

CIE4801 Transportation and spatial modelling

4-step model reprise, forecasting

Rob van Nes, Transport & Planning

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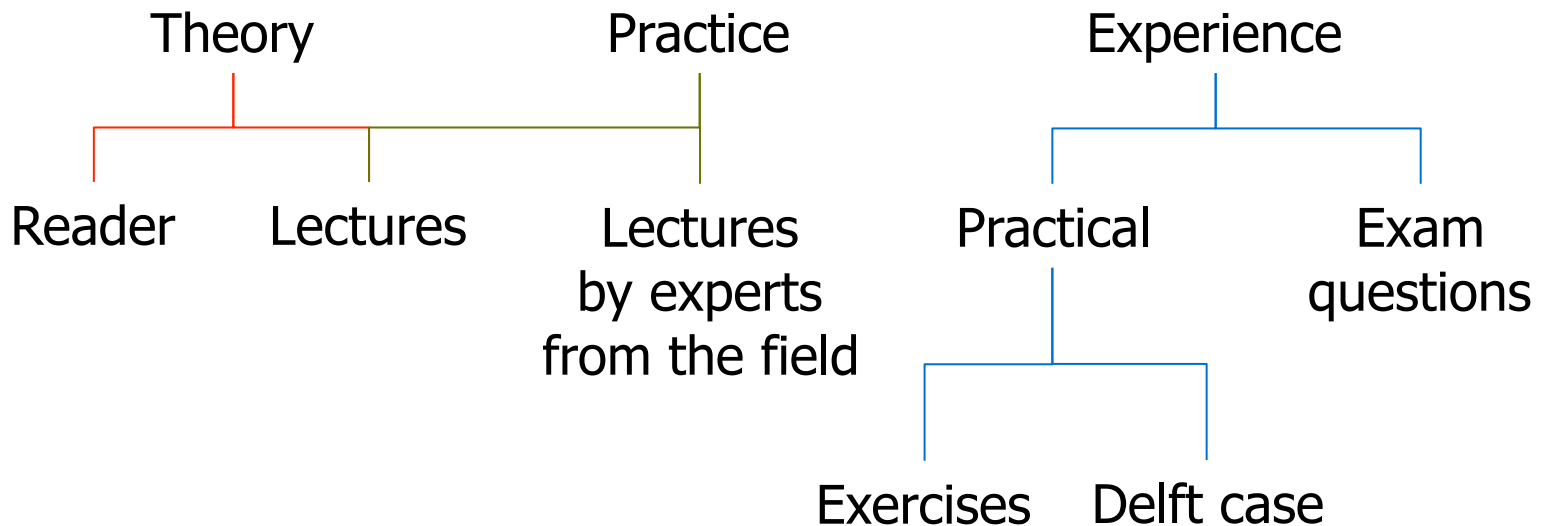
Contents

- 4 Step model: reprise
 - Your opinion on the models we discussed
 - Some comments
 - Aggregate and disaggregate models
 - Feedbacks
 - Brasesse paradox
 - Multimodality
 - Nested Logit
- Using the model in a study
 - Matrix adjustment (growth factor)
 - Just running the model
 - Pivot point method
- Model data and your (possible) MSc-thesis
 - What to do if you don't get what you want

1.

