The Alan Turing Institute

TOYOTA mobility FOUNDATION

Choice, price, and traffic: an assignment model for MaaS

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Cities need to be able to model MaaS, to support policy decisions.

- For simple policy decisions, the city needs to predict what will happen.

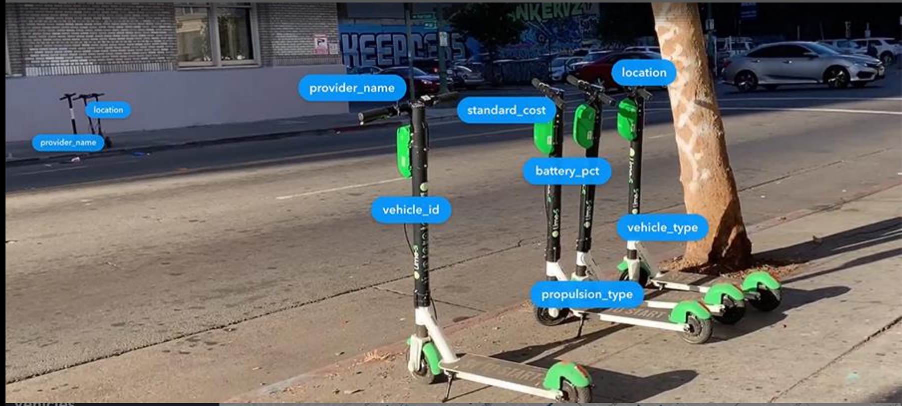
  e.g. If we licensed Uber, how many people would use it, and on which routes?

- For advanced city management, the city needs to understand how MaaS users and operators react.

  e.g. If we used micro-charging via an API, as Los Angeles is contemplating, how should we set charges?

Seleta Reynolds, general manager,
Los Angeles Department of Transport:

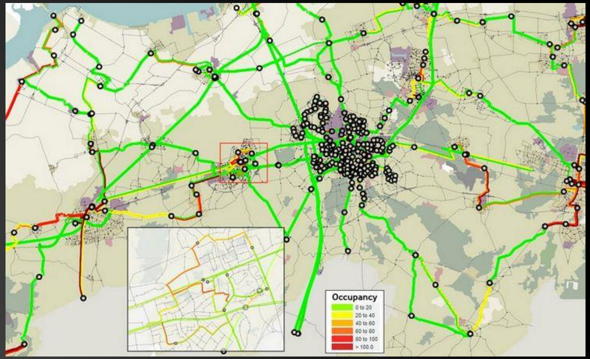
"For example, let's say the Lyft app pings the city and says, '*I want to pick up and drop off at this corner*'. But [at that corner] there's a bike lane where we don't want pickups and drop-offs. The city's operating system might say, '*You need to go right around the corner. We have a clear space for you and it'll cost you 50 cents a minute*'."



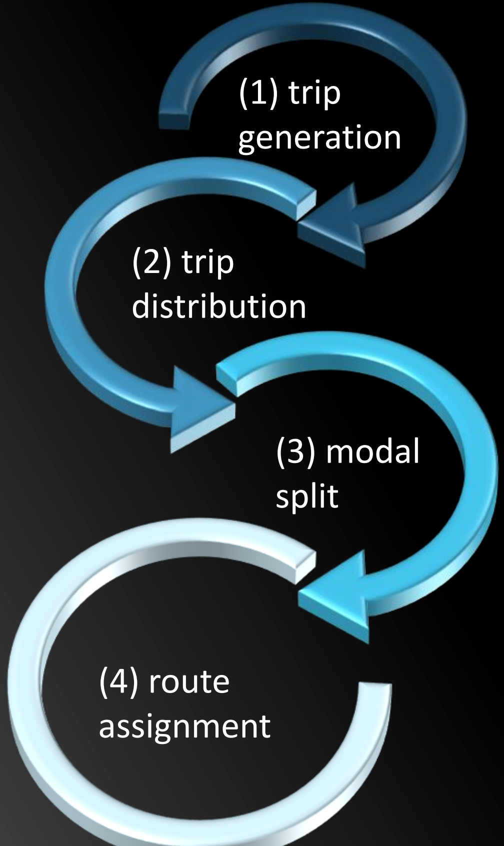
For conventional road planning, the four-step approach is in widespread use. But it doesn't work for MaaS.

The four-step model is in widespread use, for predicting traffic on roads.

