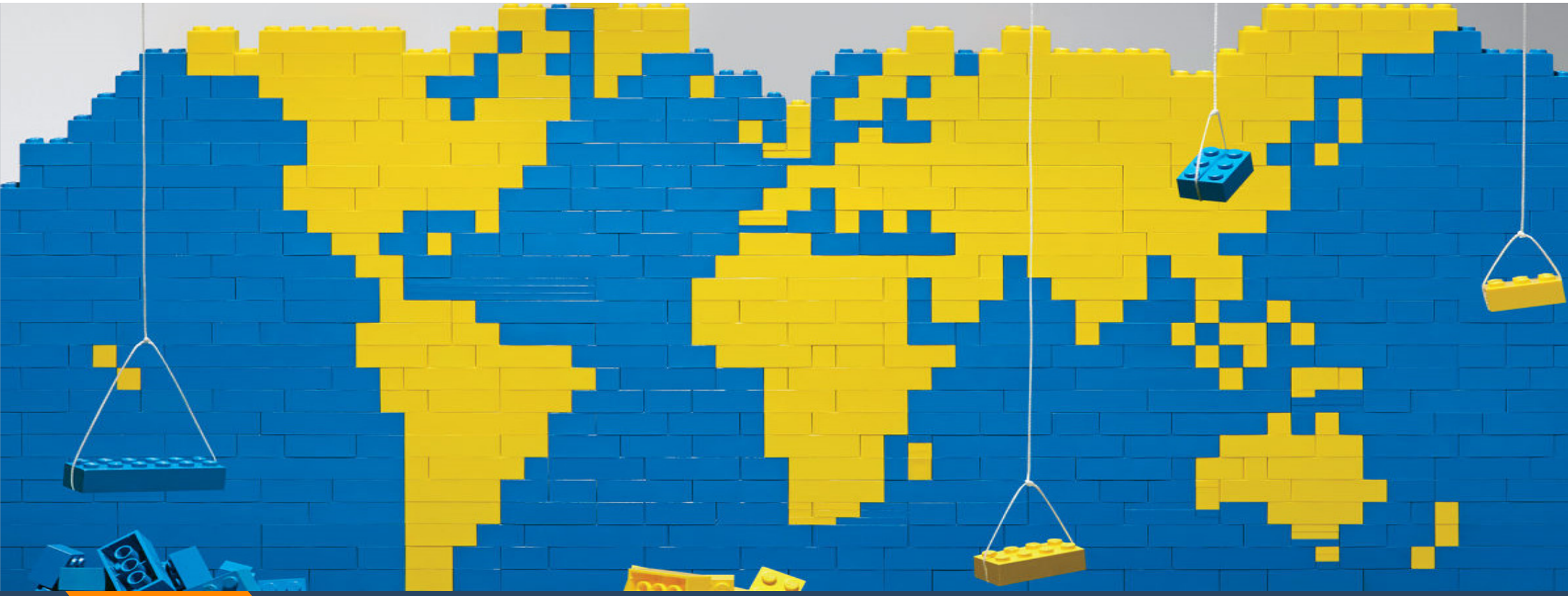


Data-driven simulation in public transport

22 February 2017 / Frederic Roulland

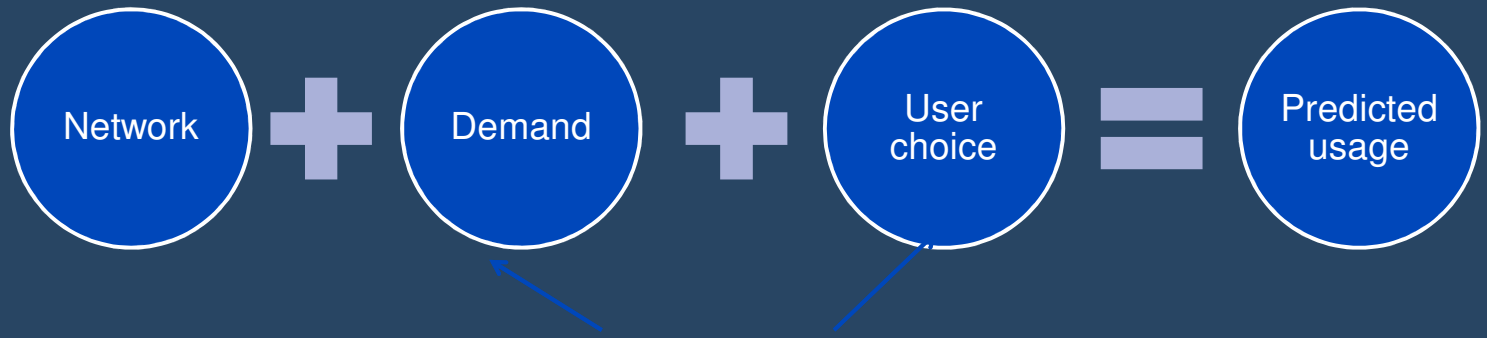
Xerox Research Centre Europe

The transportation planning objective

Can we predict the impact of changes ?

- Refactoring/expansion of network
- Schedule changes