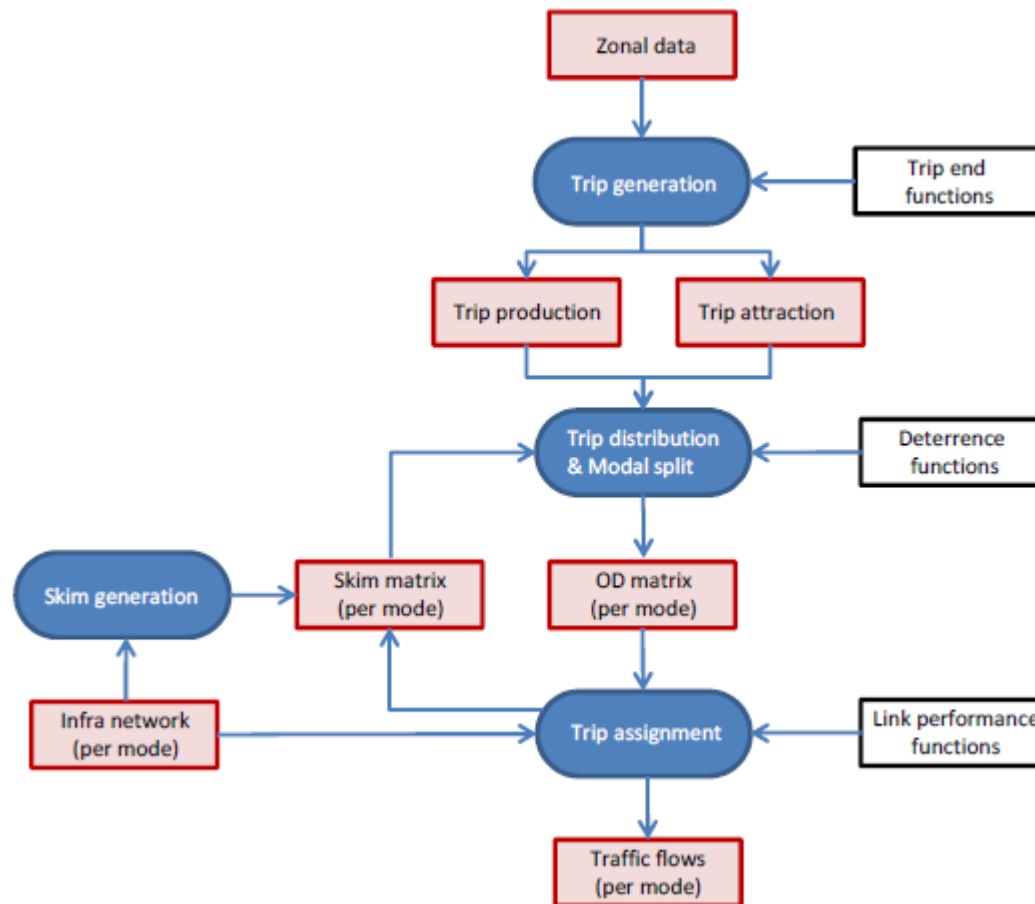
4 Step-model: reprise

Set-up course

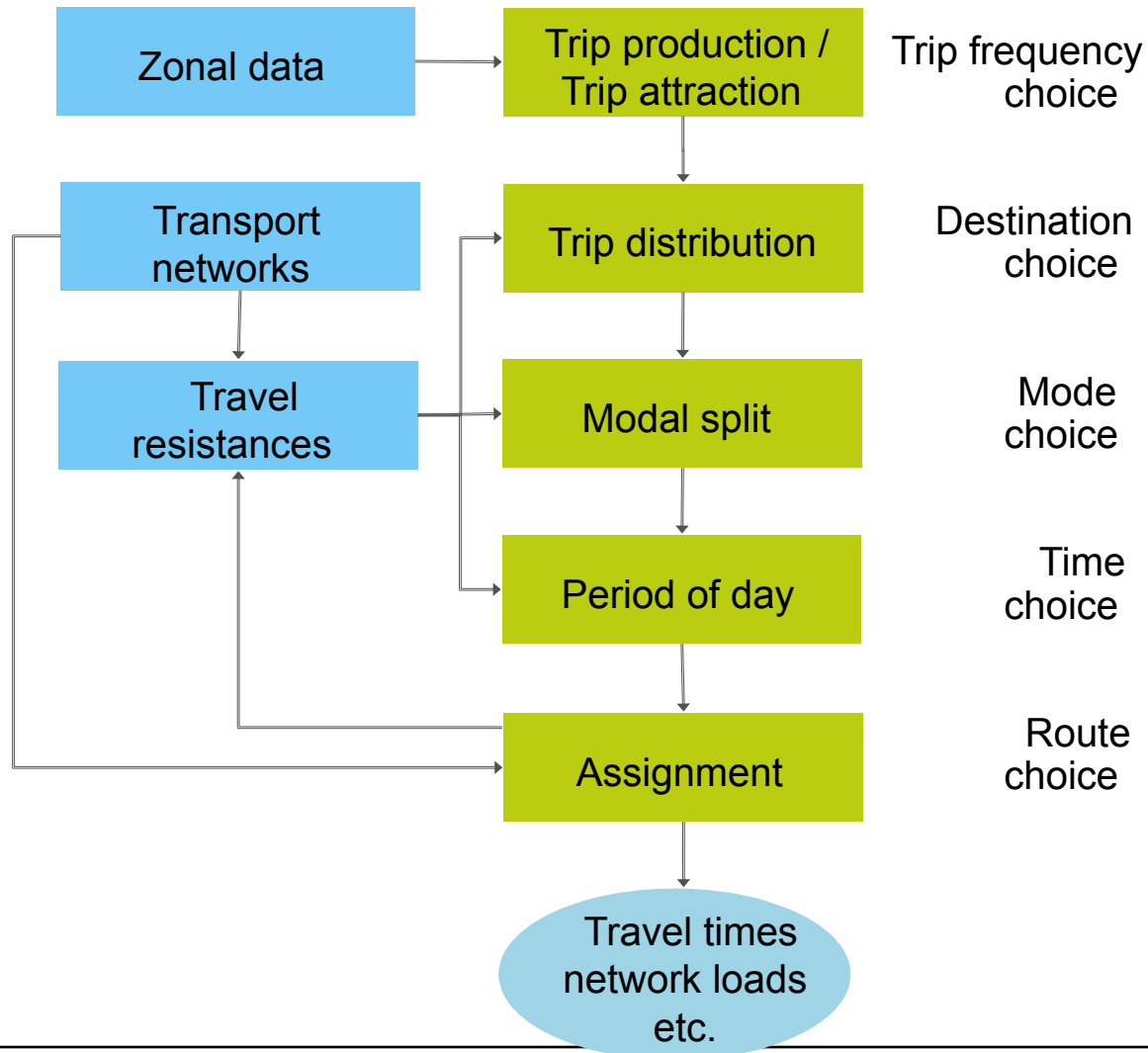


First: Transportation modelling
Second: Spatial modelling

Alternative scheme of 4-step model



How good is it?



Requirements of lecture 1

- Proper representation of the transportation system
or
Capture the key mechanisms of the system
- Theoretically underpinned
- Empirically validated
- As simple as possible, but not simpler

Overview of approaches

	Descriptive		Choice behaviour
Trip generation	Regression	Cross classification	Stop & Go
Distribution	Analogy - Gravity model - Entropy model	Growth factor model	Destination choice
Modal split	VF-ratio		Mode choice
Simultaneous distribution modal split	Gravity model $F_{ij} = \sum_v F_{ijv}$		$c_{ij} = \text{logsum}$
Time of day	Fixed shares		TOD choice
Assignment	AON	DUE	Multiple routing SUE

Possible segmentations?

