



Multimodal day-types

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Multimodal day-types

Day-types:

- Representative typical days

How we reveal representative day-types:

1. Clustering

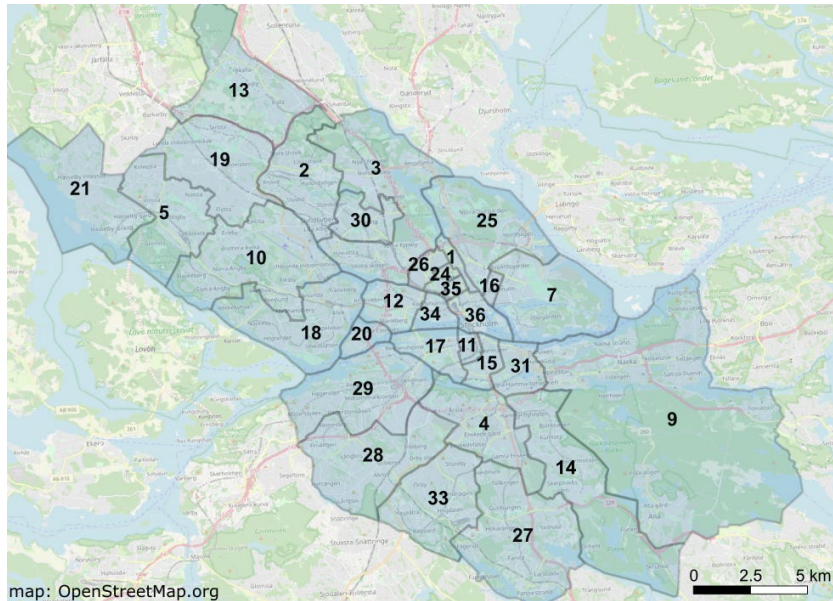
- groups the days based on their similarities, such
 - Minimize the variance/distance/dissimilarity among days in each cluster
 - Maximize the variance/distance/dissimilarity to days in other clusters

