Preferred citation style

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Measuring activity spaces and behavioural innovation: Recent results

KW Axhausen

IVT
ETH
Zürich

March 2005

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Collaborators

S. Schönfelder (PhD student; activity spaces and spatial innovation)

M. Botte (MSc student; catchment areas)

T. Ohnmacht (Intern; Biographical interviews)

How to measure spatial reach ?

Question:

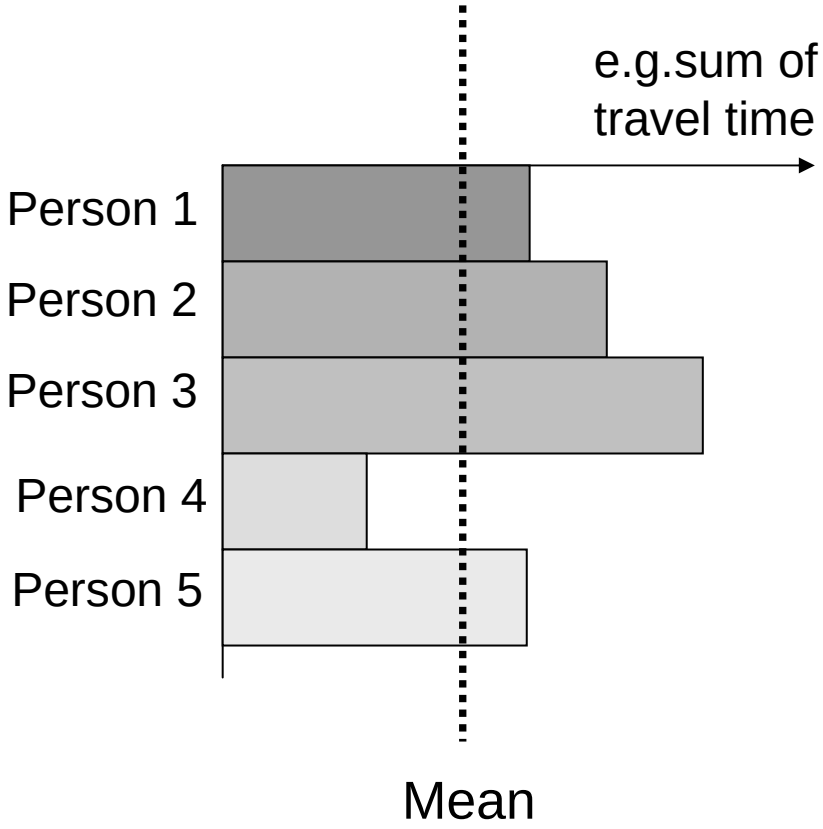
What area, footprint etc. is used by
an organisation, person or city ?

- Person: Activity space
- Network: Geography of its anchors; activity space
- City: Catchment area
- Organisation: Market

How measure variability of travel ?

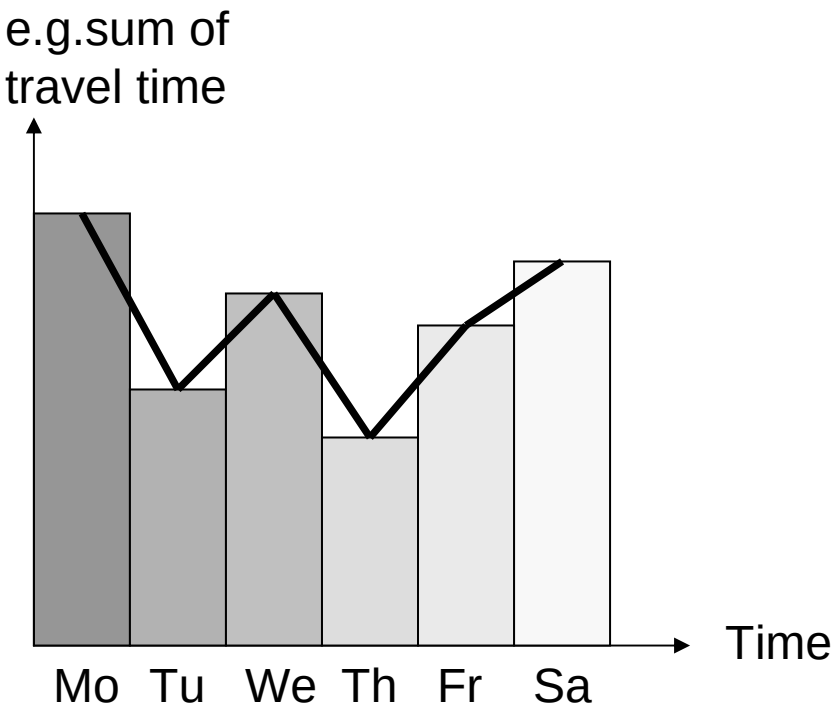
Inter-personal level

Single day



Intra-personal level

Person X



Schönfelder

Long-term issues in travel behaviour

Temporal phenomena: Behavioural issues over time

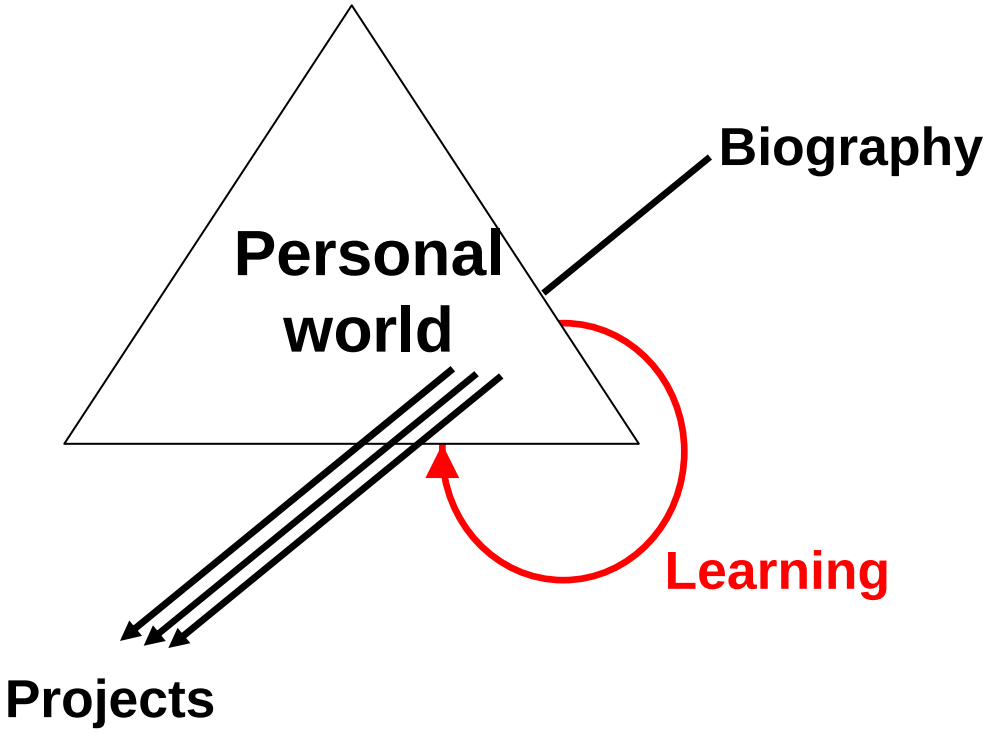
- Stability
- Regularity / Rhythms
- Variability
- Dynamics

Spatially:

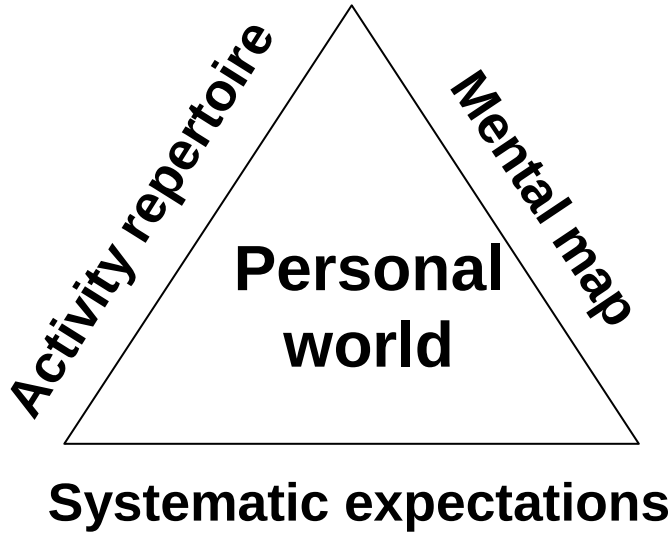
How may locational choice and the intensity of individual usage of urban space be visualised and measured?

(Geocoding/GPS facilitate)

Position: Individual in the biographical context



Position: Personal world

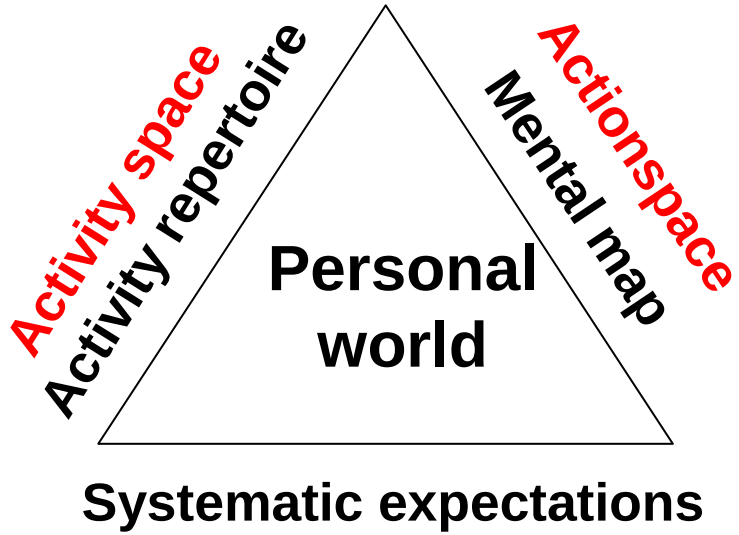


Activity repertoire: What can be done where and how

Mental map: links between locations and their generalised costs of travel

Systematic expectations about locations not yet visited

Position: Personal world



Activity space: Locations in current use

Action space: Extension of the mental map by locations known second hand via word-of-mouth or the media

Issues with the concept of „activity space“

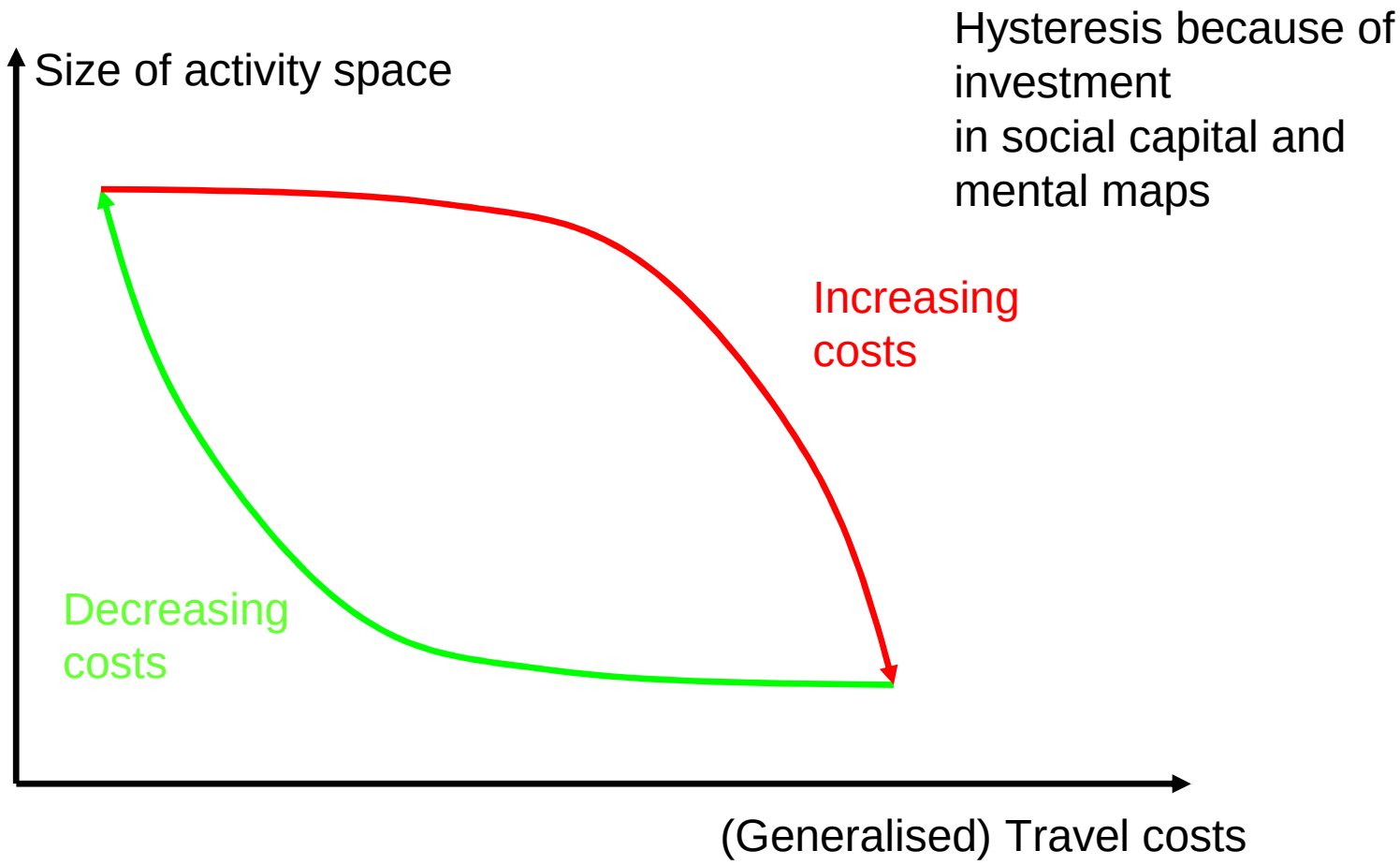
Current definition is restrictive:

