Dummy Title

By Dummies

27 JUN 2020

Abstract

On April 24th, 2020, a researcher at MIT released a working paper finding that "The Subways Seeded the Massive Coronavirus Epidemic in New York City". While the analysis in the paper has been called into question, it remains true that the role of public transportation in the spread of COVID-19 is still unknown. In this paper, we introduce an agent-based model of the New York City subway and analyze how well it can predict the spread of COVID-19 through the boroughs of New York City.

Our findings that [insert findings here] should interest public health officials looking to make policy decisions about public transportation.

[Writer's Note: Of course, this is the ideal final result. We will focus on the early infection period and I give it a 50/50 that we even get to taking into account countermeasures and ridership losses. We will make a preliminary model, improve it, and see how far we can get.]

Competencies Briefing

Purpose: Brief others on competencies so we can discuss things
Transportation Networks
specifically subways, the NYC subway. mapping, passenger flow
python, networkx, mesa
we're working with these techs.
Writer's Note: Obviously to be removed before submission
This report was last pushed to OverLeaf on 30.05.2020. You will find our latest work at the link below: https://github.com/cheung-ho-lum/NS_Epidemics_ABM_Approach/blob/master/Report/ABM_NYC_Subway.pdf

Background

Epidemics and COVID-19

Coronavirus disease 2019 (COVID-19) is a disease caused by the SARS-CoV-2 coronavirus. Since being identified in December 2019, it has been labelled by the WHO as a pandemic, and spread around the world. Epidemics such as the 'coronavirus' have been a subject of research for centuries, and is of special interest to those working in public health. Recent waves of new research came in 2002 (SARS), 2009 (H1N1), and 2014 (Ebola). However, in these prior epidemics, researchers did not have access to as much data as we have currently. In recent years, the state of data science research tools have also greatly improved, allowing researchers to answer questions in novel ways, but following the scientific method. In this paper, we will try to respect the expertise of public health

researchers, medical professionals, and the general public by being conservative when making conclusions.

The Seeding of COVID-19 in NYC

Writer's note... ok. calling it seeding is overly negative about the original article
In addition to general background knowledge about COVID-19, it would behoove the reader to know about the early spread of the disease in New York. Analysis of viral RNA in patients at the Mount Sinai Health System[**citation**] has lead researchers to conclude that the virus first came into the community through "multiple, independent but isolated introductions" from Europe and elsewhere in the USA. Below we have also given an approximate timeline of some of the most relevant events as of June 1st, 2020. We would also like to note that as forensic researchers begin examining the data, some significant new dates or corrections may arise:
Writer's Note: not working so hard on this because we might not need it.
Feb 25 - Some guy came back from Iran
Mar 3 - First P2P spread
Mar 9 - 16 confirmed cases
Mar 9 (Approx.) - Metro ridership starts decreasing
Mar 16 - schools close. Measures already taken.
Writer's note: i.e. I'm uninterested, but depending on what research route we take (i.e. quarantine measures), this all may be relevant.
Mar 18? - PAUSE government order to shelter in place

Epidemic Modeling

Blah blah blah. I would like to briefly acknowledge the superiority of statistical modeling for the purpose of forecasting.

SEIR Model

[Some explanation of SEIR goes here]
Writer's note: I think SEIR is not great for covid. But it's somewhat useful for modeling interventions. Also the fact that poop has already hit the fan when you detect patient zero

Newer Compartmental Models

Writer's note: We're looking into more advanced models (see bibliography). The key additions are 'super-spreaders' and 'asymptomatic'. At the end of the day, we just need pure mathematically modeling to provide some parameters for how agents should behave.

Epidemics on Networks

Agent Based Models

It's just a tool. like any model. Simulating agents in an environment. Key parameters are agent, model, and environment parameters. For example, we have the following list

thus far:

```
(Agent)STATUS_SUSCEPTIBLE = 'Susceptible'
(Agent)STATUS_EXPOSED = 'Exposed'
(Agent)STATUS_INFECTED = 'Infected'
(Agent)STATUS_INFECTED_ASYMPTOMATIC = 'Asymptomatic'
(Agent)STATUS_RECOVERED = 'Recovered'
(Agent)TIME_TO_RECOVER = 10
(Agent)TIME_TO_INFECTION = 3
(Model)RUN_SPAN = 60
(Model)TOTAL_POPULATION = 50000
```

The environment is new york subway mapped as a network.
All of this is still being discussed.

