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Analysing intrapersonal variability of travel behaviour using the sequence alignment method

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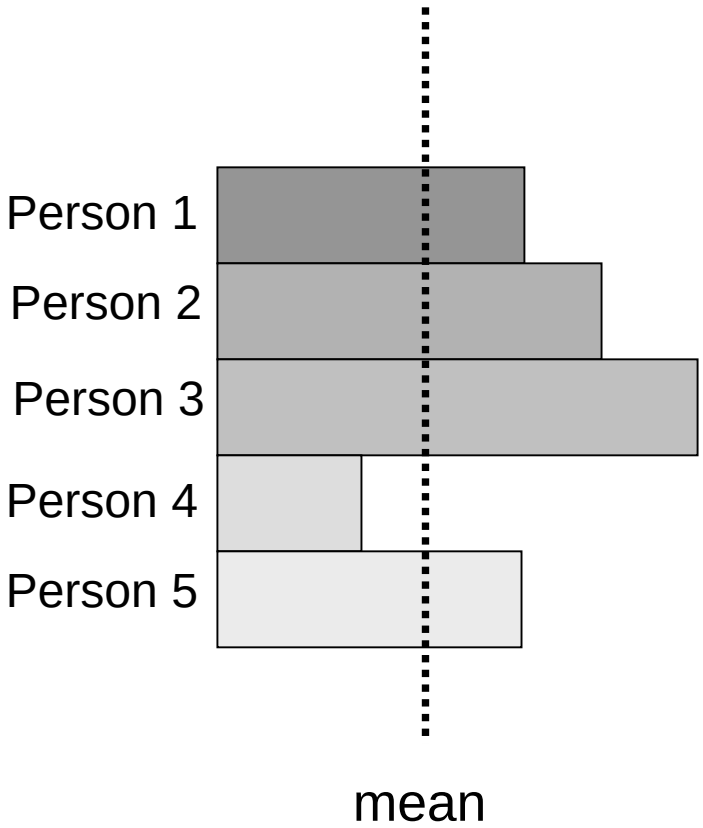
Intrapersonal Variability

