Stability and innovation of human activity spaces

http://www.ivt.ethz.ch/vpl/publications/reports/ab258.pdf

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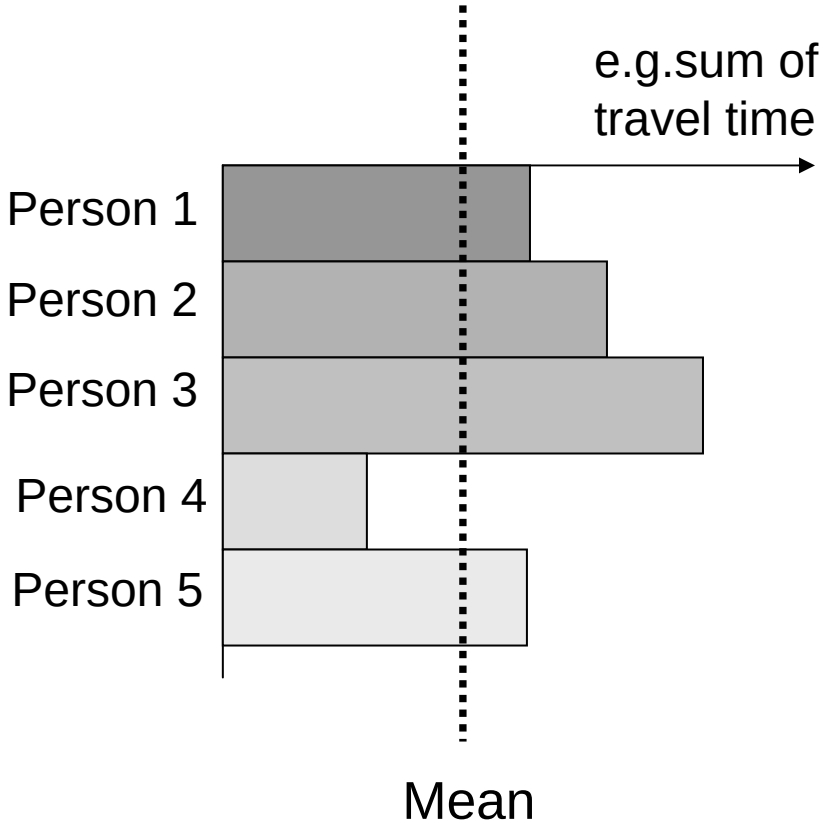
* with thanks to KW Axhausen

Intra-personal level of mobility

Behavioural variability

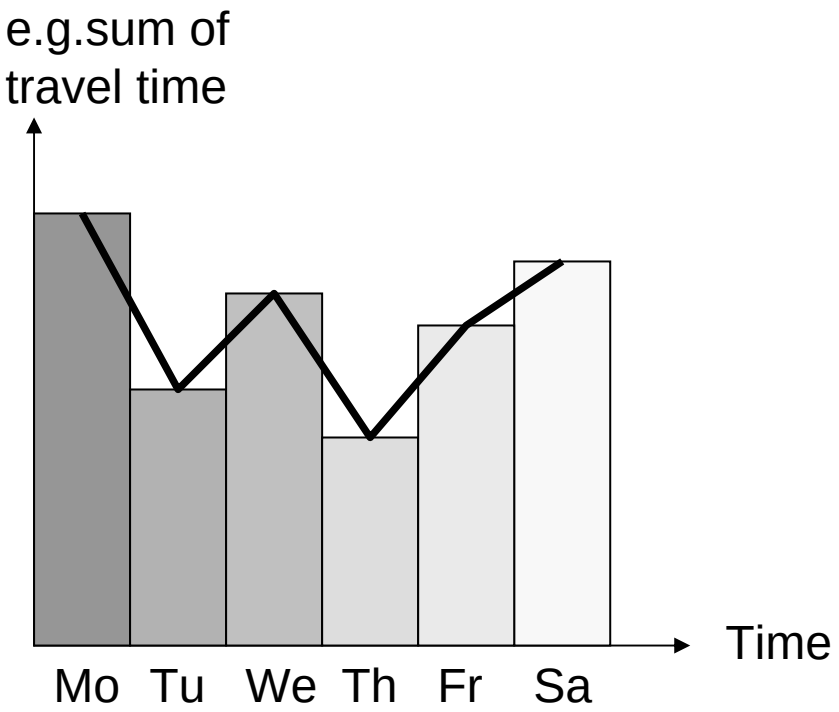
Inter-personal level

Single day



Intra-personal level

Person X



Long-term issues in travel behaviour

Temporal phenomena: Behavioural issues over time

- Stability
- Regularity / Rhythms
- Variability
- Dynamics

Spatially:

How may locational choice and the intensity of individual usage of urban space be visualised and measured?

(Geocoding/GPS facilitate)

Data sources

Place		Duration	Mode
Travel diaries:			
Uppsala 1971		5 weeks	All
Mobi*drive* 1999 (Karlsruhe, Halle)		6 weeks	All
Zürich 2001 (Leisure only)		12 weeks	All
Thurgau (CH) 2003		6 weeks	All
GPS – studies:			
Borlänge 2000-2002	up to	80 weeks	car (240.000 trips)
Copenhagen AKTA 2001-2003		24 weeks	car
Commute Atlanta 2004	>	52 weeks	car

Activity space: Concept

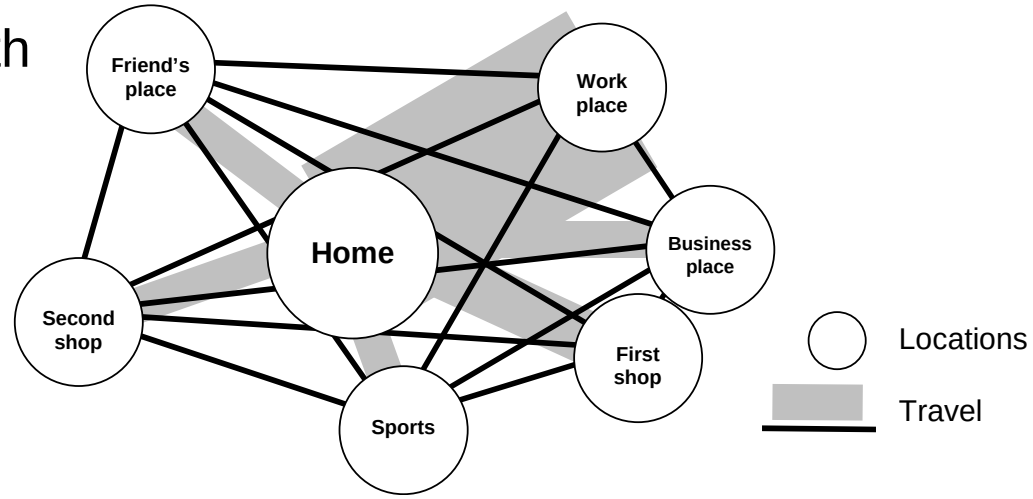
(Micro-geographical) Indicator for individual space use

Geometrical (two-dimensional) form based on distribution of visited activity locations over time ➔ **OBSERVED** behaviour

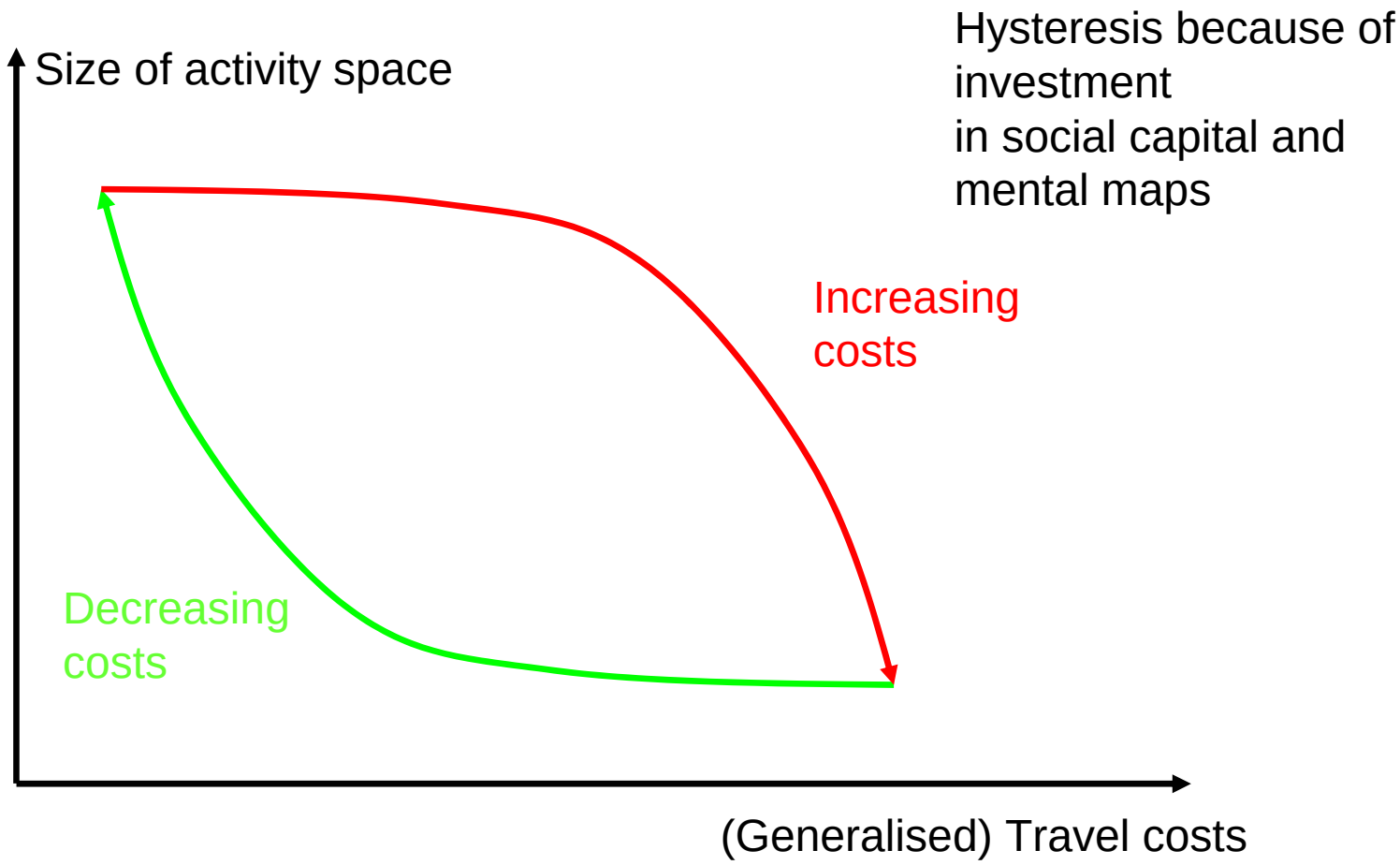
Individual panel data allows physical mapping / listing / enumeration of visited locations and travel demand in-between

