

# SCAG Activity-Based Model Development Workshop

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Modeling Task Force  
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# Model Development Team

## Consultants:

**UCSB:** *Dr. Kostas Goulias* (Prime)

**UT Austin:** *Dr. Chandra Bhat*

**ASU:** *Dr. Ram Pendyala*

## SCAG:

**Program Manager:** *Hsi-Hwa Hu*

**Model Estimation and Calibration:**

*Bayarmaa Aleksandr*

**Software/Model Operation:** *Hao Cheng*

**Model Validation:** *Mana Sangkapichai and  
Sung Su Yoon*

**Travel survey and data:** *Yongping Zhang*

# Model Concept

- The Activity-Based Travel Demand Modeling (ABM) is a agent-based model in which individuals and their interaction with each other and their environment are explicitly represented.
- The activity-based approach views travel as a derived demand to pursue activities.
  - It considers the all-important link between **activity participation behavior** and **travel behavior**,
  - It accommodates the interaction among different activities pursued by an **individual**, and
  - It accommodates the interaction between the **temporal** and **spatial** dimensions of activity participation.

# Model Application

- SCAG ABM will be fully implemented for the **2016 RTP/SCS.**
- The model will generate performance indicators, conformity analysis, and environmental justice analysis.
- To analyze the impact of infrastructure investment, land use development, pricing policy, active transportation, high speed rail, and travel demand management.

# Motivation

RTP Guideline by California Transportation Commission - the largest four MPOs in California are encouraged to transition to **activity-based travel demand** models.

# Progress

**Oct. 2008**

SCAG decided to develop an activity-based model for the region

**April 2009**

SCAG launched ABM development project

**Jan. 2013**

End of Stage 1 development

# Stage 1 Model Development

A

- **Task 1: Modeling Framework Setup**
  - Based on CEMDAP (UT Austin)

B

- **Task 2: Initial Estimation**
  - Three Core Modules
  - Based on 2001 Travel Survey