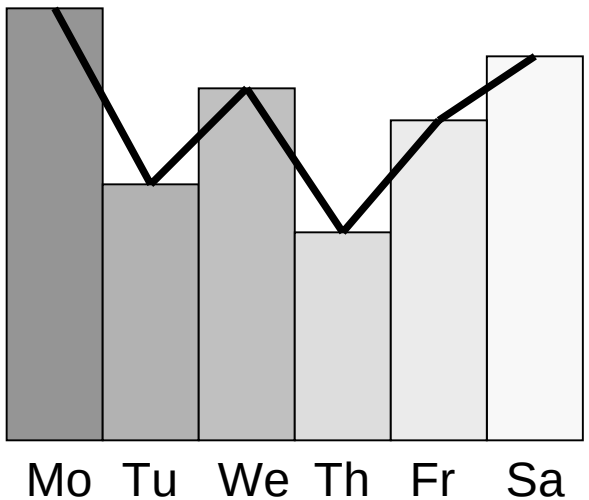
Inter-personal Variability

One single day

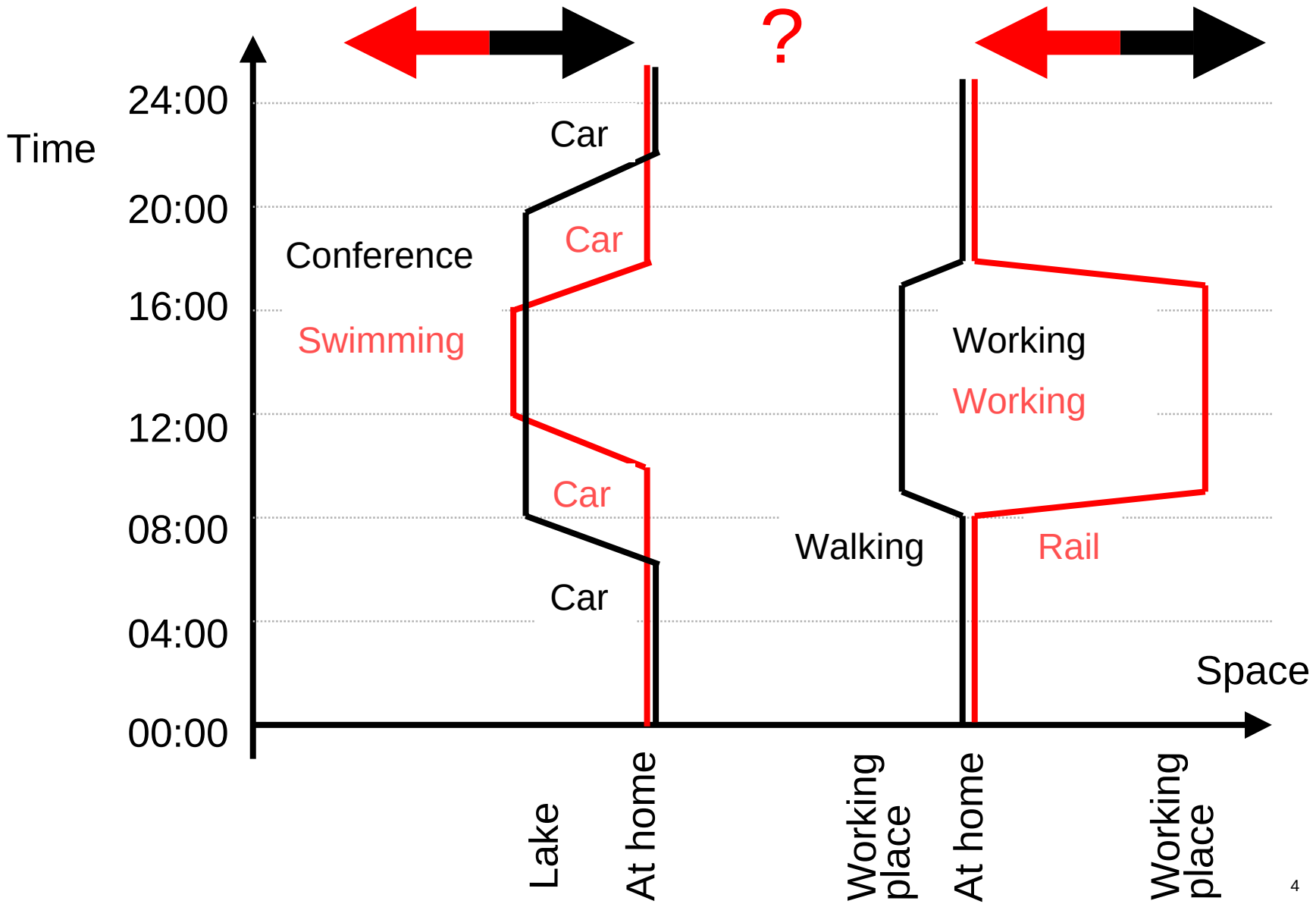


Intra-personal Variability

Person 1



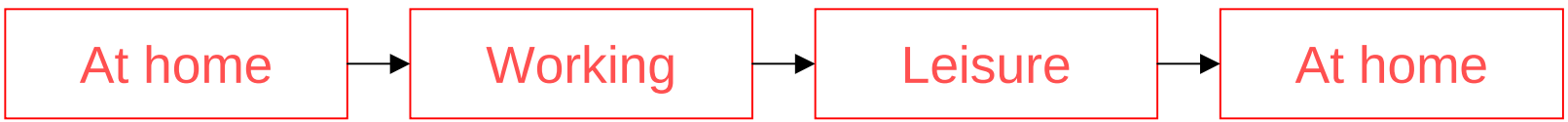
Measuring similarity



Trips and activities: different characteristics

Activity attributes:

- Duration
- Location
- Activity type



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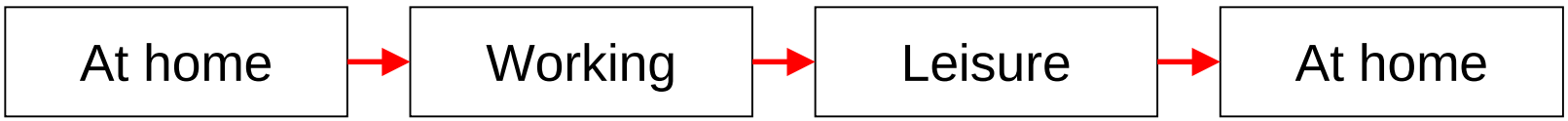


Trip attributes:

- Mode choice
- Trip distance
- Trip duration
- Route choice

Theory of sequence alignment I

Measuring differences between two strings *s* [s_1, s_2,.....s_n] and *g* [g_1, g_2,.....g_n]

$d(s,g) = \sum_{i=1}^{n} f(x)$ and

$f(x) = 1$ if $s_i \neq g_i$

$f(x) = 0$ if $s_i = g_i$

Example:

s=ABCDE

g=AFBCDE

d(*s*,*g*)=4

→ Problem of recognising sequential order or duration

Theory of sequence alignment II: Levenshtein

Similarity as total amount of effort to equalise $s[s_1, s_2,.....s_n]$ and $g[g_1, g_2,.....g_n]$

Four basic operation:

- Identity: $w_e(s_i,g_i)=0$
- Insertion: $w_i(\varnothing,g_i)=1$
- Deletion: $w_d(s_i, \varnothing)=1$
- Substitution: $w_s(s_i,g_i)=w_d(s_i,g_i)+w_i(s_i,g_i)=2$

Definition Levenshtein Distance:

Smallest sum of operation weighting values required to change $s[s_1, s_2,.....s_n]$ into g $[g_1, g_2,.....g_n]$:

Theory of sequence alignment III: Trajectories

- Different possibilities to equal two strings
- Combination of operations are called trajectories

Example

s=CAMBRIDGE
g=CAMPING

1) substitute s_4(B:P), s_5(R:I), s_6(I:N), s_7(D:G) delete s_8(G), s_9(E)
   d=10
2) substitute s_4(B:P), delete s_5(R), substitute s_6(D:N), delete s_8 (E)
   d=6

Theory of sequence alignment IV: Problems

- Qualitative and quantitative data
- Cost of operation weights
- Including duration of activities as attribute or using equal time slices?
- Different attributes
  - Sum of „unidimensional“ sequence alignments across all attribute
  - Optimum trajectory based sequence alignment (Joh et al. 1999)

Software

Dana (C.H. Joh, Universiteit Eindhoven)

- multidimensional
- restricted number of allowed elements per string
- restricted possibilities to change operation weights

ClustalG (C. Wilson, A. Harvey, and J. Thompson)

- Unidimensional
- large strings allowed
- Better possibilities to change operation weights

