

CIE4801 Transportation and spatial modelling

Discussion models in practice, Exam questions

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- Discussion Models in practice
- Exam questions
 - OD-estimation
 - LMS/NRM

1.

Discussion models in practice

Your questions: a selection

- Models in practice
- Aggregate versus disaggregate
- Pivot point
- Assignment
- Choice models

1.1

Models in practice

What are the models used for?

- Policy question is always leading in a study
- Main classification
 - LMS: impact of national policy on aggregate transport characteristics and related network effects
 - NRM: impact of local (infrastructure) measures on network usage
 - RBV: impact of traffic management
- Practical problem:
 - Building a model takes (substantial) time => new questions pop up
 - Once you've got a model it is the best thing you've got available
- Consequence: you're not using the best model for the problem
 - However, you know this from the start!

Which models are being used

Two main types

	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

Model accuracy

- Jan van der Waard: accuracy/bandwidth $\pm 10\%$
- Due to accuracy in input and in every model step
- Sensitivity analysis shows that in case of systematic variation in input and parameters inaccuracy increases with every model step, except for the assignment, that's where the accuracy improves again
- Question: is the 10% rule also appropriate if you compare two alternatives?
- NB 10% for the A13 is 13.000 vehicles, while 1.300 vehicles could already lead to a relevant increase in emission of e.g. NO_x

Consultants, clients and models

- As you might have noticed, the Ministry (and thus Rijkswaterstaat) has a centralistic view on model usage
- Consultants consider their models as a selling point
- Clients have personal preferences and they have relationships with consultants
- Models are thus a component of a larger set of services
- Having a broader coverage allows for a higher service quality, e.g. a 'regional model' as a database for regional consistency

Local model als part of regional 'model'



Supermodel for all types of clients?

- Single model for national, regional and local level?

FORGET IT

1.2

Aggregate versus disaggregate

Aggregate versus disaggregate (1 / 2)

Aggregate models

- Unit is zone, usually segmented for e.g. trip purpose
- Captures mainly net emerging effects
- Requires a limited amount of data

Disaggregate models

- Unit is person or household, usually specific types
- Allows for a more detailed modelling approach including influence of personal and household characteristics
- Requires a lot of data

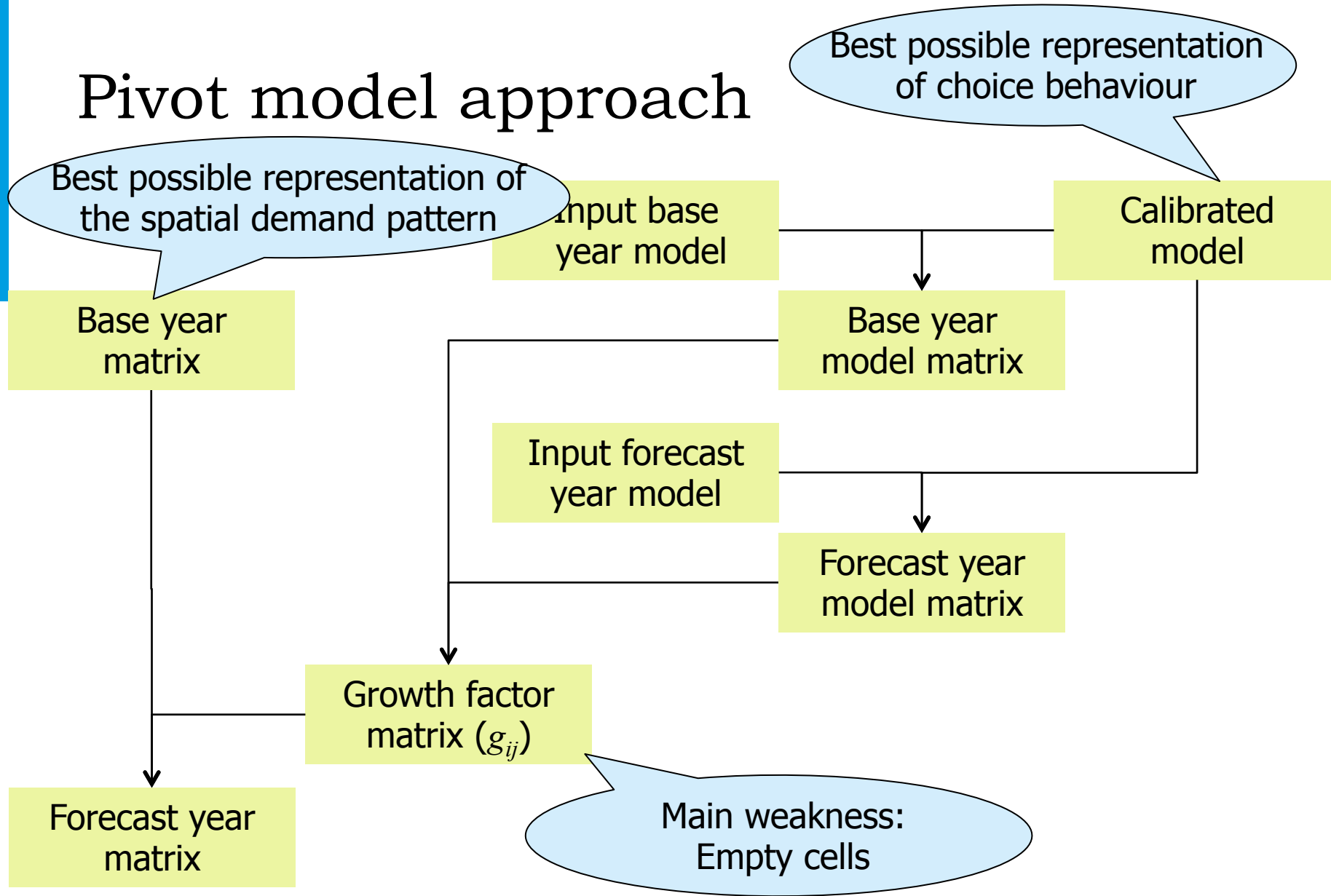
Aggregate versus disaggregate (2/2)

