Outline

- Update on Long-term Choice and Mobility Models
- Framework of Activity Generation Module
- Mandatory Activity Generation
Background

- The activity-based approach views travel as a derived demand to pursue activities.
- Simulates the entire weekday travel pattern of each person in the SCAG region (18+ million):
  - derives travel from activity participation decisions
  - explicitly accounts for within household interactions
  - incorporates spatial and temporal constraints and influences when predicting activity participation and travel
  - operates on a detailed representation of the region’s population, land use and transportation networks
Inputs & Output

**INPUTS**
- Population
- Employment
- SCAG survey
- School drop-out rate
- Education attainment status
- Zone attributes
- LOS
- Geographic correspondence files
- Road Network
- Transit Network
- Policies

**Models**
- Long term
- Mobility choice
- Activity generation
- Joint activity scheduling
- Tour Scheduling

**OUTPUTS**
- Household table
- Person table
- Activities
- Tours
- Stops
- Trip table
## Market segmentation

<table>
<thead>
<tr>
<th>Person type</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Worker</td>
</tr>
<tr>
<td>2</td>
<td>Working college student</td>
</tr>
<tr>
<td>3</td>
<td>Non-working college student</td>
</tr>
<tr>
<td>4</td>
<td>Working HS student</td>
</tr>
<tr>
<td>5</td>
<td>Non-working high school student</td>
</tr>
<tr>
<td>6</td>
<td>Adult non-worker</td>
</tr>
<tr>
<td>7</td>
<td>Children 6-15 years old</td>
</tr>
<tr>
<td>8</td>
<td>Children 0-5</td>
</tr>
<tr>
<td>9</td>
<td>Non-school kids 6-15</td>
</tr>
</tbody>
</table>
Segmentation

- Activity types:
  - Work
  - School/College
  - Escort
  - Shopping
  - Maintenance
  - Social
  - Entertainment
  - Visiting family and friend
  - Active recreation
  - Eating out
  - Work related
  - Other
Temporal resolution

- Five time periods used for skimming and assignment
  - AM Peak (6:00 AM to 9:00 AM)
  - Midday (9:00 AM to 3:00 PM)
  - PM Peak (3:00 PM to 7:00 PM)
  - Evening (7:00 PM to 10:00 PM)
  - Night (10:00 PM to 6:00 AM)

- 15-minute and 30-minute resolution for scheduling primary activity of a tour, extended to continuous

- Continuous for scheduling all other activities
SCAG - ABM User Interface

- Built in new TransCAD 7.0
Long Term Choice Models
**Workers**
- 16 years old or older.
- SCAG region has about 7 million workers in 2012; 39% of total population of SCAG region.

**Students**
- About 5 million, 28% of total population
- Are categorized by 1) Preschool, 2) Grade K-8, 3) Grade 9-12, and 4) College/University
M2.0 Preschool arrangement

For age $\leq 2$, assumed not go to school

Model specification UI

<table>
<thead>
<tr>
<th>Source</th>
<th>Variable</th>
<th>Beta</th>
<th>Market Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression</td>
<td>Person+HH, Age = 4</td>
<td>1.006</td>
<td></td>
</tr>
<tr>
<td>Expression</td>
<td>Person+HH, Age = 5</td>
<td>2.398</td>
<td></td>
</tr>
<tr>
<td>PersonHH</td>
<td>Hiwork</td>
<td>-0.302</td>
<td></td>
</tr>
<tr>
<td>Expression</td>
<td>Person+HH, HHINC between</td>
<td>0.335</td>
<td></td>
</tr>
<tr>
<td>Expression</td>
<td>Person+HH, HHINC between</td>
<td>0.960</td>
<td></td>
</tr>
<tr>
<td>Expression</td>
<td>Person+HH, HHINC $\geq 1500$</td>
<td>1.282</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>-0.426</td>
<td></td>
</tr>
</tbody>
</table>
M 2.0 Preschool arrangement

% of children

<table>
<thead>
<tr>
<th>Age</th>
<th>Target</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
M2.1 Usual School Location

- 2.1a Preschool Location Model – MNL
- 2.1b Usual School Location k-8  Rule based
- 2.1c Usual School Location 9-12  Rule based
- 2.1d University Location- MNL
M2.1 Usual School Location: K-12

**K to 8 School Location**
- Model Type: Nearest TAZ
- Decision Variable: STier2TAZID
- Segment: PersonType = 7
- Kto8 School SED Set: KTO8 > 0

