ETH zürich

ETH Library

Any Given Monday

An exploration of the stability of long term activity patterns

Other Conference Item

Author(s):
Farber, Steven; Páez, Antonio; Axhausen, Kay W.

Publication date:
2008-04

Permanent link:
https://doi.org/10.3929/ethz-b-000036144

Rights / license:
In Copyright - Non-Commercial Use Permitted

This page was generated automatically upon download from the ETH Zurich Research Collection.
For more information, please consult the Terms of use.

McMaster University

Any Given Monday

An exploration of the stability of long term activity patterns

Steven Farber – McMaster University
Antonio Páez – McMaster University
Kay Axhausen – ETH Zurich

CSpA Centre for Spatial Analysis

IVT Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Background

- Analysis of transportation systems has adopted more ideas from the activity paradigm
- We now recognize that travel is a derived demand from participating in activities
- Activity analysis is based on extended forms of travel surveys

Background

- Activity / Travel diaries are typically 1 or 2-days long in the time dimension
- How constant are activities? How much variability in behaviour is there over extended periods of time?
- With newer data collection exercises, it now becomes possible to study activity behaviour over longer periods of time

Objectives:

- Do we have any concept of how well the surveyed day represents the respondents' usual routine?
- Is a surveyed Monday just like any other Monday? Is it just like any other Weekday?
- Determine if a 1-day sample is representative of a respondent's typical travel behaviour for that day? For any weekday?

Data

- 230 respondents
- 99 households
- 6 weeks per respondent
- 36761 Episodes
- 8462 person-days

- Frauenfeld City in Canton Thurgau, and Seerucken area to the north

Methodology

Challenge

- How do we quantify between-day similarities in observed behaviour?

- Potential Solution: Multi-level models is a natural way of finding similarities between days. This would require information about days.

Solution

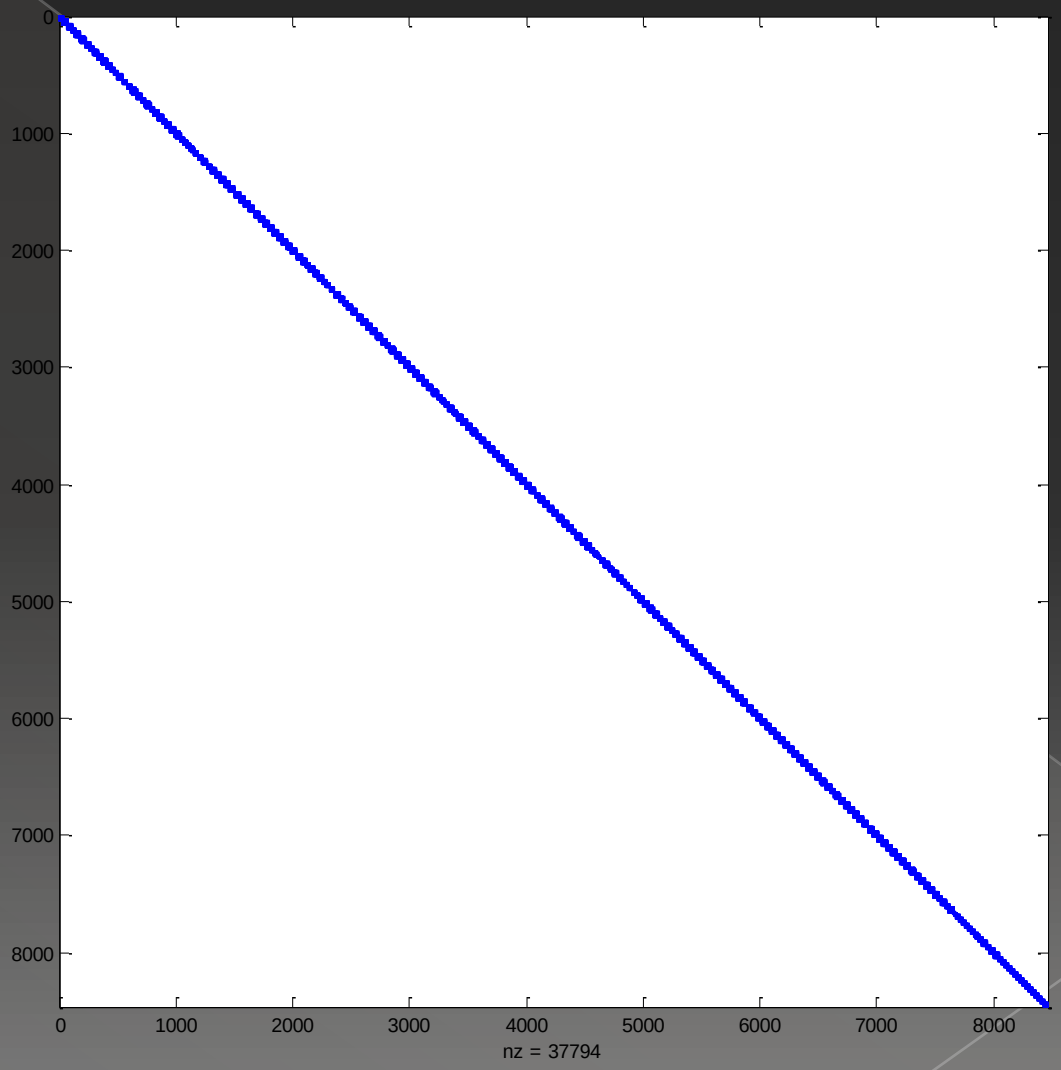
- Identify "similar" observations and check for correlation
- Model behaviour as a function of personal characteristics
- Model the residual correlation

