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
- 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
  - Large trip tables

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Differences from Activity-Based

- Less ambitious, less complex, faster
- 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

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Round-Trip Tour

- Tours start at home or work
- End is an "anchor point": work, school, location of max duration
- "Leg 1" is first half of tour (home-nonhome), "Leg 2" is second half (nonhome-home)
- 40-45% of the number of trips

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Individual Choices

- No longer use aggregate statistics
- Treat every single tour separately
- Individual choice vs. aggregate totals
- Replace zone-zone tables with a list of tours
    - Like a 100% household survey

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Logit Function

- Well-suited for estimating probabilities of discrete options
- Many existing mode choice models use it
- Probabilities sum to 100%
- $p_i = \dfrac{e^{U_i}}{\sum e^U}$
- U = "utility" = linear function of attributes
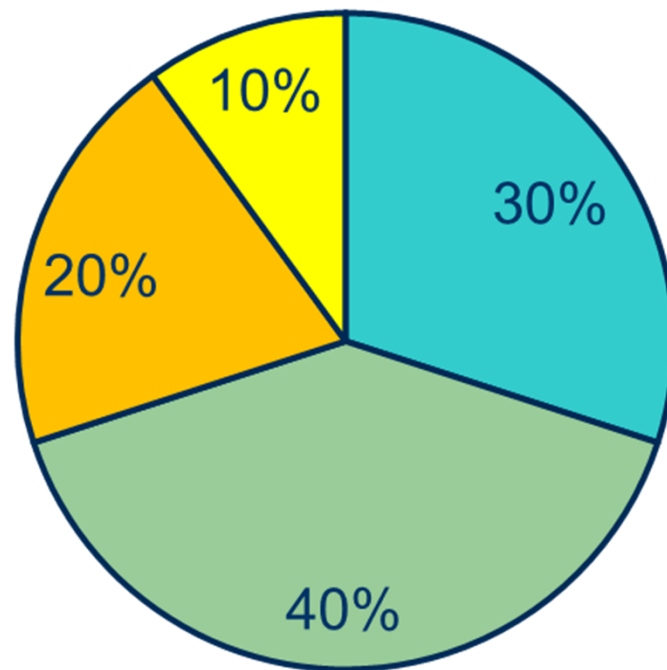
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Logit Curve
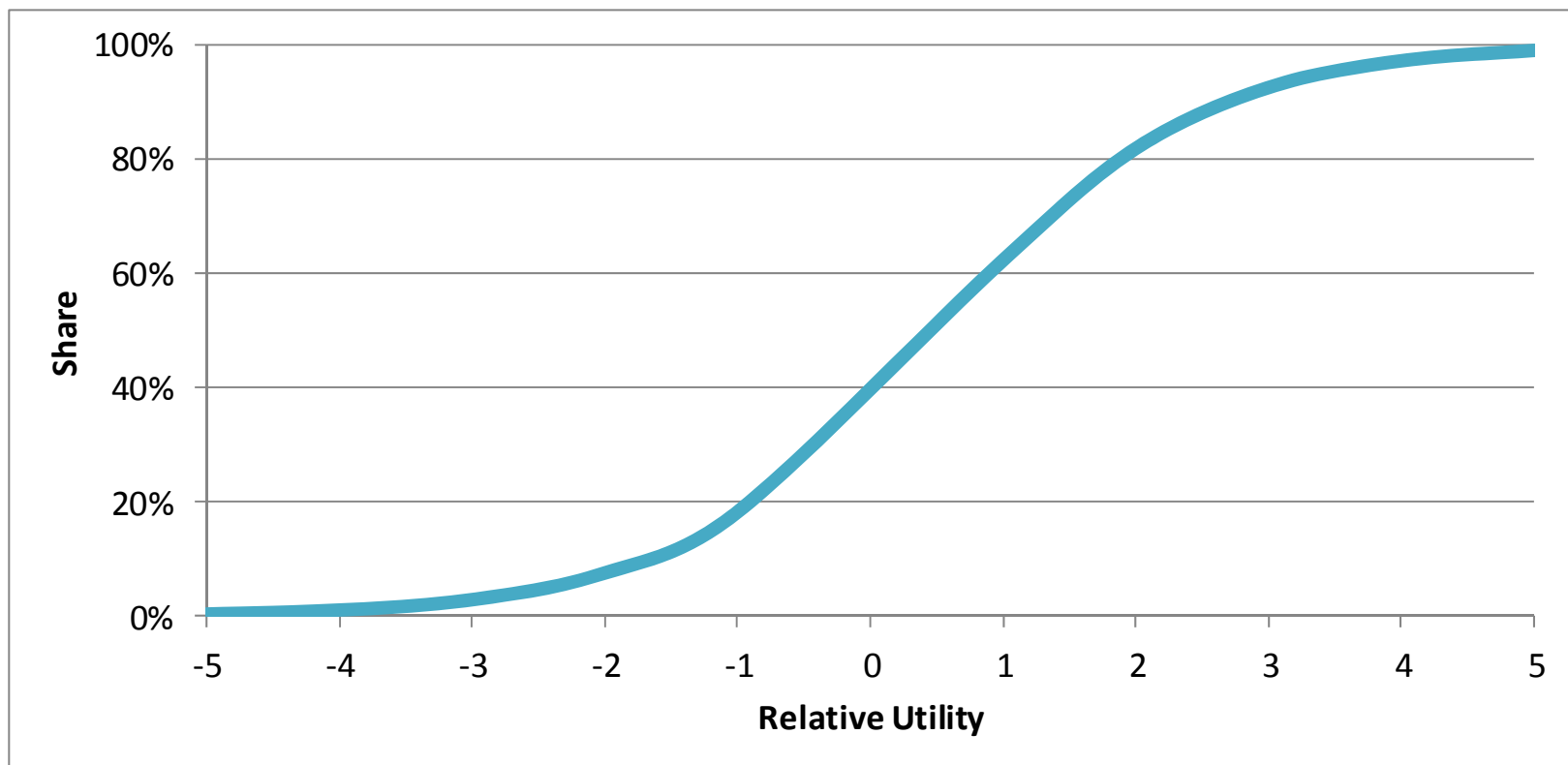
Monte Carlo Simulation

