

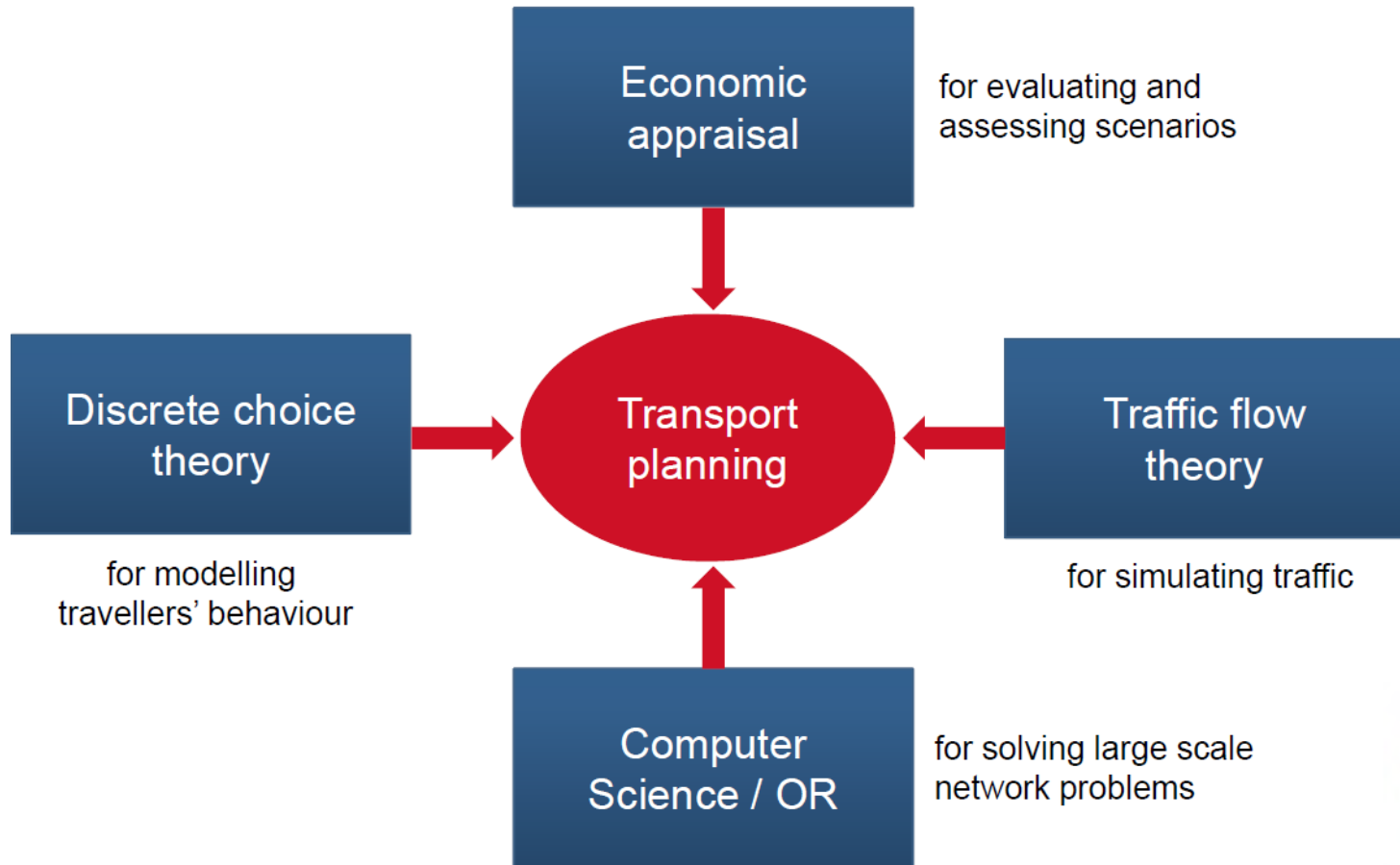
# CIE4801 Transportation and spatial modelling

## Beyond the 4-step model

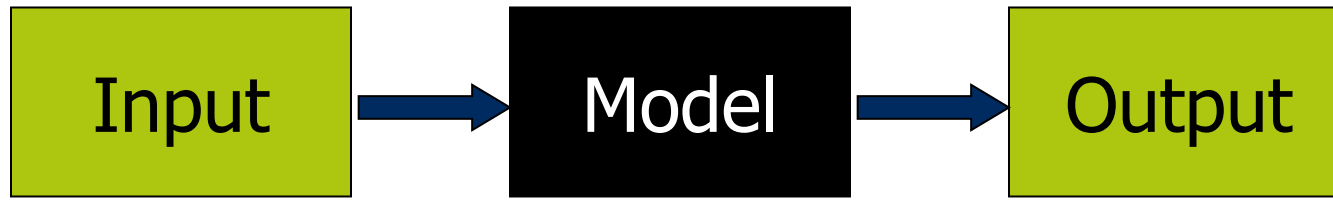
Erik de Romph, Transport & Planning

31-08-18

# Multi disciplinary



# Contents



- New data sources

- New insights
- New algorithms
- New theory
- Different behaviour

- New policies
- New visualisations
- New requirements
- New laws
- New technology

