

How the turntables: Estimating spatiotemporal impact of non-pharmaceutical interventions against COVID-19 in a large-scale artificial city

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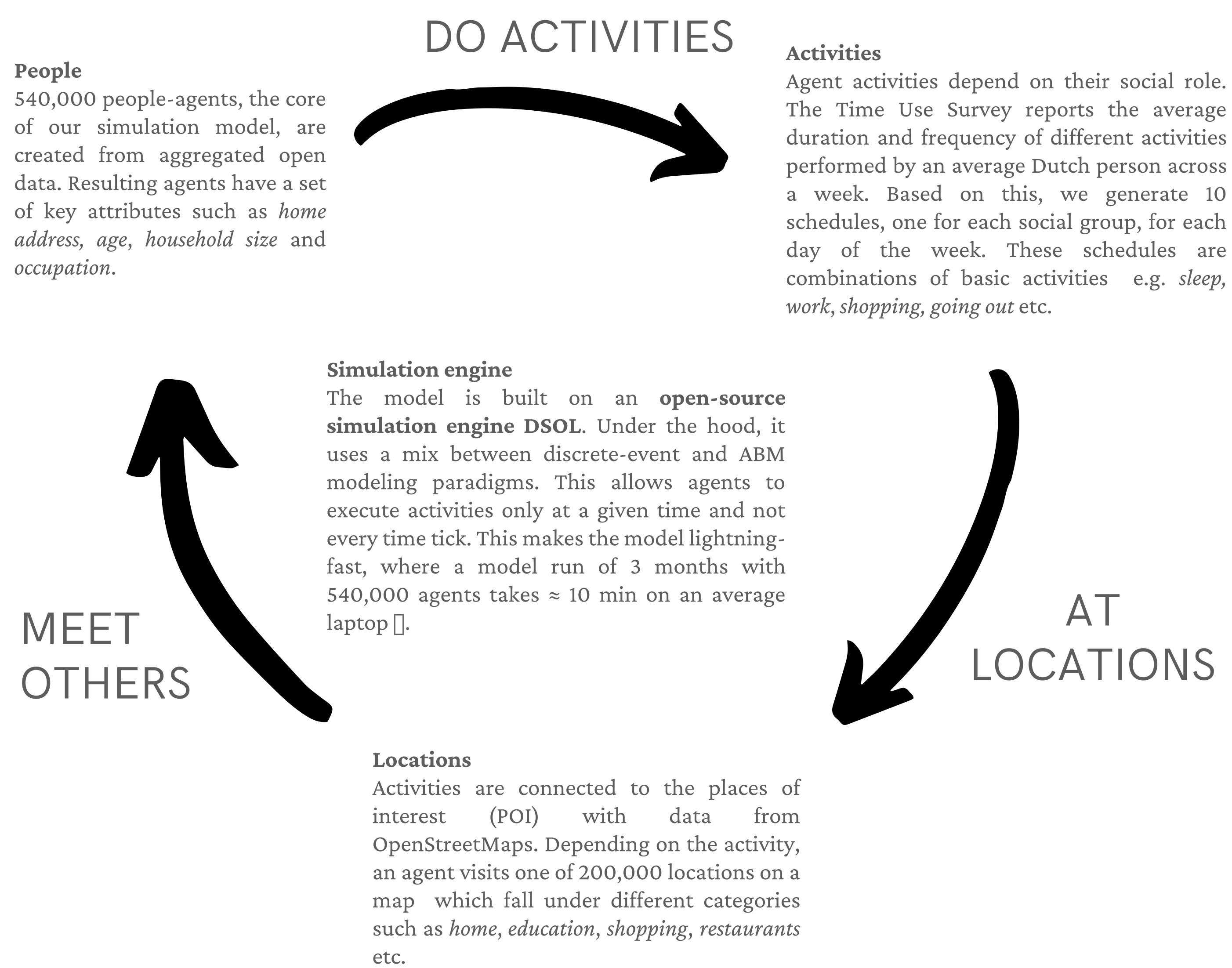


INTRODUCTION

The SARS-CoV-2 virus is an unprecedented global challenge. The uncertainty around the nature of the virus created a rapidly changing public health crisis which required Non-Pharmaceutical Interventions (NPI) to bring the spread under control. Importantly, populations in cities have been the hardest hit with 95 percent of infections occurring in urban areas. Scientific community, in its turn, has offered successful examples fitting machine learning models to predict epidemic curves, but one of the most challenging tasks remains to estimate the impact of NPI with a high spatiotemporal resolution on the urban scale.