- Determine a choice scenario
  - Tour frequency: how many tours by purpose?
  - Intermediate stop: how many stops?
  - Stop location: which zones?
  - Time of day: what time period?
- Establish a set of options
  - 0, 1, 2, 3+ work RT tours per HH
- Compute probability of each choice
- Spin the wheel

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"Wheel of Fortune"

Tour Frequency

Pie chart legend:
- 0 tour
- 1 tour
- 2 tours
- 3+ tours

30% — 0 tour
40% — 1 tour
20% — 2 tours
10% — 3+ tours

Spin the Wheel

- Sort probabilities by option
  - Larger probability = bigger wedge
- Compute cumulative probability
- Select first option whose cumulative probability exceeds a random number
- Mathematically equivalent to spinning the wheel
- Do this for each tour, for each choice

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That Was Part 1, This is Part 2

- Part 1 was presented in May
- Covered household synthesis, tour frequency
- Model calibration is now complete
- Next modules:
  - Tour destination choice
  - Intermediate stop frequency, location
  - Truck, External models
  - Time of Day, part 1

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Recap of Part 1

- HH synthesis: create a list of every HH with TAZ, size, income, workers, and life cycle
  - Similar to 4-step HH stratification submodel
- Tour Frequency: for each HH, estimate number of RT tours by purpose
 - Similar to 4-step trip generation

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Tour Destination Choice

- "Main" destination zone of the tour
- School, university, or work
  - Otherwise, place of longest stay
- Logit model
- Key variables: travel time, area type, same AT dummy, CBD dummy, intra-county dummy, accessibility
- Size variables: jobs, pop, enrollment