C

- **Task 3: Initial Calibration**
  - Base Year 2003

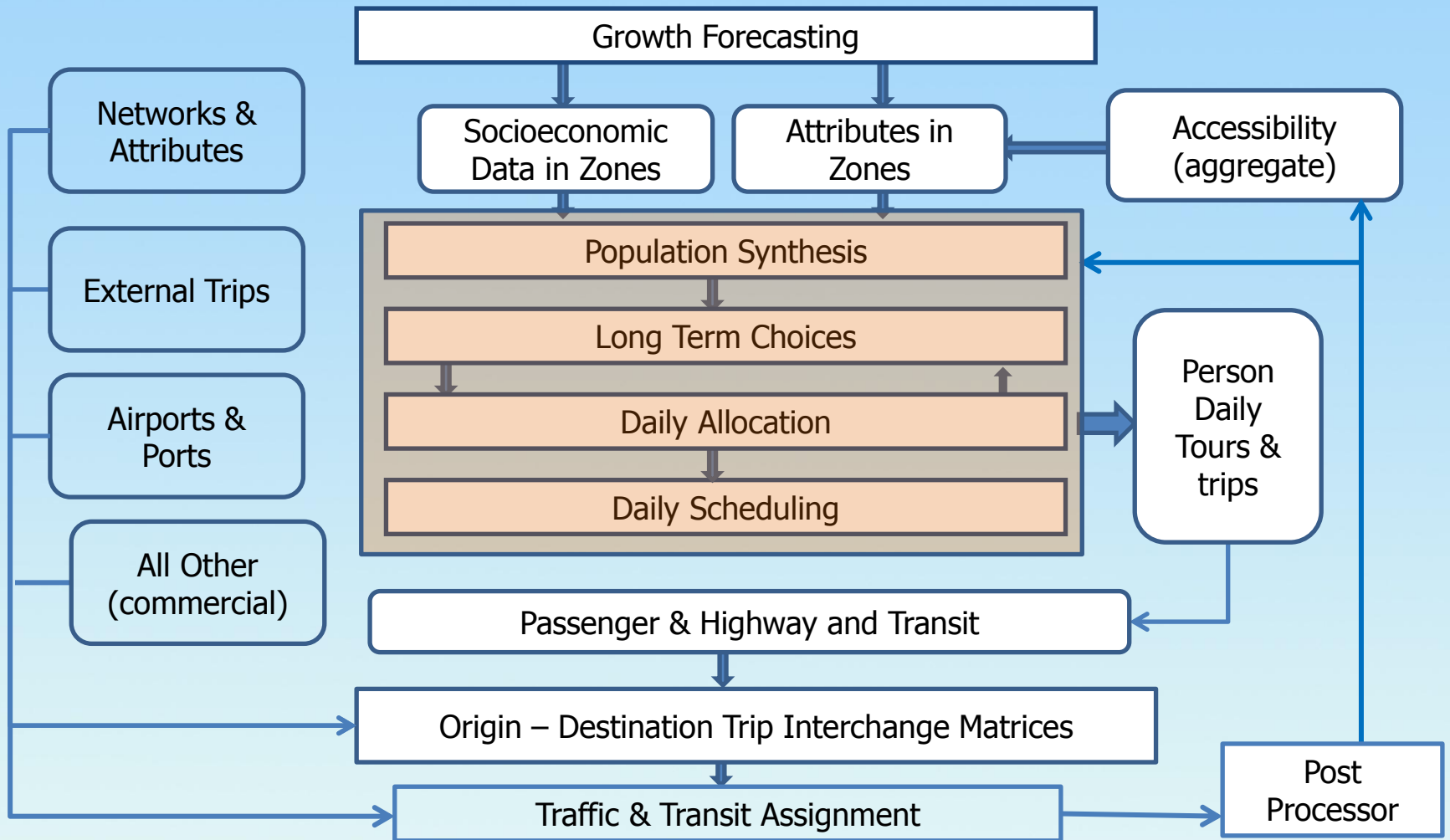
# **OVERVIEW OF SCAG ABM**



# About SCAG ABM

- Simulates daily activities and travel patterns for each person (**18 million +**) of SCAG region
- Creates rich socioeconomic characteristics for each person
- Outcome of ABM = every person with a day timer attached to them – just like travel survey
- Model outputs are converted to OD matrix, and input to assignment

# SCAG ABM Flowchart



# Salient Features of SCAG ABM

- Comprehensively characterizes the activity-travel patterns of all household members
- Incorporates **spatial-temporal dependencies and constraints** between and within individuals of a household
- Incorporates advanced **vehicle type choice model**, which determines the mix of vehicles in a fleet

# Salient Features of SCAG ABM

- Enables a holistic assessment of the effects of **land-use, built environment, and transportation policies** on entire activity-travel patterns.
- Facilitates **environmental justice (EJ)** analyses by having the ability to examine the effects of policies on any defined segment.
- **Accessibility** indicator is used as model input. It is sensitive to time of day, availability of opportunities, and variation of transportation LOS, offering increased **behavioral realism and behavioral sensitivity**.