- Based on personal experience with OD-estimation I would say that there's limited evidence that disaggregate models outperform aggregate models
- However, disaggregate models consider a larger range of input factors and have therefore a richer picture of the sensitivity of the transport system (and for a wider range of measures)
- And, of course, disaggregate models have an accepted theoretical background

1.3

Pivot point model

Pivot model approach



Base year matrices

- LMS/NRM: trucks, car for morning peak, evening peak and 24 hour (and for commuting, business and other trip purposes)
 - Motivation: base year matrices BTM are not necessary for the main goals of LMS/NRM
- NS: have their own base-year matrix (at station level) which uses growth factors of LMS/NRM
 - In contrast to base year matrices for trucks and cars the consistency between synthetic matrix and base year matrix is unknown
 - Note that matrix NS is property of NS
- VENOM: base year matrices for public transport

1.4

Assignment

Qblok

- Main idea is to check for blocking back in every iteration of the DUE, e.g.
 - Select the link having the highest V/C ratio
 - Estimate the size of the queue
 - Check whether this influences upstream links and adjust travel times of upstream links (and determine difference potential demand flow and actual flow)
 - Repeat until all links having a high V/C ratio are dealt with
- STAQ is a new algorithm for incorporating blocking back that is based on traffic flow theory

1.6

Choice models

Choice models LMS/NRM

- Alternative specific constants
 - Per mode plus intrazonal constant per mode
- Costs
 - Log(cost), parking cost, income class
- Time
 - In-vehicle time per mode, walk+wait time BTM
- Distance
 - Distance², distance > x, distance-purpose combinations, distance-age class combinations
- Person
 - Car availability, driving license, gender, full/part time, age class, education
- Household
 - One or more <12, one of more <18, single person
- Zone
 - Population density (origin and destination), jobs, education (per type), retail, service, inhabitants, high density area

Order of choices

- Simultaneous distribution modal split model using distribution functions is equivalent to modelling distribution first (using F_{ij}) and modal split in a second step (using F_{ijv})
- In a Logit-model you nest the choices: 2 options
 - Predefined by the researcher
 - Determined by the estimation results (best fit with data)
- Interpretation of nesting
 - Assume mode choice is the upper level and destination choice the lower level (Swiss model)
 - This suggests that in case of network changes travellers are more likely to change their destination than their mode

2.

Exam questions

OD-estimation: 1

From a survey we have found the following observed trip matrix:

	A	B
A	20	20
B	20	80

Further, we know that

distance AB = distance BA (interzonal), and
distance AA = distance BB (intrazonal)

Estimate the distribution function, using the Poisson estimator.
(only perform 1 iteration)

OD-estimation: 1

Step 1:

Set all accessibilities equal to 1 and scale the rows (productions)

	A	B	
A	1	1	40 $\times 20$
B	1	1	100 $\times 50$
	40	100	

Step 2:

Scale the columns (attractions)

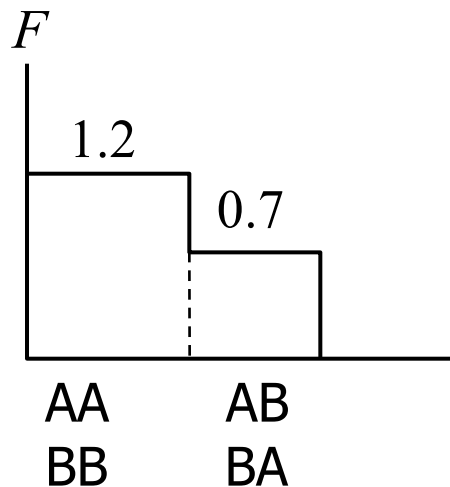
	A	B	
A	20	20	40
B	50	50	100
	40	100	
	$\times \frac{4}{7}$	$\times \frac{10}{7}$	