- Locations in use (and by implications paths used)

But measureable

Most of the literature equates activity space and mental map or action space, which is unmeasureable

Assumed relationship between activity space and costs



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

Key variables/structures

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

Measuring the size of activity spaces: Problems

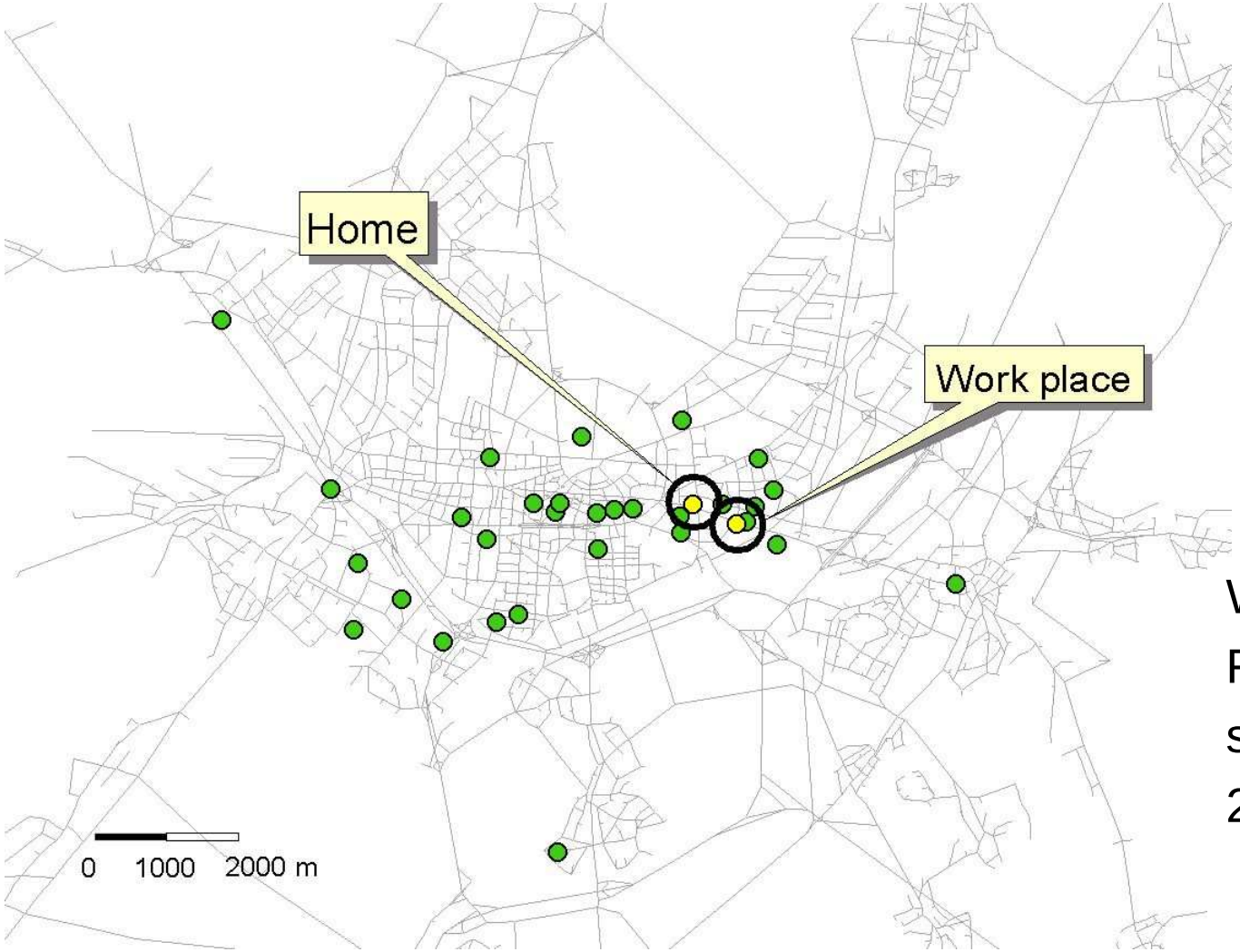
Transformation of information about the places of contact

- 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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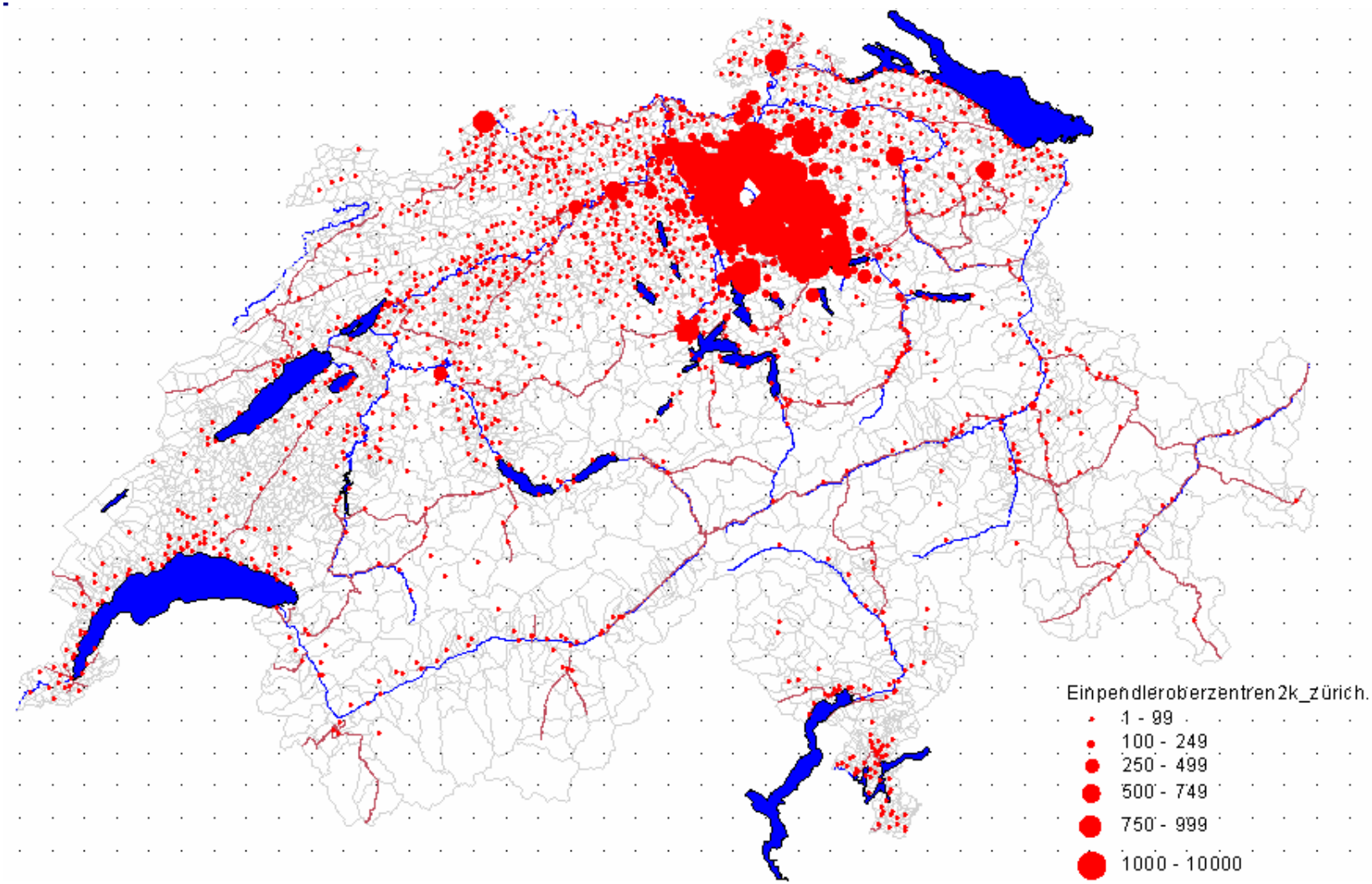
Example: Commuters to Zürich (2000)



Axhausen, Botte und Schönfelder, 2004

Approaches

„Parametric“:

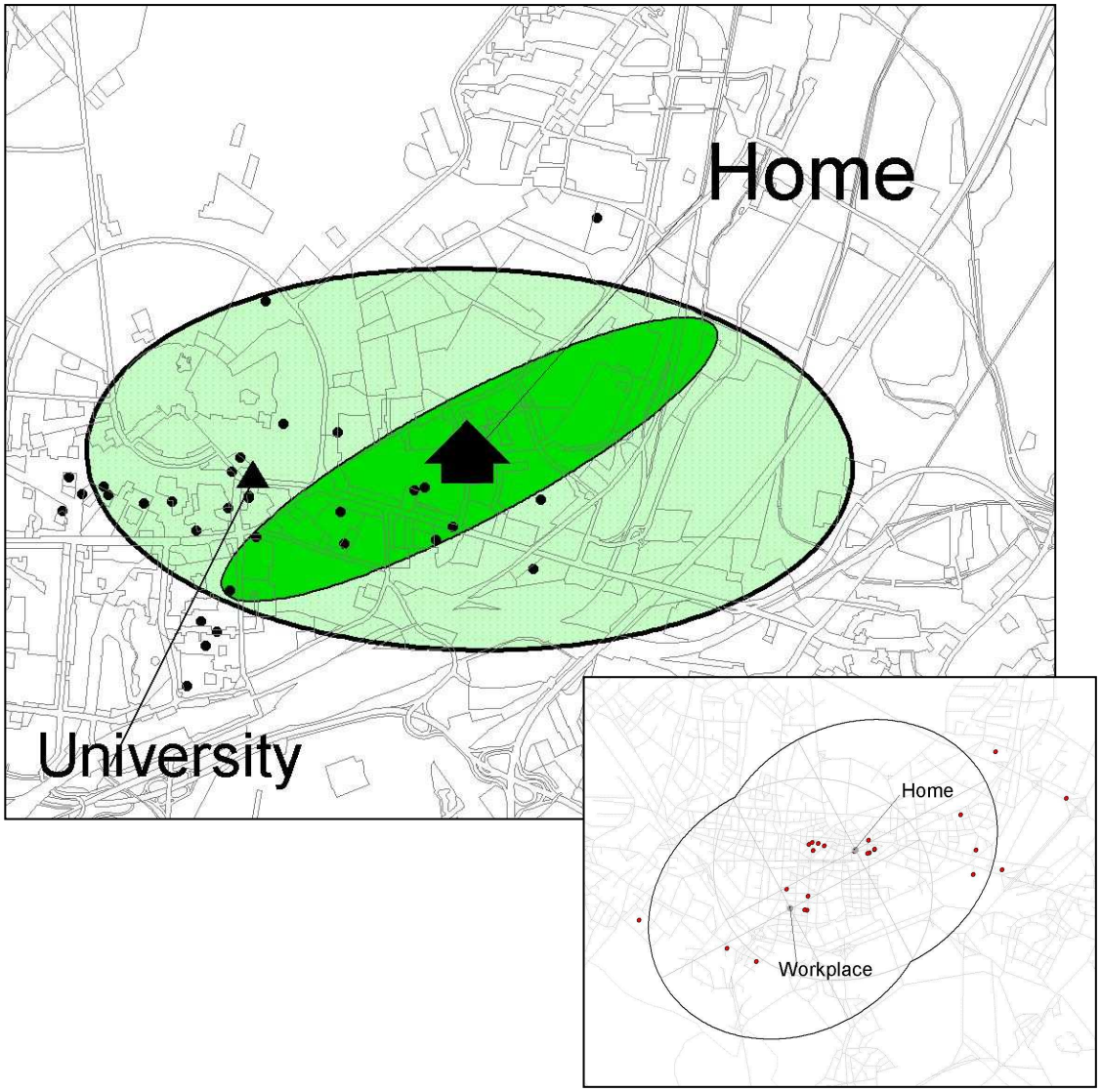
- 95% confidence ellipse

„Non-(semi)-parametric“:

