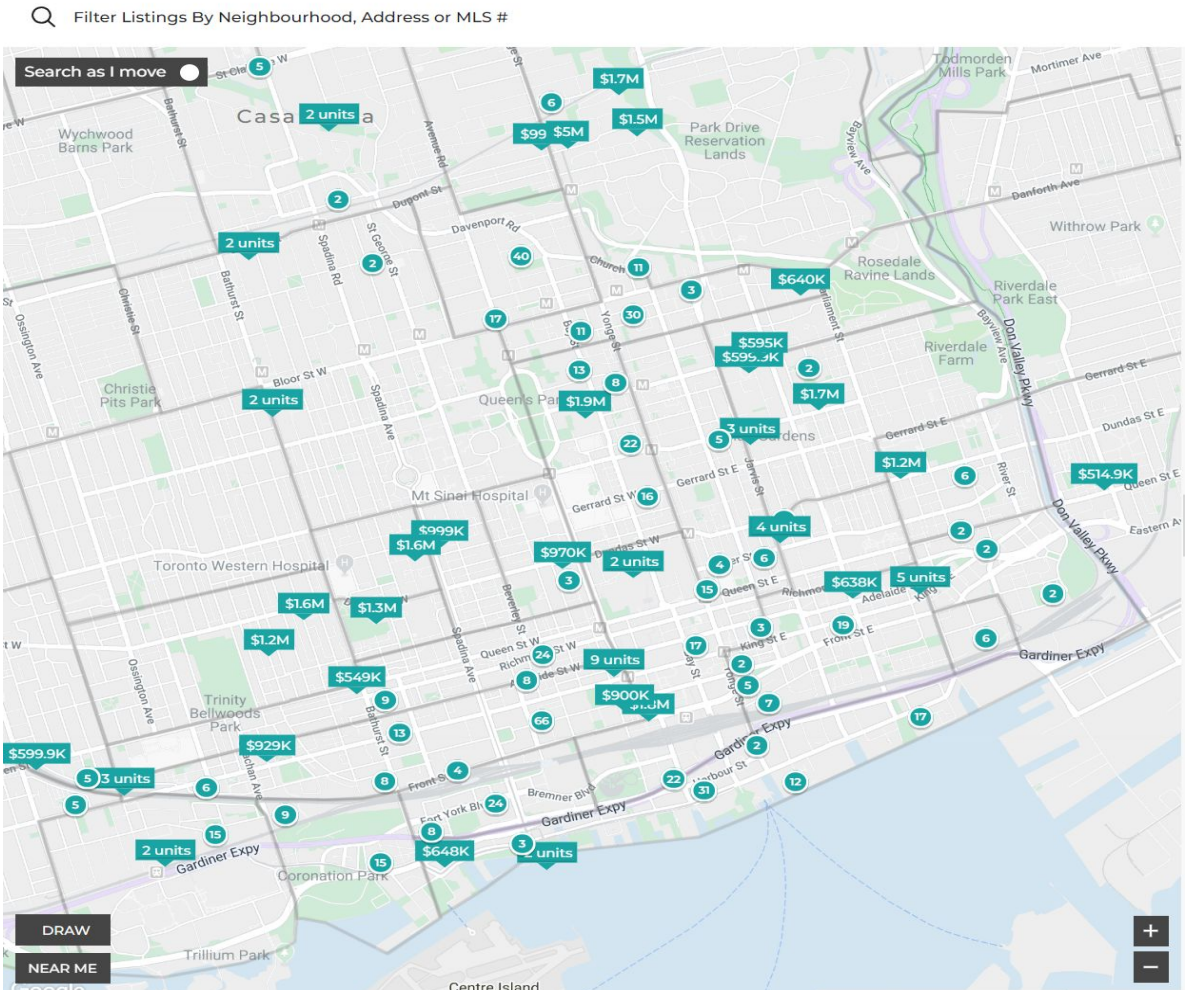

Figure 6: The Condos.ca GIS has only four buttons and labels different condo information on the map

Geographical information is displayed in muted colors, such as light-green for parks and grey for blocks and roads (Figure 6). These colors are recommended as background colors [3:119] and focus users on the most crucial information - condo labels. Only the most relevant facilities for homebuyers, such as hospitals and subway stations, are labeled (Figure 7) to help users visualize the neighborhood.

