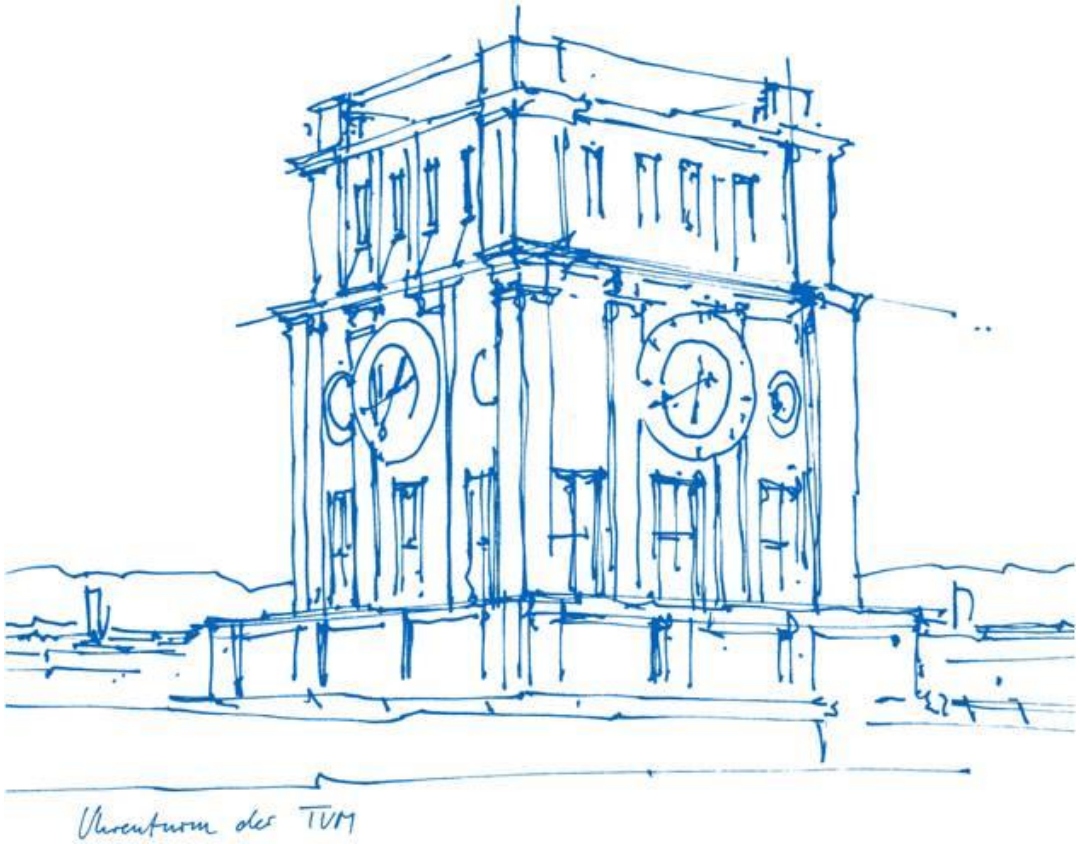
The Impact of Social Networks on the Spread of Epidemics Using EpiSim