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

Network of tracked routes

Approach 1: 95% confidence ellipse



Concept:
Probability

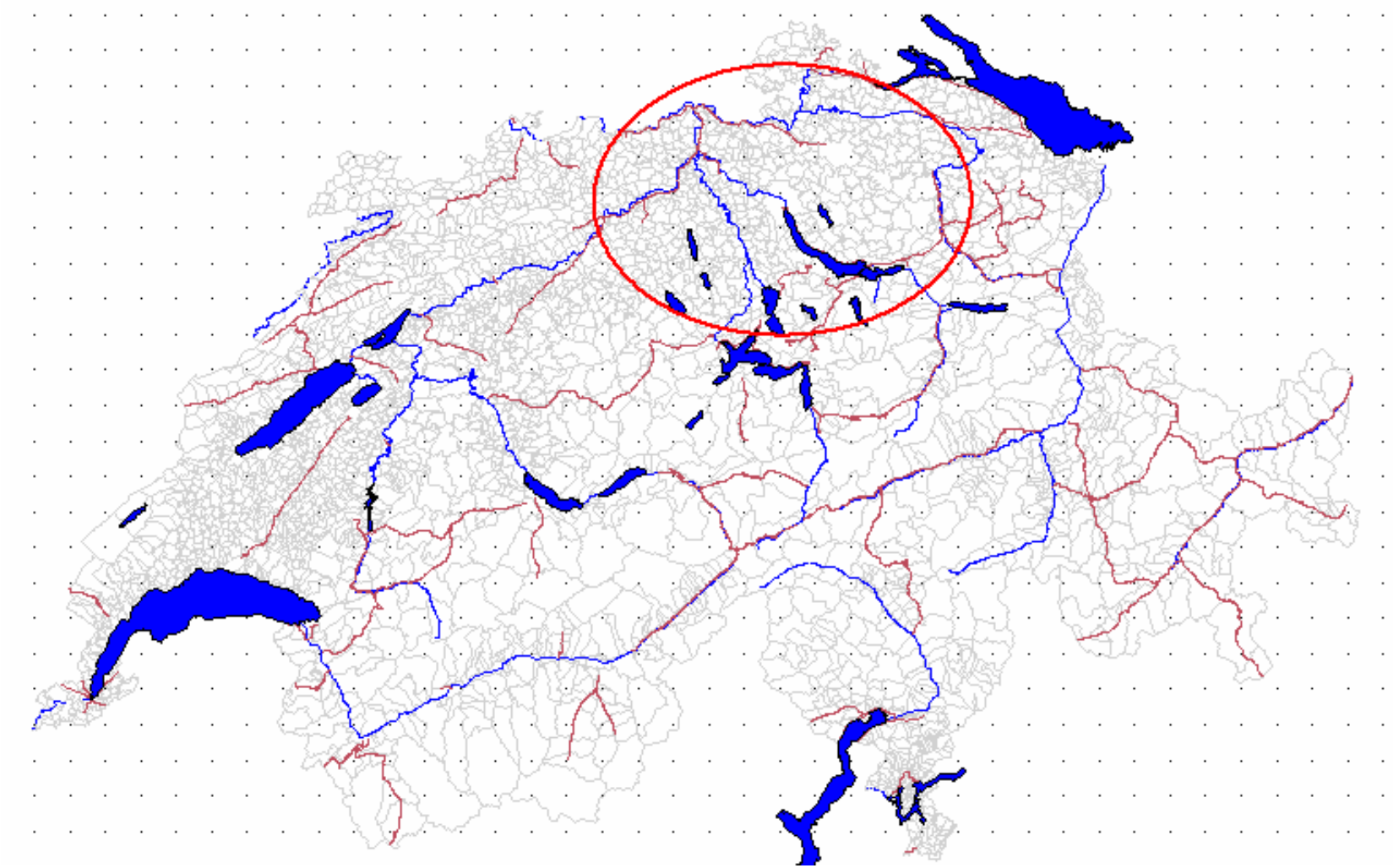
Smallest possible area of a true value of the population (i.e. activity locations)

Measure: Area

Shows dispersion / concentration

Axhausen, Botte und Schönfelder, 2004

Example: Zürich commuters (2000)



Axhausen, Botte und Schönfelder, 2004

Approach 2: Kernel densities

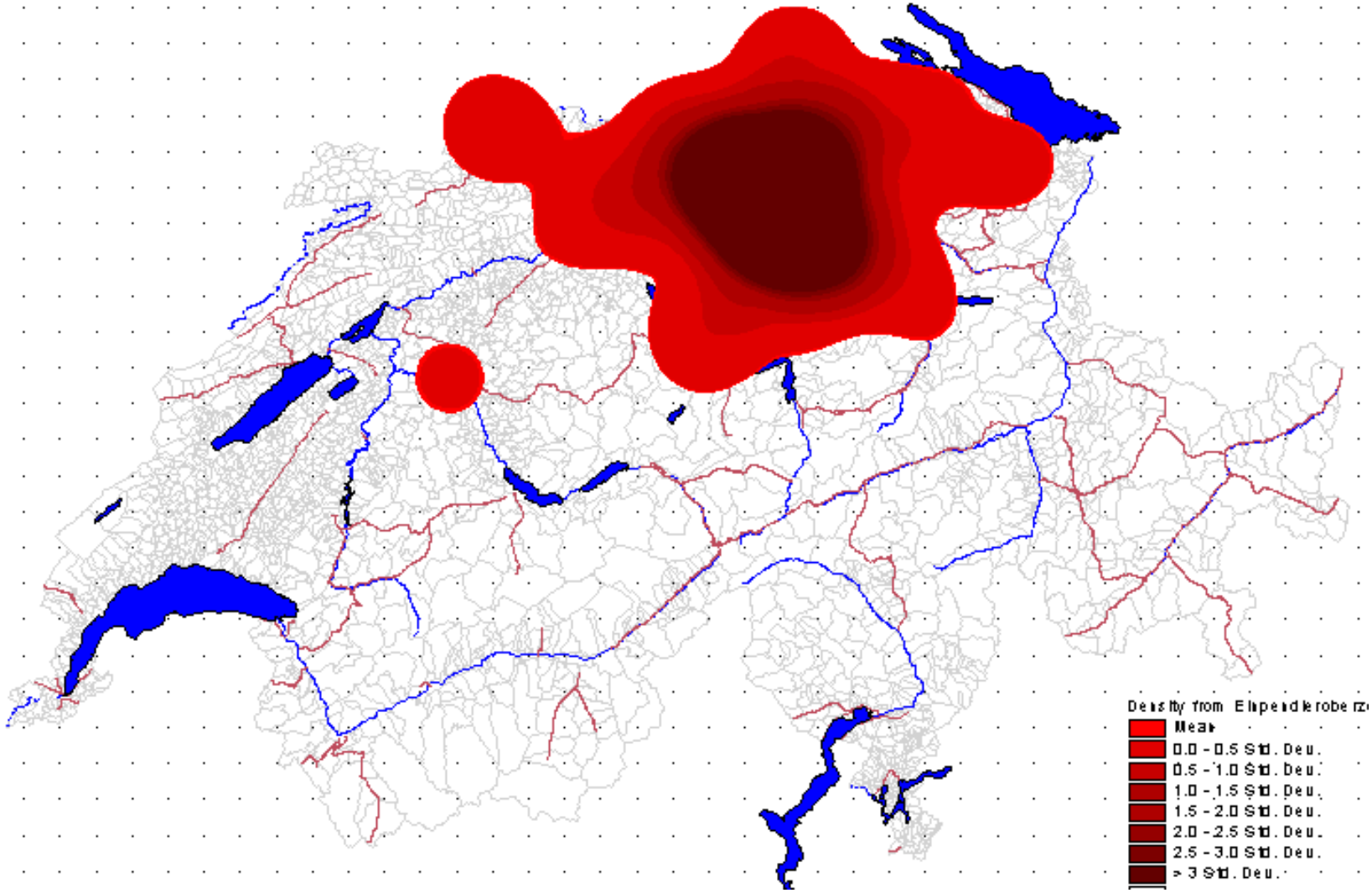
0	2	3	2
0	7	0.9	0
1	0.1	6	1

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

Measure: Area with positive density value

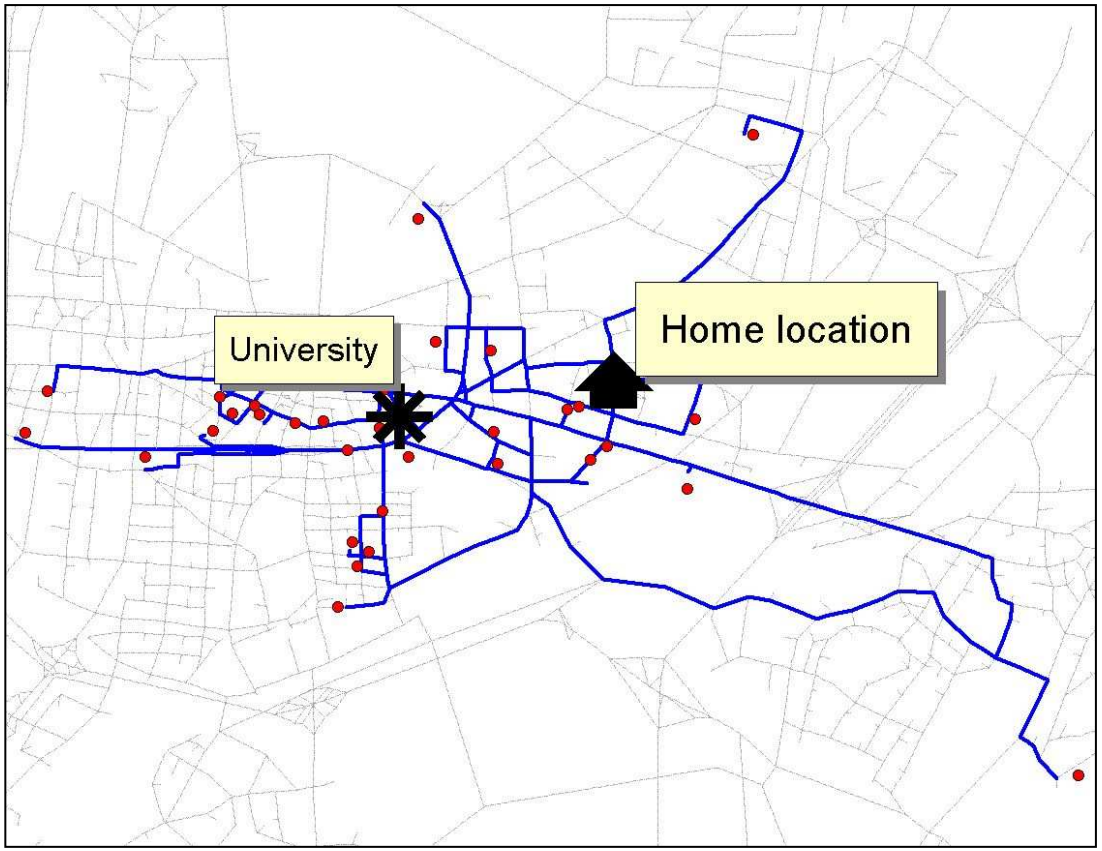
Focus: Clustering

Example: Zürich‘s commuter shed 2000



Botte, 2003

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 ?)

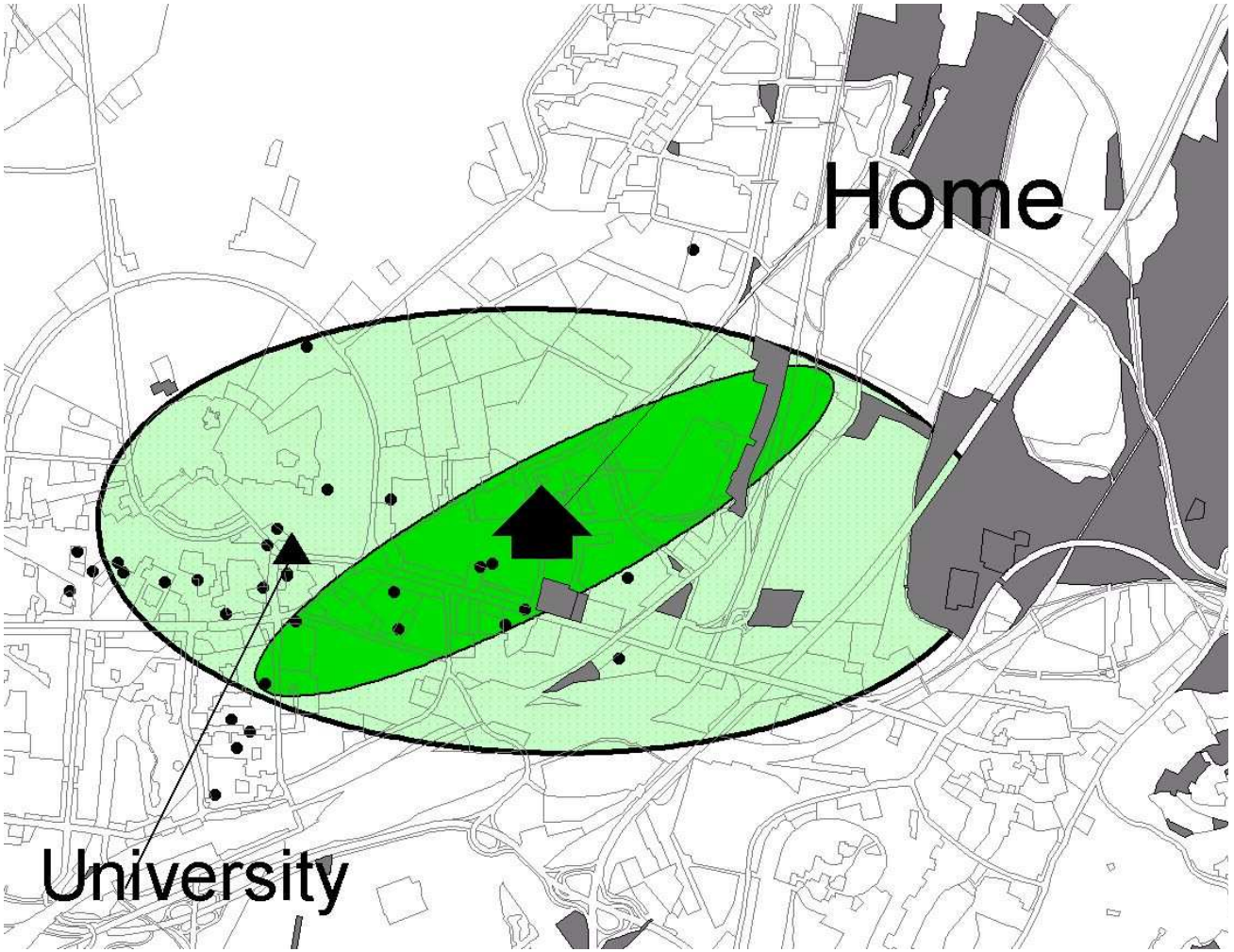
Confidence ellipse, Kernel densities:

