Examining Demographic Heterogeneities in Melbourne's MATSim Model

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RMIT UNIVERSITY

Photo by Finn Whelen: https://www.pexels.com/photo/city-buildings-and-train-6214847/

Activity-based and agent-based model of Melbourne (AToM)

MATSim Melbourne

matsim-melbourne

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Activity-based and agent-based Transport model of Melbourne (AToM)

AToM is a city-scale multi-modal transport simulation, modelling a typical mid-weekday day in the transportation system of Melbourne for understanding. AToM workflow, Figure 1, constists of open-source tools with MATSim simulation toolkit as the core traffic simulator. The open-source tools include an activity-based transport demand generator](https://github.com/matsim-melbourne/demand), a road and public transport network genereator, a mode choice model, and a set of MATSim simulation output and input postprocessing tools.

Publications:

- Jafari, A., Both, A., Singh, D., Gunn, L., & Giles-Corti, B. (2022). Building the road network for city-scale active transport simulation models. Simulation Modelling Practice and Theory, 114, 102398.
- Both, A., Singh, D., Jafari, A., Giles-Corti, B., & Gunn, L. (2021). An Activity-Based Model of Transport Demand for Greater Melbourne. arXiv preprint arXiv:2111.10061.
- Jafari, A., Singh, D., Both, A., Abdollahyar, M., Gunn, L., Pemberton, S., & Giles-Corti, B. (2021). Activity-based and agent-based Transport model of Melbourne (AToM): an open multi-modal transport simulation model for Greater Melbourne. arXiv preprint arXiv:2112.12071.

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MATSim Melbourne network
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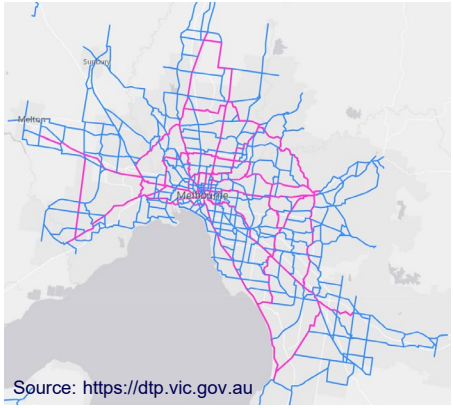
MATSim Melbourne baseline scenario
Java

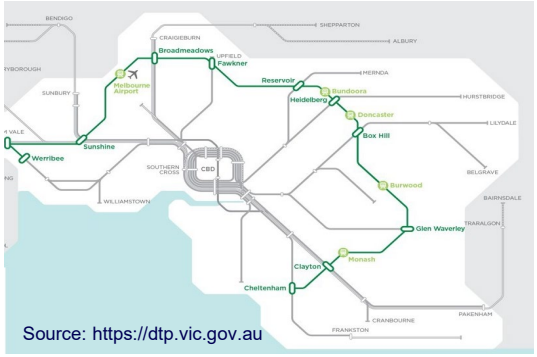
Different use cases so far:

