

# Hood Hunter: A House Hunter’s Guide to Narrowing Neighbourhoods

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## Abstract

This proposal provides an overview of an explorer visualization tool to support prospective home buyers in narrowing down neighbourhoods for a potential home purchase. Three solution mock-ups and scenarios are provided based on the data and task abstractions presented in this proposal. After synthesis of the pros and cons of each proposed solution, the final solution will be implemented using D3 Observable. It will be presented as web application for users to explore.

**Keywords:** house affordability, neighbourhood search

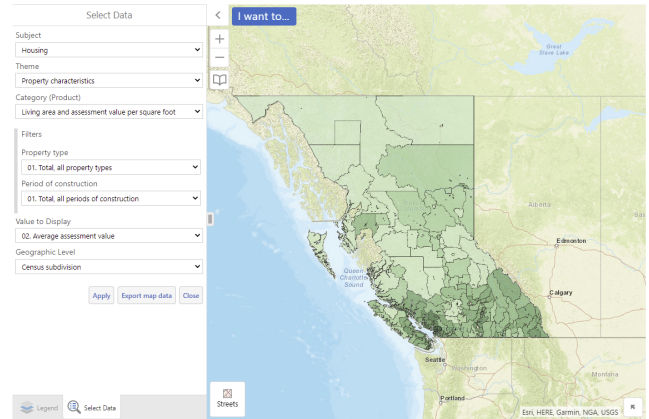
## 1 Introduction

In recent years, several urban centres across Canada have faced challenges with affordable housing. These trends have been exacerbated over the course of the pandemic with home buyers looking to move out of densely populated regions to nearby sub-urban neighbourhoods to support newly emerging remote work cultures.

Several factors have contributed to the unaffordable conditions of the Canadian residential real-estate market. Notably, the presence of foreign buyers in the Toronto and Vancouver real estate markets have contributed significantly to the current housing crisis incurred by local residents [9].

Although the house search process is unique to every buyer, certain recurring classes of requirements have been shown to be persistent across buyers and varying demographics. Olanrewaju and Wong conducted a study to determine key criteria that home buyers considered when purchasing a home [18]. Through an exploratory factor analysis, they were able to identify and rank clusters of requirements according to their impact on buying decision. These clusters include price configuration, accessibility, transportation, and sustainability.

Prospective home buyers spend a large amount of time and resources researching neighbourhoods for proximity to city centres, low crime rates, quality schools, and more. While each home buyer’s criteria and ranking of criterion importance are different, identifying neighbourhoods that meet their criteria while also falling within their budget can be a cumbersome task.



**Figure 1.** Example of an existing solution for a single attribute.

The primary objective of this project is to support prospective home buyers in narrowing down potential neighbourhoods for their residential property purchase. To narrow the scope of this project, we focus on the residential real-estate market in British Columbia. Seeing that the Toronto and Vancouver housing crises are coupled [9], this project aims to initially address the region where the housing crisis has had the most impact. As such, we propose an explorer tool to support home buyers in identifying neighbourhoods of interest that meet their specific search criteria in accordance to personal importance. An ideal task following an interaction with the proposed tool would be for the user to begin searching for homes in the neighbourhood of interest.

## 2 Related Works

Several housing affordability visualization tools already exist for house buyers to explore. Many are provided by government agencies such as *BC Assessment Maps* [1] and the *Canadian Statistical Geo-spatial Explorer* [3] (Figure 1). Both of these tools show regional residential housing prices. There are also non-government visualizations, such as [19] (shown in Figure 2), which do not have an interactive component. Other visualizations for neighbourhood characteristics such as safety and education are also provided separately by local governments such as *VPD GeoDash* [7]. Such tools locate recent crimes and the Foundation Skills Assessment (FSA) for each school district in the province of British Columbia [6].

\*All authors contributed equally to this research.