- Removal of a-priori excluded spaces

Shortest path networks:

- Use mode-specific networks
- Use stochastic assignment

Refinement: Exclusion of excluded areas



Schönfelder

Additional information

Confidence ellipse:

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

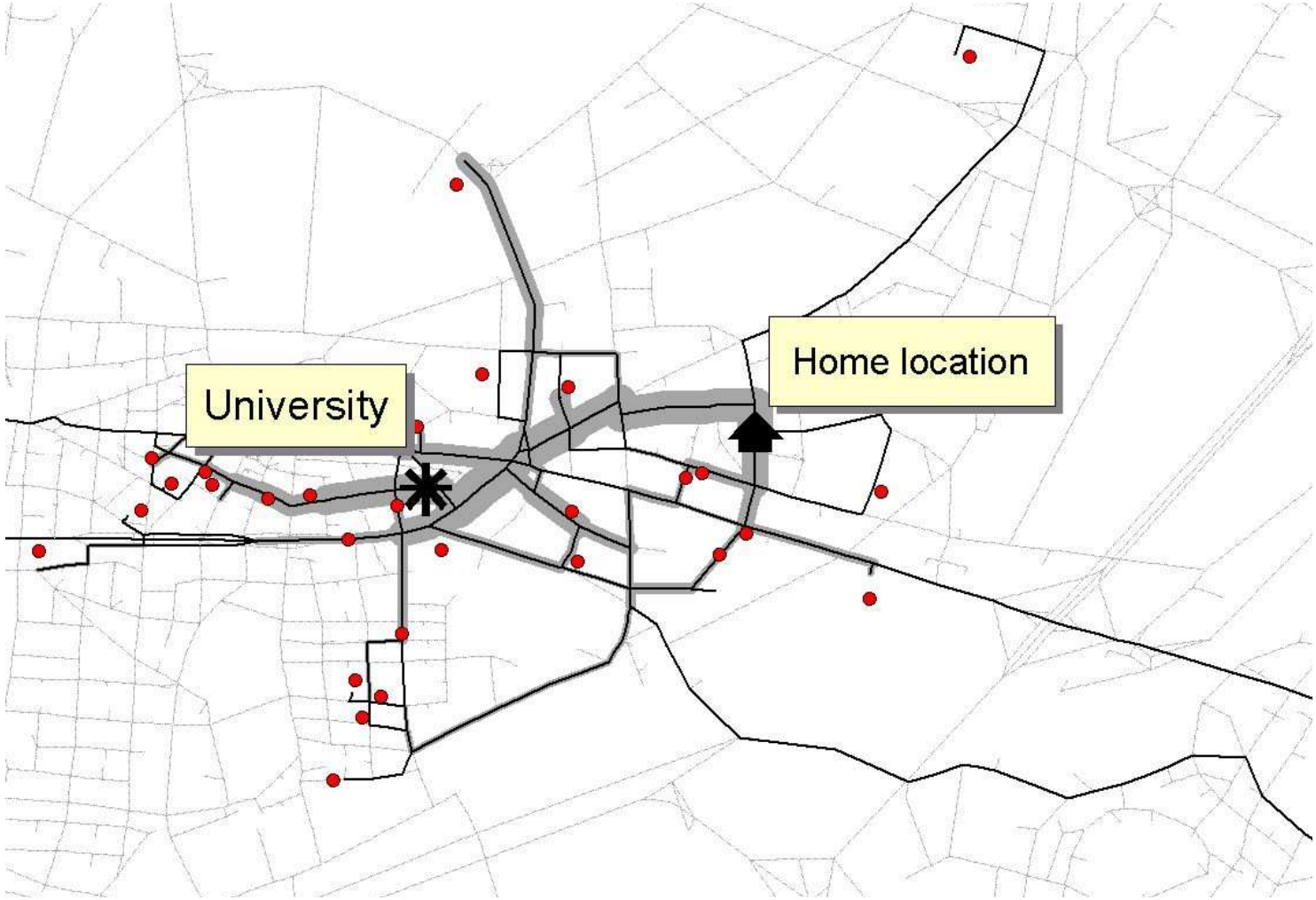
Kernel densities:

- Number of contiguous areas (clusters)

Shortest path networks:

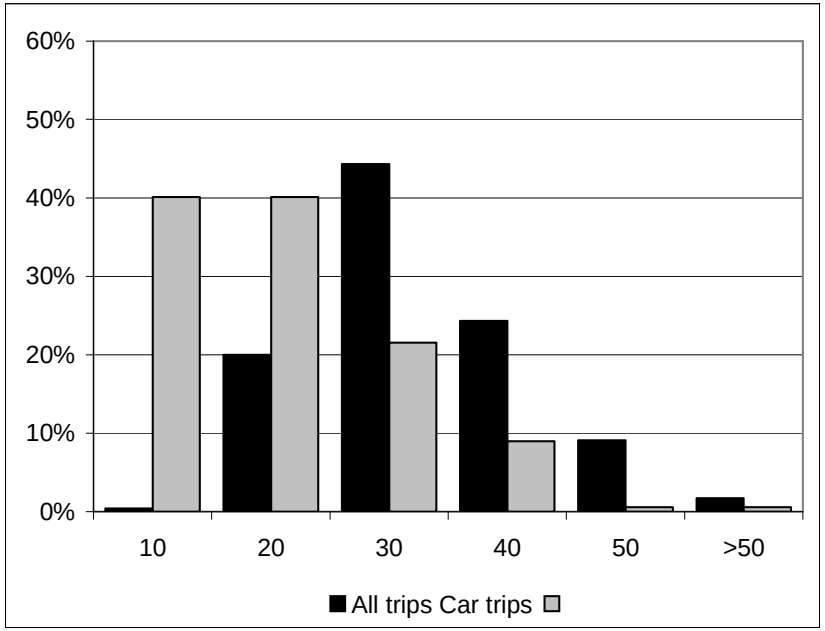
- All descriptive statistics for network graphs
- Flow estimates

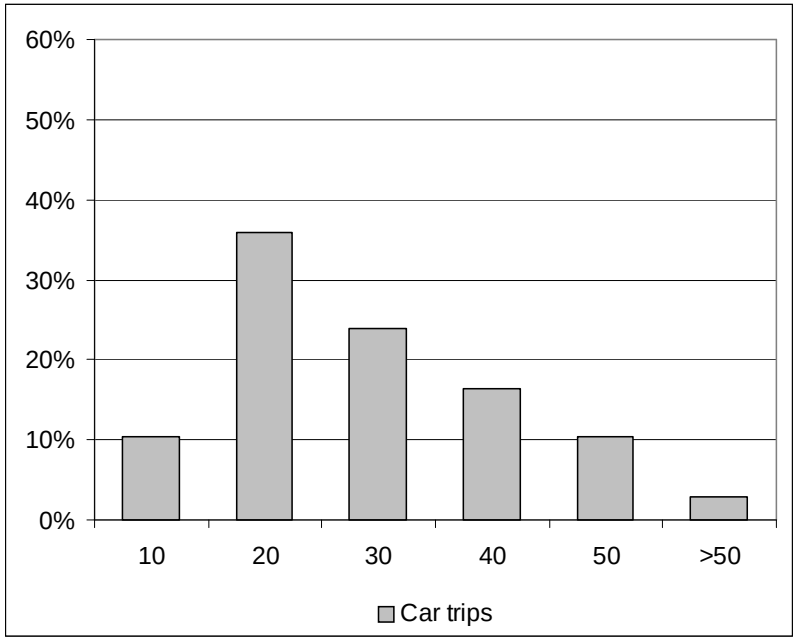
Additional information: Flow estimates



Schönfelder

Number of trips in 6 weeks

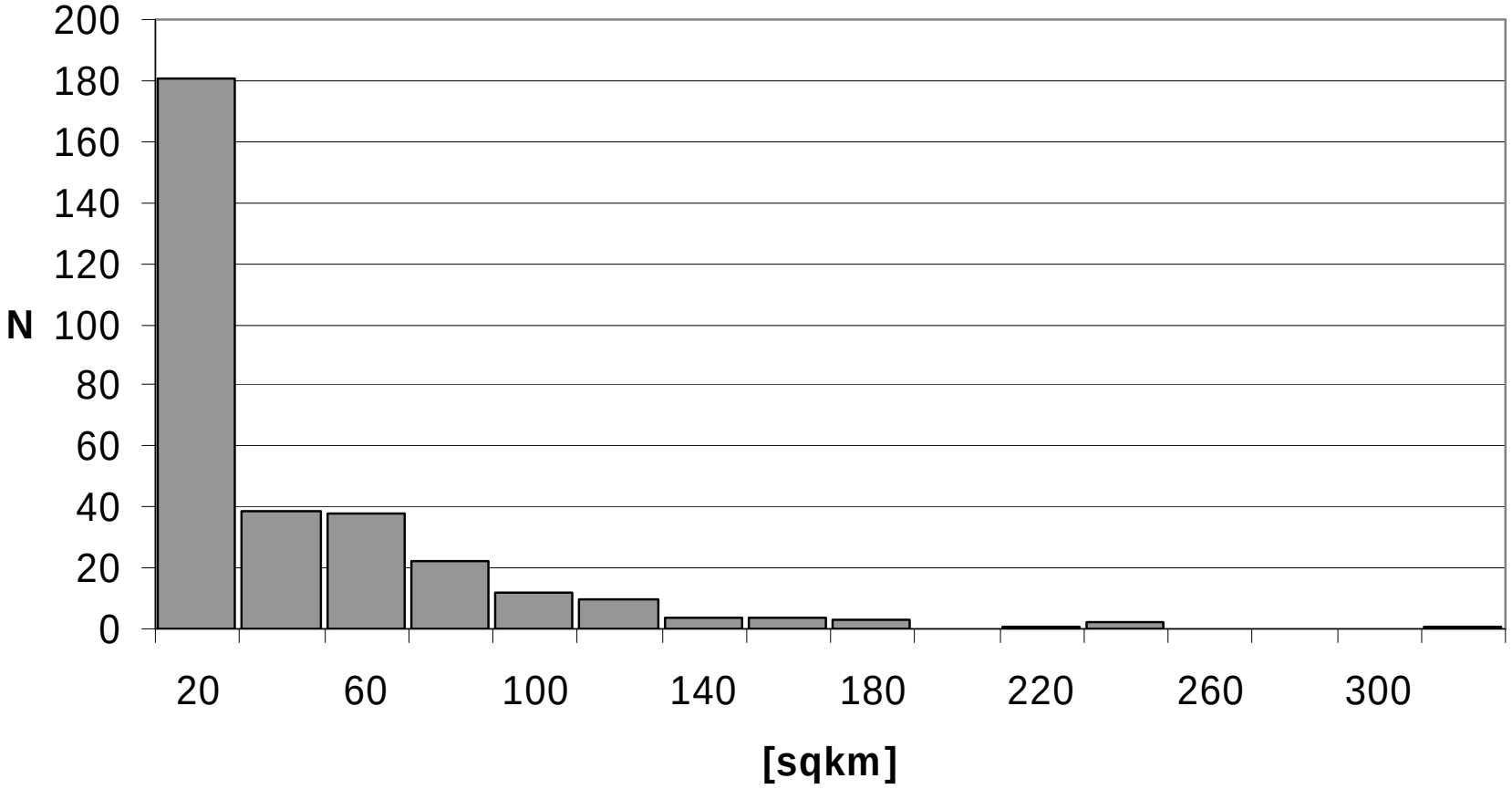




Mobi*drive*;
All trips of respondents
Car trips of “car users”

Borlänge GPS;
Car trips of “car users”

