Kate Deutsch-Burgner
Data Perspectives Consulting
kate@dpccal.com

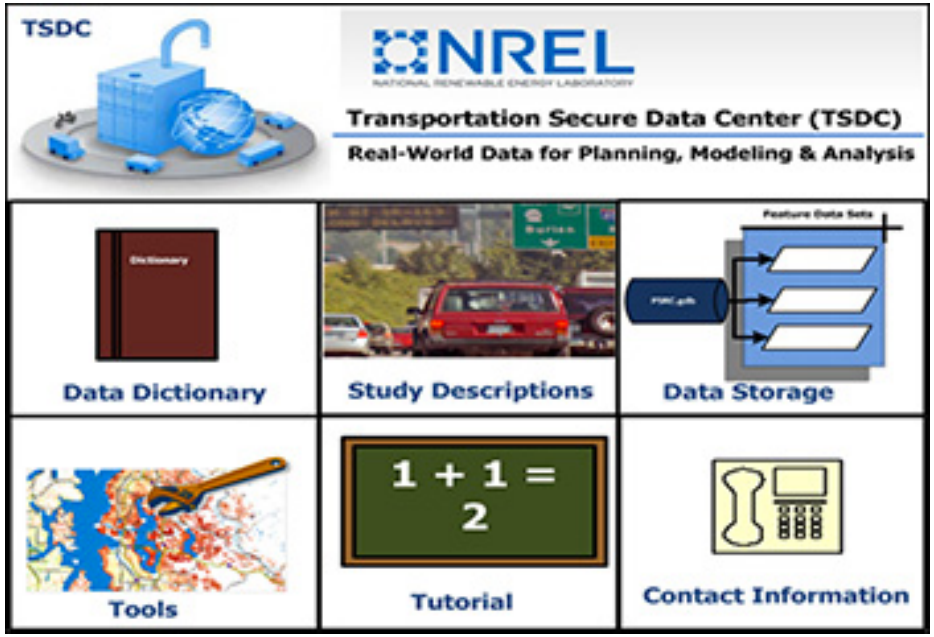
Multiday Variation in Time Use and Destination Choice in the San Francisco Bay Area

Motivation

- Data collection for one day is sensible and rational
  - Fits the diurnal patter of human life
  - Convenient unit of time for surveys
- But…..
  - One day data cannot adequately capture all dimensions of behavioral variation
    - Addressed by Hanson and Huff in a series of papers in the 1980s challenging the existence of a "typical day"
      - Used one of the only multiday datasets in existence

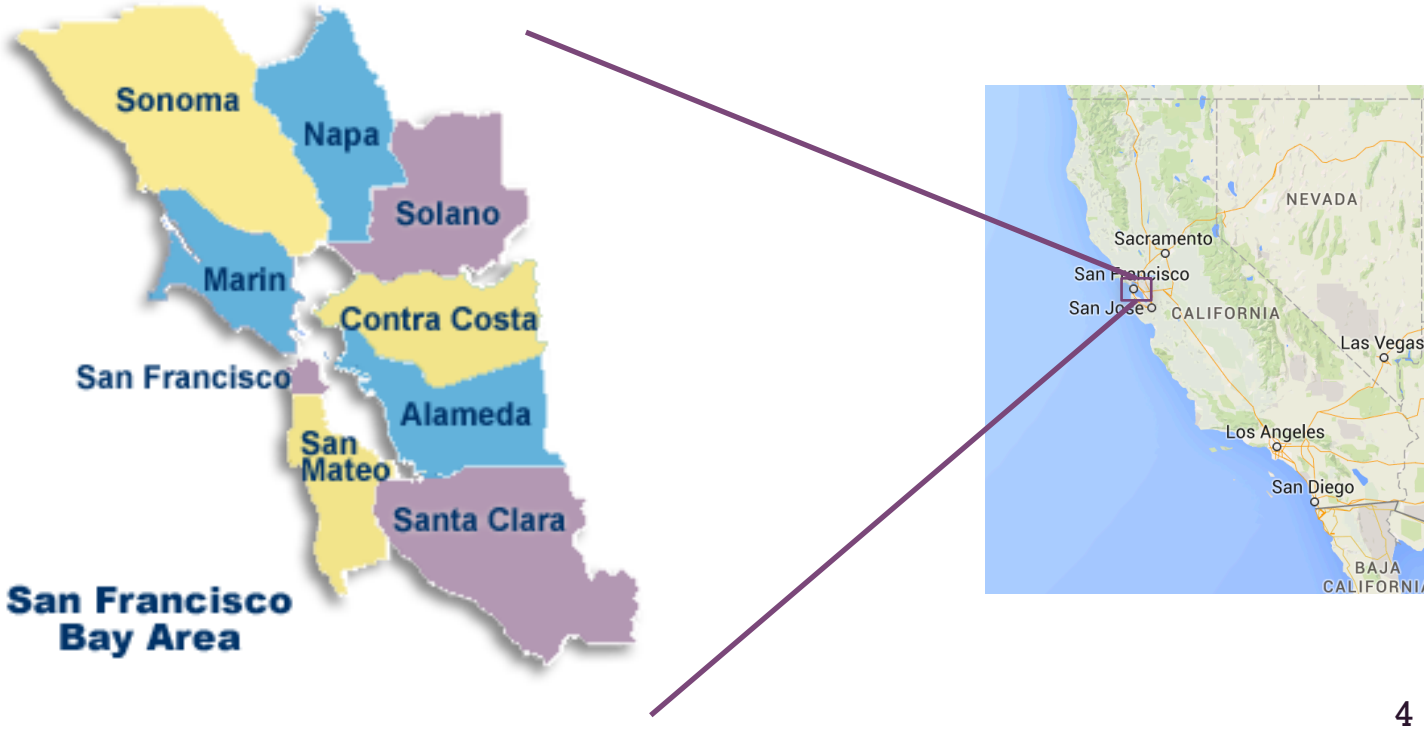
Data Description

- Data accessed through the NREL Transportation Secure Data Center
- 2010-2012 California Household Travel Survey