OD-estimation: 1

Step 3:

Determine scale factors
for distribution function

	A	B	
A	11.4	28.6	40
B	28.6	71.4	100
	40	100	



Observed:

100 intrazonal trips

40 interzonal trips

Modelled:

82.8 intrazonal trips

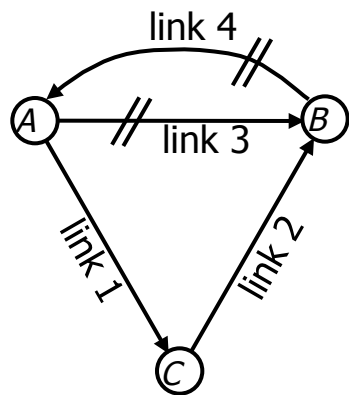
57.2 interzonal trips

$\times 1.2$

$\times 0.7$

OD-estimation: 2

Consider the following transportation network with 3 origins and 3 destinations, and the following travel demand matrix:



$$t_a(q_a) = 1 + \left(\frac{q_a}{400} \right)^2, \quad a = 1, 2, 3, 4.$$

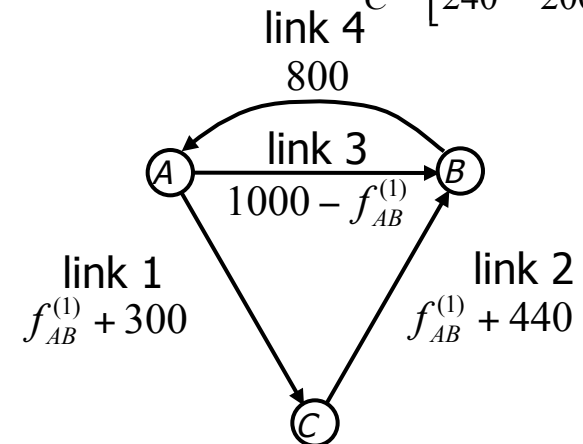
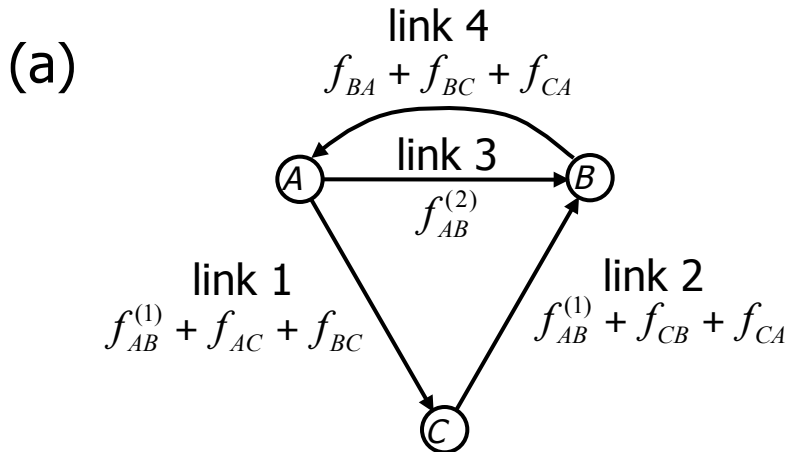
// = counter
(loop detector)

	A	B	C
A	0	1000	140
B	400	0	160
C	240	200	0

- Assuming a DUE, how many travellers will be counted on link 3?
- Suppose that the counter on link 4 indicates 1000 vehicles. Change the OD trip matrix T such that it is consistent with this count.
- Suppose that link counts on all links are available. Is it possible to uniquely determine the OD matrix matrix T ?

OD-estimation: 2

	A	B	C
A	0	1000	140
B	400	0	160
C	240	200	0

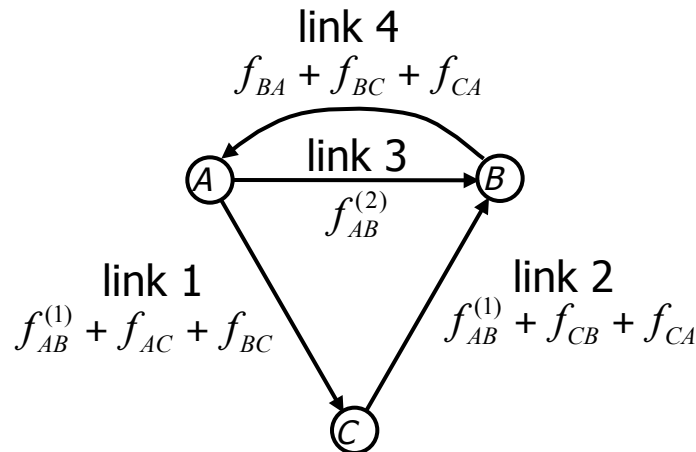


All OD pairs have only a single route, except for (A,B), which has two routes. Therefore, DUE requires (if both routes are used):