- Degraded mode due to building work or failure

Typically relies on a simulation of the transportation system



Accurate model is critical

A data driven approach for transportation planning

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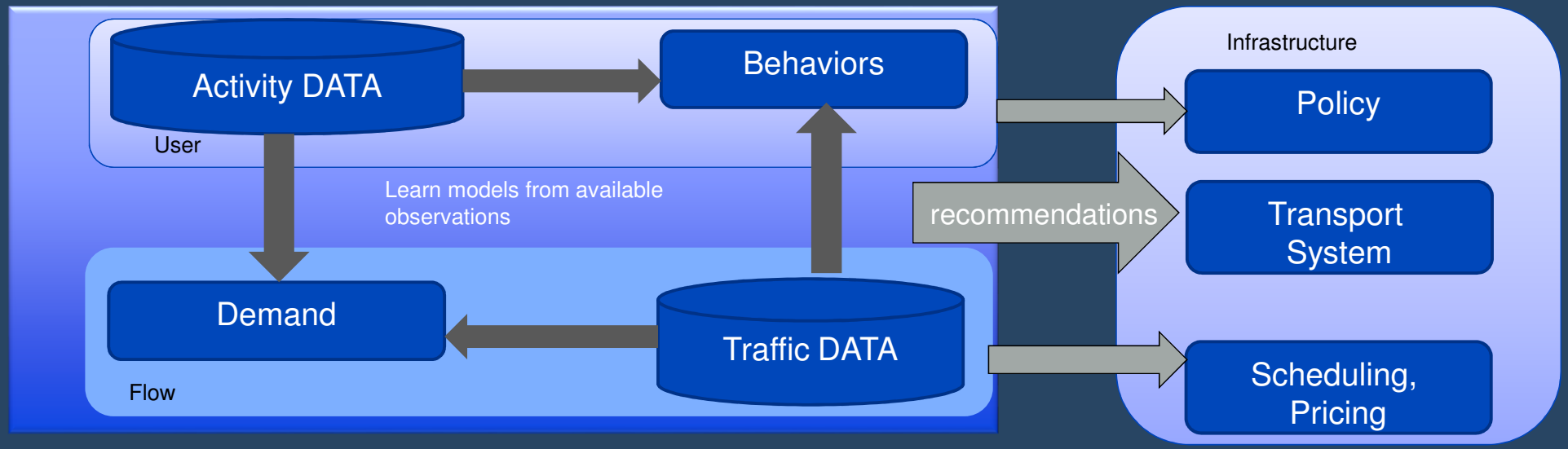
Leverage transportation operations data to plan and optimize city mobility