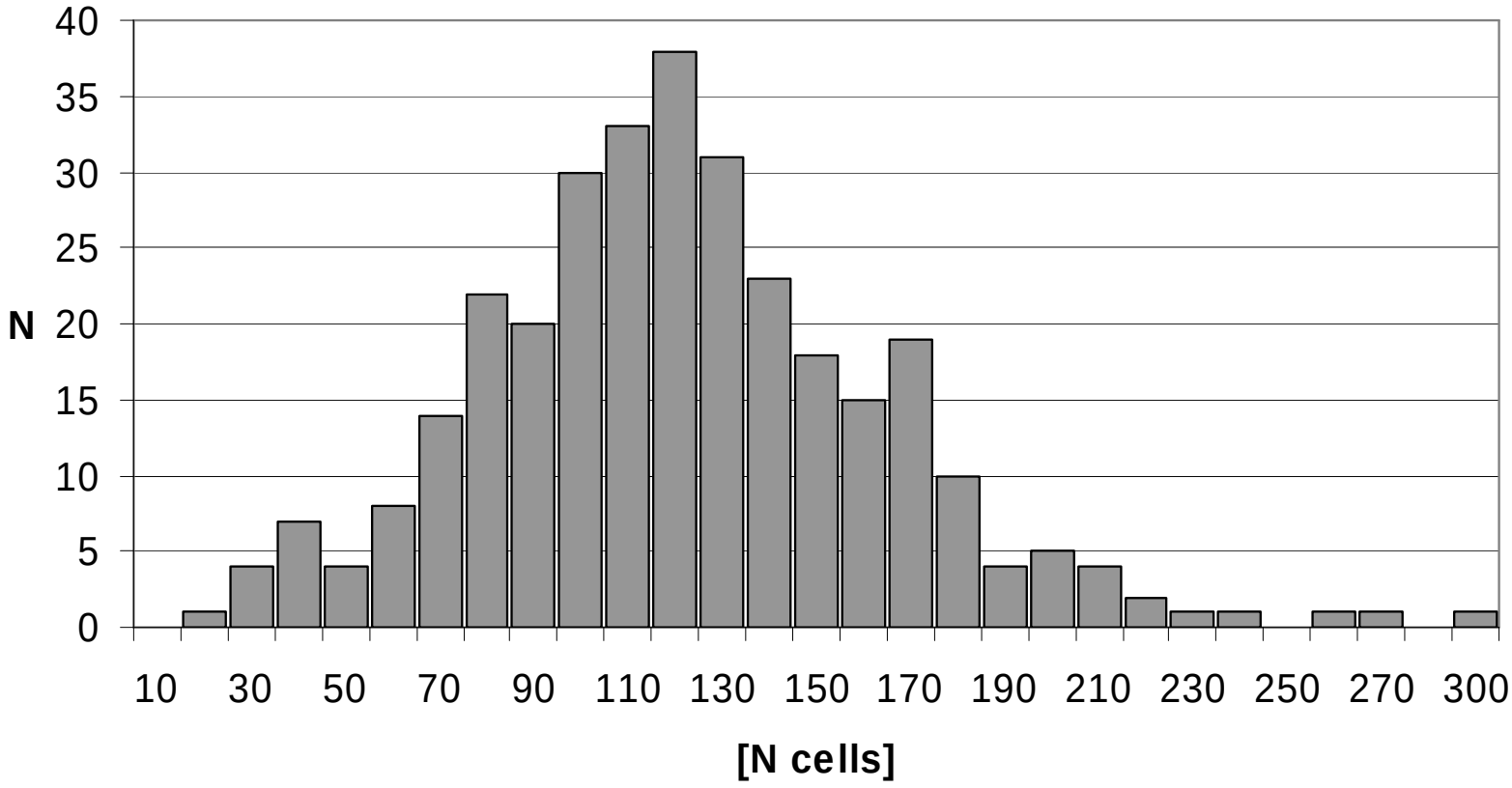
Mobi*drive*: 95% confidence ellipses



* Local trips only

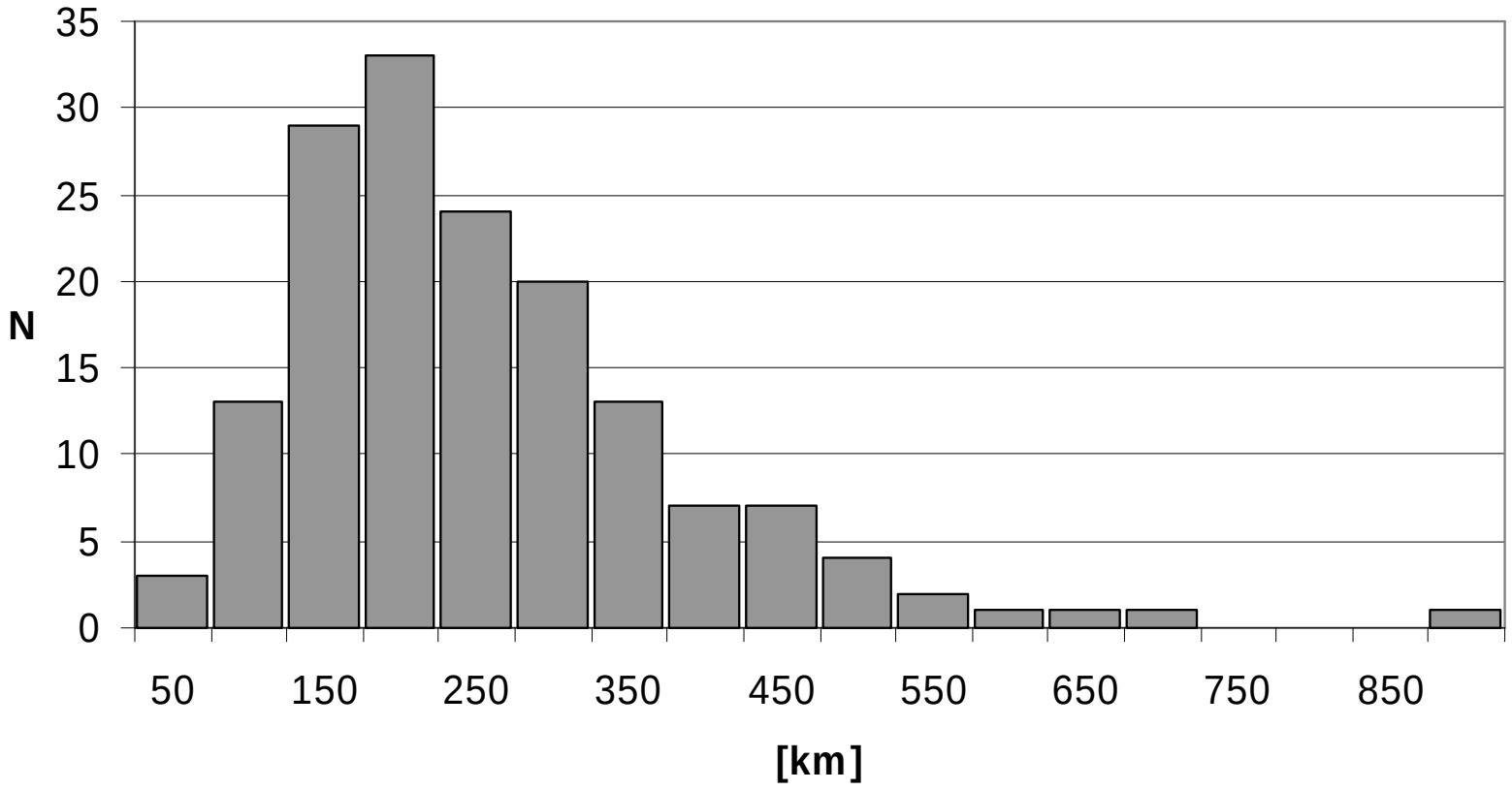
Schönfelder und Axhausen, 2004

Mobidrive: kernel density estimates



* “Visited area”, grid cells with positive Kernel densities value [500*500m]

Mobidrive: shortest path networks

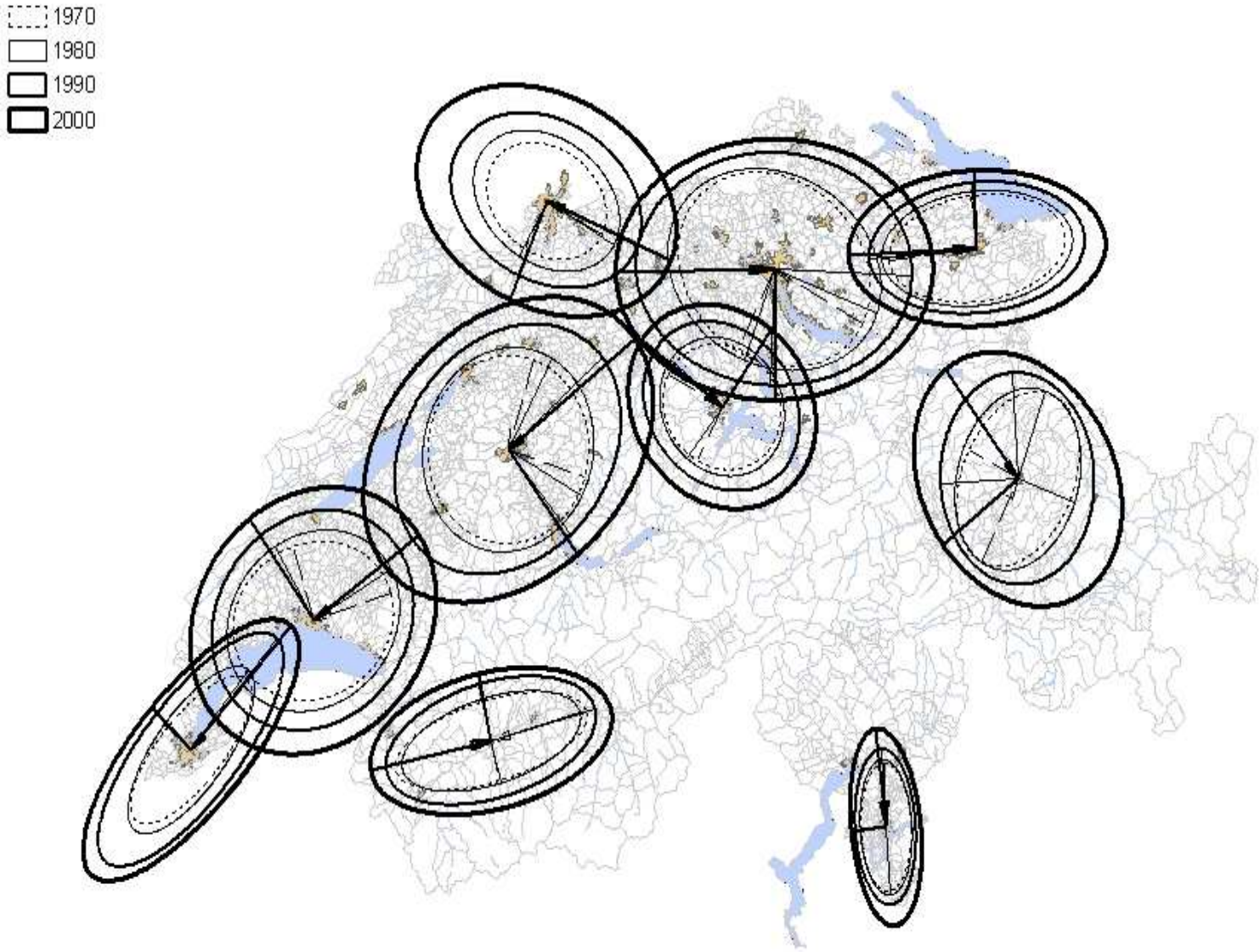


* Minimum network based on observed O-D-relations

Advantages and disadvantages

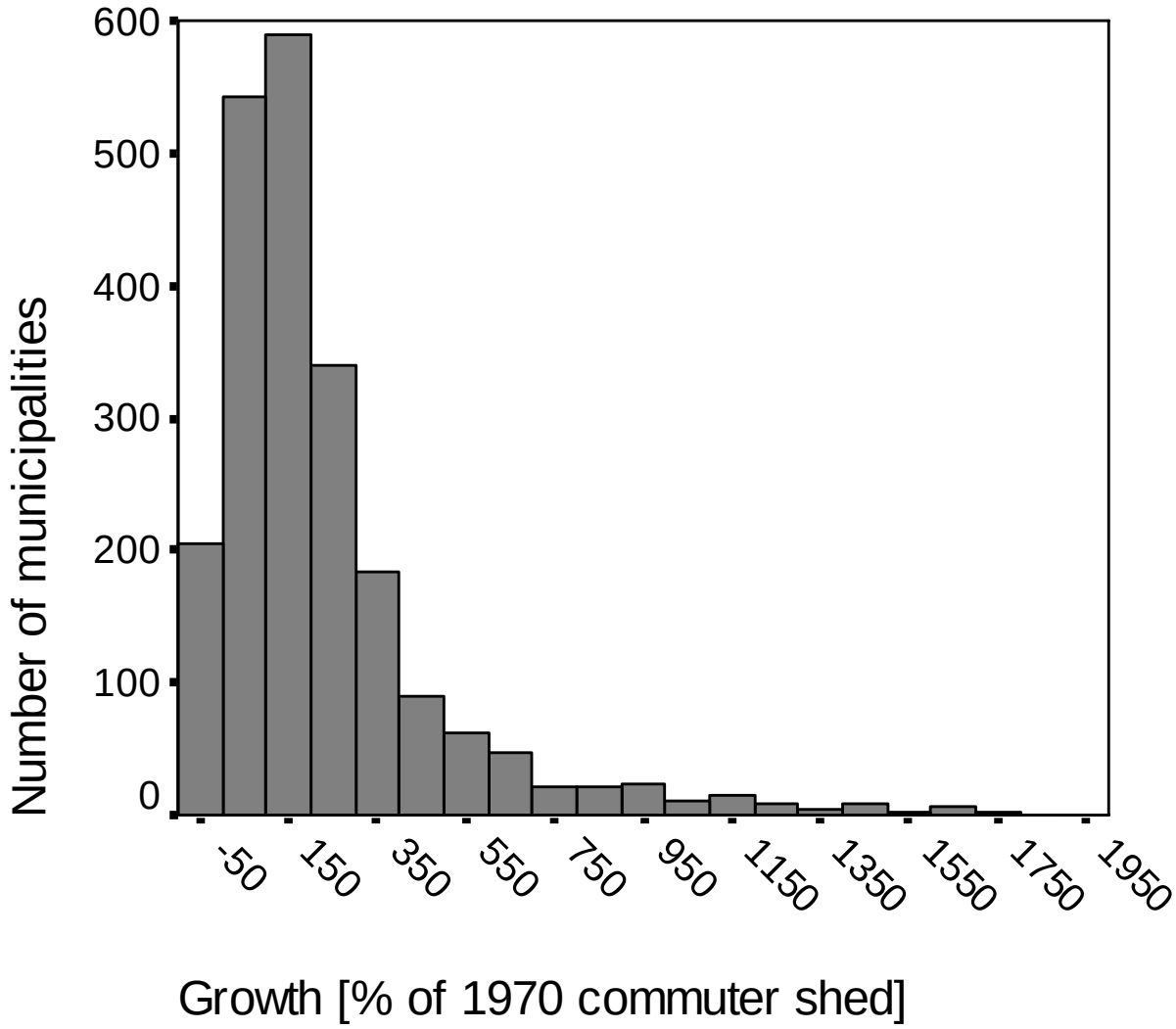
Appraoch	Plus	Minus
Confidence Ellipse	Simple Useful secondary measures	Too rigid Overestimate
Kernel density	Identification of clusters, Follows pattern	Complex calculation
Shortest path network	Travel impacts obvious	Large data needs