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Destination Choice Features

- Most tours start/end at home
  - ATW start/end at work
- Majority of tours are "simple"
- HBW, HBS, HBO split by income (high / low)
  - Higher income = longer HBW, HBS tours
- Double-constrained model
- Includes submodel to split I/I vs. I/X

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HBO TLFD
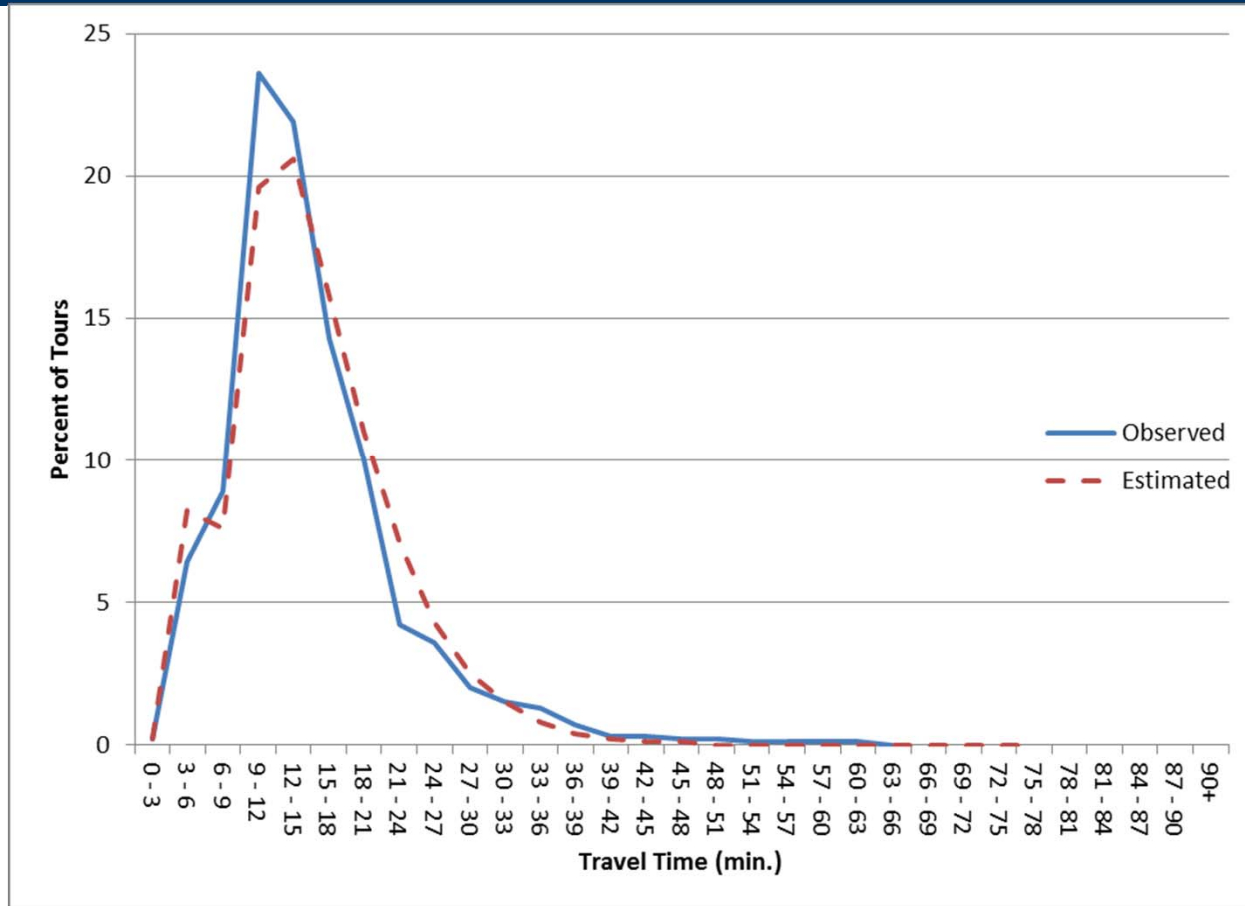
Intermediate Stops

- Stops along the tour
  - Do separately for leg 1 vs. leg 2
  - More stops on leg 2
- Secondary purposes, mostly shop and personal business
- 10 - 30% of tours make stops
- Max of 7 stops in each direction

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More Likely to Make Stops If...