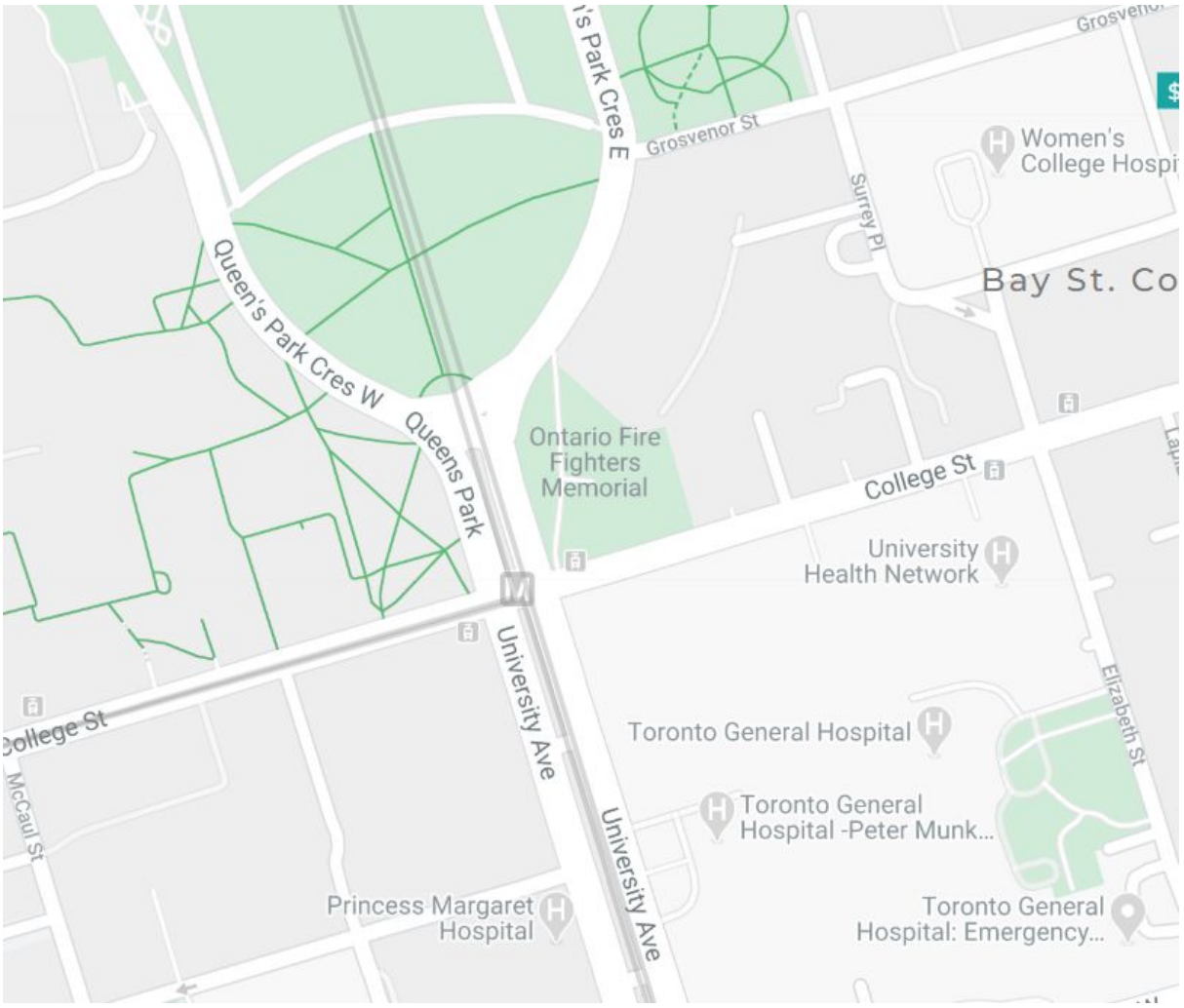

Figure 7: Parks are colored in light green while hospital and subway stations are marked using grey - sticking with the theme of using muted colors in the background.

According to IEEE member Ken Been, map labels containing information should not suddenly vanish or appear when the map is interacted upon [4] to avoid distractions. This GIS obeys this rule by synchronizing font sizes with the zoom level and making words move with the map. If the view is zoomed out so that street names become crammed, a label filtering step [4] selectively reduces the number of street names according to importance.

3. Proposal

Our GIS is for university students living in cities and includes an interface that focuses on options that benefit city-dwellers. Learning from our SAR, our implementation will include a standardized interface with discernable symbols, the fast response time when zooming and panning, and map labels that display relevant information while minimizing distractions.