An aside: Swiss commuter sheds



Nach Botte, 2003

Swiss commuter shed growth1970 – 2000 (95% CE)

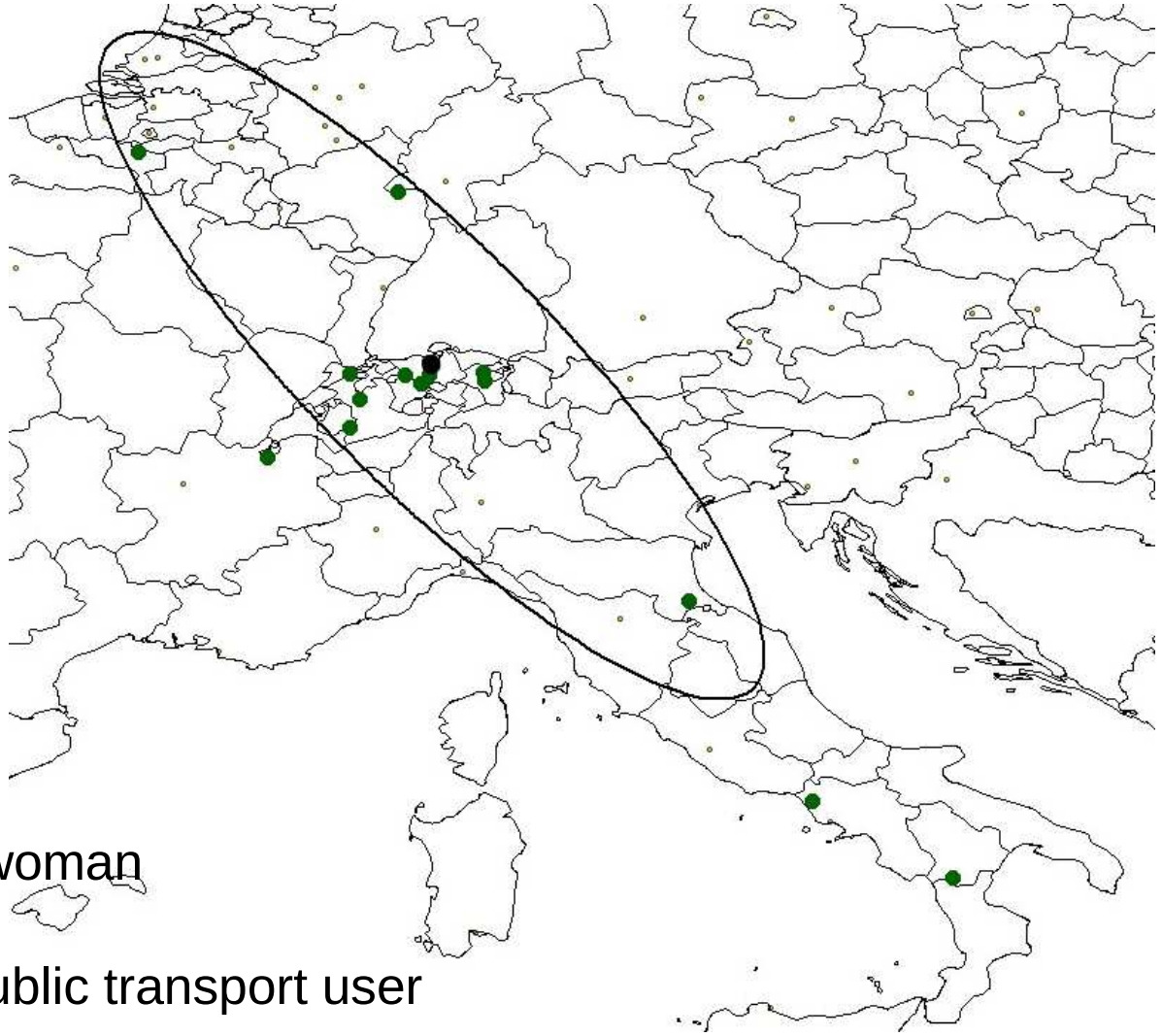


Swiss commuter shed growth1970 – 2000 (95% CE)

Type of municipality:

	Core	Secondary centre	First ring	Second ring
Mayor centre	160	207	371	243
Mid-sized centre	145		239	321
Small centre	141			
„Commuter“	300			
Industrial	298			
Semi-rural	391			
Rural	450			

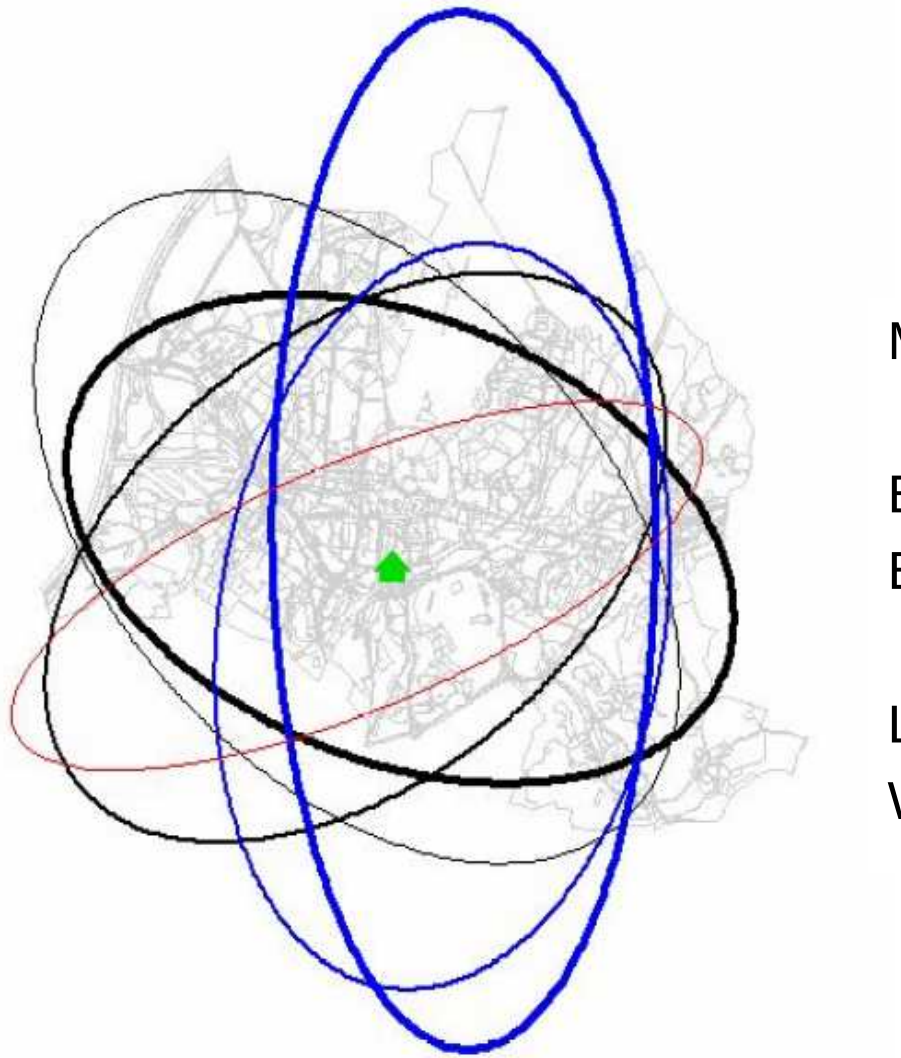
An aside: A social network geograpy - friends



28 year woman
5 moves,
Mostly public transport user

Ohnmacht, 2004

Variance of activity spaces: A Mobidrive example



Male, Full time

Black: Working days

Blue: Weekend

Line width:

Weeks 1+2; 3+4 and 5+6

Srivastava und Schönfelder, 2003

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

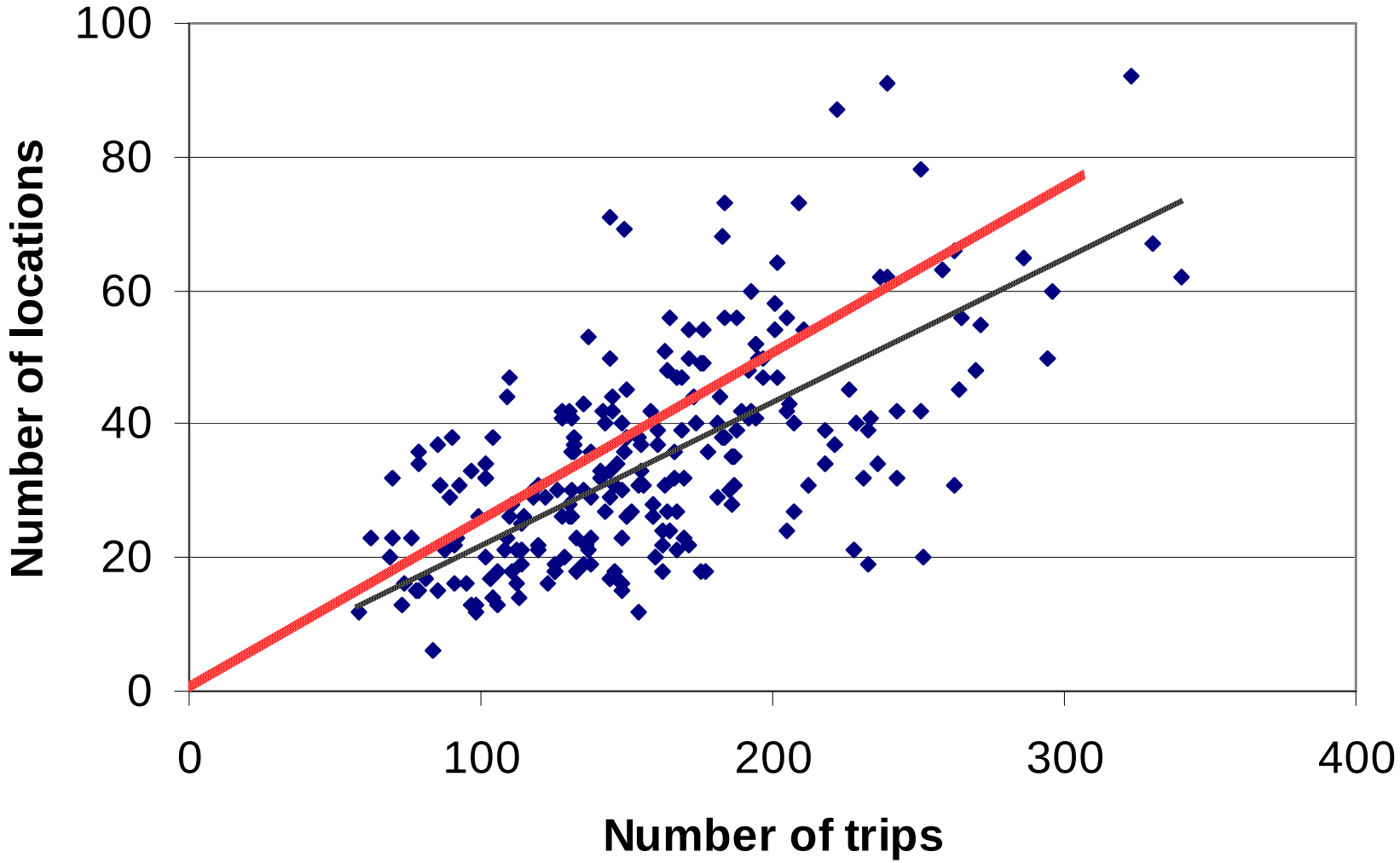
“Unique location” is defined as a combination of

- 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?