2. Representative of the cluster is the recognized day-type

- Could be an average day of the cluster

Multimodal day-types

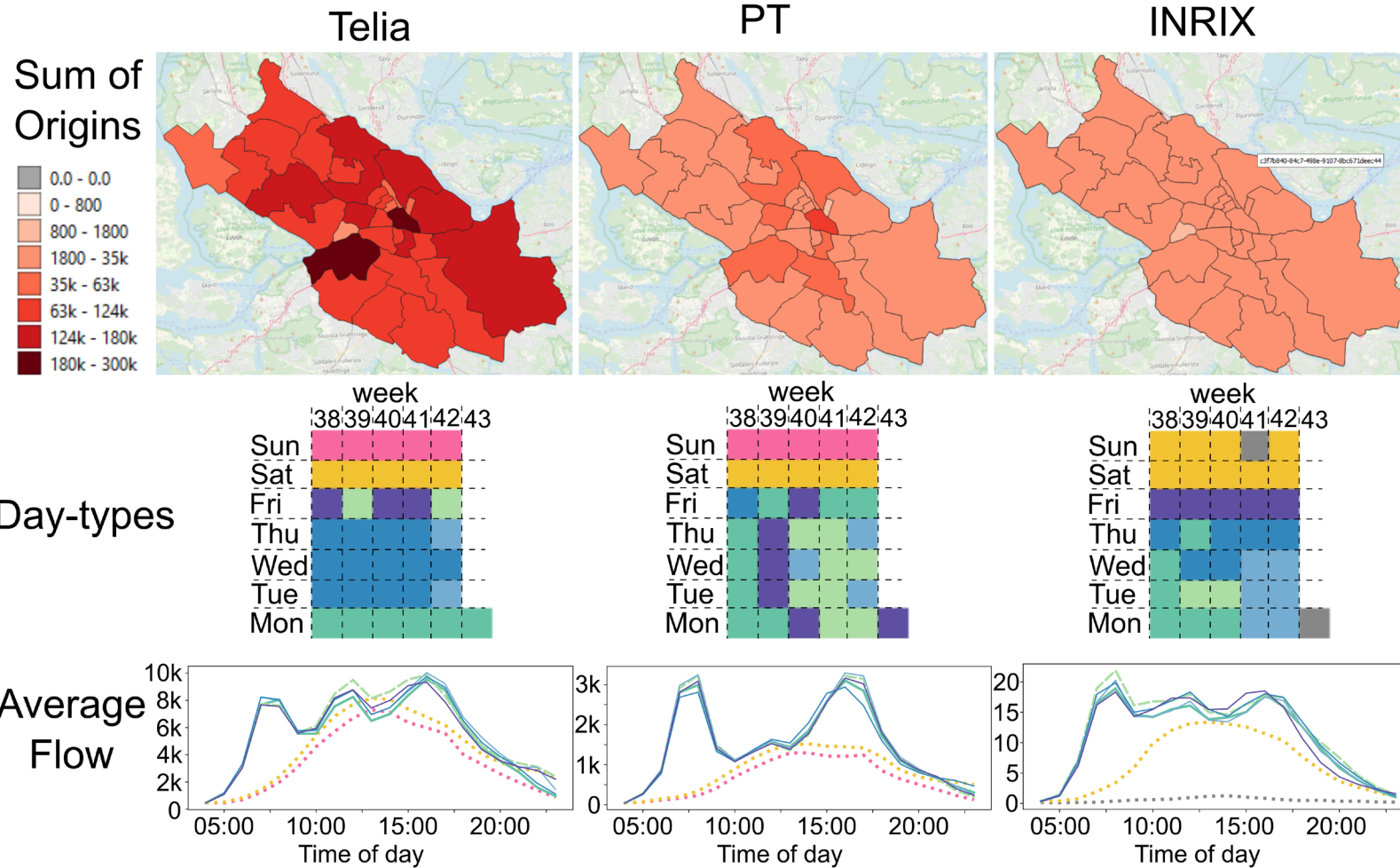
- Telia mobile data (Total demand)
- Public transport smart card data (PT demand)
- INRIX data
- PT mode share



- 31 – zones (961 OD pairs)
- 2019 (week 38–42)
- Dynamic OD matrices
- 1 hour time intervals (04:00 – 23:00)



Multimodal day-types



PT mode share estimation and analysis

Why of interest?

– Traditionally based on travel surveys

- continuous decline in respondent rates over the past decades

- 68% (from 25,000 interviews) in 2005

- 28% (from 12,500) in 2021.

source: Travel Surveys, Trafik Analysis,
<https://www.trafa.se/en/travel-survey/travel-survey/>

- concerns if samples are truly representative of the general population
- very costly to estimate PT shares over long time periods with high temporal resolution
- respondent background information and formulate questions

PT mode share estimation and analysis

Why of interest?

- Data-driven approach

Telia data

- Represent TOTAL flow
 - private cars, walking, cycling, PT, micromobility, etc.
- Historical days and high temporal resolution

Smart card data

- Represent almost TOTAL PT flow
 - Impact of inference rate, missing validations
- Historical days and high temporal resolution

- Cost-effective technology for spatio-temporal estimation of PT mode share
 - Data already being collected
 - High spatio-temporal resolution available
- Observation-based, anonymized, no additional questions