- Higher HH income
- Have kids
- High retail employment near tour O or D
- Home zone densely developed
- Rural destination
- Longer tour time
- More likely to stop on leg 2 if stopped on leg 1

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Less Likely to Make Stops If...

- Fewer people in HH
- Lowest HH income
- Tour O and D in same zone
- CBD destination
- Rural origin
- If HH made more tours (some purposes)

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IS Validation: HBW

Stops	Leg 1 Obs	Leg 1 Est	Leg 2 Obs	Leg 2 Est
0	85.6%	85.3%	74.4%	73.6%
1	11.2	11.9	17.6	18.2
2	2.2	2.0	5.6	5.7
3	0.6	0.5	1.5	1.6
4	0.3	0.3	0.4	0.4
5	0.1	0.1	0.3	0.3
6			0.1	0.1
7			0.1	0.1

Stop Locations

- Different models by work/non-work, by stop number, by direction
- Don't consider all 3,000+ zones for each tour
  - Max search radius: twice the tour O-D distance
  - Max detour time: 30-90 min (by purpose)
  - Avoid looking at zones that aren't viable choices
- Still consider a few hundred zones for each tour

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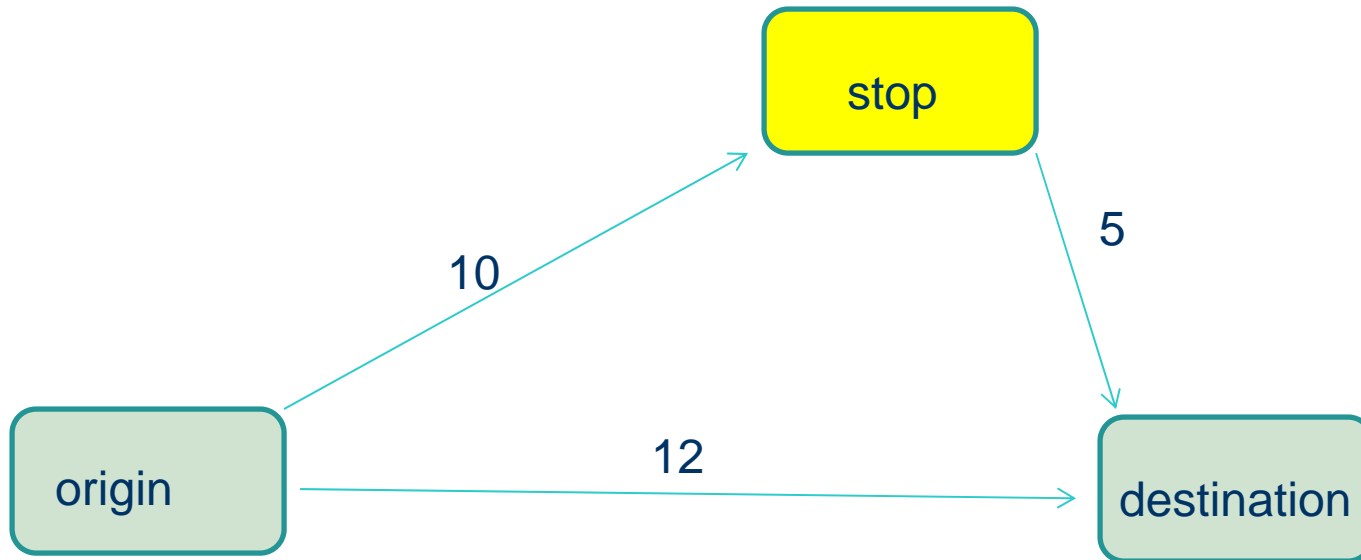
Detour Time

detour time = 10 + 5 − 12 = 3

Zone More Likely to Be a Stop If...

