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Think Forward

Intro to Modeling

presented to

Caltrans District 3

presented by

Cambridge Systematics, Inc.

Ron West, Mary Martchouk, Xuan Liu

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Agenda

- Day 1
  - Census and model geography
  - Land use categories
  - Trip-based models
    - Trip generation
    - Trip distribution
    - Mode choice
    - Time of day and traffic assignment
  - Model Calibration
- Day 2
  - Model validation
  - Activity-based models
  - Working with matrices
    - Matrix indexing and filling
    - Select link analysis
    - PA to OD conversion

Census and Model Geography

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Census Blocks and Tracts

- Census blocks (light green) make up census tracts (dark green)

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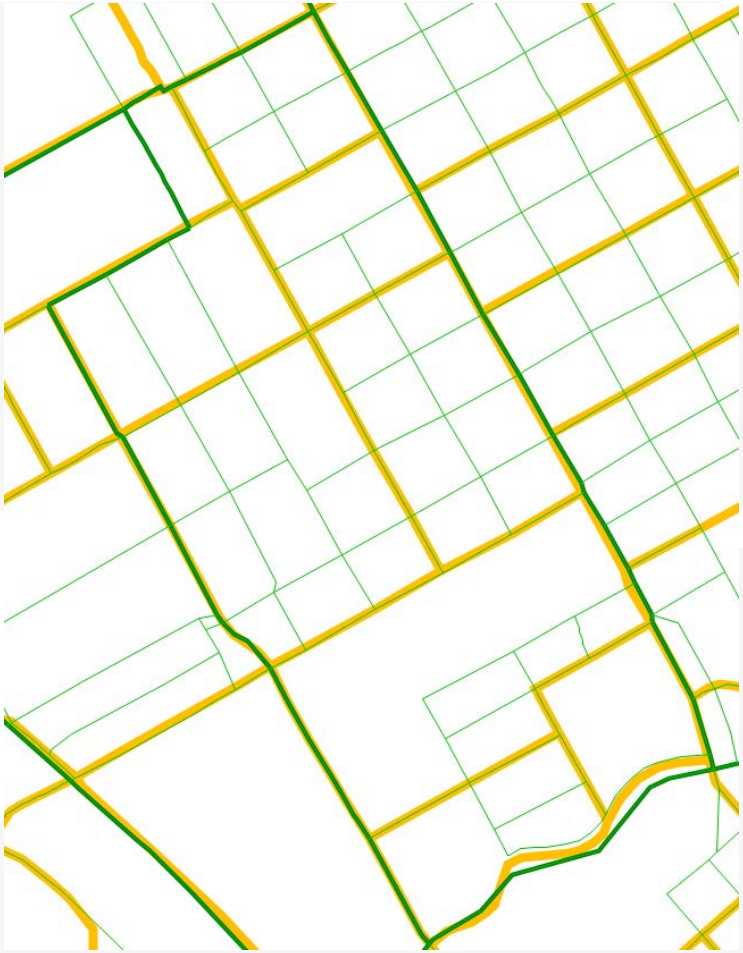
Model vs Census Geography

- Model TAZs (orange) are larger than blocks but usually smaller than tracts
- Model TAZs usually align with census block boundaries (and sometimes with census tract boundaries)
- TAZ – Traffic Analysis Zone



TAZs and Centroids

- Centroids are points in the network where trips start and end
- One centroid in each zone
- Centroids are connected to the highway network through centroid connector links

Land Use Categories

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Residential Land Use

- Residential land use refers to housing units
  - Land use file units - Typically subdivided into single-family, multi-family, and group quarters (university, senior housing etc.) but can also include mobile homes
- Households or housing units produce home-based trips and some of the non-home based trips in the model
- Residential land use is typically obtained from the American Community Survey (ACS) or local parcel database

Non-Residential Land Use

- Non-residential land uses include commercial, industrial, office, service, agricultural, etc.
- Land use units - 1,000 square feet (KSF) or number of employees
- Non-residential land uses attract trips
- Non-residential land uses are usually obtained from the MPO or City land use projections or parcel databases

BCAG Land Use File

Dataview1 - Landuse_Input

TAZ	ATYPE	ATYPE_STR	SF_DU	MF_DU	MH_DU	RET_KSF	RRET_KSF	IND_KSF	OFF_KSF	MED_KSF	HOSP_KSF	PQP_KSF
102	1	Butte	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
103	1	Butte	183.00	0.00	76.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
104	1	Butte	645.00	0.00	316.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00
106	1	Butte	11.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00
107	1	Butte	12.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
108	1	Butte	204.00	9.00	47.00	16.00	0.00	1.00	0.00	0.00	0.00	4.00
109	1	Oroville	233.00	65.00	36.00	3.00	0.00	0.00	4.00	0.00	0.00	0.00
110	1	Oroville	122.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
111	1	Oroville	39.00	2.00	1.00	6.00	0.00	3.00	2.00	0.00	0.00	4.00
112	1	Oroville	13.00	0.00	11.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
113	1	Oroville	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	1	Oroville	63.00	0.00	17.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	1	Oroville	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
116	1	Oroville	41.00	3.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
117	1	Oroville	56.00	10.00	120.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118	1	Oroville	231.00	76.00	34.00	56.00	0.00	0.00	8.00	0.00	0.00	16.00
119	1	Oroville	0.00	0.00	0.00	0.00	0.00	287.00	0.00	0.00	0.00	0.00
120	1	Oroville	2.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	4.00
121	1	Oroville	114.00	30.00	21.00	4.00	0.00	0.00	9.00	0.00	0.00	0.00
122	1	Oroville	3.00	0.00	0.00	3.00	0.00	7.00	0.00	0.00	0.00	0.00
123	1	Oroville	90.00	18.00	13.00	0.00	0.00	0.00	4.00	0.00	0.00	3.00
124	1	Oroville	56.00	0.00	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	1	Oroville	143.00	0.00	322.00	0.00	0.00	0.00	4.00	0.00	0.00	2.00
126	1	Oroville	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
127	1	Oroville	110.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Trip-Based Models

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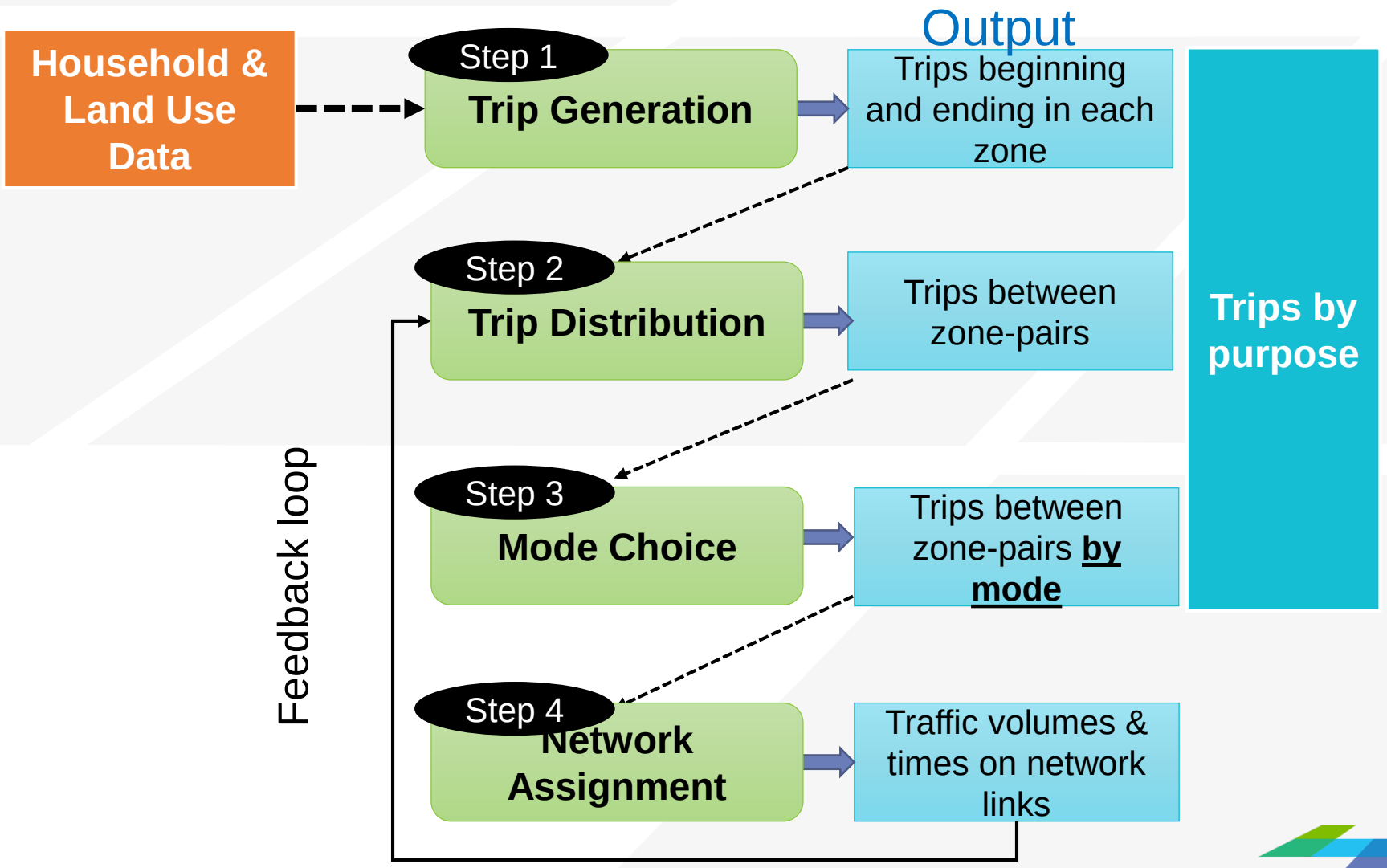
Trip- Based Models



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Trip-Based Models

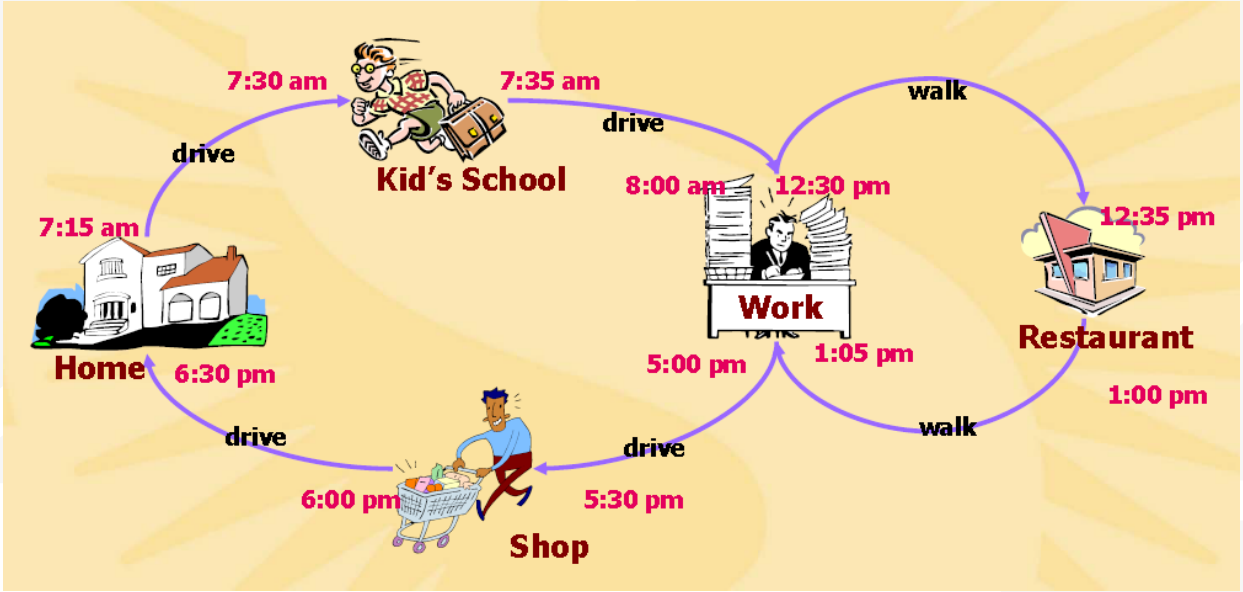
- Simplified trip-making decisions with no connections between trips or people making them
- Modeled at an aggregate zonal average level
  - Average zonal income, household size, number of workers/household
- Typically include 4 steps:
  - Trip Generation
  - Trip Distribution
  - Mode Choice (optional)
  - Traffic Assignment

Trip-Based Models

- Trip-based models typically include multiple trip purposes including home-based and non-home-based
  - Home-based work (HBW), home-based shop (HBS), etc.
- Trips are split by purpose because they have different characteristics
  - Work trips tend to be longer
  - Shop trips have higher occupancies

Trip- Based Example

- Real-life behavior



- Model translation: 6 independent trips
  - 1 home-based school trip
  - 1 home-based other trip
  - 4 work-based trips

Trip Generation

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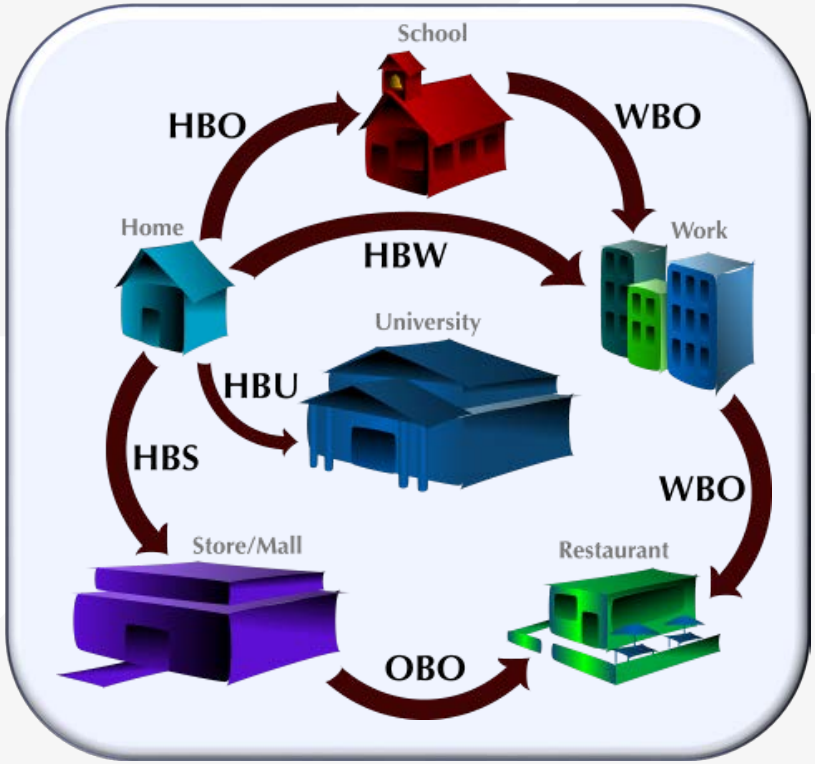
Trip Generation: *How Many Trips?*

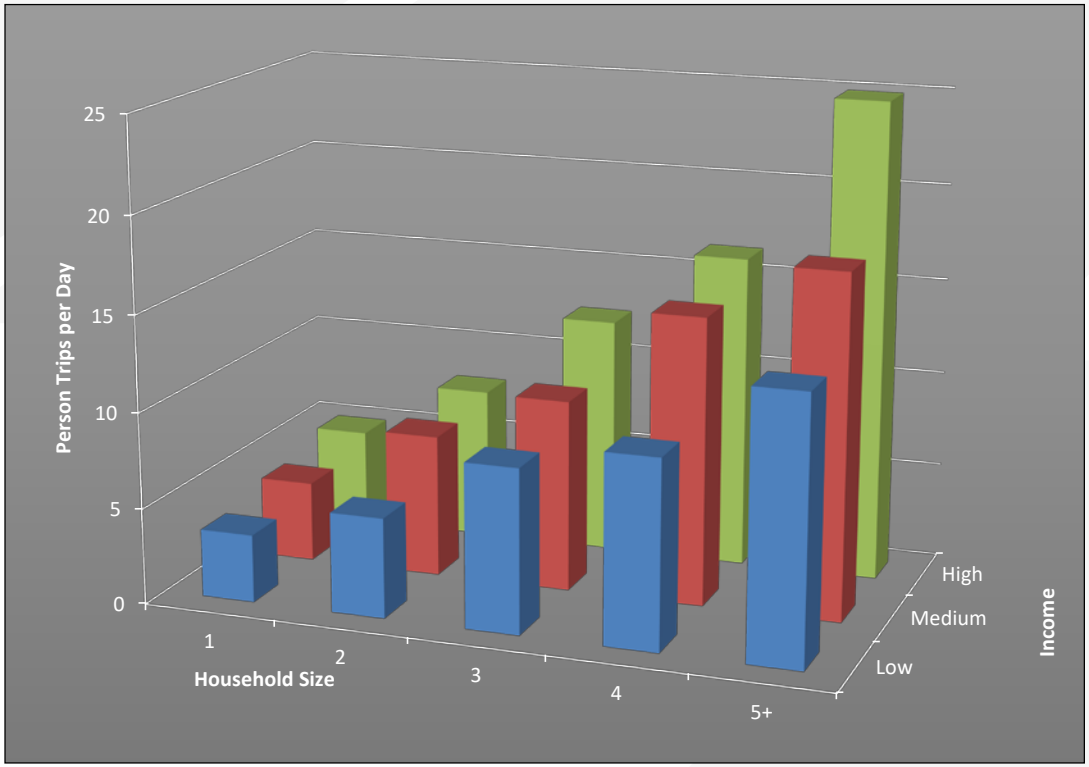
- Based on household survey
- Different trip purposes
- Generate all person trips*
  - Walk
  - Bike
  - Transit
  - Auto