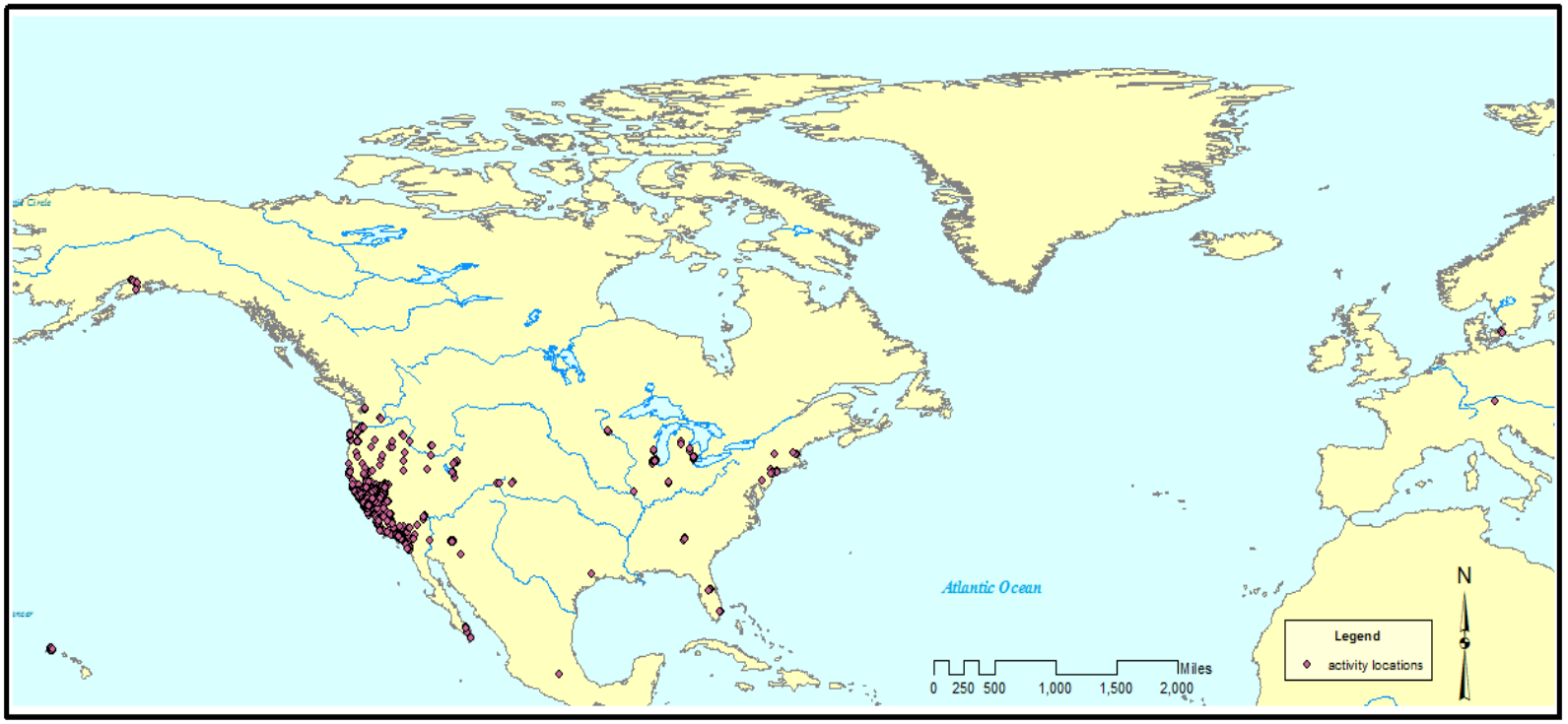
Data Description

- Nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, Sonoma,

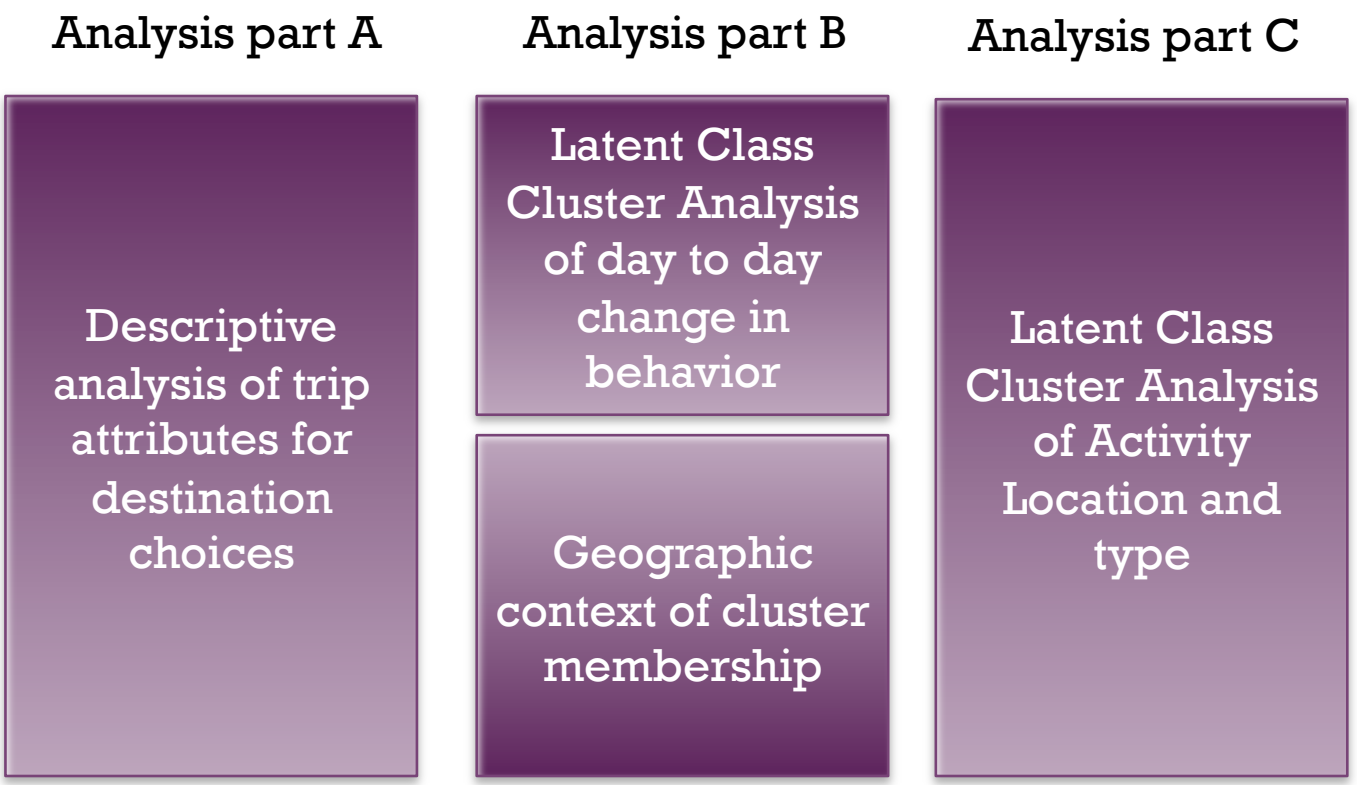


Data Description

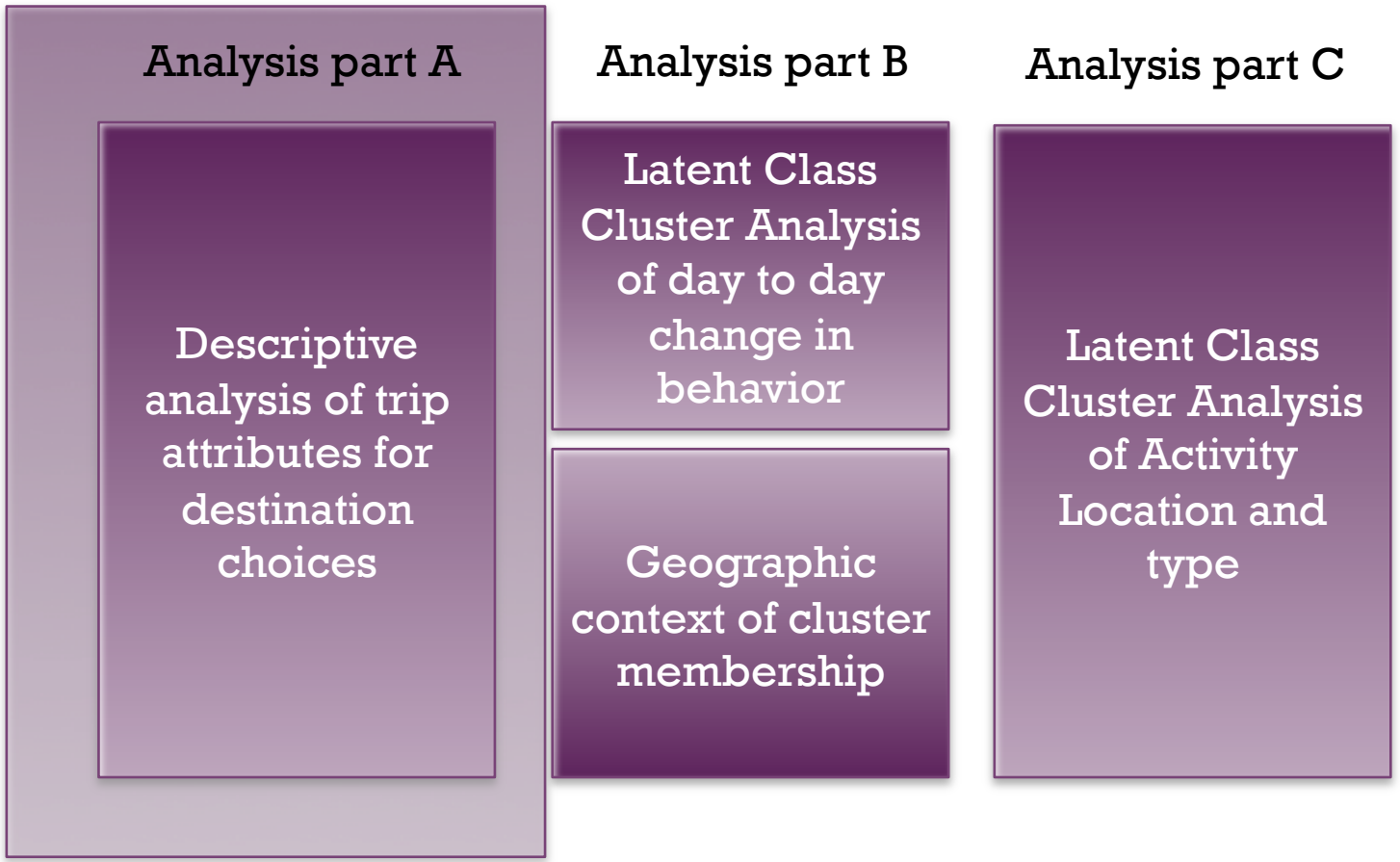
- One day travel diary + 3 day wearable GPS logger
- Sample size= 6,723 individuals, ages 16 to 75 years of age



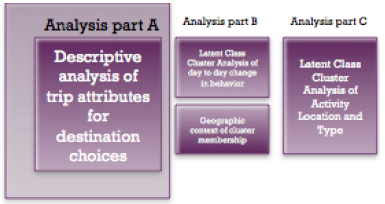
Analysis


Analysis part A
Analysis part B
Analysis part C
Descriptive analysis of trip attributes for destination choices
Latent Class Cluster Analysis of day to day change in behavior
Geographic context of cluster membership
Latent Class Cluster Analysis of Activity Location and type

Analysis


Analysis part A
Descriptive analysis of trip attributes for destination choices
Analysis part B
Latent Class Cluster Analysis of day to day change in behavior
Geographic context of cluster membership
Analysis part C
Latent Class Cluster Analysis of Activity Location and type

Analysis

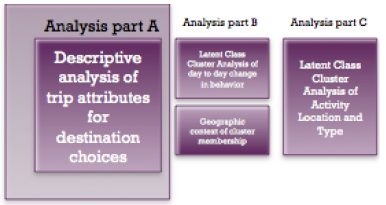


- General trip statistics:

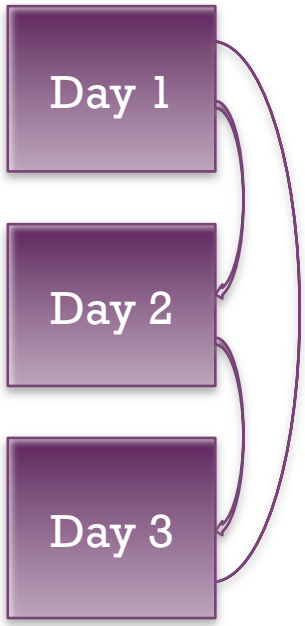
Trip summary for all three days (all individuals)		
Total Distance (Miles)		
	Minimum	0.06
	Maximum	6376.95
	Average	94.41
	Median	62.37
Total Number Of Trips		
	Minimum	1
	Maximum	88
	Average	15.15
	Median	13
Total Duration (Minutes)		
	Minimum	1.02
	Maximum	2006.48
	Average	211.28
	Median	179.53

Per trip averages (all individuals)	
Per Trip Duration (Minutes)	
Average	13.95
Per Trip Distance (Miles)	
Average	6.23
Per day trip summary (all individuals)	
Total Per Day Distance (Miles)	
Average	31.47
Median	15.96
Total Per Day Duration (Minutes)	
Average	70.43
Median	54.99
Total Per Day Trips	
Average	5.05
Median	4
Days With Recorded Trips (#)	
1	887
2	1661
3	4175
Travel Day Included Weekend	
	1521

Analysis

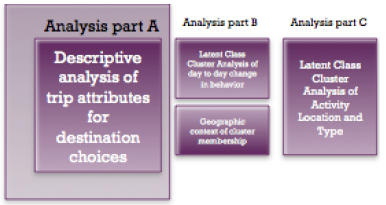


- Person based day to day changes in trip attributes



Change in total trip distance (miles)
Change in total number of trips
Change in average trip distance (miles)
Change in standard deviation of trip distance (miles)

Analysis



- Summary findings:
  - Change in total trip distance:

    5th percentile of respondents has a change in less than one mile

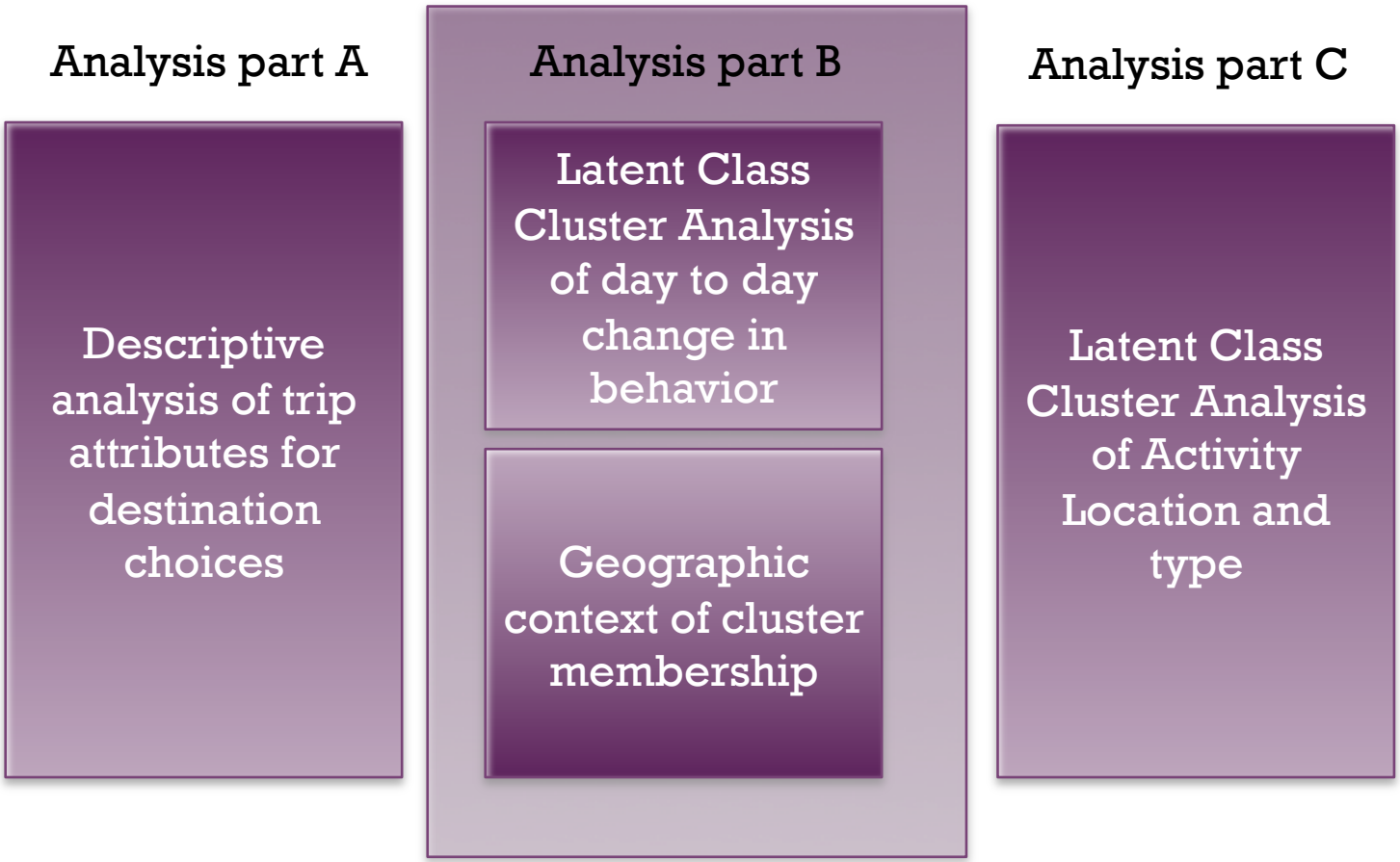
    95th percentile of respondents have large changes (trans-Atlantic or coast to coast)
  - Change in number of trips