Trip generation	Trip purpose	Car ownership Household size	Person characteristics
Distribution	Trip purpose	Mode	
Modal split	Car ownership		
Simultaneous distribution model split	Mode?		
Time of day	Trip purpose?		
Assignment	????????		

Overview special issues

Zones	Cordon model	Study, influence and external area	
Network	Connectors		
Trip generation	External zones	Balancing	
Distribution	Intrazonal costs	Through traffic	Short trips
Modal split	Car ownership	Car occupancy	Parking
Simultaneous distribution model split	See above		
Time of day			
Assignment	Trucks		

2.

Some comments

*Aggregate/ disaggregate models, feedbacks,
multimodality and nested logit*

Agregate and disaggregate models

Main concept

Single group
=> Average traveller



Individual

Common interpretation

Descriptive models



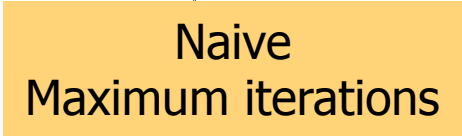
Choice models

Practice

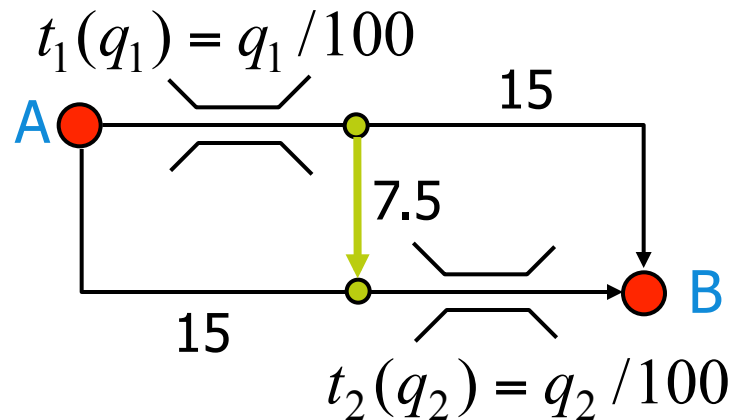
Descriptive models
for sets of groups



Choice models
for groups of individuals



Braess paradox in traffic assignment



$$T_{AB} = 1000$$

DUE:

$$f_1 = 500$$

$$f_2 = 500$$

$$t_1^{AB} = t_2^{AB} = 20$$

DUE with new (green) connection:

$$f_1 = 250$$

$$f_2 = 250$$

$$f_3 = 500$$

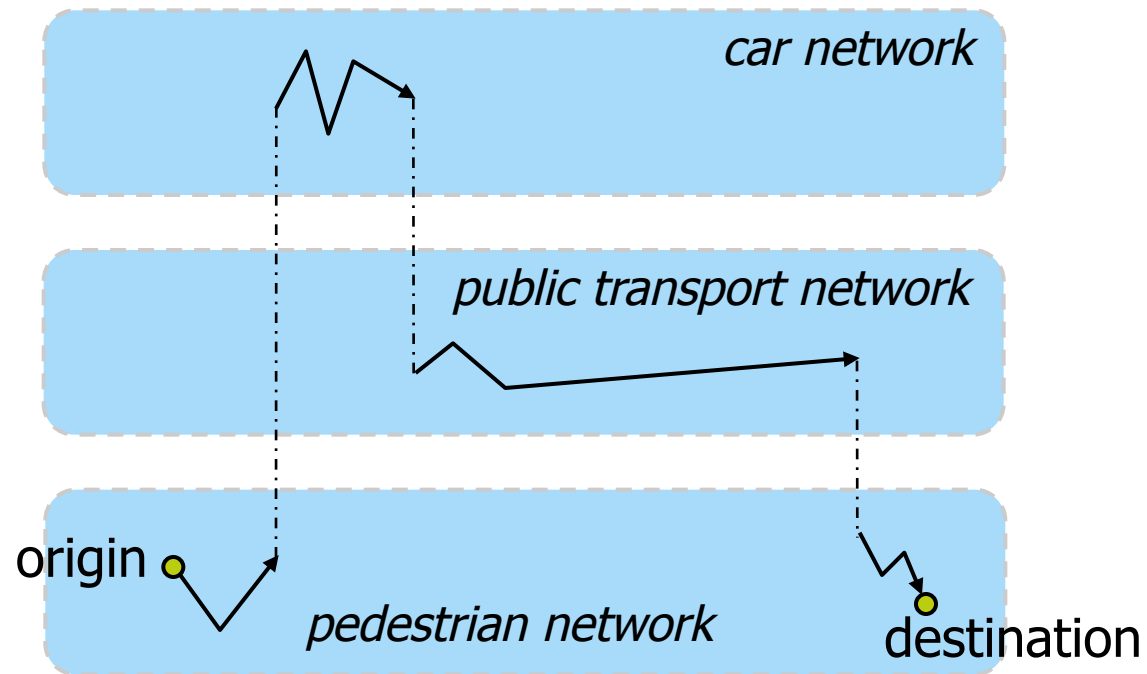
$$t_1^{AB} = t_2^{AB} = t_3^{AB} = 22.5$$



