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Agent-based models

RKI-MONID WORKSHOP | October 9, 2025

Martin Kühn

What are agent-based models?

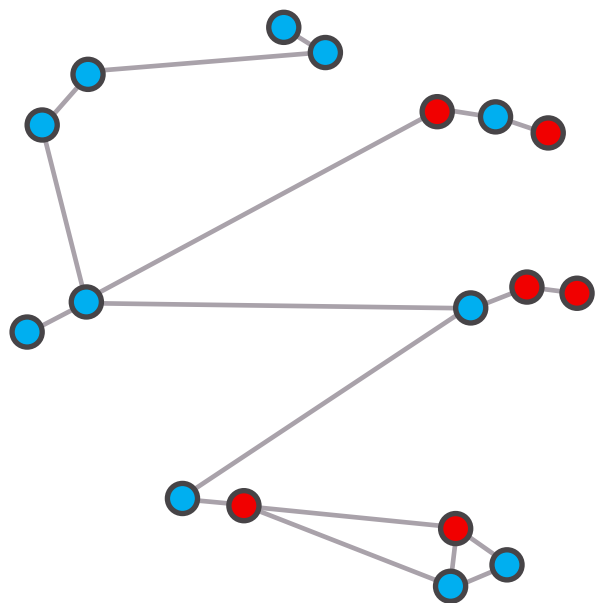
An ABM consists of a finite (or countably infinite) number of unique **agents** $\alpha_1, \dots, \alpha_n$ and an **environment** in which and to which an agent reacts. Furthermore,

- an agent is characterized by a finite number of **features** that determine its **state**,
- an agent interacts with other agents and their joint environment according to **interaction rules**,
- the state of an agent or the environment changes through interactions or with time.

What are agent-based models?

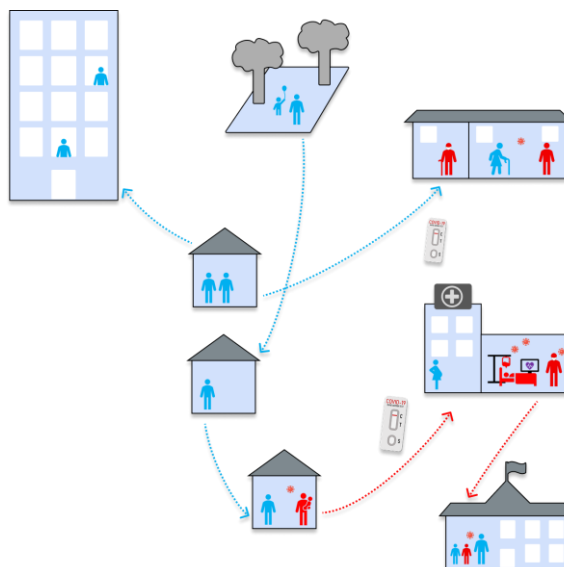
In infectious disease dynamics or computational epidemiology, three types of ABMs are most common