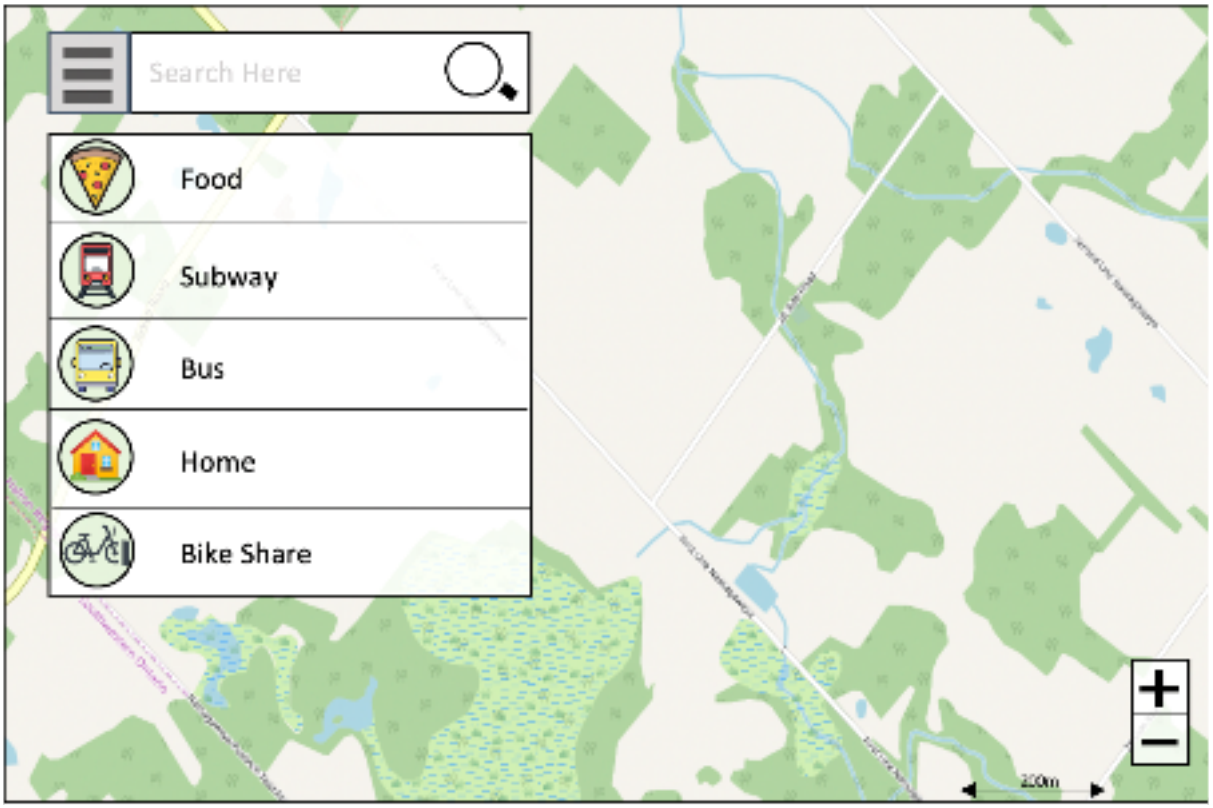

Figure 8: our GIS's proposed interface, similar to existing mapping software. Here, the advanced options are expanded after clicking on the "three bars" icon. Zooming buttons are located at the bottom right as a standardized map

3.1 User Interface

We will make our interface easy to use for university students. First, the interface (Figure 8) is similar to many popular GISs with the search bar at the top-left corner and zoom options at the bottom-right. Further borrowing from common GISs, below the search bar are buttons that display different information - for example, clicking on the "subway" button displays the subway system. These options are hidden by default, and users can activate them by clicking on the three horizontal stripes beside the search bar. Because most university students have had exposure to internet maps [5], they likely will find our interface easy to use. Secondly, we want our search methods to be simple. Learning from the Toronto Police Crime App, there would only be one search bar where users can search for streets and points of interest.

Our interface will also present data in an organized manner: search results are displayed in the tabular form like the Toronto Police Crime APP. We will also give users the ability to sort through results by distance from the current location and relevance of information since according to Resch and Zimmer's research this provides better GIS experience [1].

3.2 Responsiveness

Learning from CERP's sluggishness, we will perform all calculations during the loading stage to reduce the computer workload after the map is loaded. This allows our GIS to respond to interactions. However, the map loading time will likely increase as a result. Nielsen recommends providing estimated loading time if it takes longer than 10 seconds [3:125], hence we will display how much the map has loaded with a status bar (Figure 9).

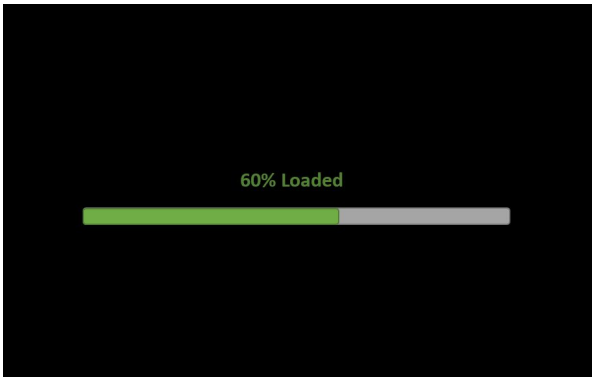

Figure 9: loading screen for our program, which contains the estimated percent of completion.