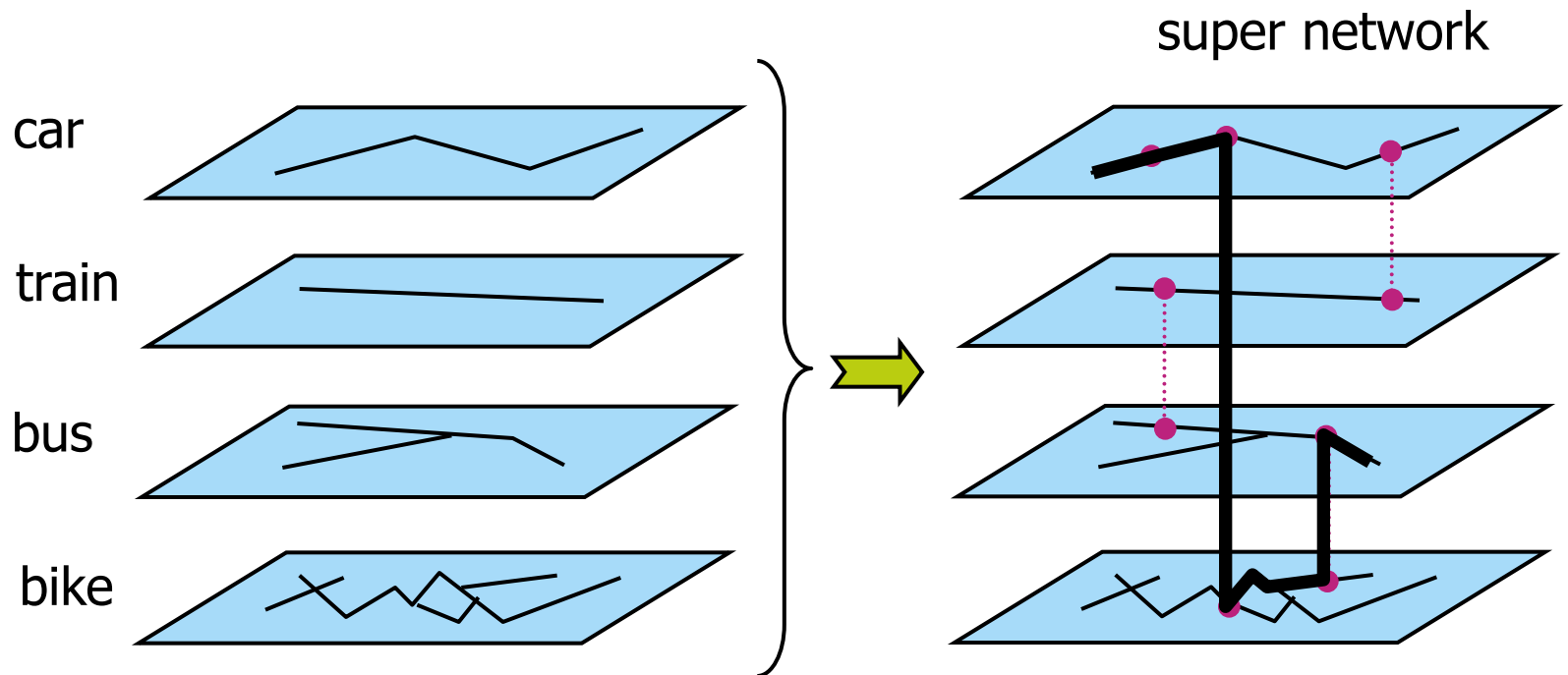
Multimodality?

- Approach so far: clear split between car, public transport (and slow modes)
- Special case: separate modes for train and BTM
- 80% of train travellers use other modes for access and/or egress
 - Bus/tram/metro, but also bike and car
- So where do we find the cyclist to the station?