METHODOLOGY

To estimate the impact of NPI we propose a large-scale agent-based model of a city, in this case of The Hague in The Netherlands. We simulate SEIR-like model and test two scenarios: no policy intervention, and a lockdown where only essential services are operating.



FINDINGS

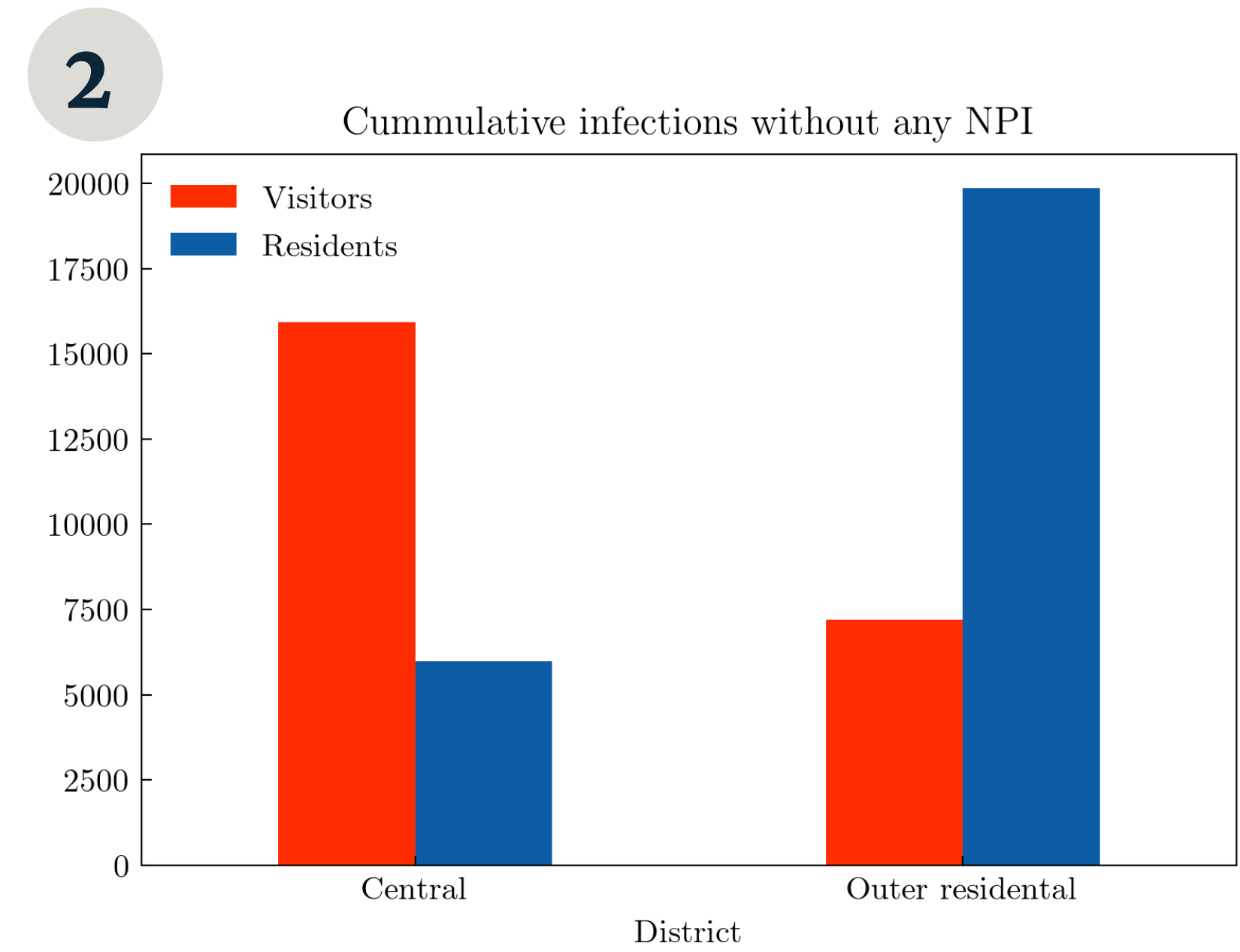
Central district is a hotspot without a policy

Without any policy, the central district can become a hotspot. The high concentration of POI and their visitors, amplified by the high population density makes it an area of a primary concern. Visitors contract the disease within the centre and spread the virus in the rest of the city.



