4600 Final Report

Suitability Analysis for Housing

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ABSTRACT

Our project is aimed at tackling the issue of housing affordability and suitability as well as convenience for students. A lot goes into finding the right space to live in, this includes the cost of housing, proximity to essential services and recreational facilities including the university and the safety of the neighborhood. This can sometimes take hours and hours of research. Our app will be programmed to make the best-informed decision on areas to look for housing based on the needs of the student. The targeted stakeholders for this project will be students, parents of students, and universities.

INTRODUCTION

Affordable housing is hard to come by, especially in Ontario. There are many factors that go into selecting a living space besides the place itself. Distance from school, amenities, easy transportation, must-have locations, are all necessities that vary from person to person. These components are stressful for students to consider coupled with the starting of school. Our goal is to make the search process easy and stress free as much as possible. Some students choose to live on-campus, close to their classes and libraries, while other students prefer to live away from campus, relying on public transit, walking, or using a vehicle to travel to and from school. Housing issues affect most students that choose to live off campus, these issues are usually related to affordability, adequacy, and suitability. Housing represents a large percentage of a student's living expenses, so affordability touches on the cost of living generally and the balance between income and expenditures.

DATASETS

Some of the data used in this project were available online and were collected manually whilst others were found by using layers of ArcGIS files. Our dataset comprises data we found on ArcGIS, resources from Google exported into Excel, datasets from previous projects, Open Data Toronto and Canada Housing and Mortgage Corporation. We decided to find data within Toronto with respect to York University and Ryerson University. We wanted to select universities that we were more familiar with as well as a university in a more urbanized area with abundant sources of factors. It would also have plenty of international students and a much higher rent price compared to any other area in Toronto. This will allow us to compare the necessities and amenities to the prices of houses and make it easier to correlate the results.

Housing and Distance
The average rent for the neighborhoods for 2014 was obtained from an ArcGIS web map created by RebeccaNickerson_brock. The 2019 and 2020 data were retrieved from Canada Housing and Mortgage Corporation (CHMC)'s Housing Market Information Portal. A blank Neighborhood polygon of Toronto was obtained from open data Toronto. The rent data for each neighborhood was sought for on the CMHC website and manually placed in an additional field of the neighborhood polygons' attribute table. Two fields were added to the attribute table, one for 2019 and the other for 2020.

Crime
We found this data through ArcGIS which includes assault, auto theft, break and enter, homicide, robbery, sexual violation, shooting, and theft over. We decided to exclude auto theft and theft over (theft involving over $5000) as they seemed to not pertain to a student as much as the other crimes. These crimes were committed since January 1, 2022, and presumably updated every day. We are unsure who created the data. We used this data to create a point density map to see where most of the crime occurrences were committed in comparison to the rest of the crimes.

Hospitals and shopping malls

The list of hospitals and shopping malls were derived from the following Wikipedia links. Addresses were found associated with the locations and were recorded onto Excel.

Grocery Stores, Universities, and Gyms

These datasets were provided from a prior GIS project. These datasets were created by searching for grocery stores or gyms in Google Maps and recording names that were spread across Toronto onto Excel. We decided to replace the plazas with shopping malls as malls are more appealing for students to frequently visit.

PROJECT DESIGN

The project utilizes various things that we have learnt in the ESSE 4600 course. The project follows the MCDM model, it uses the AHP method to determine the weightings of various layers to be used in the suitability map. The Delphi method was used to gain a final weighting matrix. Finally, a suitability analysis was conducted to test the sensitivity of the model.

The initial design involved using a rental websites API like Zolo to return housing prices within the optimal area. However, this proved quite difficult to obtain based on the lack of programming skills and the API'S not being readily available. The data used were collected from various sources and refined accordingly to finally produce the optimal area for housing for York University and Ryerson Students.

An attempt was made to create a walk score for the neighborhoods. The ideal walk score would be based on the number of bus stops in an area and the frequency of those buses. Unfortunately, we were unable to find accurate data depicting the frequency of buses for a particular bus stop. So, we only had the density of bus stops in an area to work with. A walk score was created anyways, with a rate of 1-9, based on the density of bus stops in an area.

An ArcGIS web app was created to showcase all the work we had done, however some of the layers generated on ArcGIS Pro could not be featured on the web app. The app shows the best and worst areas for students to live in, it also shows the density of the bus stops in each neighborhood. The app has an interactive legend, users can find their location on the map, it also has a routing system that was developed using Esri's routing API.