GEMS

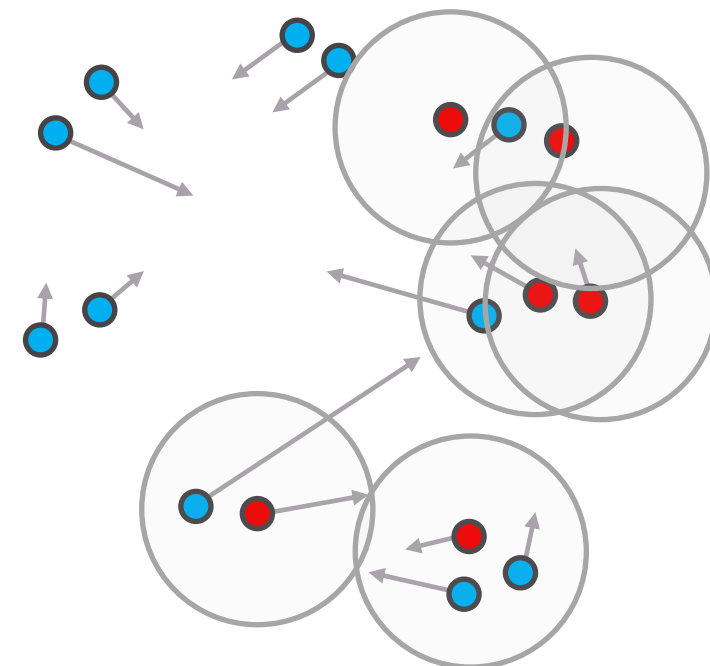


Network-based

MEmilio



Mobility-based

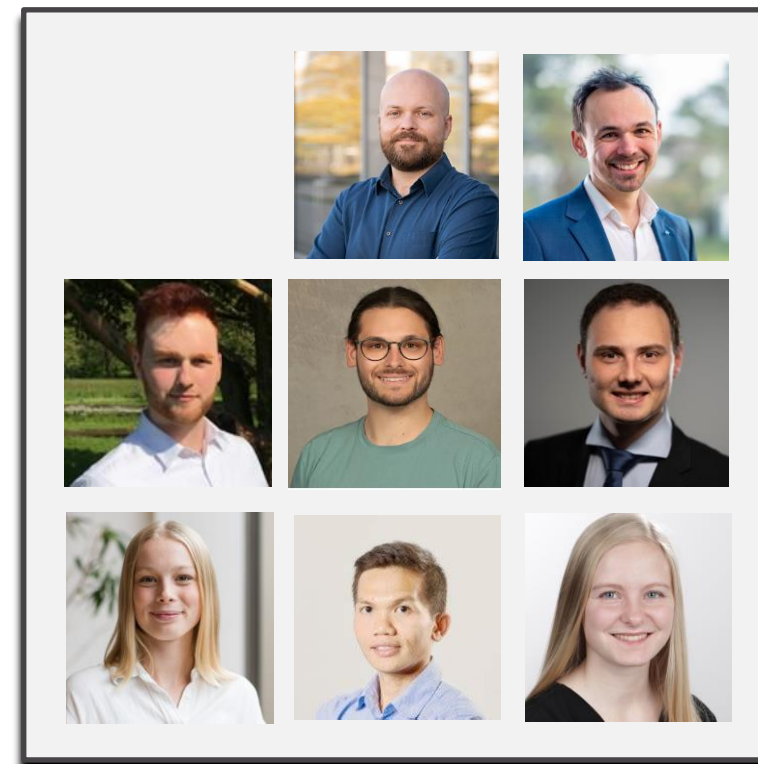
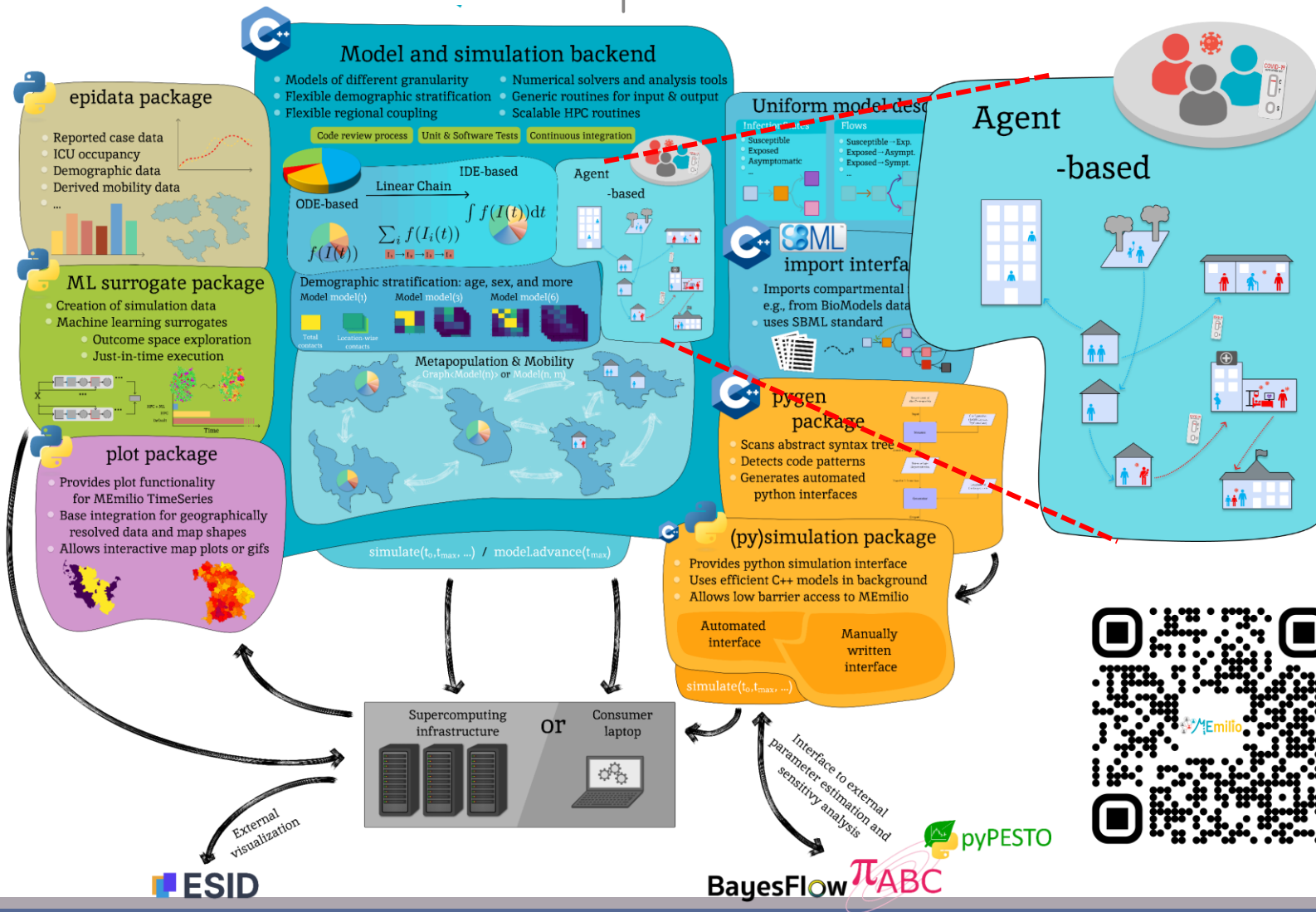