Several conceptual studies with focus on travel *potentials* (e.g. space-time prisms)

But: Few empirical work due to missing data



Assumed relationship between act. space and costs



Issues

- Size of activity spaces
- Number of places visited
- Structure of activity spaces
- Innovation in destination choice

Measuring the size of activity spaces: Problems

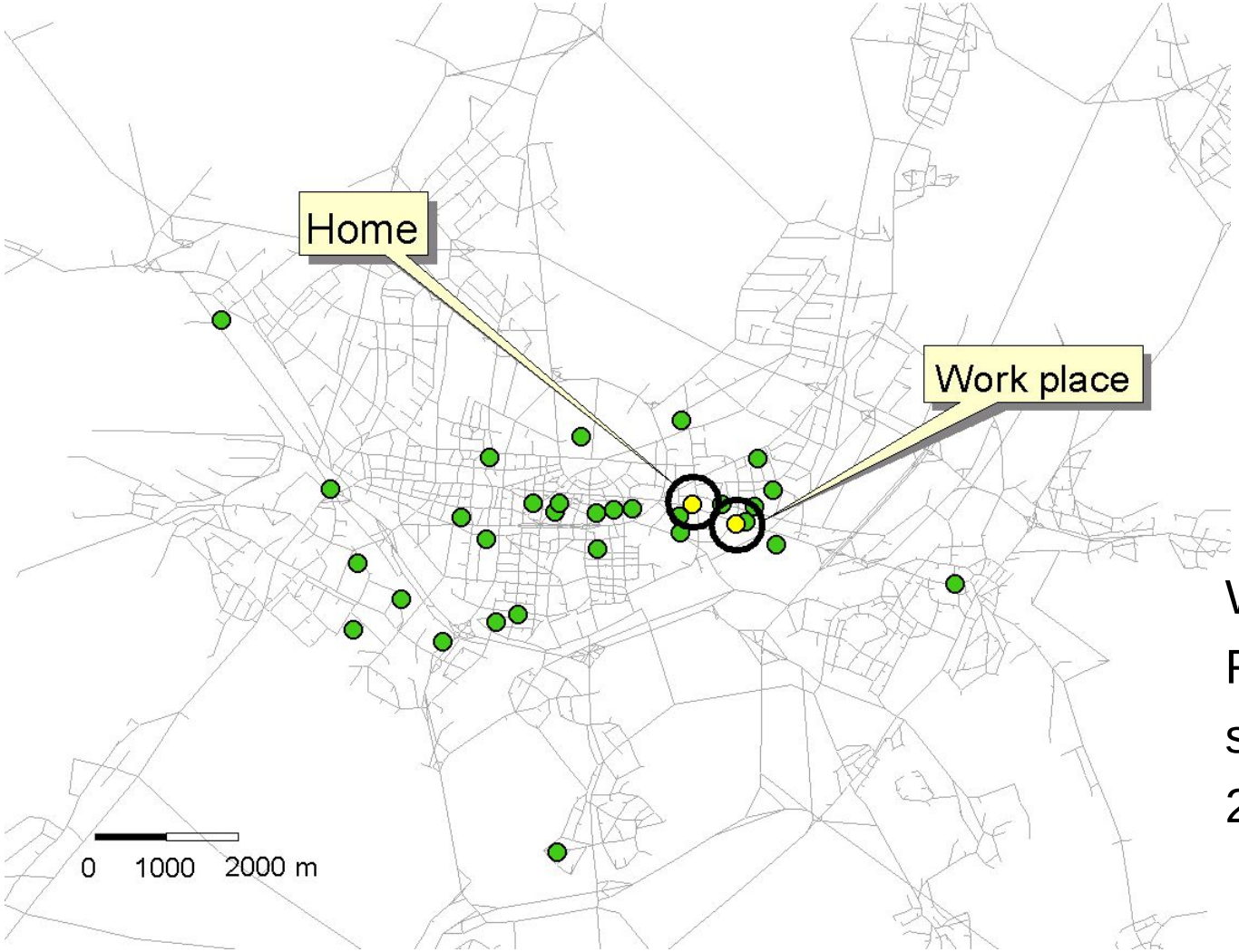
Transformation of information about the places of contact

- Social relationships
- Origin/Destination
- Sale or usage

in a low-dimensional measure of

- Comparison over time (for one traveller)
- Comparison between travellers

Example: Visited places over 6 weeks (local)



Woman, 24

Fulltime work, single

216 trips in 6 weeks

Schönfelder und Axhausen, 2004

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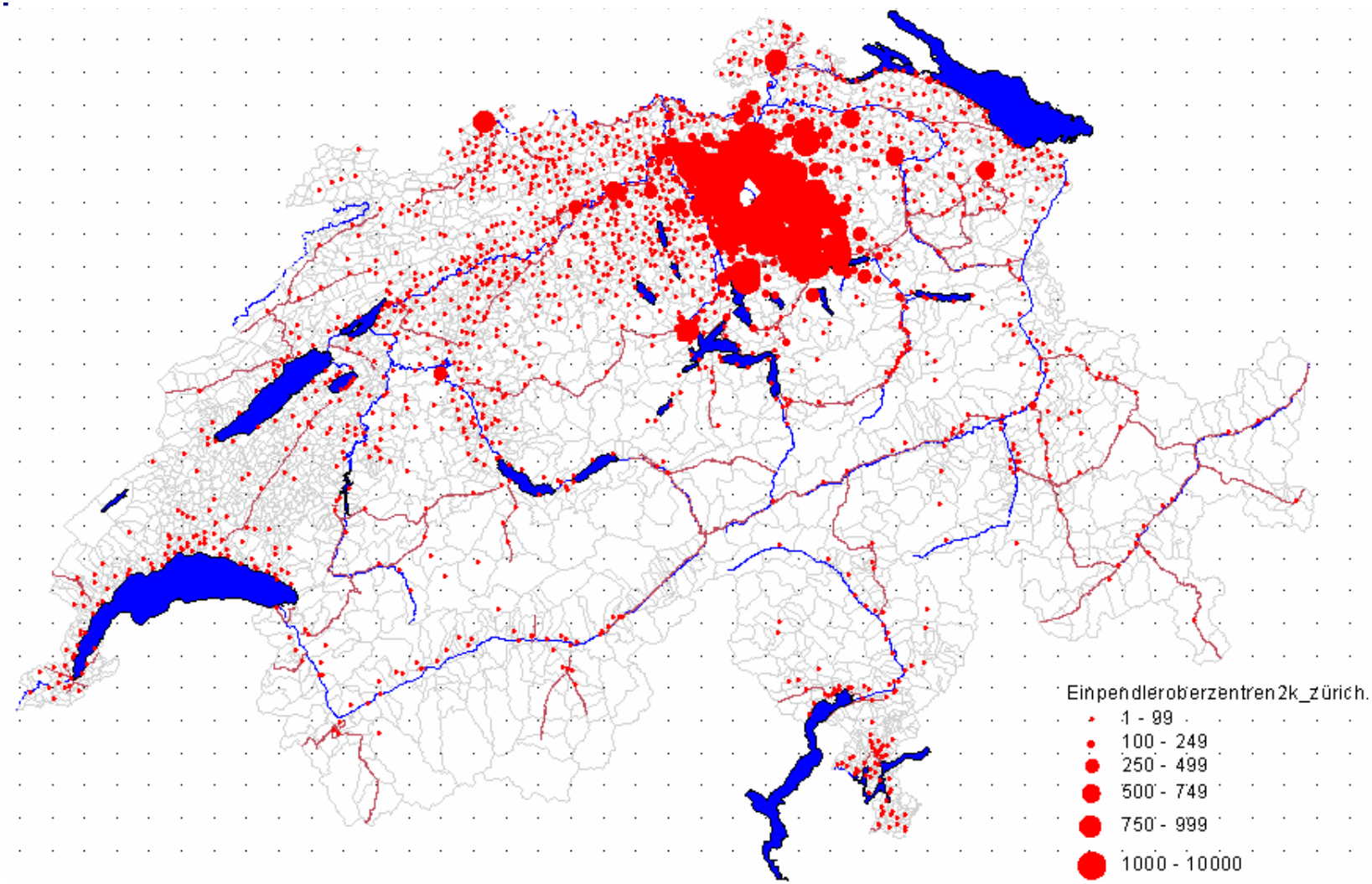
Example: Commuters to Zürich (2000)