METHODOLOGY

We developed an Analytical Hierarchy Process (AHP) for our suitability analysis for student housing through the pairwise comparison method.
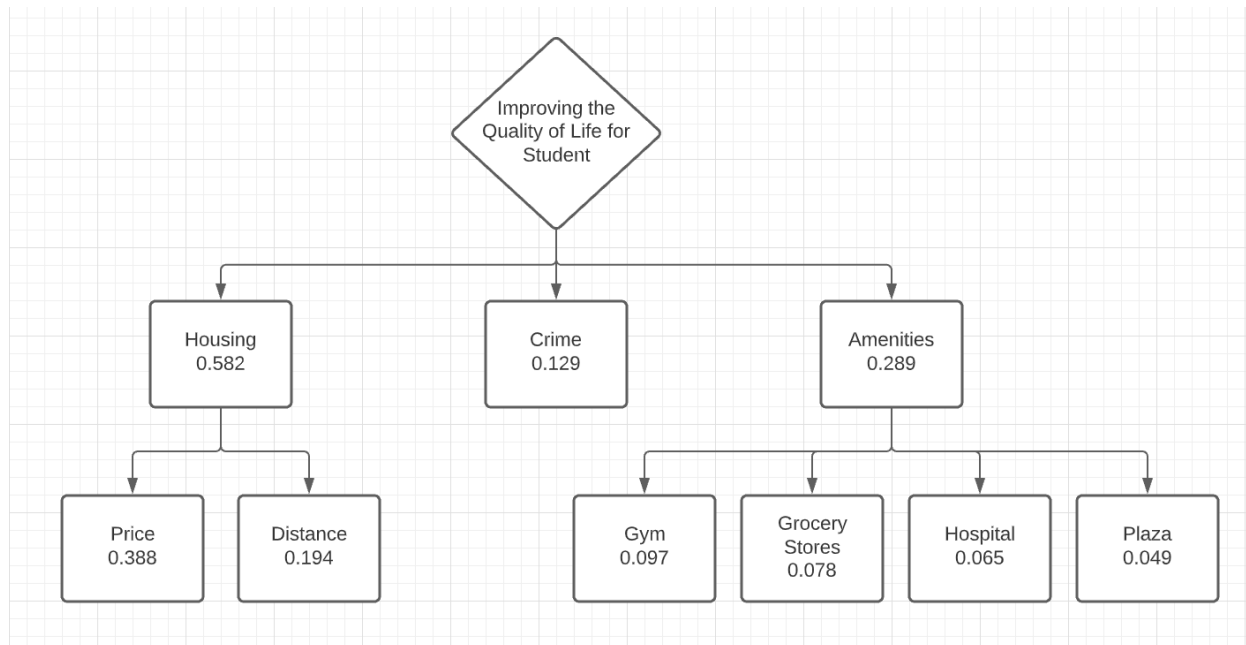
Improving the Quality of Life for Student

- Housing 0.582
  - Price 0.388
  - Distance 0.194
- Crime 0.129
- Amenities 0.289
  - Gym 0.097
  - Grocery Stores 0.078
  - Hospital 0.065
  - Plaza 0.049

Fig 1: Weighted Layers

Comparison	Price	Distance	Crime	Gym	Shopping Mall	Hospital	Grocery Store
Price	1	2	3	4	8	6	5
Distance	1/2	1	1 1/2	2	4	3	2 1/2
Crime	1/3	2/3	1	1 1/3	2 2/3	2	1 2/3
Gym	1/4	1/2	3/4	1	2	1 1/2	1 1/4
Shopping Mall	1/8	1/4	3/8	1/2	1	3/4	5/8
Hospital	1/6	1/3	1/2	2/3	1 1/3	1	5/6
Grocery Store	1/5	2/5	3/5	4/5	1 3/5	1 1/5	1

Convert to LCM		x120	Weighting (divide by sum)	Sensitivity Analysis	Notes		
Price	1	120	38.83%	29%	Price and Distance		
Distance	1/2	60	19.42%	29%	Share same weight		
Crime	1/3	40	12.94%	13%			
Gym	1/4	30	9.71%	8%	Gym and Grocery Store		
Shopping Mall	1/8	15	4.85%	5%	Switch Weights		
Hospital	1/6	20	6.47%	6%			
Grocery Store	1/5	24	7.77%	10%			
	Sum	309					

Fig 2: Pairwise Comparison and Weight Computation

We compared the importance of each of our 7 layers to one another.

Price of housing holds the most importance in weighting because it is the highest recurring expense in a student's life. A student's capital is considered limited as many students do not take up a part time job along with school.

The second most important criterion is distance of housing from university. Price and distance may be considered equally important in some cases since there are students who do not mind commuting a long distance if rent was cheaper and students who would pay higher rent prices for the luxury of living close to school. Although we defined rent to be of most importance, we did not know that after the pairwise comparison weighting that the gap between the first and second most important weighting would be this wide. Which is why we plan to perform a sensitivity analysis to the weights.

The next most important weighting is local crime. Crime is important to gage the safety of neighborhoods especially for international students.

The next set of criteria are all similarly weighted. We believe there could be controversy with gyms having a higher weighting than grocery stores. This is because we believe grocery stores are more abundant than gyms in total. Although the number of locations for both are not reflective of this, we plan on performing the sensitivity analysis to reflect a different importance in weighting. Also, physical health is very important and also impacts mental health which is crucial in learning [1].