Collect an amount of traffic data and user activity data

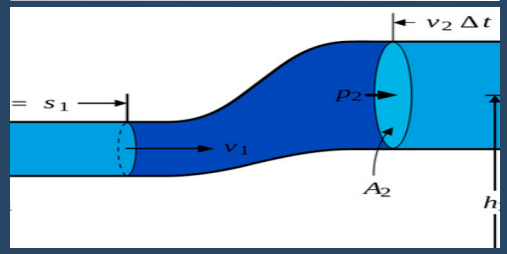
Fuse the data into a coherent reconstructed reality

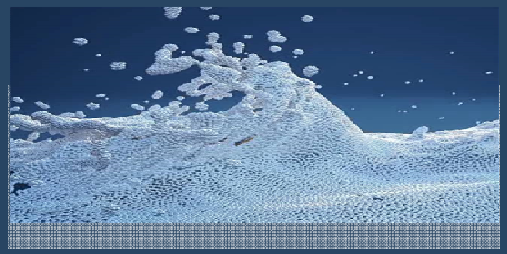
Infer mobility demand and learn user behavior model

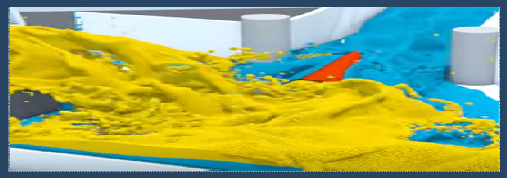
Recommend improvements in infrastructure to optimize mobility



Micro-Simulation Approach







Macro level Simulation (late 60s):

- Use flow equations : Model network as pipes and people as gaz or liquid.

Meso level Simulation (late 90s):

- Same as macro but at certain places:
- When entering, flow are converted to people,
- When exiting, people are converted to flow.

Micro level Simulation, discrete events (00s and 10s):

- Every entity (people, vehicle and places) interact with each other and every second the status of all entities is known and updated. The entities obey rules pre-defined by operators based on experience.

Next Step: Self learning micro level simulation

- Same as micro level but the behavior and demand is automatically learned and updated from daily observations.