Dataset Mobidrive

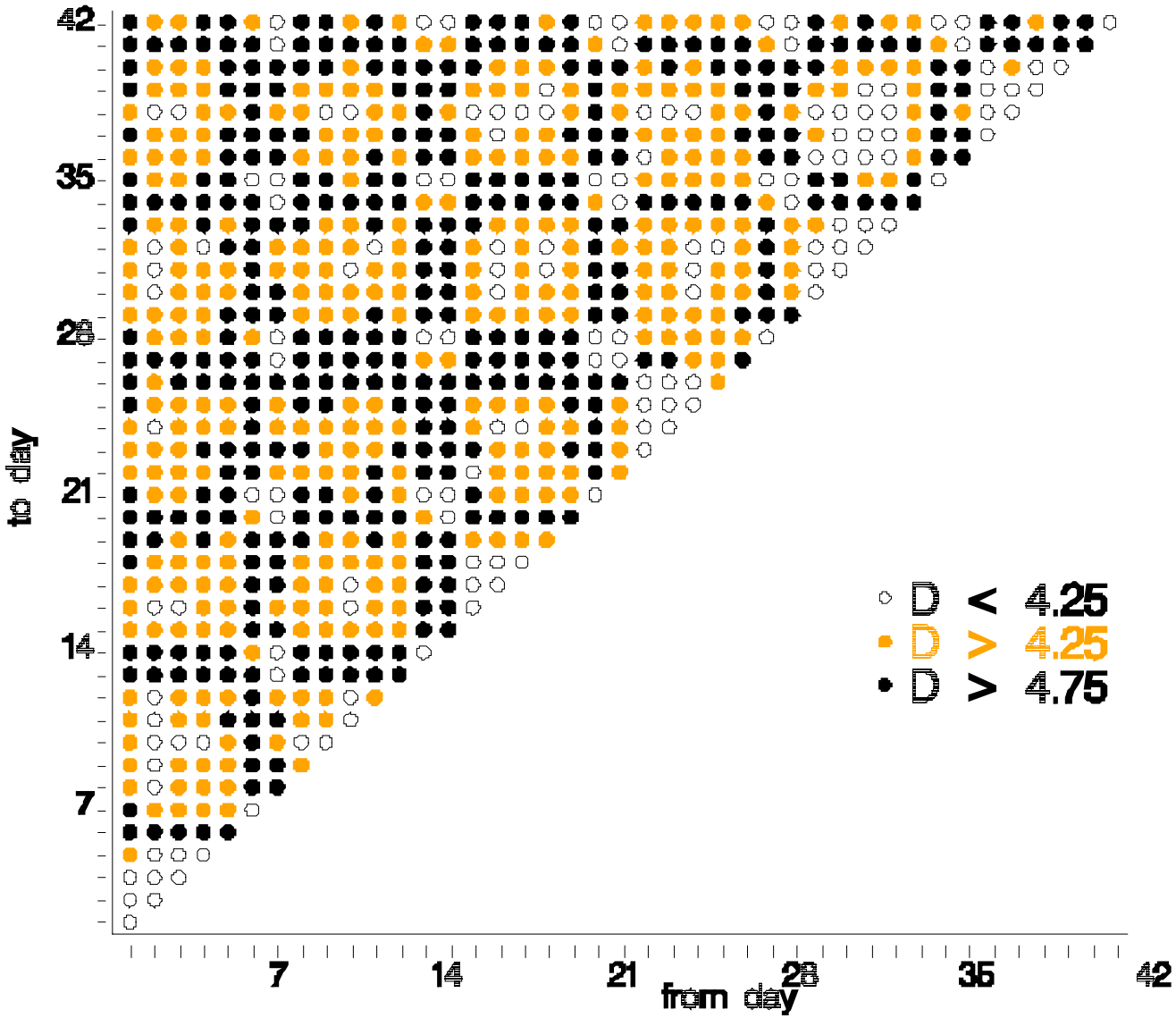
- Reporting period: six weeks
- Travel diary, weekly send out, mailed back and checked via phone
- Cities of Karlsruhe und Halle/Germany
- 162 households, 361 persons
- ca. 52.000 trips and 15.000 days reported September - November 1999 (Pretest: May-July 1999)
- used in analysis: City of Halle (159 persons, 21.000 trips)

Results: Intrapersonal variability over 42 days

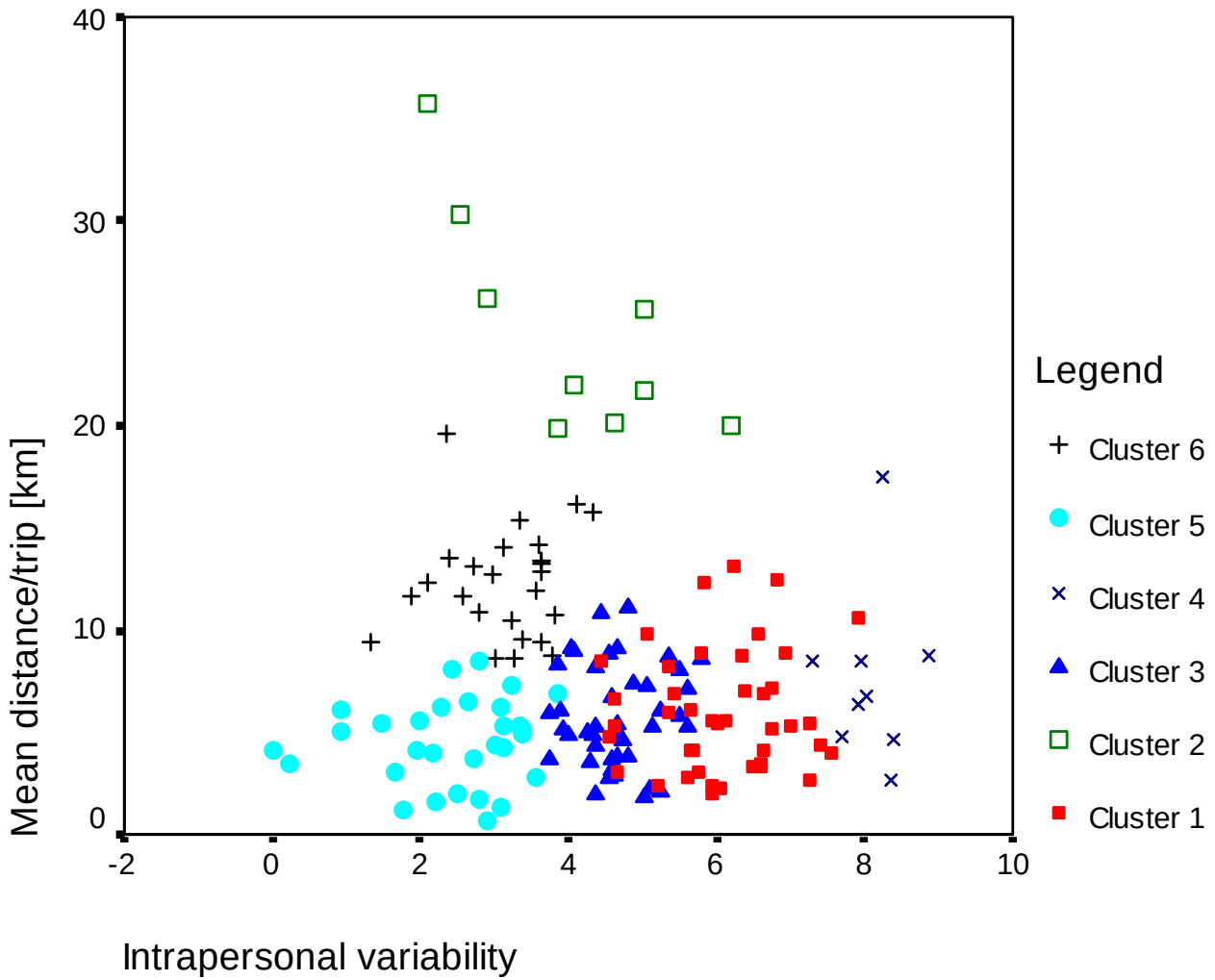
Mean daily Levensthein distance by licence ownership and age