** This is different than ITE Trip Generation, which only considers vehicle trips*

Trip Generation: *How Many Trips?*

- Cross-classified production rates
  - Household size, income, number of workers



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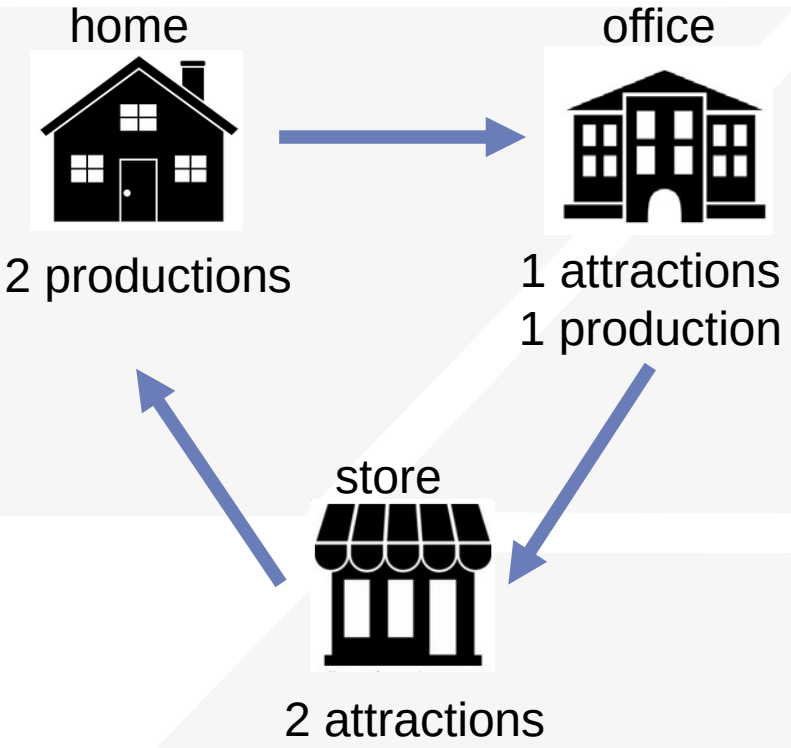
Trip Production and Attractions

- For a home-based trip, the home-end of the trip is always the production end and the other trip end is always the attraction end
- For a non-home based trip, the origin trip end is the trip production and the other end is trip attraction



Production Rates

- The most common way to estimate trip productions is based on cross-classified trip rates
- Segment population by 2 or 3 important characteristics including household size, income, number of workers, vehicle availability, etc.
- Estimate trip production rates for each segment (typically using a household travel survey)
  - Trip rates are usually estimated by trip purpose
- Smooth trip rates across segments based on expected patterns- i.e. as the income rises so should trip rates

Attraction Rates

- Attractions are typically estimated based on regression equations
- For example, in the City of SLO model

  HBS attractions=

  18.82* Drive-in retail (KSF)+

  14.12* High-generation retail(KSF)+

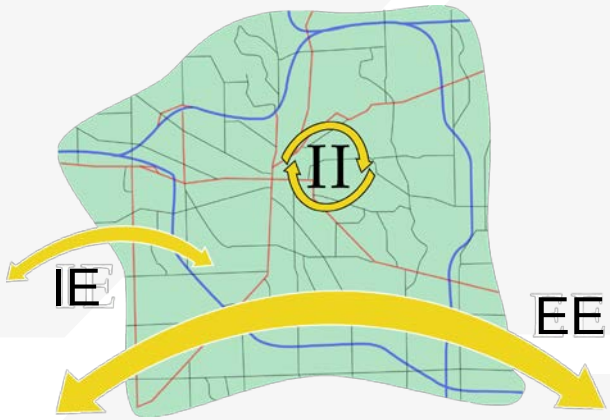
  9.41* Medium-generation retail(KSF)+

  4.71* Low-generation retail(KSF)

SLO – San Luis Obispo

External Trips

- In addition to trips within the modeled region, there are trips that begin and/or end outside the region
  - There are trips from Sacramento to Marysville
- Internal-external/external-internal (IE/EI) trips have one end in the modeled region while external-external (EE) trips are through trips
- IE/EI and EE trips are usually based on counts along facilities that cross the regional boundary
- IE/EI trips are distributed within the modeled region together with the II trips



Special Generators

- Land uses that have unique trip generation and distribution characteristics that are not well captured by the standard model trip rates and trip distribution
  - Lower or higher trip attractions
  - Different trip purposes
- These are typically attractions
- Examples
  - Universities
  - Airports
  - Casinos
  - Sports Arenas

Trip Productions/Attractions Balancing

- Since trip productions and attractions are calculated independently of each other, the total numbers will likely be different
- May get 10,000 HBO productions and 9,000 HBO attractions
- Most of the time will want to balance to productions (household estimates are more reliable than commercial land use estimates)
- To balance to productions, will increase HBO attractions in each zone by multiplying by 10,000/9,000=1.11

Trip Distribution

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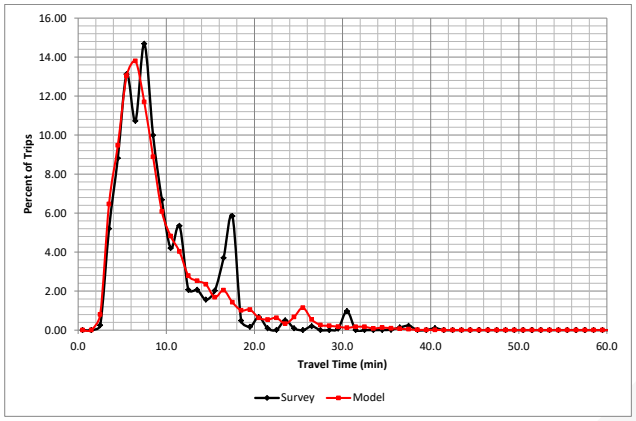
Trip Distribution: *Where will they go?*

- Match
  - Productions & attractions
- Survey Data
  - Trip length distributions
  - Subregion to subregion patterns

The *Gravity* concept can be used to model travel!



Trip Distribution

- Trips production and attractions are matched by trip purpose
- The distance between the production and attraction zones affects how many trips are made
  - Zones closer together will have more trips between them
- Distance is accounted for by *friction factors*
  - As the zones get further away from each other the friction factors decrease
- Friction factors are typically estimated based on household travel surveys or using Big Data (observed OD trip patterns)

Trip Distribution

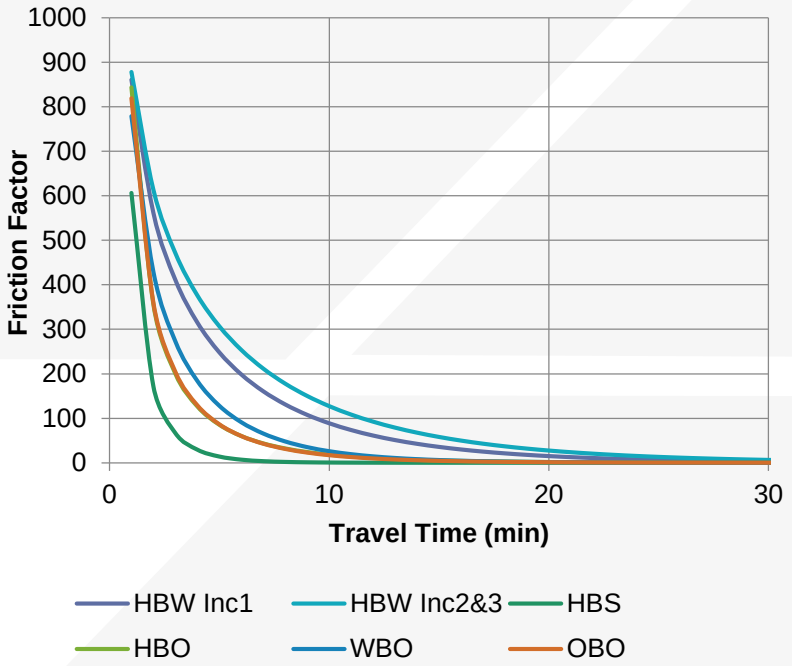
Trips between zones i and j are

$$T_{ij} = P_i \cdot \frac{A_j \cdot F_{ij} \cdot K_{ij}}{\sum_{i=1}^{n}(A_j \cdot F_{ij} \cdot K_{ij})}$$

Where:

- T_{ij} = trips from zone i to zone j
- P_i = productions in zone i
- A_j = attractions in zone j
- K_{ij} = K-factor adjustment from i to zone j
- i = production zone
- j = attraction zone
- n = total number of zones
- F_{ij} = friction factor

Example of friction factors plot



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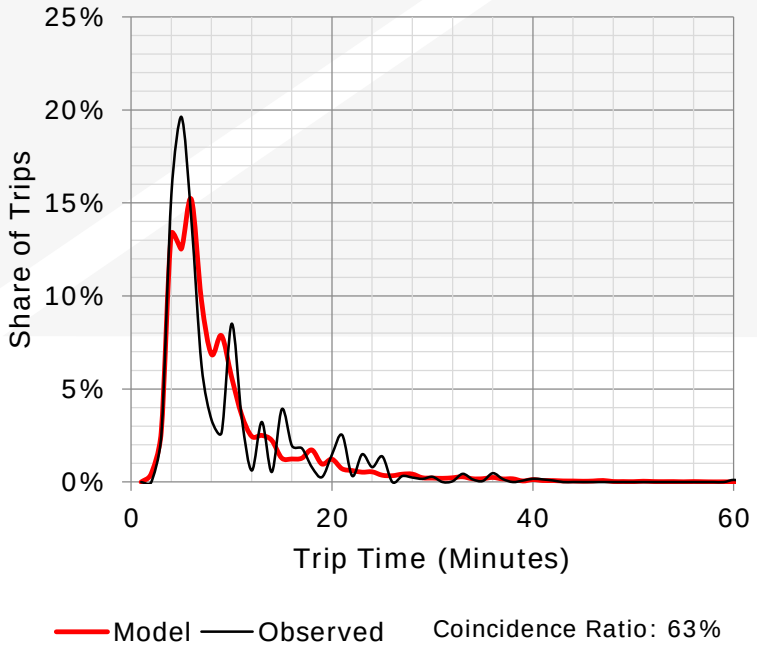
Trip Length Distributions

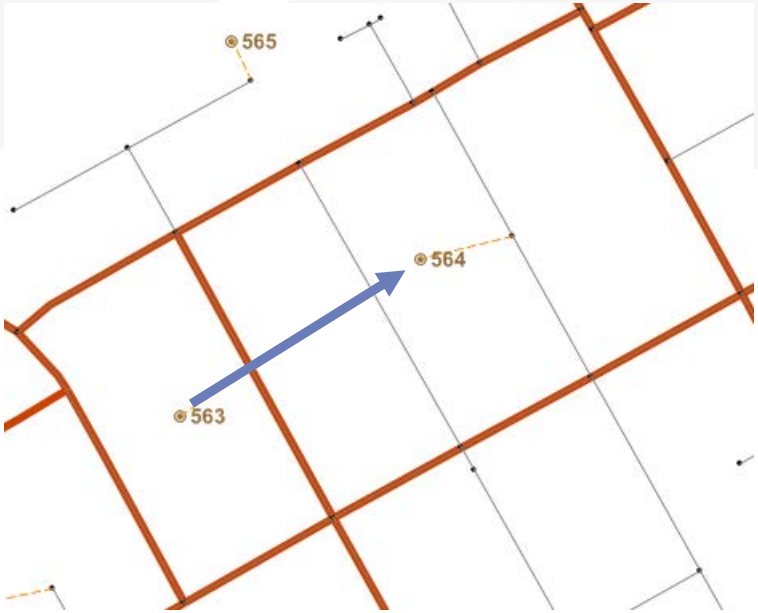
City of San Luis Obispo Home-Based Work Trip Length Distribution



- Friction factors are adjusted until the modeled trip length distribution looks similar to the observed trip length distribution
- Different friction factors are estimated by trip purpose
- Friction factor distribution is a Gamma function with 3 parameters that can be adjusted

Intrazonal Trips

- Interzonal trip
  - Considered in mode choice and assignment
  - Trips travel zone to zone



- Intrazonal trip
  - Trips stays in zone
  - Trips never appears on network links

Mode Choice

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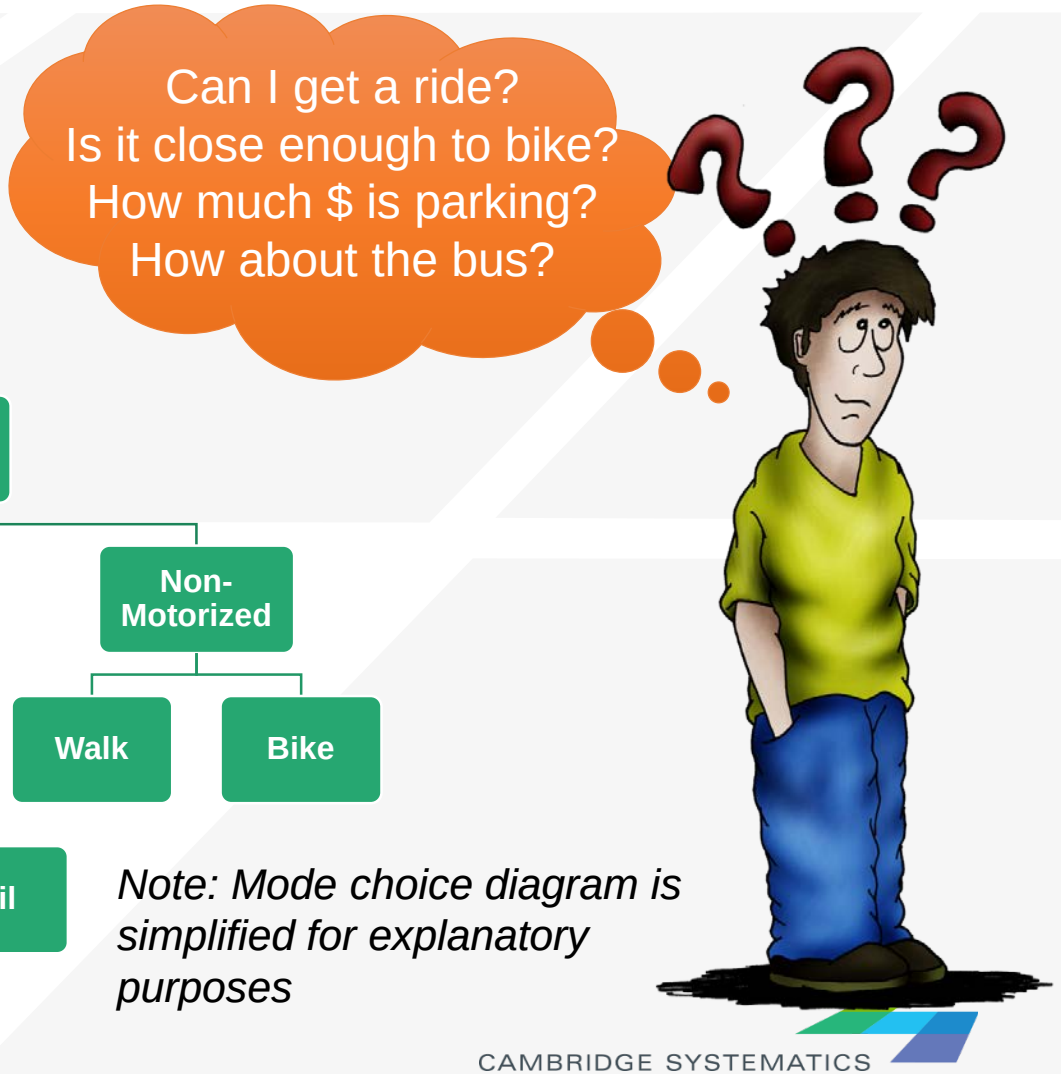
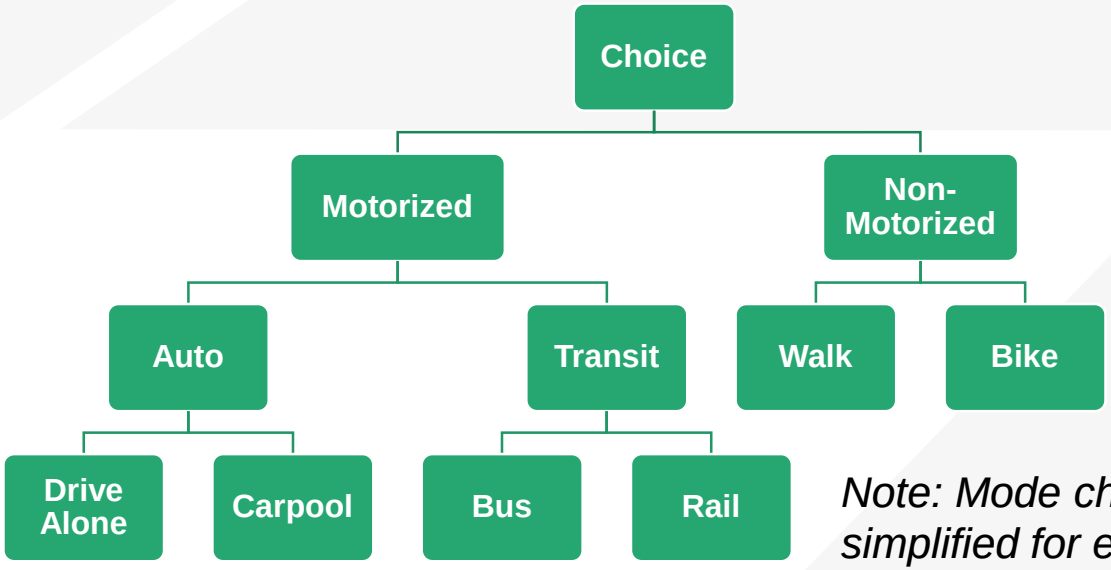
Mode Choice: *What Mode?*