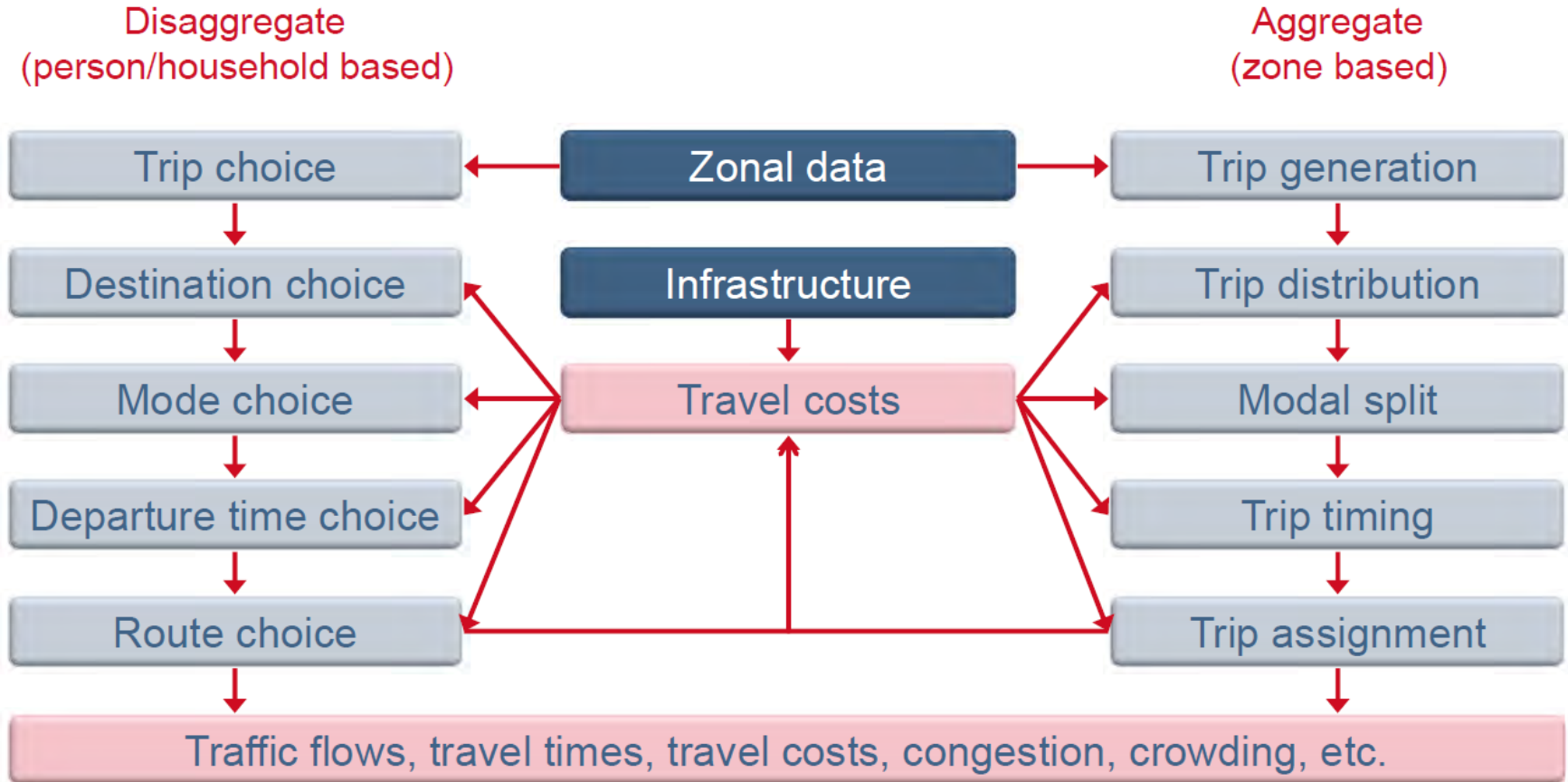
# Trends

- Dominant trend: more complexity, more detail
  - Requirement for practice
  - Models are being used for more than the purpose they were designed for (database)
  - Scientific research
- Yet, there's a need for small agile models
- Key question then is: what can be left out?  
Or is it about new modelling approaches?
- Einstein:  
**As simple as possible, but not simpler**

# Content

- The 4-step model
  - When to use what?
  - Simplifications
  - Extensions
  - Criticism
- Disaggregated models
- Dynamic models
- Data
- Model landscape
- Coming weeks

# Modelling approaches



# 1.

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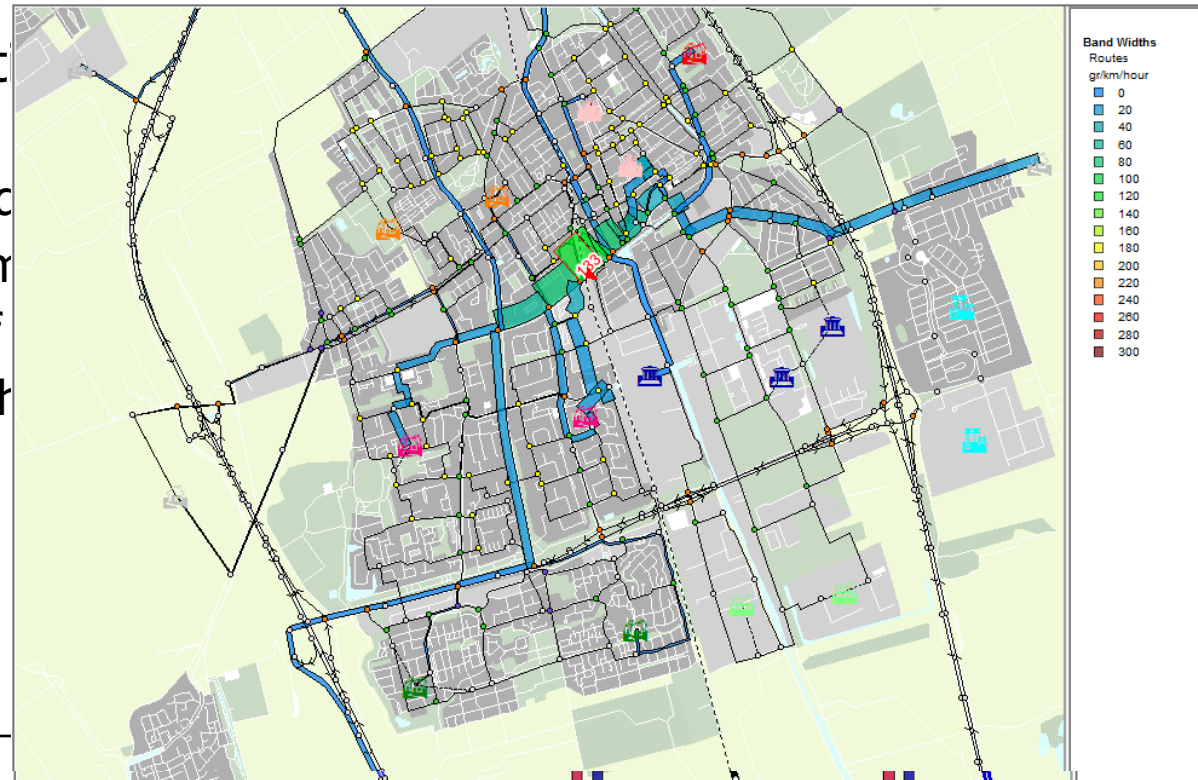
## *The 4-step model*