- **Connected network of cycleways**



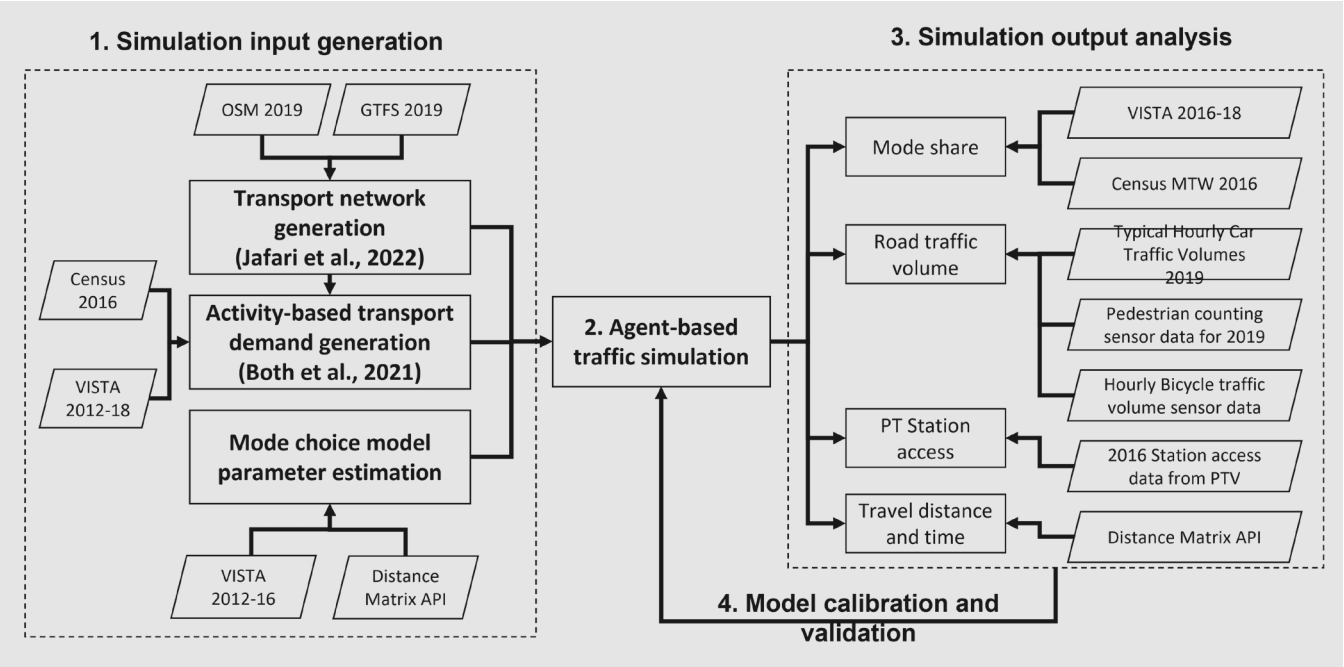
Source: https://dtp.vic.gov.au

- **A new orbital railway in Melbourne**



Source: https://dtp.vic.gov.au

Activity-based and agent-based model of Melbourne (AToM)