Shopping malls and hospitals are the least weighted because we believe they are the least visited and last in the hierarchy on where a student spends their time and money. We can see students enjoying their time at shopping malls on their weekends, hospitals have a bit of a higher weighting due to the importance of health emergencies and having resources available for student health.
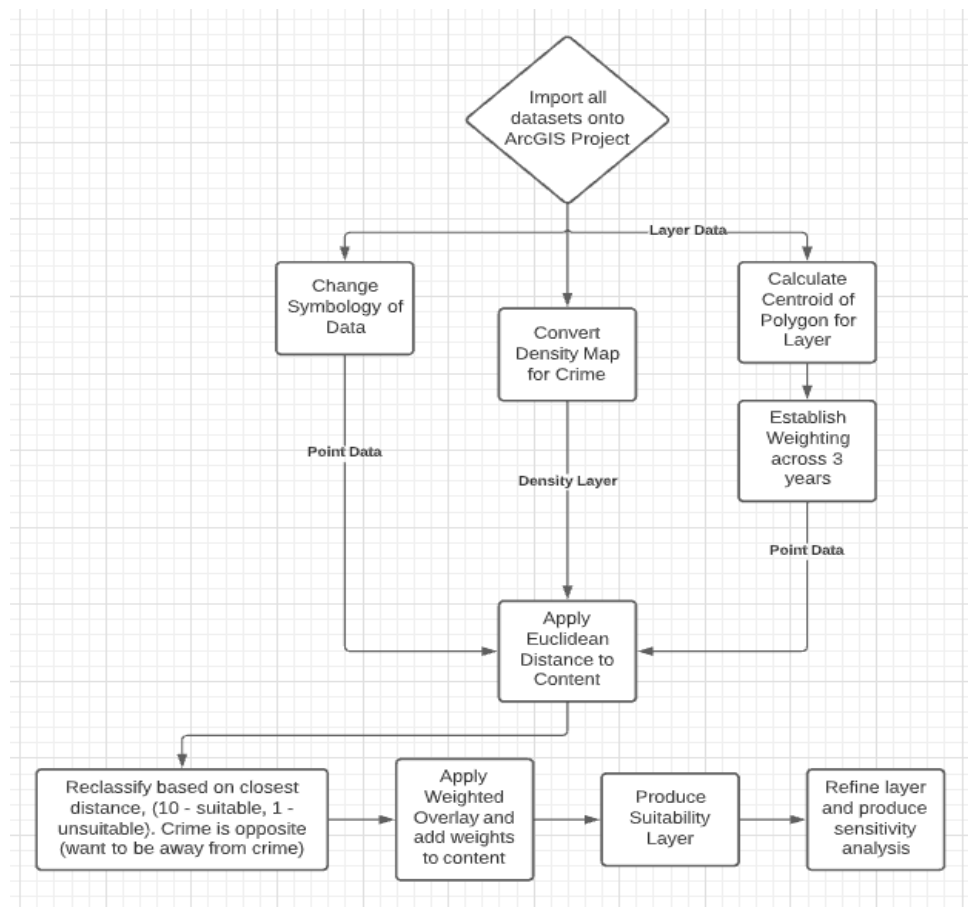

