Tour-Based Model for Metrolina

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What is Simplified Tour Modelling?

- New way of modelling individual tours
- Better represents the way people travel
- Concepts are similar, math is different
- Avoids unnecessary complexity
- Relatively simple, quick to calibrate, runs fast
Improvement Over Four-Step

- RT tours are how people actually travel
- Stops are less important locations from O to D
- No Non-Home-Based garbage can
- More accurate trip table
- Avoids problems of tiny fractions of trips
  - Lost trips
  - Slow assignment
Differences from Activity-Based

- Less complex, less ambitious
- Omits some relationships, interactions
- HH level, not person level
- 75% of the benefit of ABM for 10% of development cost, run time
- More suitable for most cities
Experience

- New concept
- 2010: Brunswick, GA
- 2013-14: truck models in Atlanta and Birmingham
- 2014: Charlotte (Metrolina)
What Is a Tour?

Origin \(i\) \(\rightarrow\) Stop \(k\) \(\rightarrow\) Destination \(j\) (Half)-Tour

Trip
Round-Trip Tour

- Tours start at home or work
- End is an “anchor point”: work, school, location of max duration
- Helpful to focus on the tour O & D
- 40-45% of the number of trips
Intermediate Stops

- Stops on the way to tour destination or on the way back
- Secondary purposes
- Mostly shop and personal business
- Related to tour main purpose, O/D, mode, time period
Individual Choices

- No longer using aggregate statistics
- Treat every single tour separately
- Individual choice vs. aggregate totals
- Replace zone-zone totals with a list of tours
  - like a 100% household survey
Monte Carlo Simulation

- Determine a choice scenario
  - tour frequency: how many tours for each HH?
- Establish a set of options
  - 0, 1, 2, 3+ work RT tours per HH
- Compute probability of each choice
- Spin the wheel
Wheel of Fortune

Tour Frequency

- 0 tour: 30%
- 1 tour: 40%
- 2 tours: 10%
- 3+ tours: 20%
“Spin the Wheel”

- Sort probabilities by option
- Compute cumulative probability
- Generate random number
- Select one option
- Mathematically equivalent to spinning the wheel
Logit Model

- Well-suited for estimating probabilities of discrete options
- Many existing mode choice models use it
- Probabilities sum to 100%

\[ p_i = \frac{e^{U_i}}{\sum e^U} \]

- \( U = \) “utility” = linear function of attributes
Logit Curve

- Share
- Relative Utility
Trip Generation → Tour Frequency

- TG: how many trip ends per zone?
- TF: probability of HH making 0, 1, 2, ... tours
- Tours represent “productions”
- Output: list of individual tours made, by purpose and zone
- Record includes the HH attributes
Sequence of Purposes

- Establish a priority of trip purposes
- Trip purposes are interrelated in a HH
- More important purposes influence less important ones
- Typical priority: school, university, work, shop, other, at-work
HH Synthesis

- Similar to four-step process to split HHs by size and autos
- Use Census relationships
- ABM: synthesize HH and persons, STM: HHs
- Metrolina HH characteristics:
  - size (1, 2, 3, 4, 5+)
  - income (4 groups)
  - workers (0, 1, 2, 3+)
  - life cycle (retired, kids, neither)
Metrolina Tour Frequency Model

- Logit model based mainly on HH attributes
- Also uses zonal data: area type, density, accessibility
- Calibrated based on 2012-13 HH survey
  - 4,100 HHs, 12,800 tours
# HBO Tour Frequency

<table>
<thead>
<tr>
<th>Tours</th>
<th>Percent of HHs (Survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>36%</td>
</tr>
<tr>
<td>1</td>
<td>27%</td>
</tr>
<tr>
<td>2</td>
<td>19%</td>
</tr>
<tr>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>5</td>
<td>2%</td>
</tr>
<tr>
<td>6+</td>
<td>3%</td>
</tr>
</tbody>
</table>
HBO Tour Frequency Model

- Choice set: 0 / 1 / 2 / 3 / 4+ tours, so 5 utility equations
- Utilities are a linear function of key variables
  - number of people (+)
  - is HH high income? (+)
  - number of workers (-)
  - area type (-)
  - any retirees? (-)
  - zonal median income (+)
  - SCH, HBU, HBW, HBS tours (-)
Sample HBO Utility Equation

- $U(4+ \text{ tours}) = -4.6880 + 1.8320 \times \text{persons}$
- $+ 0.7275 \times \text{high income?}$
- $- 0.5030 \times \text{workers}$
- $- 0.1362 \times \text{areatype}$
- $- 0.1881 \times \text{LC 1? (retirees)}$
- $+ 0.000003348 \times \text{zonal median income}$
- $- 0.4558 \times (\text{SCH+HBU tours})$
- $- 0.8007 \times \text{HBW tours}$
- $- 0.5658 \times \text{HBS tours}$
Unimportant Things

- Software: method is software-independent
  - CDOT is writing code for TransCAD
  - previous applications in Cube Voyager
- Survey method: almost any kind of HH survey can be used
- Trip purposes: can use any purposes you like
Subsequent Model Steps

- Intermediate stops
- Stop location
- Mode choice
- Time of day
- Convert tours to trips
- Assignment
So What?

- Improved representation of travel
  - more accurate trip table
- Some evidence of improved assignment accuracy
- New capabilities
- Stepping stone to ABM
Questions?

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