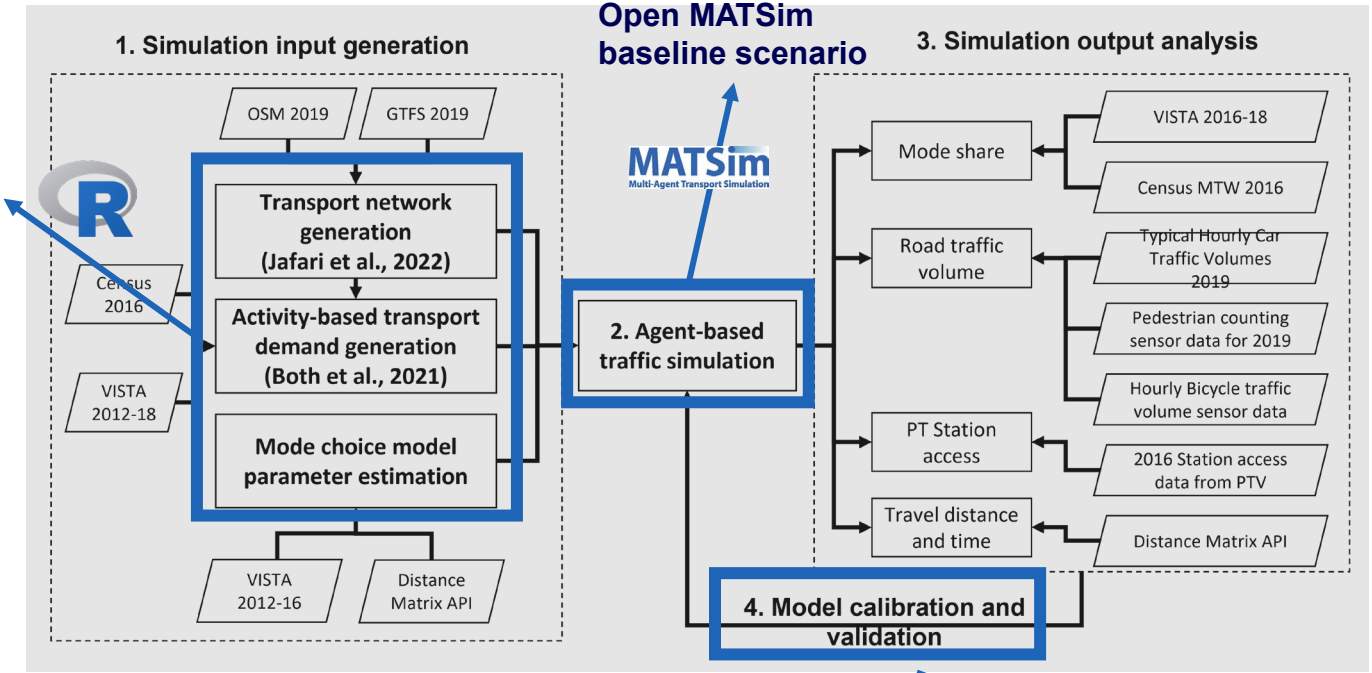


Source: Jafari, A., Singh, D., Both, A., Abdollahyar, M., Gunn, L., Pemberton, S., & Giles-Corti, B. (2021). Activity-based and agent-based Transport model of Melbourne (AToM): an open multi-modal transport simulation model for Greater Melbourne. arXiv preprint arXiv:2112.12071.

Activity-based and agent-based model of Melbourne (AToM)

Melbourne's Open MATSim baseline scenario

Stand-alone models



Source: Jafari, A., Singh, D., Both, A., Abdollahyar, M., Gunn, L., Pemberton, S., & Giles-Corti, B. (2021). Activity-based and agent-based Transport model of Melbourne (AToM): an open multi-modal transport simulation model for Greater Melbourne. arXiv preprint arXiv:2112.12071.

Set of utility tools for MATSim

AToM's activity-based transport demand is demographic cohort-based, whereas the mode choice model was only done for workers and also mode change innovation strategy during MATSim simulation was only enabled for workers.

AToM's cluster-based activity-based demand

- Step 1: Travellers from the travel survey were grouped into 24 age and gender group
- Step 2: Probability of engaging in each activity (work, shop, edu, social/recreational) was calculated for each group
- Step 3: Hierarchical clustering was applied to cluster these 24 groups based on activity probability
- Step 4: Activity-chains of the activity-based transport model were generated separately for each cluster

Cohort 1	Female and Male 0-19
Cohort 2	Female and Male 20-24
Cohort 3	Female 25-29 Male 25-59
Cohort 4	Female 30-59 Male 60-64
Cohort 5	Female >= 60 Male >= 65