Continuous Movement-based



A high performance Modular Epidemiological simulation software

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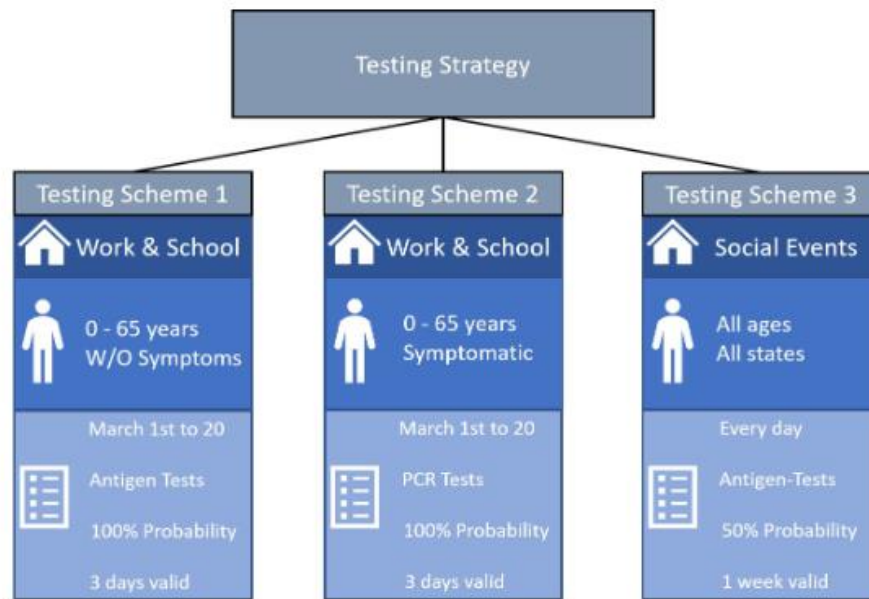
Software & Unit Tests