    65 percent have a change in total trips between 2 and 11, 50% of respondents have a change in 3 or more trips
  - Change in average trip distances

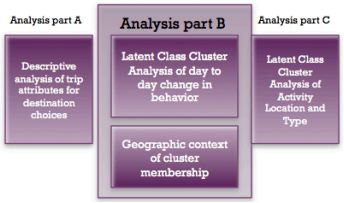
    65% have a change in average distance of between 1 and 13 miles, some due to exceedingly long distance trips.
  - Change in standard deviation of trip distances

    95% of respondents are between 0 and 20 miles

Analysis


Analysis part A
Descriptive analysis of trip attributes for destination choices
Analysis part B
Latent Class Cluster Analysis of day to day change in behavior
Geographic context of cluster membership
Analysis part C
Latent Class Cluster Analysis of Activity Location and type

Analysis



Cluster 1
Mid Variation, Local Trips

Cluster 2
High Variation Longer distance local trips

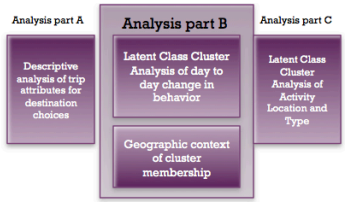
Cluster 3
Low Variation, Local trips

Cluster 6
High Variation, Long Distance Trip Makers

Cluster 5
Extreme Variation, One or Two Day Non Travelers

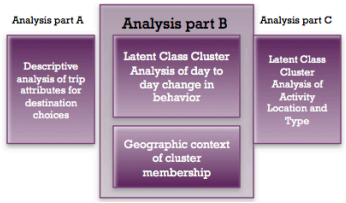
Cluster 4
High Variation, Mid Distance Trips

Analysis

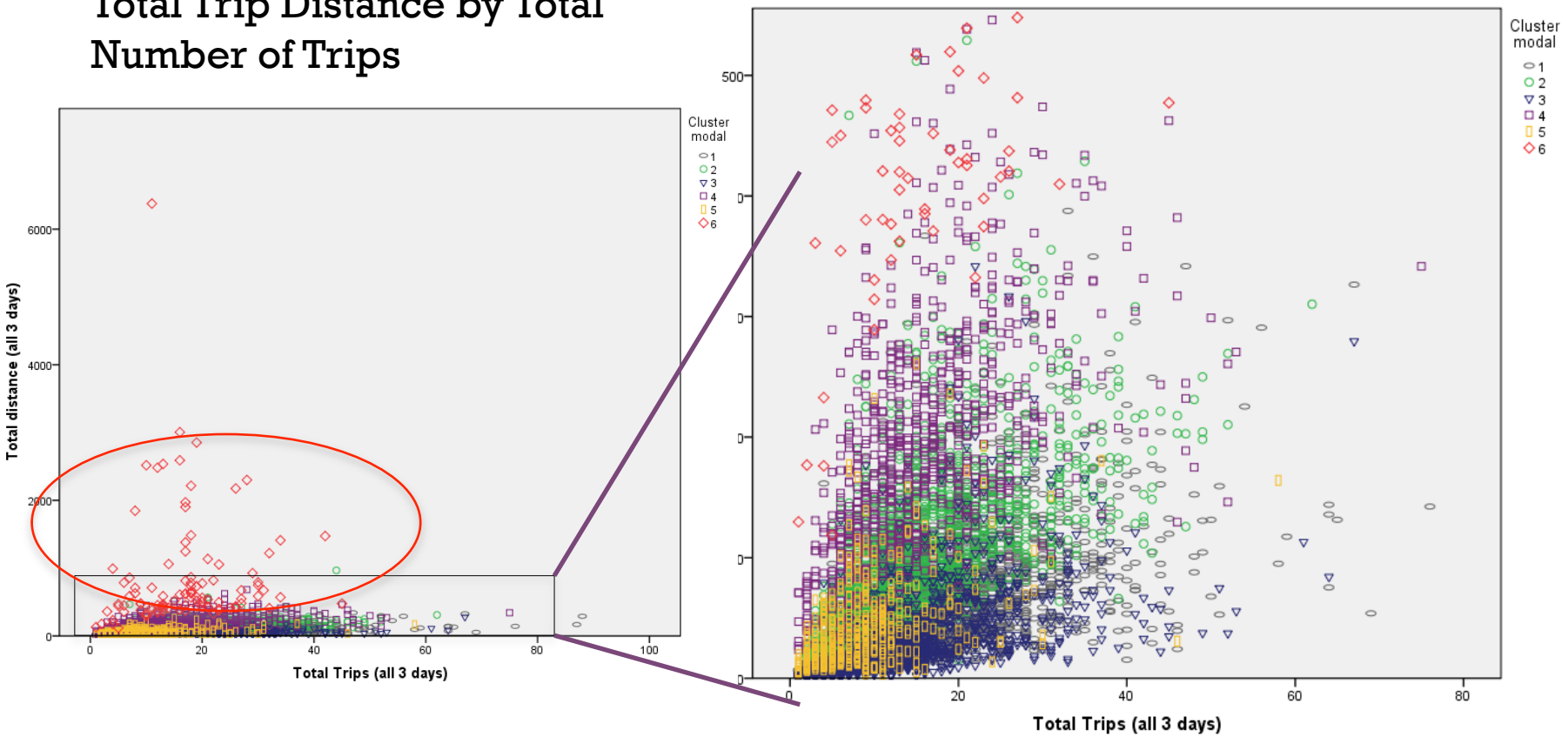


Indicator	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Change in total dist. day 1-2 Mean	14.58	27.52	4.52	79.66	34.55	429.11
Change in total dist. day 2-3 Mean	16.90	35.99	4.30	88.15	0.49	543.82
Change in total dist. day 1-3 Mean	16.17	33.75	4.81	82.07	34.61	497.66
Change in total trips day 1-2 Mean	3.93	3.49	2.45	4.25	6.62	4.37
Change in total trips day 2-3 Mean	4.67	4.28	2.23	4.59	0.17	4.21
Change in total trips day 1-3 Mean	4.41	3.97	2.63	4.76	6.57	4.94
Change in avg. trip dist. day 1-2 Mean	2.06	5.35	0.90	15.40	5.78	82.63
Change in avg. trip dist. day 2-3 Mean	2.54	6.92	0.86	17.17	0.13	108.66
Change in avg. trip dist. day 1-3 Mean	2.45	6.60	0.96	17.02	5.79	99.12
Chg. in st. dev. trip dist. day 1-2 Mean	1.89	5.14	0.67	15.32	5.21	147.87
Chg. in st. dev. trip dist. day 2-3 Mean	2.24	6.63	0.66	17.40	0.11	184.35
Chg. in st. dev. trip dist. day 1-3 Mean	2.16	6.34	0.71	16.56	5.21	173.12
COLOR SCALE	lo					high

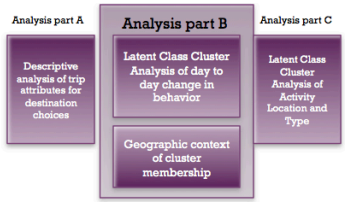
Analysis



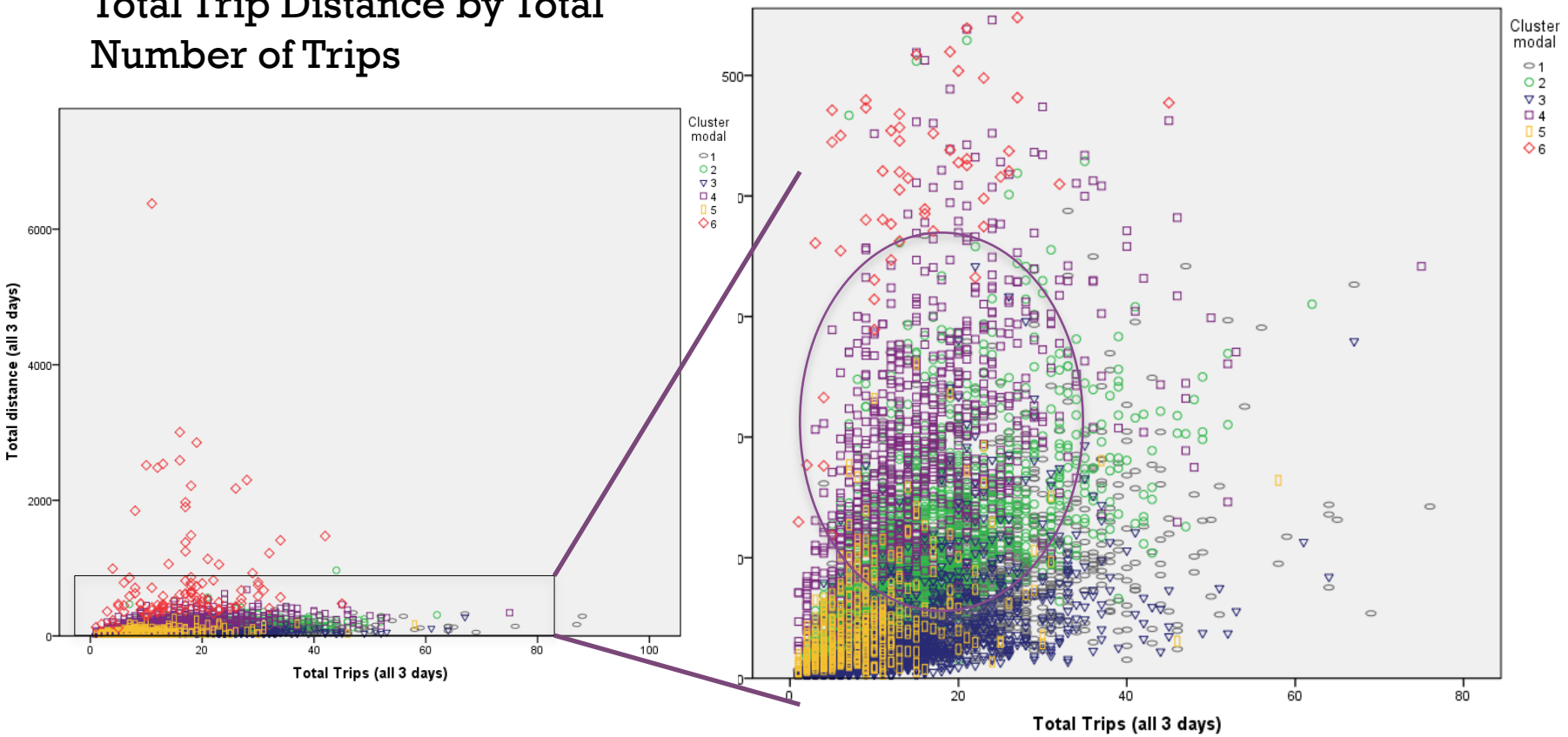
Total Trip Distance by Total Number of Trips