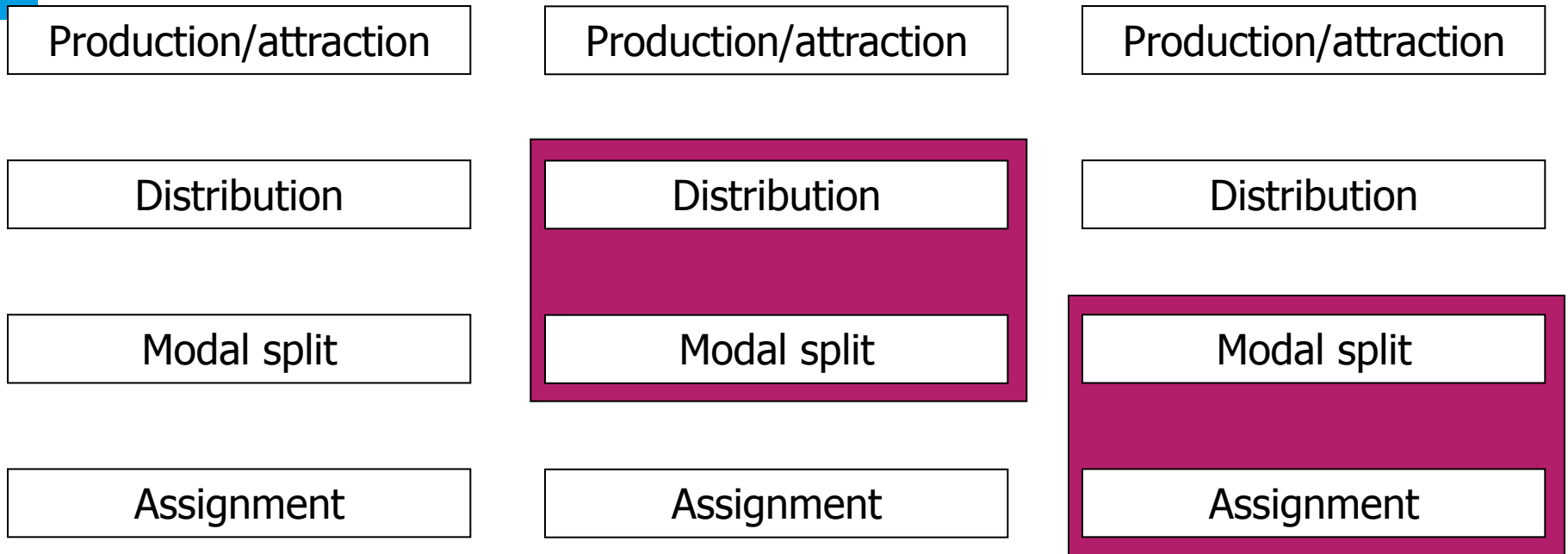
Multimodal trips



Simultaneous route/mode choice



Alternative model structures



Nested logit: Classic example

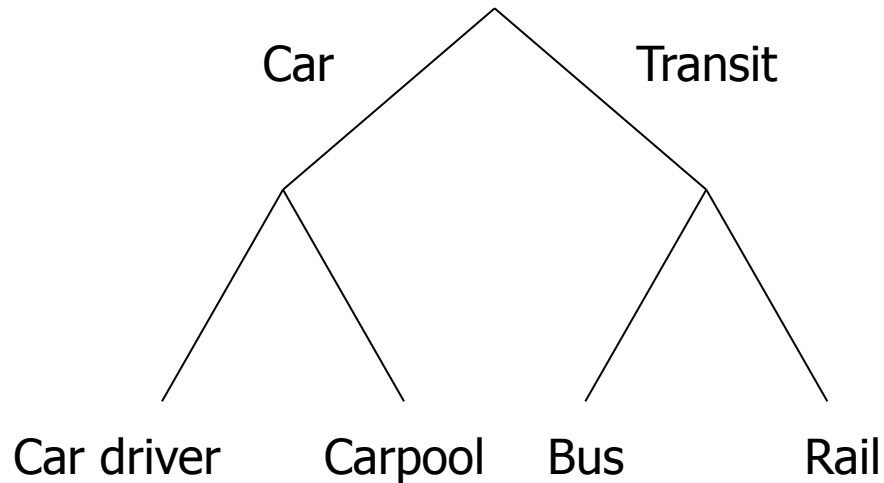
- Red and blue bus problem



Coping with correlations: Nesting

- Nesting accounts for (unobserved) similarities within nests: mix of correlation, simultaneousness and hierarchy
 - It does not necessarily imply a sequential order of choices!
- Special application/interpretation: Conditional choice:
 - Choice for alternative given choice for nest
 - Lower level choice options are part of higher level utility

Typical example



$$P_i = \frac{e^{V_i}}{\sum_j e^{V_j}} \quad \longrightarrow \quad P_i = \frac{e^{V_i/\lambda_k} \left(\sum_{j \in B_k} e^{V_j/\lambda_k} \right)^{\lambda_k-1}}{\sum_{l=1}^K \left(\sum_{j \in B_l} e^{V_j/\lambda_l} \right)^{\lambda_l-1}}$$

Decomposition in two logits

Split utility in two parts:

- variables describing attributes for nests (aggregate level): W_k
- variables describing attributes within nest: Y_j

$$U_j = W_k + Y_j + \varepsilon_j \quad j \in B_k$$

Probability alternative is product of probability of alternative within nest and probability of nest

$$P_i = P_{i|B_k} P_{B_k}$$

Decomposition in two logits

Resulting formulas

$$P_{B_k} = \frac{e^{W_k + \lambda_k I_k}}{\sum_{l=1}^K e^{W_l + \lambda_l I_l}}$$

$$P_{i|B_k} = \frac{e^{Y_i / \lambda_k}}{\sum_{j \in B_k} e^{Y_j / \lambda_k}}$$

$$I_k = \ln \sum_{j \in B_k} e^{Y_j / \lambda_k}$$

Logsum

Logsum: “translation” of aggregate quality

$$\begin{aligned} V^{\text{logsum}} &= \frac{1}{\mu} \ln \left(\sum_n \exp(\mu \cdot V_i) \right) \\ &= \bar{V} + \frac{1}{\mu} \ln \left(\frac{\sum_n \exp(\mu \cdot (V_i - \bar{V}))}{n} \right) + \frac{1}{\mu} \ln(n) \end{aligned}$$