Methodology

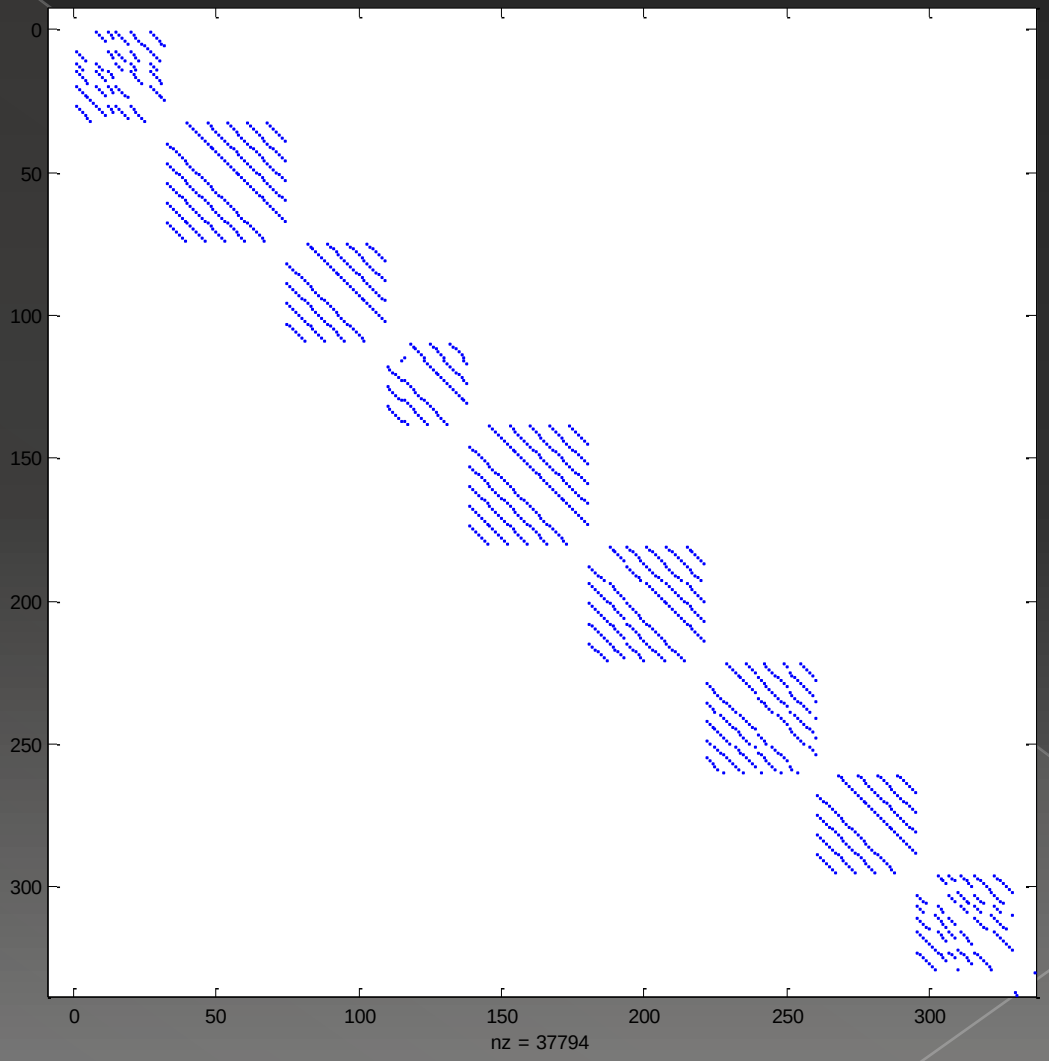
- The contiguity matrix as an exploratory and analytical tool
- W(i,j)=1 if observation i and j are related

