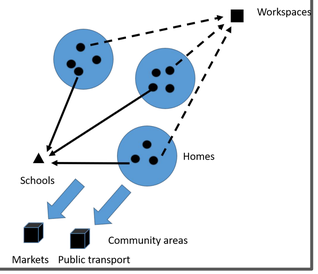
# Cohorting to Isolate Asymptomatic Spreaders: An Agent-Based Simulation Study on the Mumbai Suburban Railway

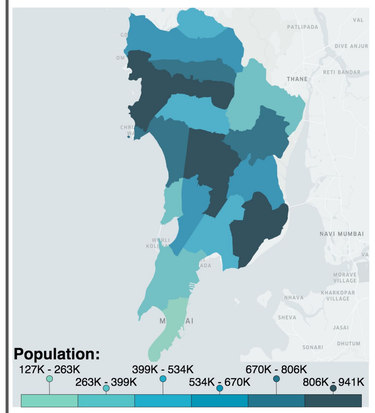
Alok Talekar, Sharad Shriram, Nidhin Vaidhiyan, Gaurav Aggarwal, Jiangzhuo Chen, Srini Venkatramanan, Lijing Wang, Aniruddha Adiga, Adam Sadilek, Ashish Tendulkar, Madhav Marathe, Rajesh Sundaresan and Milind Tambe

## Background

- Mumbai - epicenter of covid in India
  - High density of people, large commuter train network.
- Motivated by two hypotheses
  - Locally dense but globally weakly connected networks might help control the spread. This is the rationale for *social bubbles*.
  - It is easier to contact trace, test and isolate asymptomatic spreaders when travelers form cohorts.




## City-Scale ABM

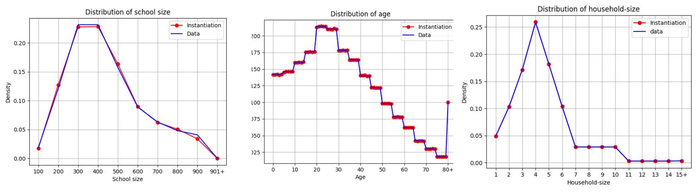



12.4 Million Agents

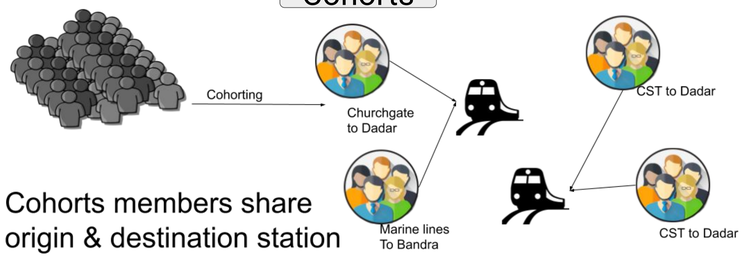
24 Wards + 24 slums (each region is modelled as high density area)

52 train stations, across 4 lines covering BMC

Instantiated city is consistent with census and train data



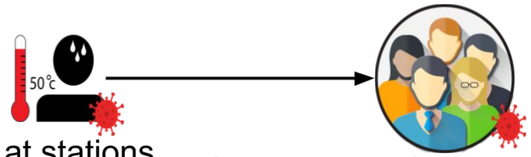

## Cohorts




Cohorts members share origin & destination station

Cohorts members travel together (stay in the same train coach)

COVID spreads in coaches based on overlap time between travelers.




Screening at stations

If a member is Symptomatic Quarantine Entire Cohorts

## Simulation Details

- We compute commute time via road and via all potential rail paths between home and work locations for every agent
- Agent's mode of travel is based on optimized commute time
- 3.7M agents commute by train

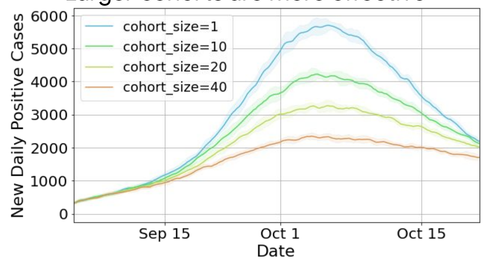
COVID-19 spread depends on

- Commute duration or overlap duration on a train coach
- Transmissibility in trains
- If anyone in the cohort is infected
- If anyone in the cohort is susceptible
- Individual's quarantine status

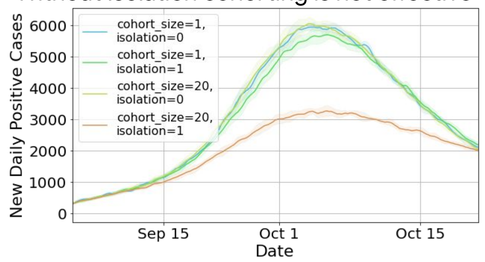
One off travelers travel in separate coaches, and so don't mix with cohorts on the train.