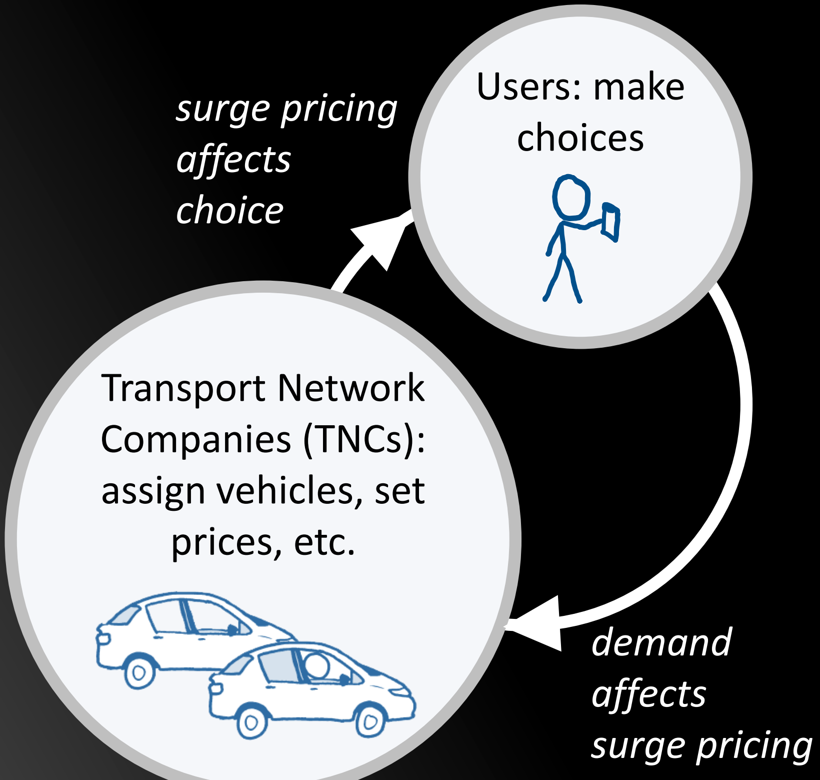
Software packages: Aimsun, PTV VISUM, etc.



In the four-step model, we estimate the number of car trips (3), before working out the routes (4).



- In MaaS, there is a feedback loop between mode choice (3) and vehicle routing (4).
- TNCs control a whole fleet, so their route assignment is much more complex than in the four-step model.



We have developed new economics-based theory for assignment, which extends the four-step model.

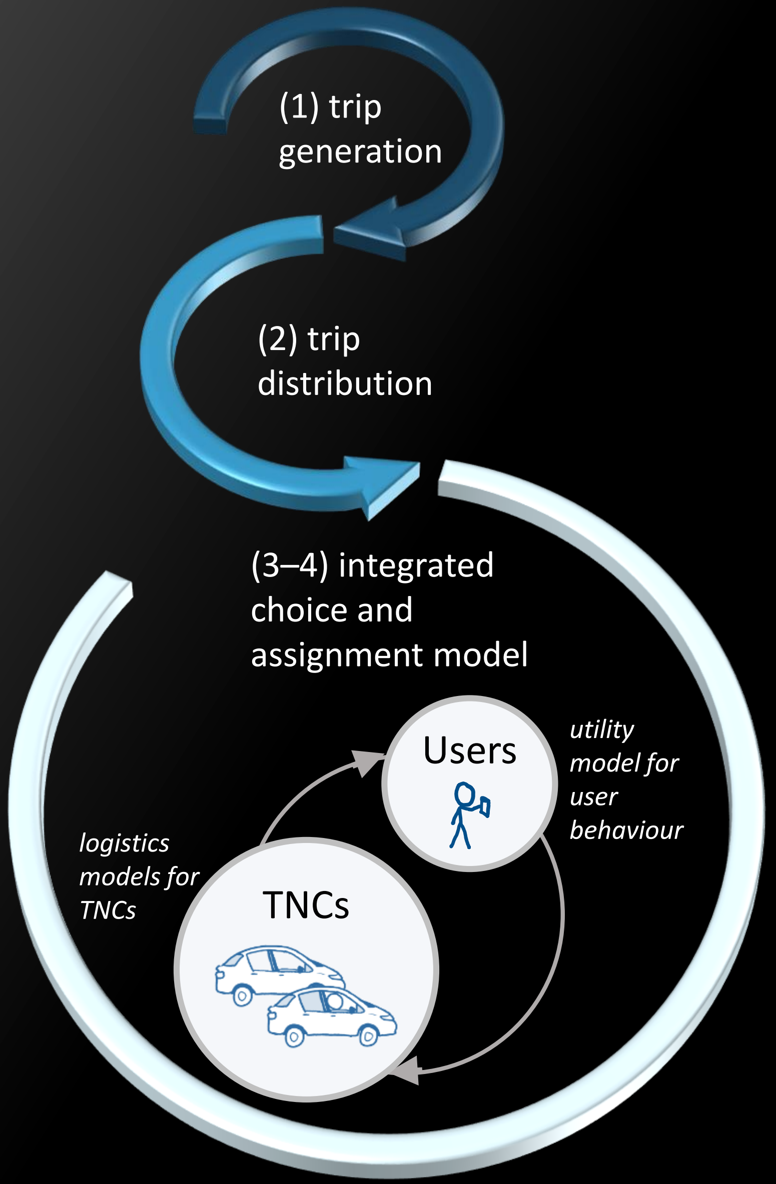
Model output

- rideshare prices
- driver assignments
- passenger choice of rideshare or other modes