More accurate and precise

System Overview

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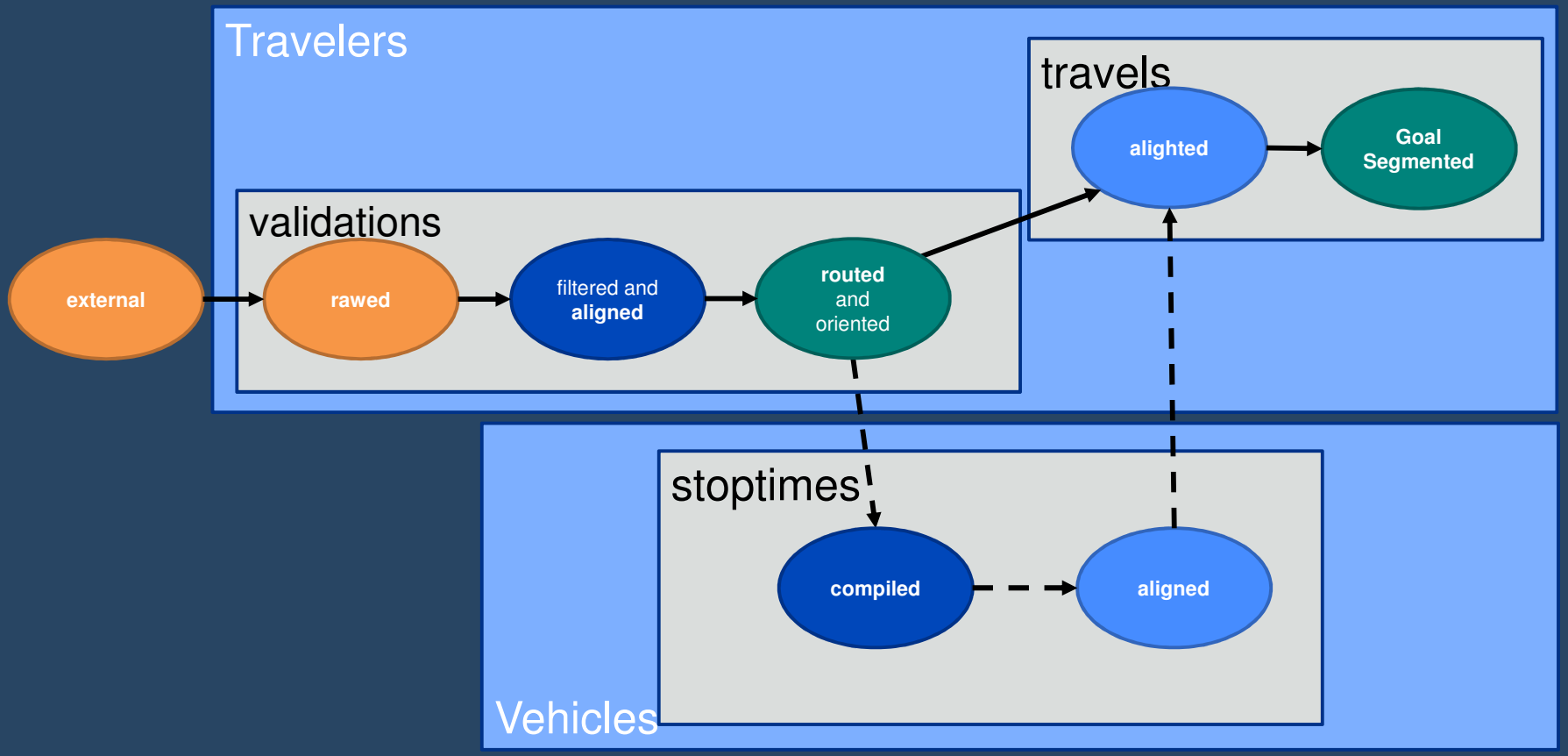
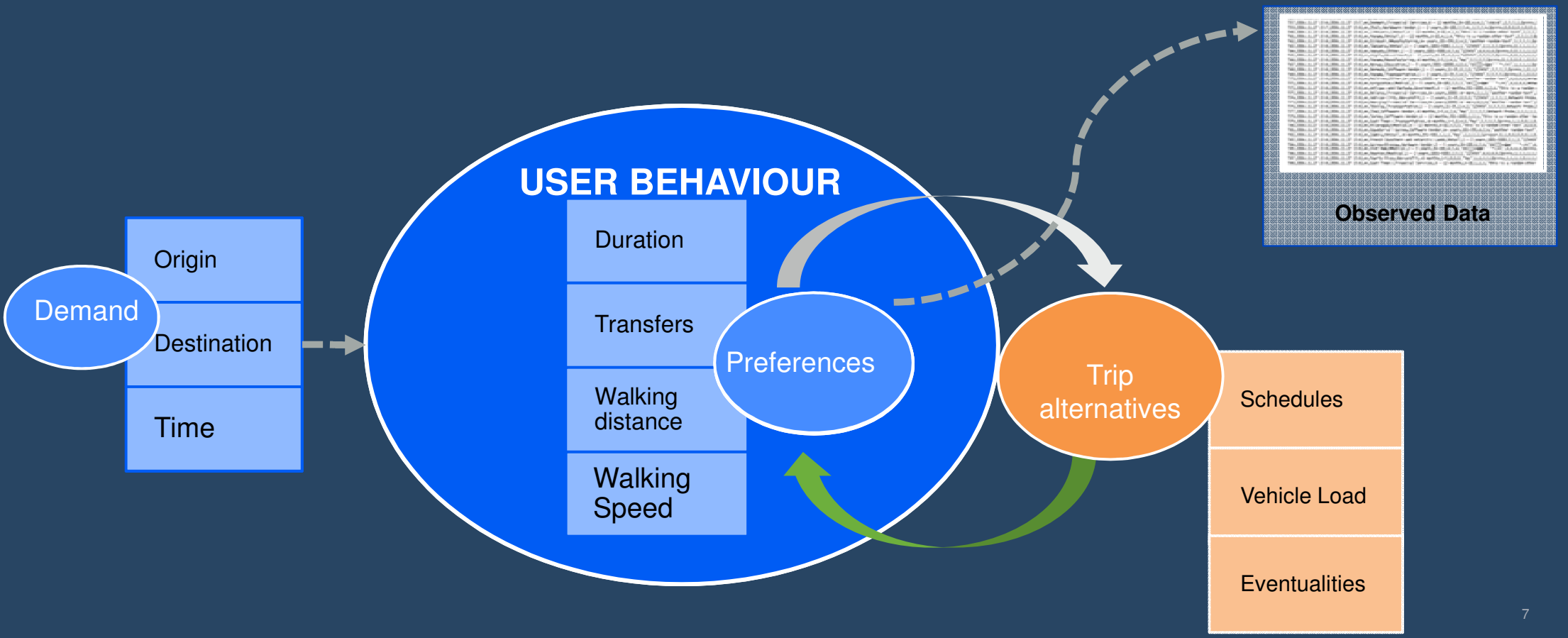
Reconstruction demand and observed scheduled from fare collection data