CI passing codecov 97%

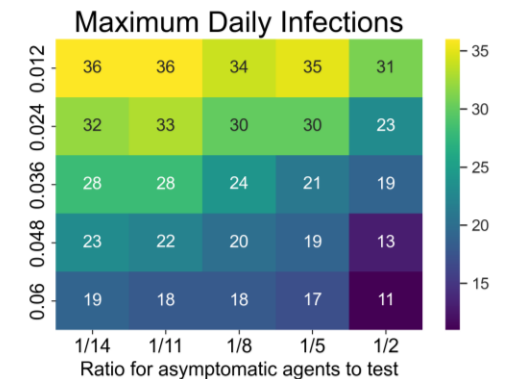
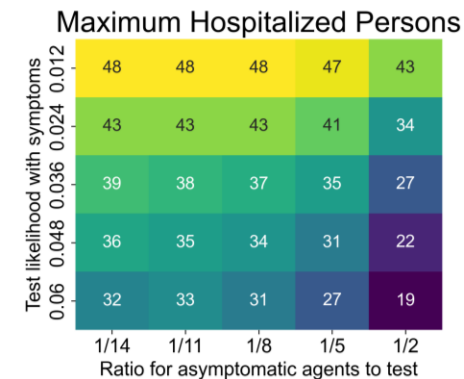
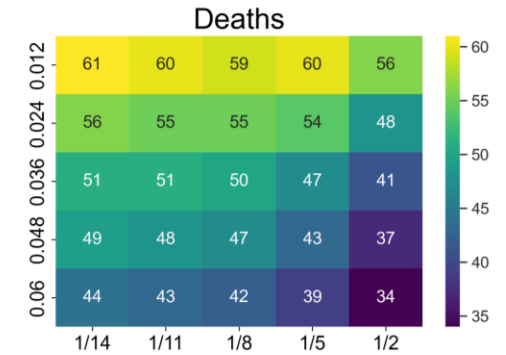
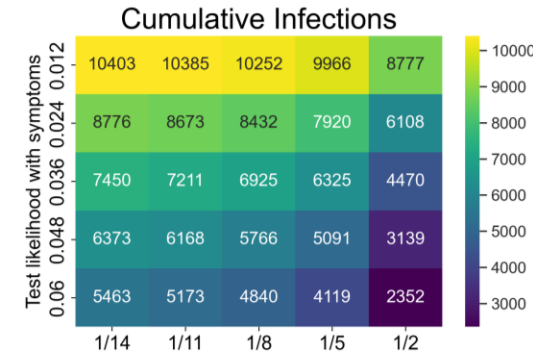
- C++: ca. 650 (2023: ca. 300)
- Python: ca. 230 (2023: ca. 200)

Application: Assessing advanced testing schemes

“How does efficiency of symptom-independent testing change with symptomatic testing frequency?”



More symptomatic testing



More symptom-independent testing

<https://doi.org/10.1016/j.combiomed.2025.110269>

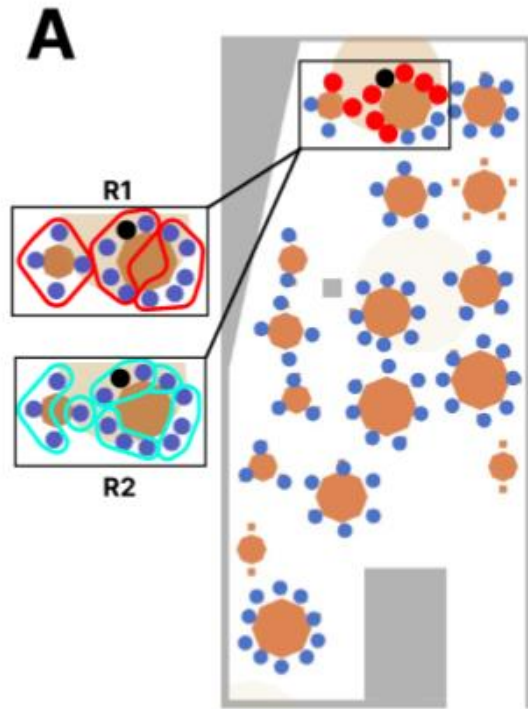
Kerkmann, Korf et al., Computers in Biology and Medicine (2025)