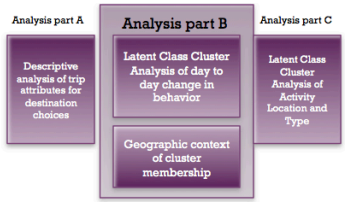
Analysis



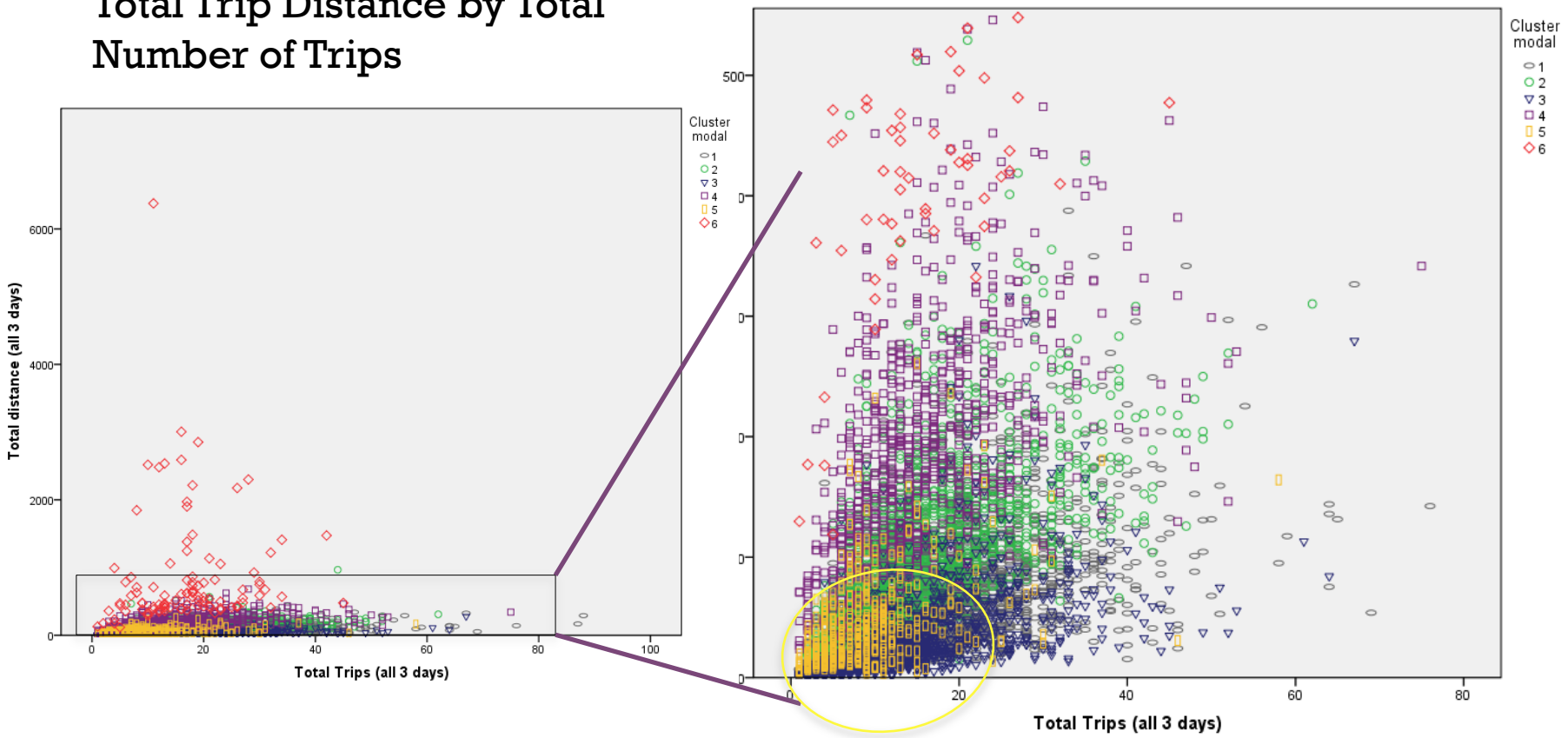
Total Trip Distance by Total Number of Trips



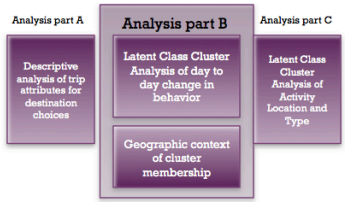
Analysis



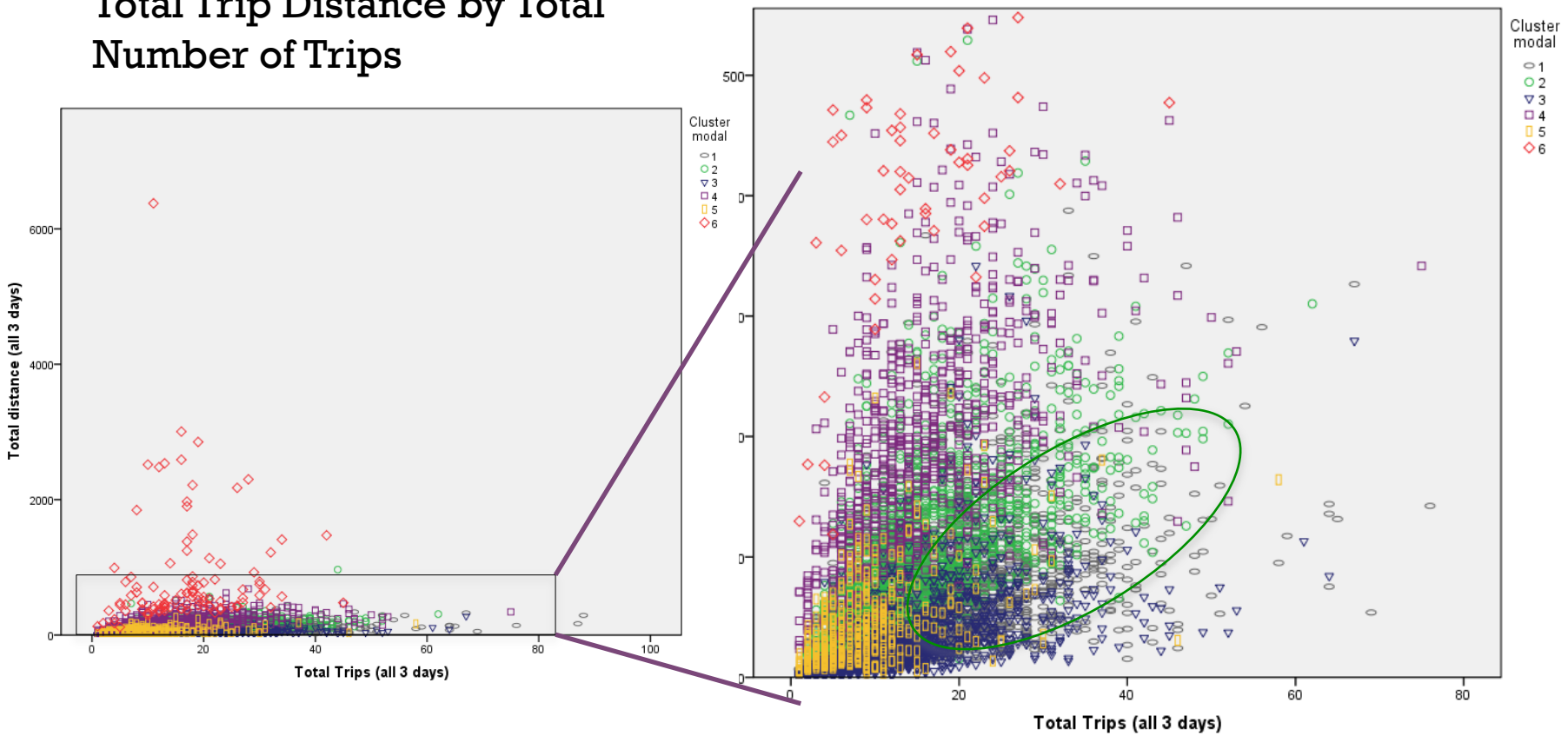
Total Trip Distance by Total Number of Trips



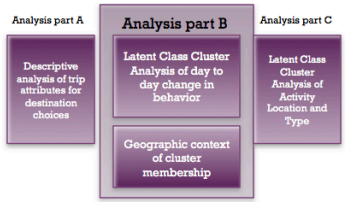
Analysis



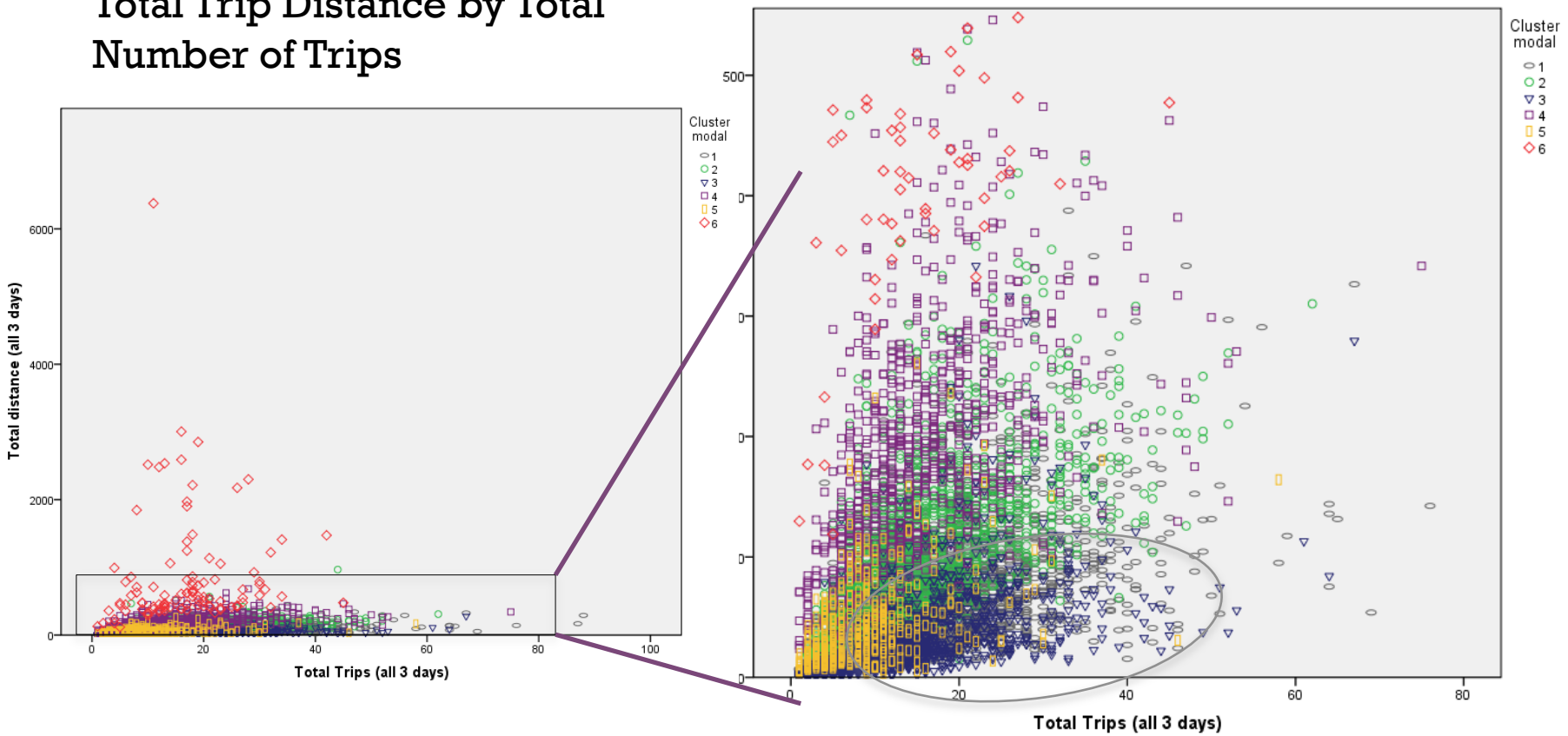
Total Trip Distance by Total Number of Trips