Cluster-based mode choice model

- **Method**: Multinomial logit model

$$S_{trav,i} = asc_i + \beta_{trav,i} \times t_{trav,i} + \beta_m \times m_i$$

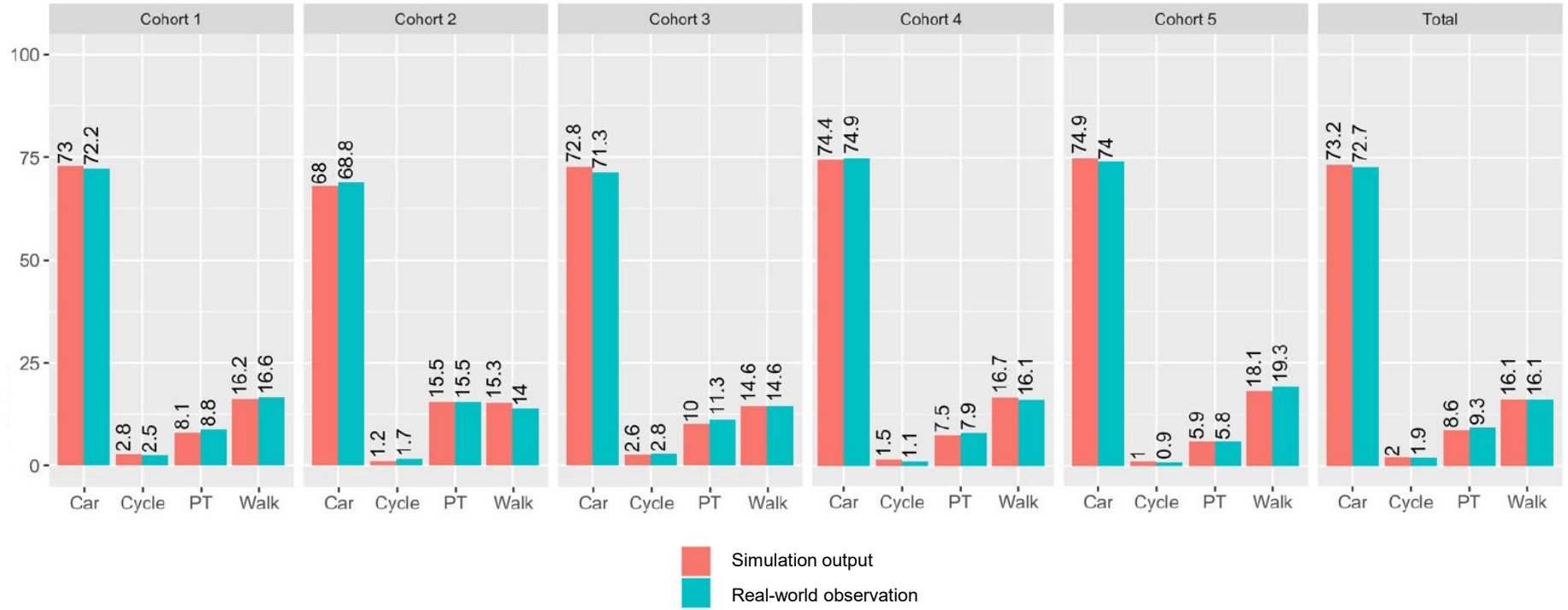
- **Alternatives**: Car, Public Transport, Bicycle, Foot
- **Travel time**: Google's Distance Matrix API, a mid-week workday in January 2022
- **Travel cost**: daily fare of $4.3 for PT and 8.8 lit/100km + $1.16 per lit for car fuel cost

Parameter	Estimated coefficients				
	Cohort 1	Cohort 2	Cohort 3	Cohort 4	Cohort 5
asc_{Drive}	0.00	0.00	0.00	0.00	0.00
asc_{PT}	0.83	-3.40	-5.12	-6.42	-4.07
asc_{Cycle}	1.71	-2.53	-3.02	-3.99	-3.63
asc_{Walk}	5.06	1.04	0.56	0.40	0.94
$\beta_{trav,Drive}$	-3.22	-5.90	-5.29	-5.96	-5.03
$\beta_{trav,PT}$	-6.96	-8.48	-5.72	-6.08	-7.80
$\beta_{trav,Cycle}$	-17.40	-10.88	-5.93	-6.23	-8.23
$\beta_{trav,Walk}$	-7.89	-6.57	-5.85	-6.12	-6.76
β_m	0.00005	0.32	0.60	0.81	0.30

MATSim scenario setting

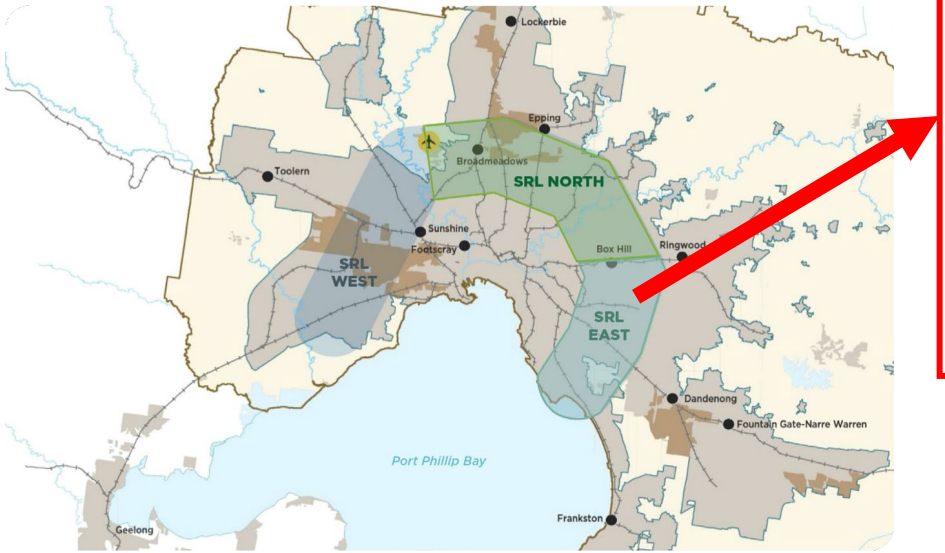
- 10% Population sample
- Subtour Mode shift (0.1) and re-routing (0.1) enabled for all clusters
- Running for 300 iteration
- PT schedules based on GTFS
- Walk and bike teleportation with constant speed