MATSim User Meeting 2022



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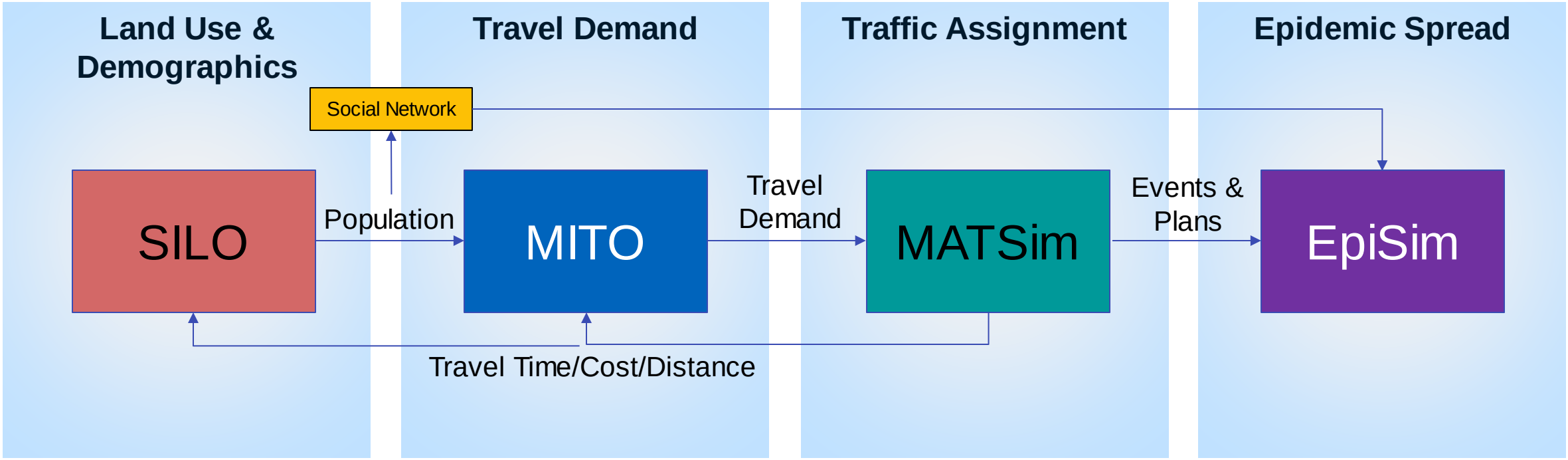
Introduction

- Person-to-person contact is fundamental to epidemic spread
- Human mobility is crucial for understanding geographic spread of infectious disease
- Transportation models can give details on human movement and contact in epidemic models (Mueller et al., 2020)
- Social network can strongly influence travel behavior and contact patterns (Frei & Axhausen, 2007)

Objective

- Verify whether social network to an agent-based epidemic model to look at impact on the spatio-temporal transmission progression of epidemics

Model set up



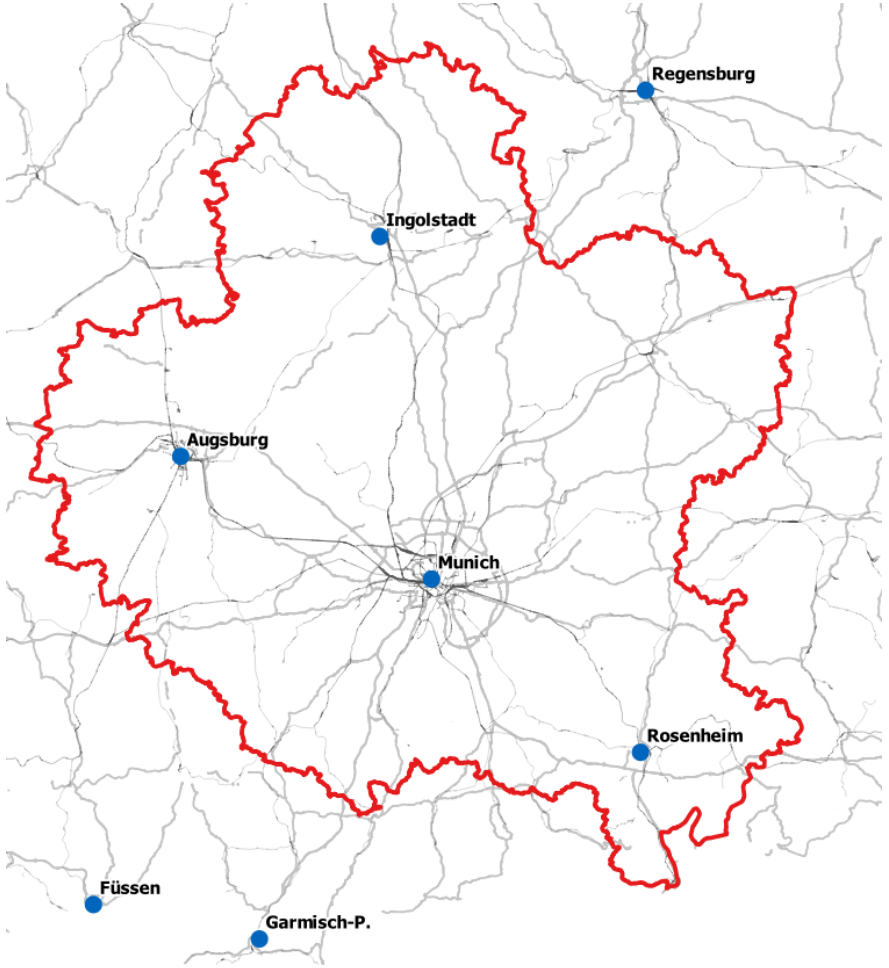
- Using the agent-based, open-sourced, fully integrated modeling suite SILO + MITO +MATSim to feed into EpiSim the necessary population and travel trajectories