Urban Transportation Networks and Epidemics

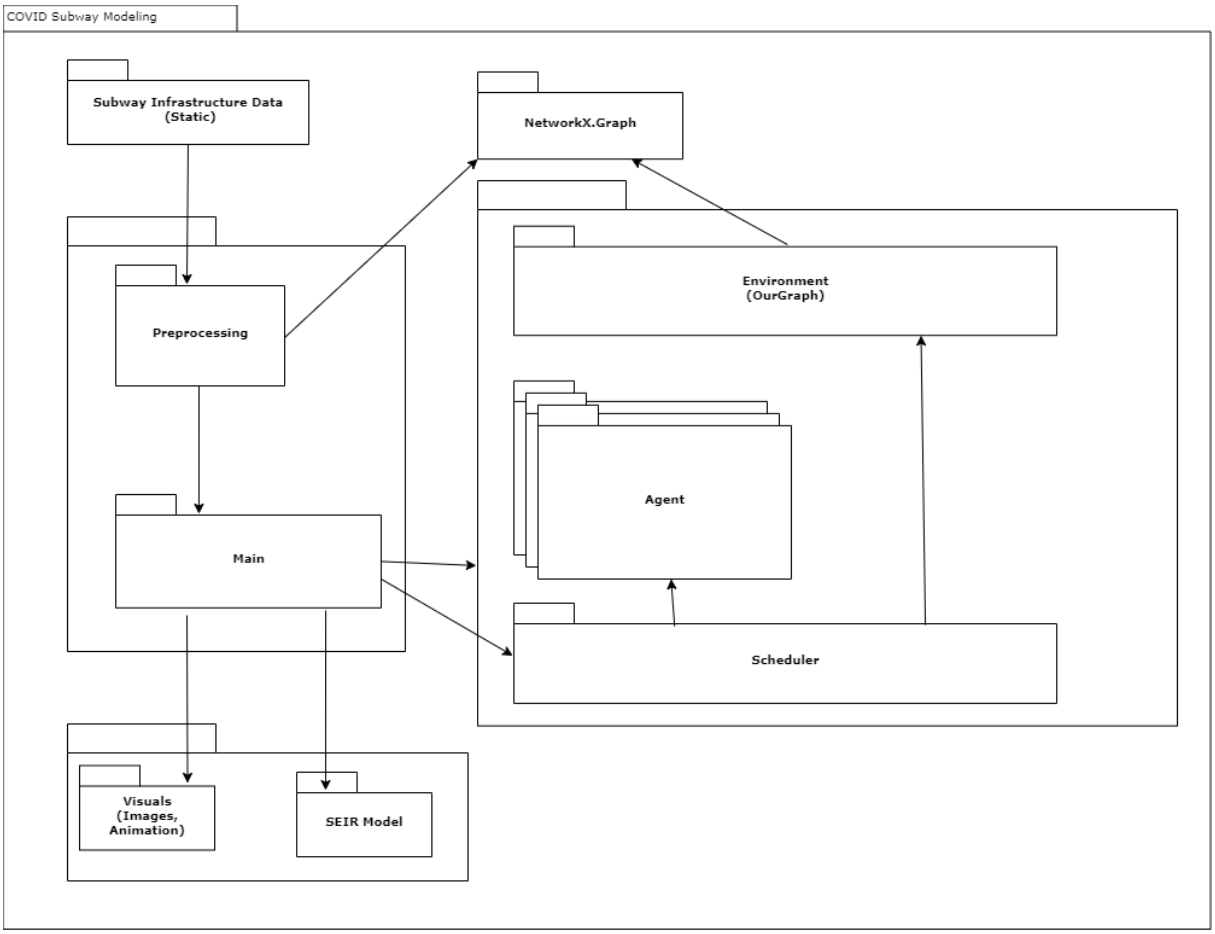
Subways and subway nomenclature

This guy is indispensable for figuring out how to parse some of this data:
https://en.wikipedia.org/wiki/New_York_City_Subway_nomenclature

Methodology

MESA(Or our ABM)

Writer's note: I'm a bit too lazy to learn tikz-uml. I'll just make a regular uml and... screenshot it