- Nested Logit Model
  - Consider all modes for each zone pair





Note: Mode choice diagram is simplified for explanatory purposes

Mode Choice

- Probability of selection any mode depends on all the available modes and relative travel times, costs, other factors

$$P_i = \frac{e^{u_i}}{\sum_j e^{u_j}} \quad (1)$$

Where:

Pi	=	probability of selecting mode i
ui	=	a linear function describing the utility of mode i
e	=	base of the natural logarithms

- Mode choice models use either logit models or nested logit models
  - » Nested logit models just group similar alternatives into a nest

Mode Choice Coefficients

	Federal Transit Authority Guidelines	
	Low Value	High Value
Coefficient		
In-vehicle travel time (IVTT)	-0.03	-0.02
Initial wait	-0.09	-0.04
Second wait	-0.09	-0.04
Walk time	-0.09	-0.04
Cost[2]	–	–
Equivalent Minutes of IVTT		
Initial wait	3.00	2.00
Second wait	3.00	2.00
Walk time	3.00	2.00
Home-Based Work Value of Time (Estimated Median Household Income)		
Low Income ($20,000)	$2.30	$3.10
Middle Income ($55,000)	$6.60	$8.70
High Income ($140,000)	$16.80	$22.40

Mode Choice Constants

- Every alternative in the mode choice except one has a mode choice constant
- Mode choice constant reflects the travelers' perception of the mode
  - Transit usually has a lower constant than auto
- Constants are estimated by trip purpose
  - Home-based school trips may have a higher bike constant than the auto constant because children are more likely to bike to school

Mode Choice Modeling

- Mode choice models can be estimated or calibrated
- Estimation refers to statistical estimations of all coefficients and constants based on observed data
  - Requires a lot of data… and patience
- Most of the models assume coefficients within the FTA range or borrow other models' coefficients
  - Only constants are then calibrated to correctly predict the number of trips by mode

Assignment

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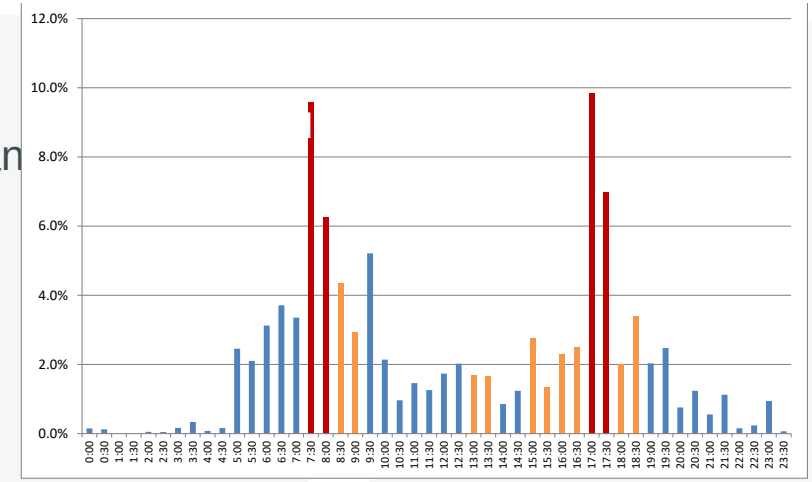
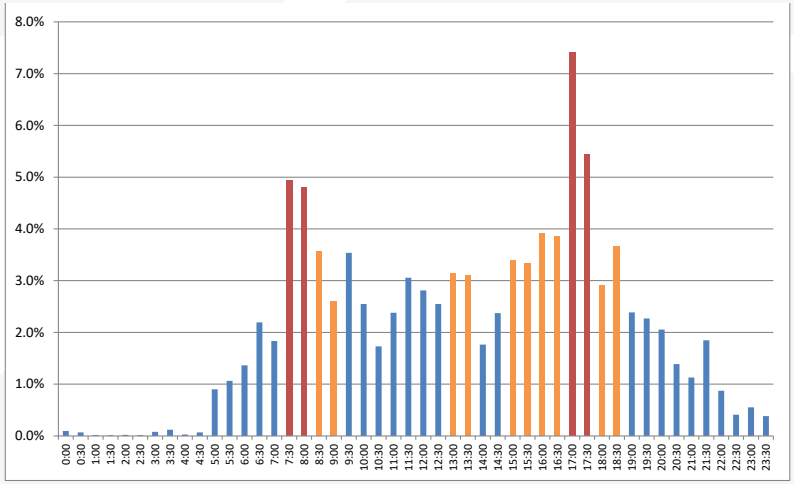
Traffic Assignment: *What Route?*

- Auto trips are assigned to the highway network
  - Transit trips and non-motorized trips can also be assigned to their respective networks as separate processes





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Traffic Assignment

- Traffic assignment can be done at the daily level where all vehicle trips are assigned to the highway network or at the peak period/peak hour level
  - Typically models have 4-5 traffic assignment periods including AM peak, Midday, PM peak, Evening, and Off peak
- Traffic assignment results allow the modeler to identify congested segments of the roadway and calculate VMT on highway facilities

Traffic Assignment

- Vehicles are allocated between roadways depending on the assignment algorithm
  - All-or-nothing assignment calculates the shortest path between each origin and destination pair and assigns all the vehicles to this path; it's not iterative
    - Not capacity constrained
  - User Equilibrium assigns vehicles in a way that no trip can improve its travel time between an origin and a destination; assumes perfect knowledge of the network
    - Capacity constrained
  - System Optimal assignment loads vehicles in such a way as to minimize the total travel time of all vehicles in the system
    - Capacity constrained

Traffic Assignment

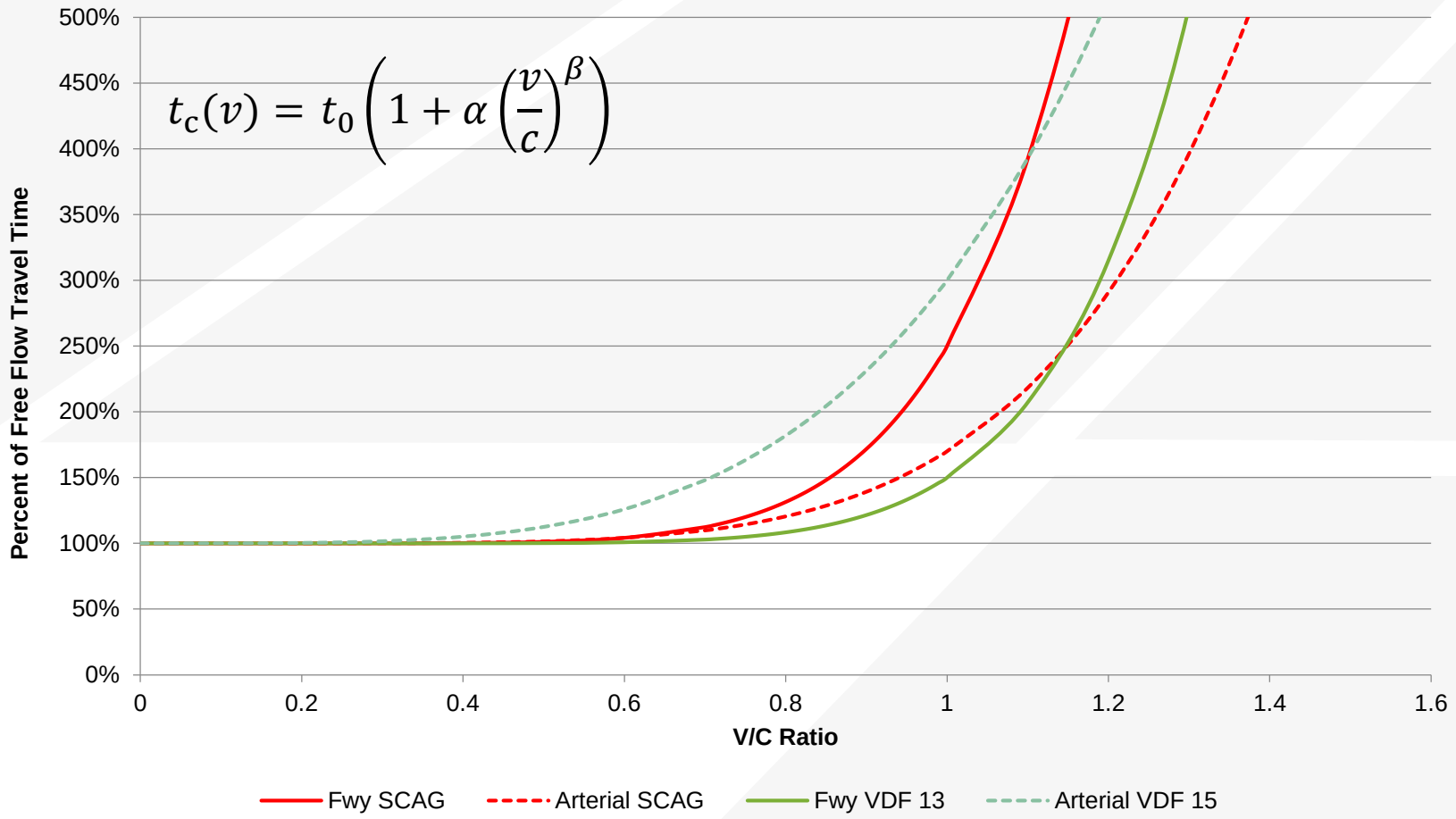
- Static traffic assignment
  - All vehicles are loaded on the network at the same time for a specified time period (peak hour or peak period)
  - Used in most models
  - Can predict volumes that exceed roadway capacities
  - Can’t capture queuing behavior
- Dynamic traffic assignment
  - Traveler optimizes travel time based on congestion levels along different paths while en route
  - Travel times are updated every few seconds
  - Very time consuming for larger networks

Volume Delay Functions

- VDFs relate increases in volumes to travel time changes
- Some of the most common VDF curves include:
  - BPR – Bureau of Public Roads
  - Akcelik
  - Conical
- VDFs are equations that are in the model script by facility type
  - Freeway
  - Expressway
  - Arterial, etc.

BPR Curve

$$t_c(v) = t_0\left(1 + \alpha\left(\frac{v}{c}\right)^{\beta}\right)$$



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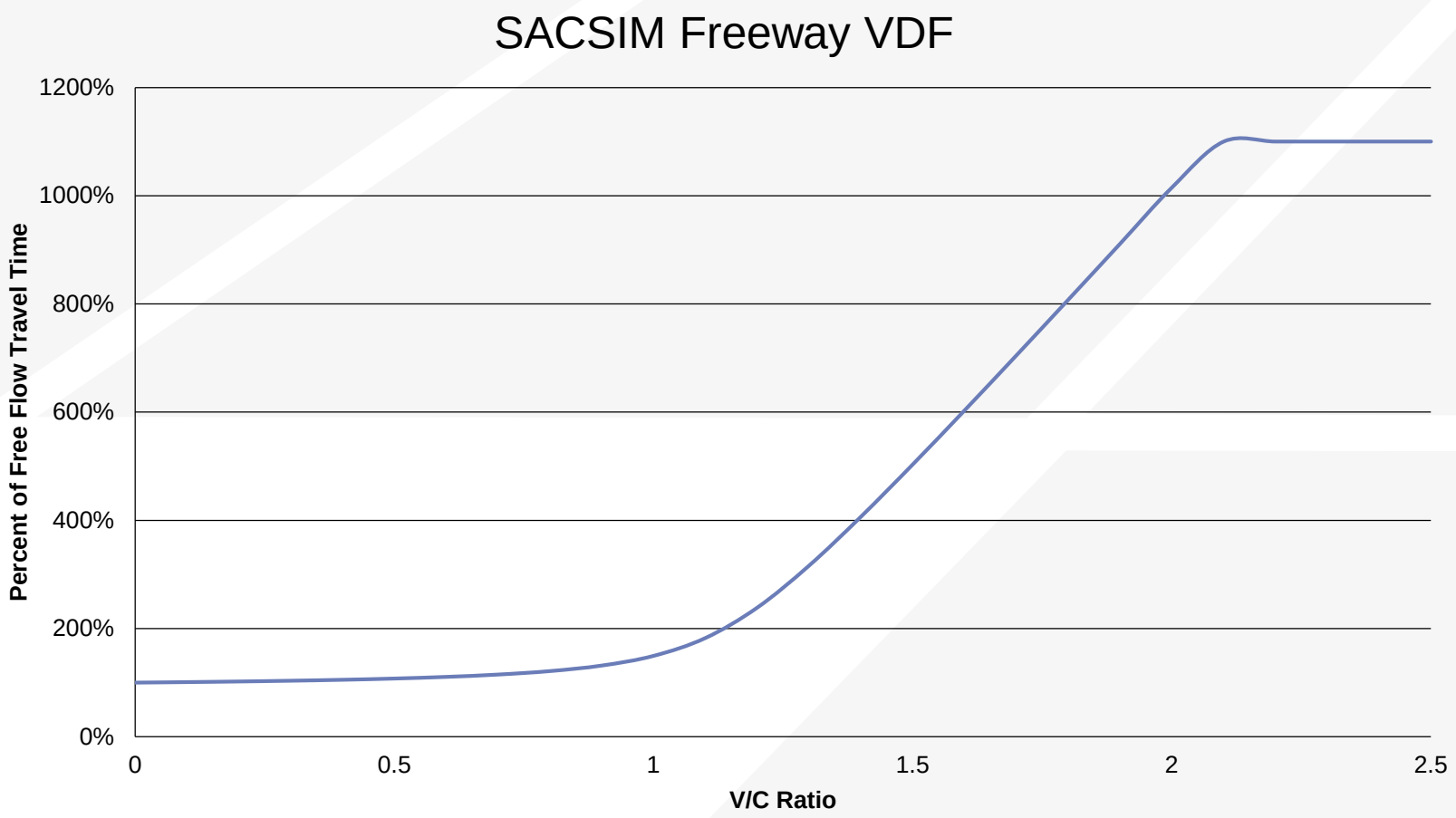
Freeways SacSIM

$$T_c = T_0 * min\left[\left(0.9 - 6 * (1 - 0.88 * VC) + \sqrt{36 * (1 - 0.88 * VC) + (1 - 0.88 * VC + 1.21)}, 11\right)\right]$$



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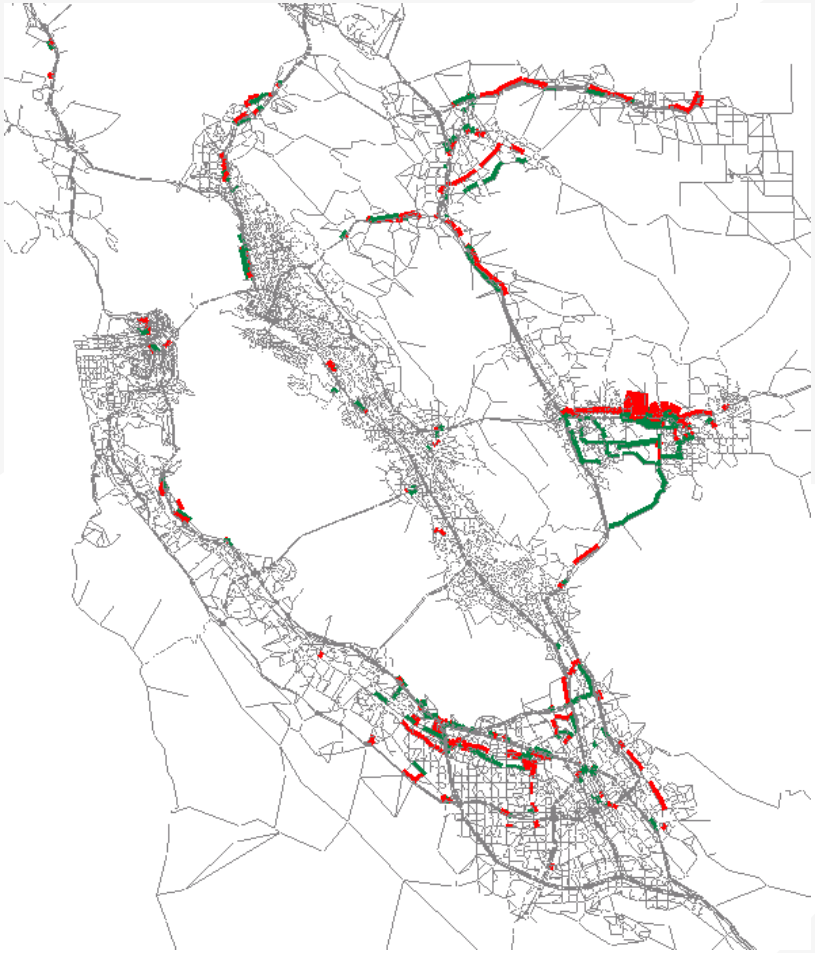
Traffic Assignment Convergence