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# 4-step concept has more potential than just the model

- The modules are building blocks for more elaborate models as well

- You can use the distribution purposes as well:
  - What's the demand
  - Where do they come from
  - What is the role of
  - Why do they use the





# Simplifications

- The order to use the modules is fixed
- However it depends on the research question which module you start with and/or which modules you skip

- If you're only interested in car?

Skip mode choice

- If you want to know the effect of a one-way street strategy?

Assignment only

- If you want to know the impact of changes in the PT-network

Mode choice and assignment

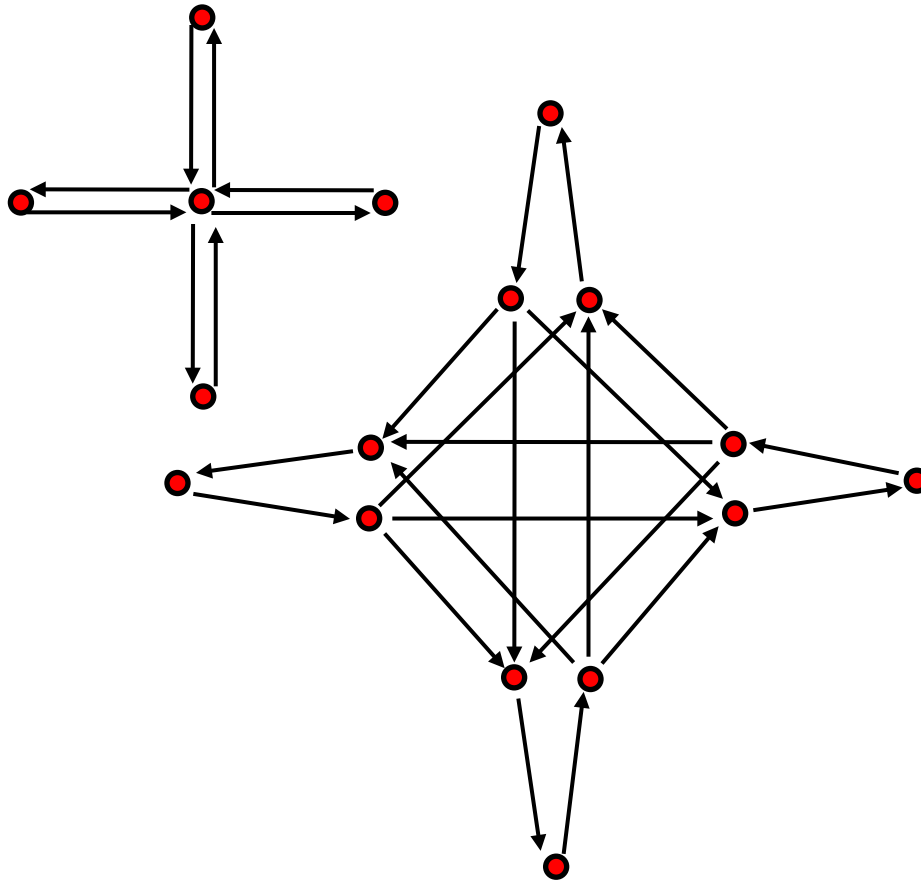
- Growth factoring – elasticity models

Assignment only

# Extensions

- Junction delays
- Parking
- Multi-modal trips
- Traffic Management
- New modes
  - Sharing systems
  - Autonomous vehicles

# Extensions



## Junction modelling

From simple to complex

- Fixed turn delays per type
- Define travel time functions per turn
  - Fixed capacity (number of lanes per direction)
  - Capacity depends on upstream node (merge, priority)
  - Capacity depends on green times
- Determine optimal green times during assignment

