Modelling tools to get us there

Milos Balac

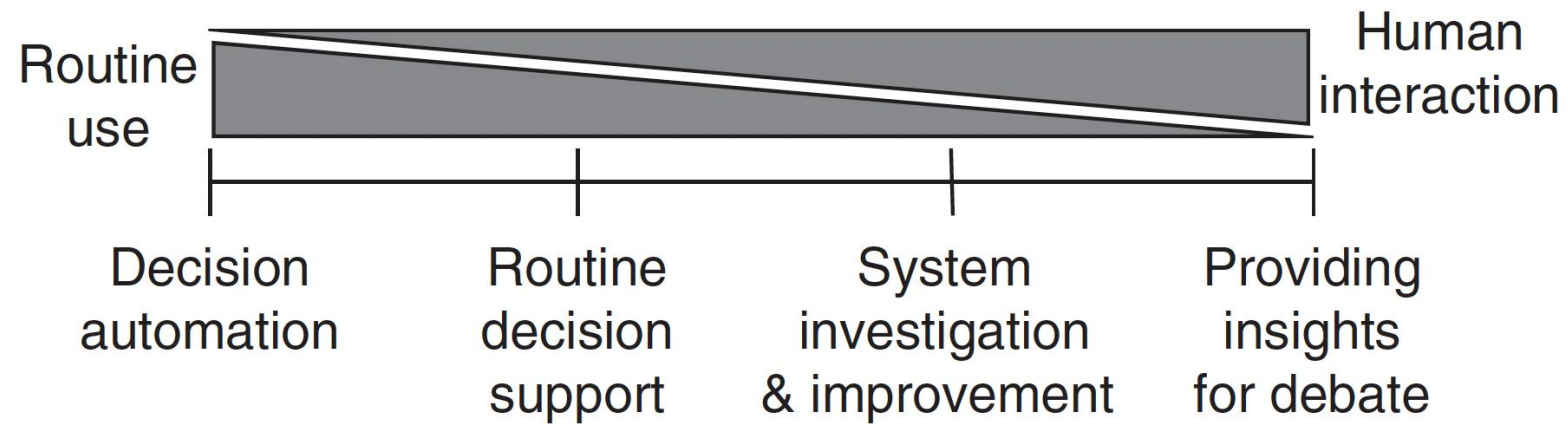07.12.2023 - ETH, Zurich, Switzerland

Background

10.5 years at Kay Axhausen's Chair – Great time ;)

Developing, maintaining and using agent-based models based on MATSim

Mostly projects focusing on emerging mobility

Currently at the Center for Sustainable Future Mobility

How do we use models?

Michael Pidd (2010) Why modelling and model use matter, *Journal of the Operational Research Society*, **61**, 14-24.

How do I (we) use transport models
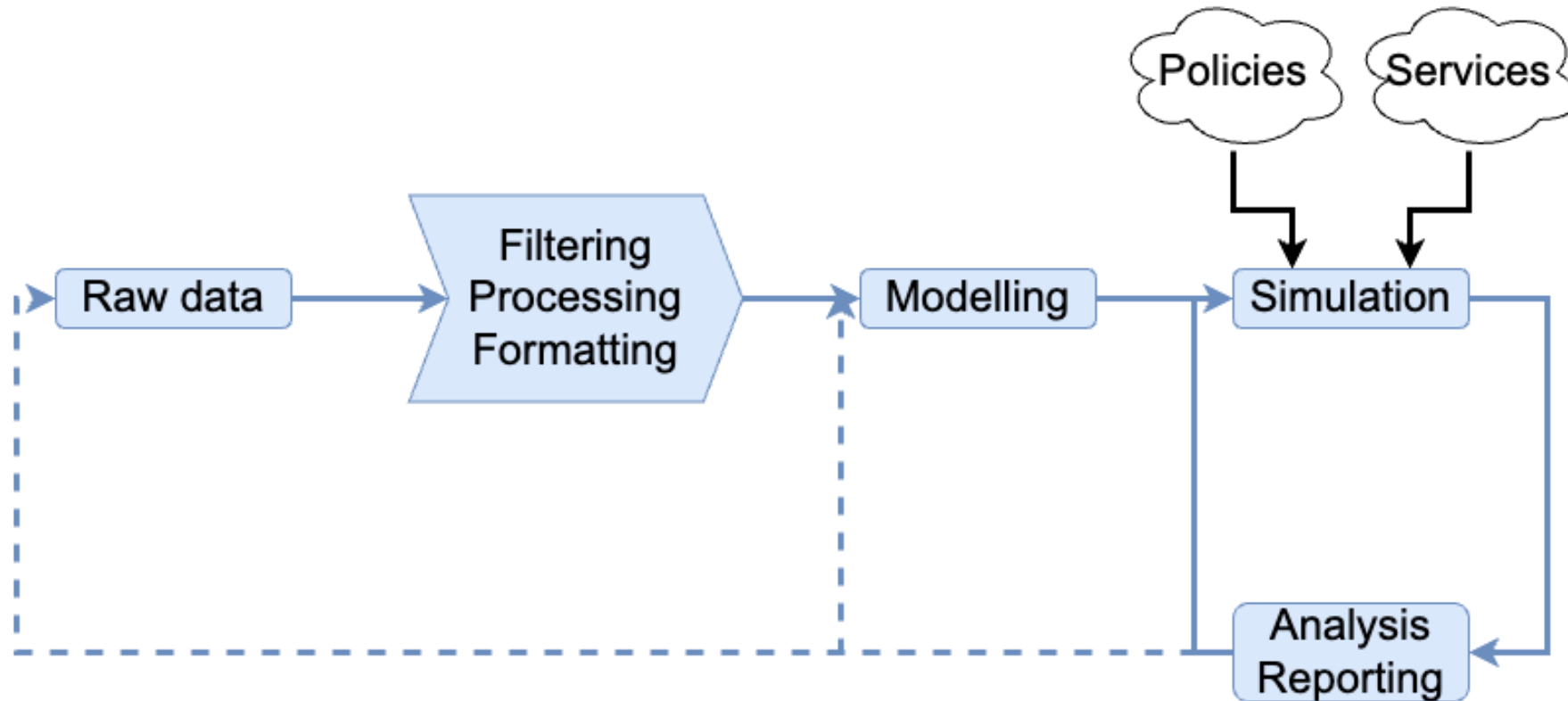
MATSim as a simulation tool