Axhausen, Botte und Schönfelder, 2004

Approaches

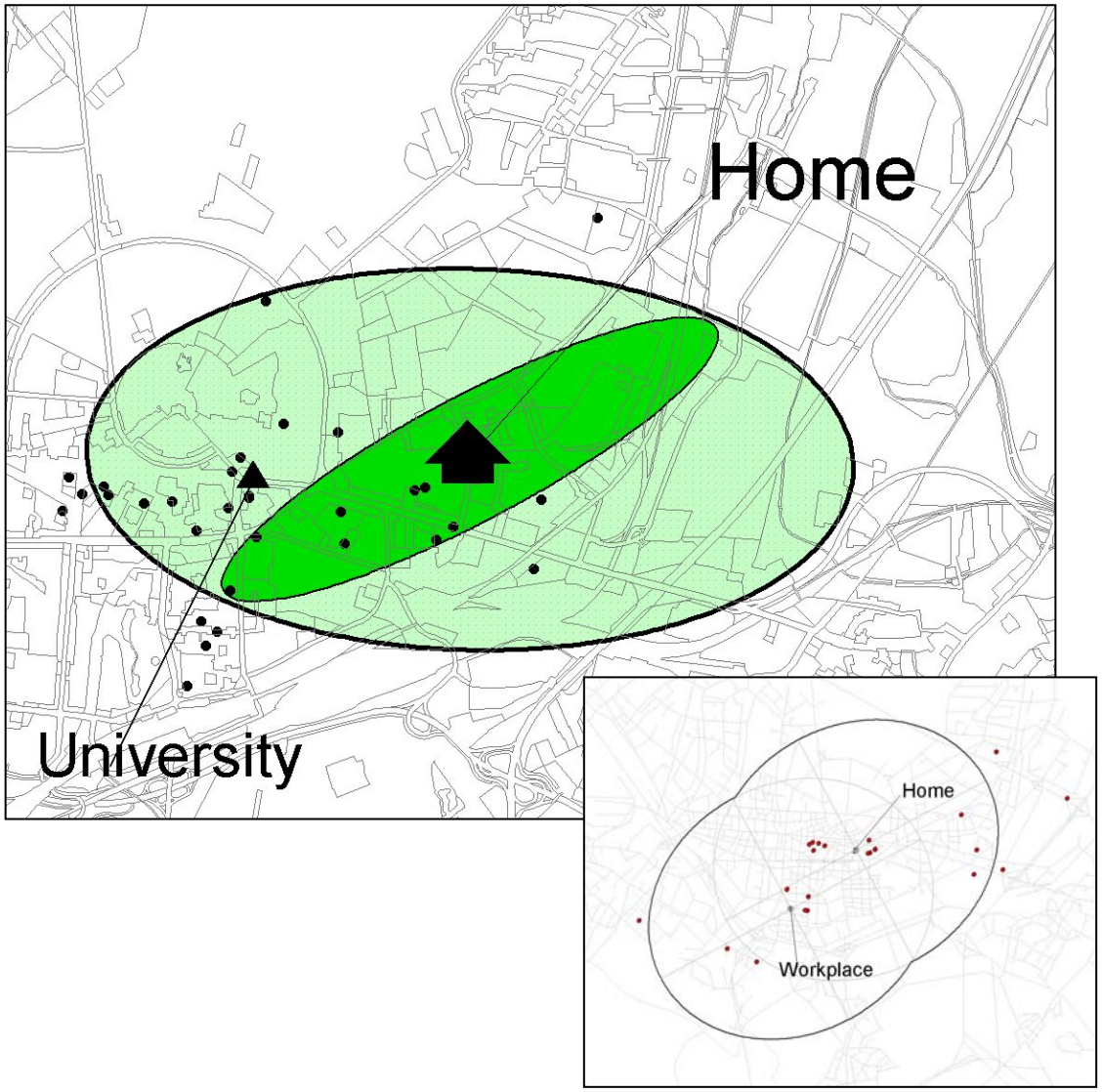
„Parametric“:

- 95% confidence ellipse

„Non-(semi)-parametric“:

- Spatial smoothing (kernel – density estimates)
- Network of shortest trips
- Network of monitored trips

Approach 1: 95% confidence ellipse



Concept:
Probability

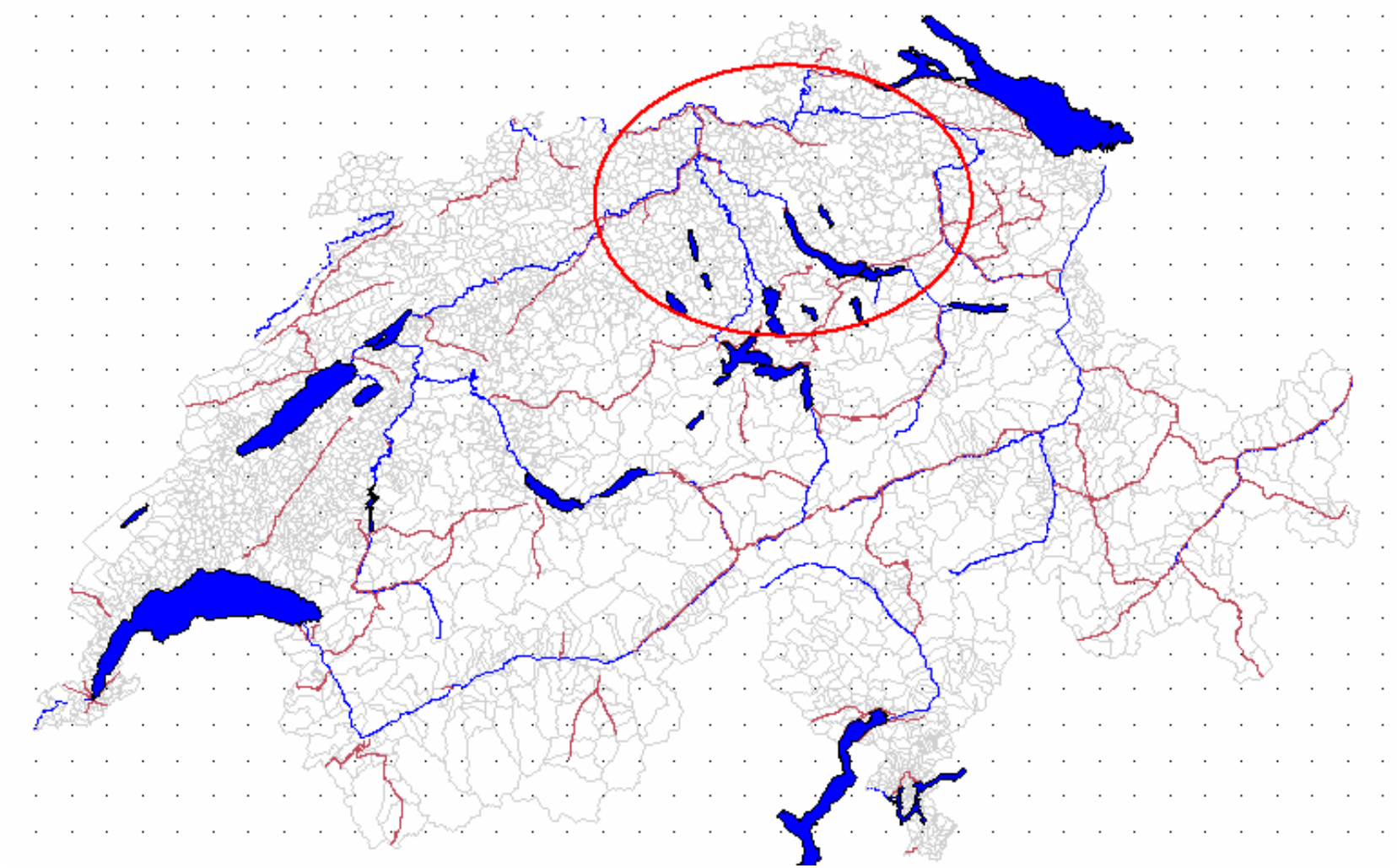
Smallest possible area of a true value of the population (i.e. activity locations)

Measure: Area

Shows dispersion / concentration

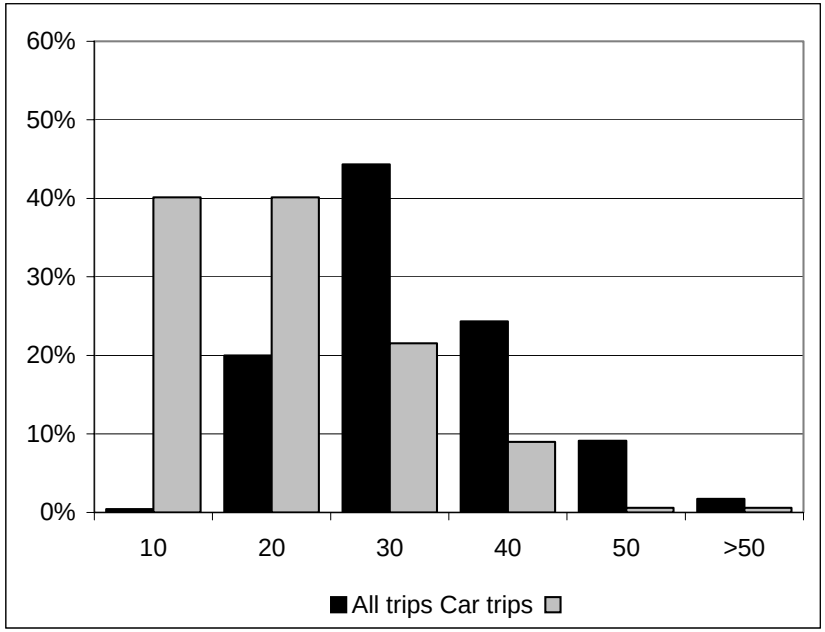
Axhausen, Botte und Schönfelder, 2004

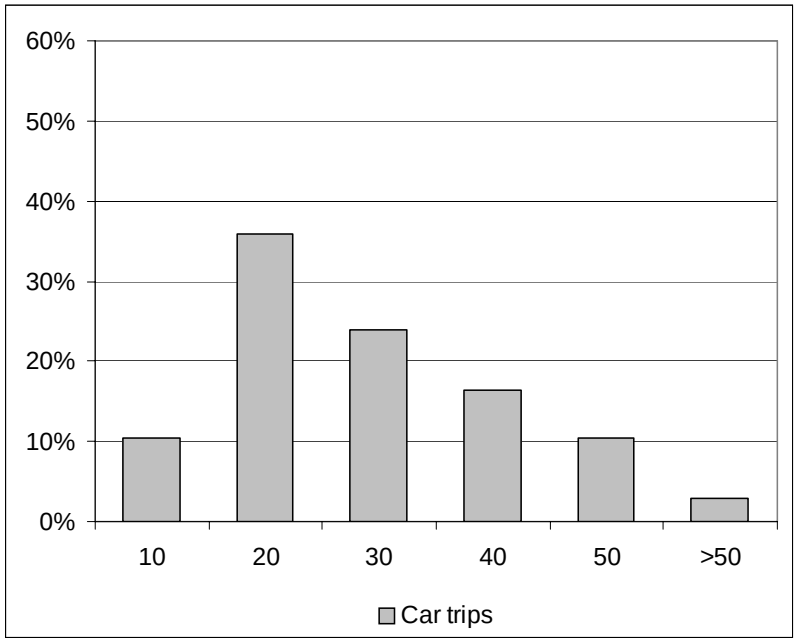
Example: Zürich commuters (2000)