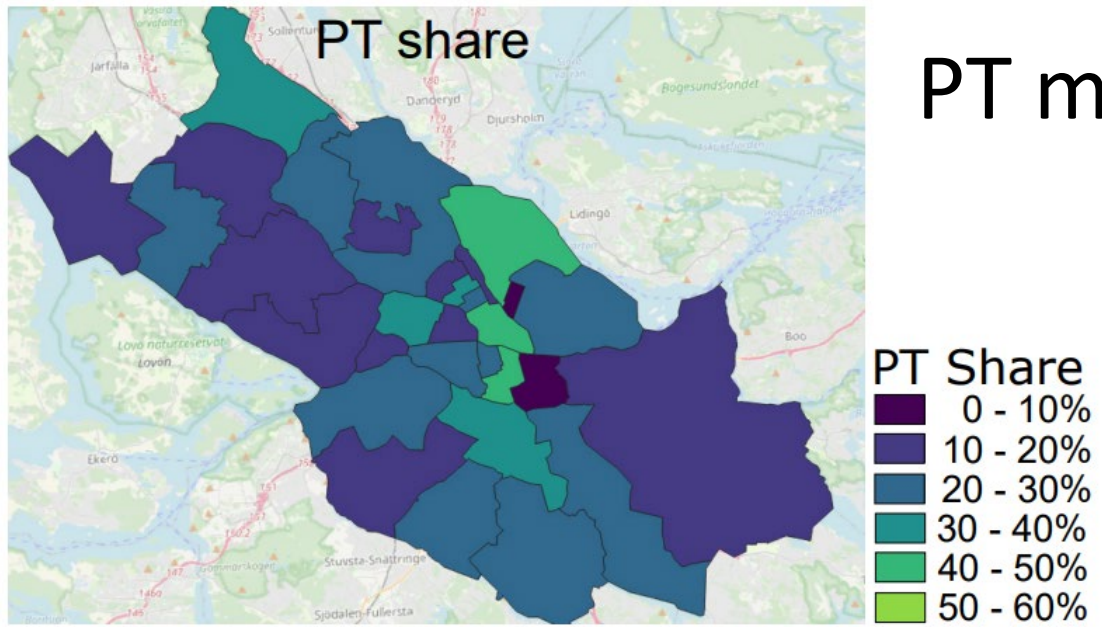
PT mode share analysis

Descriptive and cluster analysis

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PT mode share analysis



$$PTshare = \frac{PT}{Telia}$$

Data-driven estimation

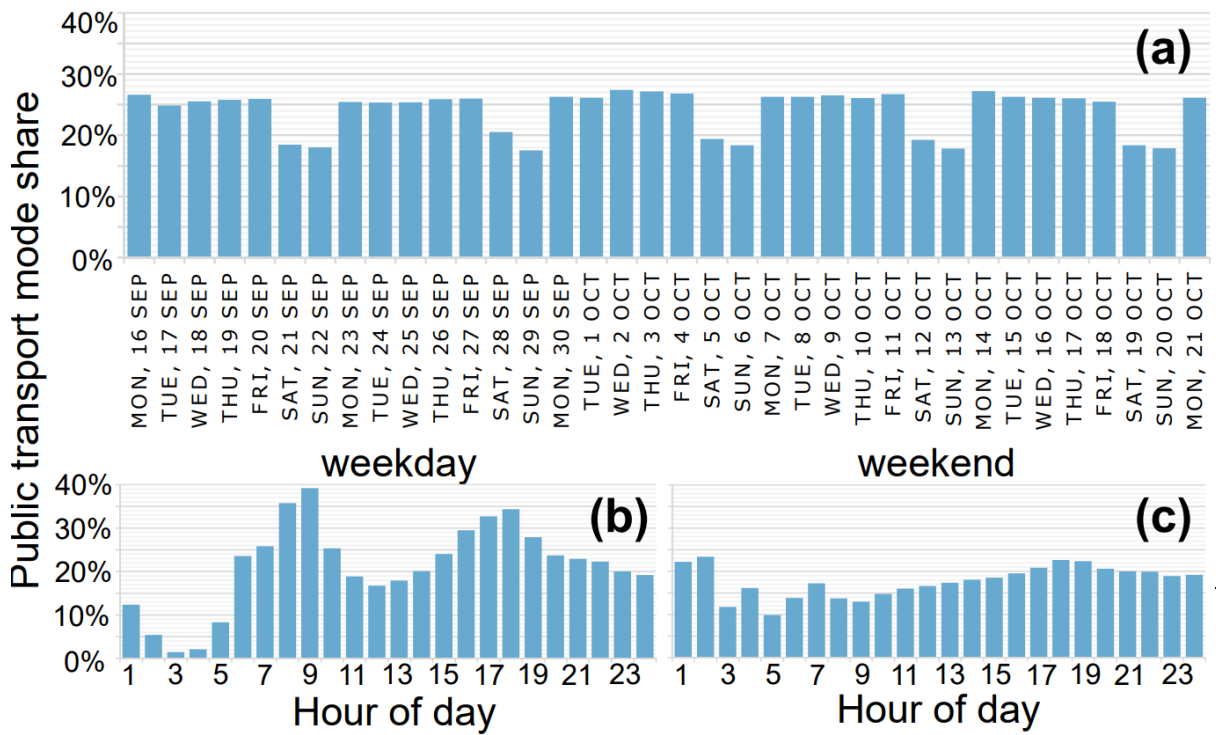
- ~85% of demand captured
- Limited to journeys within case-study zones