# Salient Features of SCAG ABM

## Temporal Resolution

- Continuous time scale

- **Spatial Resolution**

- Allows for any number of zones

# Salient Features of SCAG ABM

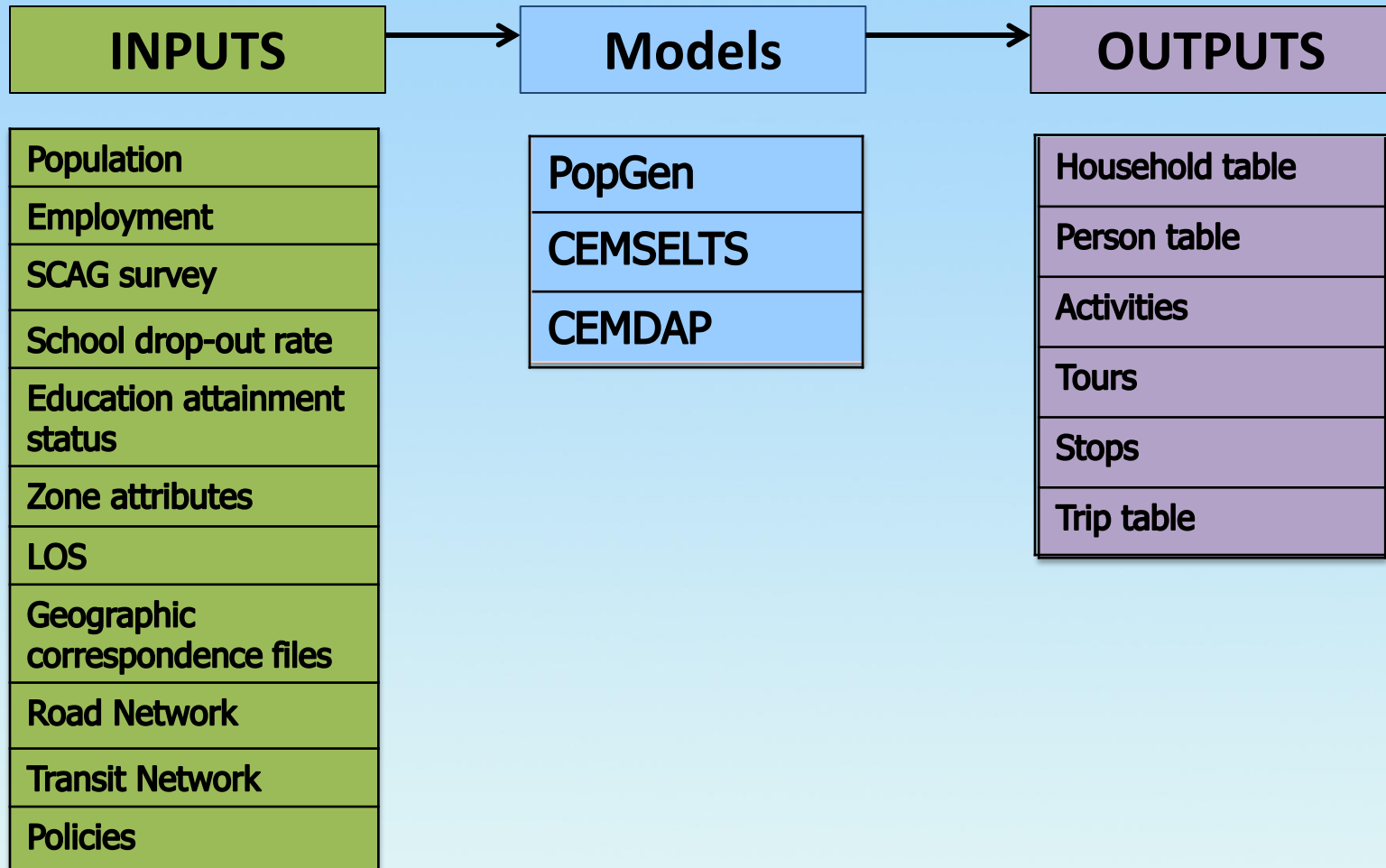
## Software

- Involves a portable and flexible object-oriented software architecture design
- Standard Window-based user interface
- Allows user to modify model parameters
- Provides a friendly interface to help the user understand the logic of the system and the underlying models

# SCAG ABM Framework: SimAGENT

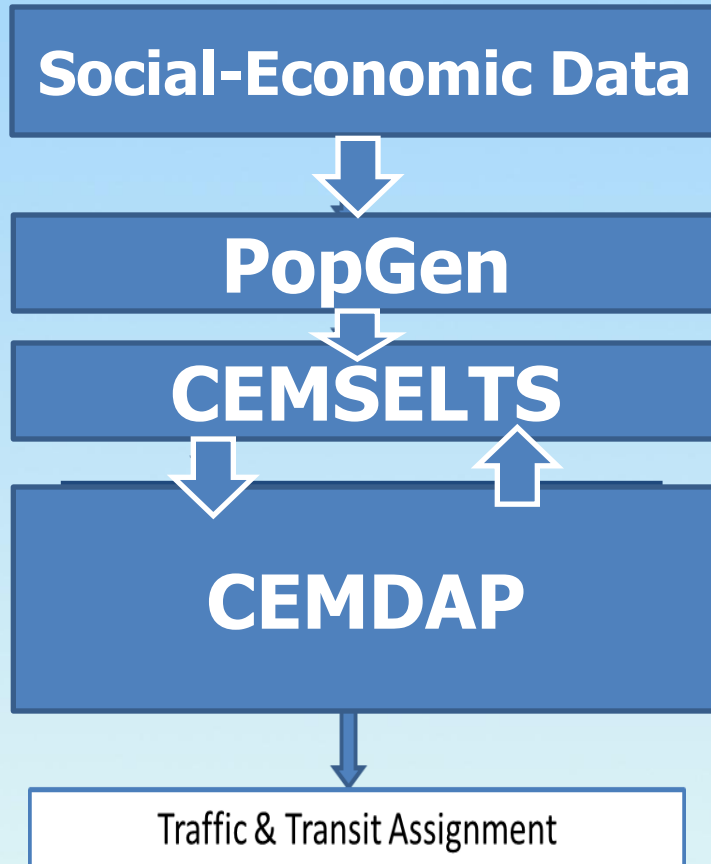
- **SimAGENT** (*Simulator of Activities, Greenhouse Emissions, Networks, and Travel*) is the base framework of SCAG ABM.
- **SimAGENT** is a model system that includes 3 core modules:
  - **PopGen**: a synthetic population generator,
  - **CEMSELTS**: a disaggregated socioeconomic module, including work location and vehicle ownership/type sub-models,
  - **CEMDAP**: a daily activity and travel scheduling module