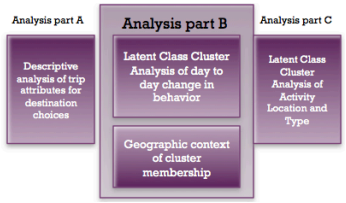
Analysis



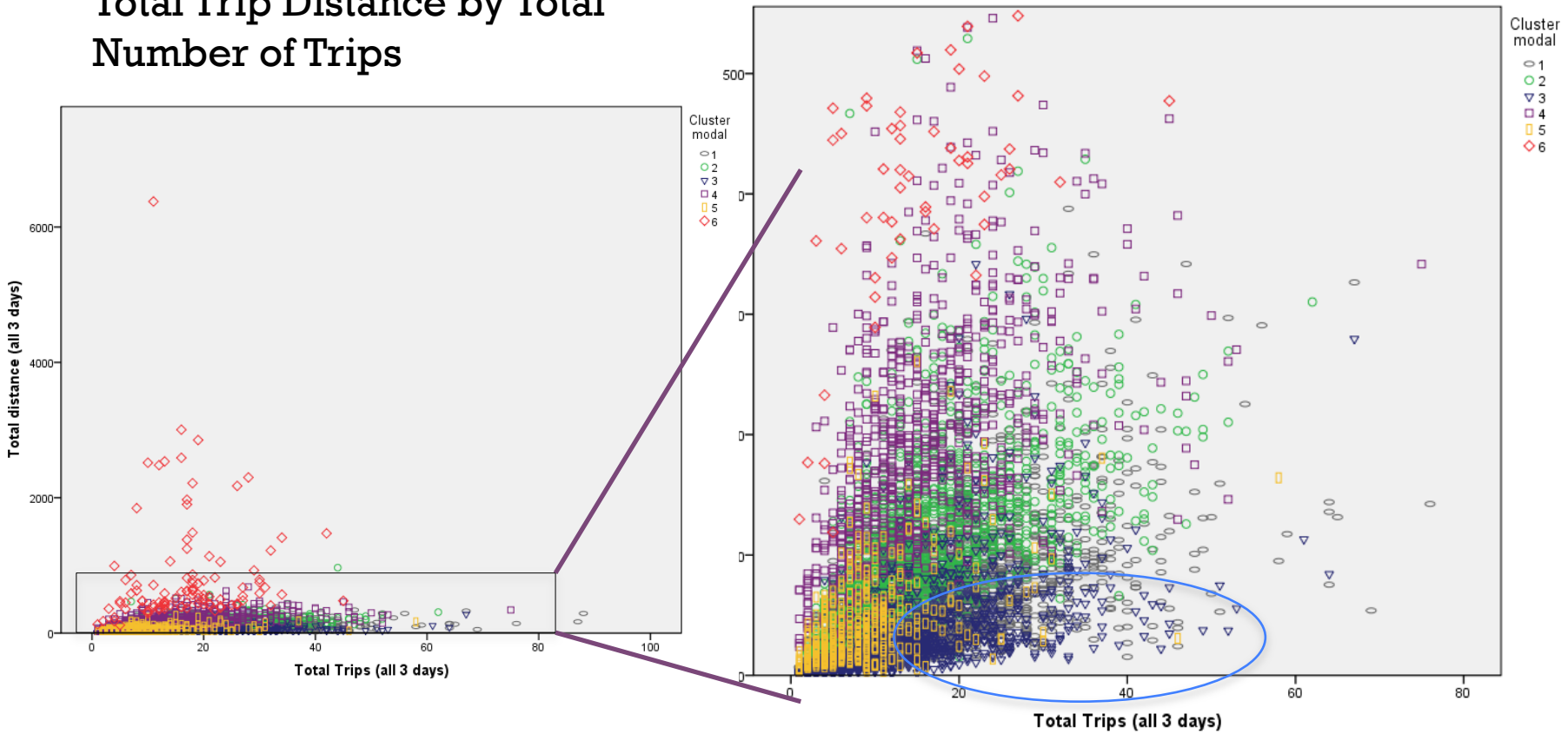
Total Trip Distance by Total Number of Trips



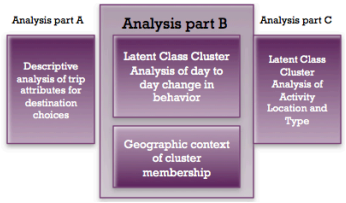
Analysis

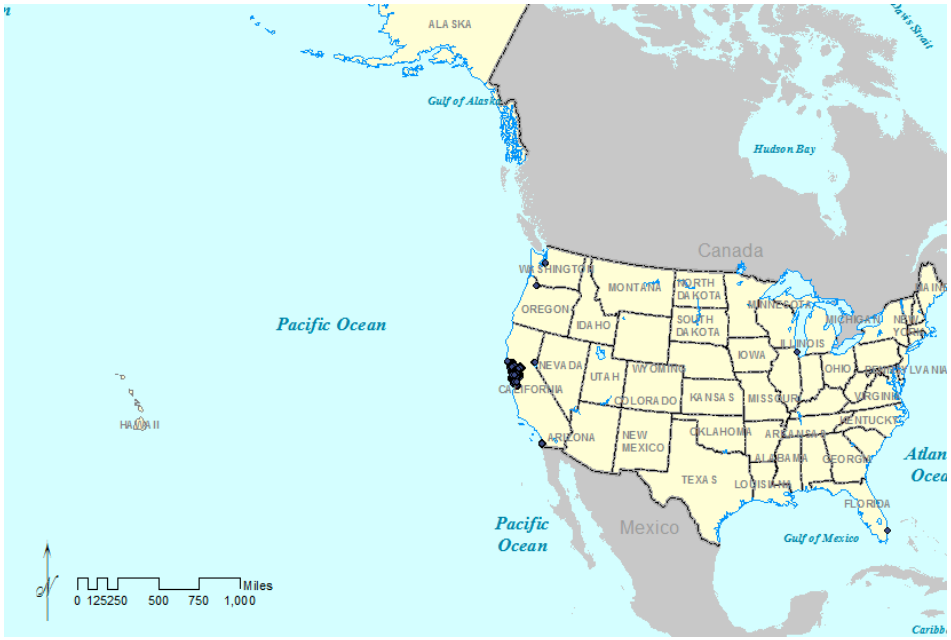


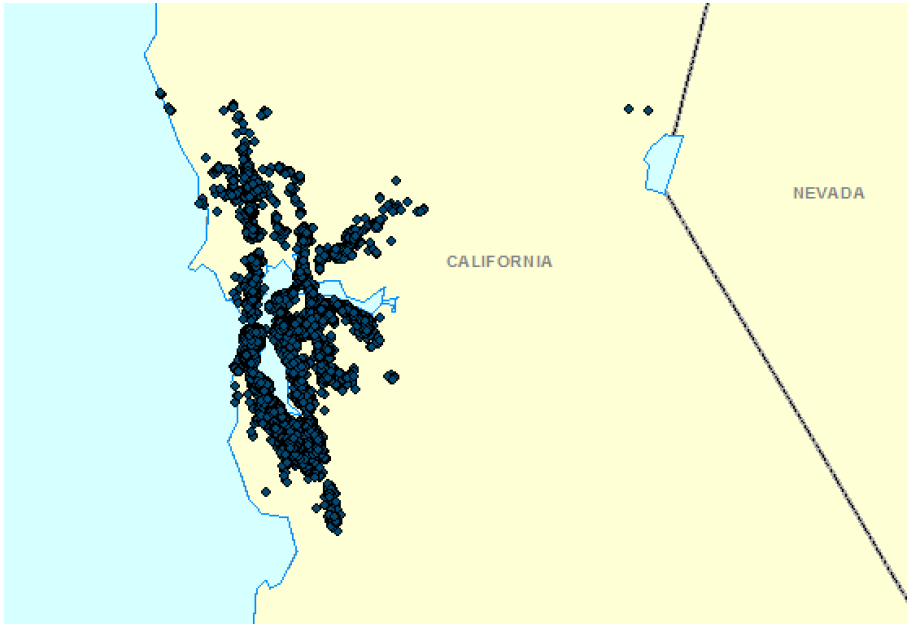
Total Trip Distance by Total Number of Trips