Locations as function of number of trips (Thurgau 2003)



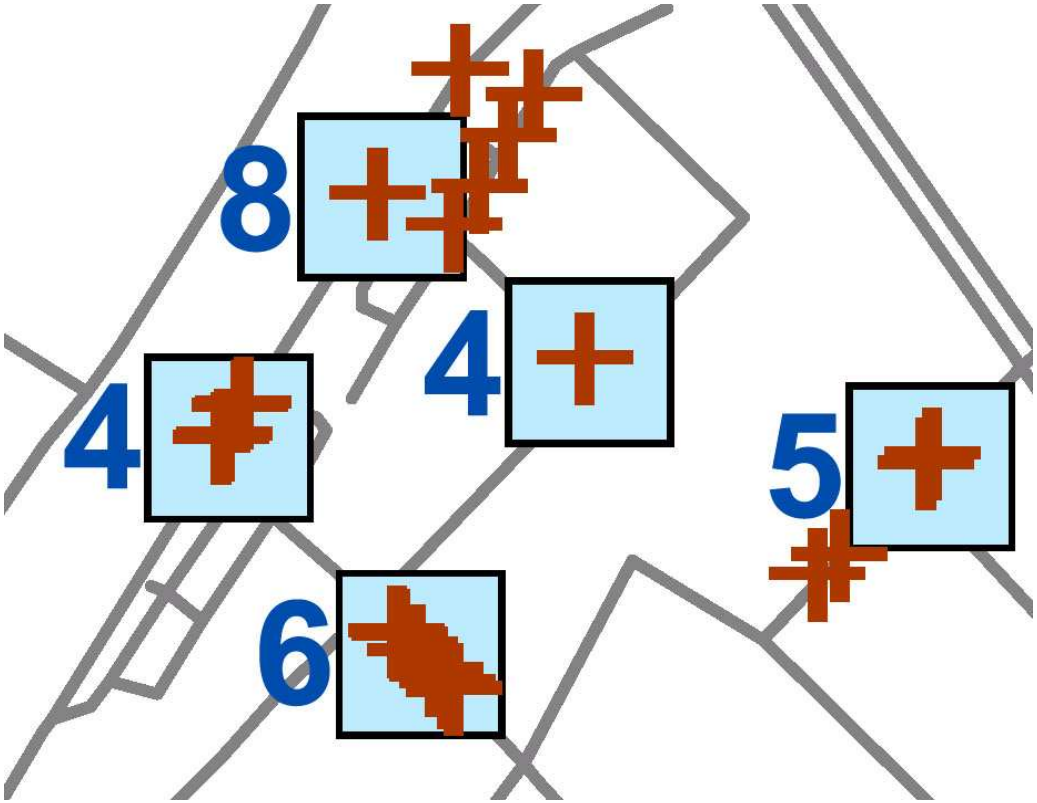
Schönfelder und Axhausen, 2004

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

Issue: Clustering GPS points into locations



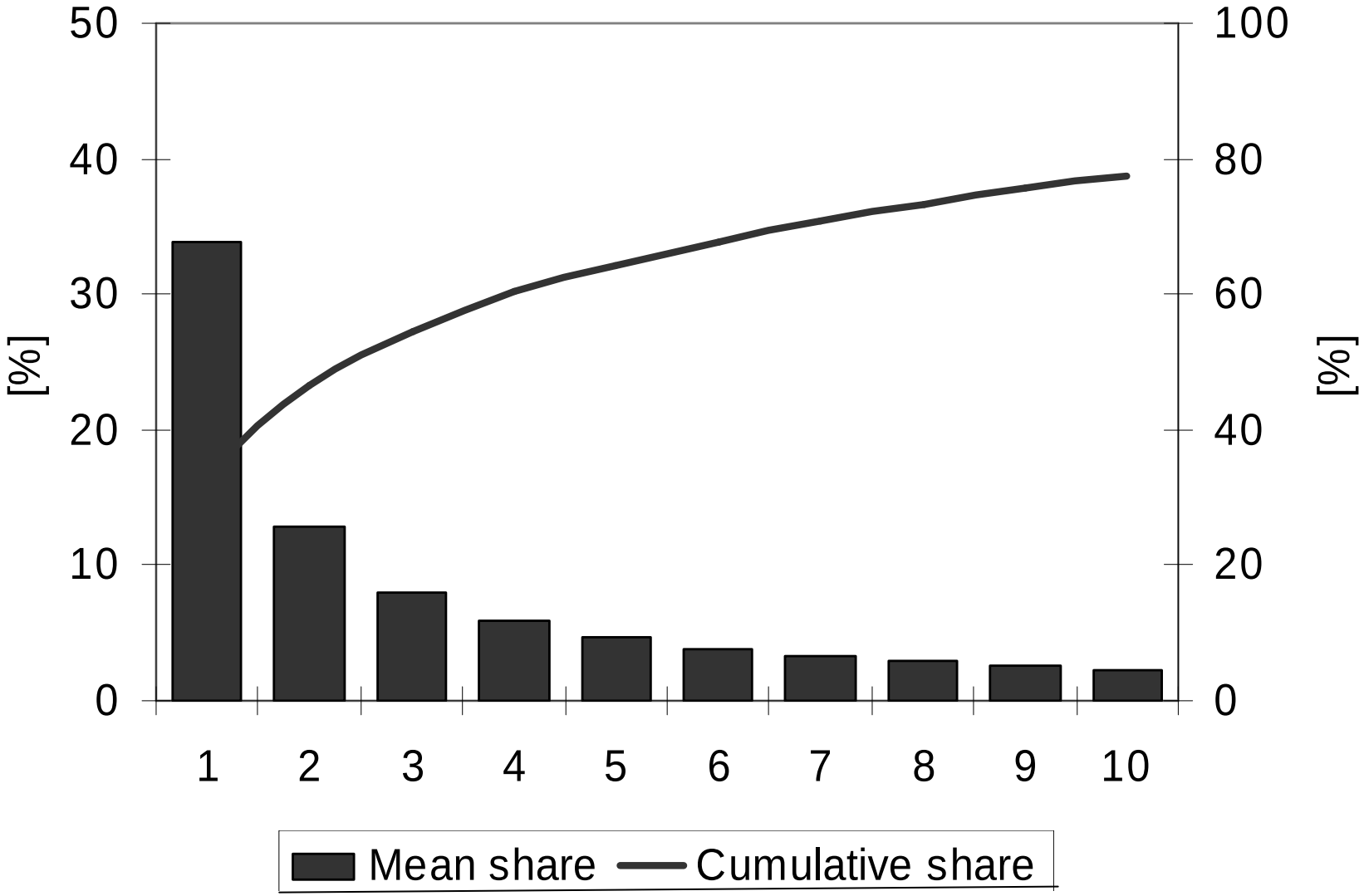
Schönfelder and Samaga, 2003

Structure of activity spaces

Criteria:

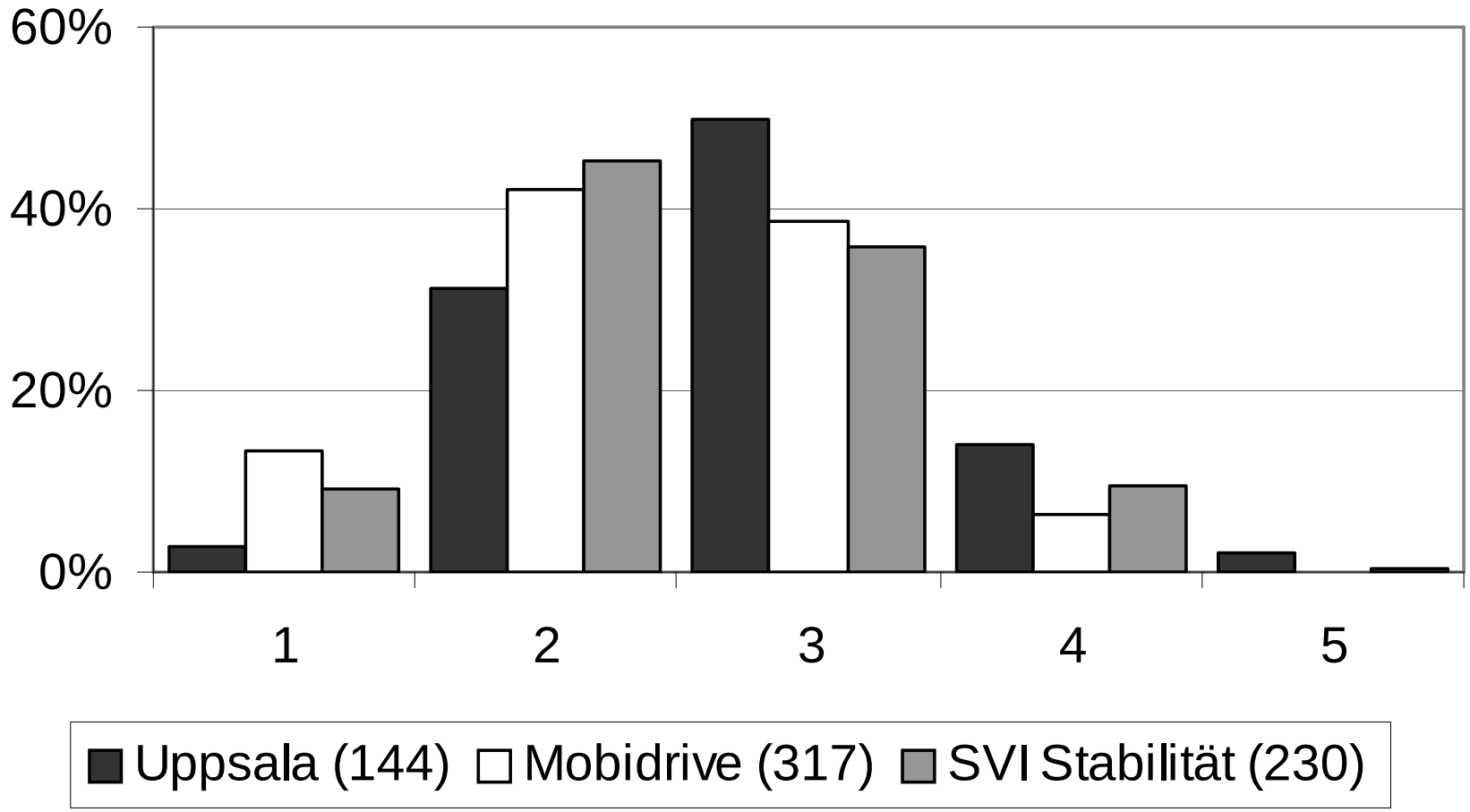
- Share of trips to most visited locations
- Cluster

Share of most important destinations (Mobi*drive*)