**High School Location**
- Model Type: Nearest TAZ
- Decision Variable: STier2TAZID
- Segment: PersonType = 4 or PersonType = 5
- High School SED Set: (BT012) > 0
M2.2 Work Arrangement

workplace type
1- Work at home?
2- OH

weekly work hours
1- \( \leq 20 \)
2- 21 - 34
3- \( \geq 35 \)

number of days
3 market
FTW - 4,5 days
PTW1 -1,2,3,4,5
PTW2 -3,4,5
## M2.2.1 Work @ Home

<table>
<thead>
<tr>
<th>Age</th>
<th>ACS 2011</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-24</td>
<td>1.86%</td>
<td>3.67%</td>
</tr>
<tr>
<td>25-44</td>
<td>4.03%</td>
<td>4.07%</td>
</tr>
<tr>
<td>45-60</td>
<td>5.97%</td>
<td>5.87%</td>
</tr>
<tr>
<td>60+</td>
<td>9.39%</td>
<td>8.18%</td>
</tr>
<tr>
<td>Total</td>
<td>4.76%</td>
<td>4.97%</td>
</tr>
</tbody>
</table>
M2.2.1 Work @ Home

![Bar chart showing the percentage of workers working at home by industry. The chart compares ACS 2011 data with a model. Industries include Agriculture/Mining, Manufacturing/Wholesale, Retail/Other services, Information Services/Business Services, Education and Health Services, Financial Real Estate, Arts/Entertainment and Hospitality/Food Service, Public Administration. The percentage of workers working at home varies across industries, with some showing a higher percentage in ACS 2011 data compared to the model.]
### M2.2.2.1 Work Duration

<table>
<thead>
<tr>
<th>Duration</th>
<th>Survey Freq</th>
<th>Survey Share</th>
<th>Initial ASC</th>
<th>Initial Share</th>
<th>Final ASC</th>
<th>Final Share</th>
<th>Final Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-20 hrs</td>
<td>658,413</td>
<td>10.14%</td>
<td>-1.920</td>
<td>13.26%</td>
<td>-2.274</td>
<td>10.36%</td>
<td>667,106</td>
</tr>
<tr>
<td>21-34 hrs</td>
<td>449,275</td>
<td>6.92%</td>
<td>-2.391</td>
<td>9.86%</td>
<td>-2.829</td>
<td>7.07%</td>
<td>454,806</td>
</tr>
<tr>
<td>35+ hrs</td>
<td>5,383,803</td>
<td>82.94%</td>
<td></td>
<td>76.88%</td>
<td></td>
<td>82.57%</td>
<td>5,315,259</td>
</tr>
<tr>
<td></td>
<td>6,491,491</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6,437,171</td>
</tr>
</tbody>
</table>

- MNL with 3 alternatives: 0-20hrs, 21-34hrs, 35+ hrs
## M2.2.2.2 Work Days

<table>
<thead>
<tr>
<th>Wdays</th>
<th>HTS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6.64</td>
<td>6.6</td>
</tr>
<tr>
<td>5</td>
<td>93.36</td>
<td>93.4</td>
</tr>
</tbody>
</table>

**Segment 1:**  
Full time workers (35 hrs/wk and more)

<table>
<thead>
<tr>
<th>Wdays</th>
<th>HTS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.98</td>
<td>9.7</td>
</tr>
<tr>
<td>2</td>
<td>17.28</td>
<td>16.8</td>
</tr>
<tr>
<td>3</td>
<td>24.19</td>
<td>23.6</td>
</tr>
<tr>
<td>4</td>
<td>14.37</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>34.18</td>
<td>36</td>
</tr>
</tbody>
</table>

**Segment 2:**  
Part time workers (1-20 hrs/wk)

<table>
<thead>
<tr>
<th>Wdays</th>
<th>HTS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>18.01</td>
<td>17.8</td>
</tr>
<tr>
<td>4</td>
<td>34.05</td>
<td>33.5</td>
</tr>
<tr>
<td>5</td>
<td>47.94</td>
<td>48.7</td>
</tr>
</tbody>
</table>

**Segment 3:**  
Part time workers (21-34 hrs/wk)

MNL on 3 Market Segments based on Work Duration
M.2.3 Work location

- Updating input files (skim and attraction rate)
- Re-estimate work location
### M.2.4 Work Schedule Flexibility

<table>
<thead>
<tr>
<th>WSCHED</th>
<th>HTS</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.69</td>
<td>41.8</td>
</tr>
<tr>
<td>2</td>
<td>44.57</td>
<td>46</td>
</tr>
<tr>
<td>3</td>
<td>11.75</td>
<td>12.1</td>
</tr>
</tbody>
</table>