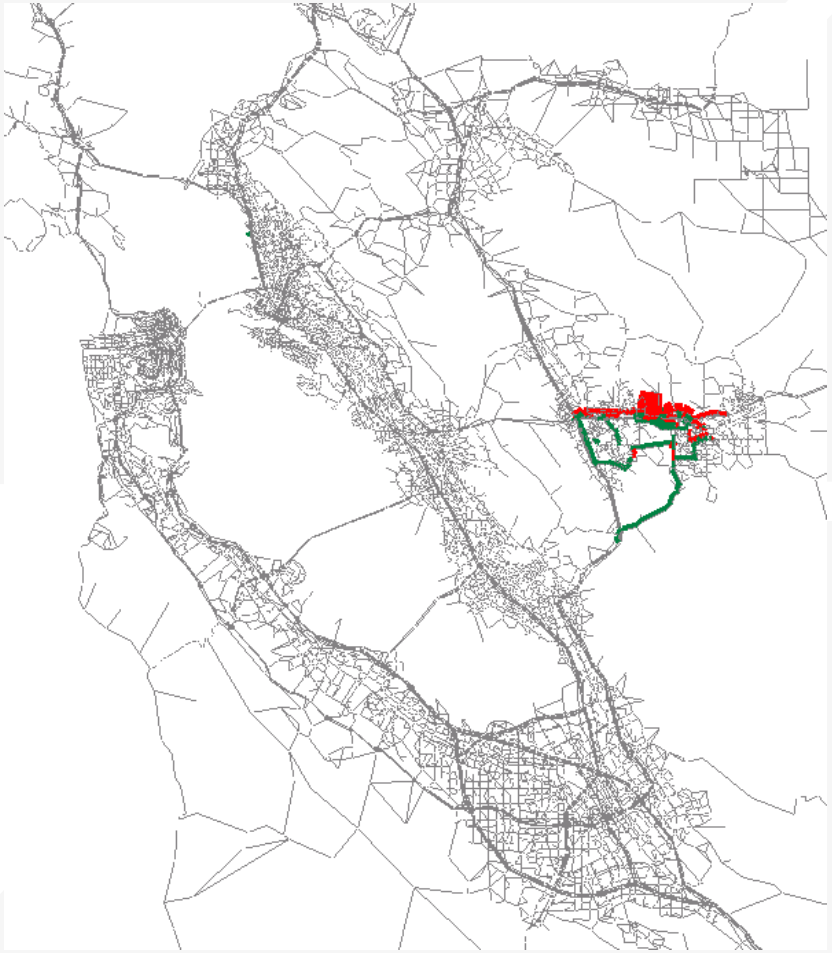
- It's not possible to calculate what volumes on each highway will result in the same travel times along all paths between and O-D pair
- Hence, the volumes are adjusted a little bit it a time until the travel times are the same and convergence is reached
- At the end of each iteration a relative gap parameter is calculated that represents the change from previous iteration- the smaller the change, the closer you are to convergence
  - Many models use relative gap of 0.01, which usually is insufficient to reach convergence
  - Some other models model use a maximum number of iterations, instead of relative gap, which is not ideal
- When the assignment is not well converged, a local change to the highway network results in volume differences far away

Traffic Assignment Convergence

MaxIters=50



Relative gap=0.0001



Model Calibration

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Model Calibration Data

- Trip generation
  - Household travel survey
  - ITE trip rates
- Trip Distribution
  - Household travel survey (HTS)
  - Big OD data (StreetLight, AirSage)
- Mode Choice
  - Household travel survey
  - American Community Survey (ACS)
- Traffic Assignment
  - Traffic counts
  - VMT data

Trip Generation Calibration: Productions

- Decide how to segment your households (eg. income and household size)
- Calculate trip rates from household travel survey by trip purpose for each segment
- Apply disaggregation curves to your zonal average income and household size to determine the number of households in each segment of your actual population

Population Segmentation

- Typically segment by income, household size
  - It's easy to get the average household income and household size from the ACS for each tract and disaggregate to TAZs
- Other parameters for segmentation can include
  - Vehicle availability (not in the ACS so will need a model that predicts vehicle availability at the household level)
  - Number of workers

Calculate Trip Rates

- Get HTS data for the appropriate geographical region
- Add up all the trips by purpose for each segment of the households
- Divide by the number of households in that segment in that segment
- City of San Luis Obispo Home-based Work Trip Rates

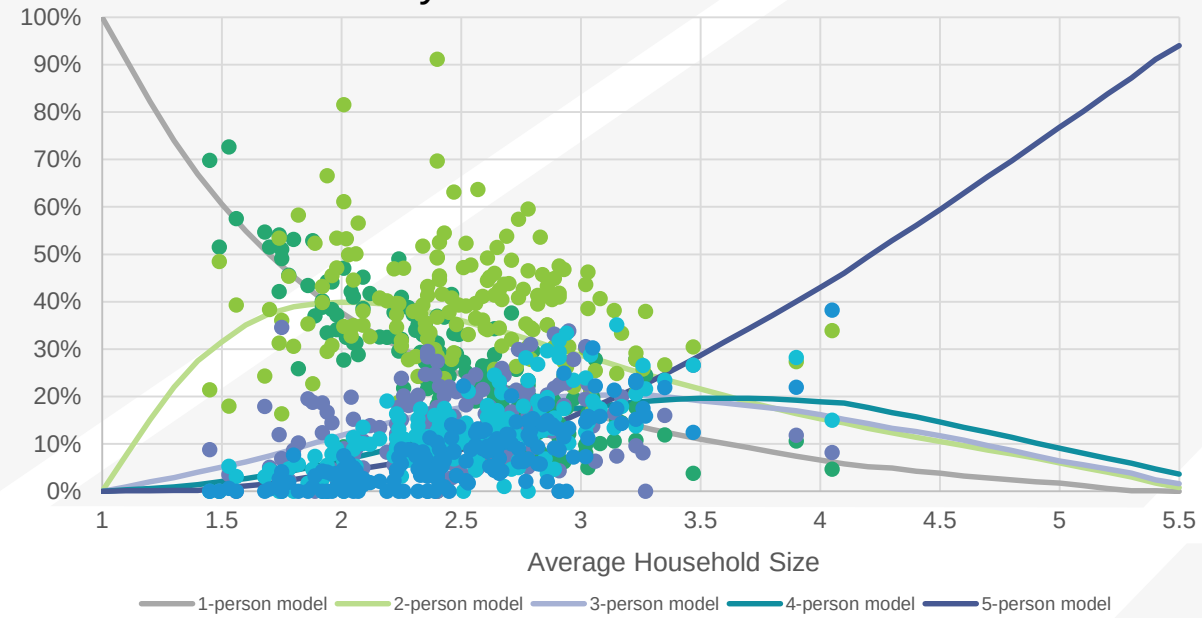
		Household Size					Total
		1	2	3	4	5+	
Income	Low	0.46	0.85	1.86	3.09	3.39	1.08
	Medium	0.71	1.31	2.50	3.09	3.39	1.80
	High	1.36	1.75	2.50	3.09	4.52	2.42
	Total	0.62	1.29	2.37	3.09	3.67	1.69

Applying Trip Rates

- Now that we have trip rates for each segment, need to determine how many households fall within each segment
- From ACS, we know
  - Number of households
  - Average income in a zone
  - Average household size in a zone
- Need to use the average information to determine the number of households of each size and income
- Also, need a joint distribution of income and household size

Disaggregation Curves

Household Size for City of SLO



Bivariate Distribution for City of SLO

Income	1 Person	2 Person	3 Person	4 Person	5+ Person	Total
Low	16,932	11,313	4,245	3,344	2,220	38,054
Medium	5,878	16,825	6,738	6,829	4,616	40,886
High	1,465	5,323	2,423	2,263	1,406	12,880
Total	24,275	33,461	13,406	12,436	8,242	91,820

Trip Generation: Attractions

- Set up the land use table that includes population and all employment categories that will be used by the regression equations
- Apply regression equations to calculate the number of attractions in each TAZ
- Balance trip productions and trip attractions
  - Typically balance to trip productions because the household data is more reliable than employment

Trip Distribution Calibration

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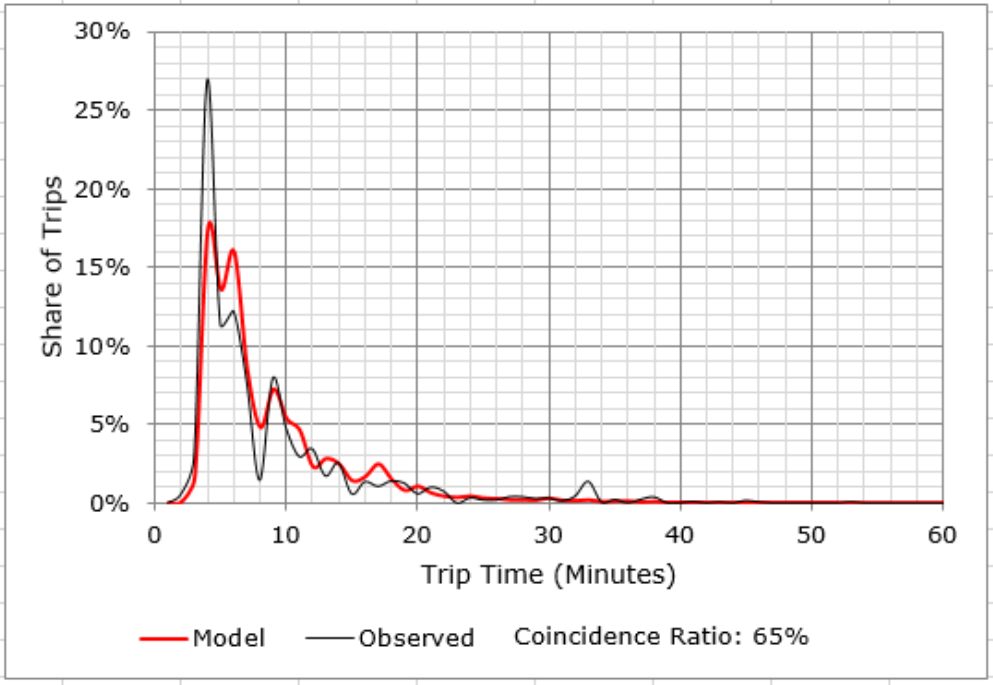
Trip Distribution Calibration

- Get observed trip length distribution from HTS
  - » Each trip has an origin and a destination and hence a corresponding travel time
- Calculate modeled trip length distribution
- Adjust the ffactors until the modeled trip length distribution matches the observed closely

Trip Distribution Calibration

City of San Luis Obispo Model

Purp	HBO		Svy Trip Length	8.37	
Inc			Mdl Trip Length	8.26	
Per	PK		Coincidence Ratio:	65%	Coincidence Ratio: 65%



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Trip Distribution Calibration

- The results is a set of trip matrices- one for each trip purpose
  - Still in production/attraction format
- City of San Luis Obispo HBO trip distribution

Matrix6 - Person Trip Table - Daily (HBO)

	102	114	118	120	122	124	128
102	2.34	0.47	0.74	15.37	7.71	19.99	7.17
114	0.11	0.14	0.14	0.83	0.38	1.25	0.73
118	0.72	0.75	1.99	5.97	2.71	8.42	5.22
120	0.20	0.05	0.08	2.22	0.81	2.05	0.70
122	0.00	0.00	0.00	0.00	0.00	0.00	0.00
124	0.00	0.00	0.00	0.00	0.00	0.00	0.00
128	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Mode Choice Calibration

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Mode Choice Calibration

- Use the HTS to get mode shares by trip purpose
- Check to make sure they make sense- sometimes there may not be enough records for meaningful numbers
- City of SLO mode choice targets

	HBW	HBSCH	HBSH	HBU	HBO	WBO	OBO	Total
SOV	83%	38%	48%	46%	35%	83%	34%	50%
HOV2	8%	30%	32%	16%	34%	7%	31%	26%
HOV3+	3%	21%	14%	0%	16%	5%	25%	14%
Transit	1%	0%	0%	9%	0%	0%	0%	1%
Walk	3%	8%	4%	4%	12%	5%	8%	8%
Bike	2.4%	2.9%	0.7%	15.0%	3.3%	0.7%	1.4%	2.1%
Total	100%	100%	100%	91%	100%	100%	100%	100%

Mode Choice Calibration

- Assuming there are existing mode choice coefficients, check them for compliance with FTA guidelines
- To calibrate mode choice constants, there is typically a script in TransCAD (or Fortran) that calibrates them automatically
- Once the constants and coefficients have been established, apply them to trip matrices from trip distribution

Mode Choice Calibration

- For the City of San Luis Obispo end up with:
  - Trip matrix for each trip purpose
    - Cores including SOV, HOV2, HOV3+, transit, bike, and walk
- Once the number of person trips by mode has been calculated, need to convert auto trips to vehicle instead of person trips
  - Divide person trips by occupancy to get vehicle trips

PA to OD Conversion

- Traffic assignment is done on the origin-destination trip table but all the work up to this point has been completed in production-attraction format
  - Take PA matrix, add the inverse of the PA matrix and divide by 2 to get OD matrix

Prod	Attr	
TAZ	1	2
1	100	200
2	400	100

+

Attr	Prod	
TAZ	1	2
1	100	400
2	200	100

Divided by 2

Origin	Destination	
TAZ	1	2
1	100	300
2	300	100

Time of Day

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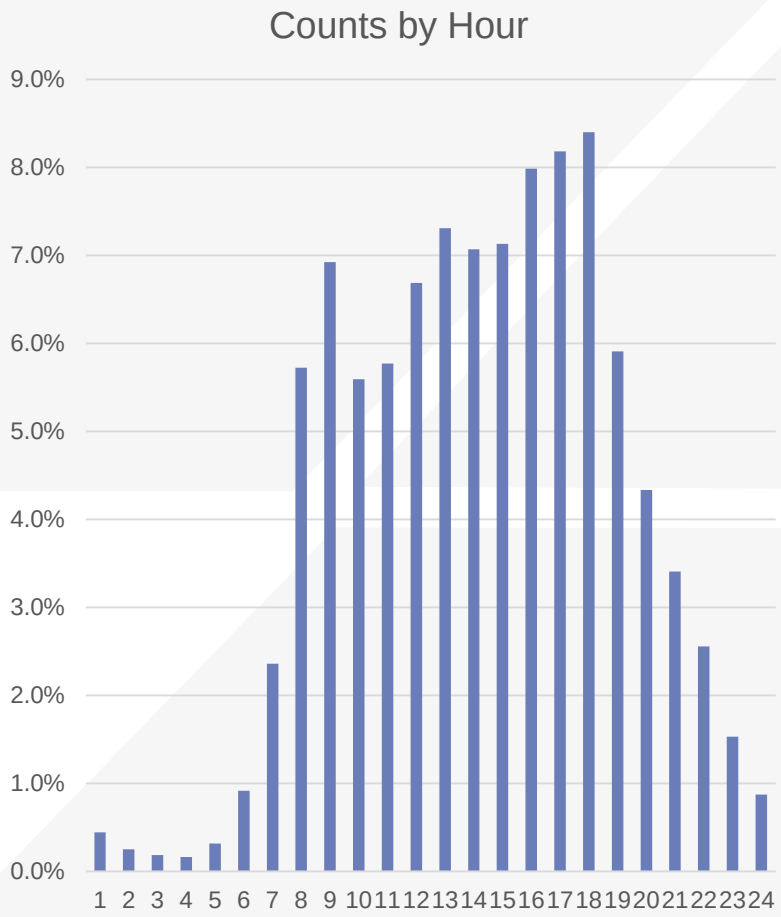
Time of Day

- Prior to traffic assignment, trips need to be allocated to different periods because daily assignment results in congested areas won't make sense (need peak period or hourly)
- Time of day split can be done prior to assignment or prior to mode choice if the traveler behavior or transit service are different during peak and off-peak periods
- If done after mode choice, can use hourly traffic counts to calculate the share of trips in each peak period or hour

Time of Day

- 15% of the daily vehicle trips take place during the AM peak period (6AM-9AM)
- 25% of the daily vehicle trips take place during the PM peak period (3PM-6PM)



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Traffic Assignment Calibration

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Traffic Assignment Calibration

- Some of the parameters that may need to be adjusted in the traffic assignment step include:
  - Volume-delay functions
  - Free-flow speeds by facility type
  - Auto operating costs
- Typically adjustments in this step are necessary if the share of volumes by roadway class is off
  - For example, if the volumes are too high on arterials and too low on freeways

VMT

- Vehicle-miles traveled is an important output from the model
- May want to calibrate/validate model to observed VMT
- Different sources of VMT include
  - CHTS
  - Highway Performance Monitoring System (HPMS)
  - ARB/CEC estimates

Model Validation
(Day 2 of Training)