V^{logsum} = Systematic utility according to logsum

$\bar{V}$ = Average systematic utility

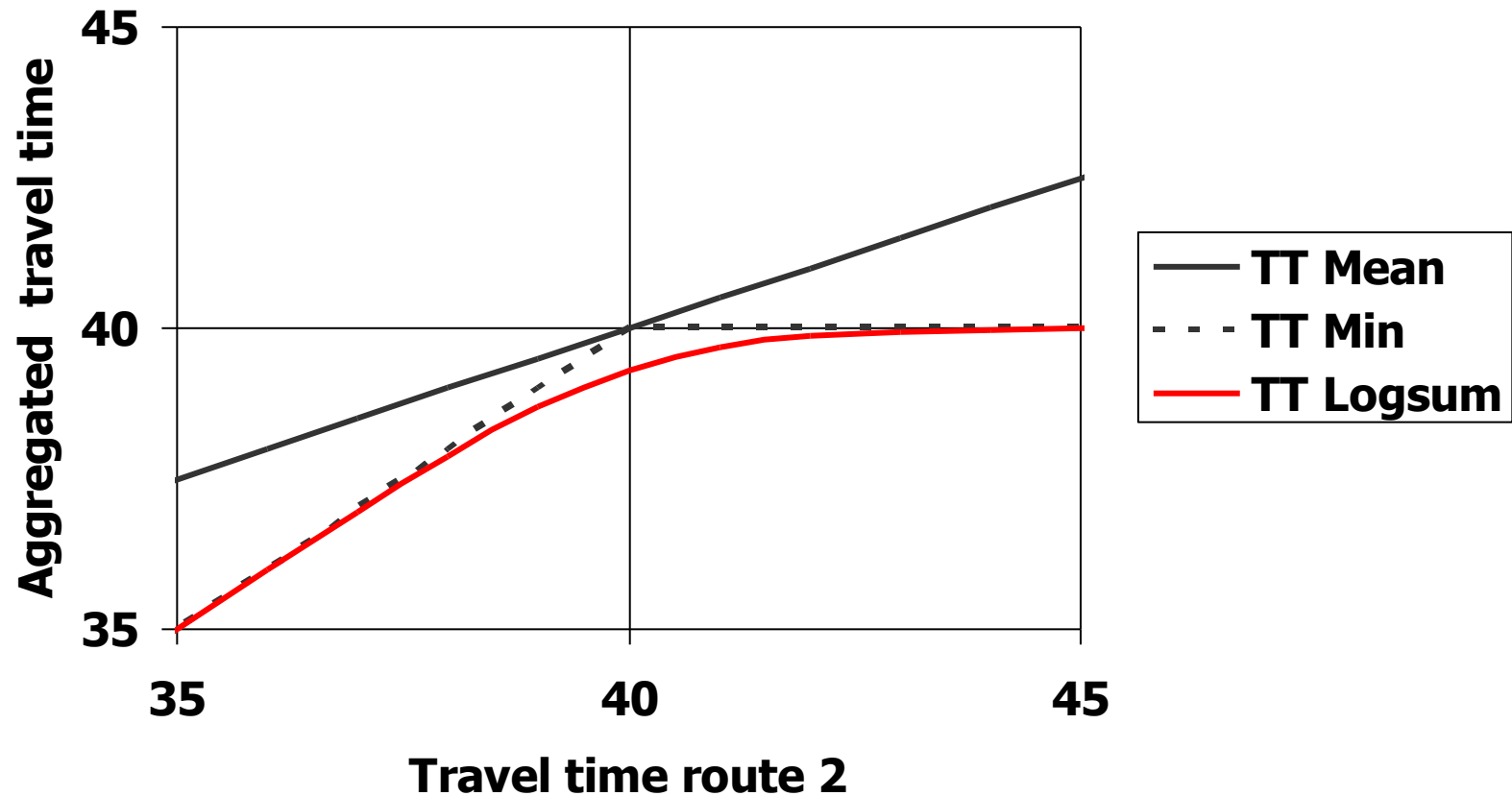
V_i = Systematic utility alternative i

μ = Scale parameter

n = Number of alternatives

Aggregated travel time for 2 routes

Travel time route 1 is 40 minutes



Nested logit and hierarchical choices

- Logsum is component in utility of higher level choice model with parameter μ^*

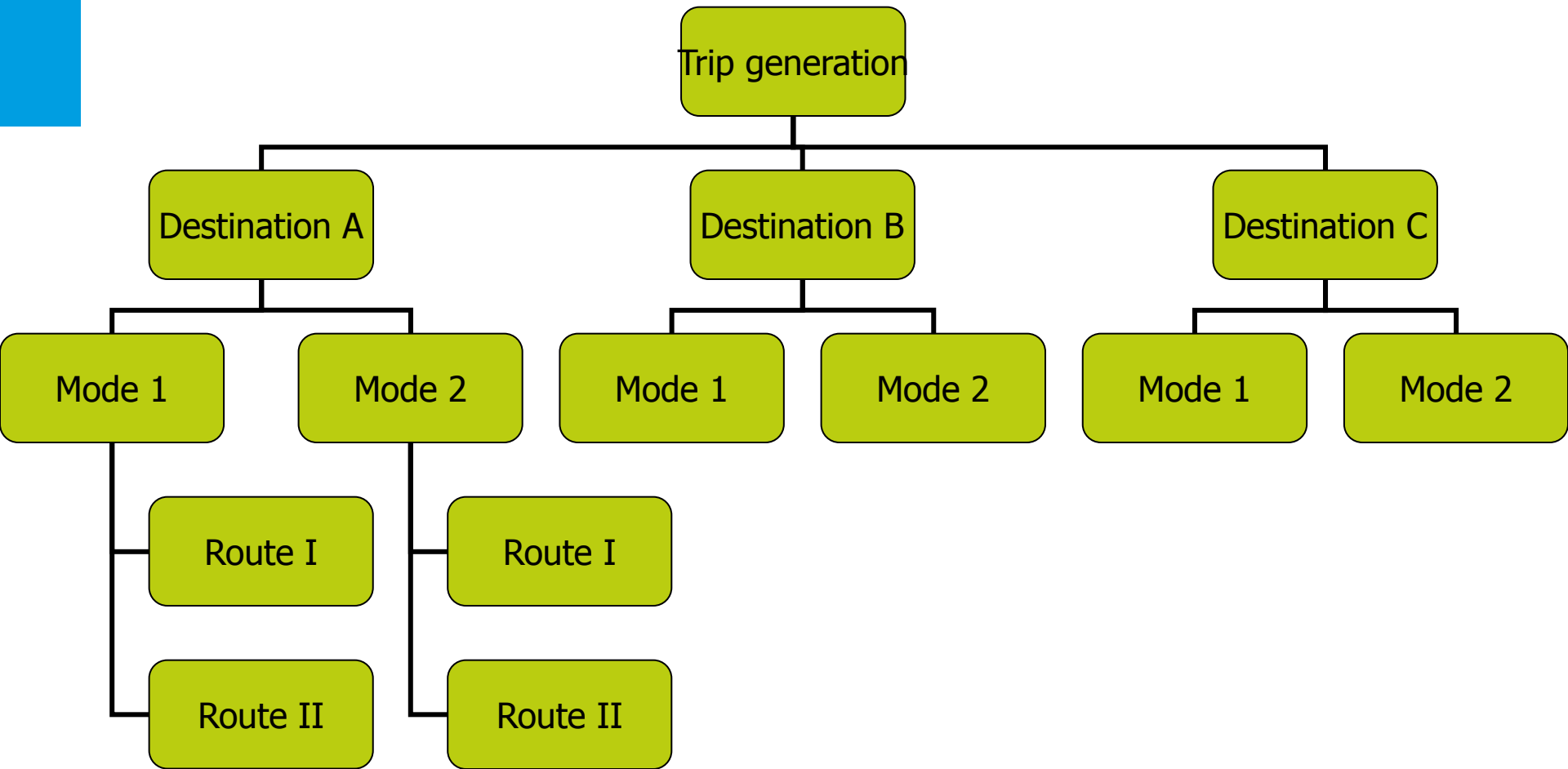
$$\mu^* \cdot V^0 = \mu^* \cdot \frac{1}{\mu} \ln \left(\sum_n \exp(\mu \cdot V_i) \right)$$