MATSim simulation scenario calibration

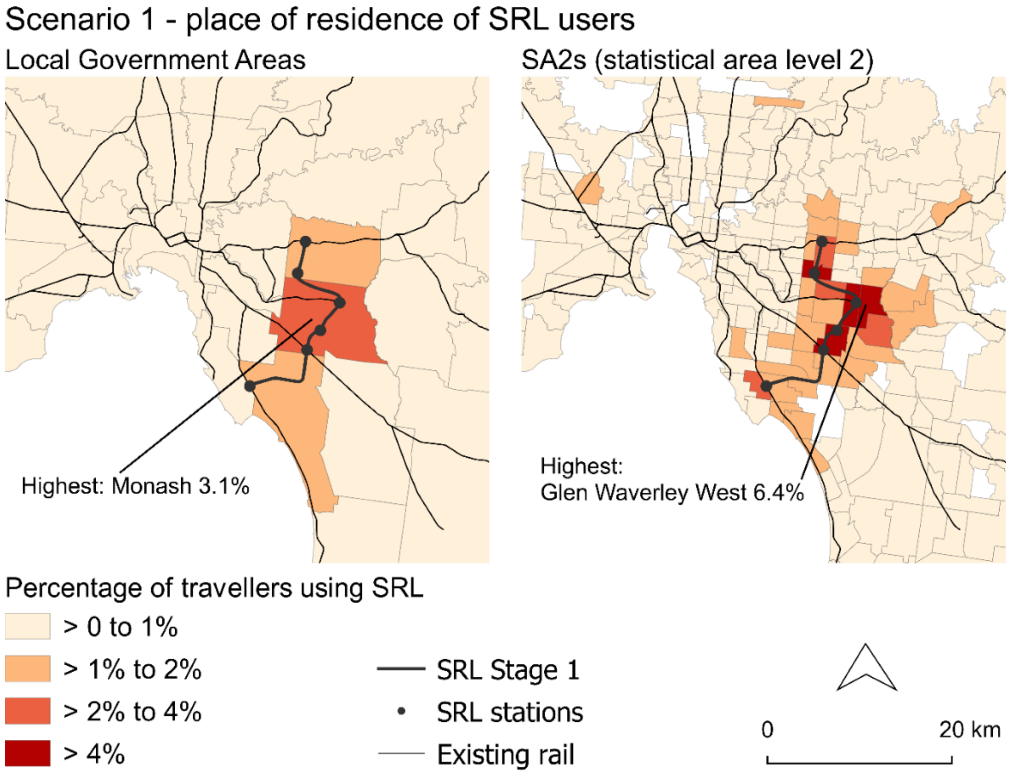


Looking at behaviour change

Modelling change in public transport use as a result of building phase one of Melbourne's orbital train network



Looking at behaviour change



Looking at behaviour change

Changes in agents walking for all purposes for at least 30 minutes per day among those travelling to/from the new station precincts

	Cohort	# of agents	Agents walking for 30 minutes or more		
			# agents	% agents	% change
Baseline	1	3,494	590	16.9	-
	2	1,307	261	20.0	-
	3	4,002	709	17.7	-
	4	3,680	622	16.9	-
	5	2,555	414	16.2	-
Scenario	1	3,501	603	17.2	0.3
	2	1,304	288	22.1	2.1
	3	4,001	751	18.8	1.1
	4	3,681	629	17.1	0.2
	5	2,553	413	16.2	0.0

Conclusion and Next steps

- Cluster-based approach can be used as a way to incorporate differences between groups of people in the simulation
- Measuring health impacts for different clusters
- Investigating future scenarios, including land use and demographic changes over time

Thank you

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