Study Area

- **Munich metropolitan region**
- Five central cities (Augsburg, Ingolstadt, Landshut, Munich and Rosenheim) and their suburbs

- Population:
  - 4.5M people
  - 2.1M households

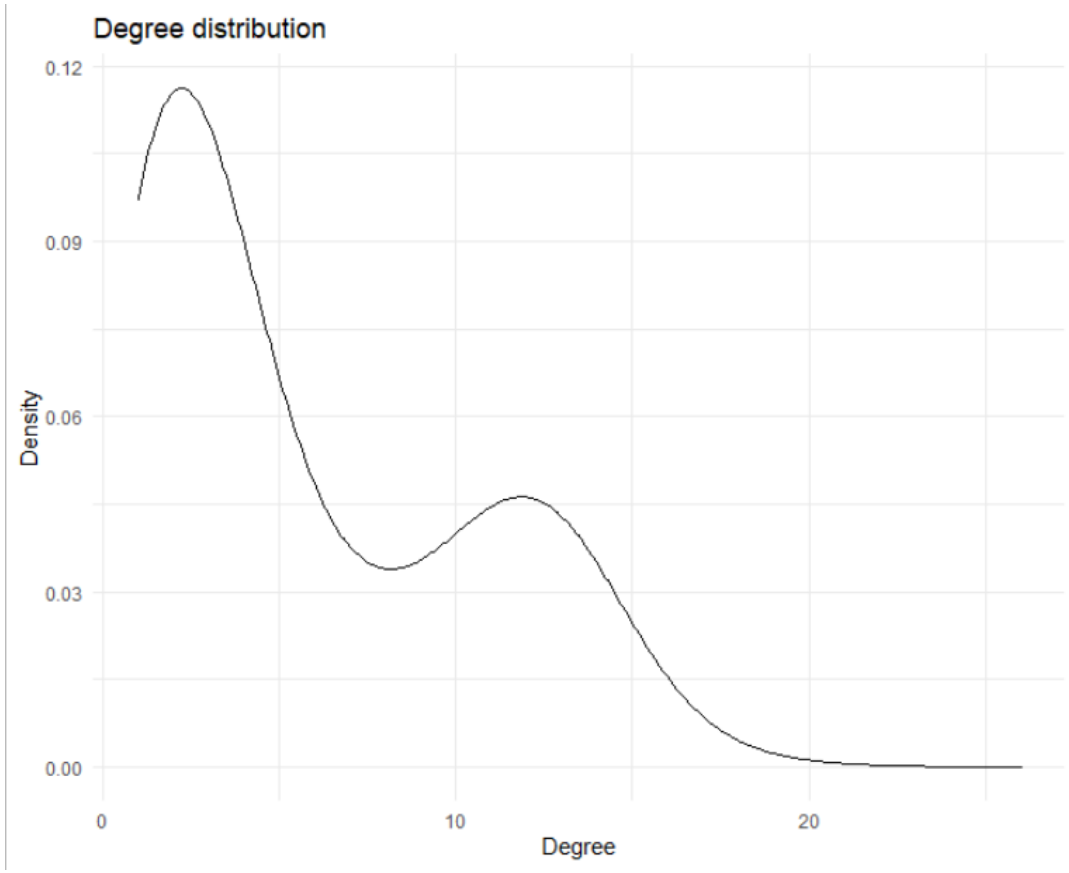
- Currently using 5% of population
  - ~220,000 people
  - ~100,000 households