Analysis

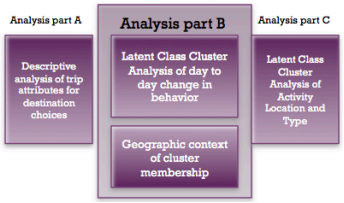


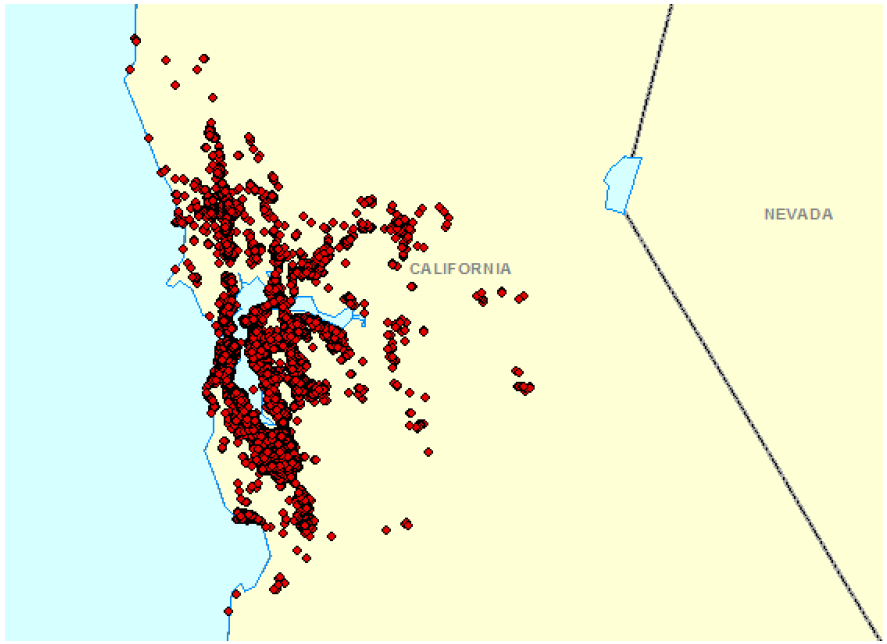




Cluster 1: Mid variation local trip makers

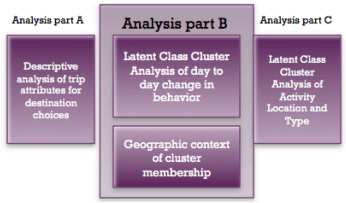
Analysis

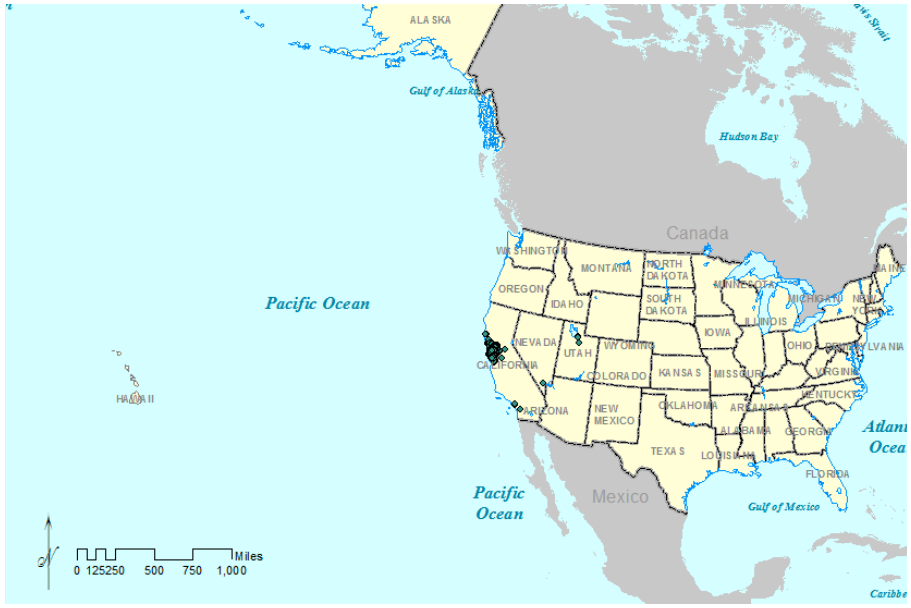


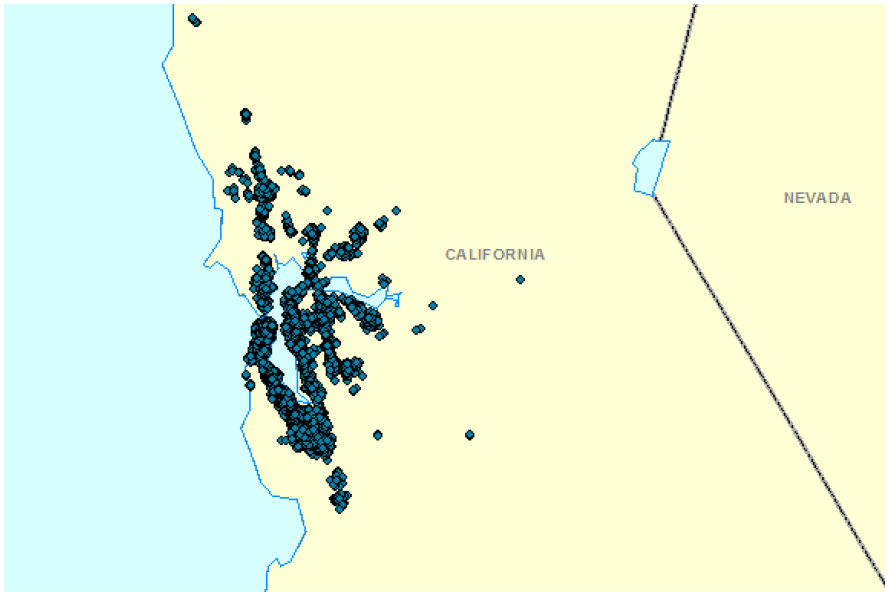


Cluster 2: local long distance travelers

Analysis

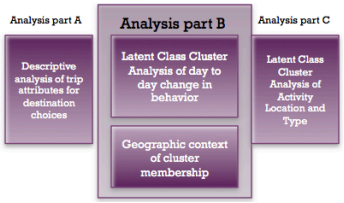


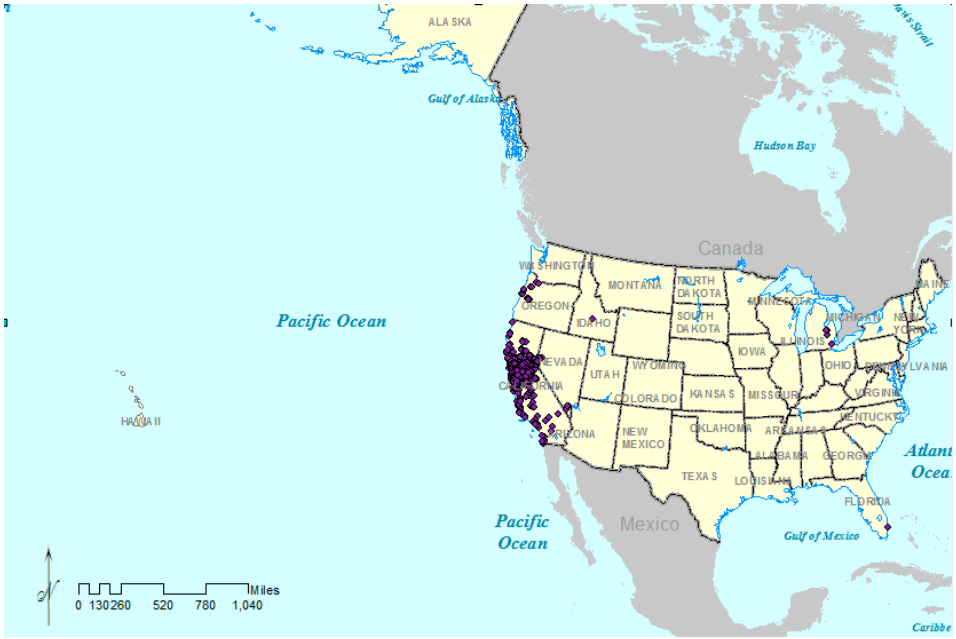


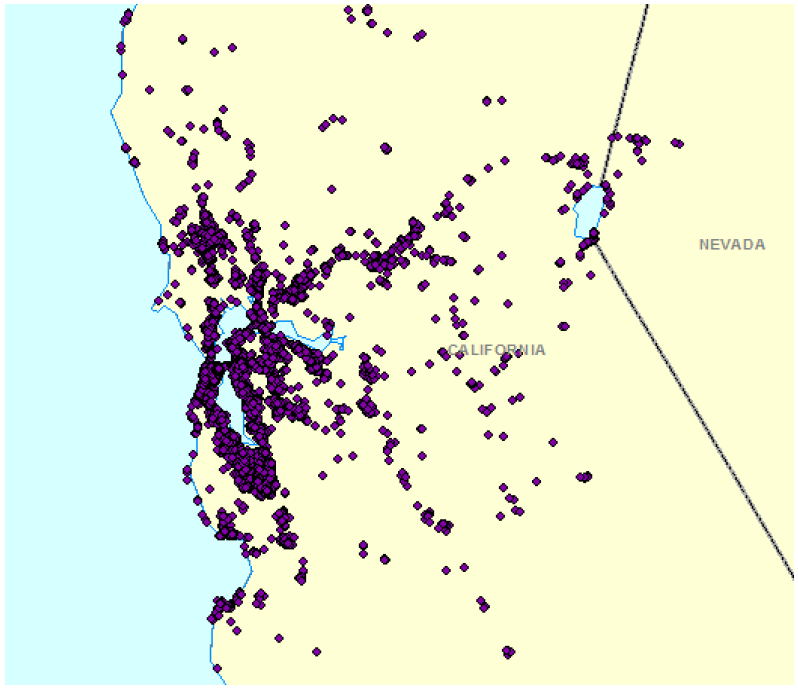


Cluster 3: low variation, local trip makers

Analysis

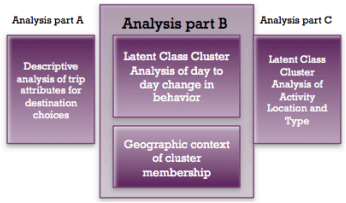


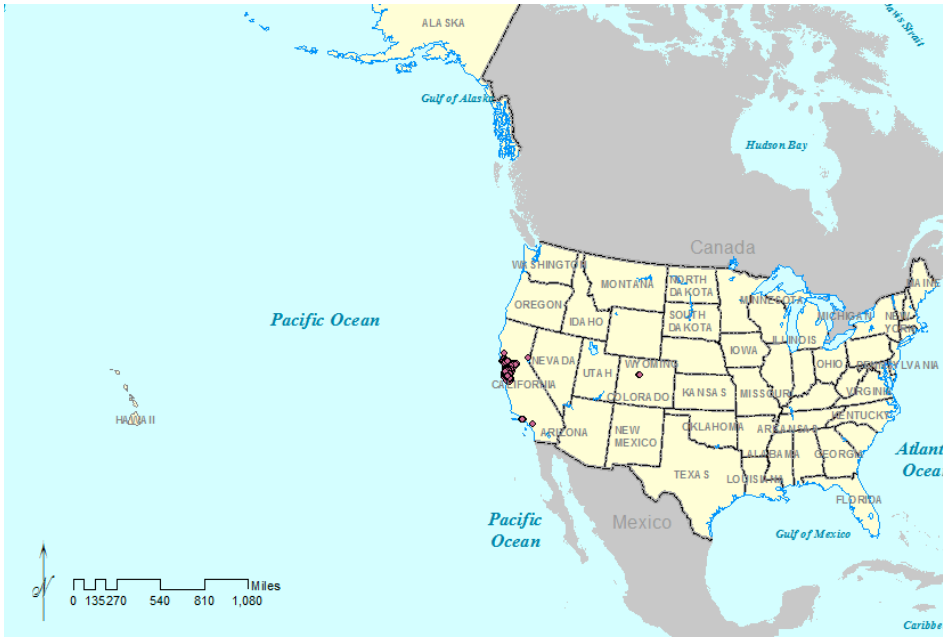


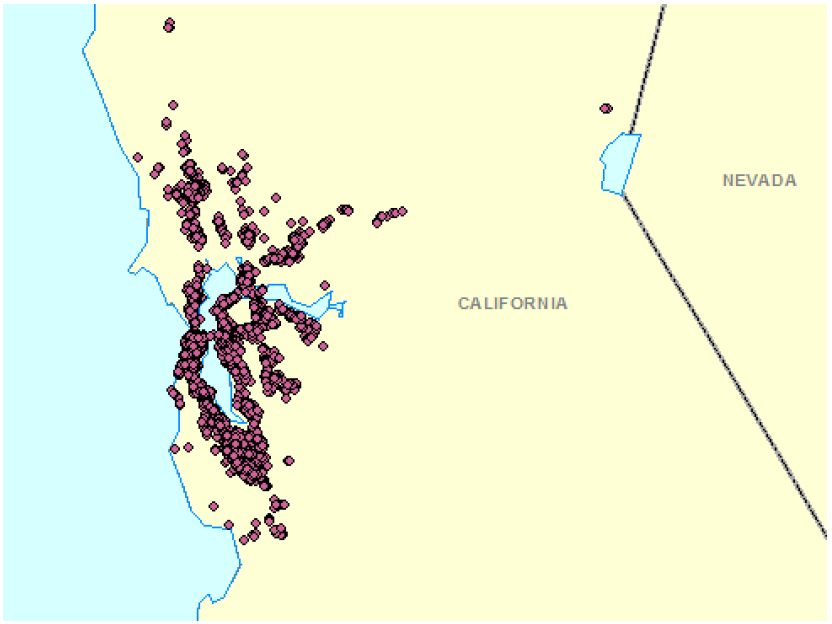


Cluster 4: Mid range long distance travelers

