A Latent Class Model of Daily Activity Patterns and Joint Activity Participation

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presented by
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Background

Daily activity pattern (DAP)

- Broad generalization of an individual’s activity participation level over a day

- Trinary characterization
  - Mandatory activities (work or school)
  - Nonmandatory activities only (no work or school)
  - Stay home (no out-of-home activities)

Joint activity participation (across household members)

- Scheduling constraints, less adaptable
- Activity and travel attributes differ from individual activities
**Motivation/Objective**

- Intra-household relationships
  - Choices of individual not made in isolation
  - Individual activity participation affects activity levels of others in household
  - Individual activity participation affects joint activity participation and vice versa

- Develop model capable of accommodating inter-relationships
  - Latent-class model
Modeling Context

Long-Term Choice Models

Daily Activity Pattern
- Mandatory Tours
  - Tour Location
  - Tour Scheduling
- Joint Tours
  - Tour Location
  - Tour Scheduling
- Other Tour and Trip-level Models

Joint Travel

Individual Nonmandatory Travel
- Individual Nonmandatory Tours
  - Tour Location
  - Tour Scheduling
Modeling Framework

Daily Activity Pattern (DAP) Model

- Person-level model
- 8 person types
- Multinomial Logit (MNL)
  - 3 choice alternatives
    - Mandatory activities (e.g., work, school)
    - Nonmandatory activities only
    - Stay home
Joint Travel Generation

- Household-level model
- Multinomial Logit
  - 3 choice alternatives
  - 0, 1, or 2 joint tours generated by household

- Fully conditional on generation and scheduling of mandatory tours of all individuals in household
Latent Class Component

Class is a discrete attribute (household level)

- Unobserved
- Number of classes is unknown

Two key components

- Class membership model – modeled using MNL
- Class-specific model – DAP & joint travel model
  - Separate models for each class

Class-specific component limited to model constants only

- Intra-household DAP relationships (across person type)
- DAP – Joint Travel relationships
Data

- Houston-Galveston Region
  - 2009 household survey
  - 18K persons, 6K households

DAP

- Mandatory
- Nonmandatory
- Stay Home

Joint Travel

- 0 Tours
- 1 Tour
- 2 Tours
DAP Class-Generic Variables

- Older children more likely to have mandatory pattern
- Female adults prefer nonmandatory patterns (relative to males)
- Younger adults favor mandatory and stay-home patterns
- Workplace existence and location have strong positive correlation with choice of mandatory pattern
Joint Class_Generic Variables

- Attributes that have positive correlation with making joint tours
  - Number of household members with nonmandatory DAP
  - Presence of two or more household members, both with nonmandatory DAP
  - Amount of free time overlap between household members
Household Segments

- Monte Carlo simulation
  - Examine household segment attributes and behavior

- Segment 1
  - 39 percent of households
  - Attributes
    - High workers
    - Few children
    - Low income
Household Segment 1

Frequency

Person Type

- Child 0-4 yrs
- Child 5-15 yrs
- Child 16-18 yrs
- College Student
- Full-Time Work
- Part-Time Work
- Non-Worker
- Senior

Frequency

Class 1
Class Membership

0.12 Joint tours per household
Household Segment 2

- 45 percent of households
- Average number of joint tours (0.27 per household)

Household Attributes
- More children and full-time workers
- High income
- High mobility levels

Frequency

<table>
<thead>
<tr>
<th>Person Type</th>
<th>MND Pattern</th>
<th>NM Pattern</th>
<th>SAH Pattern</th>
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<td>0-4 yrs</td>
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<td>16+ yrs</td>
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<td>Senior</td>
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</table>
Household Segment 3

- 9 percent of households
- Largest number of joint tours (0.52 per household)

Household Attributes
- More nonworkers and children (especially 0 to 4 years of age)
- Fewer workers
Household Segment 4

- 7 percent of households
- Some joint tours (0.30 per household)

Household Attributes
- Fewest people, especially children
- Few vehicles
- Lower mobility levels

**Person Type**
- Frequency

**Household Attributes**
- Fewest people, especially children
- Few vehicles
- Lower mobility levels
Conclusions

- Latent class approach to link two model components that we know are related

- Latent classes defined at household level
  - Accommodate complex intra-household interactions in DAP and joint activity choice
  - Retains sequencing of DAP and joint activity

- Behavioral perspective
  - Interdependencies result from household dynamics (rather than explicit coordination)