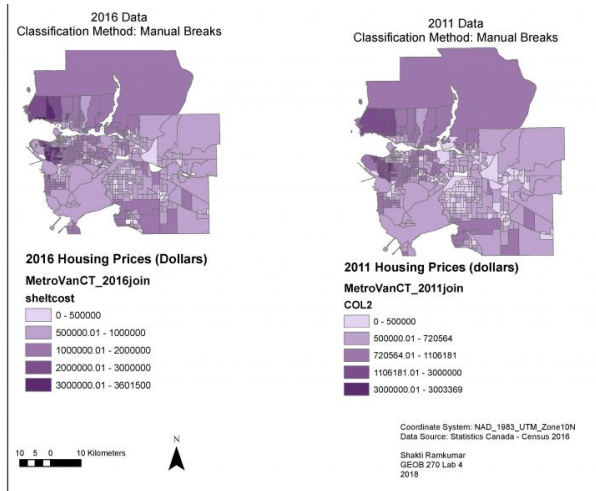


Figure 2. Example of an existing solution using a static map.

Another attribute of interest could be transportation options, such as those included in *WalkScore* [21]. However, each of these tools focus on a specific attribute and do not consider the overall neighbourhood livability. Other existing tools weigh a combination of these attributes to help potential home buyers research neighbourhoods in Metro Vancouver, including *Find Your Neighbourhood* by Vancouver Magazine [14] (shown in Figure 3) and *Find a Hood* [12]. Both of these tools require a user survey and offer less room for exploration.

In academic literature, Rinner describes a pilot study of the usefulness of geographical visualization in urban quality of life evaluations based in Toronto [20]. Liu et al. [10] and Balsas [2] show example visualizations and considerations for regional livability. Shabanzadeh et al. visualized livability in Tehran’s metropolitan districts using several choropleth maps. Other works such as [18] clearly highlight requirements that impact home-buying decisions which contribute to our visualization design.

Geographical visualizations are outlined in works such as [5] and [13]. These works present themselves as the most suitable method for presenting our data. As such, we rely on past works such as map visualizations of spatial and spatiotemporal data [22], cartograms [17], and Hotmaps [8] to explore trade-offs between various types of maps, task abstraction taxonomy, and color, respectively. Work by van Kreveld et al. help us understand implications of diagram placement on maps [24] and we leverage ideas proposed about necklace maps from [23] for some of our potential solutions. We also observe insights from Latif et al. which explore the relationship between text and geographical visualizations in data-driven stories and their influence on the reader’s understanding [11].

### What's the best Vancouver neighbourhood for you?

Tell us what matters most to you and we'll give you your own neighbourhood ranking

On a scale of 0 to 10, how important is it to you that your neighbourhood...

has lots of good restaurants and coffeeshops.   is ethnically diverse.

is a good place to bike, walk or take transit.   has neighbours with university degrees.

has lots of green space.   has neighbours who own their own home.

has neighbours who vote.   has lots of kids.

is affordable.   has lots of singles and places to meet them.

doesn't have a lot of home break-ins.   has lots of pet stores and veterinarians.

has neighbours who stick around.

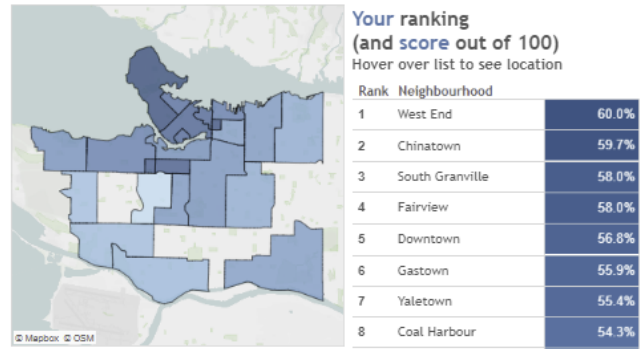


Figure 3. Example of an existing solution using user priorities.