Scenario/Input Data mostly already readily available

Set-up the tool, define/run policies, transform the output data into usable/fancy tables and figures, report the most interesting findings

Delete the data/output, make space for future studies

Repeat

Lifecycle of transport model use

How do I (we) use (modern) transport models

Fast developing environment causing transport offer and lifestyle changes:

- Car-sharing
- Bike-sharing
- Inter-modality
- On-demand mobility
- Automation
- Mobility hubs
- Electrification
- Aerial mobility

How do I (we) use (modern) transport models

Fast developing environment causing transport offer and lifestyle changes:

- **Car-sharing (7)**
- **Bike-sharing (2)**
- **Inter-modality (3)**
- **On-demand mobility (8)**
- **Automation (7)**
- Mobility hubs
- Electrification
- **Aerial mobility (4)**

- Around 25 published studies
- Close to 1000 simulation runs
- Many difficult to reproduce
- Only a single study taken into account multiple emerging modes

How do I (we) use (modern) transport models

Fast developing environment causing transport offer and lifestyle changes:

- Home-office
- Mobility tool ownership
- Online shopping

How do I (we) use (modern) transport models

And then on top of everything Kay comes and says: what about e-bike cities?

E-Bike City (Illustration: mattership.io)

How do I (we) use (modern) transport models

Fast changing environment causing technological changes, lifestyle changes, transport offer

Transport planners and modellers are struggling to keep up

We are mostly focusing on a single transport service, small regions

(Modern) transport models - Challenges

Are our transport models capable of modeling such complex systems?

Are the outcomes reliable?

How do we validate?

Are our results reproducible?