# Extensions



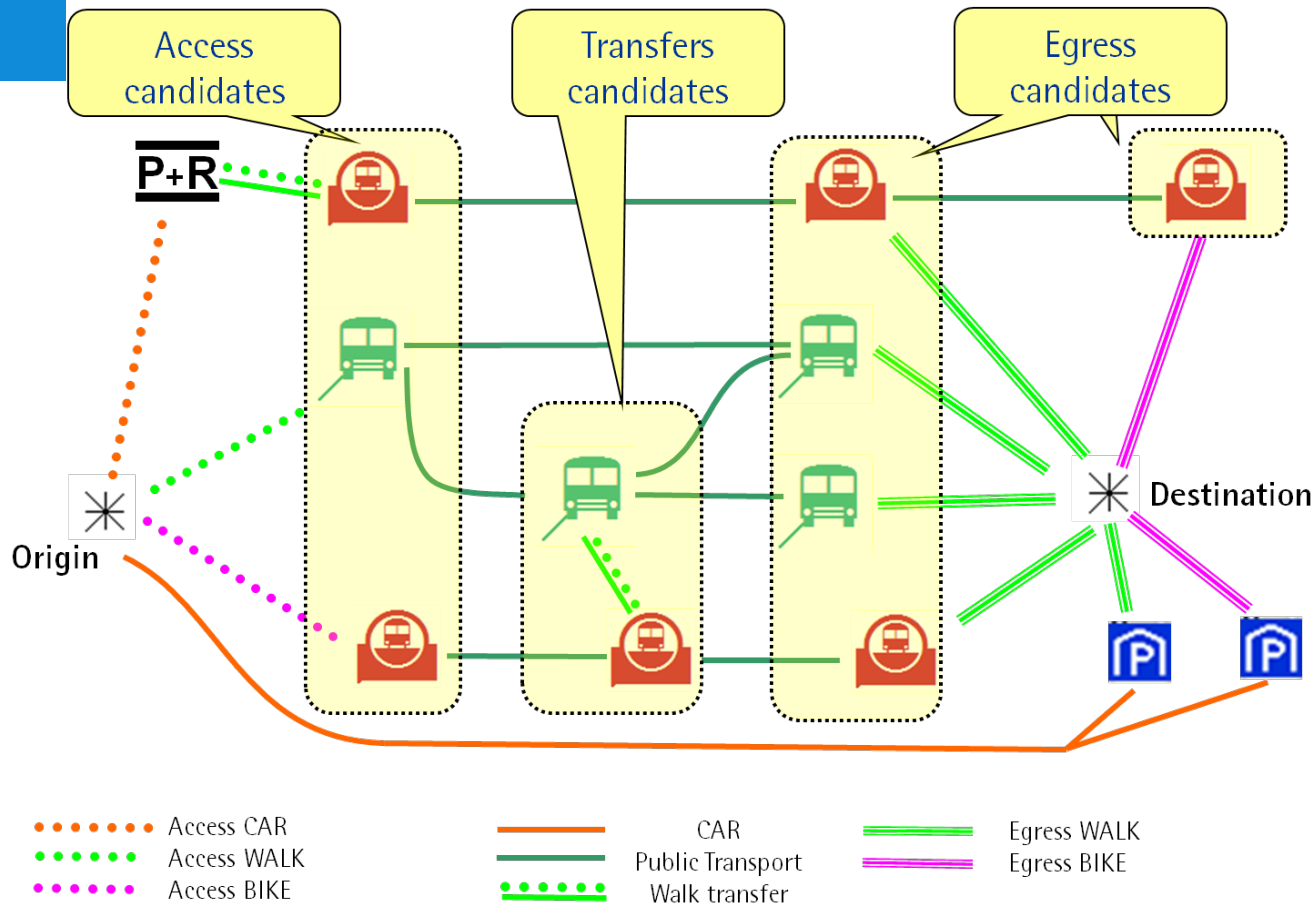
Parking

Special links

- Limited capacity
- Route choice
- Extra component in generalised cost function
  - Destination choice

# Extensions

Multi modal trips  
Public Transport  
• Access-Egress modes



# Which components are criticised?

- Trip generation
  - Ignores actual behaviour with respect to activities
- Trip distribution
  - Human behaviour – Human characteristics
  - Little known about quality of output
  - Trip chains
- Assignment
  - Congestion, queuing
- Input data

Disaggregate models

Activity based models

New data sources

Dynamic models

New data sources

# 2.

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## *Disaggregate models*

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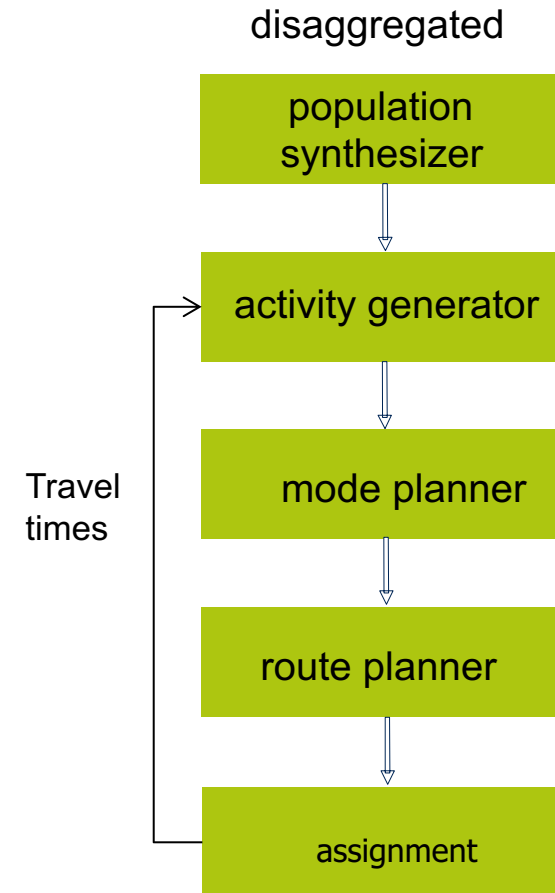
# Disaggregate modelling