Fig 3: Project workflow for Suitability map

The rent data had to be refined before being placed in figure 3 above, to do that, the workflow in figure 4 below was applied.
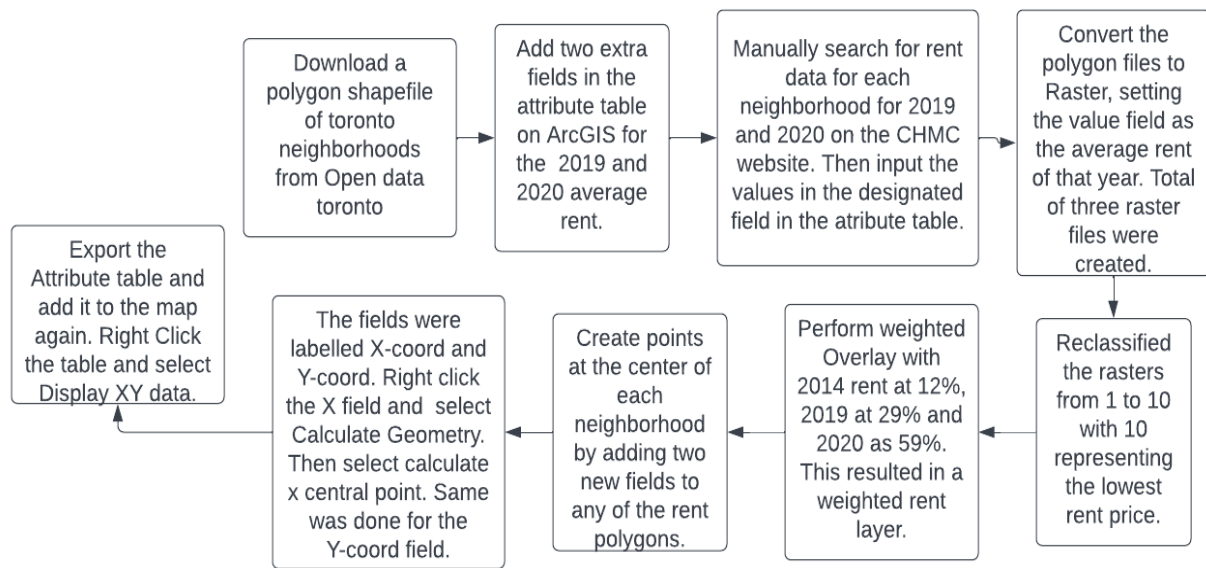
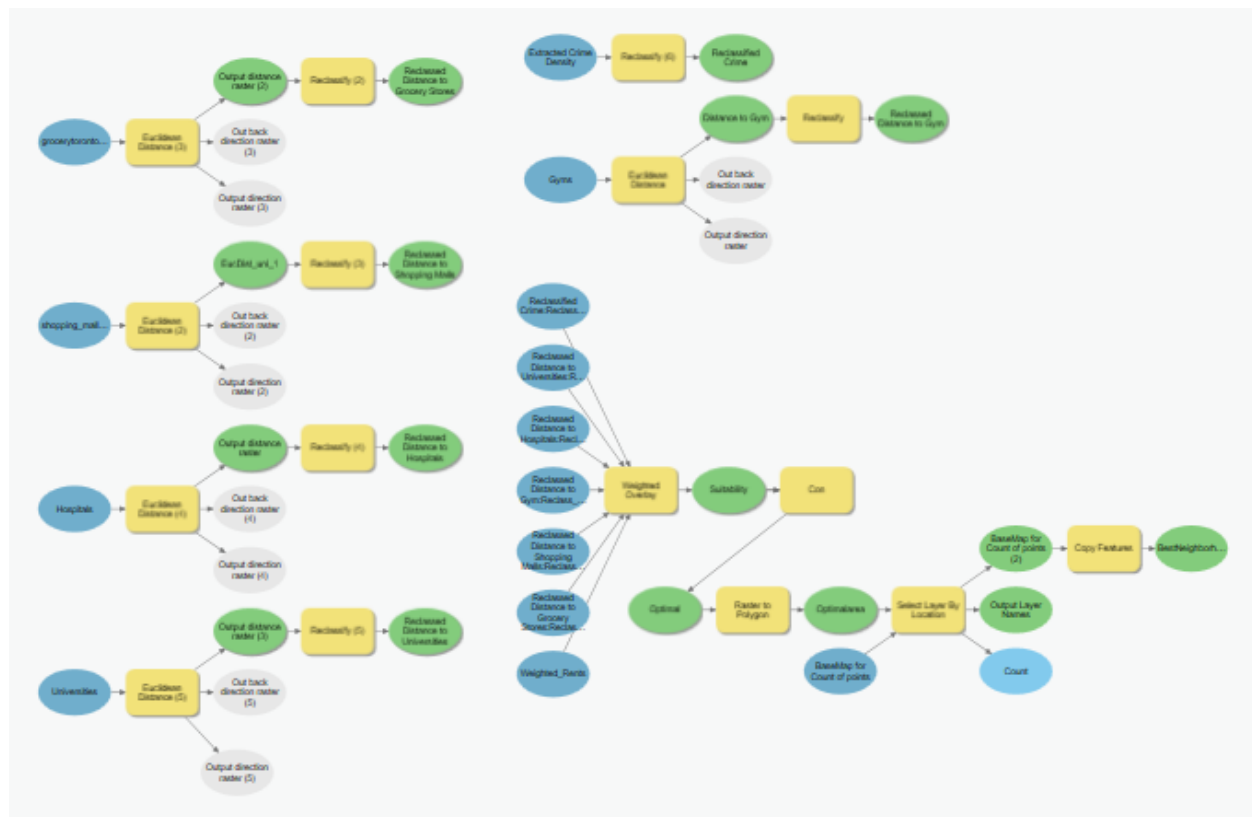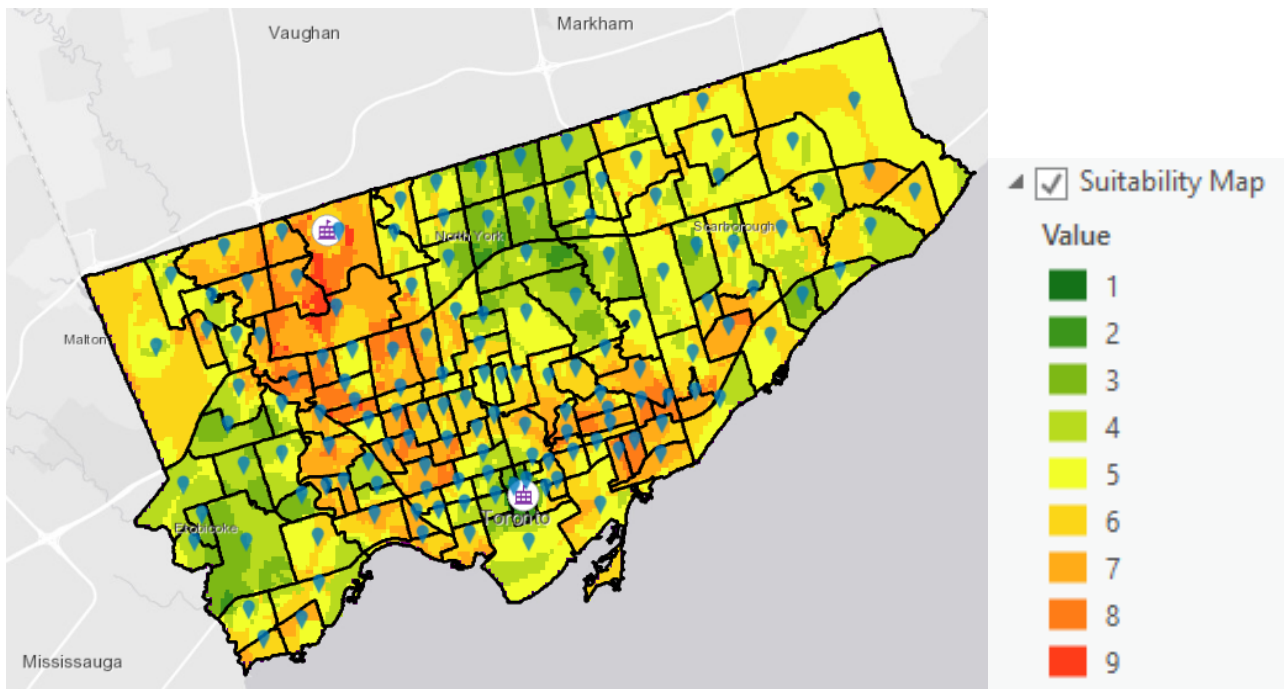Fig 4: Workflow to refine acquired rent Data