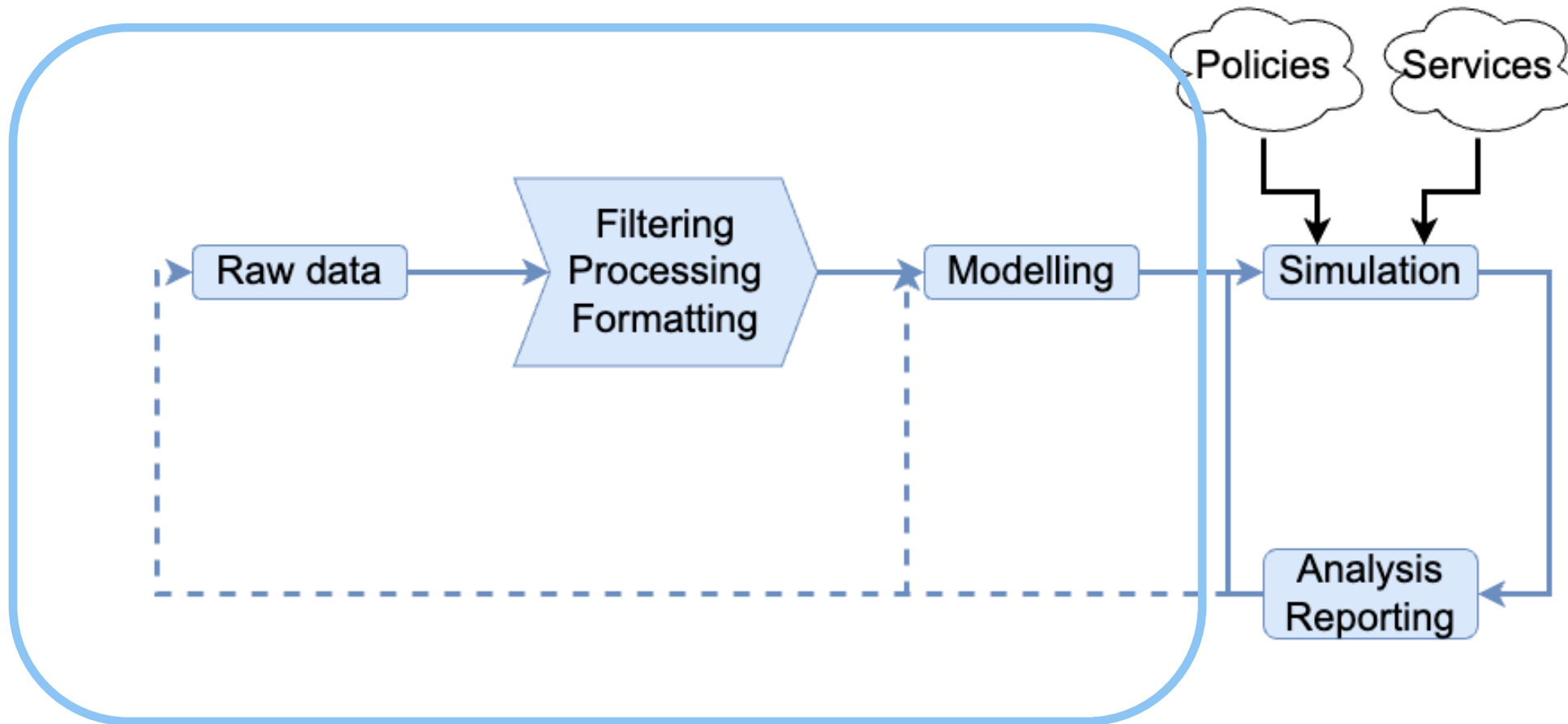**Still rarely used in practice**

Difficult to reproduce

Low accessibility

How do we go forward?

TOGETHER

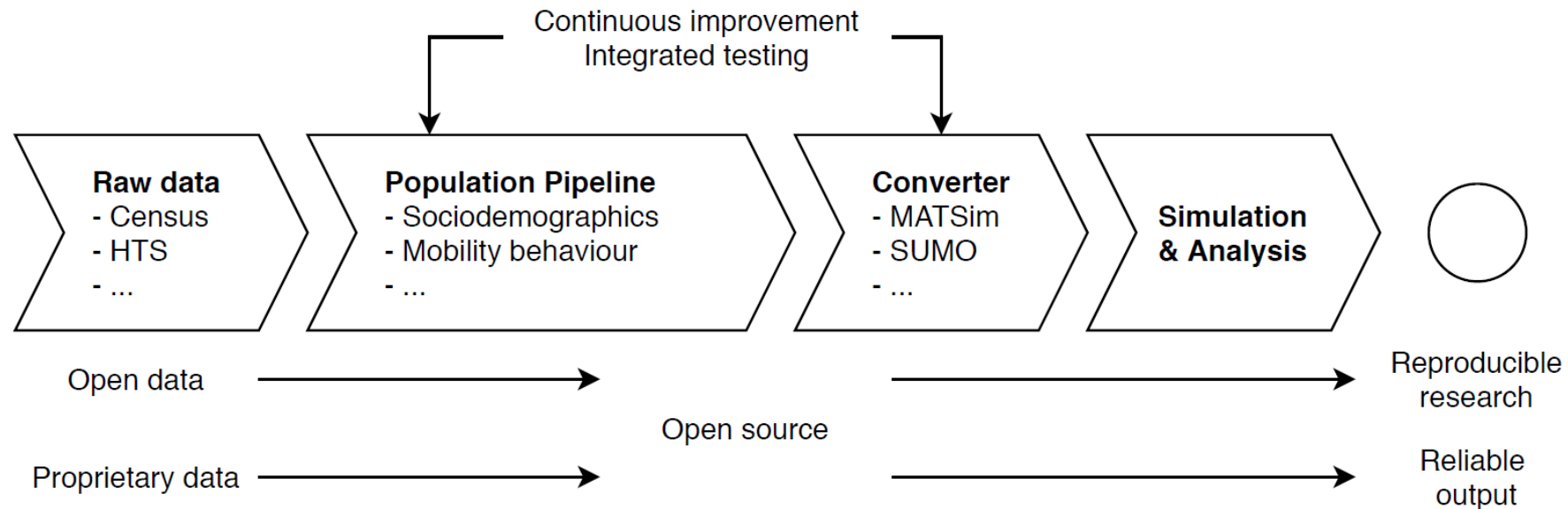# Reproducibility and transferability

Reproducibility and transferability

Generation of the agent-based scenarios:

- Integrated framework

- Reproducible

- Transferable

- Modular

- Open-source and open-data research

Reproducibility - Eqasim

An integrated Python-based pipeline from raw data to agent-based simulation based on straightforward statistical methods
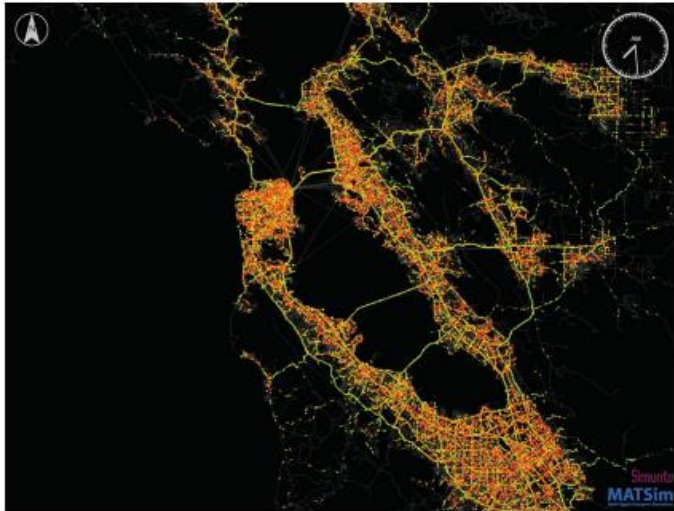
Reducibility - Eqasim

An integrated Phython-based pipeline from raw data to agent-based simulation based on straightforward statistical methods

Ile-de-France, Sao Paulo, San Francisco, Los Angeles, Jakarta, **Switzerland**, **Germany**, **Cairo** and others

Available at https://github.com/eqasim-org

Eqasim models – San Francisco, IDF, Sao Paulo

Sebastian Hörl and Milos Balac (2021) Synthetic population and travel demand for Paris and Île-de-France based on open and publicly available data, *Transportation Research: Part C,* **130**, 103291

Milos Balac and Sebastian Hörl (2021) Synthetic population for the state of California based on open-data: examples of San Francisco Bay area and San Diego County, presented at 100th Annual Meeting of the Transportation Research Board (TRB 2021), online, January 21–22 and 25–29, 2021

Aurore Sallard, Milos Balac, and Sebastian Hörl (2021) An open data-driven approach for travel demand synthesis: an application to São Paulo, *Regional Studies Regional Science*, **8**, 371-386

Eqasim models - France

Source: Sebastian Hörl

ETH *zürich*

Accessibility, Modularity, Efficiency

At CSFM together with SDSC we are developing a collaborative paltform for storing digital models, shadows and twins.

A platform that can be used to fuse and evaluate mobility data, test algorithms, build transport models and compare them and visualise policy impacts.

Reduce redundency, increase efficiency, open new research avenues, increase accessibility to mobility data and model outcomes.

Digital platform

Physical Twin

Digital Twin

What about the rest?

Modeling Complexity

Re-use of simulation outputs

From what-if to if-what scenarios

Can we think of the this collaborative platform as a "Transport Modeling ChatGPT"?

Modeling Complexity

Simulation models – How do we deal with so many different transport solutions?

Are surrogate models a solution?

Do we need alternative approaches?

Behavioral models – How do we integrate best new transport modes? How do we deal with constructing surveys with so many alternatives?

Re-use of simulation outputs

What output should be stored and which should be discarded?

Can we use outputs of previous policy runs to inform or approximate the effects of future ones?

How many simulation runs do we need?

From what-if to if-what scenarios

We are heavily relying on evaluating impact of policies in what-if scenarios:

- We propose a hypothetical situation and evaluate what the impact of that situation would be

What about instead of forecasting we develop methods for backcasting

Instead of asking the question of what is the effect of 50% space reallocation, what we would need to do to be able to ask the question of what we need to do to reach e.g., 20% emission reduction? What is the solution given the constraints?

**Open-source
Open-data
Together**

Questions?

Email me at balacm@ethz.ch