- Perspective is a person in a household
- Based on discrete modelling
  - Choices between discrete alternatives
  - Utility maximisation
  - Logit models
- Many different model structures possible
- Base for National Model LMS/ Regional models NRM
- Scientific research



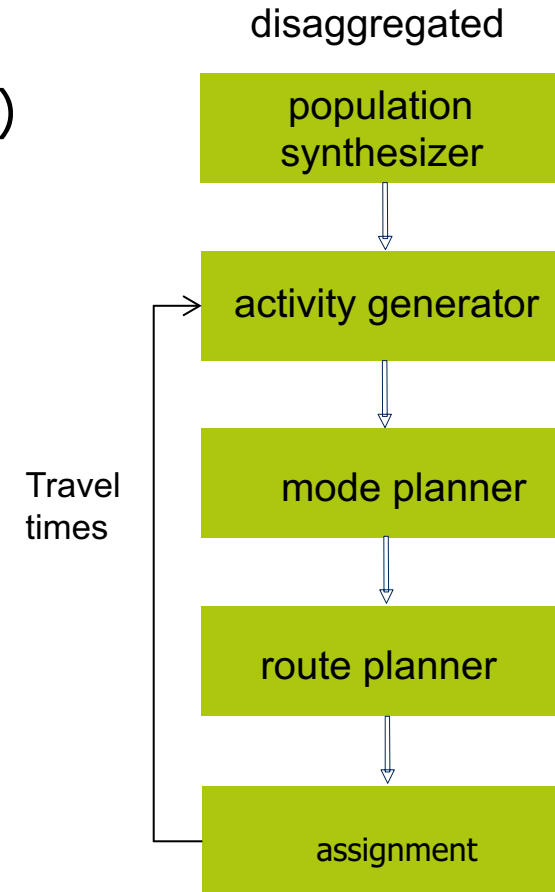
# Activity based modelling

- Especially relevant when you expect changes in activity patterns
- Unit is person in a household
- Models the scheduling of activities in a chain considering both the utilities of activities and the disutilities of travelling
  - E.g. including coordination between household members
- Note that choice modelling is, again, an important tool



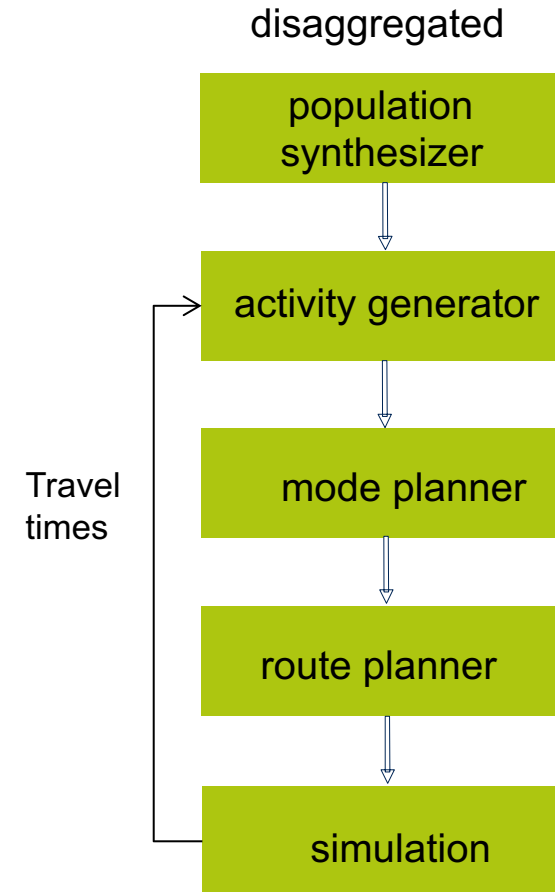
# Activity based modelling

- More common in the USA (CT-RAMP, COMPAS)
- Expertise at TU Eindhoven: Albatross (Timmermans & Arentze)



# Agent based modelling

- Micro simulation of entire population
- Agent based modelling
  - MatSim Europe
  - TRANSIMS USA
  - Open source development
  - Mainly academic



# 3.

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## *Dynamic assignment*

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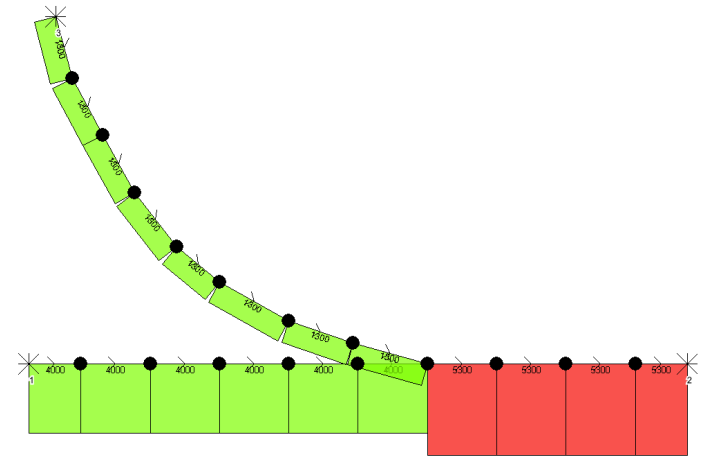
# What's wrong with the assignment?