- Lower detour time (esp. < 10 min.)
- More development (esp. retail emp.)
- Urban area type
- Closer to CBD
- Lower time from last stop
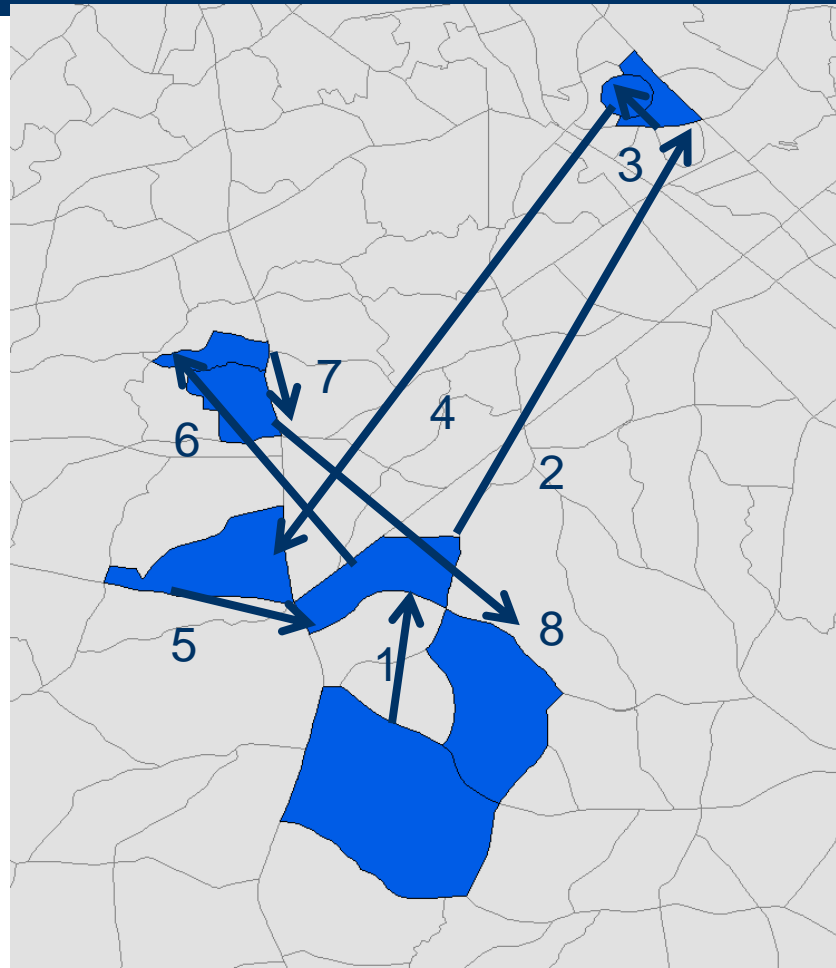- Closer to tour destination

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Sequence of Stop Locations

- O & D locations influence stop 1 location
- For stops 2, 3, ... location of previous stop is important
  - Time to the tour destination also important
- Surveyed stop locations mostly look random

