Post lecture questions Demand Modelling

Trip generation

Trip generation: theory

(a) What are the outputs of trip generation models?

(b) Name four trip purposes that are typically distinguished in trip generation models.

(c) Why is the number of trips usually calculated *per trip purpose*?

(d) Name three different models for determining the trip generation.

(e) What is meant by trip balancing?

In trip generation, regression models, cross-classification, and binary logit models can be used to estimate the number of trips produced by a household.

Assume that there has been a household survey regarding the number of trips made per day. Households were asked questions about their household income and the number of cars available. The following linear regression model was estimated from the survey data:

$T = 1.75 + 0.00002 I + 0.5 A$,

where

T = number of trips made

I = household income

A = number of cars available

The number of trips is linear with the number of available cars in the household, which is not very realistic for households with more than 2 cars. One way of solving this problem is to introduce dummy variables in the regression model.

(a) Write down a regression model with dummy variables such that the number of trips is no longer linearly dependent on the number of cars.

The same survey data can be used in a cross-classification model by classifying households into income groups and car ownership. In the table below this classification is shown. In each cell the average value of the trips made by that household type is computed. The number of observations is stated between brackets.

income / cars available	0 cars	1 car	$\geq$2 cars
< € 15.000	1.9 (7)	2.4 (5)	?? (0)
€ 15.000 - € 30.000	2.2 (12)	2.8 (25)	2.9 (3)
> € 30.000	2.3 (2)	3.1 (11)	3.5 (9)

A disadvantage of the cross-classification model is that a relatively large survey is necessary to have sufficient observations in each cell. As can be seen in the table, there are no observations for households with low income and 2 or more cars. Using multiple class analysis (MCA), this problem can be resolved.

(b) Using MCA, compute the estimate for the average number of trips made by low income households with 2 or more cars.

In a binary logit model, the trip generation is determined by sequentially computing the probability of making additional trips. Suppose that the binary logit model is applied 4 times successively to compute the probability for an individual of making additional trips, given by the following numbers:

- The probability of a person to make one or more trips is 90%.
- For people who decide to make one or more trips, the probability of making one trip is 50% (such that the probability of making two or more trips is 50%).
- For people who decide to make two or more trips, the probability of making two trips is 80% (such that the probability of making three or more trips is 20%).
- For people who decide to make three or more trips, the probability of making three trips is 100% (such that the probability of making 4 or more trips is 0%).

(c) Determine the average number of trips made by an individual using the outcomes of the binary logit model.

Trip distribution

Formulate the direct demand model for trip distribution and define its variables.

Suppose a city would like to build more houses in a certain suburb. This implies that more road infrastructure is needed for all residents in that suburb.
Which trip distribution model can be best applied for computing the OD trip matrix?

Consider two zones with the following data:

	number of inhabitants	number of jobs
Zone A	1000	300
Zone B	800	200

The number of inhabitants has been determined with a higher precision than the number of jobs. On average, the number of departing trips is 0.25 per inhabitant, and the number of arriving trips is 0.8 per job.

All the travel resistances (intra-zonal and inter-zonal) may be assumed equal.

Determine the trip distribution.

Consider a transport network with four zones. The distances (in km) between the zones are given in the skim matrix below. Also a measured origin-destination matrix is provided.

skim	zone 1	zone 2	zone 3	zone 4
zone 1	1	2	5	19
zone 2	3	1	10	15
zone 3	7	9	1	9
zone 4	18	17	6	1

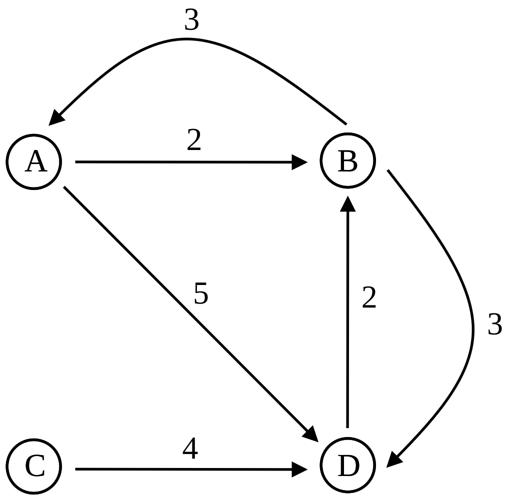
trips	zone 1	zone 2	zone 3	zone 4
zone 1	20	16	12	7
zone 2	15	31	26	18
zone 3	18	8	22	12
zone 4	11	4	15	16

(a) Compute and sketch the trip length frequency distribution using trip length intervals of 4km.

(b) What is the difference between a trip length frequency distribution and a trip distribution function?

(c) The trip distribution function is unknown. Explain in words how you can estimate the trip distribution function using the given data.