- Modelling of long distance trips, e.g. The Hague – Arnhem in a peak hour
- The (non?) modelling of congestion
- The quality of the travel times
- **Answer:** Dynamic assignment

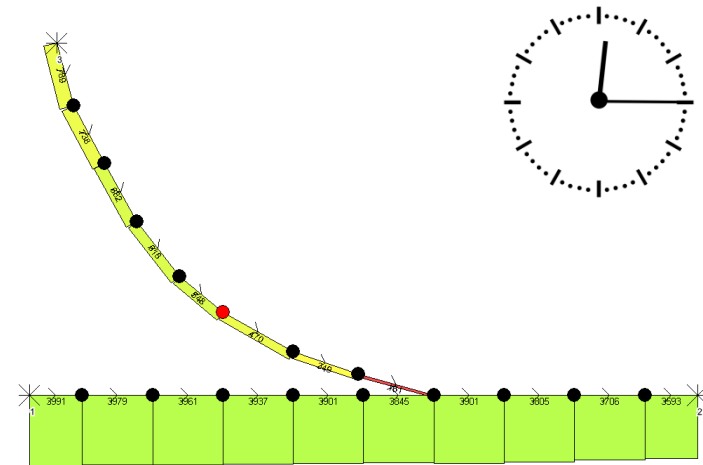


# Static vs Dynamic

Static

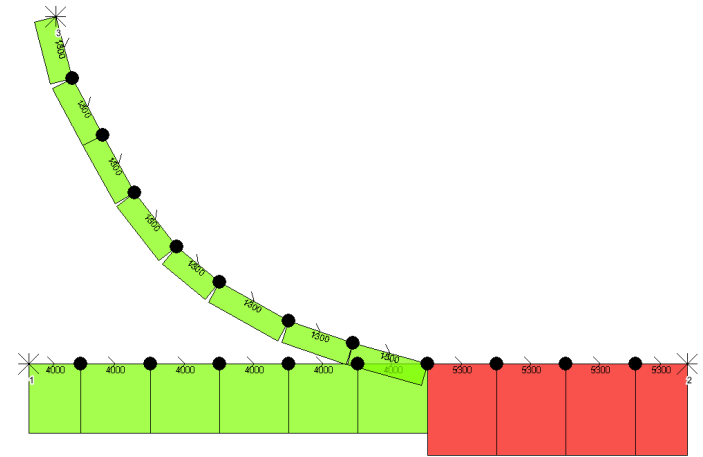


Dynamic



# Static vs Dynamic

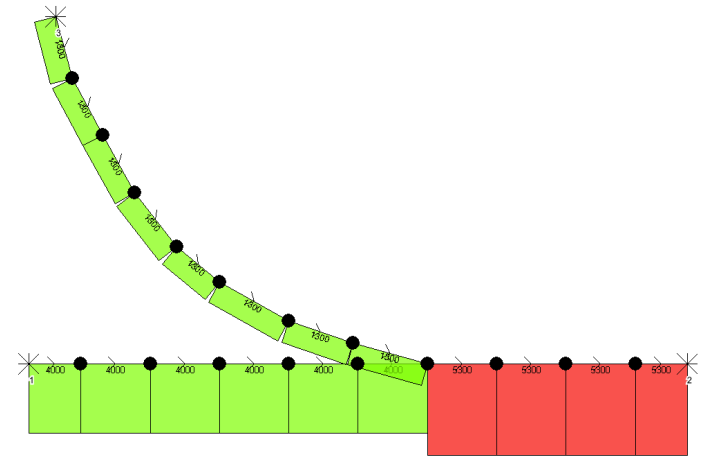
Static



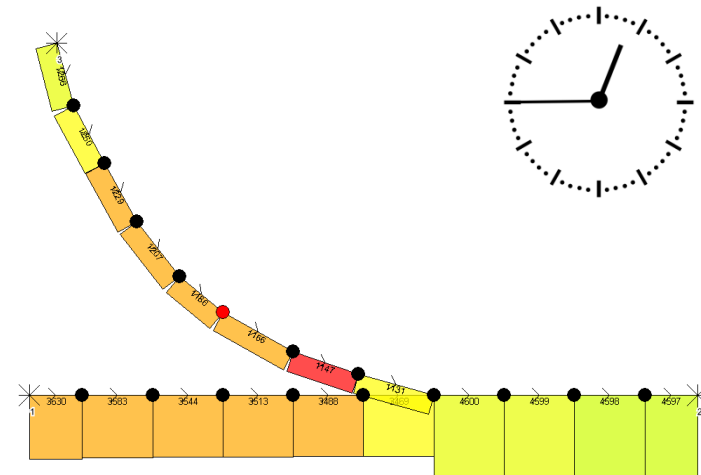


# Static vs Dynamic

Static

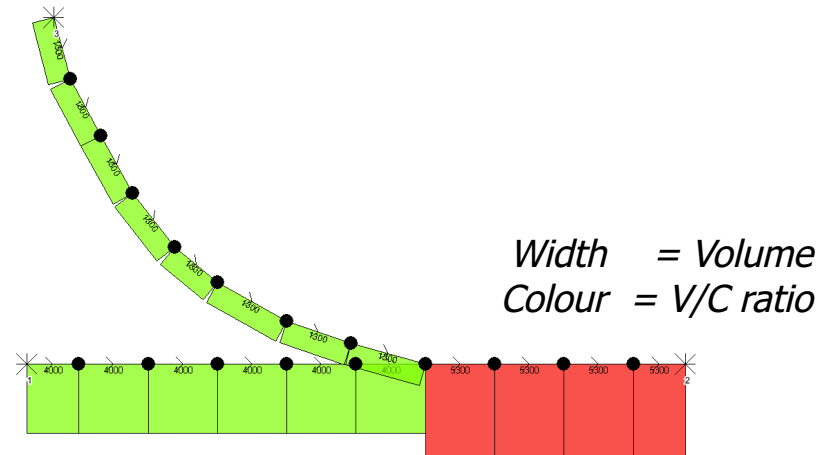


Dynamic

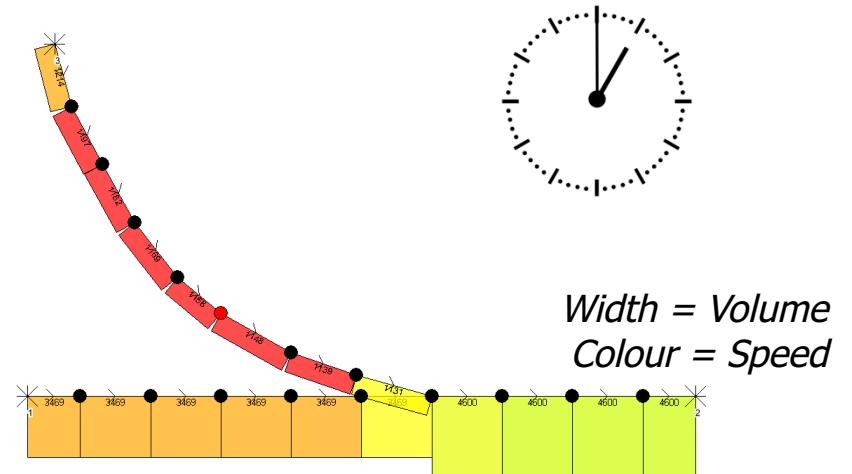


# Static vs Dynamic

Static



Dynamic



# Dynamic assignment

- Modelling the propagation of traffic through the network
- Thus
  - Models capacity as a hard constraint