NetworkX

MTA Station Data

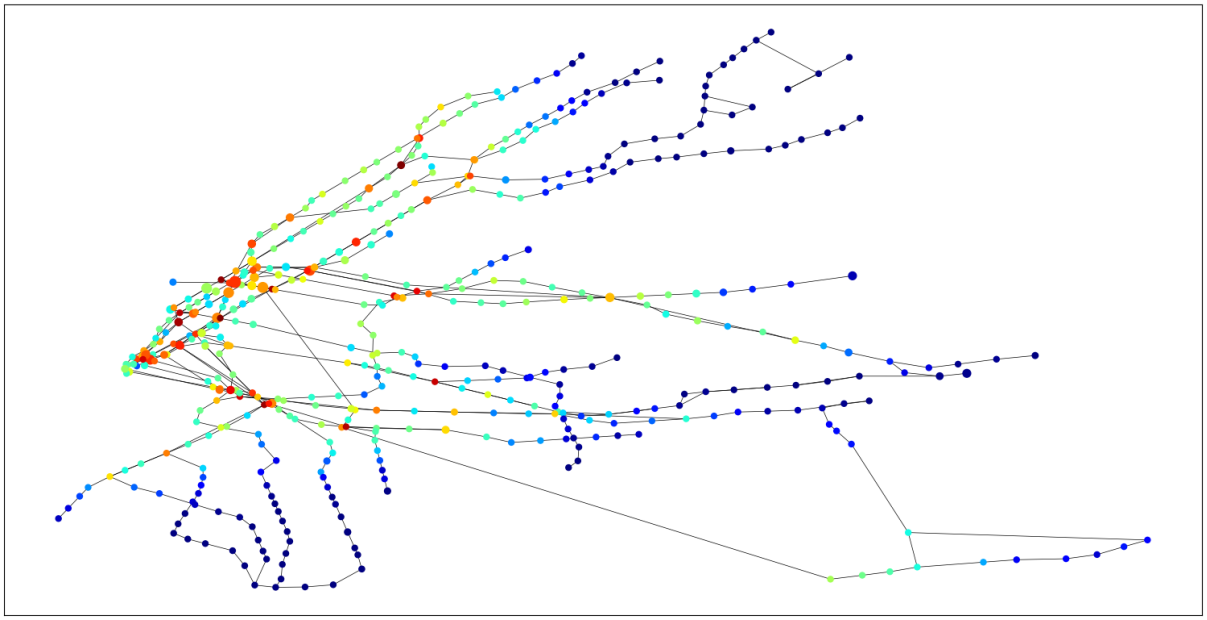
Station, Complex, Line, Route

station 167... doubled
making edges. GTFS Data... no we do it ourselves

MTA Turnstile Data

discuss format. every 4 hours, every machine. aggregation.

Results



Conclusion

Writer's Note: All Models are Wrong, Some are Useful

References

[1] Mta station data. http://web.mta.info/developers/data/nyct/subway/Stations.csv.

[2] Mta turnstile data. http://web.mta.info/developers/turnstile.html.

[3] Albert-László Barabási and Márton Pósfai. *Network science*. Cambridge University Press, 2017.

[4] Philip Cooley, Shawn Brown, James Cajka, Bernadette Chasteen, Laxminarayana Ganapathi, John Grefenstette, Craig R. Hollingsworth, Bruce Y. Lee, Burton Levine, William D. Wheaton, and et al. The role of subway travel in an influenza epidemic: A new york city simulation. *Journal of Urban Health*, 88(5):982–995, Sep 2011.

[5] Ana S Gonzalez-Reiche, Matthew M Hernandez, Mitchell Sullivan, Brianne Ciferri, Hala Alshammary, Ajay Obla, Shelcie Fabre, Giulio Kleiner, Jose Polanco, Zenab Khan, and et al. Introductions and early spread of sars-cov-2 in the new york city area. Nov 2020.

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[7] M. Laskowski, B. C. P. Demianyk, J. Witt, S. N. Mukhi, M. R. Friesen, and R. D. Mcleod. Agent-based modeling of the spread of influenza-like illness in an emergency department: A simulation study. *IEEE Transactions on Information Technology in Biomedicine*, 15(6):877–889, 2011.

[8] Faïçal Ndaïrou, Iván Area, Juan J Nieto, and Delfim F M Torres. Mathematical modeling of covid-19 transmission dynamics with a case study of wuhan, Apr 2020.