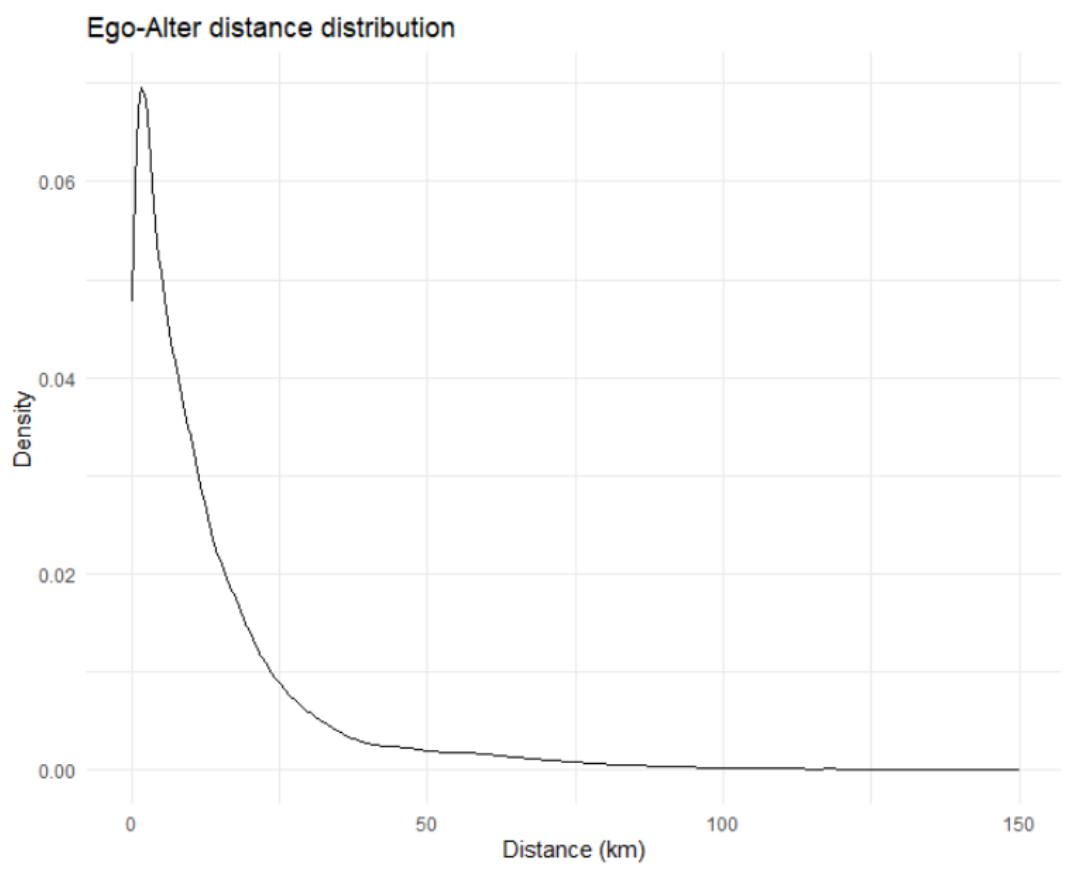


Social network

Type of social tie	Edge build criterion	Average degree
Household	From same household	2.2
Neighborhood	Share dwelling location and dwelling type	2.5
Education	Attend same school, same age	9.5
Work	Share job location and job type	5.5
Nursing home	Share nursing home location	10

Social network





EpiSim set-up

- An infection dynamics model on top of a person's movement trajectories developed by TU Berlin
- Allows testing of interventions policies – school closure, home-office mandate, etc.
- Runs for a year or until no more infections occur