Axhausen, Botte und Schönfelder, 2004

Number of trips in 6 weeks



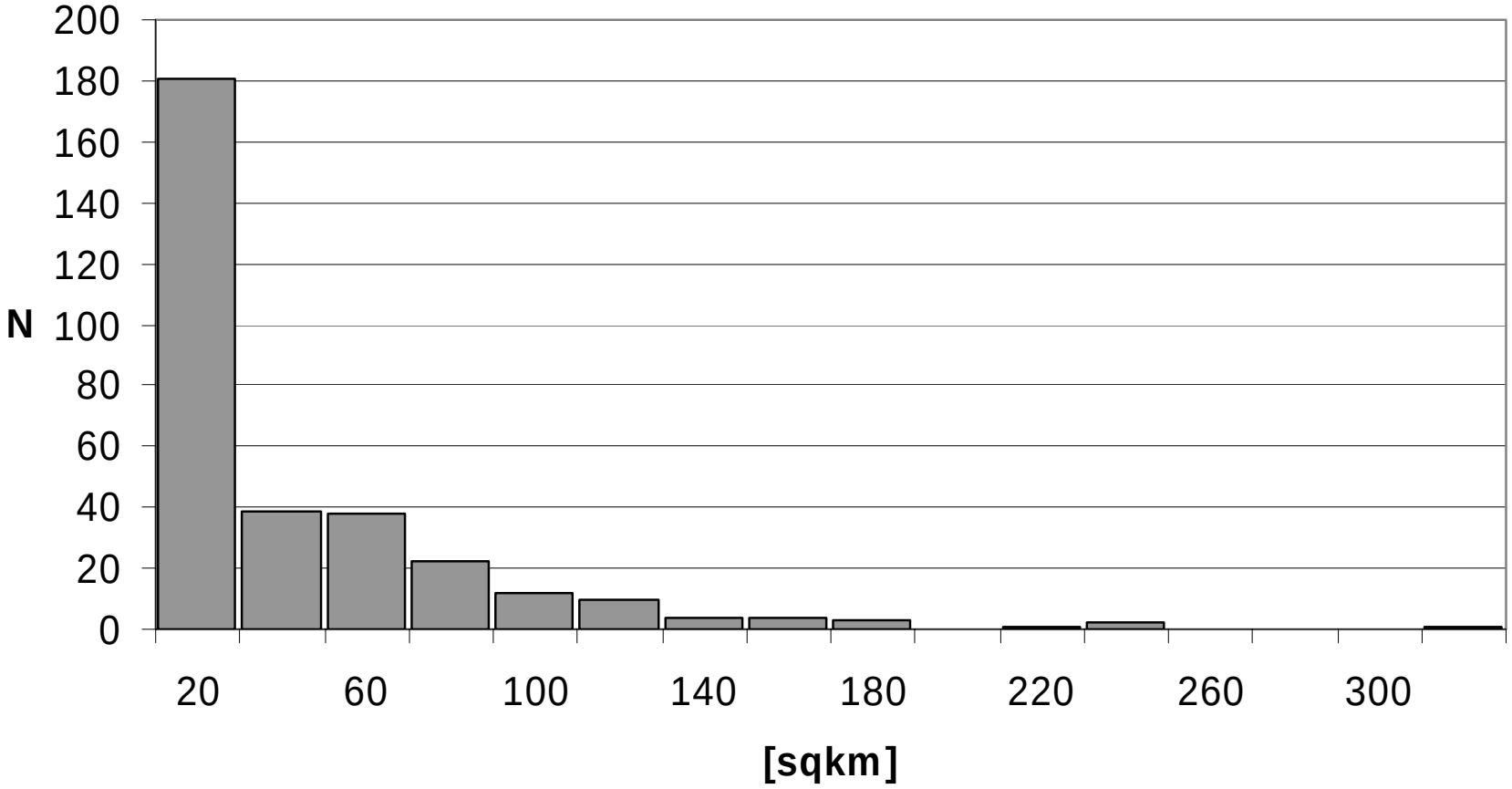


Mobi*drive*;
All trips of respondents
Car trips of “car users”

Borlänge GPS;
Car trips of “car users”

Schönfelder und Axhausen, 2004

Mobi*drive*: 95% confidence ellipses



* Local trips only

Schönfelder und Axhausen, 2004

Variance of activity spaces over time

Correlation coefficient		Last period		
		Trips	Places	95% CE
This period				
Trips	Borlänge	0.71		
	Copenhagen	0.66		
Places	Borlänge		0.62	
	Copenhagen.		0.62	
95% CE	Borlänge			0.62
	Copenhagen			0.52
N periods	Borlänge	849	849	849
	Copenhagen	252	252	252

Number of unique locations

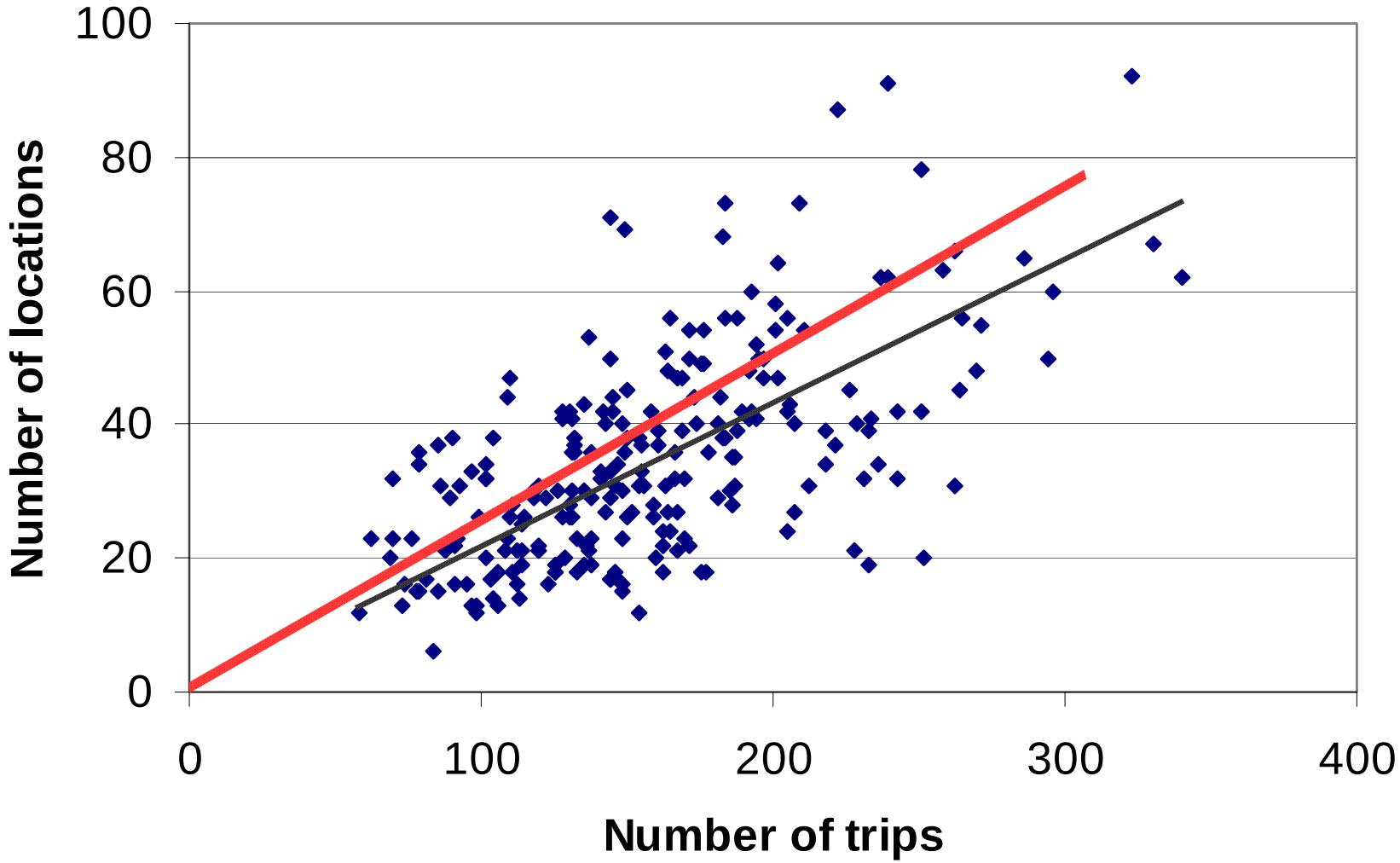
“Unique location” is defined as a combination of

- Address (street address, zip code, municipality code etc.)
- Activity purpose

Systematic problem of GPS – data:

- How to “summarise” varying parking positions to a single location?