Consider the following transportation network between four cities (A, B, C, and D), with the distances (in km) denoted on the (directed) links. The trip production for cities A and D is 100 trips, and for B and C 200 trips. The trip attraction for cities A and D is 150 trips, and for city B 300 trips. No trips are attracted to zone C. No intrazonal trips are considered.



(a) Determine the skim matrix with travel distances between all cities.

Suppose that the trip distribution function is given by $f(c_{ij}) = 1/c_{ij}$, where c_{ij} is the travel distance from city *i* to city *j*.

(b) Using the doubly constrained gravity model, determine the origin-destination trip matrix (perform only one iteration).

(c) Sketch the trip length distribution, based on the OD matrix obtained in (b).

(d) Explain why the shape of the trip length distribution is different from the shape of the trip distribution function.

Suppose that the trip distribution function is unknown, and that only the mean trip length is given.

(e) Which method could be used to perform the trip distribution and estimate the trip distribution function? Explain how this method works.

Simultaneous distribution and modal split

We can use the gravity model for simultaneously computing the trip distribution and model split. Suppose that the trip productions are known and that the attractions are unknown.

(a) Formulate the (simultaneous) singly-constrained gravity model for computing the OD matrix per mode, and define all its variables and parameters.

(b) Name two advantages of a simultaneous trip distribution/modal split model over a sequential model.

In the sequential trip distribution / modal split computation, you have to specify the travel resistance per OD pair in order to compute the distribution. If for a certain OD pair more mode alternatives are available, characterized by their own travel resistances c_{ijv}, how would you express the general (combined) travel resistance c_{ij} for this OD pair? Explain your answer.

Consider the following table with distribution values for computing the trip distribution:

	A		B		C		
	car	PT	car	PT	car	PT	
A	67	19	19	0.7	26	7	100
B	19	0.7	67	19	7	19	600
C	26	7	7	19	67	19	400
	200		1200		600		2000

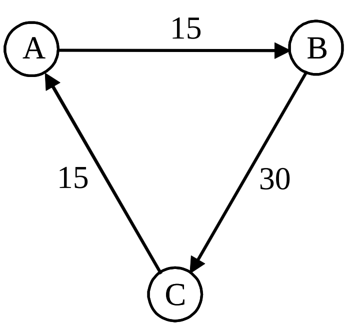
The mode-specific values of the trip distribution function have been generated from:

$$F_{ijv} = c \cdot \exp(-t_{ijv})$$

(a) What is the PT share on the relation A-C when computing the doubly constrained simultaneous modal split / distribution?

(b) What is the PT share for A-C when performing a sequential trip distribution and modal split, using a logit model for the modal split based on travel times with scale parameter 2?

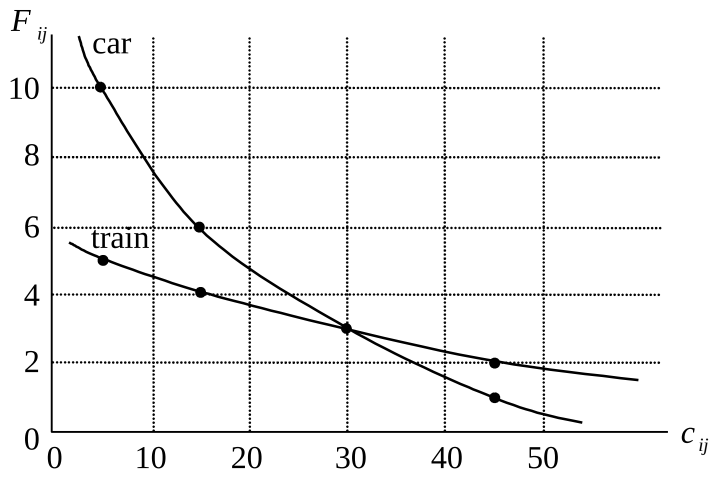
Three zones, A, B, and C, are connected by roads and rails as indicated below. Each (uni-directional) link represents both a road segment as well as a rail segment, and the distances are indicated (for simplicity it is assumed that for each link the length of road and rail are equal).



The trip production and attraction for each zone is given in the table below.

Zone	Production	Attraction
A	2800	2450
B	3600	4260
C	1550	1240

Furthermore, the trip distribution functions for each mode (car and train), which described the accessibilities F_{ij} from zone i to zone j for that mode as a function of the travel distance c_{ij} [km], are indicated in the next figure. Assume that all intrazonal distances equal 5.



(a) Determine the skim matrix $c = [c_{ij}]$ consisting of travel distances.

(b) Compute the simultaneous trip distribution / modal split based on the doubly constrained gravity model for obtaining the trip matrices for the car and train (perform only 1 iteration).

(c) Compute and sketch the trip length frequency distribution for the car (choose your own length classes, use at least three classes).