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Actual Non-Work Tour
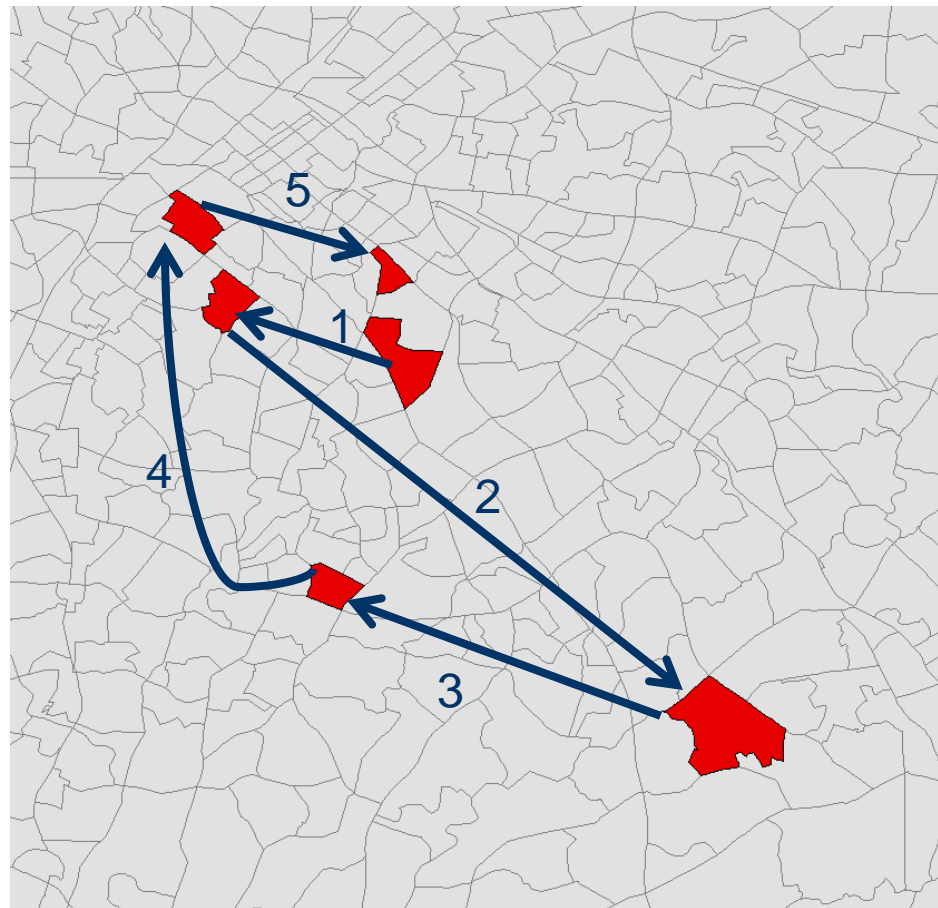
Actual Work Tour

Time of Day

- Metrolina uses two ToD models
  1) Pre-mode choice: peak vs. off-peak
  2) Post-mode choice: AM, MD, PM, NT
- Logit model by tour direction, purpose
- Tour model includes ToD 1 now
- Mode Choice and ToD 2 to be included later

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More Likely to Be Peak If...

- Higher HH income
- Fewer people in HH
- HH has kids
- Suburban home zone
- Tour destination has high job density
- Tour destination does not have much retail
- Leg 2 more likely to be peak if leg 1 is peak

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ToD Validation: HBS

	Leg 2 peak	Leg 2 off-pk
Observed		
Leg 1 peak	17.9%	15.3%
Leg 1 off-peak	9.4	57.4
Estimated		
Leg 1 peak	18.1%	15.1%
Leg 1 off-peak	9.3	57.5

Other Components

- Tour-based truck model transferred from Atlanta
  - (Light) Commercial, Medium Truck, Heavy Truck
  - Developed from GPS data
  - Tour structure more important for trucks
- I/X (resident) and X/I (non-resident) tour models included
- X/X is the only non-tour travel component

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Trip Accumulator

- Use tour records to build trip tables
- Person trips by HBW, HBU, HBO, NHB
  - By income
  - By peak vs. off-peak
  - Input to existing mode choice model
- Build external & truck trip tables for assignment

Model Application

- Model applied in TransCAD
  - GISDK code, written by CDOT
- Greater understanding of the model
- Application code in progress
- Expected to run overnight
  - Including skims and MC

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Next Steps

- This winter
  - Documentation
  - Finish application code
  - Connect to trip-based mode choice
  - Traffic assignment & validation
- 2015
  - Sensitivity analysis, testing
- Future: incorporate mode choice, ToD 2

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So What?

- Improved representation of travel
  - More accurate trip table
- Some evidence of improved assignment accuracy
- New capabilities for summarizing impacts
- Staff understands the new model
- Stepping stone to possible future ABM

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Questions?

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