# SimAGENT Model System





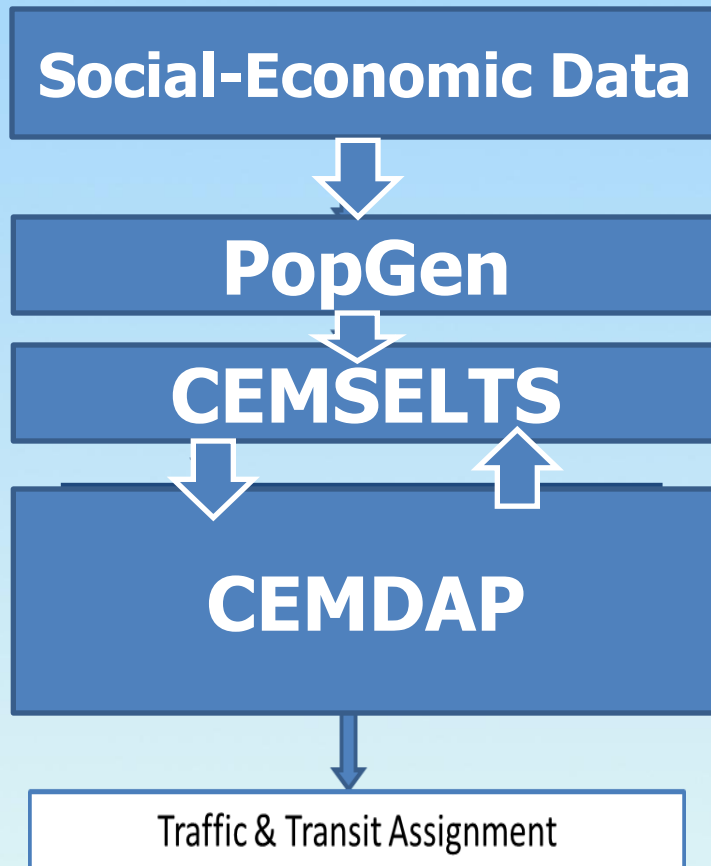
# SimAGENT Sequence and Modules



**PopGen** generates eight basic socioeconomic attributes for each of the region's 18+ million population.

| HHID | PerID | Res. TAZ | <i>Person Characteristics</i> |        |          | <i>HHld Characteristics</i> |         |
|------|-------|----------|-------------------------------|--------|----------|-----------------------------|---------|
|      |       |          | Age                           | Gender | Race     | Hhsiz                       | HH Type |
| 1    | 1     | 1121     | 36                            | Male   | Hispanic | 3                           | Married |
| 1    | 2     | 1121     | 33                            | Female | Hispanic | 3                           | Married |
| 1    | 3     | 1121     | 9                             | Female | Hispanic | 3                           | Married |
| 2    | 1     | 1121     | 66                            | Female | Asian    | 1                           | Alone   |
| 3    | 1     | 2114     | 52                            | Male   | White    | 4                           | Married |
| 3    | 2     | 2114     | 48                            | Female | White    | 4                           | Married |
| 3    | 3     | 2114     | 21                            | Male   | White    | 4                           | Married |
| 3    | 4     | 2114     | 17                            | Female | White    | 4                           | Married |

# SimAGENT Sequence and Modules

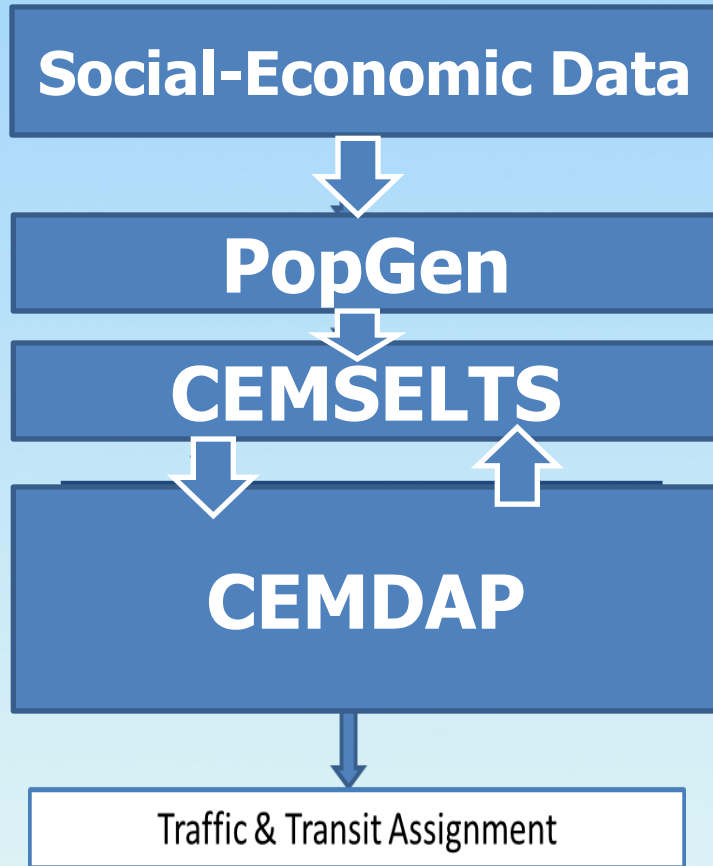


**CEMSELTS\*** generates additional person and household socioeconomic attributes that fed to CEMDAP to simulate daily activity-travel patterns.