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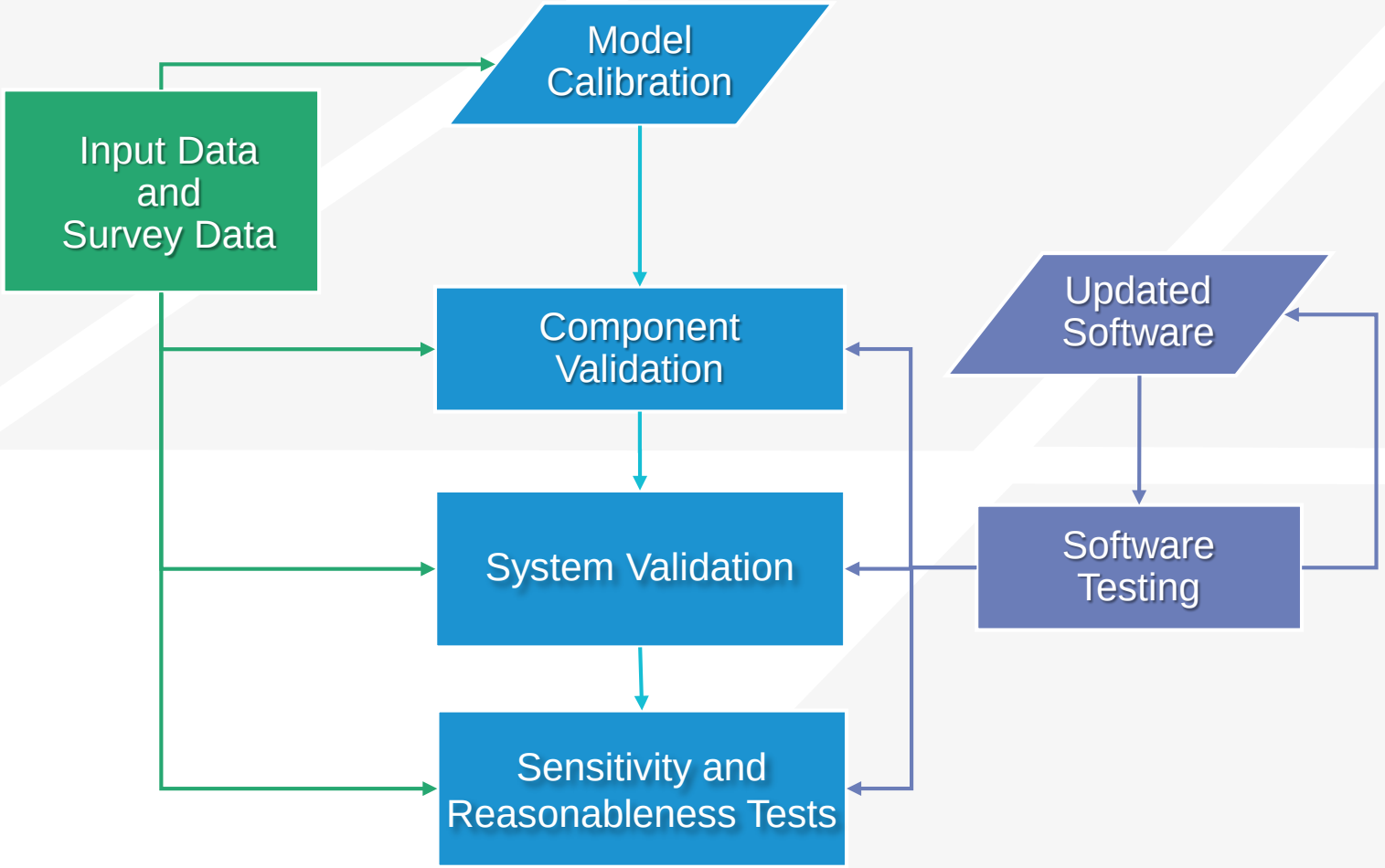
Validation Approach

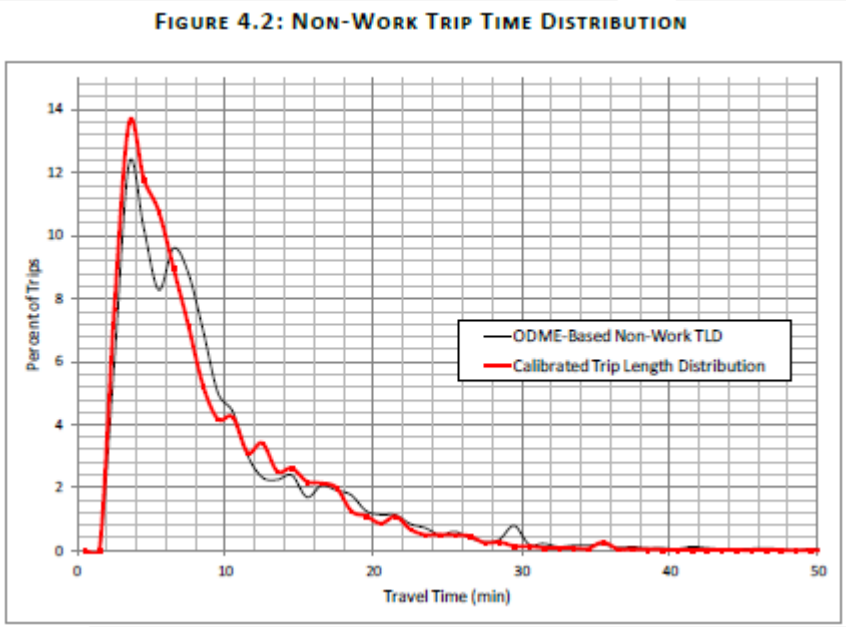


Trip Generation

- Trip Rate Review
  - Reasonableness checks
- Validation Adjustments
  - VMT compared to other sources of observed VMT
  - Volume counts may indicate a need to factor trip rates

Trip Distribution

- Trip Length Frequency Distribution (TLFD)
- Average Trip Length
- % Intrazonal
- District to District flows



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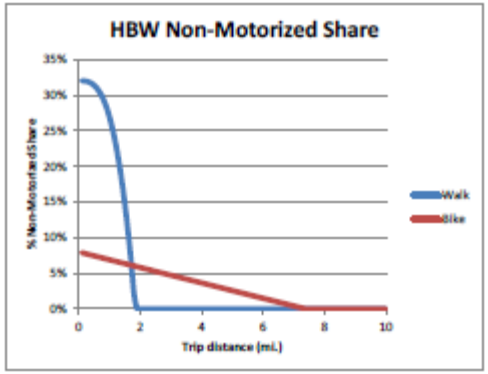
Mode Split

- Non-Motorized
  - » Calibrate to ACS or CHTS shares
  - » Can also use Big Data such as Strava for bike trips
- Transit
  - » District based summaries
  - » Calibrate to observed boarding data

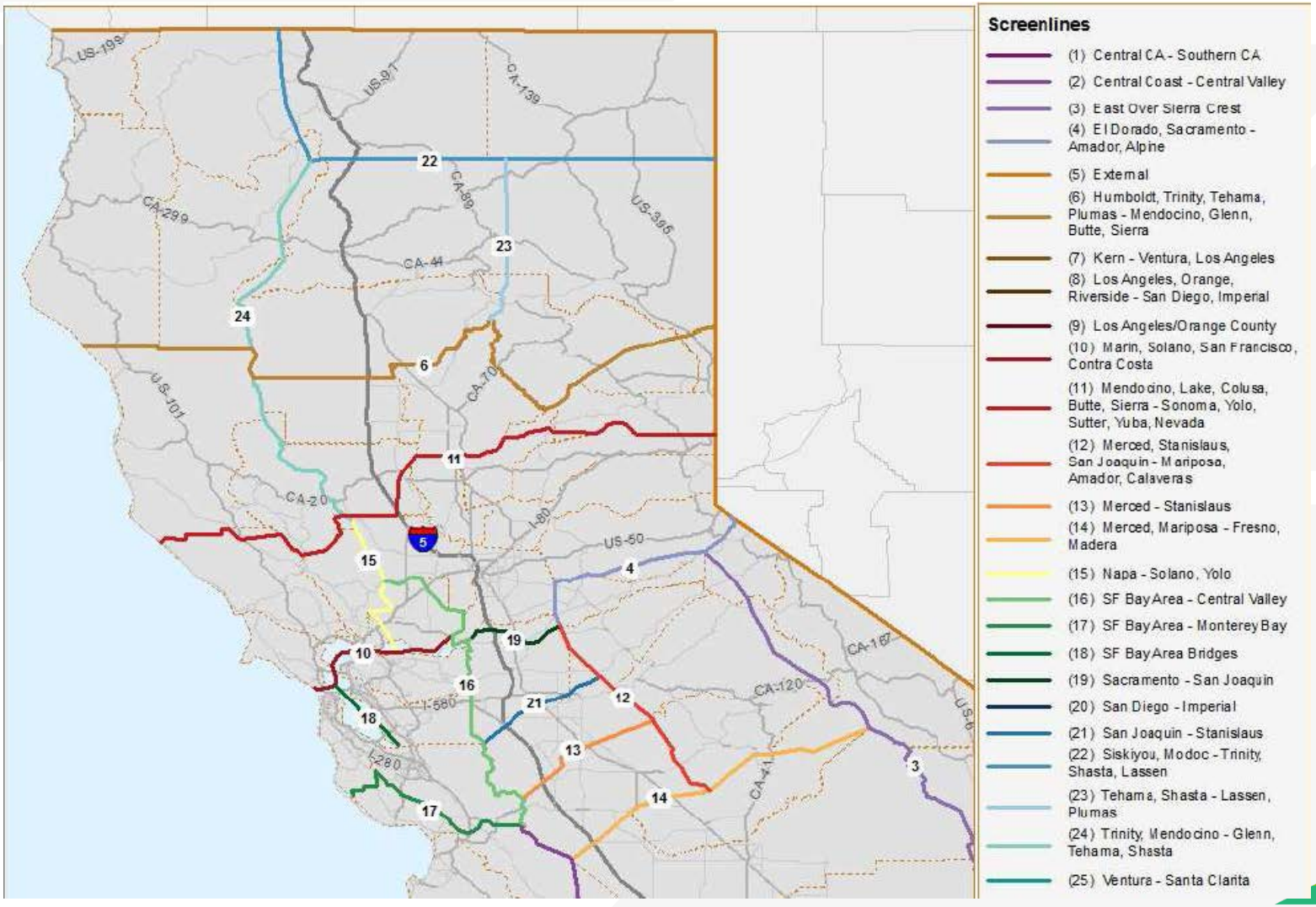


CHTS-California Household Travel Survey

Traffic Assignment

- Compare modeled and observed volumes
  - At screenlines (a screenline splits a study area into two parts, capturing performance measures for flows from one part of the study area to the other)
  - Aggregates by facility type and area type
- Can validate at daily or peak period level
- Statistics
  - R-squared, RMSE, Volume/Count ratio
  - Regional, subarea
- “Top 10” Errors

CSTDM Screenlines



CAMBRIDGE SYSTEMATICS

Activity-Based Models

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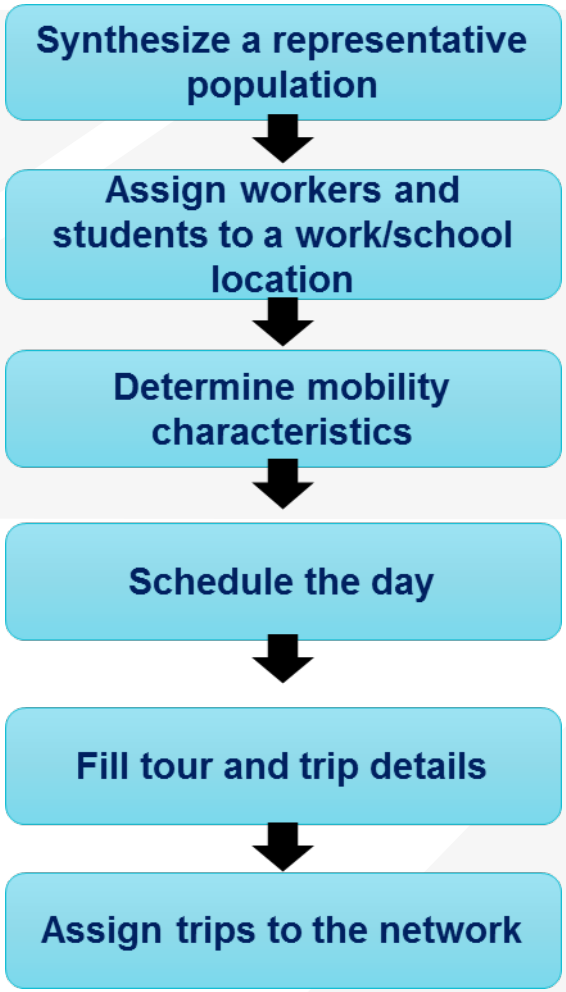
Activity vs Trip-based Models

- Activity-based models predict travel at an individual level rather than TAZ averages
- Trips are grouped into home-based or work-based *tours*
- Tours
  - Travel is an outgrowth of activities. A way of stringing activities together.
  - A tour is defined by activities (work, school, shop, meal, etc.)
  - A chain of trips beginning and ending at home

Activity vs Trip-based Models

- Activity-based models guarantee consistency between trips within tours as well as tours and household members
  - If a person took transit to get to work, they cannot drive to a restaurant for lunch
- In activity-based models, trips can change time of departure based on congestion levels

Standard ABM Components



Primary differences between Four Step and ABM?

Trip-Based Model Components	Activity-Based Model Components
Step 1: Trip generation	Activity generation and scheduling
Step 2: Trip distribution	Tour and trip destination choice
Typically absent	Tour and trip time of day
Step 3: Trip mode choice	Tour and trip mode choice
Step 4: Network assignment	Network assignment

Advantages of an ABM in terms of Analyzing Policies

Toll

Transit

HOV

Parking policies

Flexible work schedules

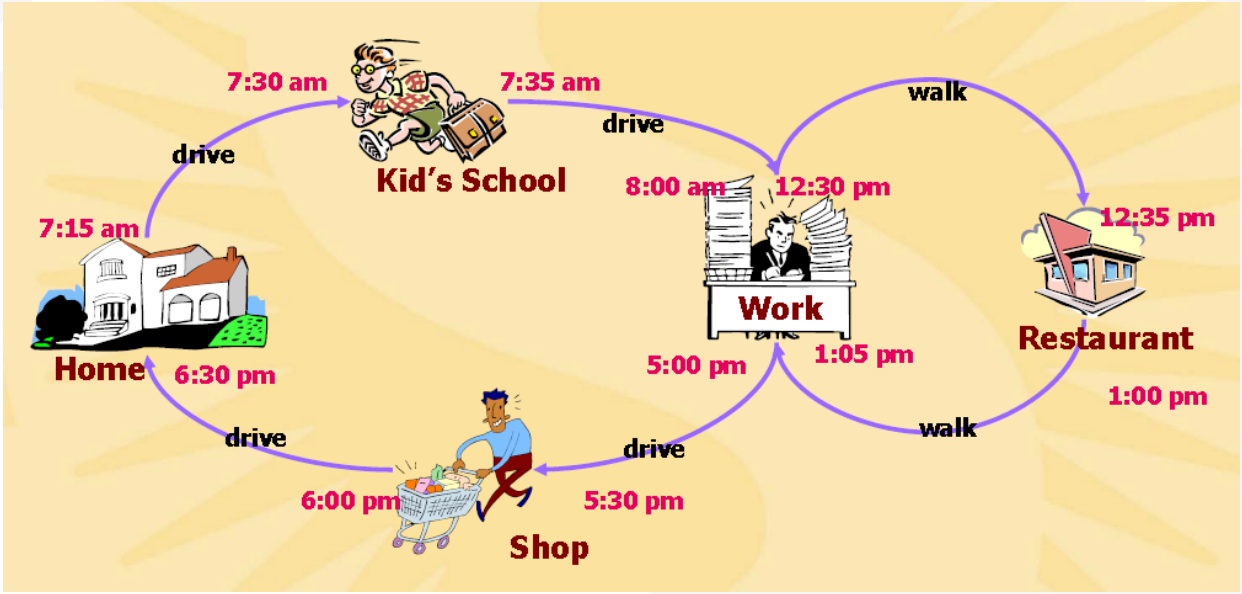
Note: 4-step models can be used to analyze these policies as well, but ABMs have better sensitivities.