RESULTS

Fig 5: ArcGIS Model used for the Suitability Map and Optimal Areas

Weighted Overlay

Parameters Environments Prop

Weighted overlay table

Rasters (+) (v)	% (=)
Weighted_Rents:W	39
Reclass_EucD5	19
Reclass_Extr1	13
Reclass_EucD1	10
Reclass_EucD3	8
Reclass	6
Reclass_EucD4	5

Fig 6: Suitability Map and weightings

The weighted overlay tool does not take floating numbers, so the weightings had to be rounded up. 9 represents the most suitable area, 1 means least suitable. The blue pins are the centers of each neighborhood, and the purple school represents York University and Ryerson University. To avoid cluttering the suitability layer, we did not display the other data used in the weighting process.

A sensitivity analysis was conducted by assigning equal weighting of 29% to rent prices and distance to university as well as switching the weighting of grocery stores and gym. The figure below was obtained.
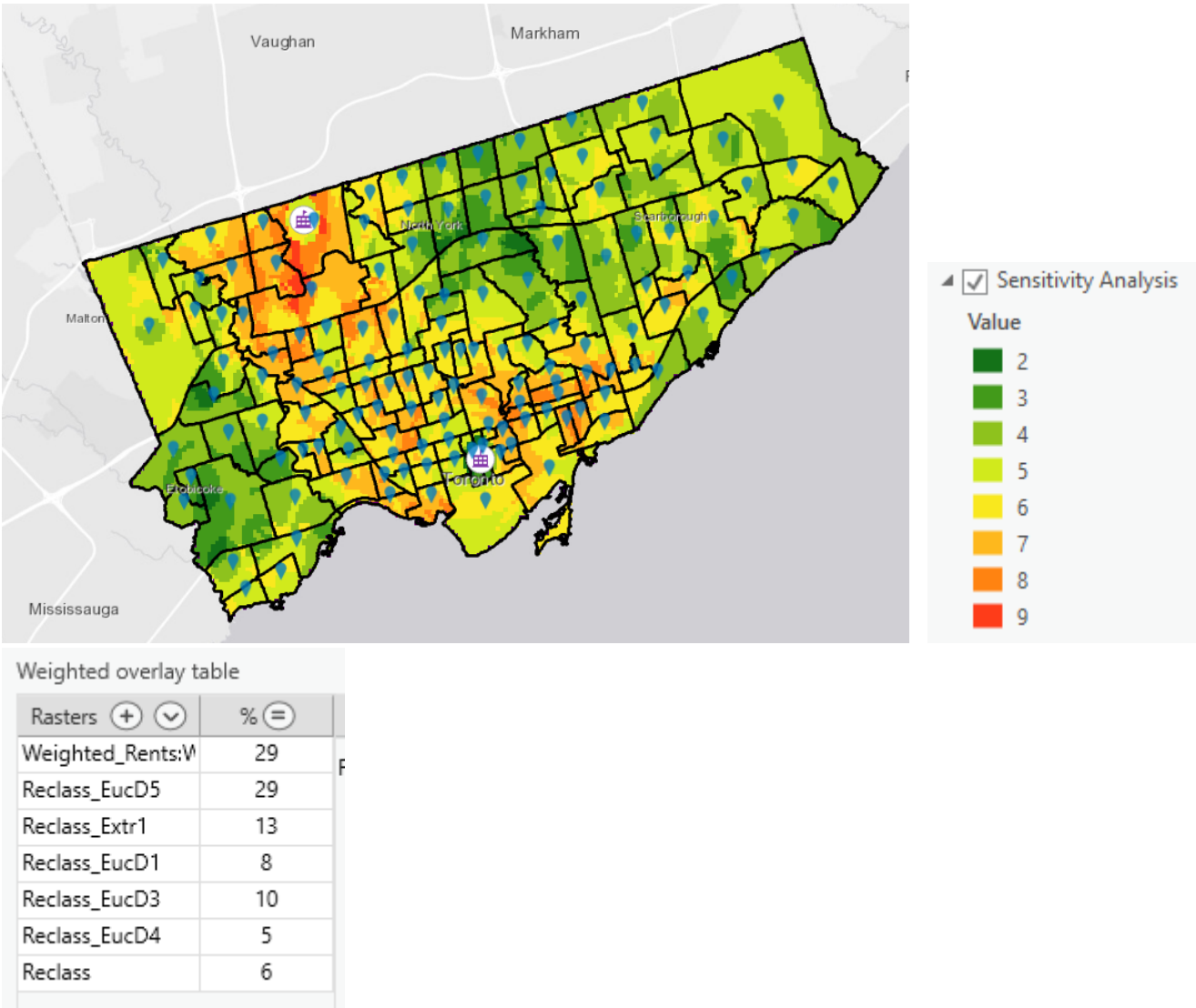