Number of places as function of number of trips (Thurgau 2003)



Schönfelder und Axhausen, 2004

Number of places as function of number of trips

	Slope		R^2
Mobi*drive*	All Car drivers	0.18 0.22	0.47 0,71
Thurgau	All Car drivers	0.22 0.25	0.37 0.73
Uppsala	All Car drivers	0.22 0.25	0.40 0.75
Copenhagen	Car drivers	0.28	0.51
Borlänge	Car drivers	0.13	0.39

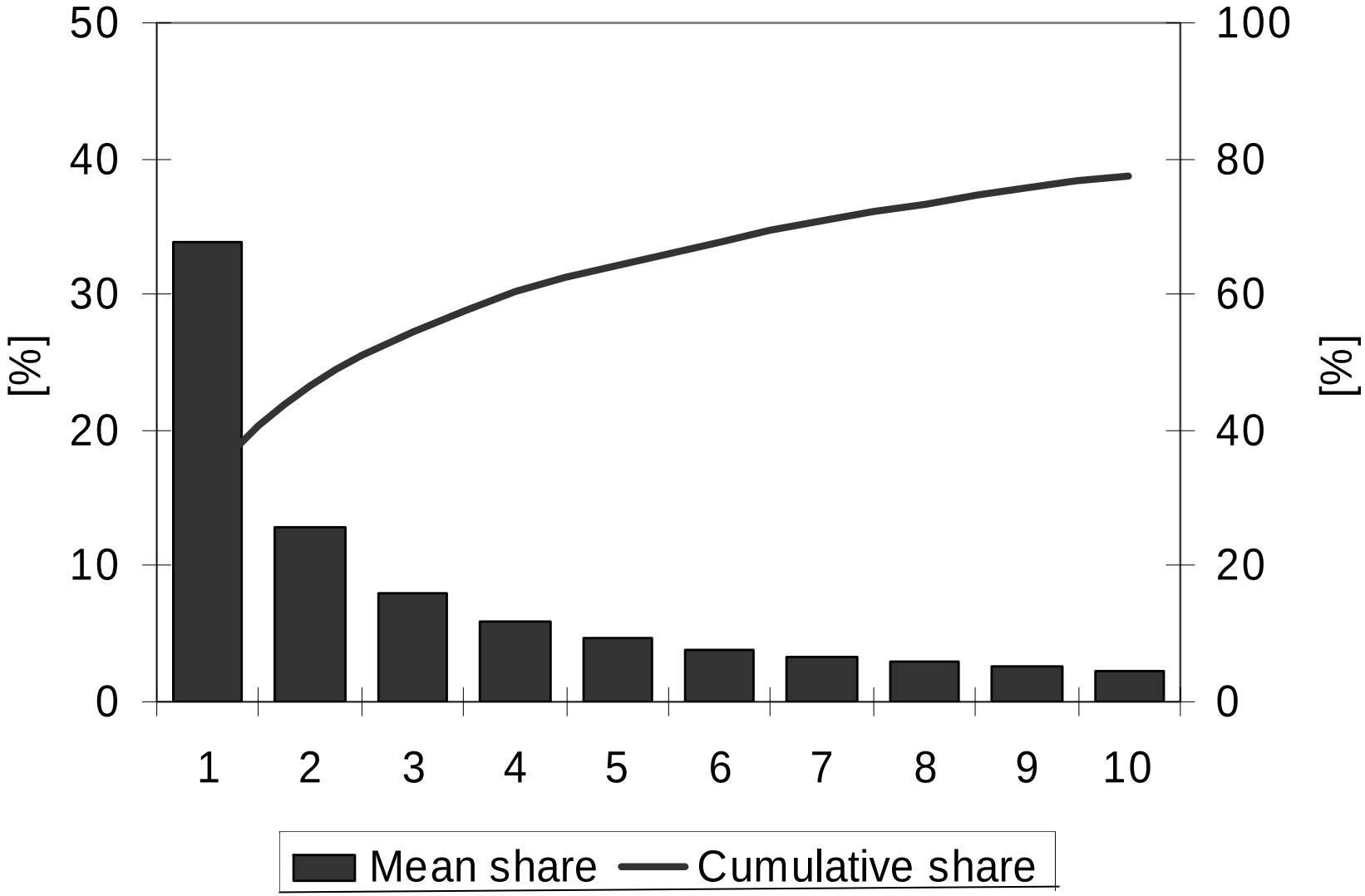
Schönfelder und Axhausen, 2004

Strukture of activity spaces

Criteria:

- Share of trips to most visited locations
- Cluster

Share of most important destinations of all trips (Mobi*drive*)



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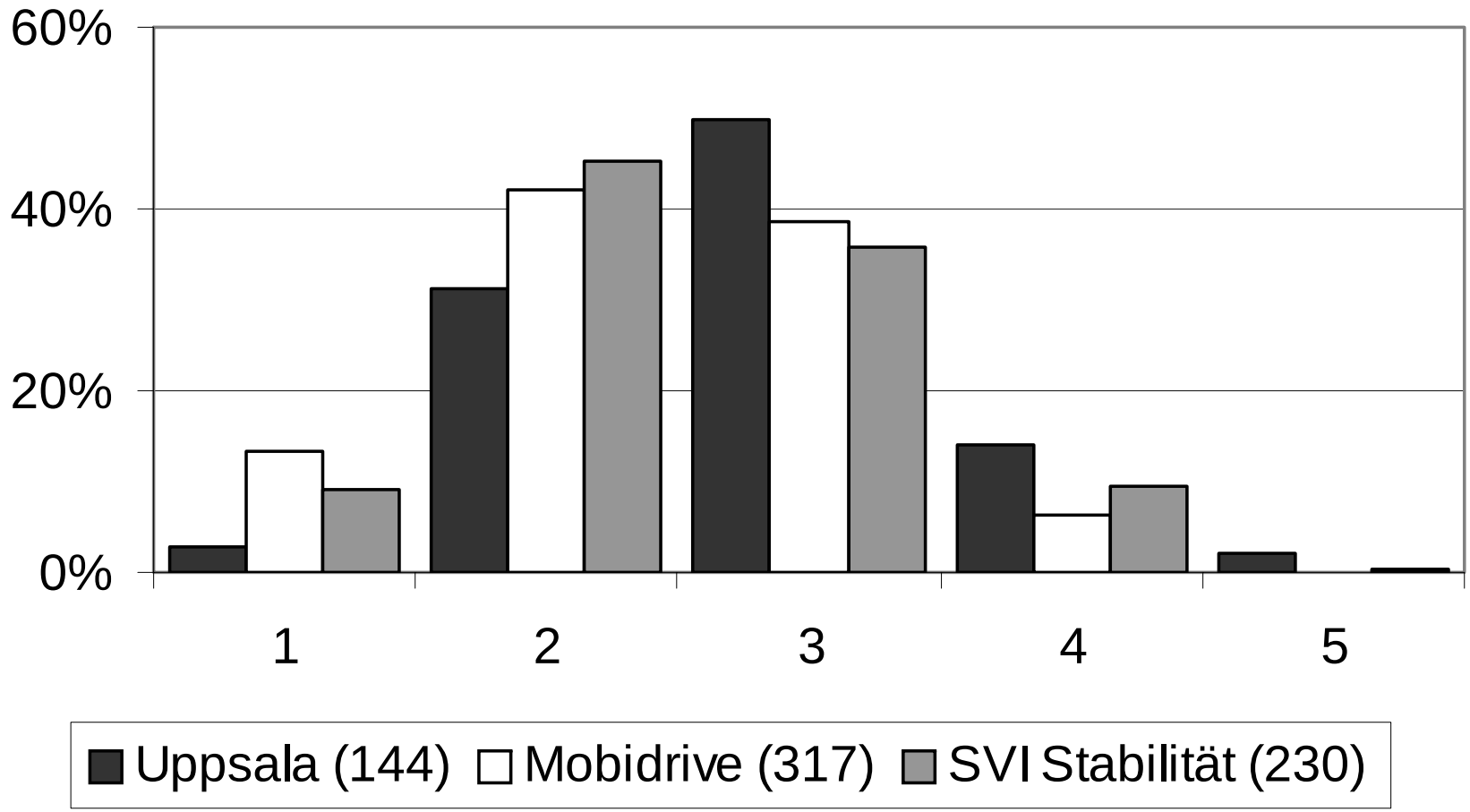
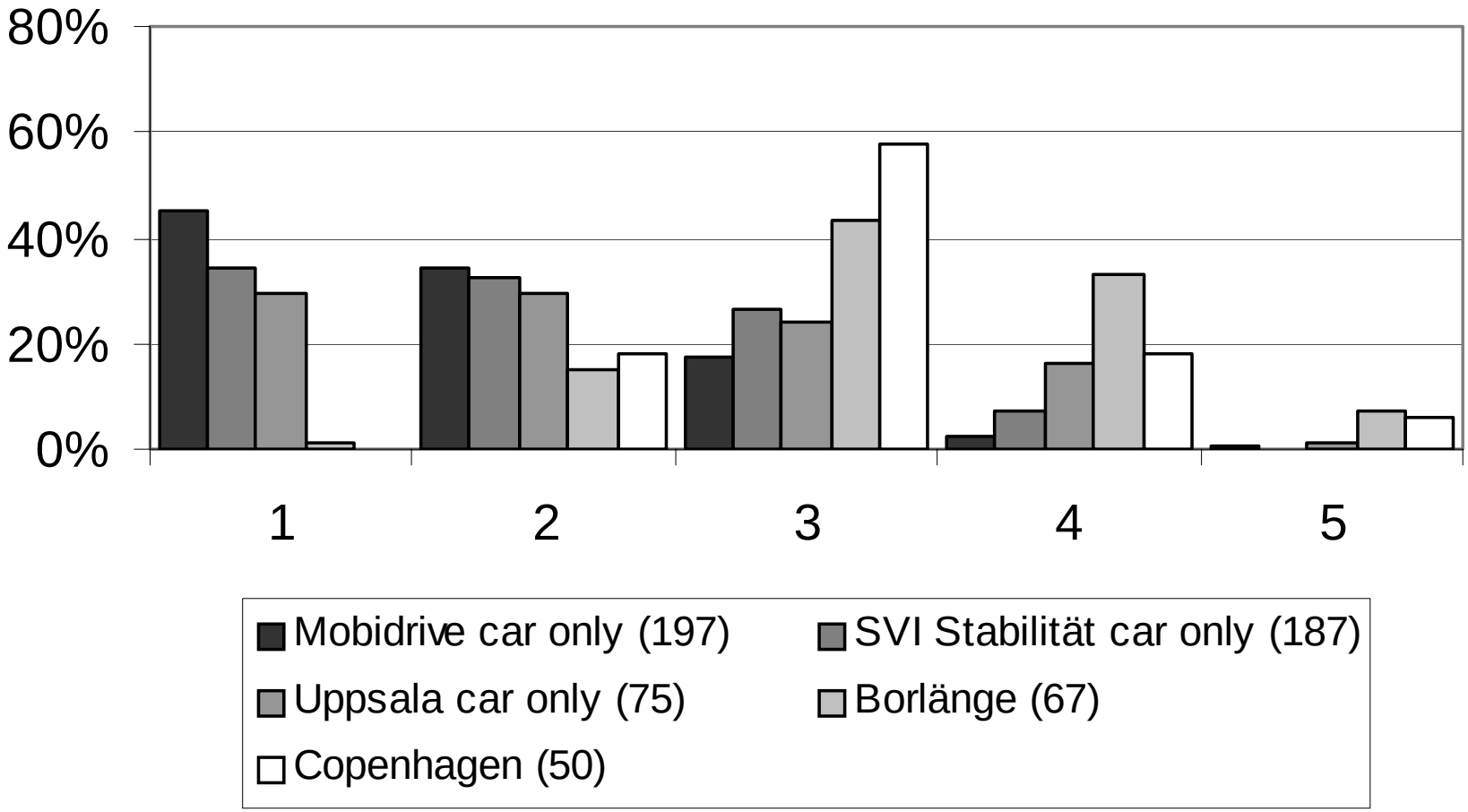
Distribution of activity clusters – number (All trips)