### 3 Data and Task Abstractions

The grounding premise of this project relies on potential home buyers finding dwelling type, budget range, community safety, quality of education, proximity to service centres, and commuter friendliness to be important criteria when searching for homes. Although this is validated and derived from a Malaysian study [18], we aim to verify that this trend applies to a North American context through the distribution of the survey presented in Figures 7, 8, and 9. The survey will be distributed through Reddit in the [r/britishcolumbia](#) thread and the [Survey and Focus Group for Canada](#) Facebook group. The survey intended for British Columbia residents will inform our project while the secondary survey distributed to a broader North American demographic will inform the validity of our assumptions.

Dataset Source	Attribute Name	Attribute Description	Attribute Type
Census	Index of remoteness	Geographic proximity to service centres and population centres	Ordinal (Quantitative)
	All Criminal Code Violations Excluding Traffic	Safety of the region, normalized per 100,000 capita	Ordinal (Quantitative)
	Percentage of Population Near Public Transit Stop	Percentage of the population near a public transit stop	Ordinal (Quantitative)
Quality of School Scores	District Name	Name of school district	Categorical
	Grade	Level of study in educational year of schooling	Categorical
	FSA Skill Code	Type of assessment issued	Categorical
	Score	Average assessment score for assessment issued	Ordinal (Quantitative)
Canadian Mortgage and Housing Absorbed Homeowner and Condominium Units	Census subdivision	Geographical region	Categorical
	Dwelling type	Type of home	Categorical
	Month, Year	Month and year the sales data was aggregated for	Ordinal (Categorical)
	Price Distribution	Histogram of distribution of home prices per dwelling type within a specific region.	Ordinal (Quantitative)

**Table 1.** Summary of data attributes.

Attribute Name	Range (Quantitative)	Ordering Direction	Number of Items
Index of remoteness	Possible Range: [0, 1], Max: 0.829, Min: 0.017	Sequential	735
All Criminal Code Violations Excluding Traffic	Min: 2,159.72, Max: 24,793.39	Diverging	735
Percentage of Population Near Public Transit Stop	0-100%	Sequential	480
Score	Min: 1, Max: 612.3617	Sequential	360
Price Distribution	Number of Ranges: 65	Sequential	224

**Table 2.** Quantitative attribute details.

Attribute Name	Number of Categories (Categorical)	Number of Items
District Name	60 categories	360
Grade	2 categories (4, 7)	360
FSA Skill Code	3 categories (Writing, Reading, Numeracy)	360
Census subdivision	735	735
Dwelling type	4	224
Month, Year	56	224

**Table 3.** Categorical attribute details.

### 3.1 Dataset Information

We obtain our data from multiple sources in order to consider different attributes in our analysis. These datasets include Canadian Census data from 2016, Criminal Code Violations from 2020 [3], BC Foundational Skills Assessment data (FSA)

from the 2020 to 2021 school year [6], and home purchase prices according to home type from 2016 to 2021 [16]. These datasets are intended to support the following dimensions neighbourhood search:

**3.1.1 House Preference and Affordability.** The Canadian Mortgage and Housing Corporation offers a dataset of newly-built homes by price range, dwelling type, and municipality for urban centres with more than 50,000 residents [15]. These dwelling types include single detached homes, semi-detached homes, row homes or townhouses, and apartments. It offers monthly data from 2016 to 2021 with the option to view quarterly overviews for each year. Regional divisions correspond to Census subdivisions. Price ranges are represented as a histogram of price buckets from a range encompassing homes sold for less than \$150,000 with \$50,000 increments to \$3,450,000+.

**3.1.2 Safety.** Statistics Canada provides a dataset on incident based crime statistics across Canada [3]. The most recent report was generated from all incidents in 2020. For relevance, we select the crime rates normalized by 100,000 population for all criminal code violations excluding traffic violations to use in our tool. The geographic level of analysis chosen was police service and detachment for the richest data available on this subject.

**3.1.3 Quality of Education.** The BC Foundational Skills Assessment from 2020 to 2021 school year provides an overview of literacy (reading and writing) and numeracy in grades 4 and 7 students by school district. This dataset contains 60 unique districts with 360 items [6].