Learning user preferences



Integration into Mobility Analytics Platform

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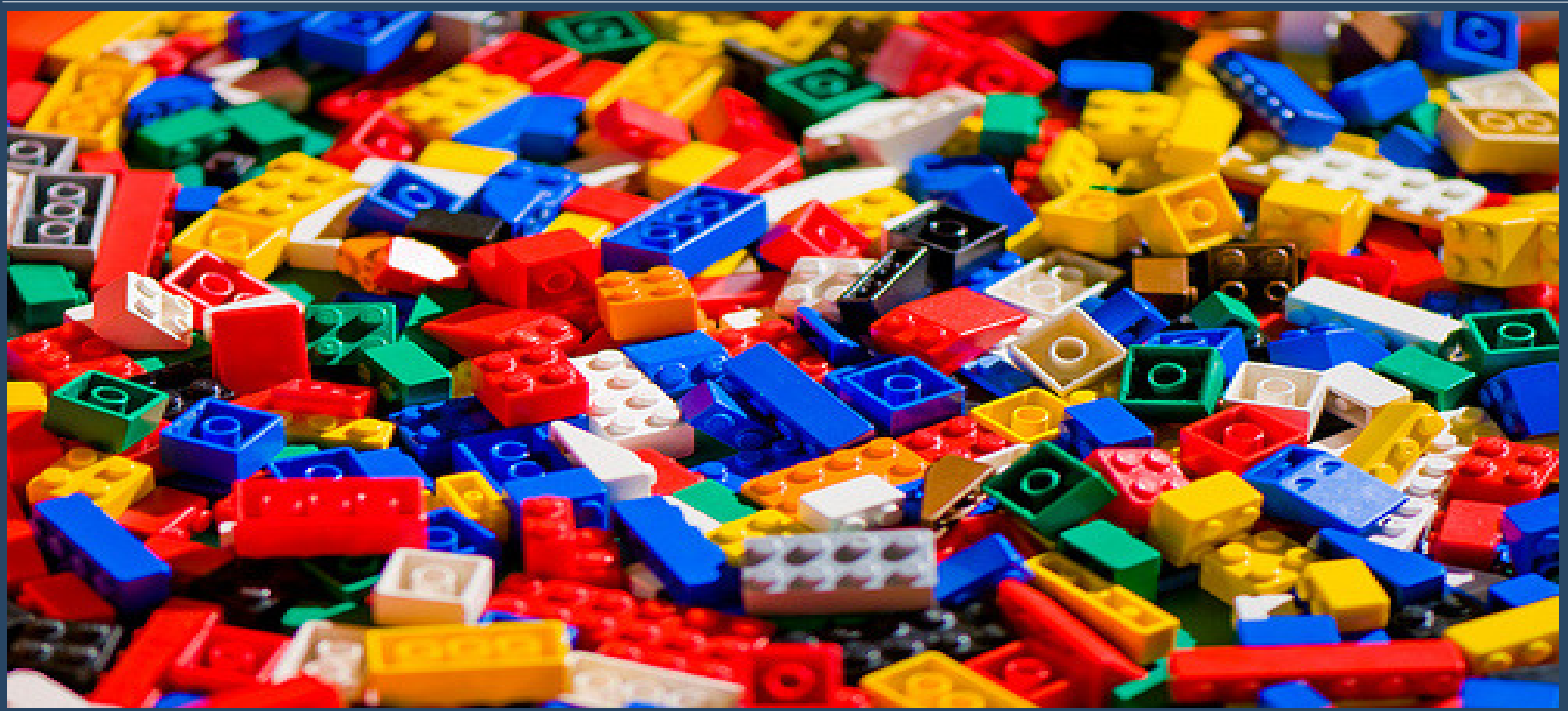
DEMO