- $0 < \mu^* / \mu \leq 1$: not relevant to fully independent (NB $\mu^* / \mu \approx \lambda$)
- Limitation: alternative can only be allocated to a single nest

Examples

- Logsum over routes in mode choice
- Logsum over modes in destination choice
- Logsum over activities in activity choice
 - Activity based modelling
- Dutch National Model considers nesting when modelling destination and mode choice (and tour generation)

Four stage model and logsums



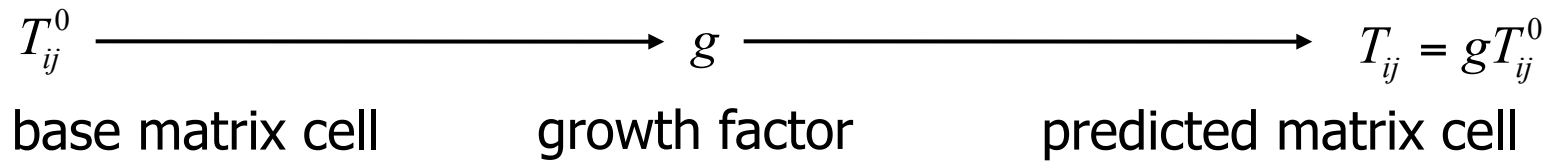
3.

Applying a model in practice

Applying a model in practice

- Base year model
 - Justification of your model
- However, model is a simplification of reality. How to deal with that when making a forecast?
- 3 options
 - Rely on base year matrix
 - Rely on model
 - Combination of both
- In all cases: proper interpretation of the results

Growth factor models: reprise



$$T_{ij} = gT_{ij}^0$$

Network independent,
general factor

$$T_{ij} = g_i T_{ij}^0 \quad \text{or} \quad T_{ij} = g_j T_{ij}^0$$

Network independent,
origin or destination specific factor

$$T_{ij} = g_i g_j T_{ij}^0$$

Network independent,
factors for origins and destinations

$$T_{ij} = g_{ij} T_{ij}^0$$

Network dependent,
OD-specific factors

Rely on the base year matrix

- Make sure that the base year is of high quality
 - Good fit with counts using a high quality a priori matrix
- Use a growth factor method for the forecast
 - Especially changes in production and attraction ($g_i g_j$)
- Limitations
 - Network effects on distribution and modal split are not included
 - Mostly suitable for short term forecasts only