Application: Impact of (missing) tracing

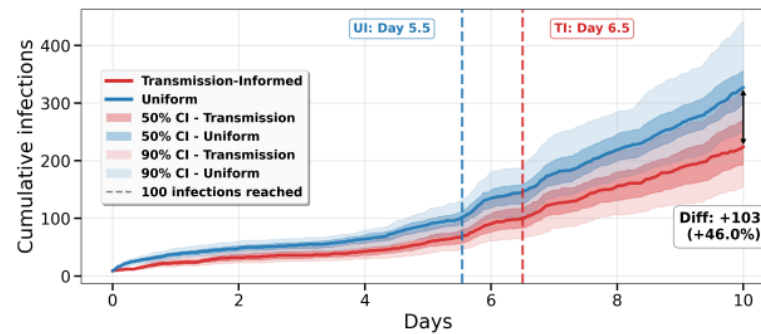
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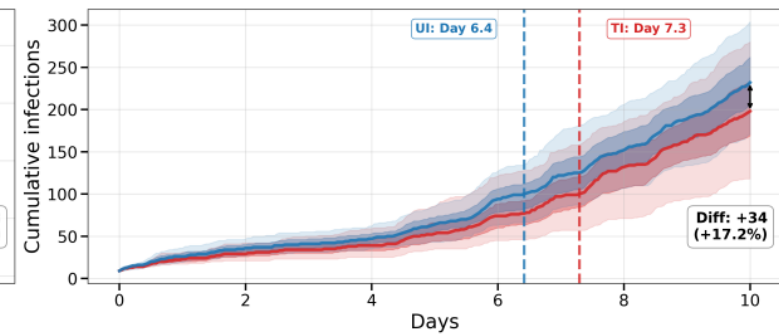
“How does missing transmission chain information impact my epidemic outcomes?”



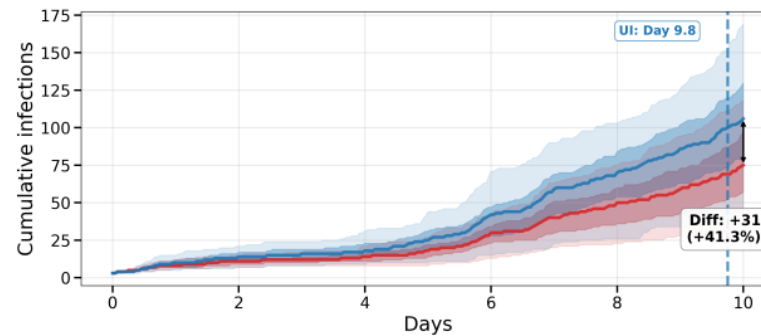
R1: Limited Inter-Household Mixing



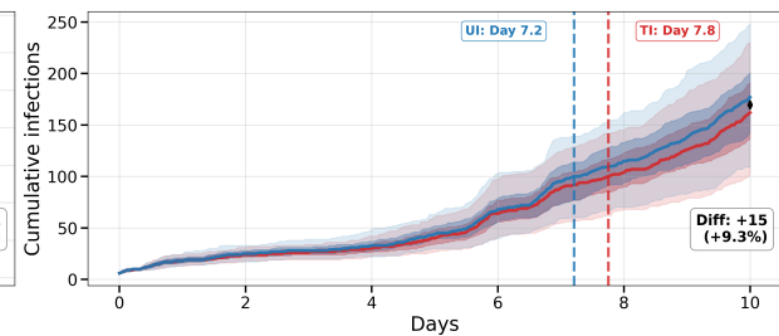
R2: More Inter-Household Mixing



W1: Few Meetings, Limited Mixing



W2: More Meetings, More Mixing



Korf et al., Submitted (2025)