ABM Household and Person Attributes (Example)

Household Attributes	Person Attributes
Number of persons & ages	Relationship
Location	Gender
Housing tenure	Age
Number of workers	Worker status
Income	School status & grade
Number of students	Transit pass ownership
Vehicles owned	Parking subsidy at work
Bicycles owned	

Activity-based Models

- Based on activities
  - Temporal connections between tours
  - Members of a household considered together when selecting an activity-pattern (ie. parent dropping a child off at school)
  - Each activity has start time and duration



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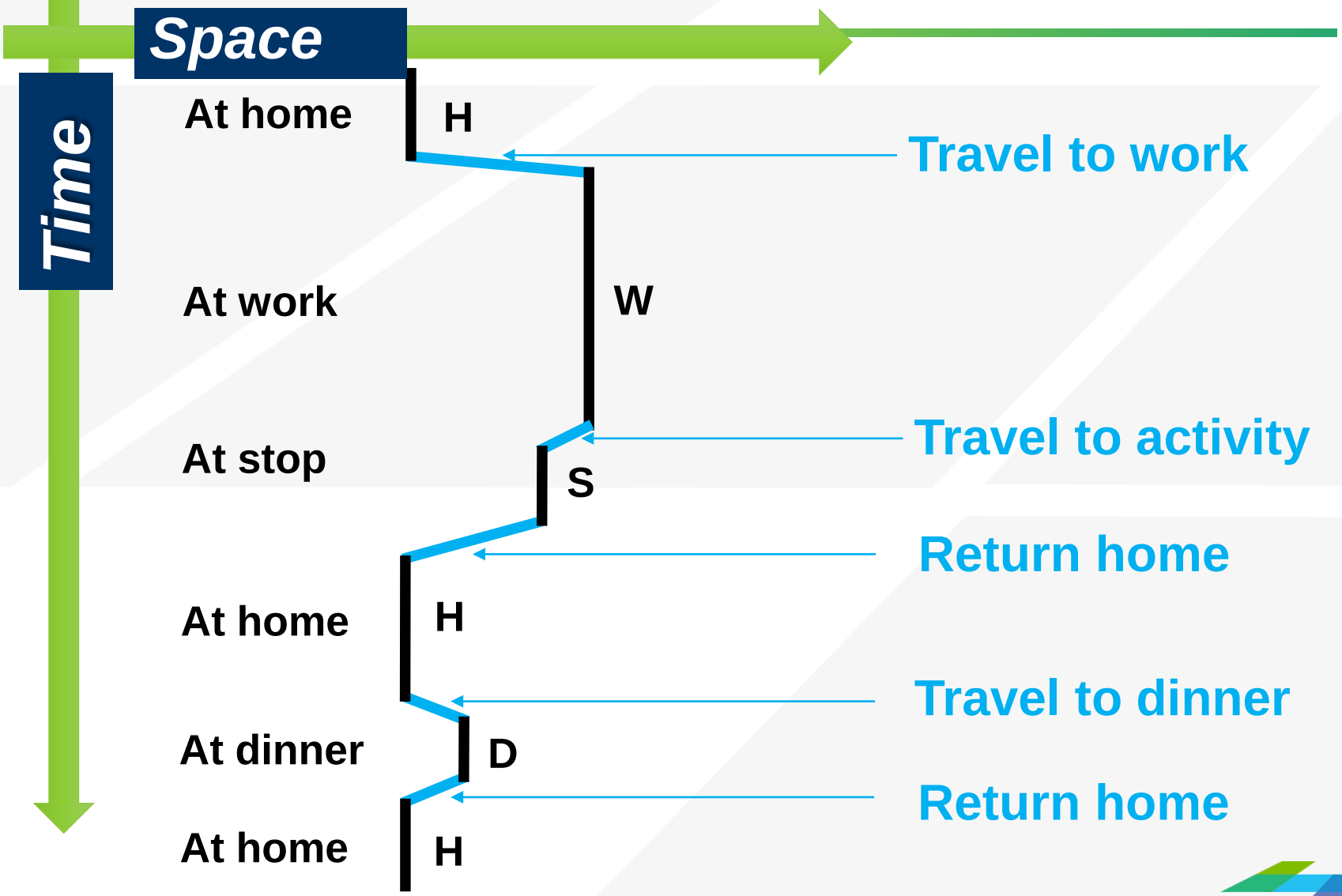
Fine temporal and spatial resolution



Working with Matrices

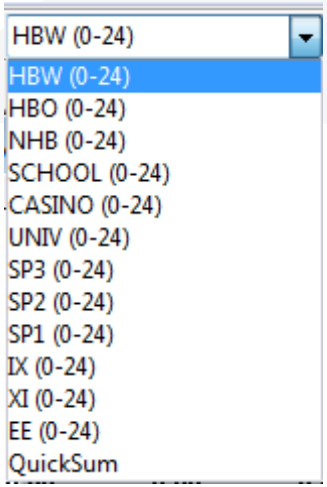
CAMBRIDGE SYSTEMATICS

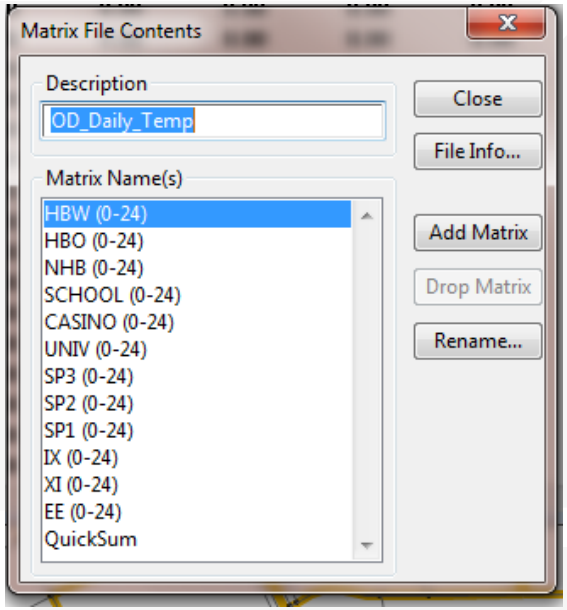
Matrix Files

- Contain zone to zone data
  - Trip tables
  - Shortest Paths (“Skims”)
    - The route or travel path on the transportation network that has the lowest “cost” for the traveler
    - The cost can be travel time, distance or some monetary value.
  - Mode shares
- Tend to be very large files
  - Real numbers = Big files

Matrix Files

- Matrix Cores
  - One file, multiple tables
  - Add/Delete/Rename Cores ( )
  - Select the active core





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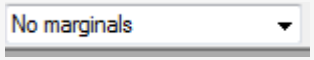
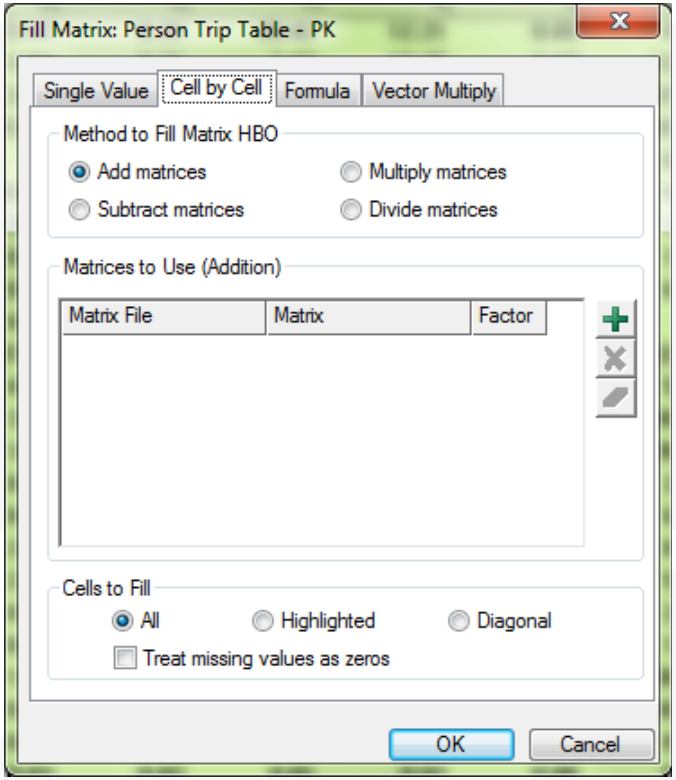
Matrix Files

- Show row/column statistics
  - Sum, min, max, etc.
  - Sort by matrix marginals 

  - Store marginals in a table ()
- Get matrix statistics with Matrix Statistics ()
- Compare all core values in a single cell
  - Right-click→ Info
- QuickSum (Σ) Adds a new core with the sum of all existing cores in the file

Matrix Files

- Matrix Calculations
  - » Matrix → Fill ( )
- Single Value
  - » Simple add/subtract/clear/replace
- Cell by Cell
  - » Compute values from two or more matrix cores
- Formula
  - » Mix operators and use functions
- Vector Multiply
  - » Multiply by a row or column from a dataview



TransCAD Sample

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Matrix Files

- Matrix Indices ()
- View only a subset of a matrix file
  - Use a selection set to identify rows/columns to view
  - The matrix will be “shrunk”
  - Row/Column marginals will reflect the smaller matrix
- Change ID numbers
  - Use a dataview as a correspondence table

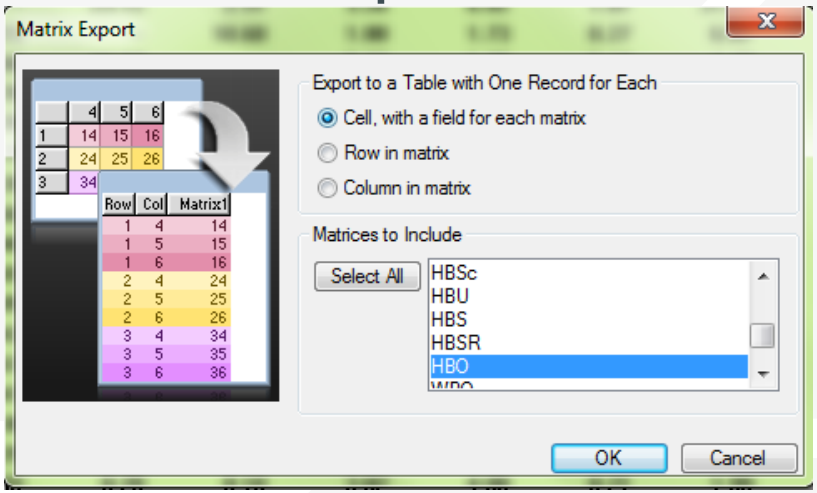
Matrix Files

- Aggregate Matrices
  - Squeeze a matrix, summing within districts or superzones
  - Matrix → Aggregate
  - Requires dataview
  - Rows, Columns, or both
- Disaggregate Matrices
  - Matrix → Disaggregate
  - Requires a specially designed dataview
    - Multiple rows for some existing rows/columns
    - Unique sub-zone field

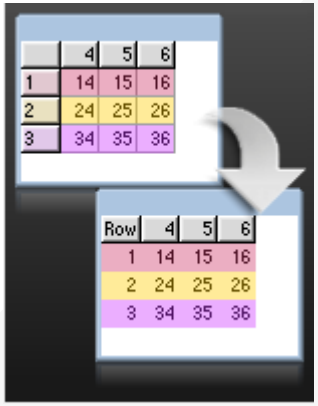
ZONE	NewID	Percent
1	101	.20
1	102	.20
1	103	.60
2	2	1.00
3	301	.30
3	302	.70

Exporting / Importing

- Matrix → Import and Matrix → Export
  - Format 1:
    - Good for database work



  - Format 2/3
    - OK for manual work



CAMBRIDGE SYSTEMATICS

Matrix Indexing and Filling

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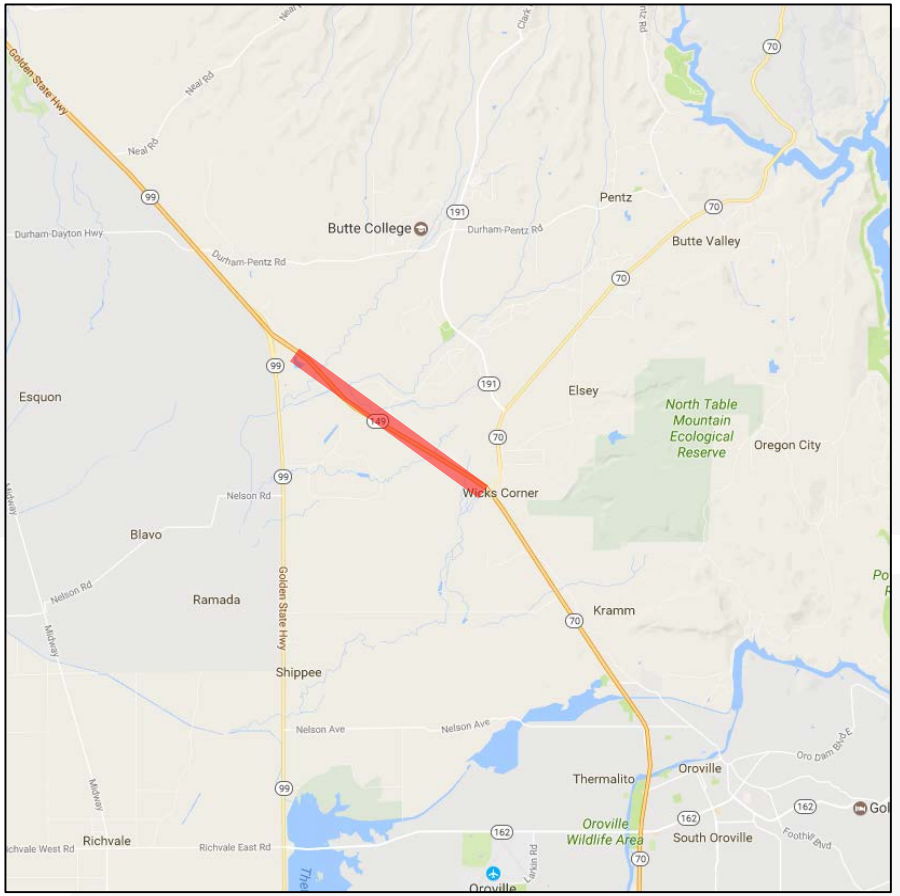
Background

- New Data Source for Corridor Evaluation
- For Example:
  - Big Data, e.g. AirSage, Inrix
  - CA-149 between CA-99 and CA-70



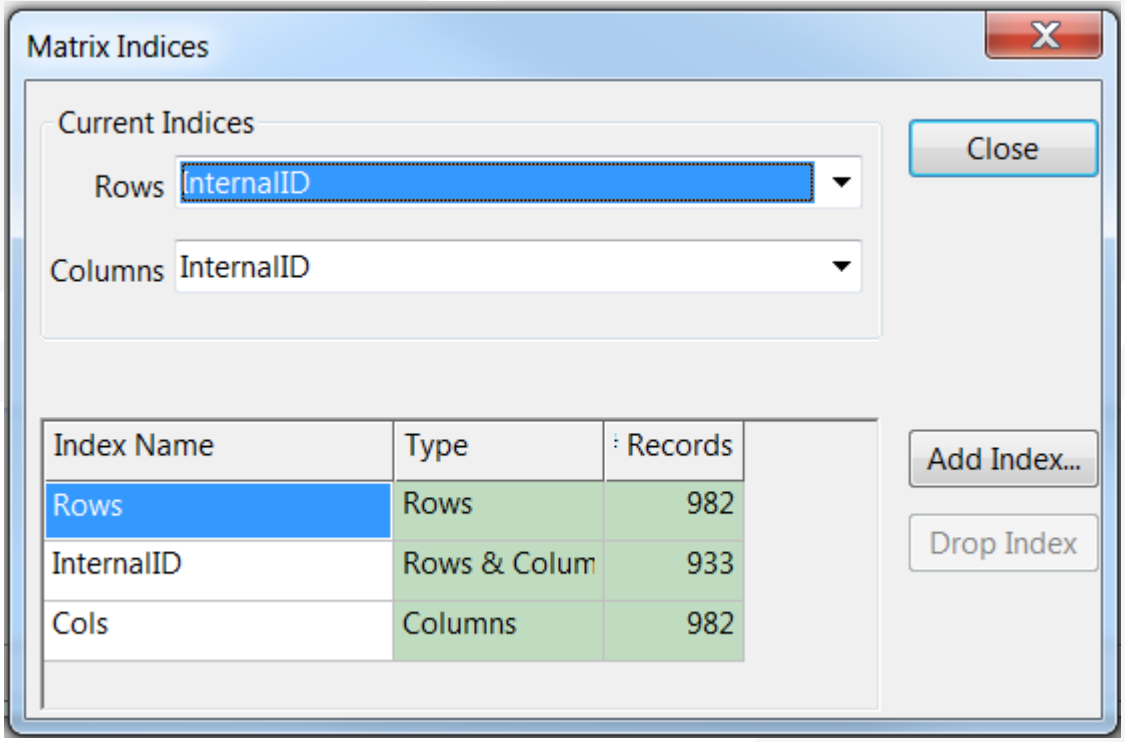
CAMBRIDGE SYSTEMATICS

What We Do

- Review Big Data
- Model Origin-Destination (OD) Matrix
  - Aggregation
- Big Data OD Matrix
  - Disaggregation

Matrix Indexing

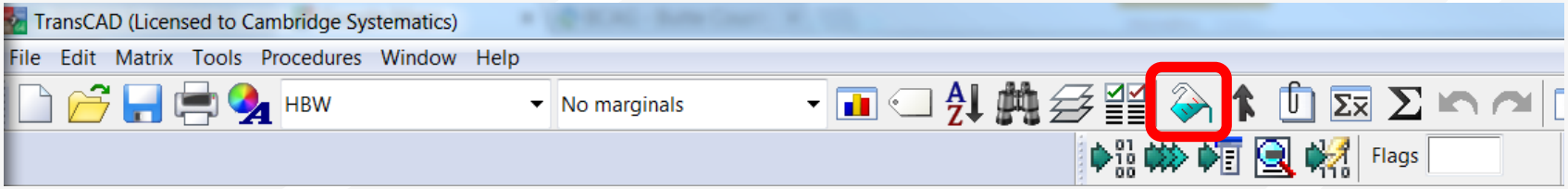
- Re-organize Matrix (partial of TAZs)