  - Models the upstream shockwave of congestion and thus blocking back
  - Models the way congestion dissolves
- Consequences
  - More detailed data on networks (esp. for potential bottlenecks)
  - Data needed on departure times per zone (OD-pair)
  - More computation time
  - Complicated to apply (sensitive)

# 4.

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## *Data*

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# Data

- Traditional
  - Road side interviews
  - Manual traffic counts
  - Loop detectors
- Today
  - Electronic loop detectors
  - Camera
- New
  - Blue tooth – wifi
  - OV chipcard / GOVI
  - GSM cell phone
  - Navigation devices
  - Apps



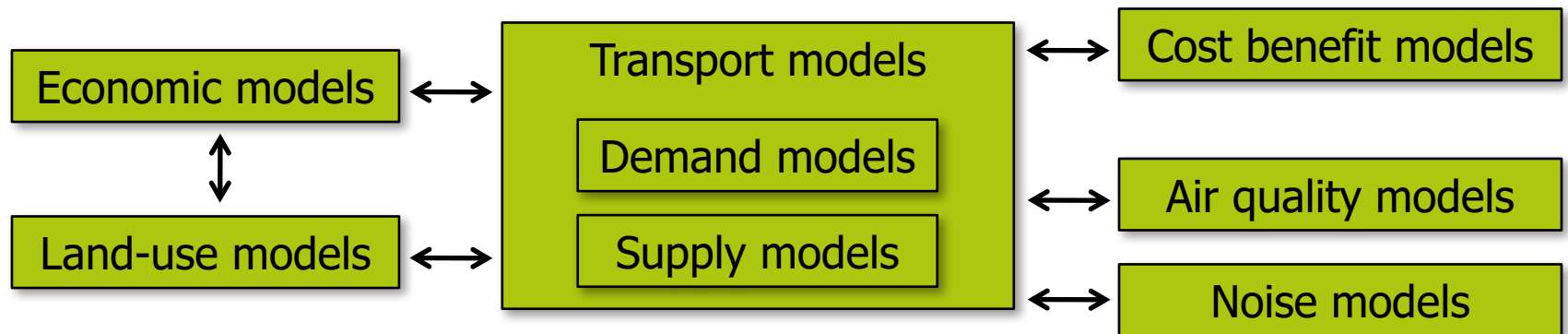
# 5.