Weighted overlay table

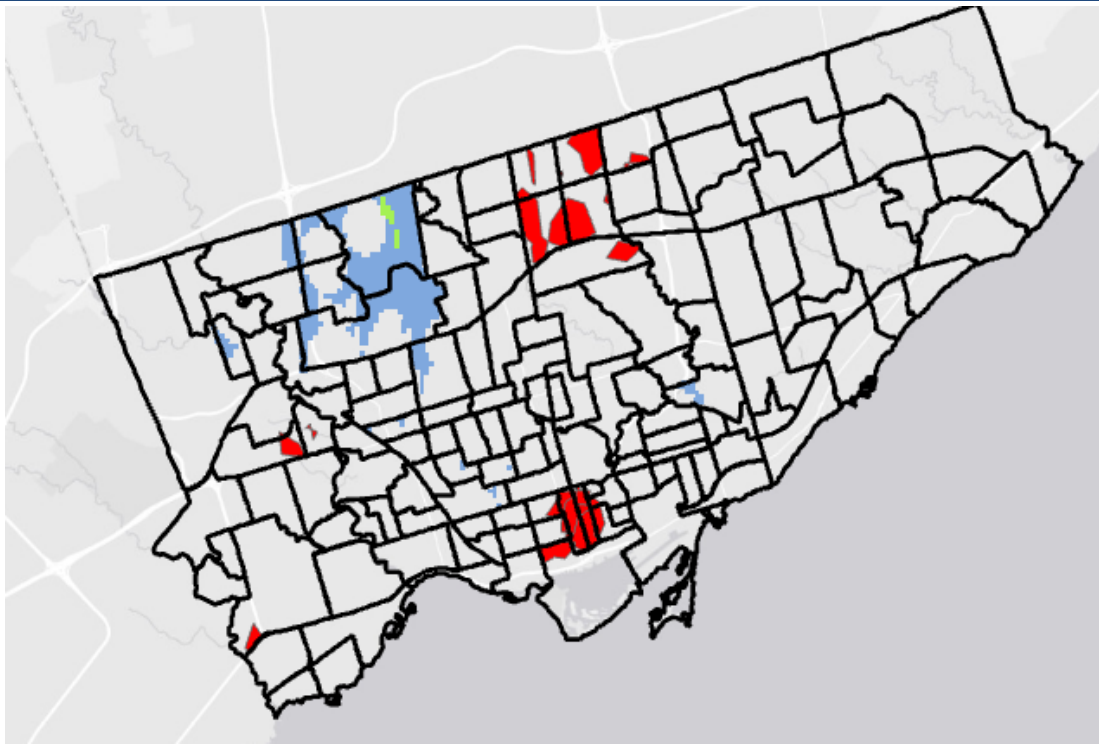| Rasters ⊕ ⌄	% ⊜
Weighted_Rents:W	29
Reclass_EucD5	29
Reclass_Extr1	13
Reclass_EucD1	8
Reclass_EucD3	10
Reclass_EucD4	5
Reclass	6