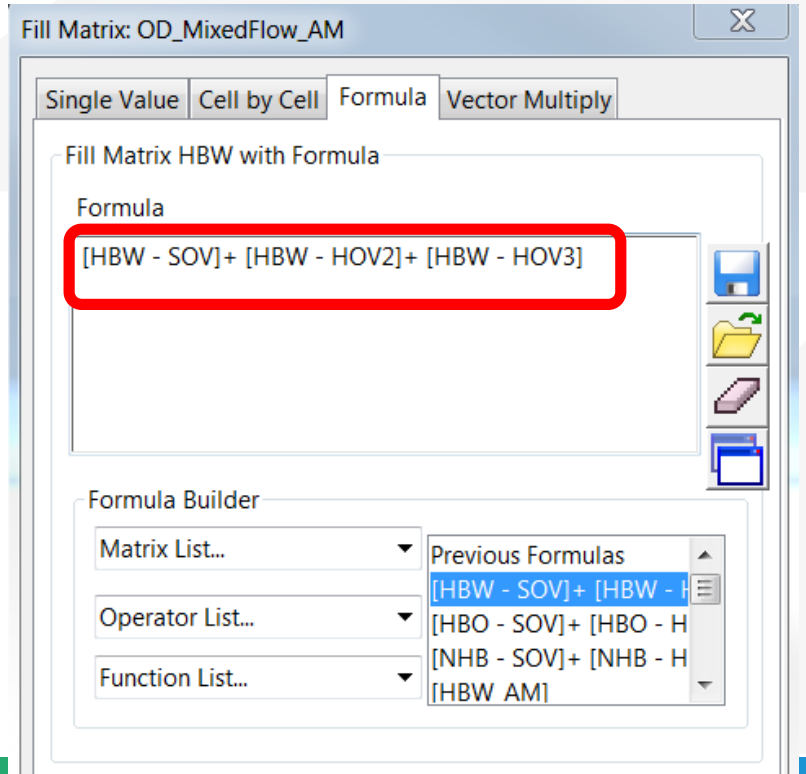


CAMBRIDGE SYSTEMATICS

Matrix Fill

- Merge Matrix Cores by Trip Purposes

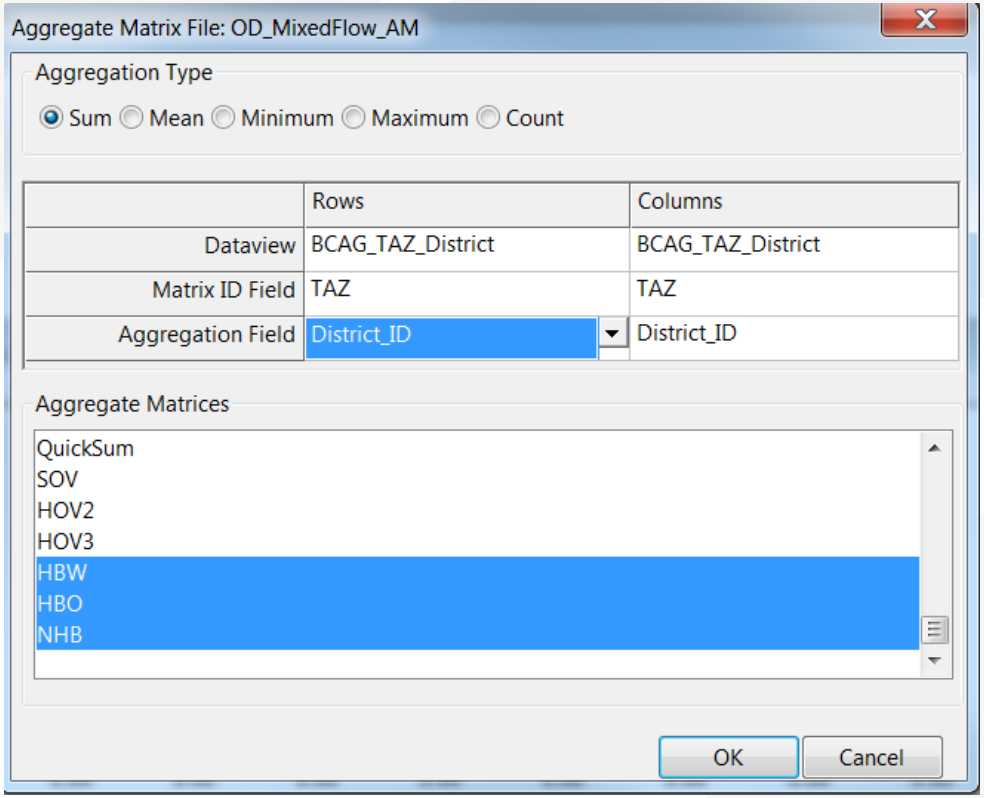


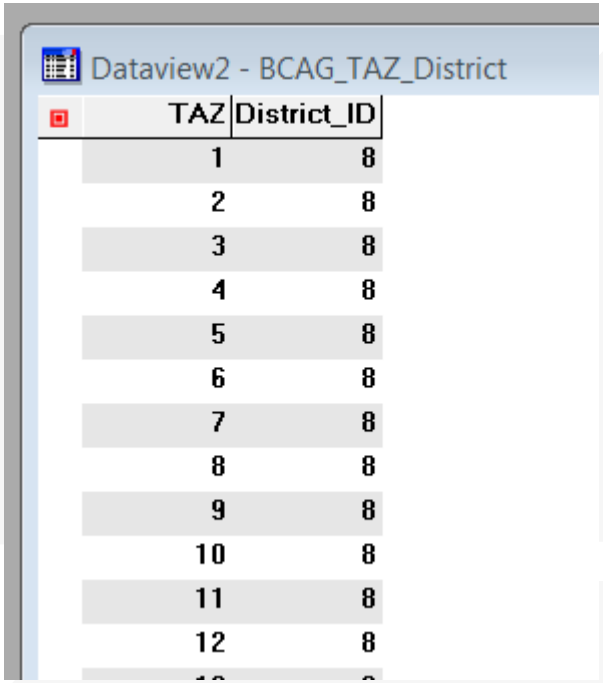


CAMBRIDGE SYSTEMATICS

Matrix Aggregation

- Aggregate Model OD Matrix
  - » TAZ to district mapping





TAZ	District_ID
1	8
2	8
3	8
4	8
5	8
6	8
7	8
8	8
9	8
10	8
11	8
12	8

Matrix Comparison

- Calculate the difference by using formula

Matrix1 - BigData (HBW_AM)

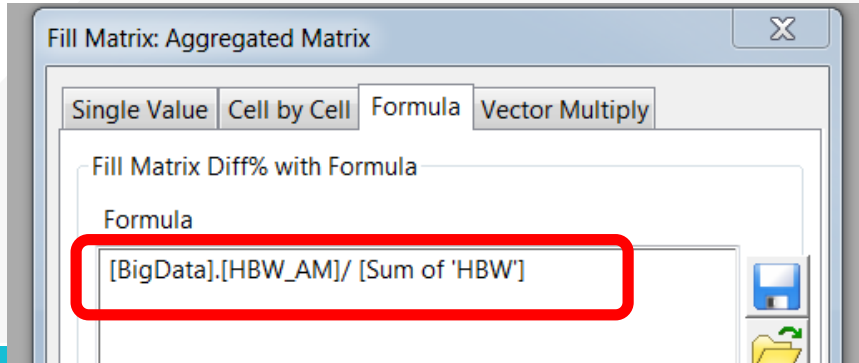
	1	2	3	4	5
1	194.16	26.27	0.19	6.13	0.03
2	74.69	1013.26	0.28	2404.84	2.93
3	2.18	0.71	0.00	0.09	0.00
4	4.64	1321.61	0.01	10000.00	0.33
5	0.70	6.42	0.00	8.94	30.20

Matrix5 - Aggregated Matrix (Sum of 'HBW')

	1	2	3	4	5
1	176.50	23.88	0.17	5.57	0.02
2	67.90	921.15	0.25	2186.22	2.66
3	1.98	0.65	0.00	0.08	0.00
4	4.22	1201.46	0.01	11540.02	0.30
5	0.64	5.84	0.00	8.13	27.45

Matrix5 - Aggregated Matrix (Diff%)

	1	2	3	4	5
1	1.10	1.10	1.10	1.10	1.10
2	1.10	1.10	1.10	1.10	1.10
3	1.10	1.10	1.10	1.10	1.10
4	1.10	1.10	1.10	0.87	1.10
5	1.10	1.10	1.10	1.10	1.10



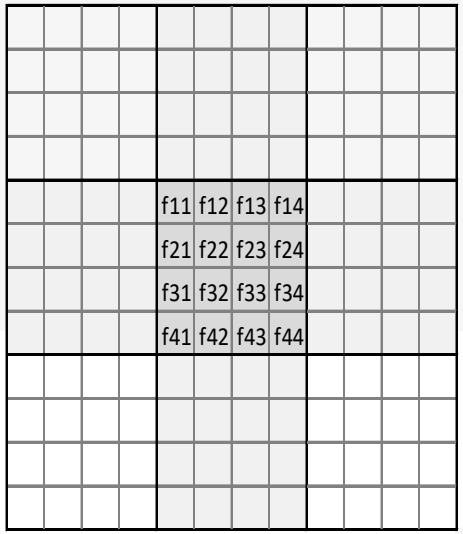
Matrix Disaggregation

SCAG Model Example

AirSage Data

	D	
A	B	C
	E	

SCAG OD Data



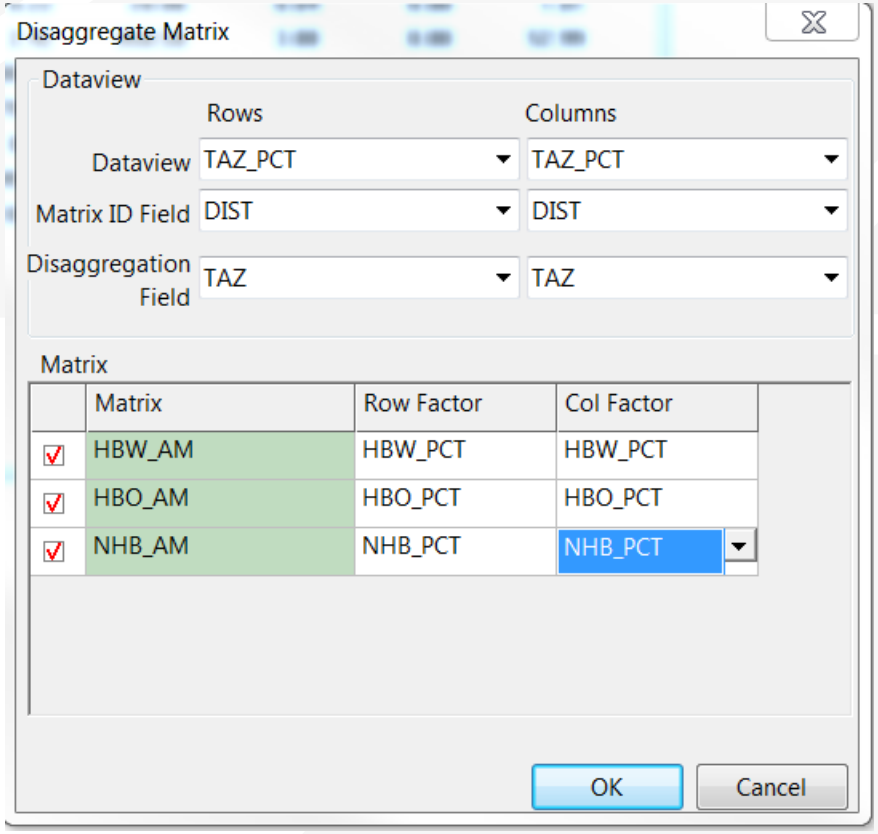
Adjusted AirSage Data (Cell B)

f11 * B	f12 * B	f13 * B	f14 * B
f21 * B	f22 * B	f23 * B	f24 * B
f31 * B	f32 * B	f33 * B	f34 * B
f41 * B	f42 * B	f43 * B	f44 * B

$$fij = \frac{Value_{ij}}{\sum_{i,j\ in\ Zone\ B} Value_{ij}}$$

Matrix Disaggregation

- Open Factor File
- Open BigData_OD Matrix



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Split Matrix Core-Homework

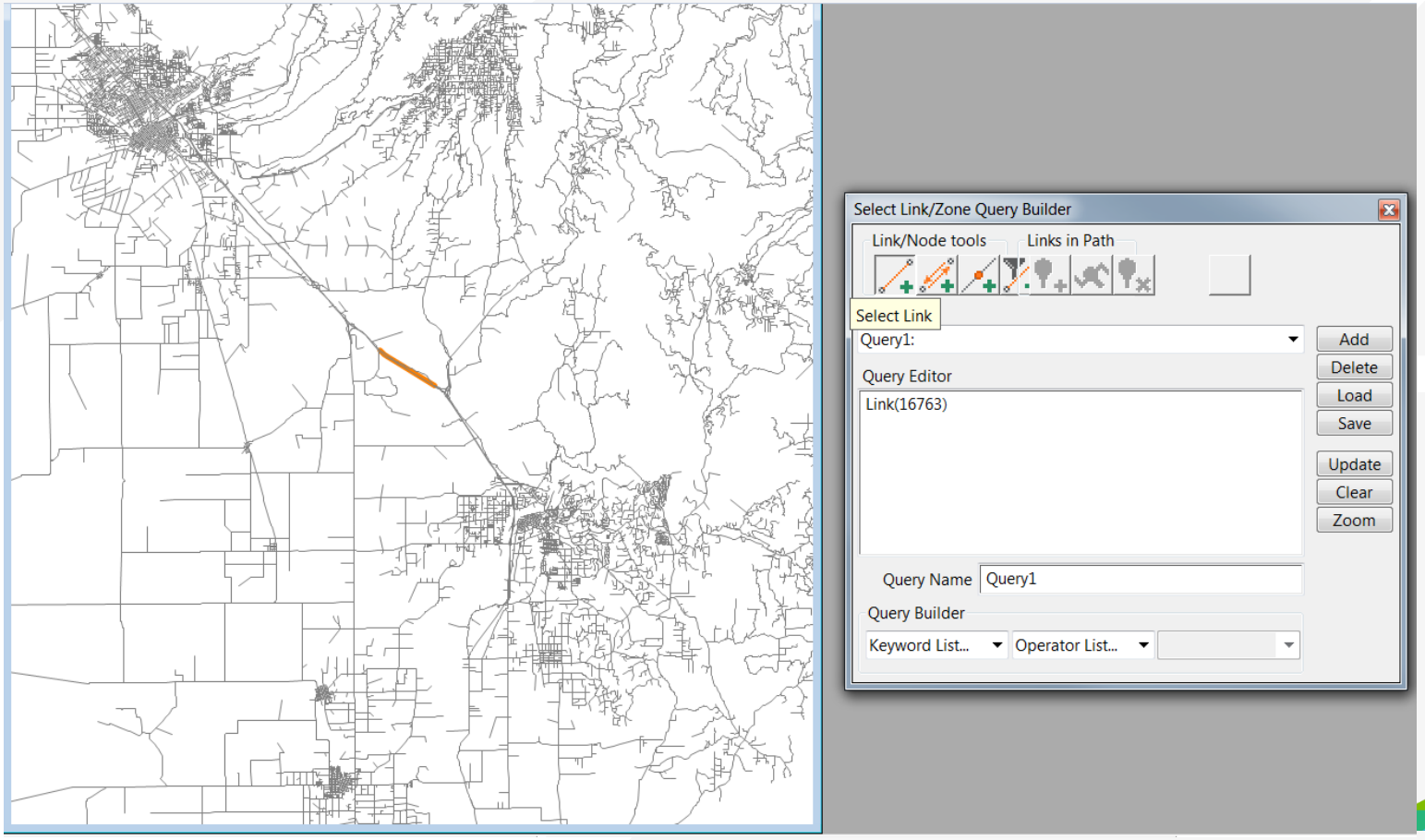
- Split Trip Purpose Total by Modes
- Hint:
  - Percentage of mode within each purpose
  - Formula: HBW_total x Mode_share