Region Stockholm Travel survey, 2019

- All journeys within region
- 30% of all journeys are made by PT
- Regional centers

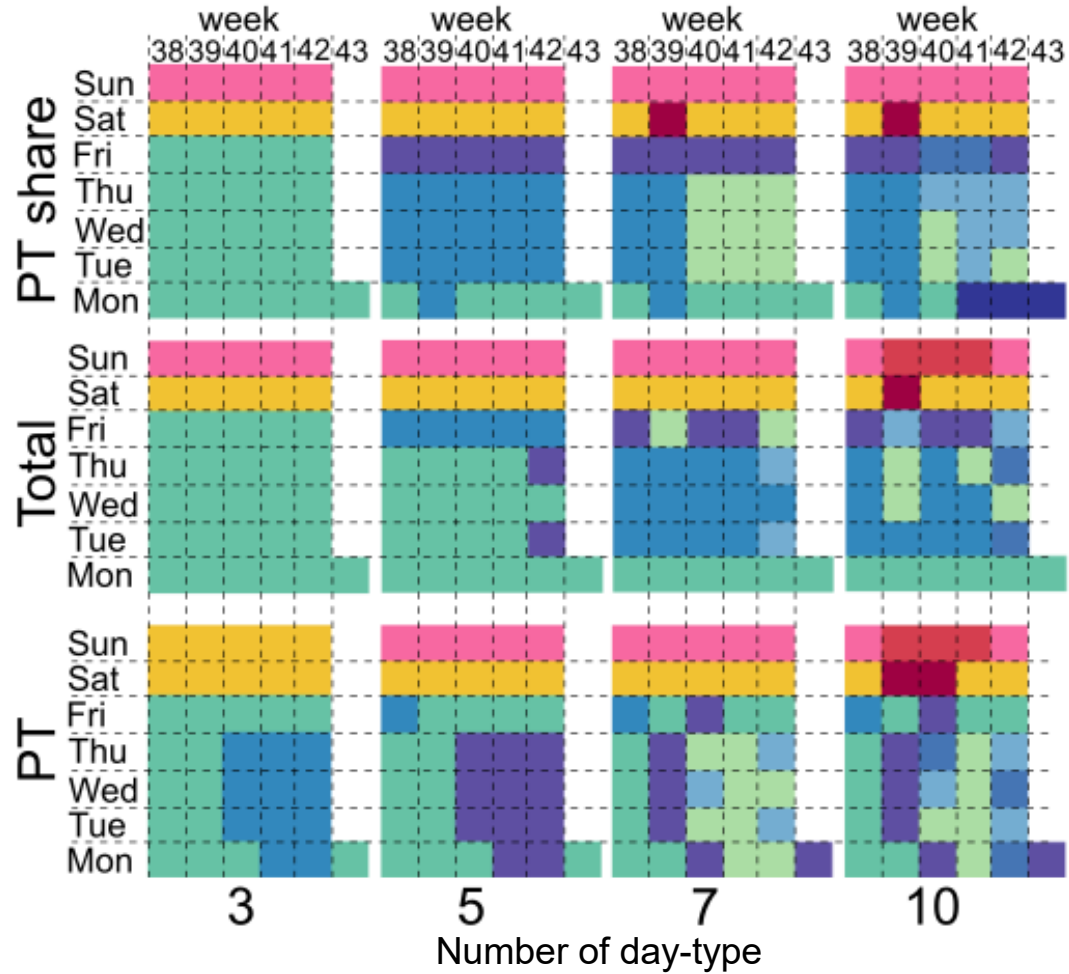
- Sundbyberg 32%
- Solna 40%
- Stockholm inner city 36%