Analysis

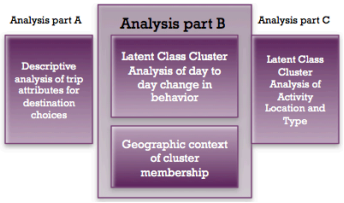


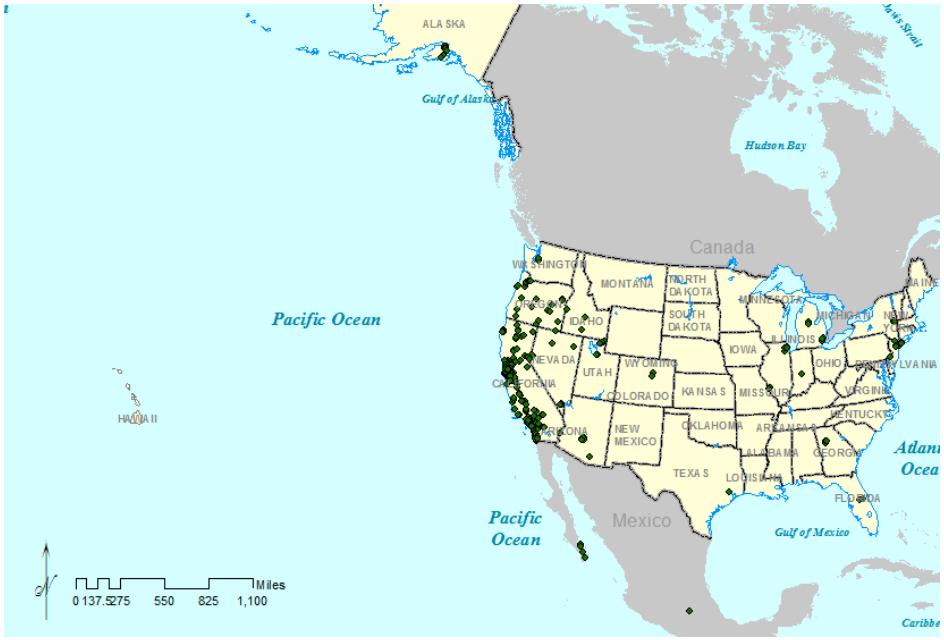


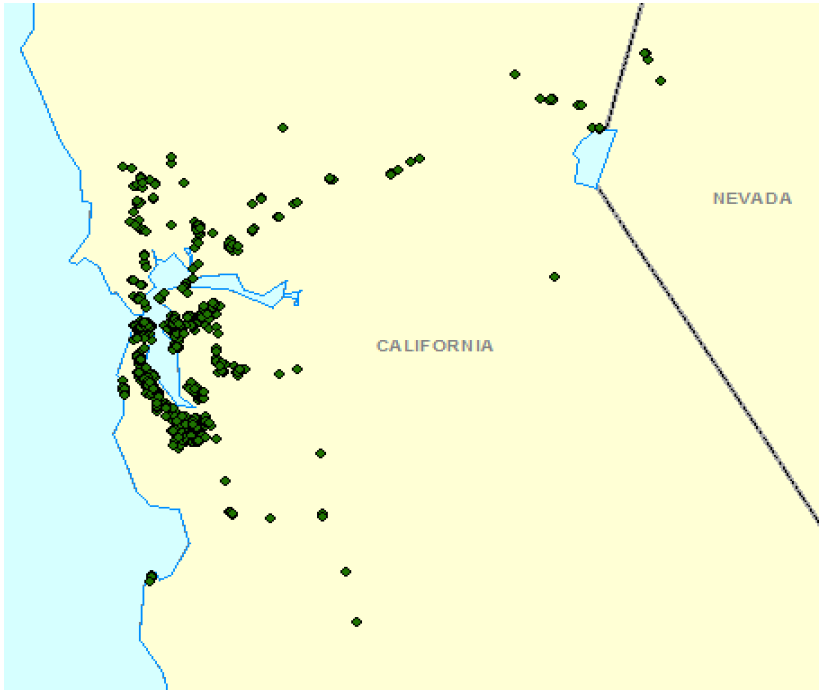


Cluster 5: The partial non-travelers

Analysis

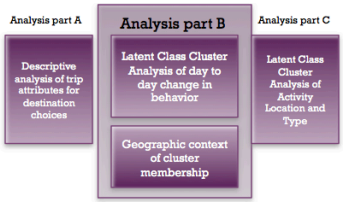


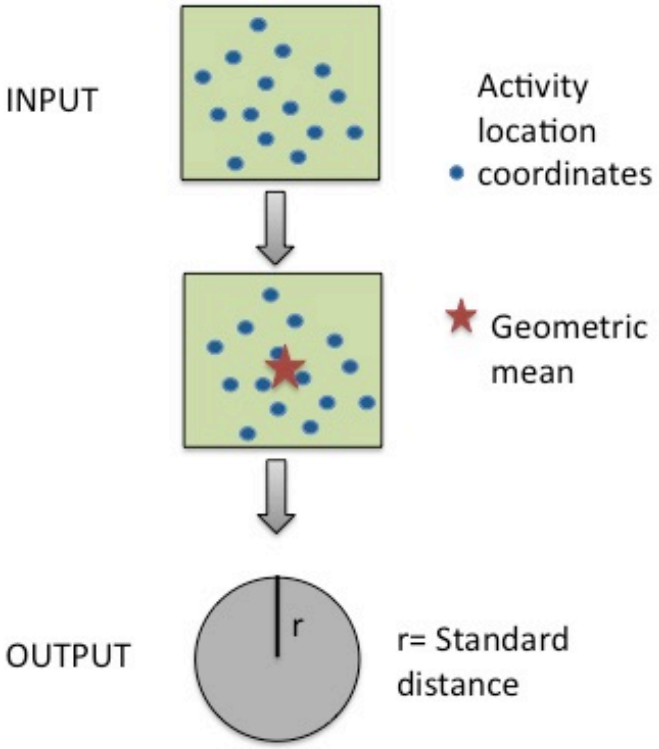




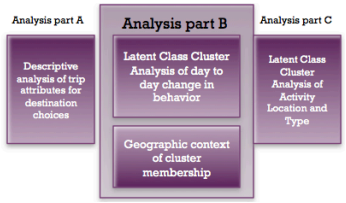
Cluster 6: Long distance trip makers

Analysis

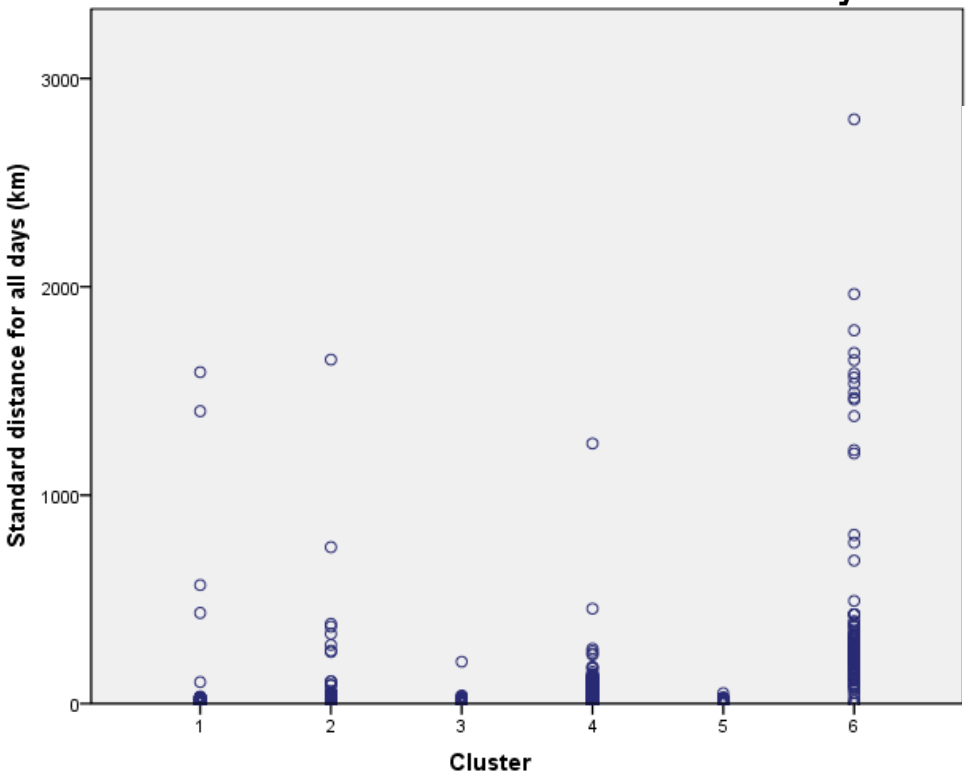

Analysis part A
Descriptive analysis of trip attributes for destination choices
Analysis part B
Latent Class Cluster Analysis of day to day change in behavior
Geographic context of cluster membership
Analysis part C
Latent Class Cluster Analysis of Activity Location and Type