Model input

- operational cost of running rideshare (travel time, fuel and wear and tear, surcharges)
- fares and travel time for other modes

We can explore policy variations by modifying the operational parameters for rideshare.



- *We model users using utility theory—this is an economics-based approach*
- *We treat TNCs as efficient fleet operators: we assume they've worked out how to manage their drivers*

Some MaaS scenarios, which we have considered in more or less detail ...

What is a fair cost for running a rideshare service?

To model this: compare a for-profit rideshare model, with a non-profit model.

Can we replace under-used bus routes with rideshare?

To model this: remove the public transport mode option from selected areas.

scenarios we've explored

Should the city levy a surcharge on empty rideshare vehicles?

To model this: increase the operational cost for empty vehicles.

Should rideshare vehicles be allowed to use bus lanes?

To model this: alter the travel time for rideshare.

Where should the rideshare company be allowed to operate?

To model this: set the user choice to always prefer other modes, outside the permitted area.

scenarios that are easy to explore: all that's needed is the data

What is the impact of rideshare on congestion and travel time?

To model this: include congestion delay in the assignment model.

Should the city levy a congestion charge on rideshare vehicles?

To model this: use two types of rideshare vehicle, one that has paid, one that hasn't.

scenarios that take a little more model development work

Case study: what is a fair cost for running a rideshare service?

- We ran two scenarios:
  (A) for-profit monopoly rideshare, competing with buses
  (B) non-profit rideshare, competing with buses
- We modelled user preference and travel demand, from the Bay Area Travel Survey 2000, and we used data from bus trips and taxi trips
  (so this is just a demonstration of the technique, not a serious estimate!)
- We modelled just the rideshare operator's task of assigning vehicles and setting prices; we ignored congestion.
  We treated the rideshare operator as efficient: we didn't model the details of driver incentives.

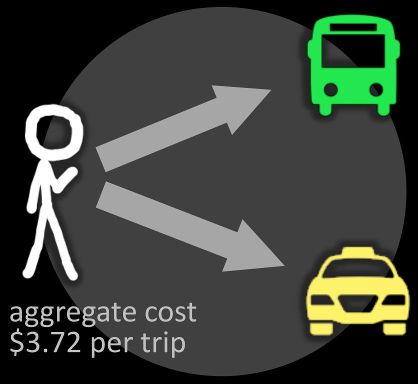
$$\text{rideshare price} = \overbrace{\text{direct cost of travel} + \text{induced cost}}^{\text{opex (operating costs)}} + \text{profit}$$

fuel cost, wear and tear, driver wages

cost of moving empty vehicles around to where they're needed

the surplus that passengers are willing to pay
(included in scenario A, not included in scenario B)

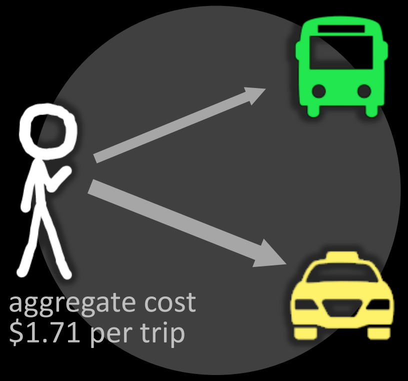
SCENARIO A:
buses, and for-profit monopoly rideshare