Application: Joint ABM-Wastewater model

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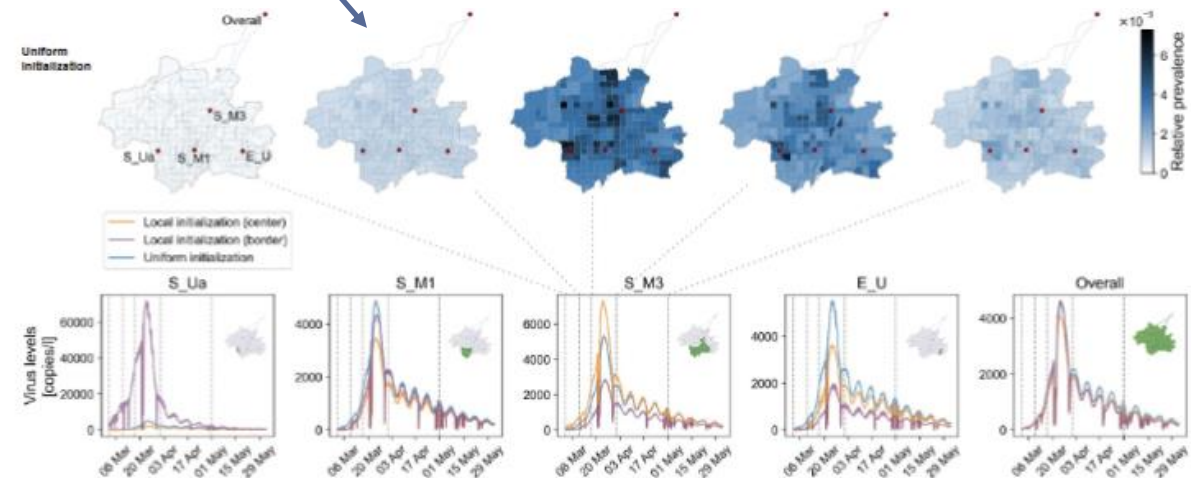
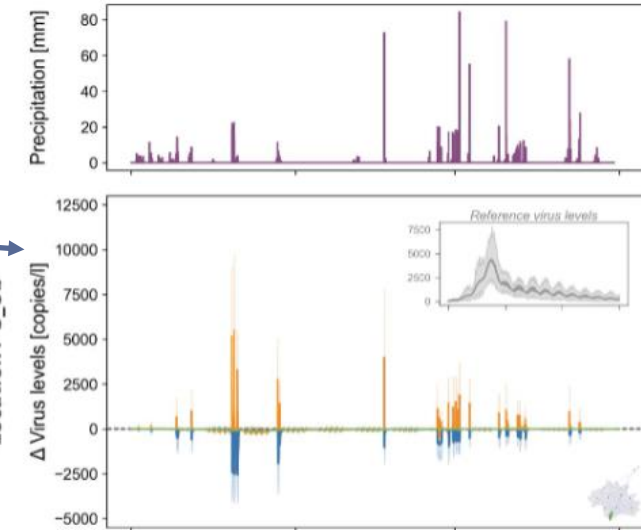
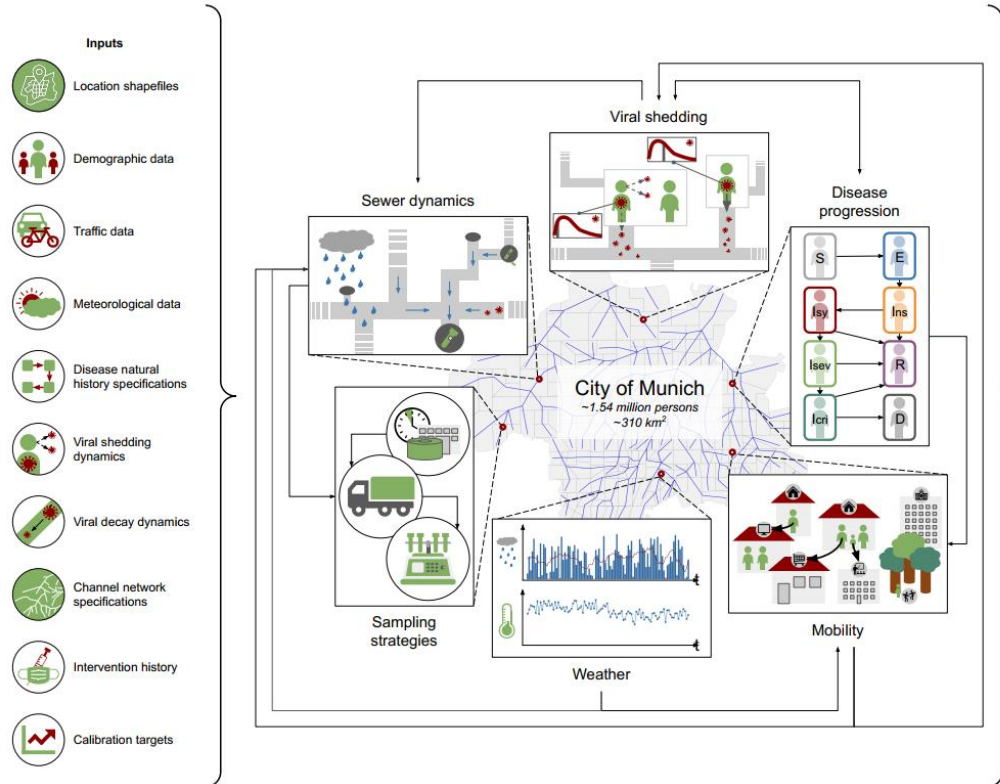


“How does can testing-based detection be improved by combination with wastewater?”



Studying the effect of different normalization strategies for rain events

Detailed insights into population and wastewater dynamics



<https://doi.org/10.1101/2025.09.25.25336633>
Bicker, Tomza, Wallrafen et al., Submitted (2025)