Emerging variant detection as a function of dispersal, timing, and budget constraints

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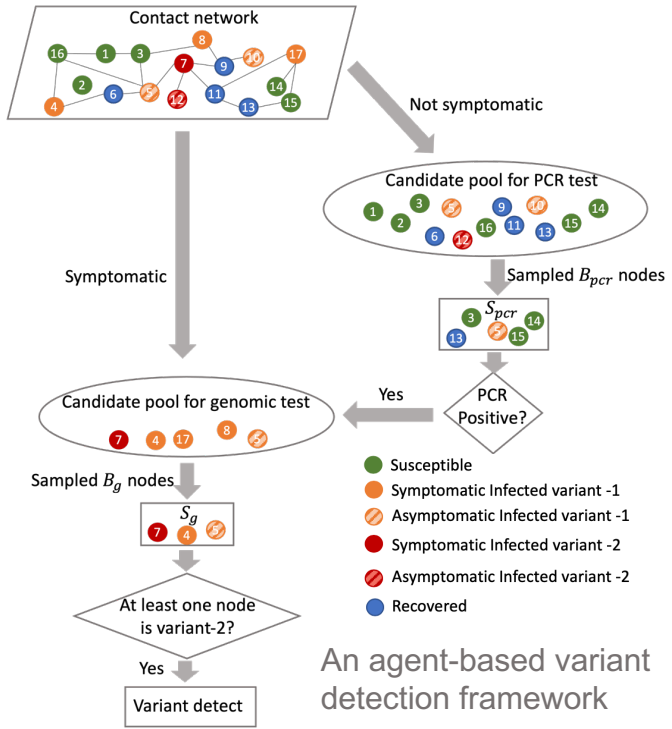
Motivation

- The SARS-CoV-2 virus is continuously evolving because of genetic mutations or viral recombination; as a result, the world has already experienced multiple waves of infection.
- It is essential to quickly detect an emerging Variant of Concern (VOC) to implement better response strategies.
- A data driven agent-based model has the potential to understand the challenges of the early detection of an emerging VOC

Methods

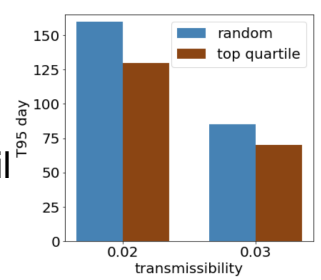
- To model the dynamics of SARS-CoV-2 variants, we use an agent-based two variants stochastic epidemic process on a social contact network, G= (V, E), here, V ≈ 8 million, and E ≈ 372 million.
- VariantDetect framework finds the detection time T_{95} for sampling strategies (S_{pcr}, S_g) and given budgets (B_{pcr}, B_g). T_{95} denotes the minimum time so that the probability of detection of variant 2 is at least 95%.

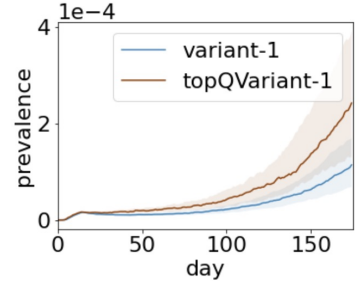


An agent-based variant detection framework

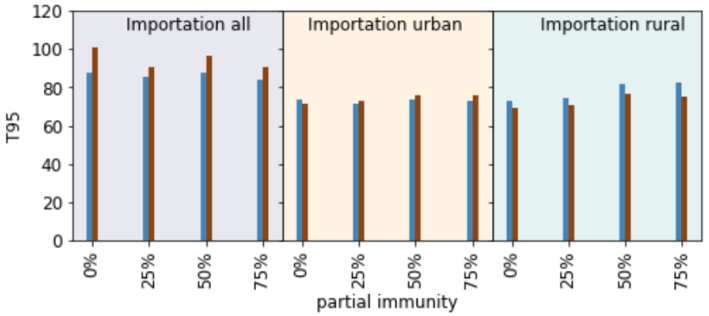
Results

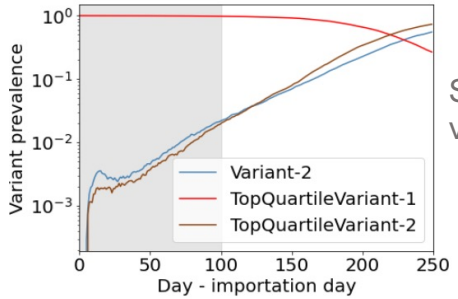
- Sampling strategies: random, and degree-based (static, top-quartile).
- Second variant detection is different than the first variant detection.
- Sensors in the top quartile degree region perform better for first variant detection but fail to detect the second variant earlier.





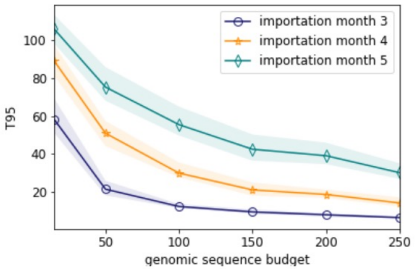
First variant





Second variant

- Detection time sharply decreases with the increase of budget until an elbow point.



Impact of B_g budget

Conclusions

- Early detection of an emerging VOC depends on the disease characteristics, possible importation scenarios, and budget constraints.