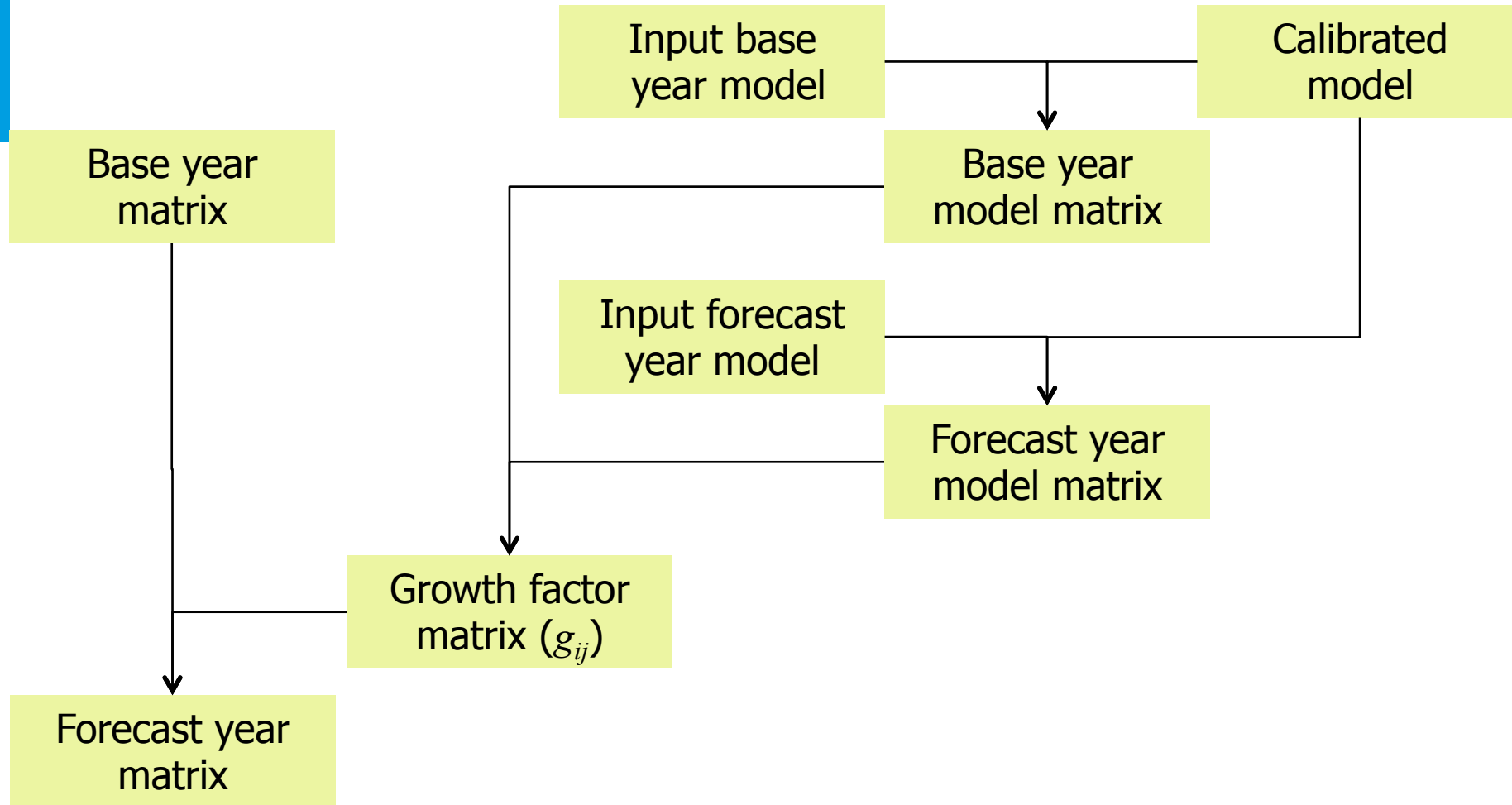
Rely on the model

- Make sure that the model is of high quality
 - Proper functions and parameters
 - Decent match with counts etc.
- Run the model using the input for the forecast year
- Check the model for those results where the base year model had some limitations

Combination of both worlds

- Key philosophy:
 - Model is the best representation of the mechanisms in the transport system, i.e. of the sensitivity for measures you're interested in
 - Base year matrix is best representation of the spatial pattern
- Thus use the model to determine the relative changes between base year and forecast year (synthetic model or shadow model)
- Next, use these relative changes to update the base year matrix (pivot) (g_{ij})

Pivot model approach



Points of attention for the pivot method

- Relationship between base year matrix and base year model matrix?
- Growth factor method extrapolates “errors” in the base year matrix
=> Demand patterns should be consistent
- How to account for changes in spatial structure (empty cell problem)
 - There’s nothing to multiply with

Substitute cell value with results synthetic OD-matrix

Or,

First, use matrix manipulation to account for changes in spatial structure (see lecture 3) and then use pivot to account for network and policy changes only

In all cases

- Take care of the relevant accuracy
 - Within the model there are partial persons and partial cars!
 - Exact values tend to become a fact
- Use your common sense!
 - What's the logic?
 - Do you believe the changes and their magnitudes?
 - Can you explain it in laymen's terms as well?

4.

Using a model in a MSc-thesis project

For many MSc studies you would like to use a model

- Option 1: You can't get any modelling data
- Option 2: There's a model and you can get networks and OD-matrices
- Option 3: You've got access to the full modelling framework

No modelling data at all

- Use other data to get an idea of the main transport characteristics
 - Counts
 - Household surveys, e.g. OVG/MON/OViN
 - Reports on modelling studies in the same area
- Use engineering judgement
 - For typical OD-pairs determine the level of service (skims of travel times etc) and use e.g. a logit model to estimate mode choice or route choice (the parameters are your choice)

You've got networks and matrices

- You can do matrix manipulations and assignments
 - Usually you're interested in a part of the model
=> adapt the zoning system
- What's missing is e.g. a mode choice model
- 2 options
 - Determine level of service using the networks (skims) and apply a (self-made) version of the Poisson-model
 - Determine level of service and estimate a mode choice model (e.g. a Logit model having mode specific constants and parameters for the level of service of the modes)
- In both cases select a set of relevant OD-pairs that are consistent in size

You've got the full framework

- Don't get lost in all the data and all modelling features
- You might want to adapt the zoning system to your study goal

5.

Coming next: Guest lectures

Next lectures

- Lectures from practice in The Netherlands
 - Dutch National Model System: Gerard de Jong (Significance, ITS Leeds)
 - Base year matrix estimation (Regional Model): Peter Mijjer (4Cast)
 - Regional Model application: Jan van der Waard (KIM)
 - Urban transport modelling: Bastiaan Possel (Goudappel Coffeng)
- Goal of these presentations:
 - Lectures focus on basic theory, practical on a simple case
 - These lectures focus on models in practice and their context
- Your task:
 - Determine similarities and differences between my story and theirs