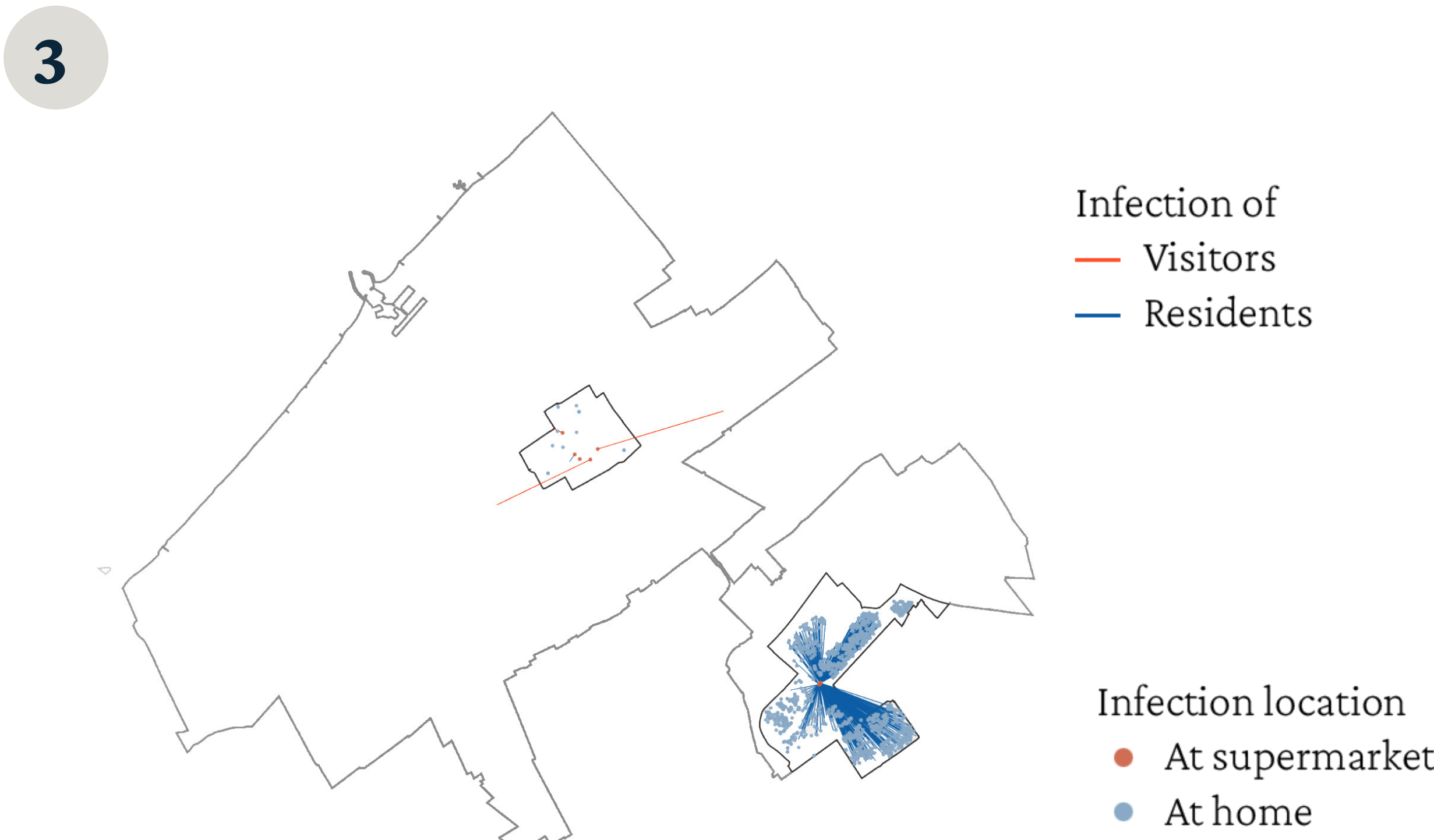
Infections in the outer residential district are fueled by its residents

The outer residential district has less visitors, but the limited number of POI available to its residents (only 3 supermarkets per almost 20,000 residents) can create crowding and super-spreading events.