Fig 7: Sensitivity Analysis

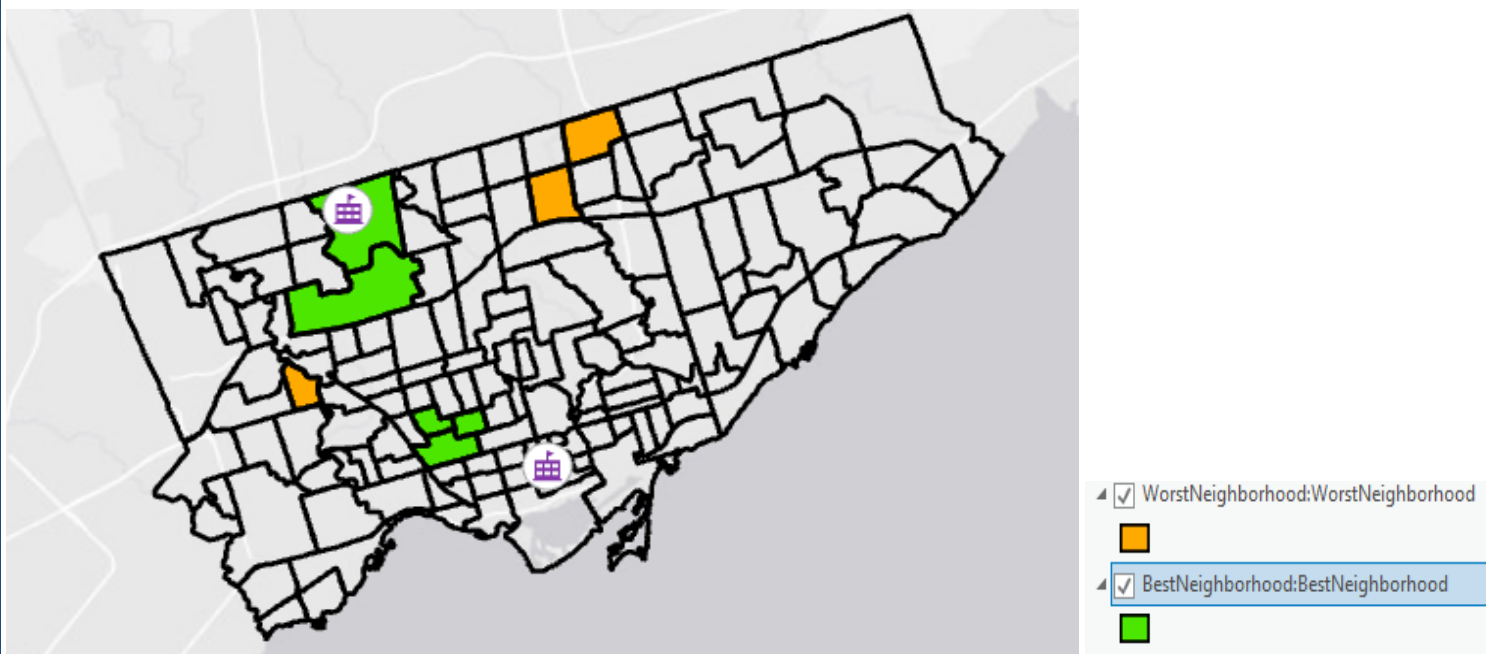Fig 8: Best areas(blue) and Worst areas (Red)

Fig 9: Best and Worst Neighborhood

The best neighborhoods are York University Heights, Downsview Roding, Corso Italia-Davenport, Wychwood and Dovercourt-Wallace Emerson-Junction. The worst neighborhoods were Humber Heights-Westmount, Bayview Village and Hillcrest Village.
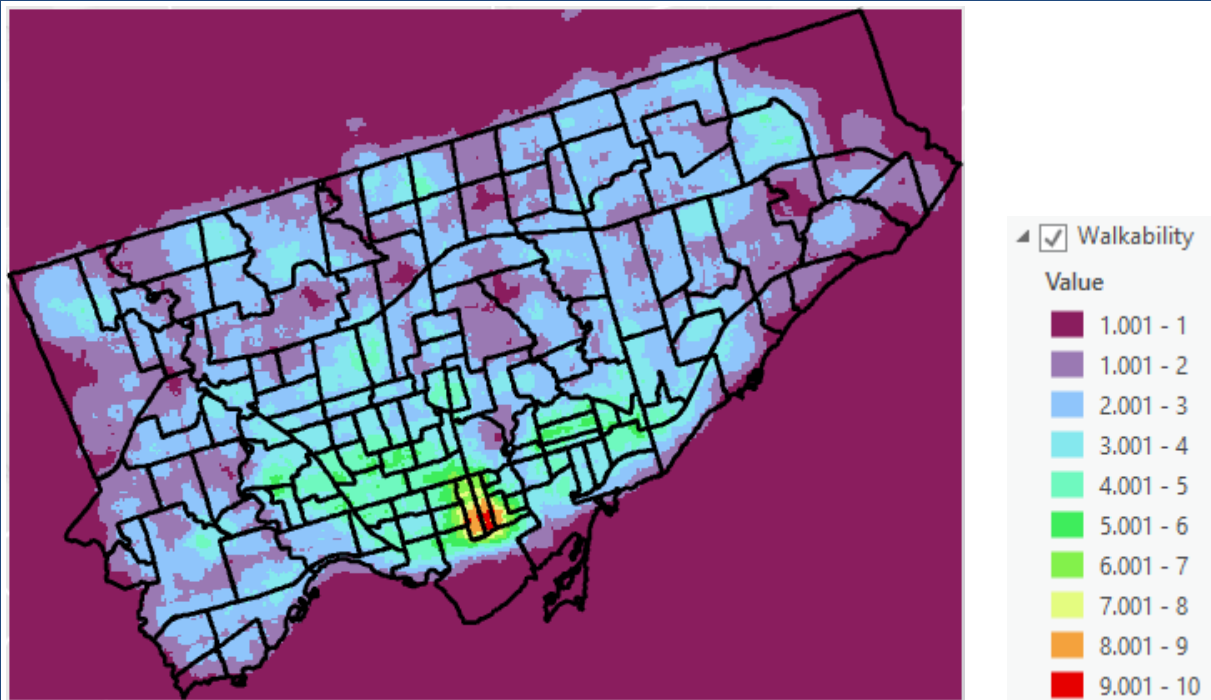
Fig 10: Walk score

The walk score was calculated based on the density of the bus stops, the areas with the highest density (red) was considered to have the highest walk score. The walk scores only considered Toronto neighborhoods and the density of the stops are relative to each other. The score was not considered when making the suitability map but it would clearly have an effect on the best areas chosen since the score in those areas is quite low.