**3.1.4 Transportation.** Two datasets of interest are considered for the transportation category. The index of remoteness characterizes geographic proximity to service centres and population centres. Statistics Canada determines this index as the distance to such centres in a given travel radius with consideration to population size [4]. The 2016 index of remoteness acquired during Census data acquisition is the latest dataset available for this source. The second dataset of interest also stems from the 2016 Census. It characterizes the percentage of the population near a public transit stop per city [3]. This dataset serves as an indicator for the commuter-friendliness of the region of interest.

## 3.2 Data Abstraction

All of our datasets are organized by census subdivisions (such as cities, villages, towns, etc.) with the exception of the FSA dataset, which is organized by school districts. We convert the FSA school districts into equivalent census subdivisions and combine our dataset into a single table as the source of our visualization. Since census subdivisions also include regions, which encompasses other subdivisions such as cities, we extract only non-overlapping subdivisions from the dataset. These datasets also have a temporal element, each associated to a year between 2016 to 2021. We select the most recent data available to us, some stemming from the 2016 census and others acquired more recently. Therefore, we believe each attribute is the best representation of the

present state and do not adjust for time differences between attributes. For house preference and affordability, we optionally consider a separate representation to communicate any time series data available to us.

Table 1, Table 2, and Table 3 outline the detailed data abstraction of these datasets. We evaluate our data abstraction based on the raw data, excluding columns that we do not plan to include in our visualization. Further modifications are necessary for our datasets, but we do not yet have our finalized data to perform our data abstraction.

Some abstractions are decided based on our currently planned solution. We choose *diverging* for the criminal code violation attribute considering that it is important for users to know if cities are a lot safer than the mean or a lot more dangerous than the mean when the safeness of each city is relative to one another. For FSA score, a rank will be assigned to each census subdivision depending on the average school performance.

## 3.3 Task Abstraction

**3.3.1 Who.** The intended users of our visualization tool consist of potential home buyers who are trying to pinpoint which neighbourhood to purchase residential housing in. The visualization tool should help users answer questions of where to look for housing prior to house hunting. This specific iteration of this tool will target home buyers interested in residential housing within British Columbia. One additional question we hope to help users answer is when to look for housing in a particular neighbourhood. We will optionally include this in our visualization based on time and resource constraints.

**3.3.2 Actions.** At the *analyze* abstraction level, the main use for our visualization tool is to consume existing data regarding neighbourhoods in BC. In particular, users will use our visualization to discover new insights regarding which neighbourhoods are more suitable for their needs. Another use of the visualization tool is to produce new information about neighbourhoods. In some cases, we will be transforming raw quantitative data to ordered ranged data to improve the legibility of the information presented to them.

In terms of *search*, we expect the users to perform either *lookup* or *browse*. In the most common case, users will have a budget and a few criteria in mind when searching for places to live in. This would then fall into the category of browsing. In other cases, a user might already have a neighbourhood in mind and want to look up certain attributes regarding that neighbourhood. *Lookup* could also follow after *browse* as users start to gain a better understanding of their neighbourhoods of interest.

For *query*, we expect users to *identify*, *compare*, and *summarize*. Users can use our visualization to identify attributes regarding a particular neighbourhood after *lookup* or identify a particular neighbourhood with certain attributes after

browsing. One example of this is to identify the neighbourhood with the cheapest housing. Another use of the visualization is help users make comparisons between multiple neighbourhoods to find the most suitable one. Lastly, the ability to summarize is not only useful for users to have a high-level overview of the attributes for all neighbourhoods in BC, it also provides them with opportunities to identify trends in certain attributes for particular neighbourhoods.

**3.3.3 Targets.** The main high-level targets are *outliers* where users are trying to find the most suitable neighbourhood to their criteria. One example of this is that a user who prioritizes safety might want to find the neighbourhood with the lowest crime rate in BC. *Trends* might also be a target of interest to provide users with richer insights into attributes of neighbourhoods. One example of how this might be useful is for a user who cares about the investment value of housing. They can compare how fast the housing price within a particular neighbourhood is growing compared to another. For the specific attribute of housing price, *distribution* and *extremes* are also targets of interest. The distribution of the price for houses sold in a neighbourhood will give a more accurate representation of pricing than solely average price. Looking for extreme minima and maxima in pricing data over time can also enable users to identify when the most appropriate time is to purchase houses in a particular neighbourhood.