Cluster: 1 km radius; minimum 3 unique locations and 10% of all trips

Distribution of activity clusters – number (car drivers)



Cluster: 1 km radius; 3 unique locations and 10% of all car trips

Schönfelder und Axhausen, 2004

Centre of clusters: Activity purposes

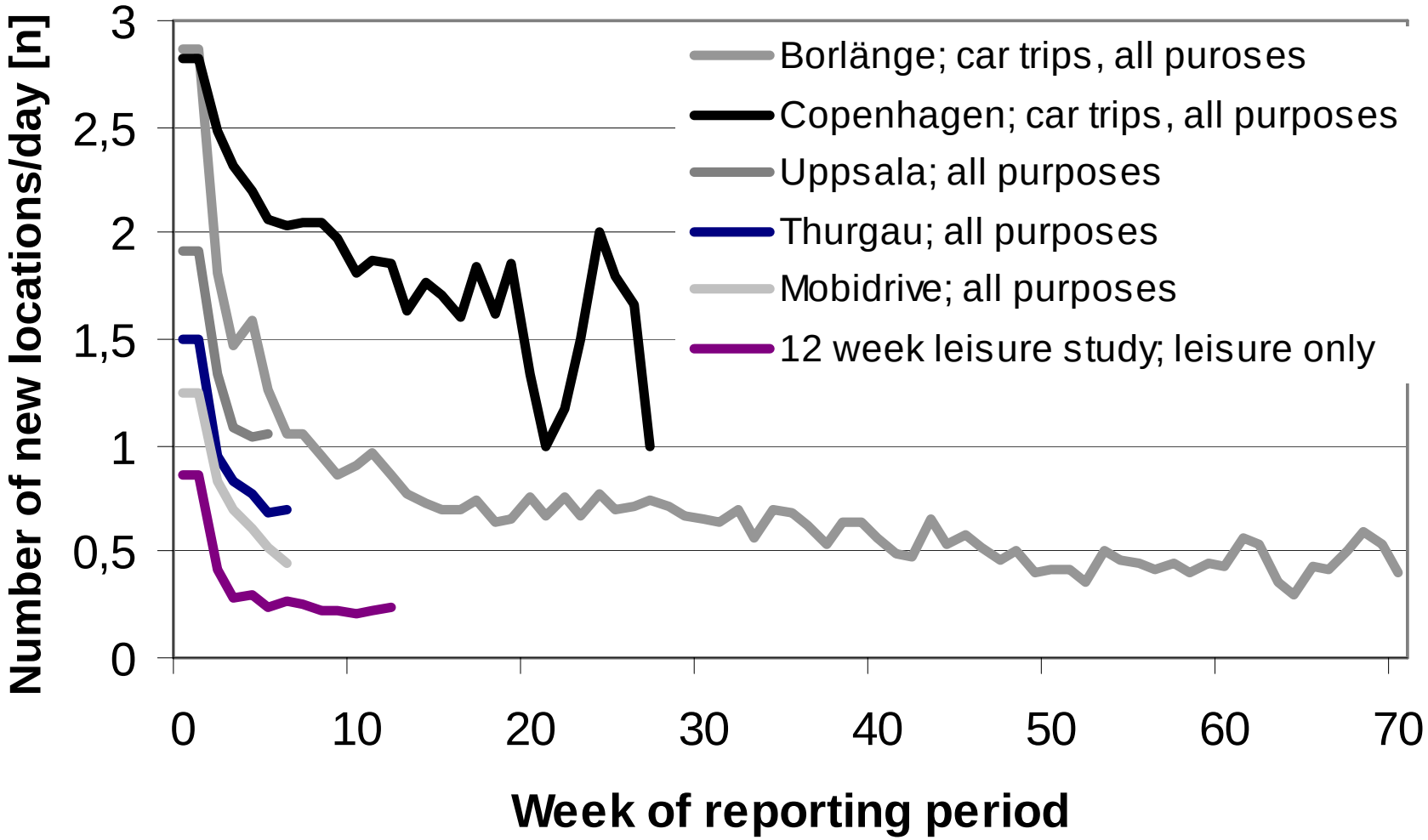
Purpose	Mobi All	Mobi Fulltime	Thurgau All	Thurgau Fulltime	Uppsala All	Uppsala Fulltime
Home	55	57	43	42	44	44
Leisure	12	11	14	10	12	12
Work	11	24	15	22	18	25
School	8	1	8	11	0	1
Grocery	6	4	9	5	19	12
Private business	5	0	3	1	2	1
Long-term shopping	1	1	0	1	1	0
Pick/Drop	1	1	4	4	2	3
Work related	1	0	4	4	0	0
Other	0	1	0	0	2	2

Innovation in destination choice

Two types of observation:

- “New” locations over the reporting / monitoring period
- Locations visited for the first time

“New” locations



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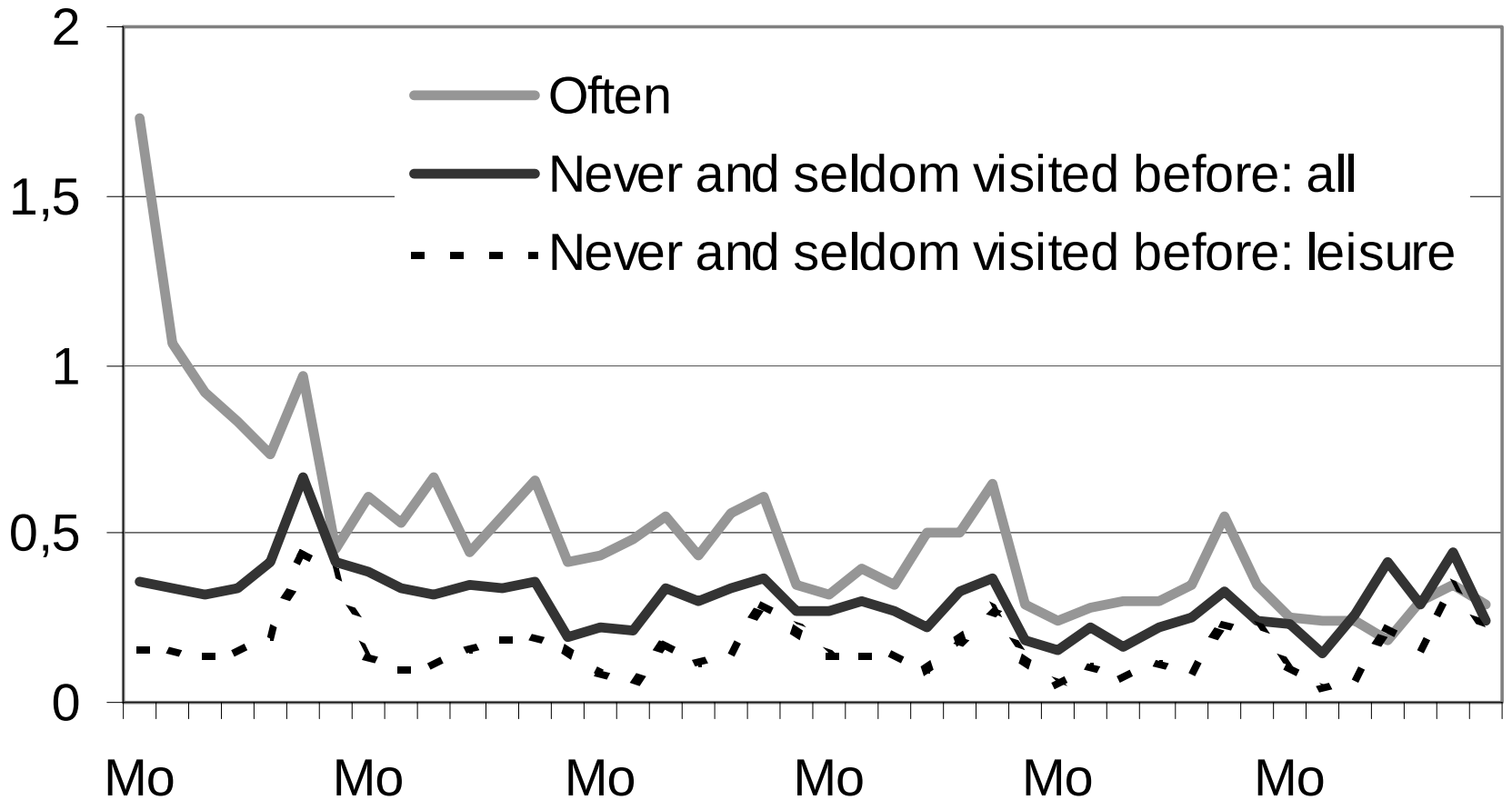
Places visited for the first time (Thurgau 2003)