1. Person – If observation i and j are the same respondent
2. PersonDay – If observation i and j are the same respondent and same day of week
3. PersonWeek – If observation i and j are the same respondent and same week
4. PersonWeekday – If observation i and j are the same respondent and both Mon-Fri
5. PersonWeekend – If observation i and j are the same respondent and both Sat-Sun

What does the W matrix look like?



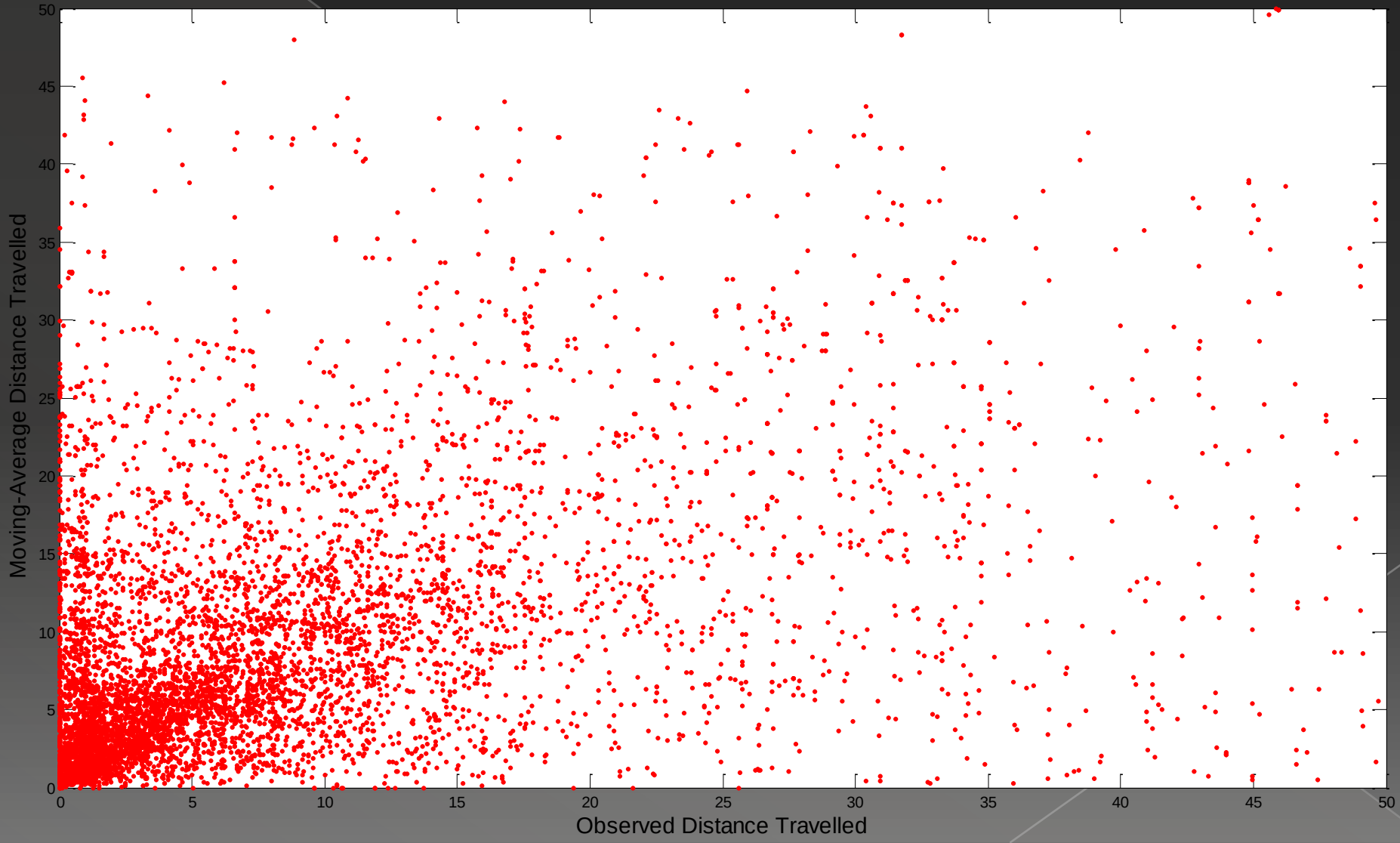
What does the W matrix look like?