## 4 Solution

### 4.1 Proposed Solutions

This section outlines three potential scenarios and the possible solutions associated with them.

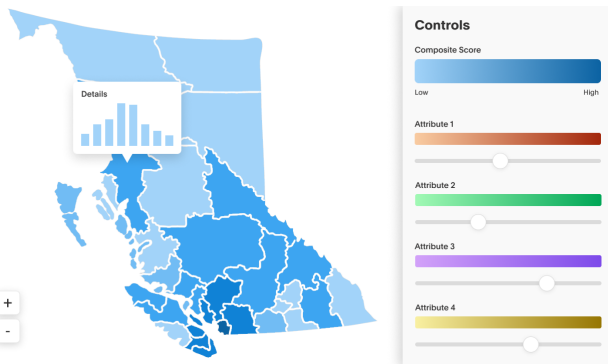


Figure 4. Solution A mockup

**4.1.1 Solution A & Scenario.** Figure 4 shows a possible visualization design. In this example, a user may be interested in finding a potential neighbourhood in British Columbia that is most suitable for them to live in. They are in an exploration phase and are open to the possibility of living anywhere in the province. The map provides the user with a generalized view. The main map is divided into Census

subdivisions and the luminance channel encodes a composite score based on the user’s priorities. These priorities are defined by the position of the slider inputs. The hue channel encodes different regional characteristics and the luminance of each of these indicators encode their value. To explore different attributes, the user can also select a specific attribute to colour the map in replacement of the composite score.

Once the user has selected a suitable region, they may zoom into the map further to view smaller Census subdivisions on the map. When they have narrowed down their search to specific subdivisions, the user can select the subdivision and view further details. For instance, a histogram encoding the distribution of housing prices in the subdivision with corresponding lengths.

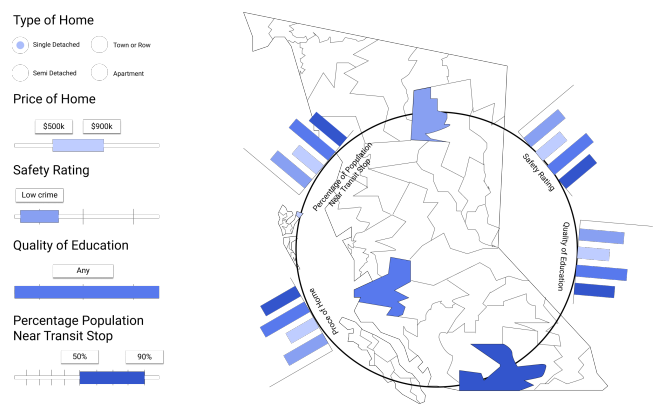


Figure 5. Solution B mockup

**4.1.2 Solution B & Scenario.** Loosely inspired by the concept of Necklace Maps [23], Figure 5 presents an interactive explorer tool to support neighbourhood search.

The mark of type containment encodes census subdivisions. The fit of neighbourhood is a cumulative score of each attribute. The visual channels saturation and luminance redundantly encode a unique neighbourhood and the fit of the neighbourhood. The top four results are shown to assist the user in the task of filtering. Each neighbourhood’s attribute value is represented by a mark of type line. The hue and luminance of the mark on the histogram denote the neighbourhood on the map. Additional labelling may be used to display neighbourhood names.

In order to manipulate this tool, the user is required to input their desired criteria to filter the neighbourhoods for best fit. These inputs will be user defined ranges of tolerance for each attribute. The user may drag the line mark and expand it to indicate a wider tolerance and shrink the length to indicate a narrower tolerance. The user is asked to input type of home preference through a multiple choice selector. As the user toggles these controls, a cumulative score will be computed according to the ratings inputted by the user. The top four neighbourhoods will be assigned saturation

and luminance values indicating best fit. Darker and more saturated regions will indicate better fit than lighter and less saturated regions. The histograms along the necklace may be used to easily understand and compare each attribute for the top four neighbourhood recommendations.