First time or never before less than 4 visits
Often: 4 to 10 visits

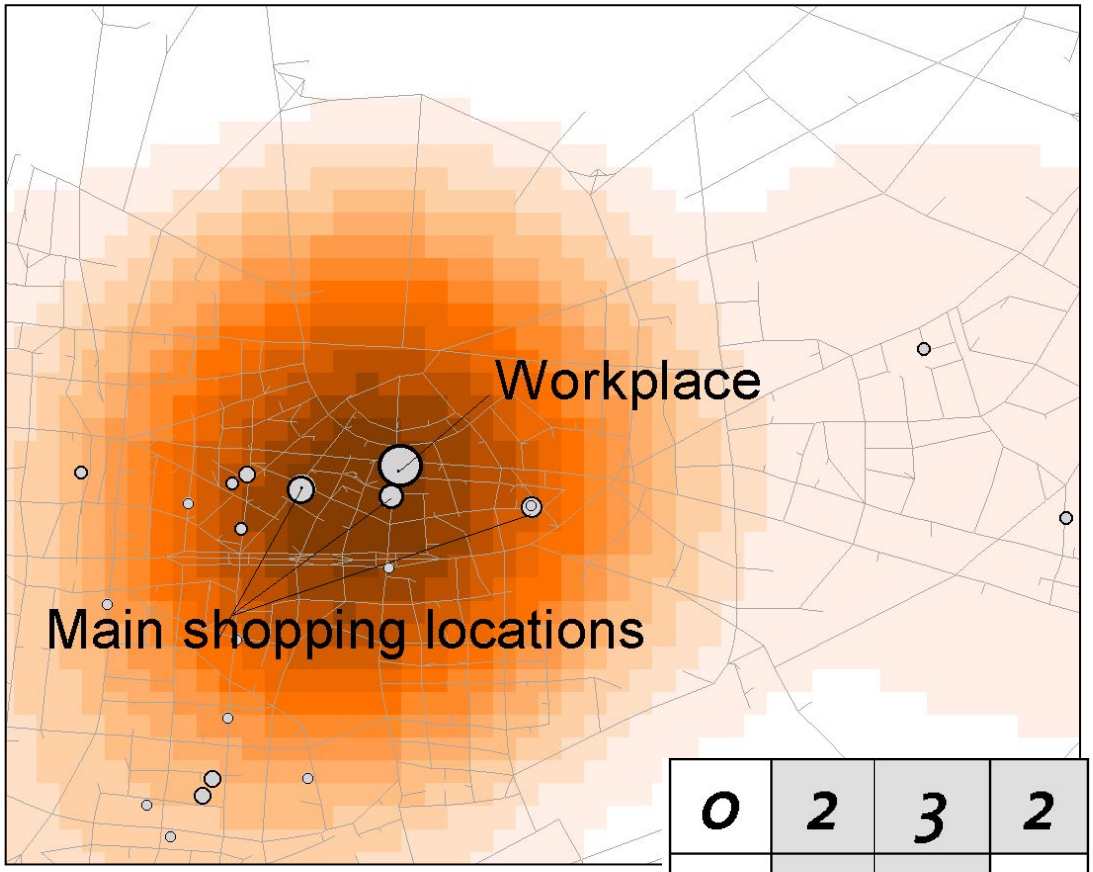
Schönfelder und Axhausen, 2004

Summary

- Activity spaces are measurable
- The relationship between number of trips and number of unique locations seems constant
- AS has a structure with few clusters
- The set of known places increases permanently
- The “rate of innovation” is constant
- The size of activity spaces is temporarily not or only partly stable

Appendix: Measuring activity spaces (Part 2)

Approach 2: Kernel densities



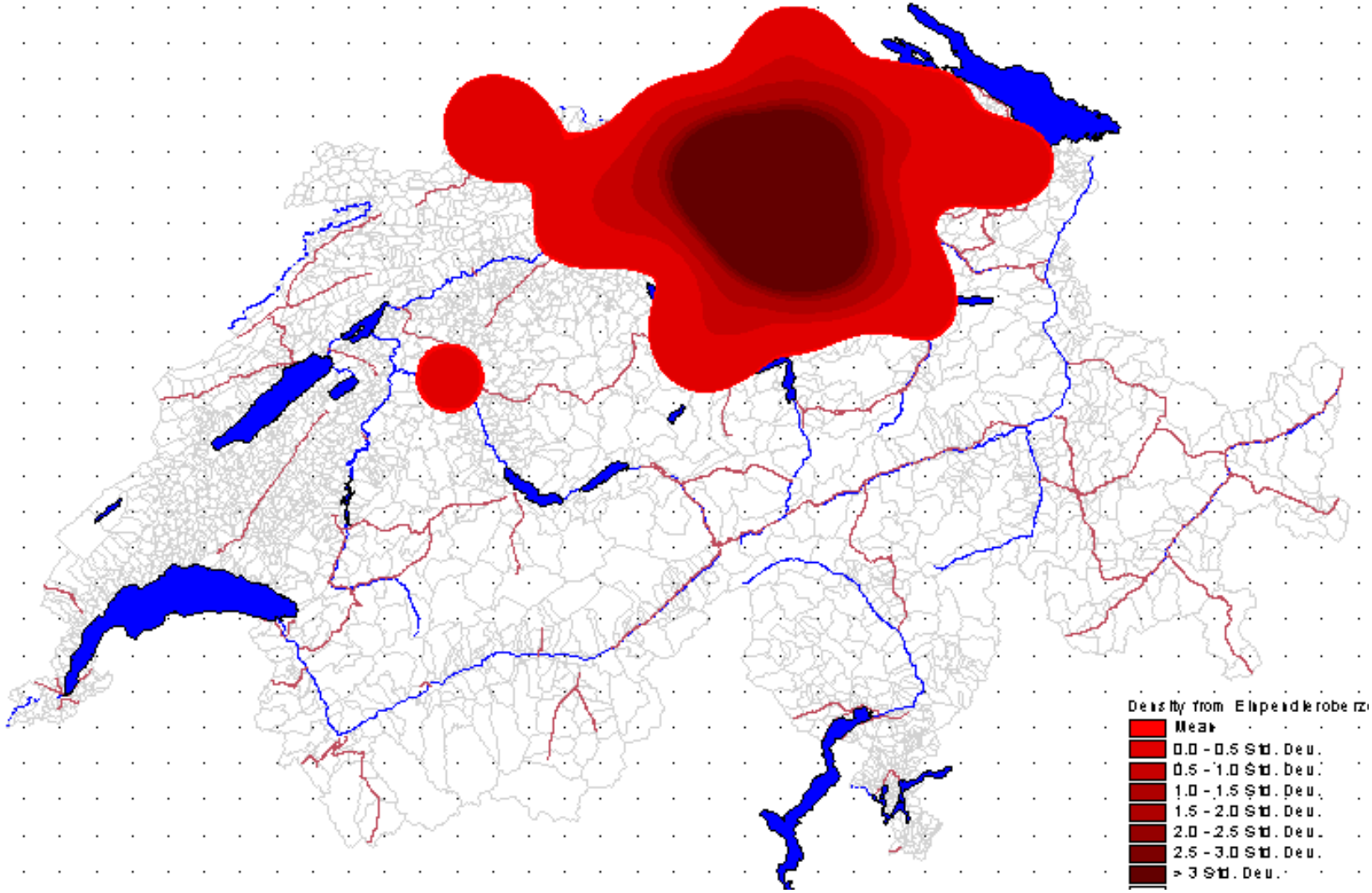
0	2	3	2
0	7	0.9	0
1	0.1	6	1

Density surface created by distribution of locations weighted by frequency of visit

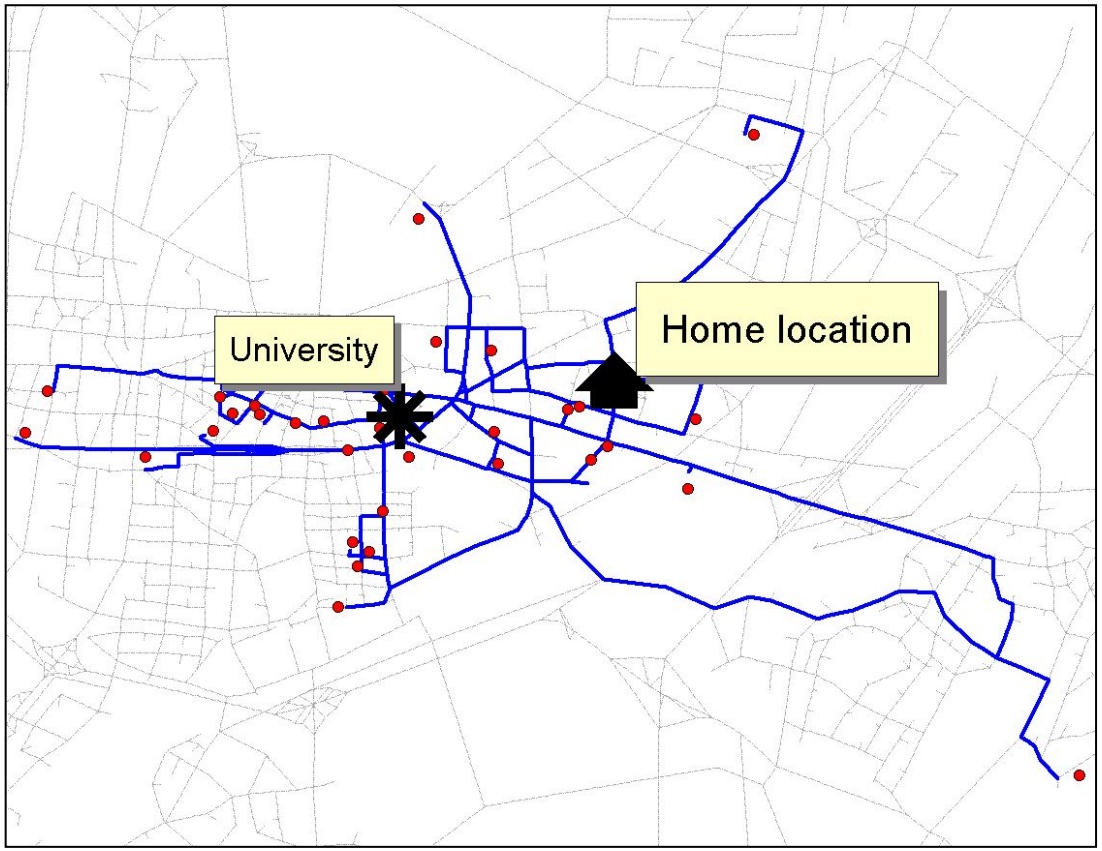
Measure: Area with positive density value