INPUT
Activity location coordinates
Geometric mean
OUTPUT
r
r= Standard distance

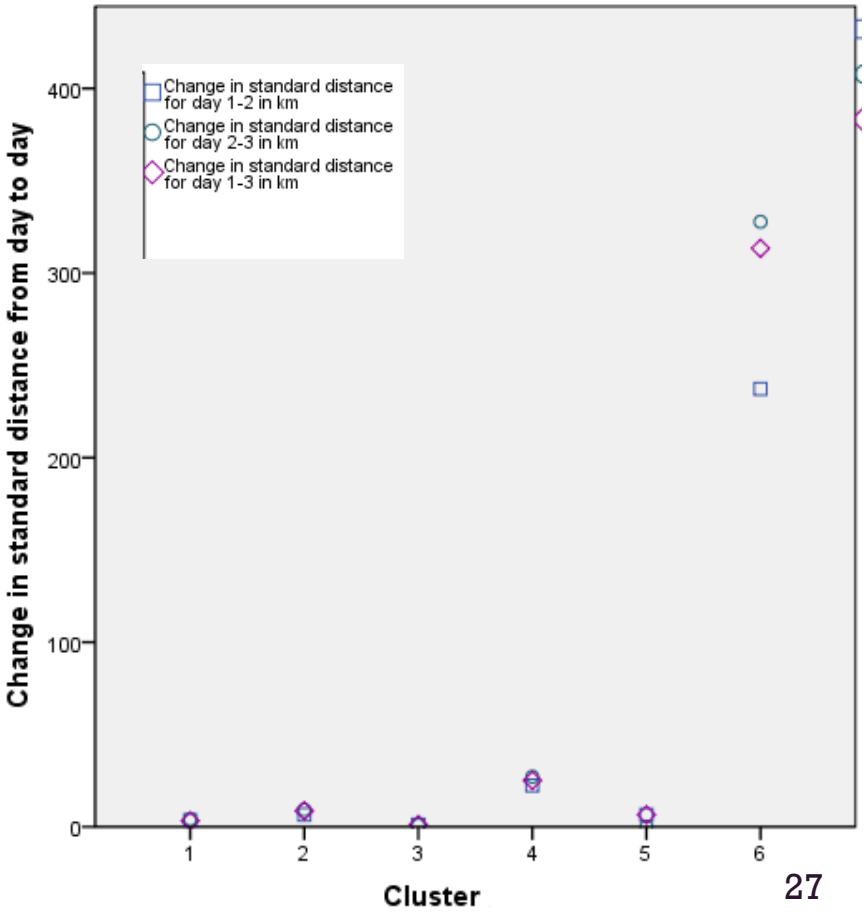
Analysis



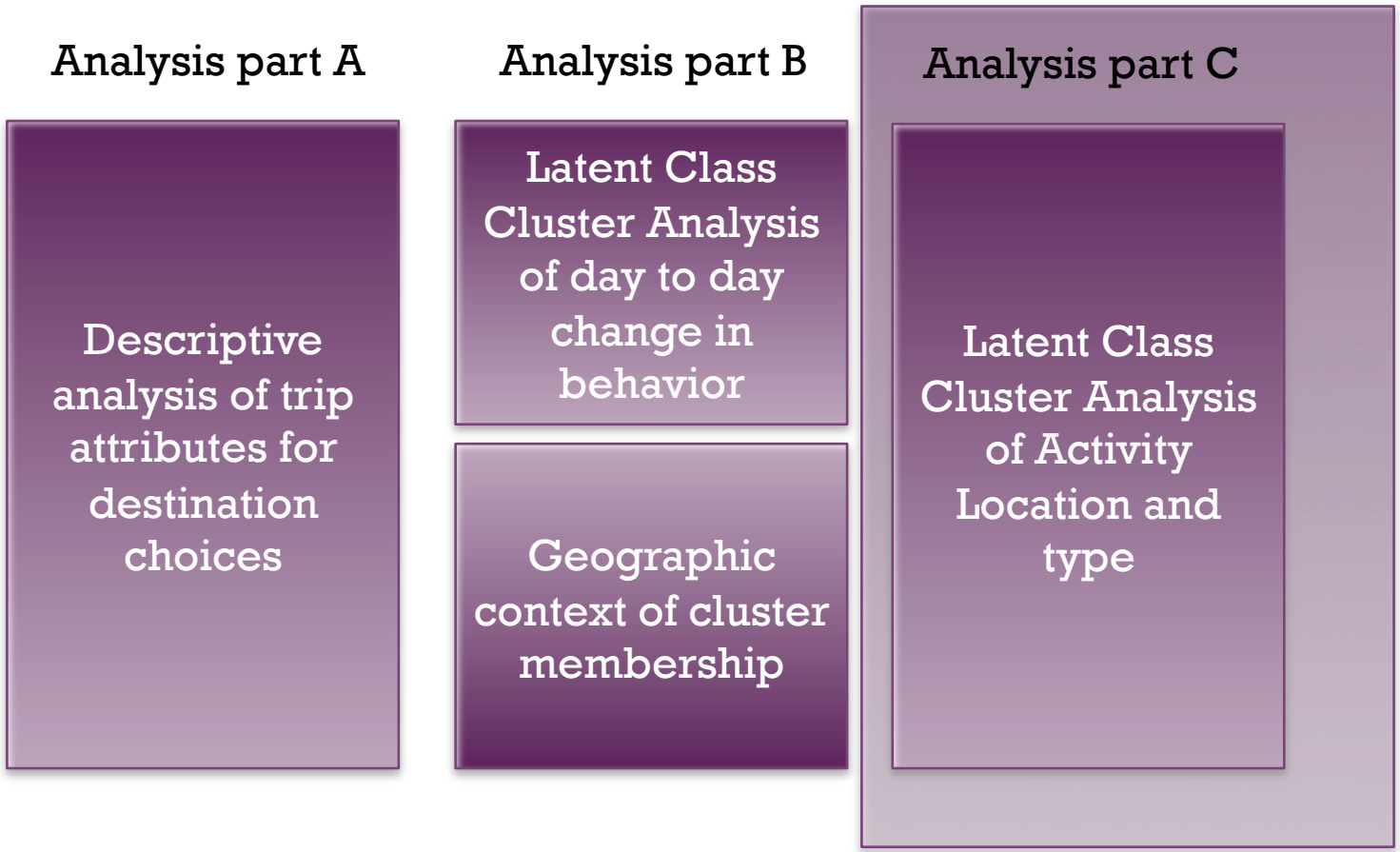
Standard Distances for all days



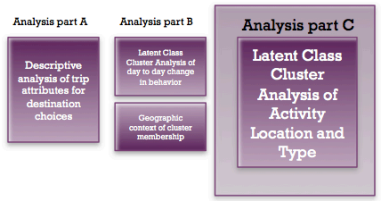
Average Change in Standard Distance



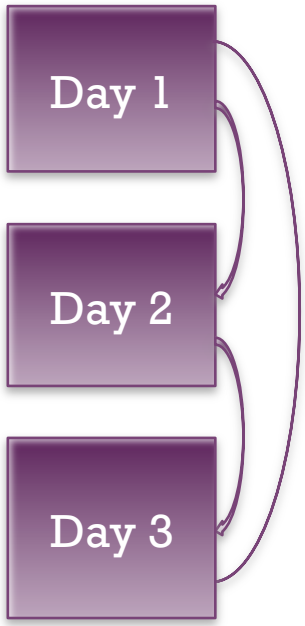
Analysis


Analysis part A
Descriptive analysis of trip attributes for destination choices
Analysis part B
Latent Class Cluster Analysis of day to day change in behavior
Geographic context of cluster membership
Analysis part C
Latent Class Cluster Analysis of Activity Location and type

Analysis



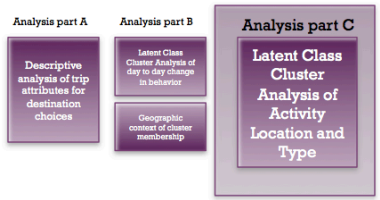
- Person based day to day changes in destination



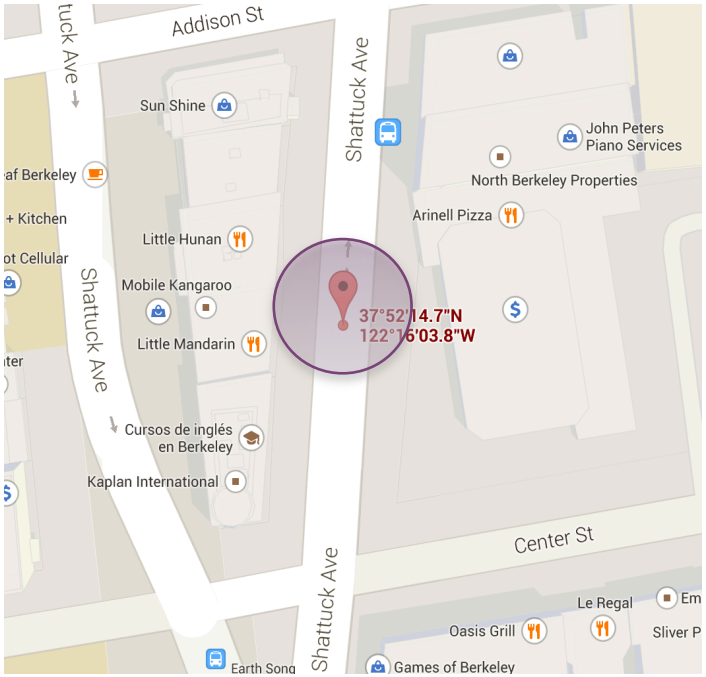
Δ in # of

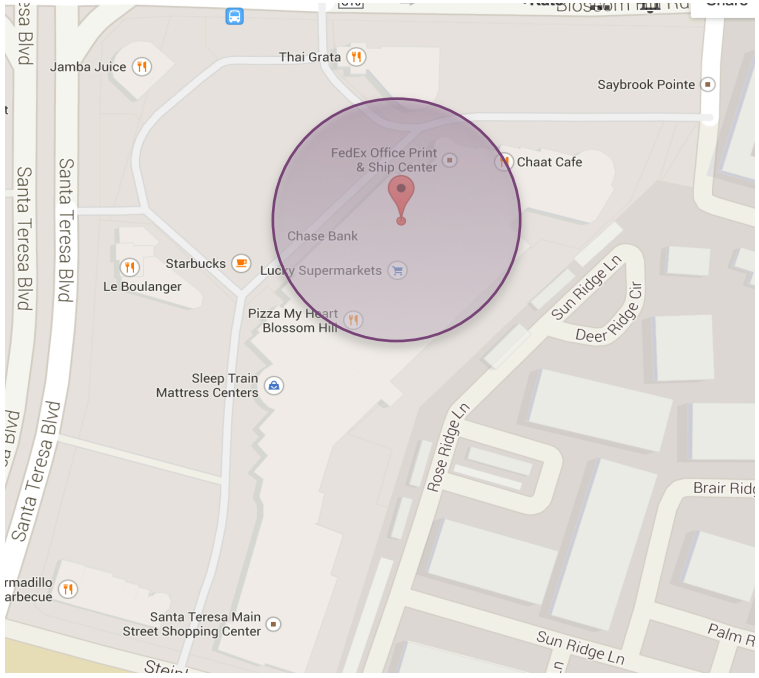
Home destinations trips
Work destinations trips
School destinations trips
Residential destinations trips
Other destinations trips

Analysis

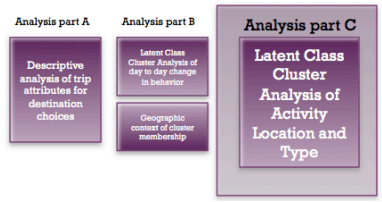


- Used home, work and school x and y coordinates from survey
- Also used Google places API to refine destination type of "other"



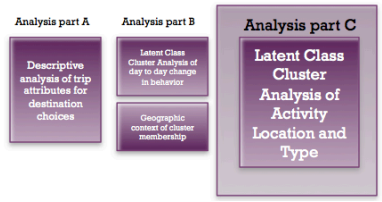


Analysis



Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Change in home destinations day 1 to 2 Mean	0.93	0.77	1.34	1.26	1.51	1.13
Change in home destinations day 2 to 3 Mean	0.95	0.85	1.50	1.34	0.00	1.15
Change in home destinations day 1 to 3 Mean	0.98	0.85	1.47	1.46	1.51	1.27
Change in work destinations day 1 to 2 Mean	0.00	1.27	0.51	0.17	0.57	0.30
Change in work destinations day 2 to 3 Mean	0.00	1.15	0.43	0.16	0.00	0.29
Change in work destinations day 1 to 3 Mean	0.00	1.43	0.60	0.18	0.57	0.35
Change in school destinations day 1 to 2 Mean	0.00	0.04	0.06	1.52	0.14	0.12
Change in school destinations day 2 to 3 Mean	0.00	0.05	0.07	1.43	0.00	0.10
Change in school destinations day 1 to 3 Mean	0.00	0.04	0.07	1.68	0.14	0.12
Change in other residential destinations day 1 to 2 Mean	0.85	0.75	1.83	1.11	1.10	4.38
Change in other residential destinations day 2 to 3 Mean	0.90	0.78	1.94	1.12	0.00	4.42
Change in other residential destinations day 1 to 3 Mean	0.92	0.75	2.00	1.11	1.10	5.21
Change in other destinations day 1 to 2 Mean	1.69	1.50	4.78	1.87	2.70	0.61
Change in other destinations day 2 to 3 Mean	1.80	1.55	5.45	1.95	0.00	0.60
Change in other destinations day 1 to 3 Mean	1.68	1.48	5.35	2.03	2.70	0.61
COLOR SCALE	low					high

Analysis



- What can we tell about people in these clusters?

Covariates	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
Day one had no travel	0.40	0.09	0.14	-0.60	0.05	-0.08
Day three had no travel	-1.02	-1.02	-1.02	-0.86	4.86	-0.92
Gender is female	0.00	-0.04	-0.04	0.18	0.01	-0.12
Age 51 to 64	0.19	0.08	0.00	-0.32	-0.03	0.08
Age is 65 or older	0.06	-0.08	-0.20	-0.41	0.51	0.13
Employed full time	-0.14	0.64	0.22	0.37	-1.29	0.19
Student status	0.20	0.17	0.00	0.76	-1.39	0.27
Survey day one was a workday	-0.36	0.36	-0.07	-0.31	0.40	-0.02
Survey day two was a work day	0.10	0.15	-0.12	-0.09	0.19	-0.22
Survey day three was a workday	0.17	-0.08	-0.28	-0.01	0.28	-0.07
Income higher than $100,000 /year	-0.05	0.06	-0.14	0.15	0.08	-0.10
Household size	-0.14	-0.19	-0.13	0.51	-0.03	-0.02
Number of employees in the household	0.02	0.17	0.21	-0.30	0.00	-0.09

Discussion

- Development of clusters reveals different groups of individuals with different variation types
  - Some individuals have small variation in day to day variation, some large
  - Geographically, four clusters specifically highlight the variation in local travel, one with mid range long distance (cluster 4), and one with long range long distance trips (cluster 6)
- Latent cluster membership is correlated to socio-demographic attributes

Conclusions

- The creation of clustering allows us to recognize and statistically demonstrate the importance in considering the variation within a persons own behavior rather than only among persons.
- Although this was an important first step, time use was not investigated, but is another large aspect of variation in daily patterns

Conclusions

- Operationalizing this knowledge:
  - Data collection methods- we might be able to know, but we also need to know why…
  - Modeling methods to include intra-person and inter-person variation

The Future

- With limits on resources, it is our ongoing job to determine the best tradeoff between respondent burden and richness of data
- Activity purpose from GPS devices is still a thorn in our side, but some aspects may improve with smartphone based data collection
- Using a three-day survey period revealed differences among individuals, however a five or seven day survey is likely to reveal even more richness in the data

Thank you

Kate@dpccal.com

Full text: FHWA Report: Multiday GPS Travel Behavior Data for Travel Analysis

http://www.fhwa.dot.gov/planning/tmip/publications/other_reports/multiday_gps/chapter00.cfm