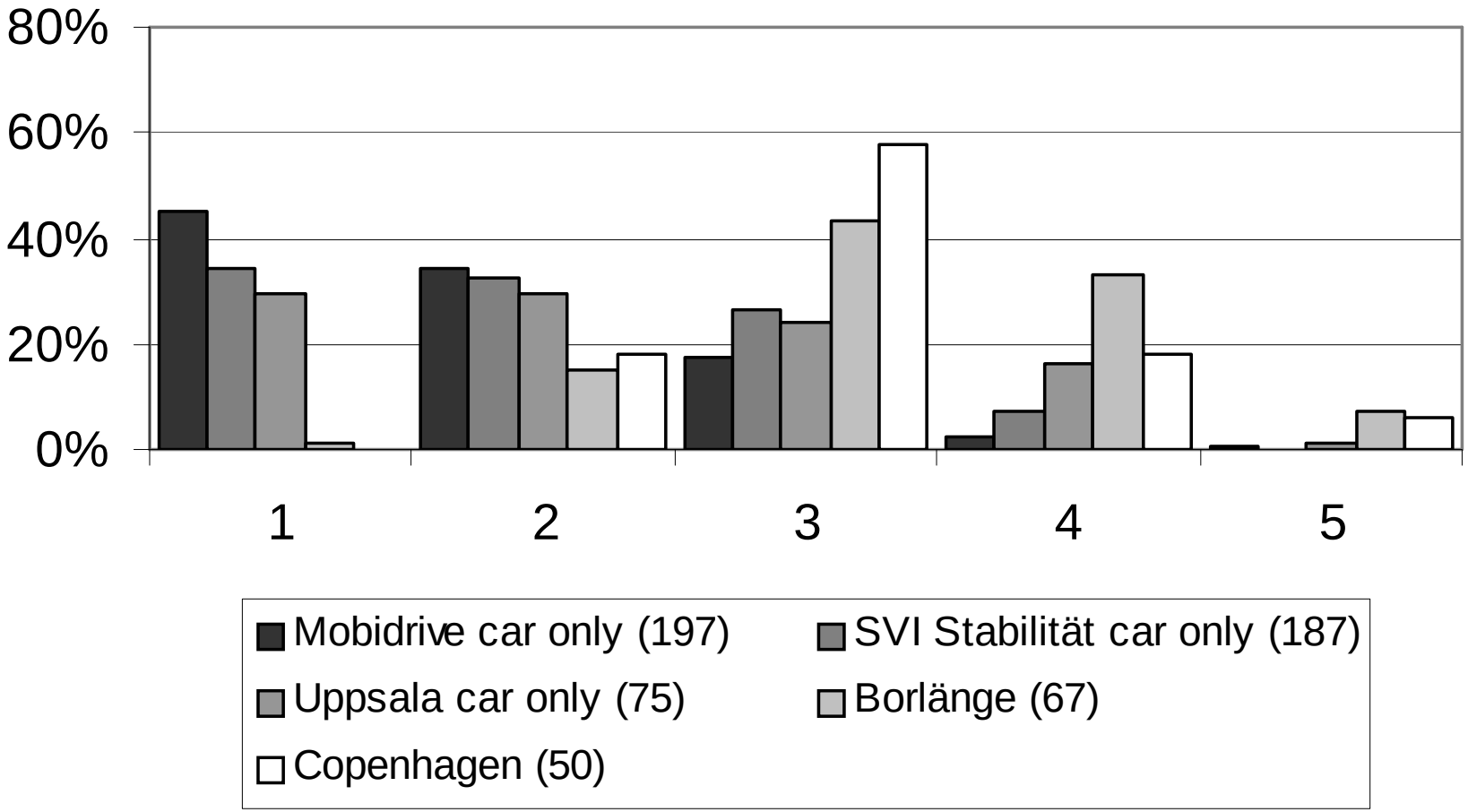
Schönfelder und Axhausen, 2004

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

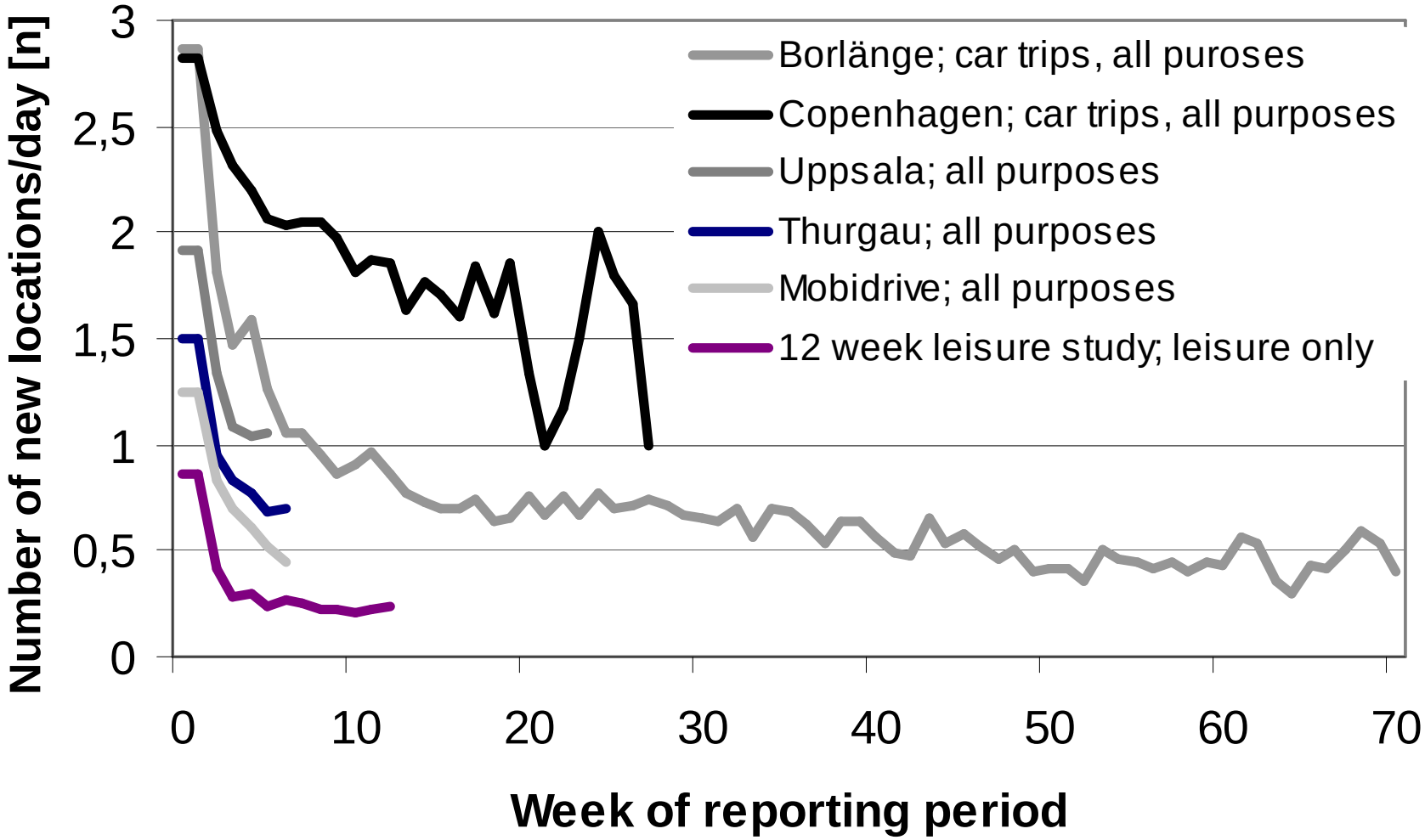
Purpose	Mobi All	Mobi Fulltime	Thurgau All	Thurgau Fulltime	Uppsala All	Uppsala Fulltime
Home	55	57	43	42	44	44
Leisure	12	11	14	10	12	12
Work	11	24	15	22	18	25
School	8	1	8	11	0	1
Grocery	6	4	9	5	19	12
Private business	5	0	3	1	2	1
Long-term shopping	1	1	0	1	1	0
Pick/Drop	1	1	4	4	2	3
Work related	1	0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

Innovation in destination choice

Two types of observation:

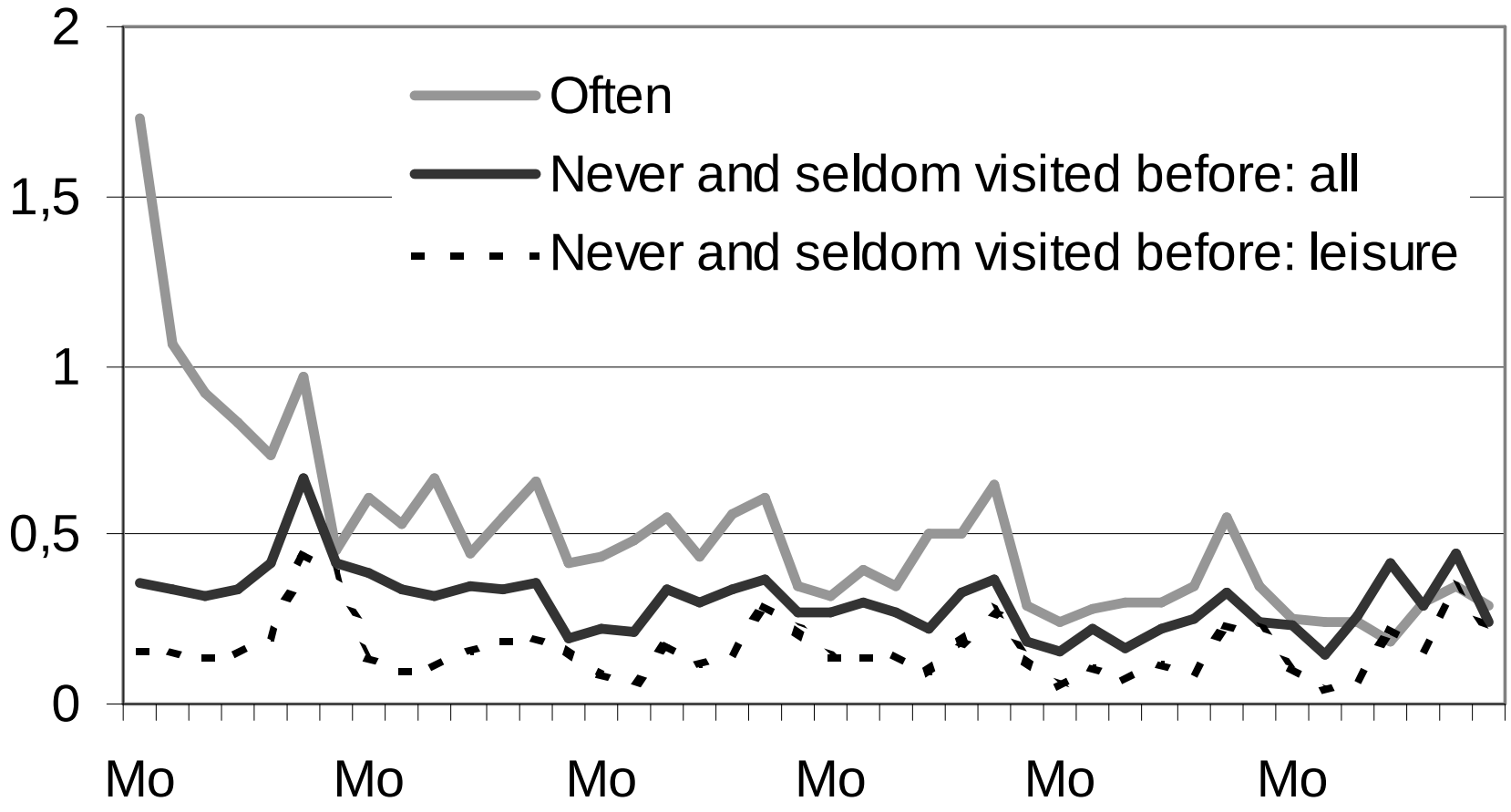
- “New” locations over the reporting / monitoring period
- Locations visited for the first time

“New” locations



Schönfelder und Axhausen, 2004

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
- Activity space has a structure with few clusters
- The “rate of innovation” is constant
- The size of activity spaces is temporarily not or only partly stable

Measurement issues

- Are these the best measures ?
- What refinements are needed ?

Empirical issues

- Are the finding really robust ?
- Are there „scaling laws“ ?
- Are there links between the distributions and the characteristics of the area ?
- Weak link between activity space size and socio-demographics
- Weak link between activity generation and socio-demographics

Modelling challenges

Static (agent-based) models:

- Definition of choice set for location choice (see route choice)
- Cope with innovation and clustering
- Less emphasis on work as a behavioural „peg“

Dynamic (agent-based) models:

- Maintain link between number of locations and trips
- Reproduce the dynamics of the activity space
- Reproduce innovation rates

Literature

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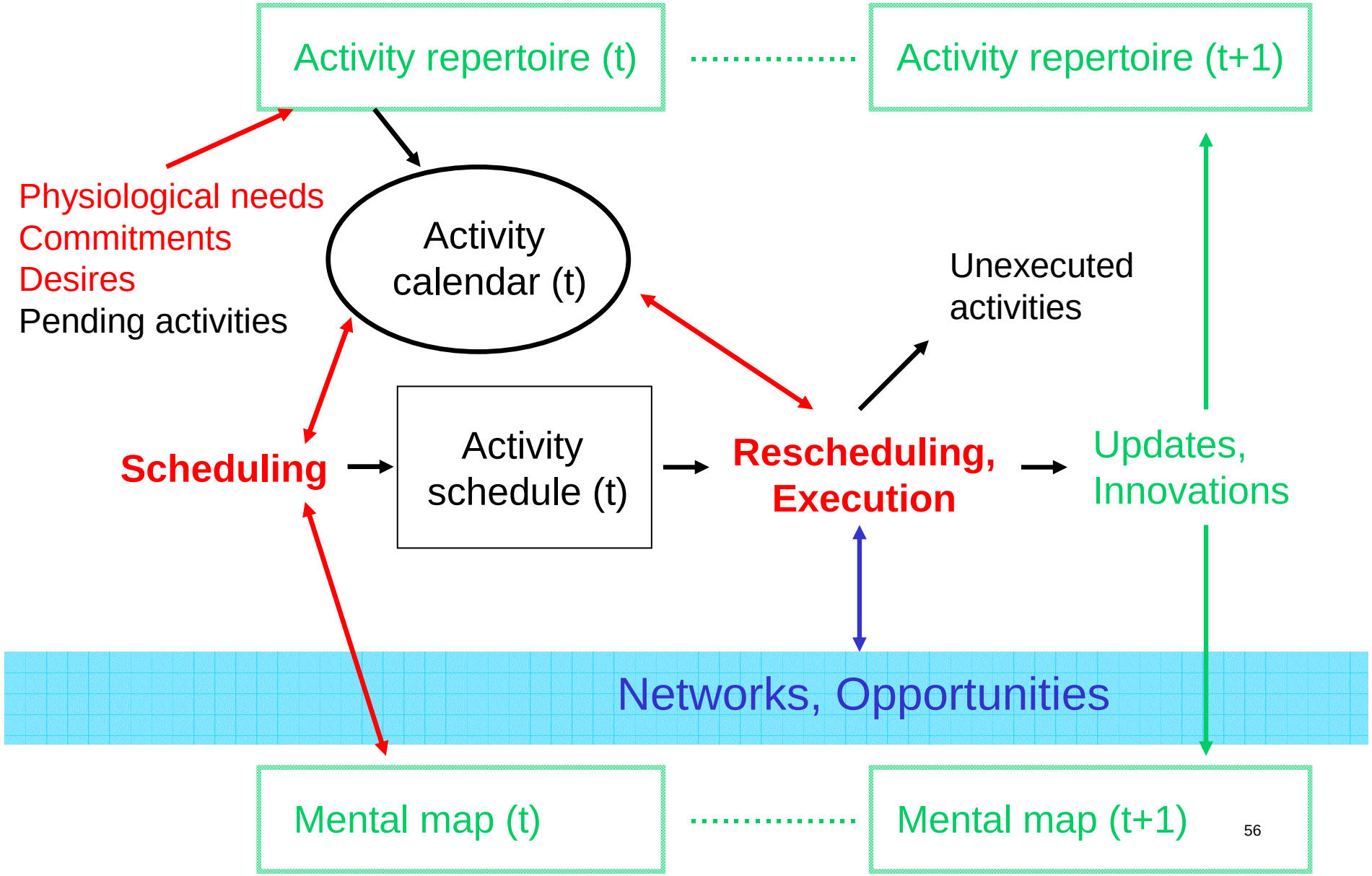
Position: Personal daily dynamics



Position: Personal long-term dynamics