|      |       | <i>Person Characteristics</i> |            |          | <i>HHId Characteristics</i> |       |         |
|------|-------|-------------------------------|------------|----------|-----------------------------|-------|---------|
|      |       | Work/Scl                      |            | Work/Scl |                             |       | Housing |
| HHID | PerID | Status                        | Education  | TAZ      | Hhid Inc                    | # Car | Type    |
| 1    | 1     | Worker                        | Master     | 1334     | \$75-\$100K                 | 2     | SF      |
| 1    | 2     | N-Worker                      | Master     | n/a      | \$75-\$100K                 | 2     | SF      |
| 1    | 3     | Student                       | Elementery | 1121     | \$75-\$100K                 | 2     | SF      |
| 2    | 1     | N-Worker                      | College    | n/a      | < \$25K                     | 0     | MF      |
| 3    | 1     | Worker                        | Bechalor   | 2145     | > \$100K                    | 3     | SF      |
| 3    | 2     | Worker                        | Cechalor   | 2113     | > \$100K                    | 3     | SF      |
| 3    | 3     | Student                       | College    | 1334     | > \$100K                    | 3     | SF      |
| 3    | 4     | Student                       | High Scl   | 2114     | > \$100K                    | 3     | SF      |

\* *C*omprehensive *E*conometric *M*icrosimulator of *S*ocio-economics, *L*and-use, and *T*ransportation *S*ystem

# SimAGENT Sequence and Modules



**CEMDAP\*** is the core module that simulates activity schedule and travel characteristics for each individual of the region.

*Household ID = 1; Person ID = 2*

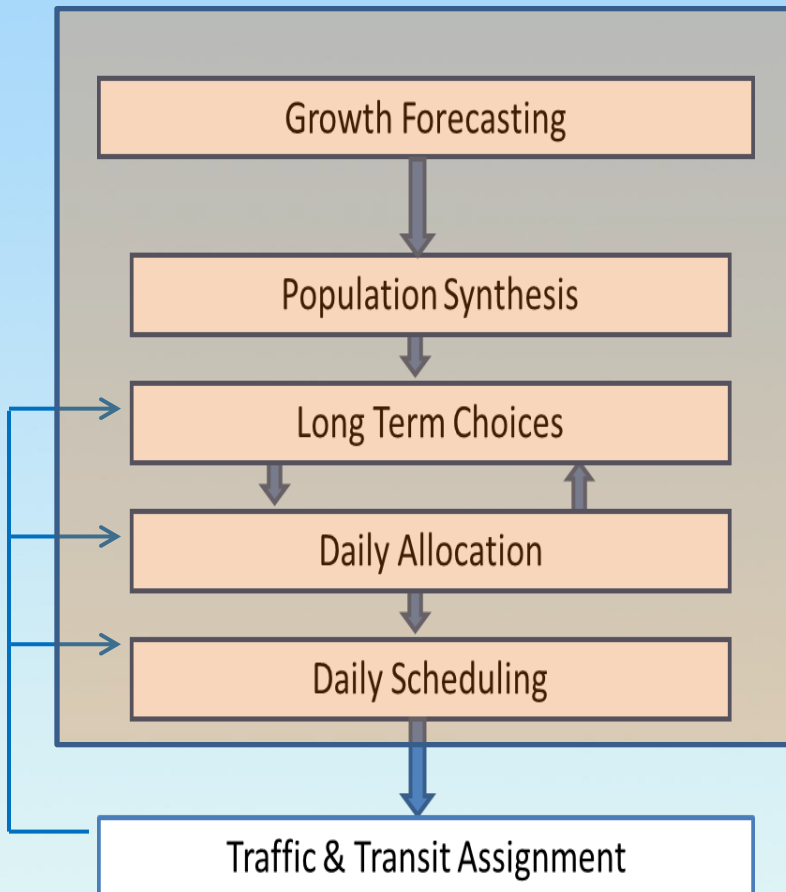
| HH ID | Per. ID | Tour ID | Stop ID | Activity | Origin | Dest. | Start Time | Travel Time | Duration | Mode |
|-------|---------|---------|---------|----------|--------|-------|------------|-------------|----------|------|
| 1     | 2       | 1       | 1       | P. Busi  | 1121   | 1126  | 8:30       | 10 mins     | 30 mins  | Walk |
| 1     | 2       | 1       | 2       | Home     | 1126   | 1121  | 9:10       | 10 mins     |          | Walk |
| 1     | 2       | 2       | 1       | Eating   | 1121   | 1156  | 11:40      | 20 mins     | 60 mins  | Auto |
| 1     | 2       | 2       | 2       | Shopping | 1156   | 2113  | 13:00      | 15 mins     | 45 mins  | Auto |
| 1     | 2       | 2       | 3       | Home     | 2113   | 1121  | 14:00      | 20 mins     |          | Auto |