3.3 Colors and Labels

Inspired by Condos.ca, our GIS will mostly use muted color to represent features such as parks and public facilities. When displaying search results, the relevant information will be highlighted using a brighter color to contrast with the faded background color.

Our GIS will include a labeling algorithm that sets a limit for the number of labels shown on-screen. If this limit is exceeded, information that is less relevant for the viewer will be filtered out. For example, if the user selects a category, such as "food", and zooms out, then restaurant markers will persist for longer than other point-of-interest markers before disappearing. Map labels will also fade in and out slowly instead of appearing and vanishing suddenly.

4. Testing

We will conduct "constructive interaction" tests, where two test users from our target audience - university students - complete tasks together [3:198]. This format is intended to expose user experience issues by encouraging participants to communicate their findings amongst themselves and to us. Three categories of tests will be conducted in order: "simplicity testing" deduces a user's first impressions, "interface testing" examines the interface associated with each function, and "performance testing" can reveal users' opinions toward our GIS's response time.

4.1. Simplicity Testing

This test measures the testers' first impressions of our GIS and should indicate whether the standardized interface allows users to quickly learn the functions. The map of Toronto will be pre-loaded before the test begins.

Tests	Indications of success
Step 1: Show an image of our GIS's interface (similar to Figure 7), and let the testers suggest the features that our GIS may have and the ways to enable these features.	Guess correctly more than five features and ways to access these features
Step 2: Let the testers use our GIS for 1 minute without giving them directions or hints. After 1 minute, ask how many more features they have discovered, and let them describe how they enabled these features.	State correctly more than five additional features (different from above guessed features) and ways to access them

Table 1: tests for simplicity that we will conduct, along with metrics.

4.2. Interface Testing

This test involves testers using our GIS's functions in depth. We will measure how long users spend at each task, and whether any errors are made - this way, we can determine if the interface related to that function can be improved. To derive the target completion time, we performed the same tasks in Google Maps and recorded the time required for that task.

Tests (not in order)	Target completion time (seconds)
Find the current location	5
Have the testers find the closest restaurant to a given intersection.	10
Search for the second closest subway station, and obtain the next departure time.	20
Obtain the fastest driving direction from the current location to George Brown College.	10
Identify five hospitals on the map.	15
After instructing the users on how to switch maps, let the users switch from displaying Toronto to displaying St. Helena.	15

Table 2: tests for functionality that we will conduct, and the projected time of completion. The estimated time of completion are obtained by completing these tasks in Google Maps.

4.3. Performance Testing

Due to the nature of our development tools, our GIS's response time will not match online GISs. However, performance testing allows us to estimate when performance slow-downs impact user experience and then to optimize for these situations.

Testers will launch the program from scratch; no map is preloaded. Then, they will perform the following computationally-intensive functions implemented in our GIS:

- Load new York map
- Calculate the fastest route between the farthest points on the map
- Find the most optimized delivery option (milestone 4)
- Locate all restaurants
- Perform zoom and pan operations consecutively

We will record the computer screen to find stutters, as these can negatively affect user experience. Also, we will record if the testers express frustration toward our GIS's performance. After iterative improvements, we will declare success if the user frustration rate is consistently low.

5. Conclusion

By analyzing the usability of existing GISs, we identified beneficial GIS characteristics that allow their users to easily access information. We propose to use a standardized and simple interface, to make our GIS feel responsive to the users, and to use clear labels with muted colors. We hope that these features will help our target user - university students - find our GIS intuitive.

References

[1] B. Resch and B. Zimmer "User Experience Design in Professional Map-Based Geo-Portals" ISPRS Int. J. Geo-Inf. 2013, 2(4), 1015-1037. Available: https://doi.org/10.3390/ijgi2041015 [Accessed Feb 1, 2020].

[2] C. Heath and D.Heath, Made to Stick: Why Some Ideas Survive and Others Die, 1st Edition, Kindle Edition Random House, 2007 [E-book] Available: Amazon kindle e-book

[3] J. Nielsen, *Usability Engineering*. San Diego, CA: Academic Press, Inc., 1993.

[4] Been, Ken & Daiches, Eli & Yap, Chee. (2006). Dynamic Map Labeling. Visualization and Computer Graphics, IEEE Transactions on. 12. 773-780. 10.1109/TVCG.2006.136.

[5] Statistics Canada, "A Portrait Of Canadian Youth", *Statistics Canada*, May 8, 2019. Available: https://www150.statcan.gc.ca/n1/pub/11-631-x/11-631-x2019003-eng.htm. [Accessed Feb 4, 2020]

Attribution Table

	SAR	Proposal	Testing	Intro/Conclusion
Zichun Huang	SAR #3	Revision		First draft Revision
Haolin Wang	SAR #2	Revision	First draft Revision	Revision
An Yu	SAR #1	First draft		