- 70% of motorized trips





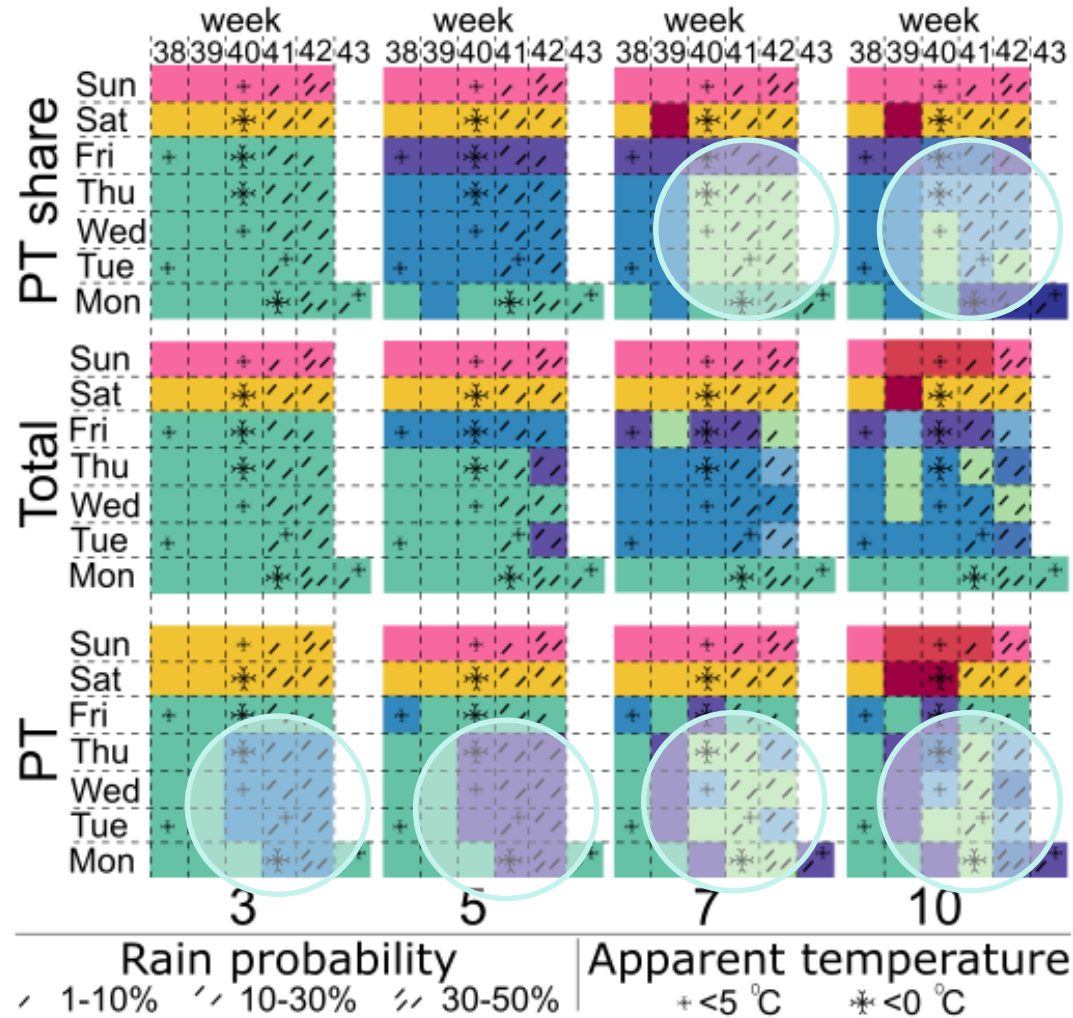
PT mode share analysis



Evolution of representative day-type patterns

1. Weekdays and weekends
2. Saturdays and Sundays
3. Fridays
4. Mondays
5. Using contextual information

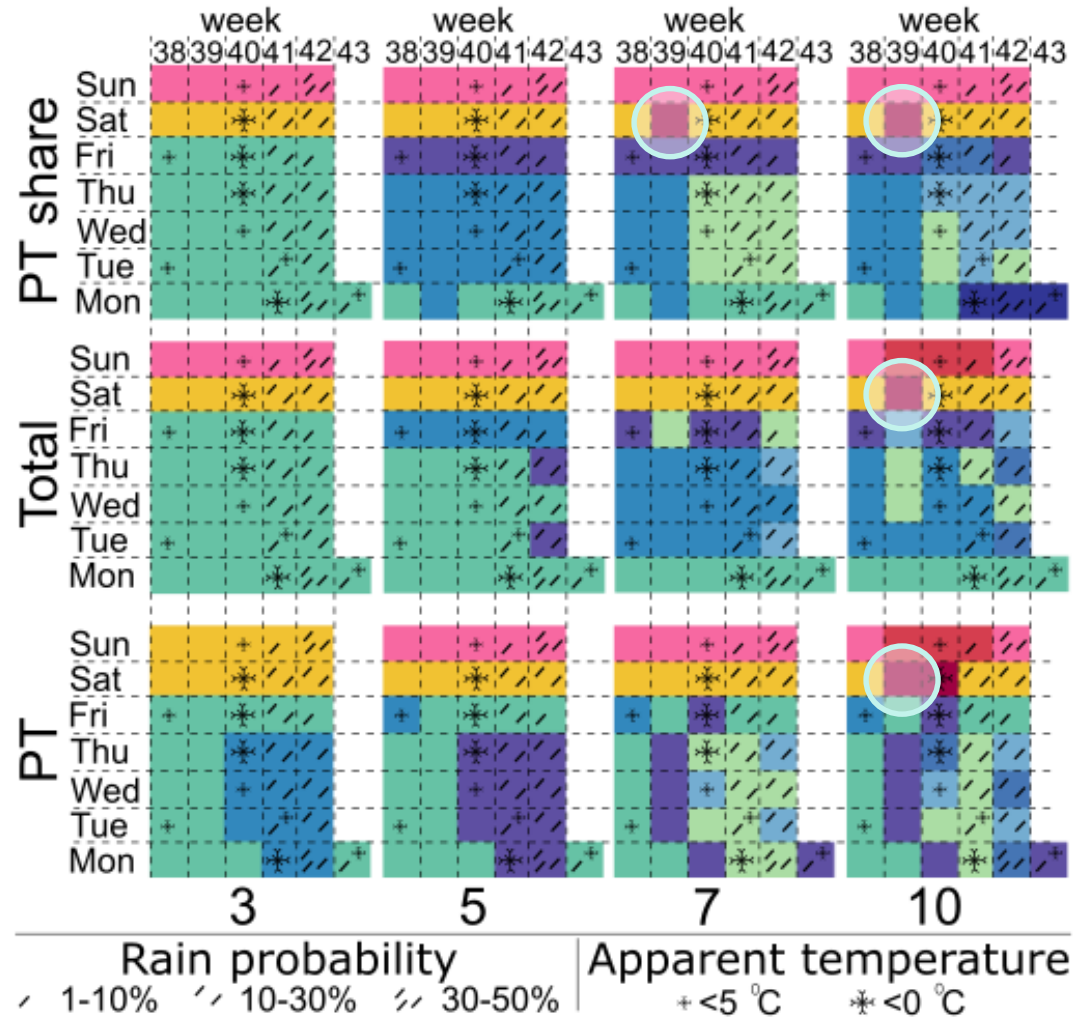
PT mode share analysis



Evolution of representative day-type patterns

1. Weekdays and weekends
2. Saturdays and Sundays
3. Fridays
4. Mondays
5. Using contextual information
 - Impact of weather on PT
 - More rainy and cold weather
 - Does it attract traveler to PT?