Contact model

- Persons at the same location (either in transit or at activity location) can potentially infect each other
- When leaving transit or activity location, a probability of infection is calculated using infection model

Infection model

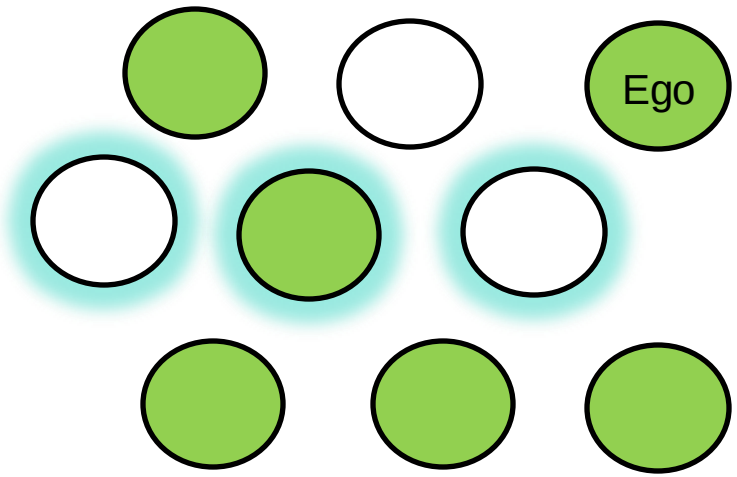
- Gives a probability for infection based on contact intensity, duration, viral shedding and intake

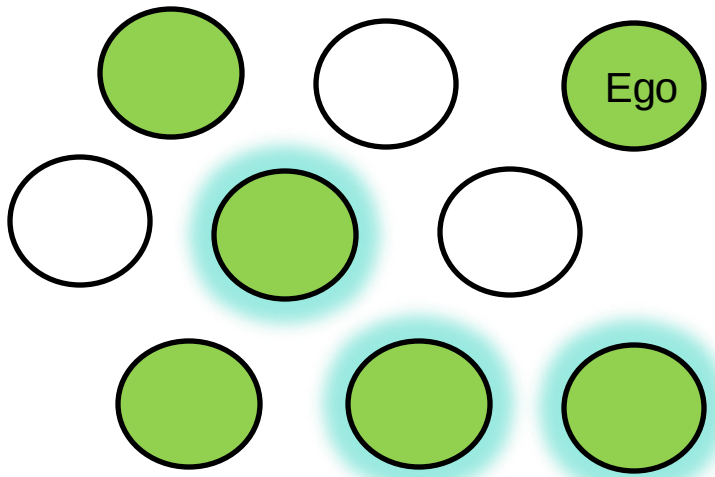
Disease progression model

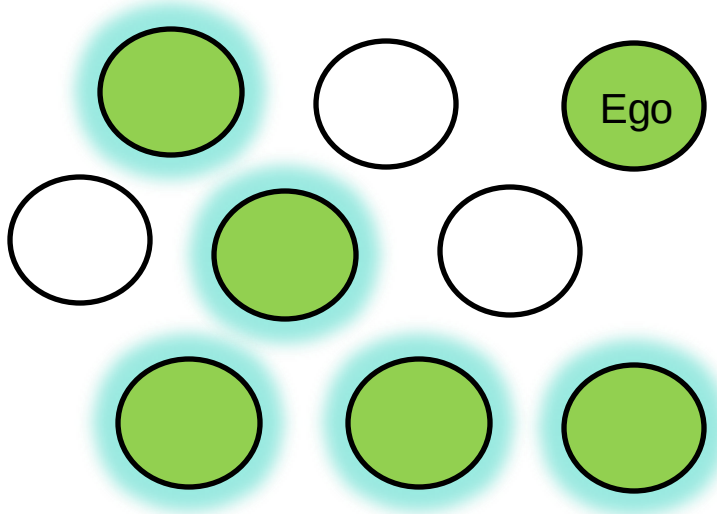
- Once infected, probability of progressing to next stage of disease