MNL with 3 alternatives: None, Moderate and High
Mobility Choice Models
## M.3.1 Drive License

- **Driver License**
  - For Age $\geq 16$,
  - Survey Share was 83.46%
  - Model Share was 81.0%

<table>
<thead>
<tr>
<th>Age</th>
<th>Yes</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-18</td>
<td>708,401</td>
<td>170,602</td>
<td>80.6%</td>
</tr>
<tr>
<td>19-24</td>
<td>1,347,450</td>
<td>211,434</td>
<td>86.4%</td>
</tr>
<tr>
<td>25-29</td>
<td>1,116,940</td>
<td>159,182</td>
<td>87.5%</td>
</tr>
<tr>
<td>30-44</td>
<td>3,282,869</td>
<td>456,032</td>
<td>87.8%</td>
</tr>
<tr>
<td>45-60</td>
<td>3,371,269</td>
<td>438,643</td>
<td>88.5%</td>
</tr>
<tr>
<td>60-70</td>
<td>963,316</td>
<td>424,706</td>
<td>69.4%</td>
</tr>
<tr>
<td>70-80</td>
<td>355,602</td>
<td>452,071</td>
<td>44.0%</td>
</tr>
<tr>
<td>80+</td>
<td>192,438</td>
<td>289,123</td>
<td>40.0%</td>
</tr>
<tr>
<td></td>
<td>11,338,285</td>
<td>2,601,793</td>
<td>81.3%</td>
</tr>
</tbody>
</table>
M.3.2 Auto Ownership

- Predicts number of household vehicles
- Nested Logit
- Households (HHs) with no licensed drivers should automatically be assigned 0 cars.
# M.3.2 Auto Ownership

<table>
<thead>
<tr>
<th></th>
<th>0Cars</th>
<th>1Car</th>
<th>2Cars</th>
<th>3Cars</th>
<th>4+Cars</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS</td>
<td>7.65%</td>
<td>32.28%</td>
<td>37.22%</td>
<td>15.03%</td>
<td>7.81%</td>
<td>100.00%</td>
</tr>
<tr>
<td>HTS</td>
<td>7.56%</td>
<td>31.86%</td>
<td>38.88%</td>
<td>14.81%</td>
<td>6.89%</td>
<td>100.00%</td>
</tr>
<tr>
<td>(HTS) - Households have at least 1 license driver</td>
<td>3.53%</td>
<td>32.90%</td>
<td>40.79%</td>
<td>15.55%</td>
<td>7.23%</td>
<td>100.00%</td>
</tr>
<tr>
<td>Model*</td>
<td>11.8</td>
<td>30.8</td>
<td>33.2</td>
<td>14.9</td>
<td>9.2</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
Activity Generation Module

1. Population Synthesis
   - 2.0 Preschool Arrangement
   - 2.1 Usual School Location
   - 2.2 Work Arrangement
   - 2.3 Usual Work Location
   - 2.4 Work Scheduling Flexibility

3. Mobility Choices
   - 3.1 Driver License
   - 3.2 Auto Availability

4. Activity Generation-Allocation
   - Mandatory Activity Generation
     - Child Mandatory Activities
       - 4.1.1 Frequency
         - 4.1.2 Start/End Time
         - 4.1.3 Trip Mode
     - Adult Mandatory Activities
       - 4.2.1 Frequency
         - 4.2.2 Start/End Time
         - 4.2.3 Allocation of Dropoff/Pickup
   - Non-Mandatory Household Activity Generation
     - 4.3.1 Out-of-Home Activity
     - 4.3.2 Activity Duration
     - 4.3.3 Out-of-home activity generation
     - 4.3.4 Serve Passenger Activity Generation

5. Joint Activity Scheduling
   - 5.1 Primary Purpose
   - 5.2 Location
   - 5.3 Tour mode
   - 5.4 Start time
   - 5.5 Duration of intermediate stop