\* **C**omprehensive **E**conometric **M**icrosimulator of **D**aily **A**ctivity-**T**ravel **P**atterns

# SimAGENT Sequence and Modules

- From SCAG ABM output, for each person, we have information about the type of activity, when, where, how long, how to travel, with whom, in what sequence, and interrelationships with other persons and locations in the engagement pattern.

# Assignment



- CEMDAP output is converted to **OD** matrix as input for assignment
- Using the same assignment module from **SCAG Trip-based Model** in TransCAD
- Feedback LOS & accessibility

# Current Status

## Three Core Modules and Software

- PopGen, CEMSELTS, CEMDAP

## 67 Sub-Models

- Estimated Based on 2001 Travel Survey

## Research

- Papers and Conference Presentations

Continuing Research and Model Enhancement

# CORE MODULES

PopGen

Generates complete synthetic population by expanding the **disaggregate sample data** to mirror known **aggregate distributions** of household and person variables of interest.

CEMSELTS

- Create additional variables for each individual
- Create Long-Term Choice Variables

CEMDAP

Simulates activity schedule and travel characteristics for each individual of the region

## Population Synthesizer

# PopGen – A Population Synthesizer

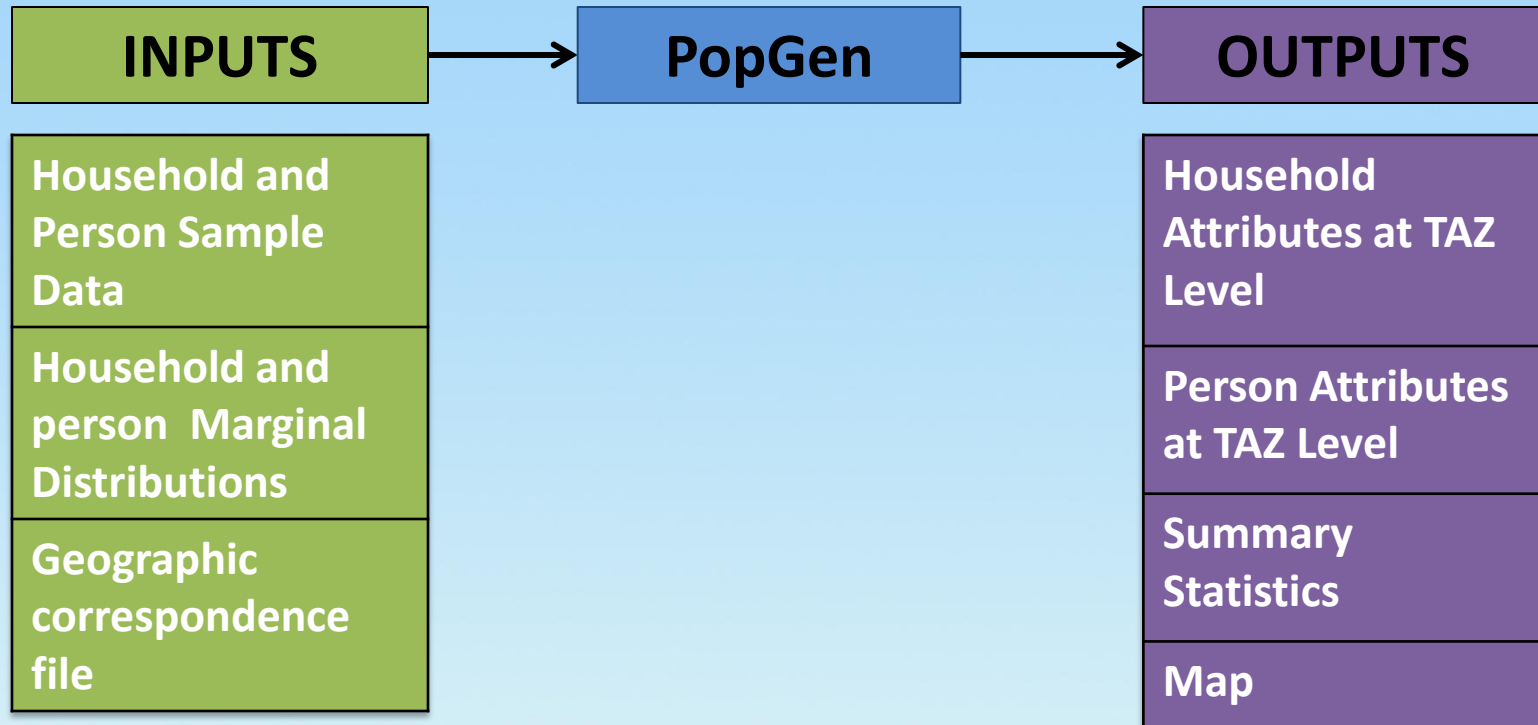
- Activity-based model estimates travel decisions for each person – need a population synthesizer to create socioeconomic data for each person
- PopGen is an advanced population synthesizer developed at Arizona State University.
- It uses Iterative Proportional Updating (IPU) method which can simultaneously control **household** and **person** attributes.