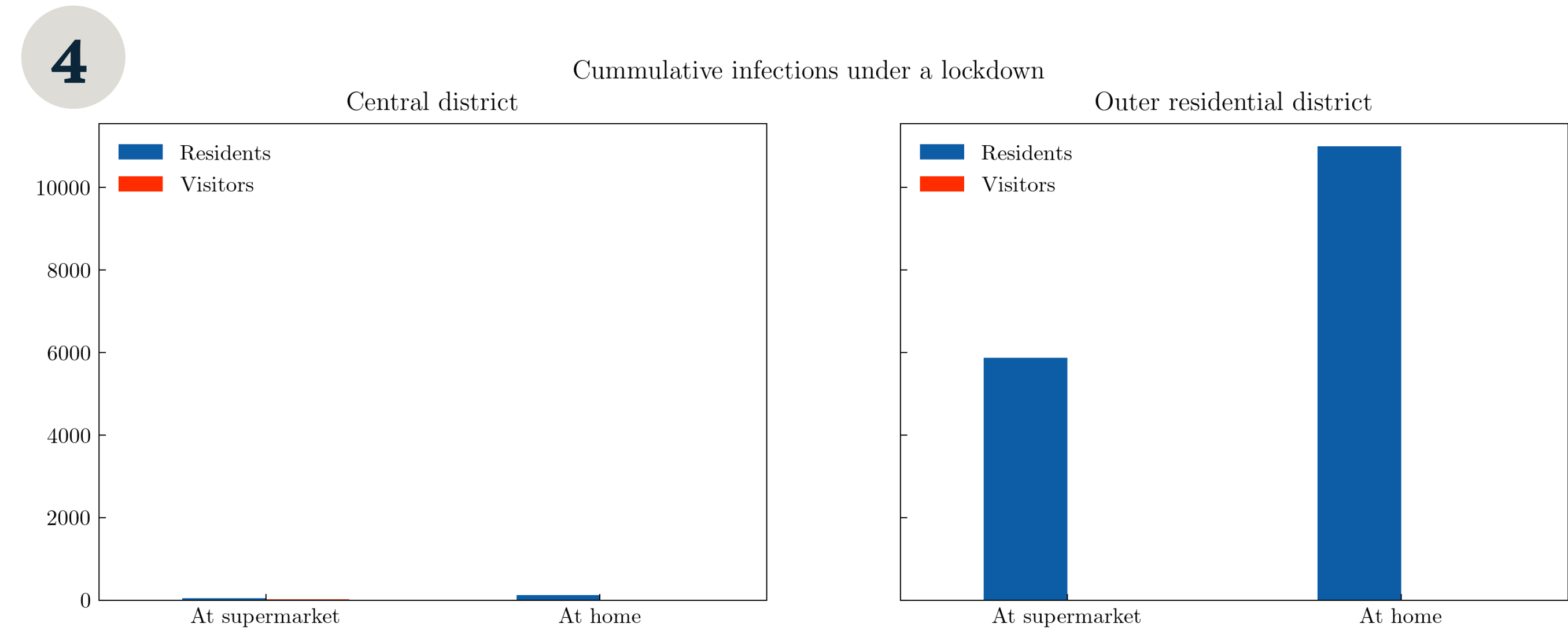
Outer residential district becomes the hotspot under the lockdown

Under the lockdown, **the tables turn** with the centre no longer being an area of concern. Since the number of POI in the centre planned to handle not only local but also "pass by" demand, its residents can spread their activities across a higher number essential services, while the outer residential becomes a hotspot with only a few.



Residents contract the virus in supermarkets and spread it further at home

The lockdown makes people to shift almost all of their activities to the place of their residence. Without an extra policy: *max visitors, home delivery*, the lack of POI leads to a local outbreak when people first got infected at supermarkets and further spread the virus at home to the family members.



CONCLUSION

Simulating people's behavior under uncertain virus parameters revealed that district-specific risk is a complex emergent phenomenon created not only by agent attributes and their activities, but also the POI that are unequally distributed across the city. Such a finding highlights the importance of the policy assessment on the urban scale. As the model showed, even such a relatively straight forward policy as a lockdown **have turned the tables** in the undesirable manner. More comprehensive policy requires a close cooperation between national and local government, essential services providers (e.g. supermarket chains) and citizens, who should be informed of the district specific risk.



Well, well, well, how the turntables...
The central district of The Hague is a hotspot when there is no NPI in place. But when a lockdown is imposed, the tables turn and the outer residential district becomes a hotspot. Let's find out why.