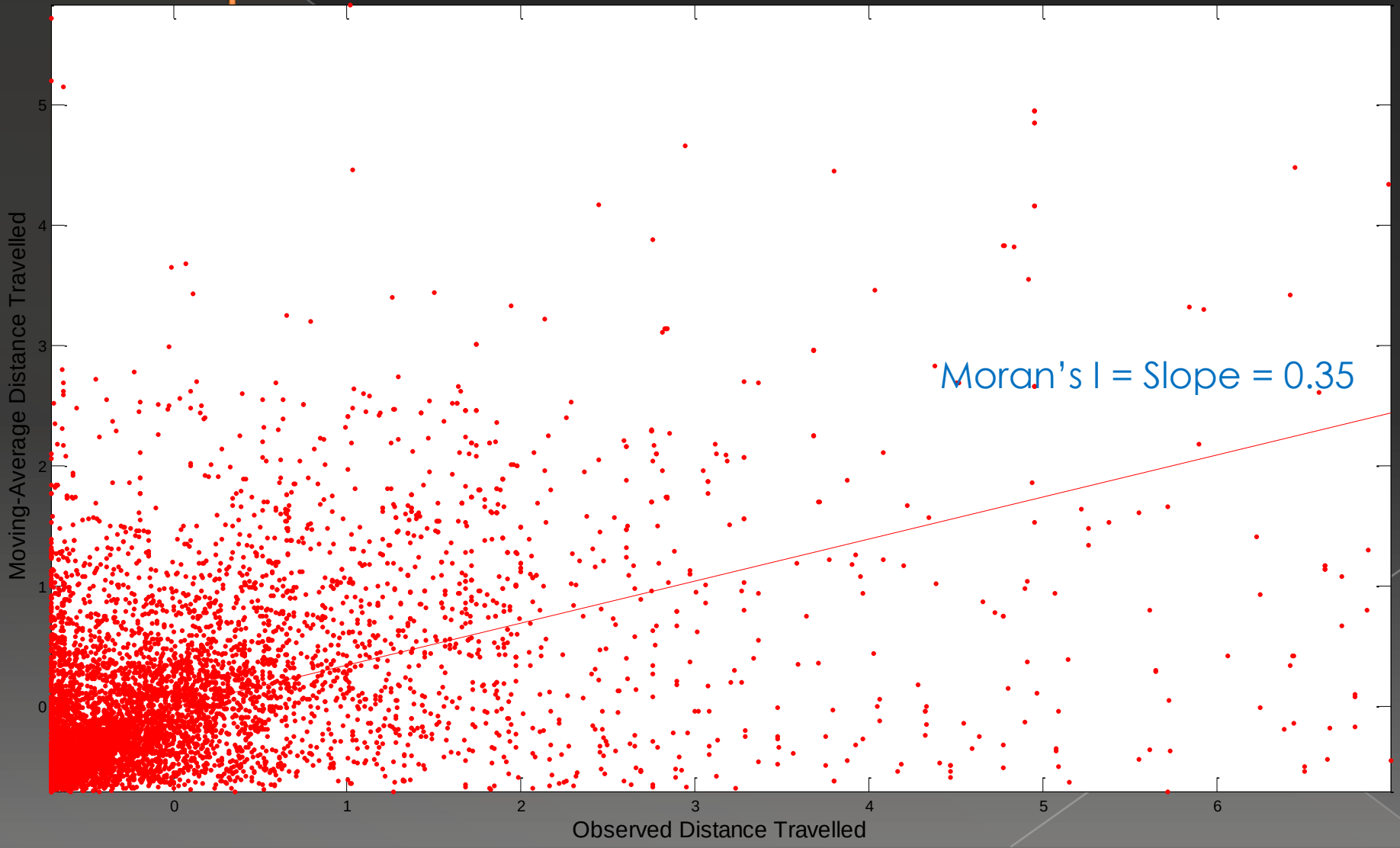
Exploration

- If W matrix is row-standardized, ie: every row sums to 1, then Wy is a vector of neighbourhood averages around each observation
- The observed values, y, can be plotted against Wy and examined for correlation
  - Anselin Moran Scatterplot
- Let Y be daily distance travelled – A summary measure of personal mobility

y vs Wy using the PersonDay Matrix



Moran Scatterplot with Least Square Fit



Moran's I Coefficients for Raw Data

$$I = \frac{\text{correlated variance}}{\text{total variance}} = \frac{Y_s^{'} W Y_s}{Y_s^{'} Y_s}$$