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## *The model landscape*

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# Model landscape



# Model landscape

## Demand models

macroscopic  
aggregate gravity models

mesoscopic  
disaggregate choice models

microscopic  
disaggregate activity-based models

## Supply models

macroscopic  
static and dynamic assignment models

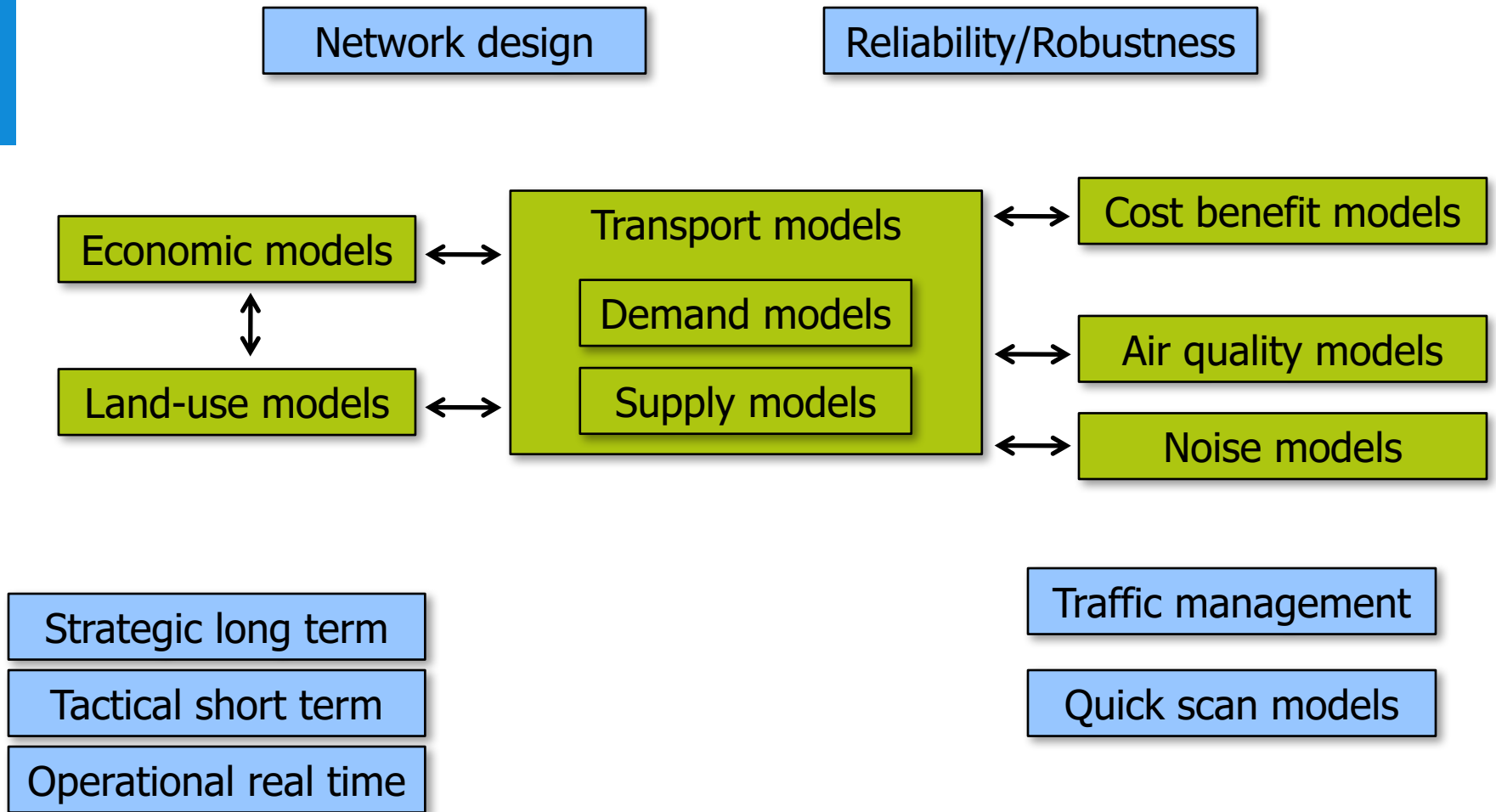
mesoscopic  
dynamic assignment models

microscopic  
dynamic simulation models





# Model landscape

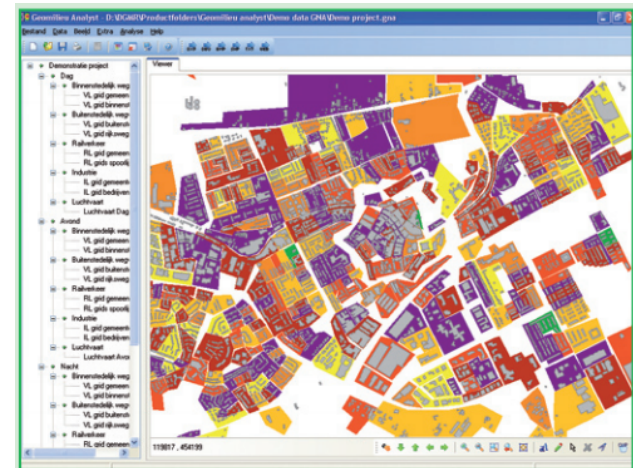
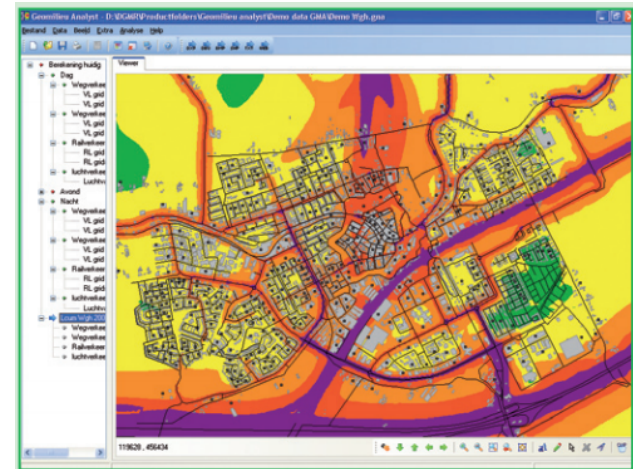


# Link with other transport models

- Two main options
- Linking of models to achieve consistency
  - E.g. using a regional model to determine ingoing, outgoing and through traffic for an urban model
- Use data of a model as an input for a more detailed model
  - Usually a 'cut out'
  - Usually requires new calibration of network and OD-matrix

# Environmental models

- In many studies the impact on noise hindrance and air quality needs to be quantified
- For both topics elaborate models exist which try to model physical phenomena using traffic flows as an input
- For both topics there's a dedicated data requirement
  - For noise hindrance the truck flows during the night are often critical
  - For air quality a yearly average is used with again a distinction in vehicle types



# 6.

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## *Research*

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# Policy and research topics

- Agile, quick-scan models
- True multi-modality
- Activity based and dynamic assignment
- New data sources – new models
- Reliability in transport
- New behaviour / new technology
- Network design problems

# Challenges

- Every topic sets requirements for the building blocks of the model
- How to combine dynamic assignment with discrete time schedules?
- How to model behaviour in case of exceptional conditions? Does the equilibrium principle still hold?
- How do all kinds of information services affect network usage? Adaptive route choice instead of pre-trip route choice
- In network design and in robustness/reliability analyses you need many network evaluations. So how can you speed up a model run?