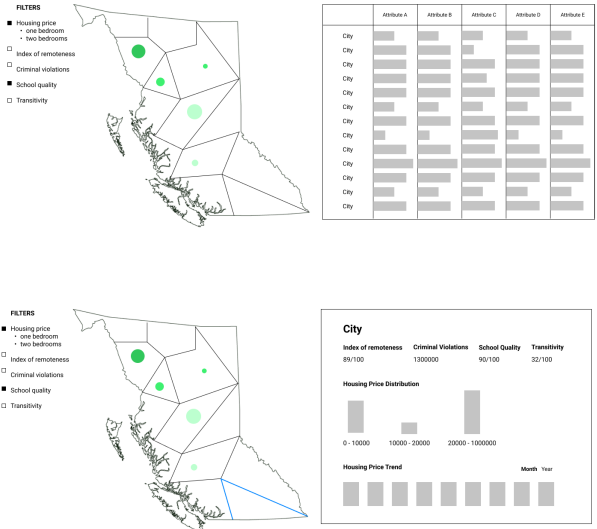


Figure 6. Solution C mockup

**4.1.3 Solution C & Scenario.** Figure 6 showcases another possible visualization design which allows users to visualize particular attributes of interest to support the task of neighbourhood comparison. On the left hand side, a user can filter which attribute to visualize on the map. Each neighbourhood is represented with a point mark where size and saturation channels are used to encode two attributes. A user can choose up to two attributes to visualize with the default attribute being housing price encoded by the size channel. As this attribute’s assumed significance is high, it would be justified to encode it using a channel with relatively higher effectiveness. Users can then choose which other attribute they want to encode as well on the map. On the right, there is a table with embedded bars showcasing attributes for every neighbourhood. Users can use this table to easily rank and compare neighbourhoods by attributes of interest.

The lower mock-up on Figure 6 shows how the display changes once a neighbourhood is selected. The selected area will be highlighted as the table with embedded bars is replaced by a summary of key information regarding the selected neighbourhood. This will support the task of lookup, offering an overview of a particular neighbourhood. The overview will showcase the values for attributes such as index of remoteness, criminal violations, school quality, and transitivity. It will also showcase the neighbourhood’s housing price distribution and housing price trend overtime. This

can be particular useful if users want to learn more about a neighbourhood they are further interested in.

4.2 Tools

In order to implement our interactive explorer visualization tool, we will leverage D3, particularly, D3 Observable due to ease of prototyping and integration with web. We aim to host our visualization tool on a website which can be easily accessed by prospective users. To perform any background processing or algorithmic computation, we may leverage Python.

5 Milestones

Table 4 outlines our proposed milestones, their associated deadlines and the team members assigned to the task. The total amount of hours estimated is 80 hours per group member.