LIMITATIONS AND PROJECT GOALS

We were able to collect every dataset needed for the criteria we specified but we decided to merge the crime layers into one whole layer, which changed our weighting for the project. The sources of our data could be inconsistent or not reliable as some layers were taken from ArcGIS Online while others were taken from reliable sources such as Toronto Police and CHMC. For the rent data, we chose to average the rents in the neighborhoods in Toronto as we didn't have enough time to collect individual sets of rent data for blocks of houses. We initially decided to create an API to update the rent prices from a housing site online but didn't follow through due to time constraints and programming constraints. The timeline provided in the progress report was also followed and we were able to achieve our goals on time. The alternatives we could have done to improve the project was to become familiar with how API's work to allow us create a rent layer with constantly changing data, which was the initial goal. Another factor we would like to include in our project going forward would be to program our app so that users could decide on what layers they want to include in the weighting process.

Lessons Learned

During the process of this project a lot has been learnt. We have been able to successfully apply MCDM, AHP, Delphi method and sensitivity analysis.

10

CONCLUSION

The project was completed successfully, there are a lot of areas that we can build on like the walk score and designing a better web application. It was also noted that areas that had a high density of bus stops also had a higher density of crime. This might be something to look at in the future. Finding the relationship between crime and transportation availability.

TIMELINE

Feb 17th week
Look over datasets we need to prepare for integration
Considering the accuracy of the data sources
The datasets will be divided into three and each person will be responsible for finding the data and researching on the source of the data. Nadine- Rent and bus stops, Ryan-Hospitals and Plazas, Lithira-Gyms and Crime

Feb 25th week (reading week)
Defining our weighting for the parameters in our suitability analysis (which we will discuss in lab and work as a team)

March 4th-11th week
Learn how to integrate data from online sources (using python and how to integrate python to our ArcGIS platform)- *No success*

March 18th week
Determining how accurate our app is and sensitivity analysis
Work on display of analysis- Used ArcGIS Web App

March 25th week
Prepare for final paper
Prepare for final presentation

April 1st-8th week
Finalize paper and presentation

RESOURCES
DATA
[1] https://www.news.iastate.edu/news/2022/03/30/exercise-depression
  Housing/Neighborhoods and Distance
[2] Toronto Average Rent Price per Neighbourhood 2014 (arcgis.com)
[3] https://www03.cmhc-schl.gc.ca/hmip-pimh/en#TableMapChart/3520005/4/Toronto (C) (Ontario)
[4] Open Data Catalogue - City of Toronto Open Data Portal

Crime

[5] https://services.arcgis.com/S9th0jAJ7bqgIRjw/arcgis/rest/services/YTD_Crime/FeatureServer

Hospitals and Shopping Malls

[6] https://en.wikipedia.org/wiki/List_of_hospitals_in_Toronto

[7] https://en.wikipedia.org/wiki/List_of_shopping_malls_in_Toronto

Bus stops, TTC lines and routes

[8] TTC Routes and Stops (arcgis.com)

Walk Score

[9] Toronto Public Health. The Walkable City: Neighbourhood Design and Preferences, Travel Choices and Health. April 2012

The Walkable City: Neighbourhood Design and Preferences, Travel Choices, and Health (toronto.ca)

RESEARCH

[1] Lee, H. (2021, September 22). Students struggle to find housing as Toronto rent returns to pre-pandemic rates. The Eyeopener. Retrieved February 10, 2022, from https://theeyeopener.com/2021/09/students-struggle-to-find-housing-as-toronto-rent-returns-to-pre-pandemic-rates/

[2] K. B. (2019, December 13). The role student housing plays in Communities. Shelterforce. Retrieved February 10, 2022, from https://shelterforce.org/2019/09/06/the-role-student-housing-plays-in-communities/

[3] Dubinski, K. (2021, September 14). Violence, fears about sexual assault mark grim start to Western University school year. CBCnews. Retrieved February 10, 2022, from https://www.cbc.ca/news/canada/london/western-sex-assault-fears-1.6174894

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[5] Jaschik, S. (2013, January 29). The Customer Is Always Right? Retrieved February 10, 2022, from https://www.insidehighered.com/news/2013/01/29/many-students-opt-colleges-spend-more-nonacademic-functions-study-finds

[6] Major, R. (2019, April 5). *Student accommodation*. Canadim. Retrieved February 11, 2022, from https://www.canadim.com/study/live-as-a-student-in-canada/student-accommodation/

[7] Calder, M. J., Richter, M. S., Mao, Y., Kovacs Burns, K., Mogale, R. S., & Danko, M. (2016). International Students Attending Canadian Universities: Their Experiences with Housing, Finances, and Other Issues. Canadian Journal of Higher Education, 46(2), 92–110. https://doi.org/10.47678/cjhe.v46i2.184585