Person	0.25
PersonDay	0.35
PersonWeek	0.26
PersonWeekday	0.19
PersonWeekend	0.07

Day on Day correlations stronger than Type of Day correlations
→ a Monday IS a Monday more than just a weekday

A weekend observation is almost uncorrelated to other weekend observations

Model Variables

- Daily Distance Travelled
  - Summary measure of overall mobility
- Demographic
  - Frauenfeld or Seerucken
  - Age
  - Gender
  - Partner
  - Employment Status
  - Income Class
  - Household Composition
  - Housing Tenure

Model Variables

- Activity/Transportation Behaviour
  - Work-Hours
  - Motor Vehicles At Home
  - Average Daily Trips: Mode Choice
    - Public Transport
    - Motorized Individual
    - Non-Motorized
  - Average Daily Trips: Purpose
    - For Business
    - Personal Business
    - For Leisure

Variables

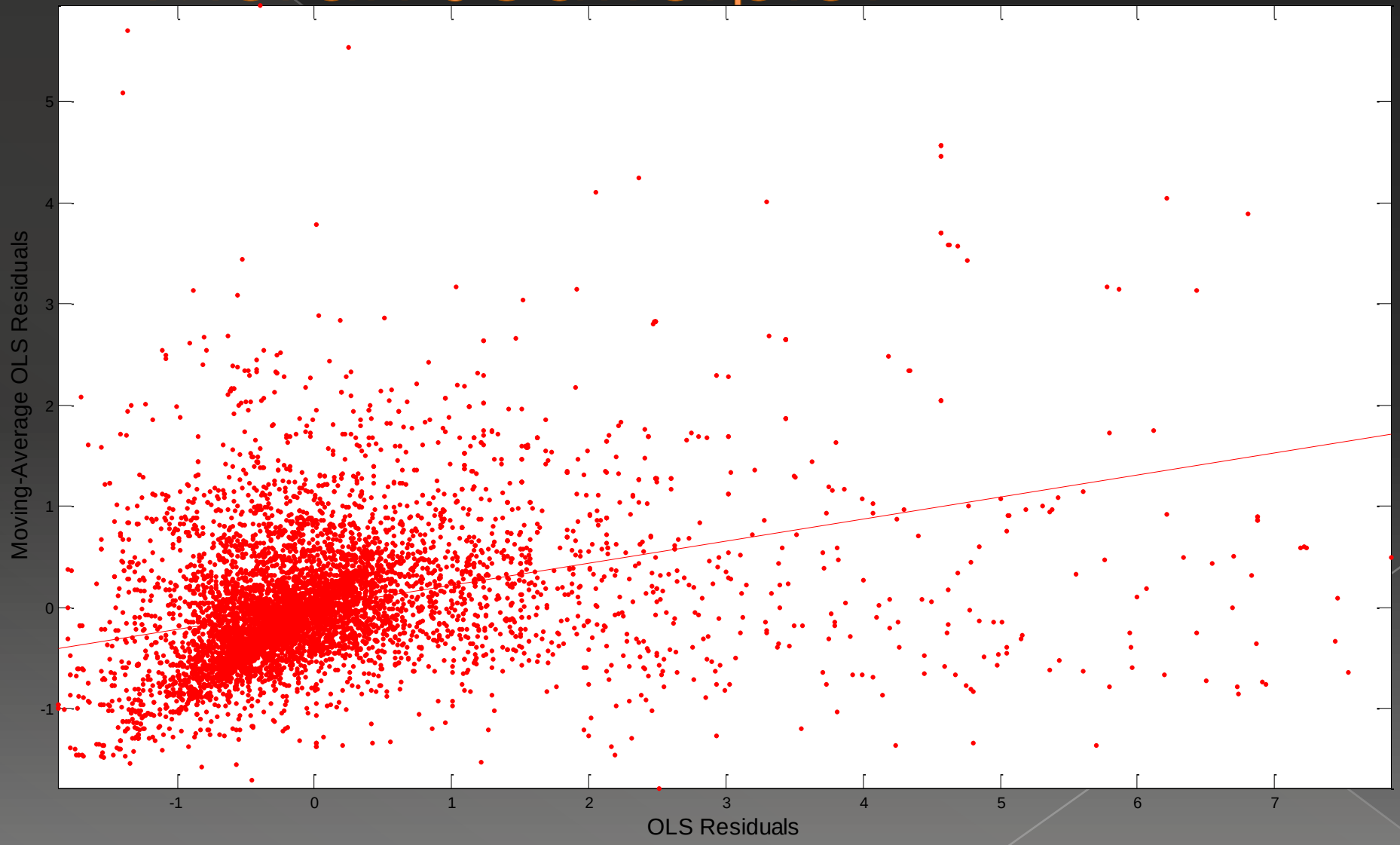
- Walkability of residence
  - Within a 10 minute walk of:
    - kindergarten
    - doctor's office
    - bank
    - bus stop
    - rail station
    - close friends or relatives