Current Results & Challenges



Use case

Nancy (France)

Key figures

- ~ 250 K Inhabitants
- ~ 100 K Public transport tickets validations / week day
- 1032 Stops
- 2 Tramways + 36 bus routes

Data experiment

- 93196 Validations from June 3rd 2016
- 55727 qualified travels out of 60352 reconstructed passengers travels
- 2189 Reconstructed vehicle trips

Learning preferences

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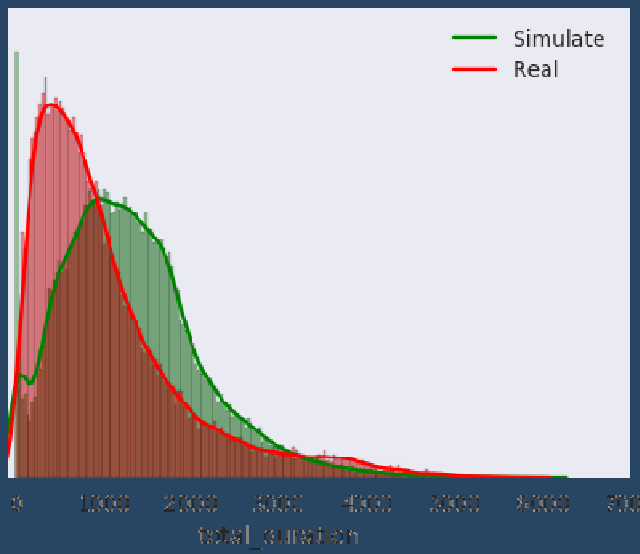
Objective function:

Distance based on correlation of travel times histograms

$$1 - \frac{(u-\bar{u}).(v-\bar{v})}{\|(u-\bar{u})\|_2 \|(v-\bar{v})\|_2}$$

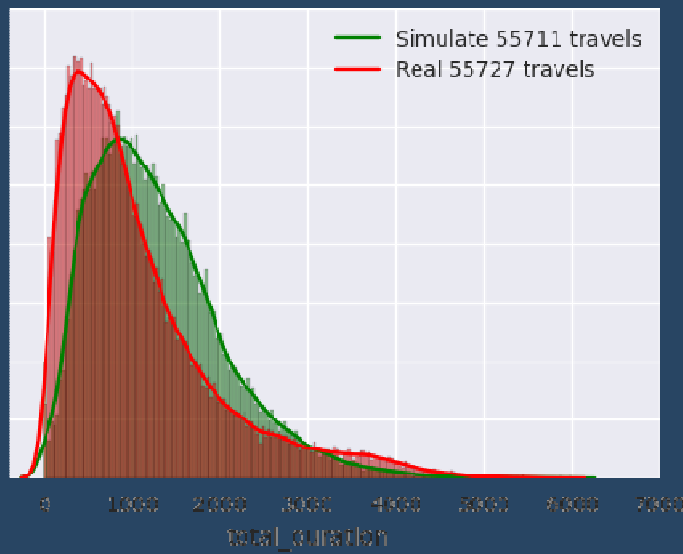
u, v are vectors capturing histograms of real travel times and simulation