6. Tour and Trip Scheduling
   - Adult Mandatory Tour
     - 6.1.1 Tour Mode
     - 6.1.2 Intermediate stop
     - 6.1.3 Distance to stop
     - 6.1.4 Stop Location
     - 6.1.5 Stop Duration
     - 6.1.6 Departure Return timeperiod
   - Non-Mandatory Tour
     - 6.2.1 Tour Frequency
     - 6.2.2 Primary Purpose
     - 6.2.3 Primary destination
     - 6.2.4 Tour time window
     - 6.2.5 Tour mode
     - 6.2.6 Stop frequency
     - 6.2.7 Distance to stop
     - 6.2.8 Stop location
     - 6.2.9 Stop duration
First step in the prediction of daily activity and travel
Travel being viewed as a derivative of out-of-home activity participation and scheduling decisions
Mandatory and non-mandatory activities
The predictions from these models are used later in the model chain to form mandatory and non-mandatory tours, as well as to predict the frequency and purpose of intermediate travel stops on tours
<table>
<thead>
<tr>
<th>Model Number</th>
<th>Model Component</th>
<th>Model Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.1</td>
<td>Child Mandatory Activity Frequency</td>
<td>Monte Carlo</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Child Mandatory Activity Start/End Time</td>
<td></td>
</tr>
<tr>
<td>4.1.3</td>
<td>Child School Mode</td>
<td>HD</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Adult Mandatory Activity Frequency</td>
<td></td>
</tr>
<tr>
<td>4.2.2</td>
<td>Adult Mandatory Activity Start/End Time</td>
<td></td>
</tr>
<tr>
<td>4.2.3</td>
<td>Allocation of Escort Responsibilities</td>
<td>Rule based</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Out-of-Home Activity Participation</td>
<td>BL</td>
</tr>
<tr>
<td>4.3.2</td>
<td>NM activity time</td>
<td>Regression</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Out-of-Home Activity Generation</td>
<td></td>
</tr>
<tr>
<td>4.3.4</td>
<td>Serve Passenger Activity Generation</td>
<td>BL</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Tour formation</td>
<td></td>
</tr>
</tbody>
</table>

- **Market segmentation**
- **Model components**
- **Model Structure**
Mandatory Activities

Crucial in shaping overall daily activity-travel pattern

Serves a peg around other activities are scheduled

Key constrain on non-mandatory activity generation

Predicted before predicting non-mandatory activities
M4.1 Children Activities

- M4.1.1 Child Mandatory Activity Frequency
- M4.1.2 Child Mandatory Activity Start and End Time
- M4.1.3 School Mode
M4.1.1 Child Mandatory Activity Frequency

- Decision to attend school on a day
- Monte Carlo simulation based on attendance rate of 0.85
- All children 3 years and older
M4.1.2 School Start and End Time

- Predict children school start and end time
- Hazard Duration Models
  - Start time
  - End time
- Duration – calculated
- Choice alternative: Continues time
- Apply to: all children with non-zero activity frequency
- Age, grade level, household income and number of employed adults
M4.1.3 School Mode

Predict mode to/from school

MNL

Two sub-models
K-8
9-12
MNL with 4 alternatives

Step 1: Rule based “School Bus”
Step 2: MNL

MNL with 5 alternatives

SOV
Carpool
Transit
Walk
Bike
M4.2 Adult Mandatory Activity

A. Worker
- Go to work?
- work start/ end time?
- Escort responsibilities?

B. Student
- Go to school?
- school start/ end time?

Decision tree
M4.2.1a Go to work

- Monte Carlo based on days of work from M2.2 for each market segment
- **Apply to:** Person.Pertypenote=1 who work outside of home

M4.2.1a Go to school

- Monte Carlo based on initial attendance rate=0.7
- **Apply to:** Individuals with Person.Pertypenote==2 and 3
M4.2.2a Work Start and End time

- Predict activity start time and end time at primary work place
- For all workers in a household who go to work on the given day
- Model structure: MNL
- Choice Alternatives: 48 bin (start from 3.00 am )
- Apply to: (Person.Pertype==1) who work outside of home
- Estimation data: SCAG HTS 2012
M4.2.2b College start and end time

- **Model structure**: MNL
- **Choice Alternatives**: 7 alternatives:
  - before 7.30
  - 7.30-8.29
  - 8.30-9.29
  - 9.30-10.29
  - 10.30-11.29
  - 12.00-3.59pm
  - 4pm-
- **Apply to**: All university students (Person.Pertype==2 and 3) who go to school on the day
- **Reference time**: 7.30-8.29
M.4.2.3 Escort responsibility

- Allocates children drop-off and pick up episodes to parents
- Rule based allocation

**If child is Car pool passenger in M4.1.3?**

- **Yes**
  - Assign pick up/drop off responsibility

- **No**
  - Find working adult who has available time window based on M4.2.2 and M4.1.2

- Non-working adult with valid DL
Thank You

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aleksandr@scag.ca.gov