Anran Zheng
CPLN 680
Project proposal 1

Spatial accessibility to the COVID-19 testing sites and the driven factors behind in NYC

Introduction

With the emerging variants, the COVID-19 is spreading all over the world, posing health and economic threats to numerous regions. The outbreak of COVID-19 has reflected some challenges that many cities are facing with, such as the unequal distribution of medical resources and the insufficient supply of COVID testing packages and vaccination. Currently few studies explored the spatial accessibility to COVID testing sites. Such research mainly focused on Florida state (Ghorbanzadeh et al., 2021). However, investigating a smaller, more precise level region will be more meaningful because in reality, people tend to travel within a sub-region to access the COVID-19 medical resources timely. In addition, many research analyzed the relationship between confirmed cases and its influencing factors (Cordes & Castro, 2020), and very few explored the driven factors of spatial accessibility to medical resources, especially from a geographic perspective.

Based on these challenges, this study will explore the spatial distribution of COVID testing sites, analyze the testing sites accessibilities and its influencing factors in NYC. It will answer the following questions: Based on the transit network, do New Yorkers have equal access to the COVID testing sites? If not, what's the possible reasons and how to solve in the future? The findings can provide a framework for urban decision makers to plan the spatial distribution of medical infrastructures and allocate the medical resource rationally.

Data

Instead of collecting data of ZCTA level at first, I gather the data of census tract level since this is much more precise. Here is the data source:

Data	Source
COVID testing sites	URISA's GISCorps (https://covid-19-giscorps.hub.arcgis.com/apps/locate-a-covid-19-testing-provider/explore)
Road network	Open Street Map (https://download.bbbike.org/osm/bbbike/NewYork/)
Subway/bus stations	OpenMobilityData (https://transitfeeds.com/p/mta)
NYC Demographic Data (ZCTA level) e.g. median income, age, race …	US Census (https://www.census.gov/)

Table 1. Possible data sources for capstone project

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Methods

1. the spatial distribution of COVID-19 testing sites

With spatial autocorrelation and kernel density estimation methods, the spatial clustering pattern of COVID-19 testing sites will be identified at the very beginning.

2. the spatial accessibility of COVID-19 testing sites based on the transit network

I hope to explore the testing sites spatial accessibilities over different census tracts in NYC by four different transit modes, including walking, buses, subways or cars. By integrating and analyzing the road network, population weighted centroids and COVID-19 testing sites, the GIS-based network can build a O-D travel time matrix, which evaluate the travel time from people to testing sites.

Considering that for convenience, people will walk or drive to only a few testing sites within a relatively short distance, this study will only measure the most facilities in a given distance from each census tract centroid. Typically, a more accessible census tract means that a greater volume of population, companied with more counts of closest facilities within a given range and less total time to arrive at the destinations. So the calculation of census tract i's accessibility can be measured as the following equation:

$$A_i=P_i*\sum_{n}^{0} 1/Ti$$

Where A_i is the accessibility of census tract i, P_i is the population number of census tract i, n is number of testing sites that people can access within a given region and T_i is the time people spend getting to each testing site. For cars, I may assign different speeds based on the different road types.

The calculation of transit and non-transit accessibilities differs. To define the O-D matrix, the origin will be centroid points of tracts for non-transit, while transit stops for transit system. For transit accessibility measurement, the equation will be:

$$A_i= P_i*\sum_{m}^{0} \sum_{n}^{0} 1/Tmn$$

Where m will be the number of subway or bus stops contained in each census tract, n will be the maximum number of testing sites that transit can achieve, and T_{mn} is the time traveled from stop m to the testing sites n.

To see how transportation helps improve the accessibility to testing sites, I will compare the different O-D travel time matrix for transit and non-transit. In addition, considering that cars and buses have different average speeds during peak or smooth period, I hope to explore the difference of accessibility during different time period.

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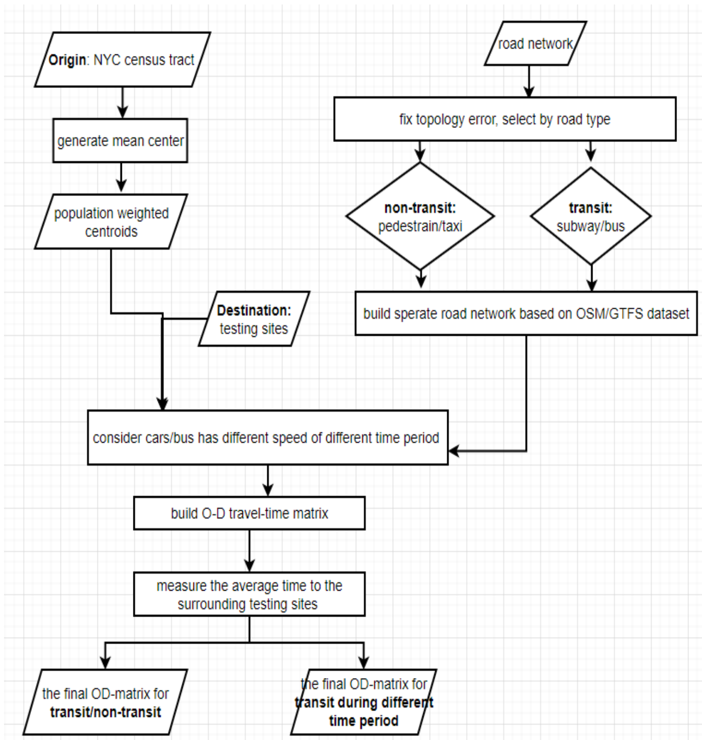

Workflow of spatial accessibility measurement

3. the influencing factors of spatial accessibility to COVID-19 testing sites

Based on some internal factors (the density of testing sites, population and road network) and some external factors (median income, age, race, etc) in every census tract in NYC, this study will apply Geodetector method to analyze the influencing factors of spatial accessibilities of testing sites.

Expected Results

My final deliverable will be a research paper with GIS analysis about a substantive question. As a PhD applicant, I would like to publish this finally as a manuscript.

References

[1] Ghorbanzadeh, M., Kim, K., Erman Ozguven, E., & Horner, M. W. (2021). Spatial accessibility assessment of COVID-19 patients to healthcare facilities: A case study of Florida. Travel Behaviour and Society, 24, 95-101. http://doi.org/10.1016/j.tbs.2021.03.004

[2] Cordes, J., & Castro, M. C. (2020). Spatial analysis of COVID-19 clusters and contextual factors in New York City. Spatial and Spatio-temporal Epidemiology, 34, 100355. http://doi.org/10.1016/j.sste.2020.100355

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