## Results

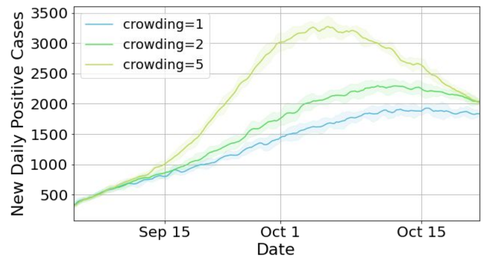
Larger cohorts are more effective



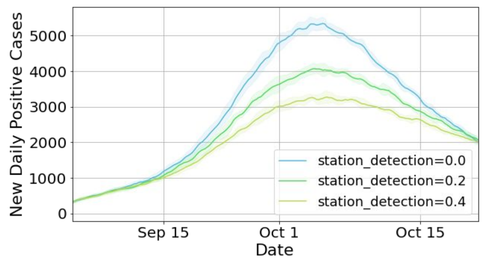

Without Isolation cohorting is not effective



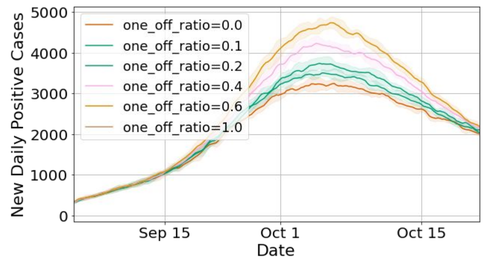

Covid spread is sensitive to Crowding



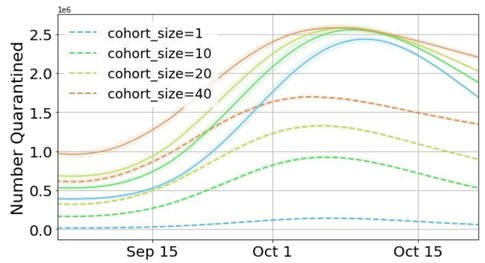

Detecting symptomatic cases is critical




Cohorting is Effective even with significant one-off travelers




Total Quarantined cases don't increase significantly with Cohorting




## Conclusions

- Traveling in cohorts enables an efficient and smart testing+isolate policy
- Cohorting can be effective incrementally
- Due to practical considerations, cohort sizes of 12-20 are appealing
- Our results are generally applicable to other cities and other modes of public transport like buses
- Cohorting plays an additive role to mitigation policies (eg. masks, social distancing) in a multilayered policy of reduction of spread of covid

## References

[1] Shubhada Agrawal et.al. 2020. City-Scale Agent-Based Simulators for the Study of Non-Pharmaceutical Interventions in the Context of the COVID-19 Epidemic.Journal of the Indian Institute of Science 100, 4 (2020), 809–847.
[2] Jeffrey E Harris. 2020. The subways seeded the massive coronavirus epidemic in new york city.NBER Working Paper w27021 (2020).
[3] World Health Organization. 2020. WHO Director-General's opening remarks at the media briefing on COVID-19. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---16-march-2020
[4] Hannah Ritchie. accessed on 17 August 2020. Google mobility trends: How has the pandemic changed the movement of people around the world.Our World in Data.Available online(accessed on 17 August 2020). https://ourworldindata.org/covid-mobility-trends
[5] Alok Talekar et al.2020. City-Scale simulator for Epidemic spread in Indian conditions. https://github.com/cni-iisc/epidemic-simulator/tree/mumbai_local
[6] Alok Talekar et al. 2020. What is cohorting? https://youtu.be/6H8hZBNcP8k
[7] Alok Talekar, Sharad Shriram, Nidhin Vaidhiyan, Gaurav Aggarwal, Jiangzhuo Chen, Srini Venkatramanan, Lijing Wang, Aniruddha Adiga, Adam Sadilek,Ashish Tendulkar, et al.2020. Cohorting to isolate asymptomatic spreaders: An agent-based simulation study on the Mumbai Suburban Railway.arXiv preprint arXiv:2012.12839(2020).

Google Research

भारतीय विज्ञान संस्थान

UNIVERSITY of VIRGINIA BIOCOMPLEXITY INSTITUTE