65% of trips are by bus
average cost $2.77

35% of trips are rideshare
average cost $5.47,
profit is 80% of fare

SCENARIO B:
buses, and non-profit rideshare



24% of trips are by bus
average cost $2.77

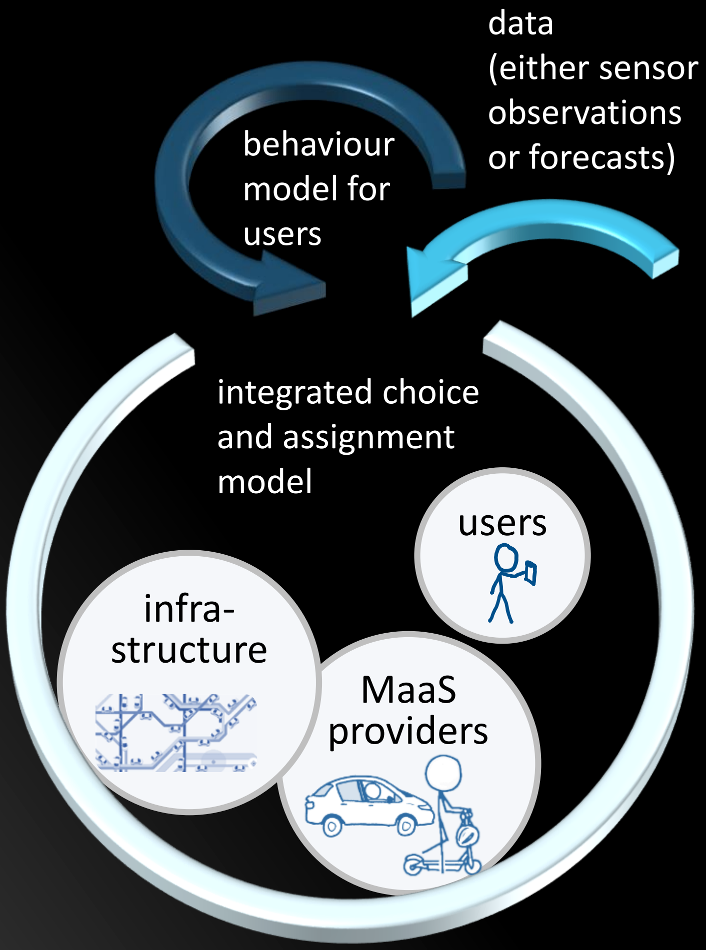
76% of trips are rideshare
average cost $1.37

Sanity check:

For this exercise, we used demand data from 2000. We found that the profit is 80%, for a monopoly rideshare operator.

A recent survey found average profit 35–38%, worldwide, for competitive operators.
https://jalopnik.com/uber-and-lyft-take-a-lot-more-from-drivers-than-they-sa-1837450373

Our model extends further, to a wide class of problems based on prediction or inference about user choice.

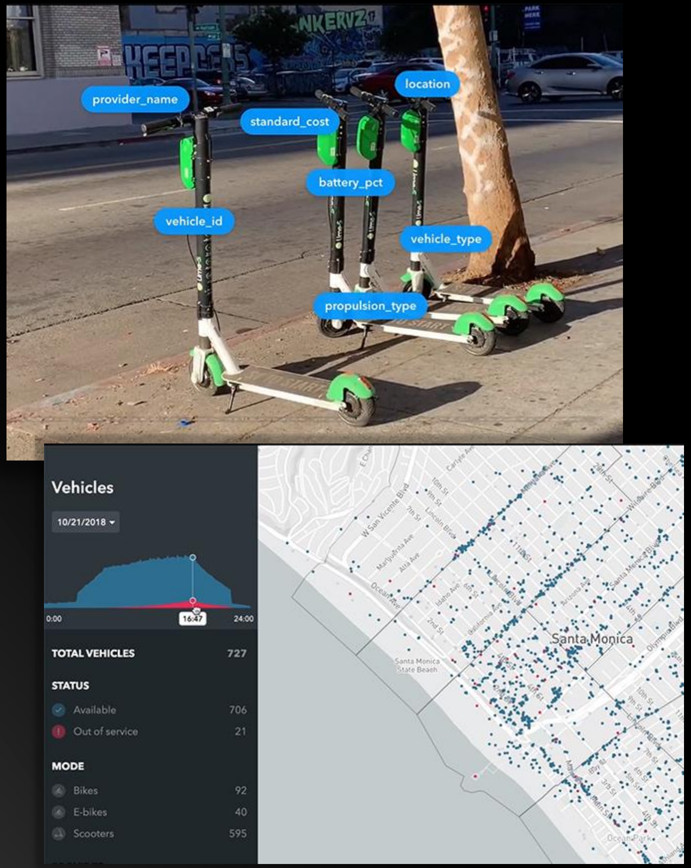


The full economic assignment model

We have developed a flexible economics-driven approach. It unifies steps 2–4 of the four step model. It permits machine-learnt user models.

How do people use the streets?

Using pedestrian counts from stationary cameras, we can infer the patterns of movement around a district.



Other MaaS options

The model can be extended to describe dockless scooters etc. This could be used to set tariffs relating to availability or clutter.

We are building a "Mobility Data Toolkit", an interactive system for exploring MaaS scenarios (and more). It combines macrosimulation, microsimulation, and report generation. See the accompanying video for more.