Traffic Assignment with Select-Link Analysis

CAMBRIDGE SYSTEMATICS

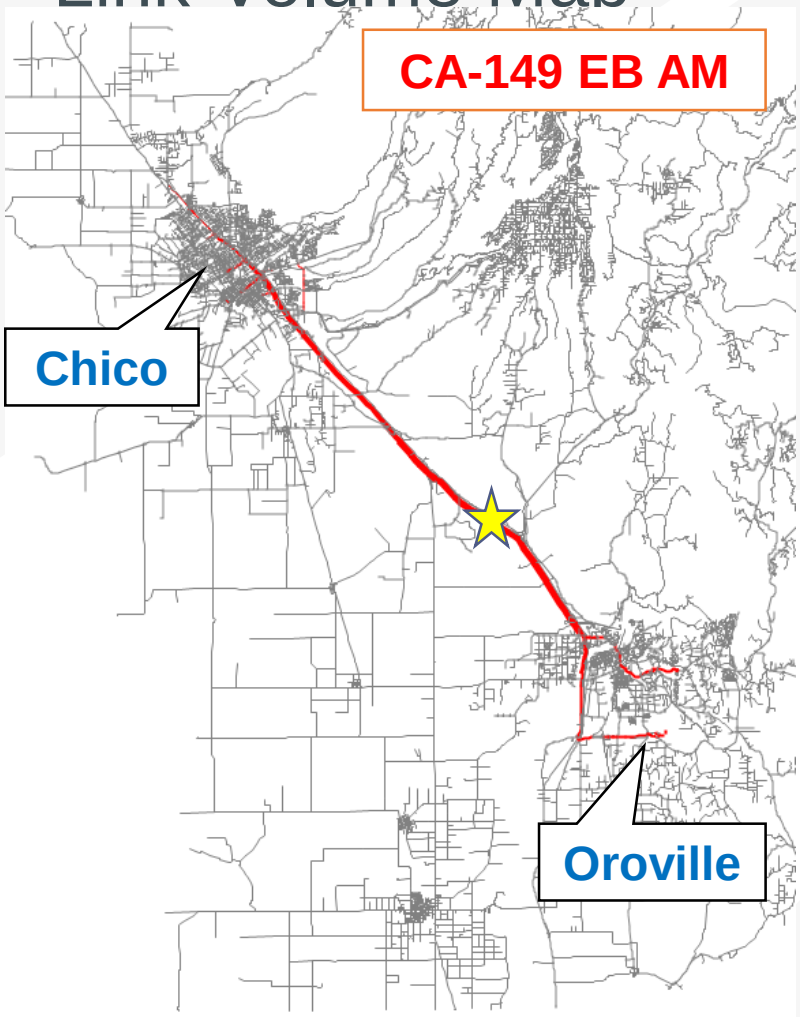
SelectLink Setup

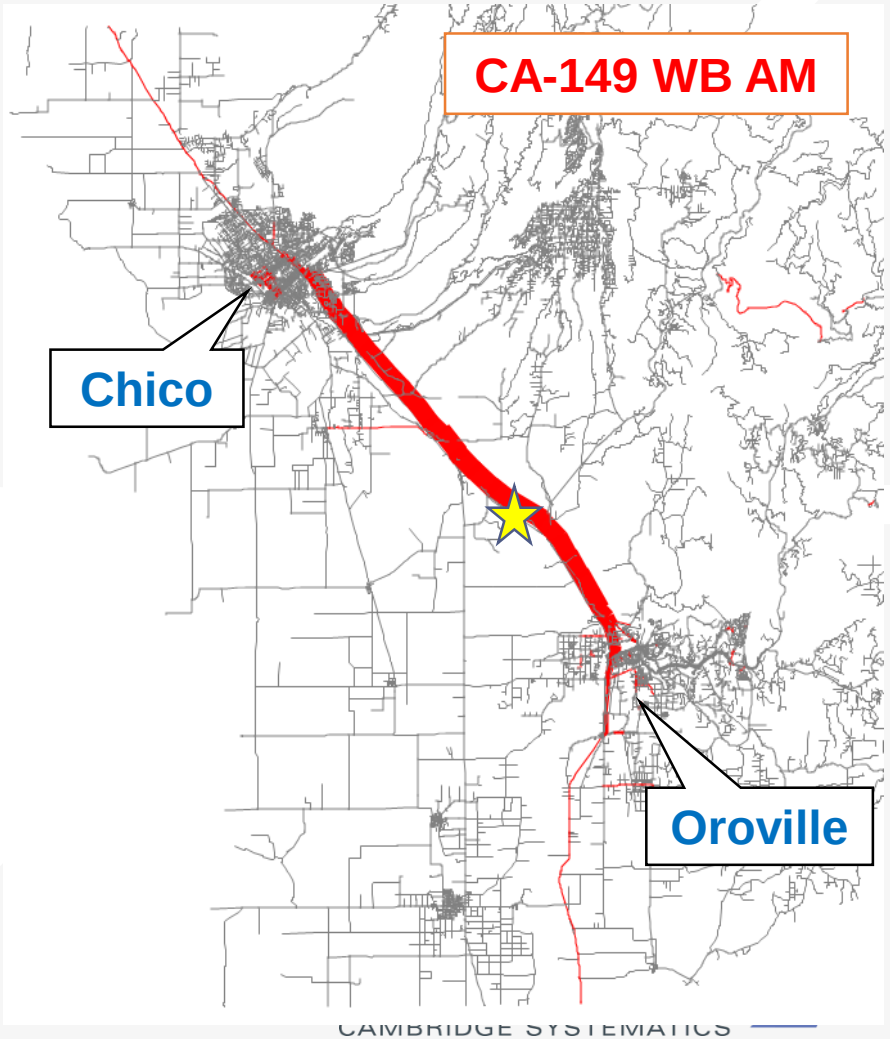
- Input Query Build



SelectLink Analysis

- Link-Volume Map





PA Format Trip Table

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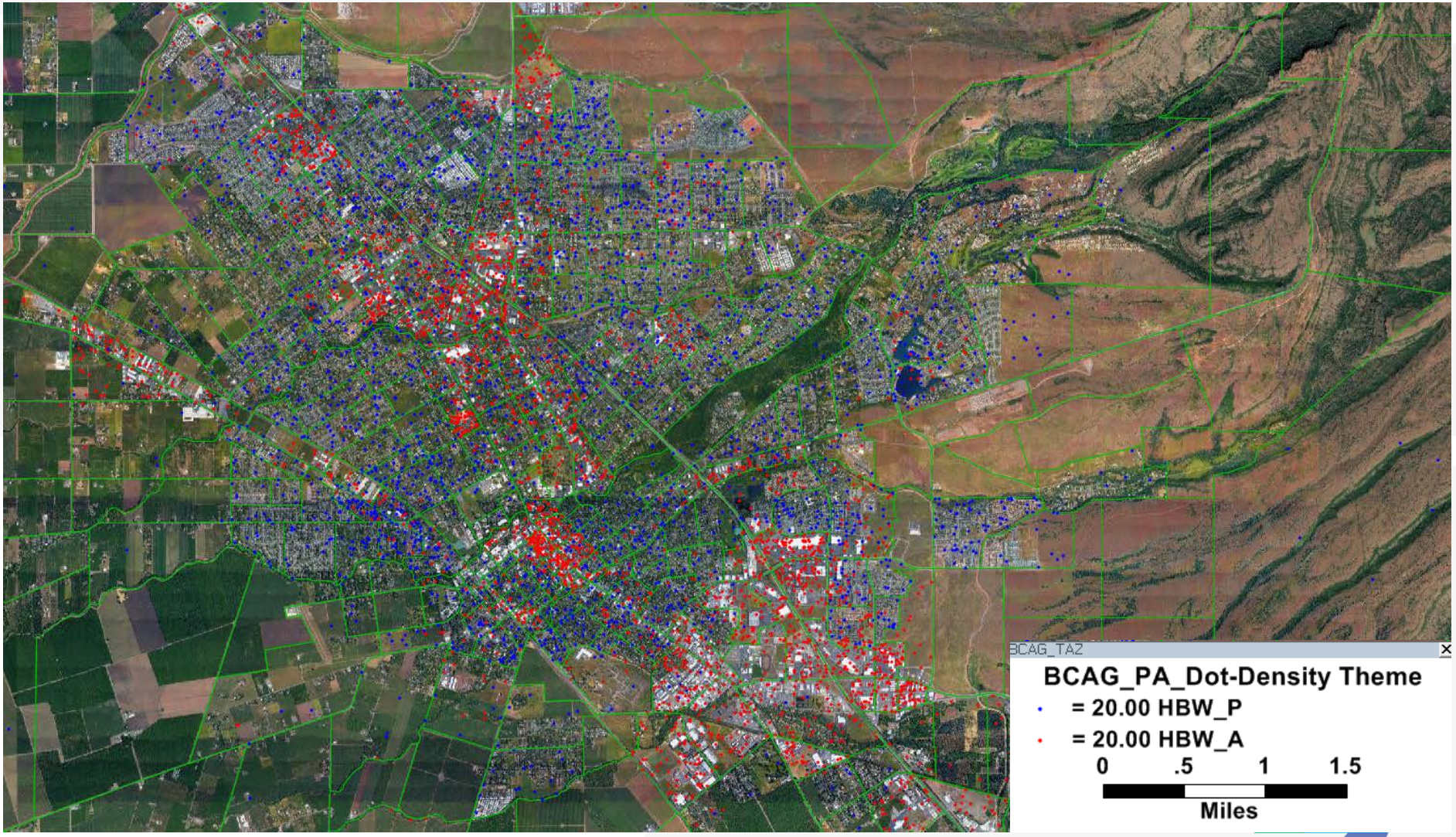
Dot Density P-A Trip Table



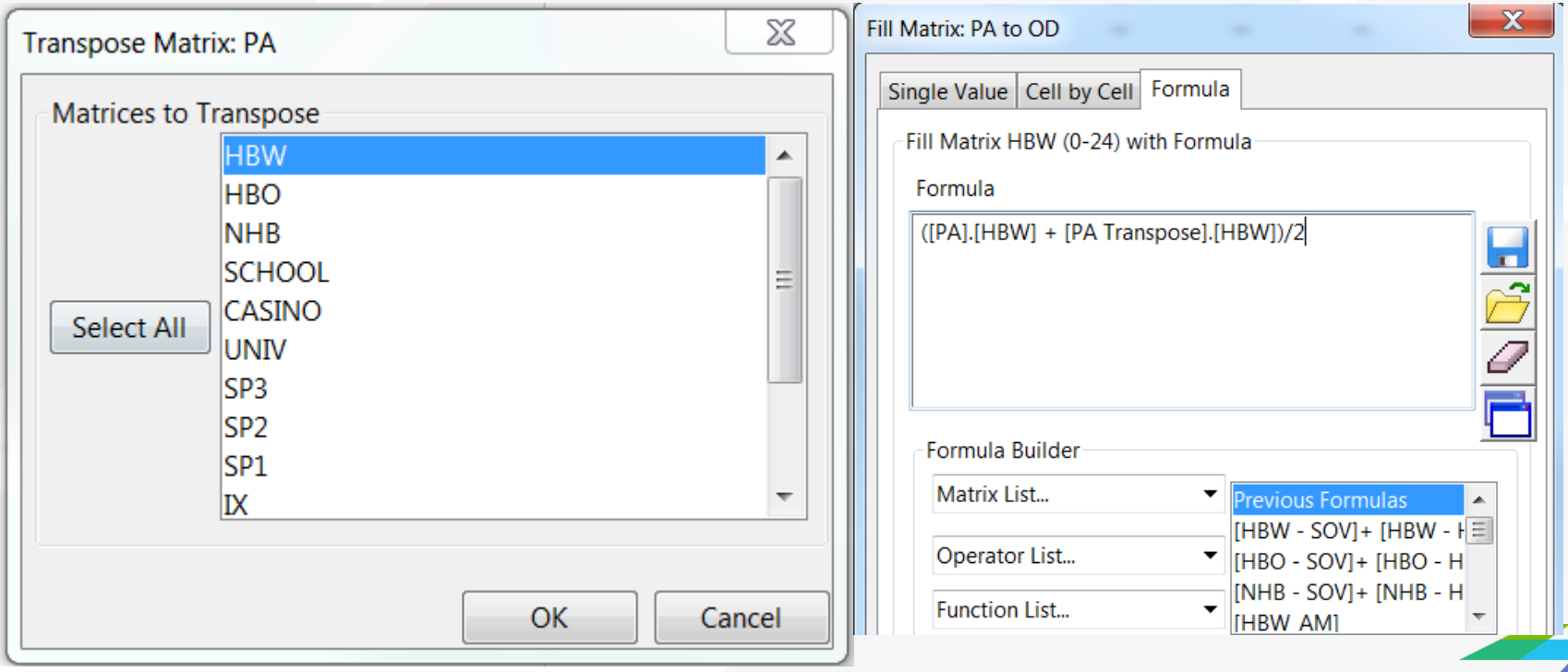
PA2OD

- PA Trips– No Direction
  - HBW trip
    - Go to work: P = Home; A = Work
    - Go Home: P = Home; A = Work
  - PA matrix: two trips from Home zone to Work zone
- OD Trips – Directional travel
  - HBW trip
    - Go to work: O = Home; D = Work
    - Go Home: O = Work; D = Home

PA2OD

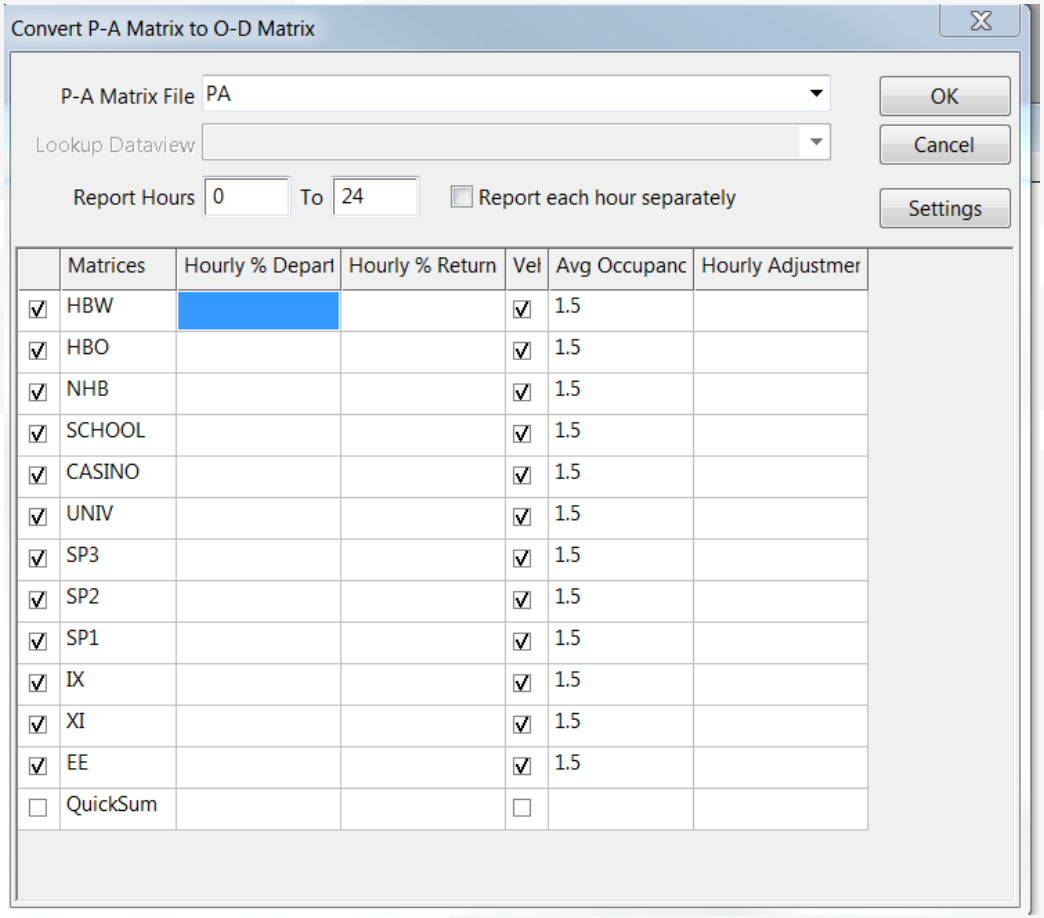
- Methodology

$$OD_{trips} = \frac{PA\_trips + PA\_trips^{T}}{2}$$



PA2OD

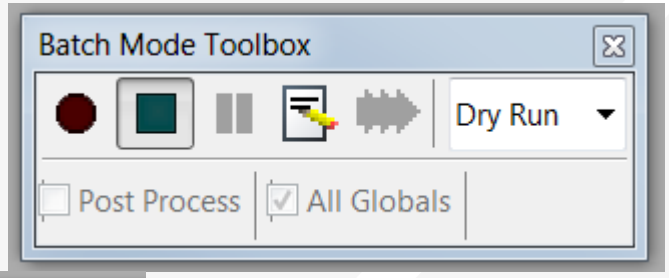
- Interface Operation



CAMBRIDGE SYSTEMATICS

PA2OD GISDK Recording

- Batch Recording
  - » Record standard operation
  - » Customize parameters



PA2OD.rsc - Notepad

File Edit Format View Help

```
Macro "Batch Macro"
    RunMacro("TCB Init")
    input_path = "c:\\users\\xuanliu\\desktop\\d3\\bcag\\2014_copy\\outputs\\matrices\\"
    output_path = "c:\\users\\xuanliu\\documents\\caliper\\transcad 7.0\\"
// STEP 1: PA2OD
    Opts = null
    Opts.Input.[PA Matrix Currency] = {input_path + "PA.mtx", "HBW", "Row ID's", "Col ID's"}
    Opts.Field.[Matrix Cores] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12}
    Opts.Field.[Adjust Fields] = {, , , , , , , , , , , , }
    Opts.Field.[Peak Hour Field] = {, , , , , , , , , , , , }
    Opts.Global.[Method Type] = "PA to OD"
    Opts.Global.[Start Hour] = 0
    Opts.Global.[End Hour] = 23
    Opts.Global.[Cache Size] = 500000
    Opts.Global.[Average Occupancies] = {1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5}
    Opts.Global.[Adjust Occupancies] = {"No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No"}
    Opts.Global.[Peak Hour Factor] = {1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1}
    Opts.Flag.[Separate Matrices] = "No"
    Opts.Flag.[Convert to Vehicles] = {"Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes"}
    Opts.Flag.[Include PHF] = {"No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No"}
    Opts.Flag.[Adjust Peak Hour] = {"No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No", "No"}
    Opts.Output.[Output Matrix].Label = "PA to OD"
    Opts.Output.[Output Matrix].Compression = 1
    Opts.Output.[Output Matrix].[File Name] = output_path + "PA2OD.mtx"
    ok = RunMacro("TCB Run Procedure", "PA2OD", Opts, &Ret)
    if !ok then goto quit
    quit:
        Return( RunMacro("TCB Closing", ok, True ) )
endMacro
```

CAMBRIDGE SYSTEMATICS