Scenarios

	No social network	With social network	
Initial infection seeded randomly	Max three contacts, randomly selected	Max three contacts, selection priority given to those within the agent's social network	No restriction on number of contacts within social network, max three random contacts in lieu of contacts within social network







Scenario results

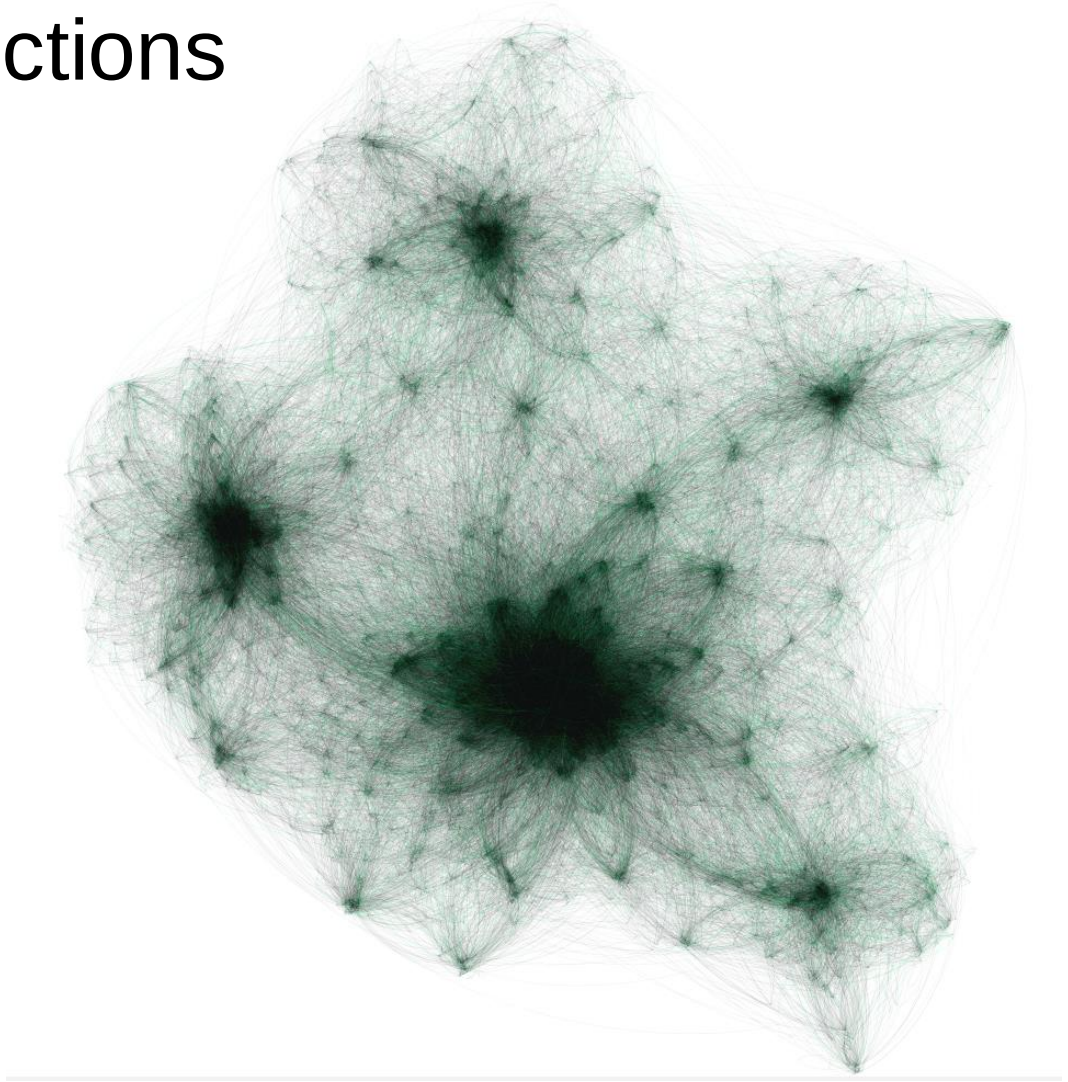
Percentage of total infections per each activity purpose