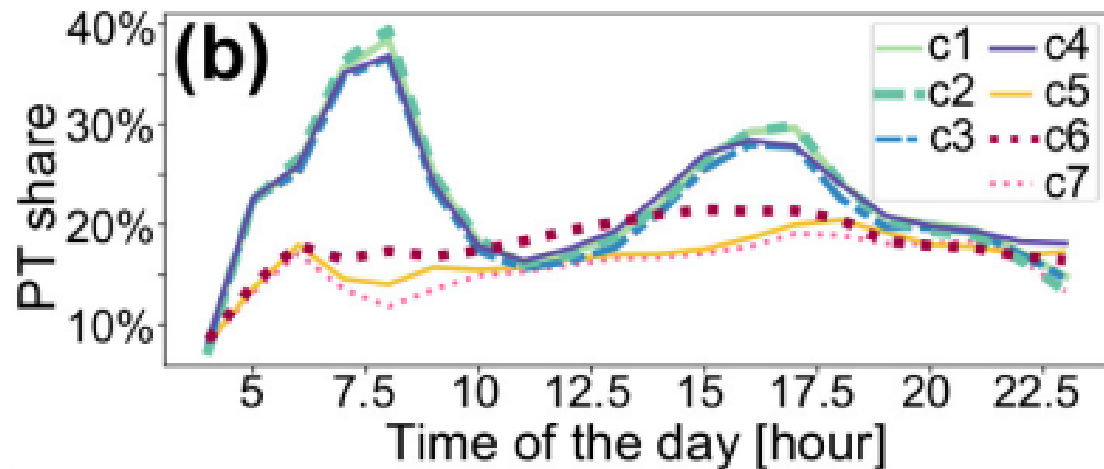
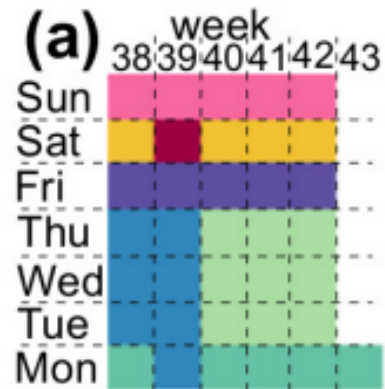
PT mode share analysis



Evolution of representative day-type patterns

1. Weekdays and weekends
2. Saturdays and Sundays
3. Fridays
4. Mondays
5. Using contextual information
 - Impact of weather on PT
 - More rainy and cold weather
 - Special events
 - 28th of September - large memorial ceremony related to the passenger ferry M/S Estonia ship disaster.

PT mode share analysis



Spatio-temporal PT mode share analysis for 7 day-types

- c6 (28th Sep) – PT mode share is larger about 5%, as other Saturdays in c5 cluster
- Mondays have a larger PT mode share during peaks
- Fridays have about a 10% larger PT mode share for late hours than other weekdays
- c1 has a larger PT share than cluster c3, does rainy and colder weekdays attract more travelers to PT.



PT mode share analysis

Regression analysis with socio-economic-weather-PTsupply context

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Indep. variable	corr
Monday	0.103
Tuesday	0.071
Wednesday	0.083
Thursday	0.081
Friday	0.074
Saturday	-0.188
Daily max precip-probability	0.07
Daily min temperature	-0.116
Daily max temperature	-0.058
Daily max wind speed	0.003
log(PT stops)	0.086
metro	0.193
tram	-0.098
train	0.292
bus	-0.156
age 0-15	-0.209
age 16-19	-0.112
age 20-24	0.277
age 25-39	0.189
age 40-59	-0.036
age 60 and more	-0.049
foreign background	0.070
median income	0.165
log(median income)	0.002
male	0.376
unemployed	0.254
pre-secondary education	0.015
secondary education	0.005
university-undergraduate	0.315
university-graduate-post	0.042
accommodation-owned	-0.209
accommodation-condominium	-0.086
accommodation-rent	0.383
registered vehicle	-0.348
households with children	-0.335