OLS Regression Model

Variable	Coefficient	t-statistic	Probability	Variable	Coefficient	t-statistic	Probability
Constant	13.68	9.57	0.0000	n_o_mv	0.46	3.62	0.0003
Seerucken	1.57	4.56	0.0000	t_ratoev	2.11	5.91	0.0000
age	0.06	3.81	0.0001	t_ratmiv	-2.44	-12.26	0.0000
Under19	-3.38	-4.52	0.0000	t_ratlv	-3.25	-16.60	0.0000
Over65	-1.79	-2.34	0.0195	t_ratson	-4.06	-6.68	0.0000
partner	-1.38	-2.72	0.0066	rat_gesc	2.82	6.52	0.0000
EmpFull	1.35	2.26	0.0238	rat_frei	2.45	6.35	0.0000
EmpPart	1.25	2.44	0.0147	rat_erle	2.23	2.77	0.0056
n_o_wh	0.07	5.39	0.0000	walk_kin	-1.19	-2.93	0.0034
INC1	-6.70	-3.31	0.0009	walk_doc	1.56	3.75	0.0002
INC2	-5.84	-5.65	0.0000	walk_ban	-2.02	-5.15	0.0000
INC3	-4.24	-4.50	0.0000	walk_bus	2.05	4.46	0.0000
INC4	-6.30	-7.77	0.0000	walk_rai	2.85	6.96	0.0000
INC5	-2.34	-5.41	0.0000	walk_rel	-1.05	-3.29	0.0010
INC6	0.45	1.24	0.2156				
n_o_hha	-1.99	-7.02	0.0000				
n_o_hh6	-4.89	-3.05	0.0023				
n_o_hh12	0.56	2.04	0.0410				
rented	0.68	1.85	0.0646				

Summary Statistics
R-squared = 0.1710
sigma^2 = 140.1282
Nobs, Nvars = 8462, 33

Residuals – Moran Scatterplot



Residual Autocorrelation

$$I = \frac{\text{correlated variance}}{\text{total variance}} = \frac{\varepsilon' W \varepsilon}{\varepsilon' \varepsilon}$$

Person	0.10
PersonDay	0.22
PersonWeek	0.12
PersonWeekday	0.09
PersonWeekend	0.04

Moran's I coefficients suggest there is an unobserved correlation structure between observations

(Spatial) Model Options

(Spatial) Error Model

$$Y = X\beta + u$$

$$u = \lambda Wu + \varepsilon$$

Implies that we are missing information
on observations that are somehow related

SEM Results

Specification	Log-Likelihood	R-Squared	Sigma-Squared	lambda	Probability
Person	-29693	0.23	129.0	0.56	0.9700
PersonDay	-29654	0.25	126.0	0.32	0.0000
PersonWeek	-29847	0.20	134.0	0.23	0.0000
PersonWeekday	-29746	0.22	130.7	0.54	0.0000
PersonWeekEnd	-29945	0.18	138.5	0.25	0.0000

1. Improved model fit indicated by R-Square increase and reduction in variance of the estimates
2. Insignificant Person on Person error autocorrelation, individual characteristics are well-described by covariates in the model
3. Weekday and Weekend correlation is much stronger than previously indicated

Future Work

- Decomposition of the correlation coefficients into LISA statistics to explore the factors that cause some people to have more consistent activity patterns compared to others
  - Are some people typically atypical?
- Extend the analysis to other summary measures such as coded DAP's or durations of different activity types
- Convert findings into an improved understanding of behavioural patterns. Would be nice to know how many days are necessary to capture "weekday", a "weekend day", a "Tuesday" etc

Questions?