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Milestone	Task	Hours per Person	Deadline	Task Description	Team Member
<b>Pitch</b>	Individual pitches	2h	September 29, 2021	Research projects of interests, develop presentation, present to class or generate video	Everyone
<b>Proposal</b>	Idea selection meeting	1h	October 7, 2021	Decide project of interest, research relevant datasets, initial task split for proposal	Everyone
	Survey development and existing solution research	1.5h	October 12, 2021	Created a survey to gather initial user preference, researched existing solutions	Ivan
	Pre-proposal report writing	1.5h	October 12, 2021	Set up overleaf, write introduction and literature review	Abi, Lucy
	Pre-proposal meeting	3h	October 13, 2021	Meeting with Tamara, initial brainstorming, iterate on survey	Everyone
	Collect datasets	1h	October 14, 2021	Search for datasets that can be used for the project	Everyone
	Define data and task abstraction	2h	October 14, 2021	Meeting to discuss data and task abstraction	Everyone
	Proposal write-up	3h	October 21, 2021	Finish proposal writing	Everyone
<b>Update Report</b>	Evaluate pros and cons of proposed solutions	1h	October 23, 2021	Discuss each solution ideas and decide on an unified design	Everyone
	Tool familiarization	10h	October 26, 2021	Learn D3, Observable	Everyone
	Analyze survey results	1h	October 26, 2021	Distribute survey and analyze results	Everyone
	Finalize mock-up	4h	October 30, 2021	Create finalized design mock-up for visualization tool	Ivan
	Data cleaning	4h	October 30, 2021	Clean up data for implementation	Abi, Lucy
	Create initial implementation	15h	November 14, 2021	Create the MVP of the solution	Everyone
	Update writeup	2h	November 16, 2021	Finish writeup for updates	Everyone
<b>Implementation Deadline</b>	Finalize implementation	20h	December 1, 2021 (can be extended to Dec. 8)	Finalize implementation of the solution, make changes from update's feedback, prepare for demo	Everyone
<b>Validate Implementation</b> (optional: time can be allocated to implementation if needed)	Create evaluation plan	1h	December 3, 2021	Create an evaluation plan for validating the solution	Everyone
	Execute evaluation study	2h	December 6, 2021	Recruit participants and conduct the evaluation studies from the plan	Everyone
	Summarize results	1.5h	December 8, 2021	Merge, discuss, and analyze evaluation results	Everyone
<b>Final Presentation</b>	Finish presentation	3h	December 14, 2021	Prepare and rehearse presentation	Everyone
<b>Final Report</b>	Finalize report	6h	December 17, 2021	Update report from update write-up, and finalize all other sections	Everyone

Table 4. Milestone timeline

knowledge discovery in database methods. *International Journal of Geographical Information Science* 13, 4 (1999), 311–334.

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## 6 Appendix

### 6.1 Attribute of Interest Survey

The following survey is intended to be used to learn the criteria that are most important to prospective home buyers when searching for a neighbourhood to purchase residential property in. A copy of this survey will be distributed specifically to BC home buyers while another copy will be distributed along a wider Canadian channel. Synchrony between results gathered from both surveys would indicate that a solution developed to visualize these attributes would be scalable to a country-wide visualization tool.

**THE UNIVERSITY OF BRITISH COLUMBIA**

### A House Hunter's Guide to Narrowing Neighbourhoods

**Introduction:** Thank you for participating in our study! This work is affiliated with the UBC course "Information Visualization" (CPSC 547).

**Purpose:** In this study, we would like to learn about your research strategies when thinking of purchasing a home. Your answers are anonymous and will only be used in the scope of this project.

Your time spent on this survey will be around 5 minutes.

**Figure 7. General description of survey objective**

**Tell Us About Yourself**

Age: How old are you?

- Under 18 years old
- 18 - 24 years old
- 25 - 34 years old
- 35 - 44 years old
- 45 - 54 years old
- 55 years or older

Relationship Status: Are you married or in a common-law relationship?

- Yes
- No

Dependants: Do you have any children who currently live with you?

- My children live with me
- My children do not live with me
- I do not have children

Interest: Have you purchased a residential property or do you plan on purchasing residential property?

- Yes
- No

**Figure 8.** Demographic information about survey respondent



**House Search Preferences**

When do you plan to purchase a residential property?

- Already purchased
- This year
- Within 1 - 2 years
- Within 3 - 5 years
- More than 5 years later
- I don't know

Please rank the following criteria based on importance to you when choosing where to live.

Drag and drop the options below to desired rankings.

- Quality of nearby schools
- Neighbourhood safety
- Proximity to public transportation
- Investment value
- Cost of purchase
- Access to parks and recreation

Other than the criteria mentioned above, what other criteria are important to you?

In your most recent experience, what was your process to find which neighbourhood to live in?

Step 1:

Step 2:

Step 3:

Which tools did you use to help with your search? (eg. google search, specific websites, google maps, friends, etc)

What were some things that made the neighbourhood search easy?

What were some things that made the neighbourhood search challenging?



**Figure 9.** House search preferences of survey respondent