Scenario	Base	Limited SN contacts	Unlimited SN contacts
Home	49%	50%	50%
Work	12%	13%	13%
Education	5%	4%	4%
Nursing	1%	1%	1%
Other	31%	30%	30%
Public transit	2%	2%	2%
Recreation	1%	1%	1%
Shopping	0%	0%	0%
Total	100%	100%	100%

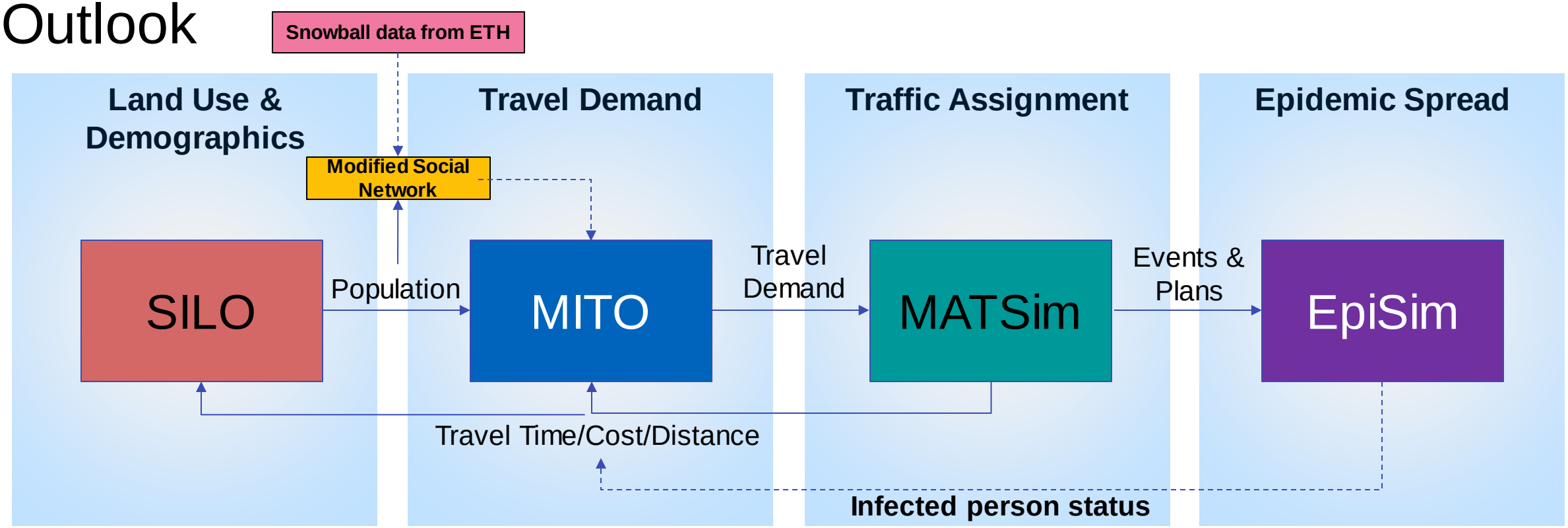
Percentage of infection from social network contacts

	per total number of infections		
Scenario	Base	Limited SN contacts	Unlimited SN contacts
Home	20%	32%	34%
Work	4%	8%	9%
Education	1%	1%	1%
Other	0.27%	0.31%	0.31%
Nursing	0.13%	0.71%	0.75%
Public transit	0.002%	0.01%	0.01%
Recreation	0%	0%	0.0003%
Total	25.39%	42.51%	45.11%

Infection connections



Outlook



- Social network implementation in MITO – joint travel decisions
- Population status feedback from EpiSim
- Multi-day simulation including weekend trips

Thank you

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Sources

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EpiSim modifications

- Contact intensity

- No facility files
- Separation of recreation and other activity purposes