	Not Licenced		Licenced		All	
	Mean	Std	Mean	Std	Mean	Std
18-24	4.5	2.6	5.6	1.7	5.4	1.8
25-34	4.8	1.2	5.3	1.8	5.2	1.7
35-44	5.9	1.9	5.0	1.9	5.1	1.9
45-54	4.0	2.0	4.5	2.0	4.4	2.0
55-64	2.9	1.3	4.6	1.5	4.0	1.7
65 and more	2.5	1.2	4.7	0.8	3.7	1.5
All	4.0	1.7	4.9	1.8	4.5	1.8

Results: Mean distance from different type of day



Cluster analysis



Behavioural characteristics of the clusters

	[Levensthein distance]	Mean trip distance [km]	Mean number of trip per day	Cluster size [n]
Cluster 1	6.1	6.0	4.6	42
Cluster 2	4.0	24.6	3.3	9
Cluster 3	4.7	5.9	3.4	43
Cluster 4	8.1	7.6	6.0	9
Cluster 5	2.4	4.5	2.5	30
Cluster 6	3.1	12.3	2.6	25
Overall	4.5	7.8	3.6	158

Sociodemographic characteristics of the clusters

	Cluster						
	1	2	3	4	5	6	Sum
Mean Age [years]	38.5	41.9	32.7	38.4	43.0	44.4	38.9
Proportion of females [%]	52.4	22.2	51.2	44.4	53.3	56.0	50.6
Proportion of parents [%]	47.6	55.6	9.3	55.6	23.3	48.0	33.5
Proportion of people without licences [%]	26.2	11.1	60.5	11.1	60.0	28.0	40.5
Proportion of fulltime employed people [%]	52.4	88.9	23.3	33.3	26.7	60.0	41.8

Summary

Day-to-day variability measured with multidimensional sequence alignment:

- Sociodemograpic characteristics as expected: highest variability for persons between 25 and 45 years with driving licence
- High variability between weekend days and week days

Clusters based on trip distance, number of trips per day and day to day variability

- 6 cluster solution
- Good differentiation in terms of travel characterisits
- Reasonable differences for the sociodemographic characterisitcs

Outlook

Further research: Sequence alignment

- Check for other operation costs (deletion, substitution, insertion)
- Check for other weights (Consideration of meaning of different attributes, e.g. mode choice)
- Consideration of duration of activities („long form“)

Further research: Travel behaviour

- Classification based on systematic and comprehensive description of travel behaviour
- Relevance for transport policy

Dataset: fatigue