Focus: Clustering

Example: Zürich‘s commuter shed 2000



Approach 3: Shortest path network



Smallest geometry based on all O-D-relations observed (e.g. shortest paths)

Measure: Length of geometry / area spanned / buffered area

Focus: Spread of locations

Obvious refinements

All:

- Segmentation by type of interaction; time period
- Appropriate weighting schemes (ln ?)

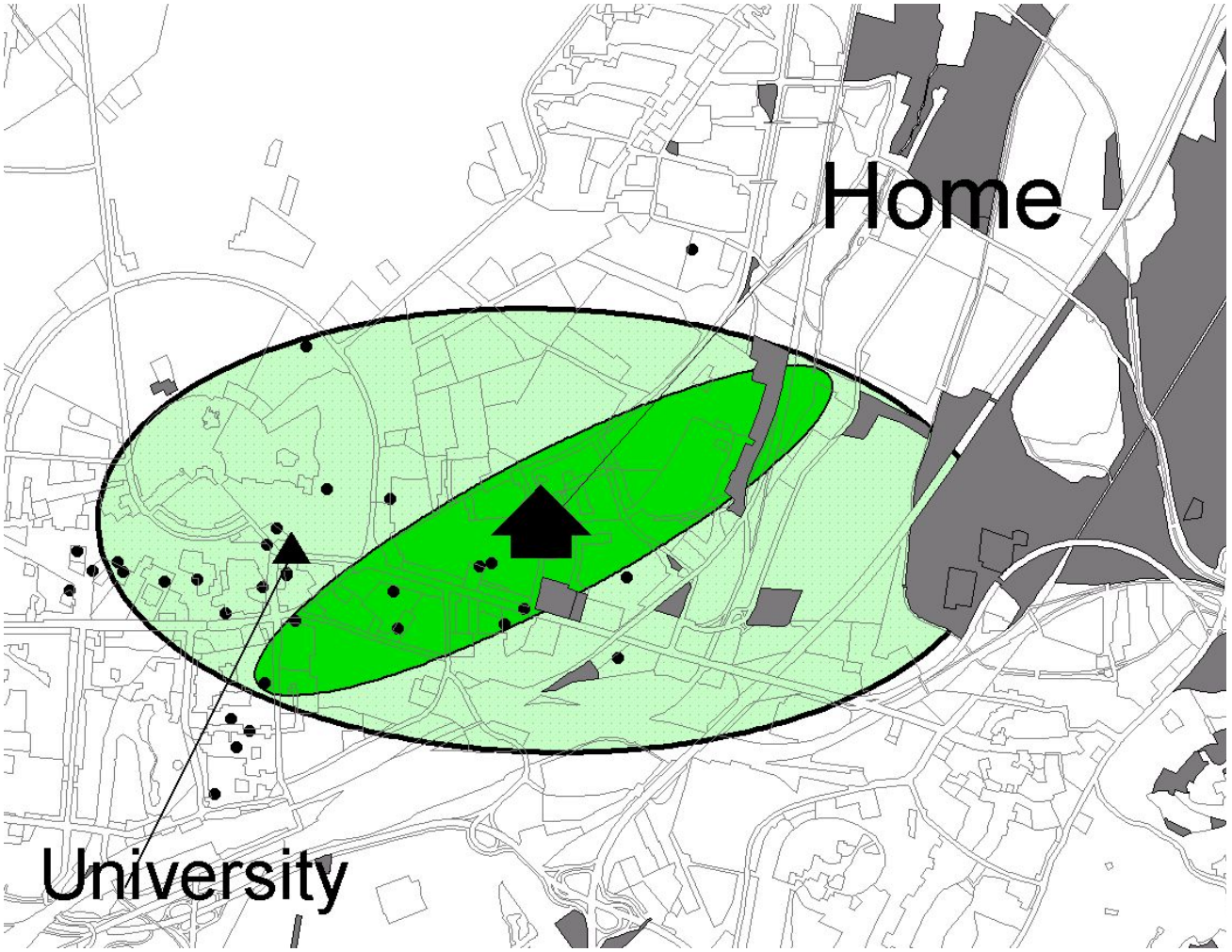
Confidence ellipse, Kernel densities:

- Removal of a-priori excluded spaces

Shortest path networks:

- Use mode-specific networks
- Use stochastic assignment

Refinement: Exclusion of excluded areas



Additional information

Confidence ellipse:

- Angle of the main axis relative to reference point
- Mean vector between point of interaction and base

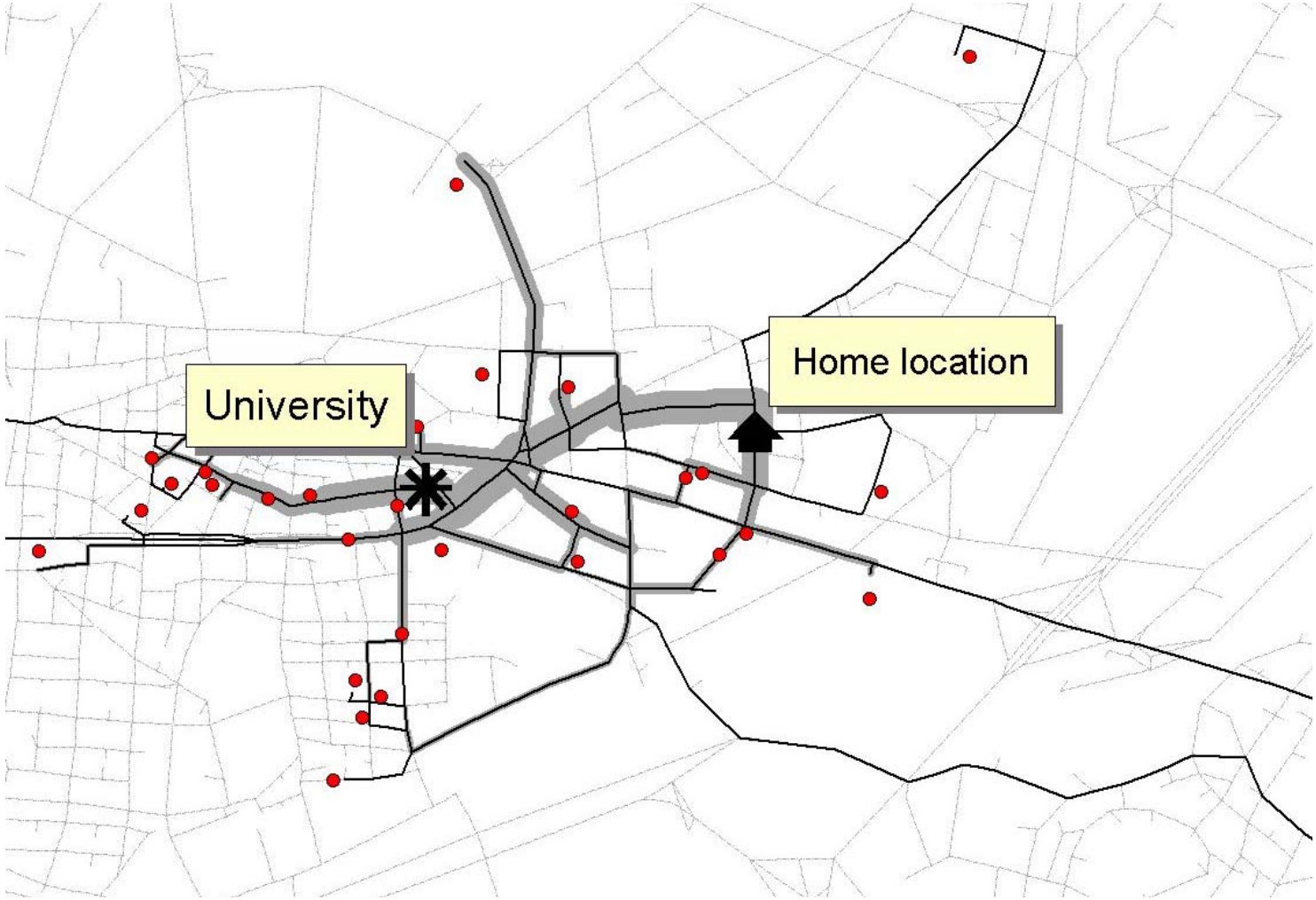
Kernel densities:

- Number of contiguous areas (clusters)

Shortest path networks:

- All descriptive statistics for network graphs
- Flow estimates

Additional information: Flow estimates



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