R^2	
adjusted R^2	
Prob(Omnibus)	
Condition number	

Zonal PT mode share correlation analysis

- **Positive correlations**

- Weekdays, Mondays the most
- Zone metro and train station ratio
- Age 20 – 39 ratio, mostly 20-24
- Male ratio in zone
- Unemployed ratio in zone
- Bachelor degree ratio in zone
- Rented accommodation ratio in zone

- **Negative correlations**

- Higher the minimal daily temperature lower the PT share
- The tram (missing validations) or bus ratio
- Age 0 – 10 ration, mostly 0-15
- Ration of owned accommodation
- Ratio of registered vehicles per households
- Ration of households with children





Indep. variable	corr	M1			M2		
		coef	$P > t $		coef	$P > t $	
Monday	0.103	0.0852	0.000	0.0784	0.000		
Tuesday	0.071	0.0807	0.000	0.0727	0.000		
Wednesday	0.083	0.0835	0.000	0.0761	0.000		
Thursday	0.081	0.0824	0.000	0.0754	0.000		
Friday	0.074	0.0819	0.000	0.0736	0.000		
Saturday	-0.188	0.0121	0.001				
Daily max precip-probability	0.07	0.0056	0.165				
Daily min temperature	-0.116	0.0007	0.051				
Daily max temperature	-0.058	-0.0011	0.000				
Daily max wind speed	0.003	0.0003	0.642				
log(PT stops)	0.086	0.0578	0.000	0.0907	0.000		
metro	0.193	3.5852	0.000	0.3645	0.000		
tram	-0.098	3.9381	0.000	0.1990	0.000		
train	0.292	5.2703	0.000	1.7791	0.000		
bus	-0.156	3.4089	0.000				
age 0-15	-0.209	-9.8436	0.000				
age 16-19	-0.112	-22.441	0.000				
age 20-24	0.277	-3.7796	0.000				
age 25-39	0.189	-4.8367	0.000				
age 40-59	-0.036	-3.7243	0.000				
age 60 and more	-0.049	-4.2791	0.000				
foreign background	0.070	-0.4419	0.000				
median income	0.165	-0.0030	0.000				
log(median income)	0.002			0.0154	0.000		
male	0.376	5.9922	0.000				
unemployed	0.254	3.2880	0.000	2.0984	0.000		
pre-secondary education	0.015	0.4481	0.643	-4.1979	0.000		
secondary education	0.005	2.4897	0.000	1.3706	0.000		
university-undergraduate	0.315	0.1073	0.874	3.5796	0.000		
university-graduate-post	0.042	1.6039	0.003				
accommodation-owned	-0.209	-0.0133	0.960	1.0542	0.000		
accommodation-condominium	-0.086	-1.5476	0.000				
accommodation-rent	0.383	-1.9679	0.000	-0.0698	0.005		
registered vehicle	-0.348	-2.1761	0.000	-2.1204	0.000		
households with children	-0.335	-6.8592	0.000	-5.2320	0.000		
R^2		0.985		0.970			
adjusted R^2		0.985		0.969			
Prob(Omnibus)		0.818		0.922			
Condition number		7.09e+04		1.20e+03			

Regression analysis

- Ordinary Least Squares (OLS) regression model
- Day-of-week, weather, income, education, PT supply, access to a private vehicle, and families with children all impact the zonal PT share and have significant explanatory and predictive power

What next?

What next?

- A mode choice component will be added to analyze multimodal traffic management
- Analysis and overview of typical days, route choice, and demand in Stockholm
- Analysis of incidents
- Simulation with mesoscopic traffic model (Dynameq)

Tack så mycket!

Frågor?

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