Baseline: Assuming shortest path



score =0.2489

Using fitted choice model



score =0.1267

Multi legs vs single legs

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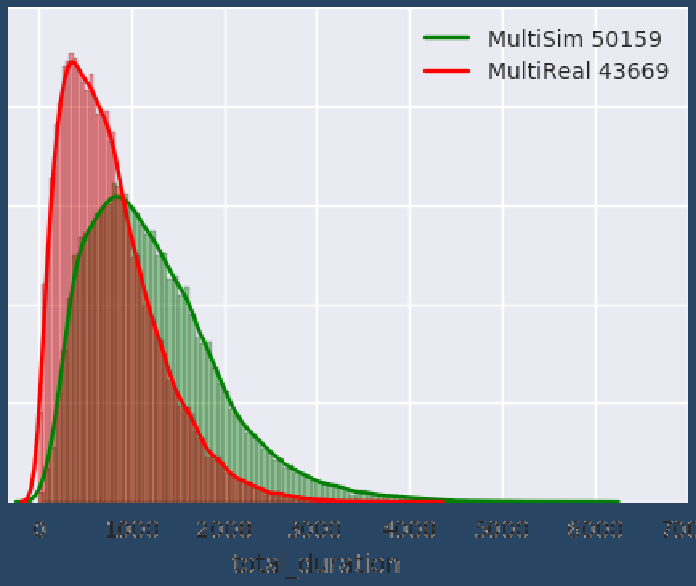
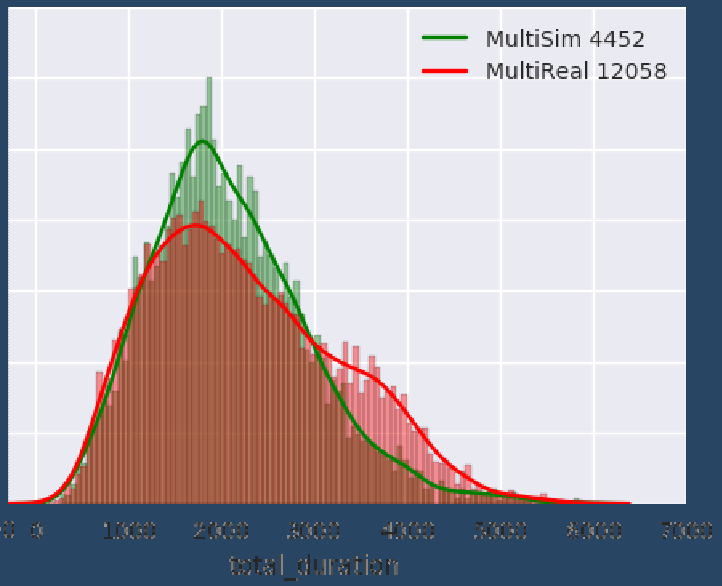
Qualitative analysis

~ 50% of <1H multi legs travels are serving multiple goals and therefore cannot be reproduced by a trip planner assuming only final destination as the goal.

Single legs trips



Multi legs trips



Conclusion & Next Steps

This work shows promising results of a game changing approach to transportation simulation and planning

Further validation

- Study stability of user choice model over different contexts and network configurations

Demand modeling

- Sample demand over a larger period
- Model actual origins and destinations
- Integrate estimates of demand using other modalities

THANK YOU