$$\begin{aligned}
 t_1(q_1) + t_2(q_2) &= t_3(q_3) \\
 \Rightarrow 1 + \left(\frac{f_{AB}^{(1)} + 300}{400} \right)^2 + 1 + \left(\frac{f_{AB}^{(1)} + 440}{400} \right)^2 &= 1 + \left(\frac{1000 - f_{AB}^{(1)}}{400} \right)^2 \\
 \Rightarrow (f_{AB}^{(1)} + 300)^2 + (f_{AB}^{(1)} + 440)^2 + (1000 - f_{AB}^{(1)})^2 &= 400^2 \\
 \Rightarrow f_{AB}^{(1)} = 153, \quad f_{AB}^{(2)} = 1000 - 153 = 847 &\quad \text{Count on link 3 is 847 vehicles.}
 \end{aligned}$$

OD-estimation: 2

(b)



	A	B	C
A	0	1000	140
B	400	0	160
C	240	200	0

$$f_{BA} + f_{BC} + f_{CA} = 800$$

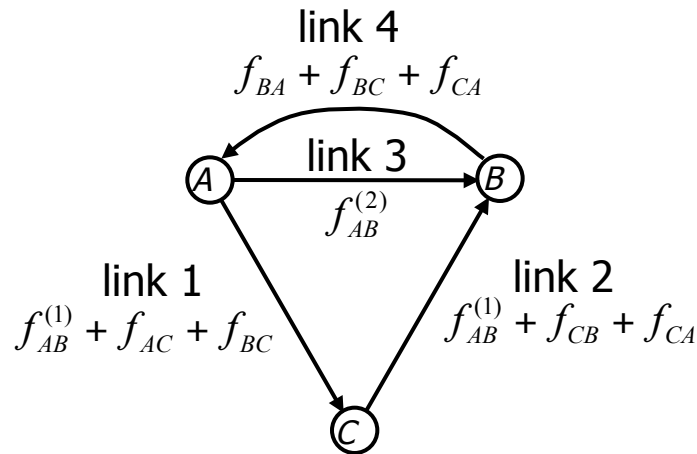
The count is 1000, so each OD flow through link 4 should be increased by 25%, the rest remains the same:

	A	B	C
A	0	1000	140
B	500	0	200
C	300	200	0

NB. DUE changes into 125 using links 1 and 2 and 875 using link 3

OD-estimation: 2

(c)



$T =$

	A	B	C
A	0	??	??
B	??	0	??
C	??	??	0

There are 6 unknown values, and only 4 counts, therefore it is not possible to uniquely determine the trip matrix (an infinite number of possibilities exist).

LMS/NRM: 1

- In disaggregated models (such as the Dutch National Model system, LMS), trip attractions are not needed in order to determine the trip distribution. ✓
- The QBLOK assignment method used in the Dutch LMS and NRM models differs from the regular user equilibrium assignment methods in that it does not allow the traffic flow to exceed the capacity. ✓

LMS/NRM:2

- Explain the main advantage of using tours in LMS as opposed to using trips.
- Explain how the pivot point method works.
- What is a major disadvantage of such a pivot point method?
- Explain the main difference between QBLOK and traditional traffic assignment models.
- The estimated OD matrix in the LMS model should only be assigned with QBLOK and not with another assignment method. Explain this dependence between the OD matrix and the assignment technique.

LMS/NRM: 2

- Consistency between outward bound and homebound trip, especially w.r.t. mode choice
- See slides lecture 10
- Empty cells
- Flow can not exceed capacity, blocking back is accounted for
- Due to the calibration using counts there's a strict relationship between OD-matrix and assignment technique

Example impact assignment technique

Qblok versus DUE



LMS/NRM: 3

- A classical transportation model consists of four submodels. Which are these four submodels? And what travel choices are being modelled in each of these submodels?
- In the Dutch transportation models LMS and NRM, two of these submodels have been combined. Which two submodels have been combined? And give two reasons why these submodels are usually combined.
- For each submodel, an aggregate (on a zonal level) or disaggregate (on a household or individual level) approach can be taken. Name the main advantage and the main disadvantage of the disaggregate approach.

LMS/NRM: 3

- Trip generation, trip distribution, modal split, assignment
- Trip generation and modal split
 - Choice are made simultaneously
 - Consistency w.r.t. resistance used in trip distribution
- NB Note that you could also state that attraction is included as well
- Advantage: more detailed modelling of travel behaviour (at personal and household level) and thus more realistic
Disadvantage: requires more detailed data