# PopGen Procedure

- PopGen generates complete synthetic population by expanding the **disaggregate sample data** to mirror known **aggregate distributions** of household and person variables of interest.
  - Disaggregate sample data of the population
    - *PUMS, ACS, travel survey (SCAG uses ACS)*
  - Marginal distribution for the entire region: *census summary files, agency forecasts*
    - *SCAG Forecasting unit develops marginal distribution by TAZs*

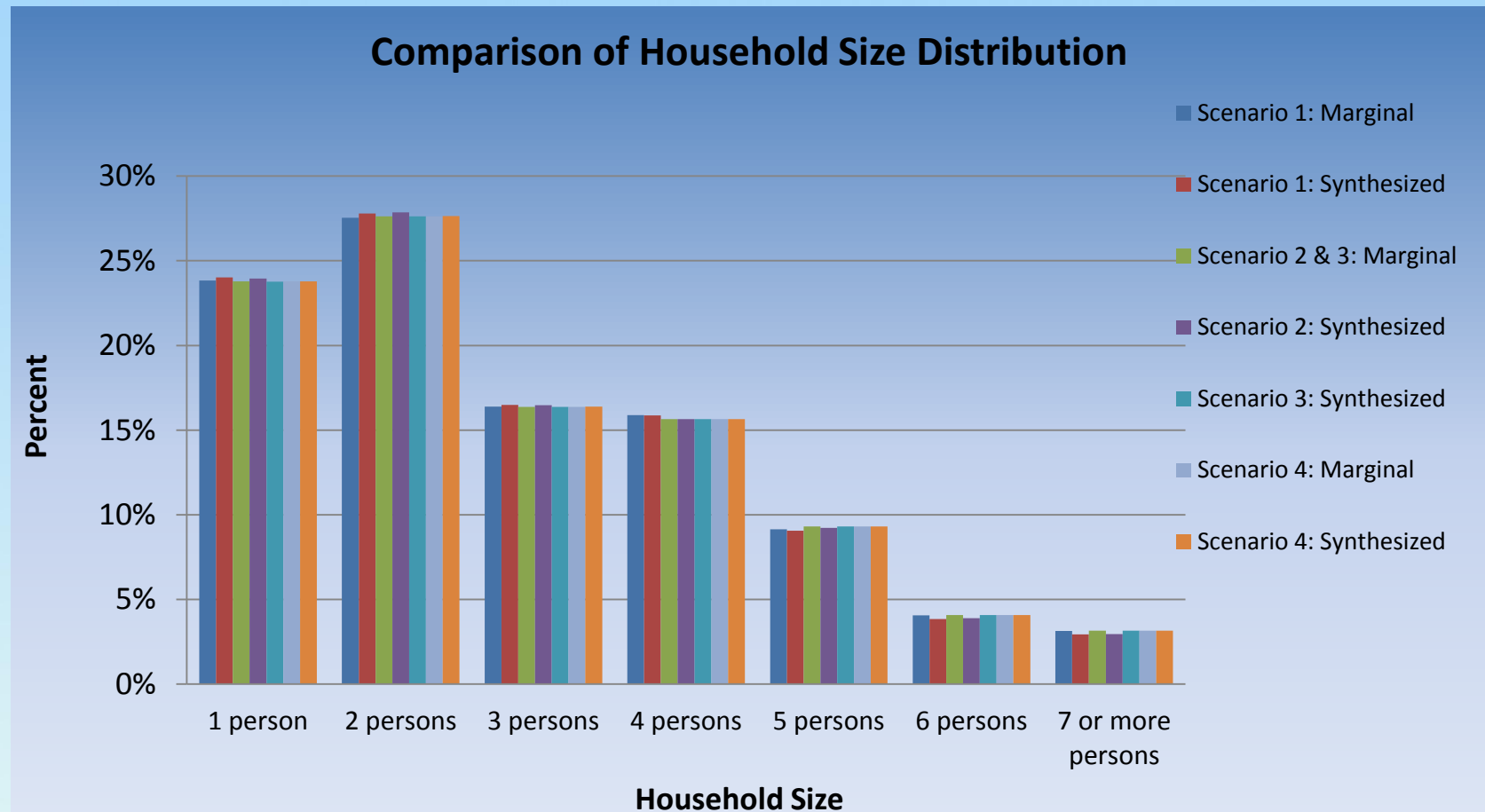
# SCAG Population Synthesizer



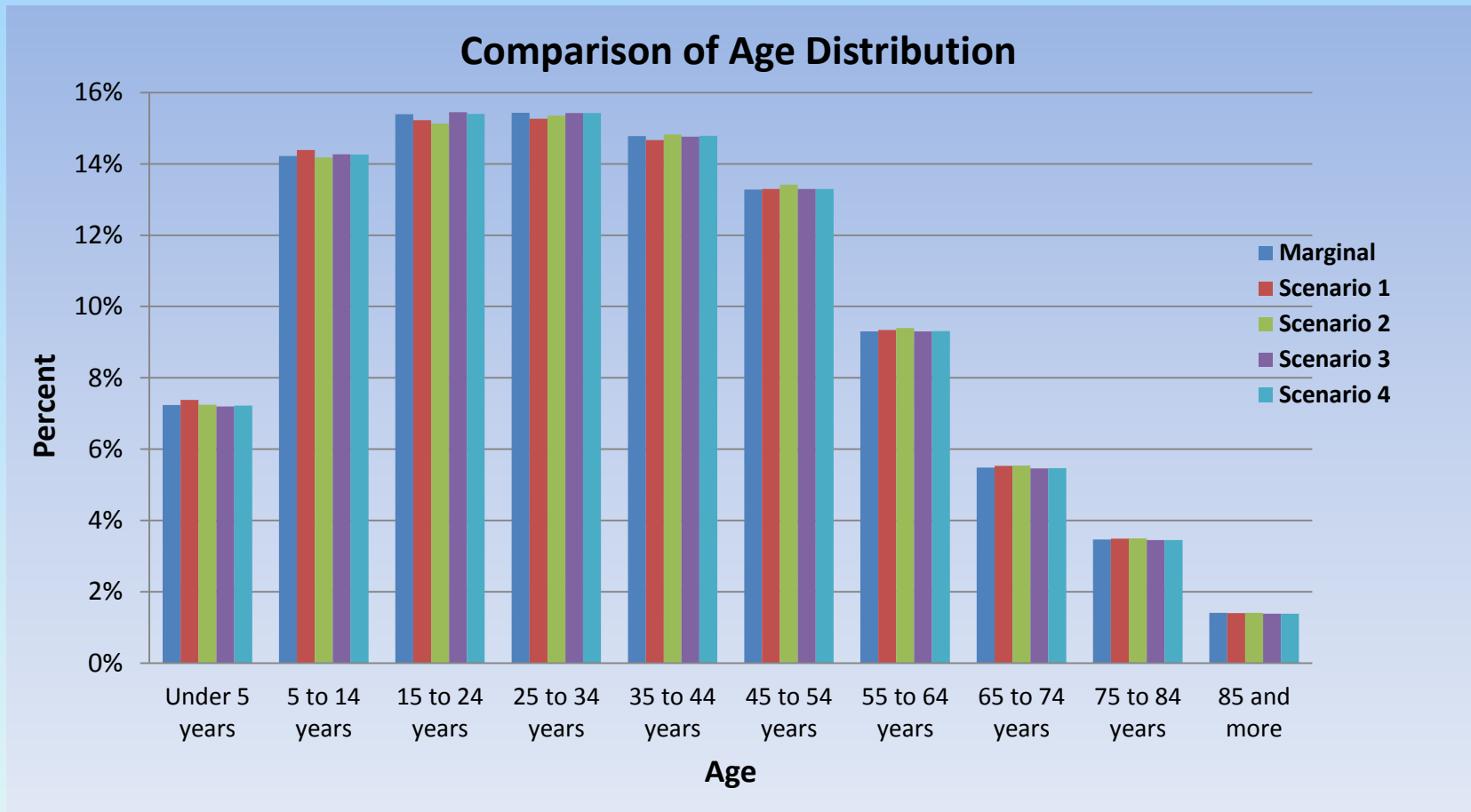
# Features of PopGen

- Controls for both household and person attributes
- Automatically corrects for zero-marginal and zero-cell problems
- Computationally tractable method implemented in user-friendly Windows systems
- Provides goodness-of-fit measures to assess performance of population synthesis process

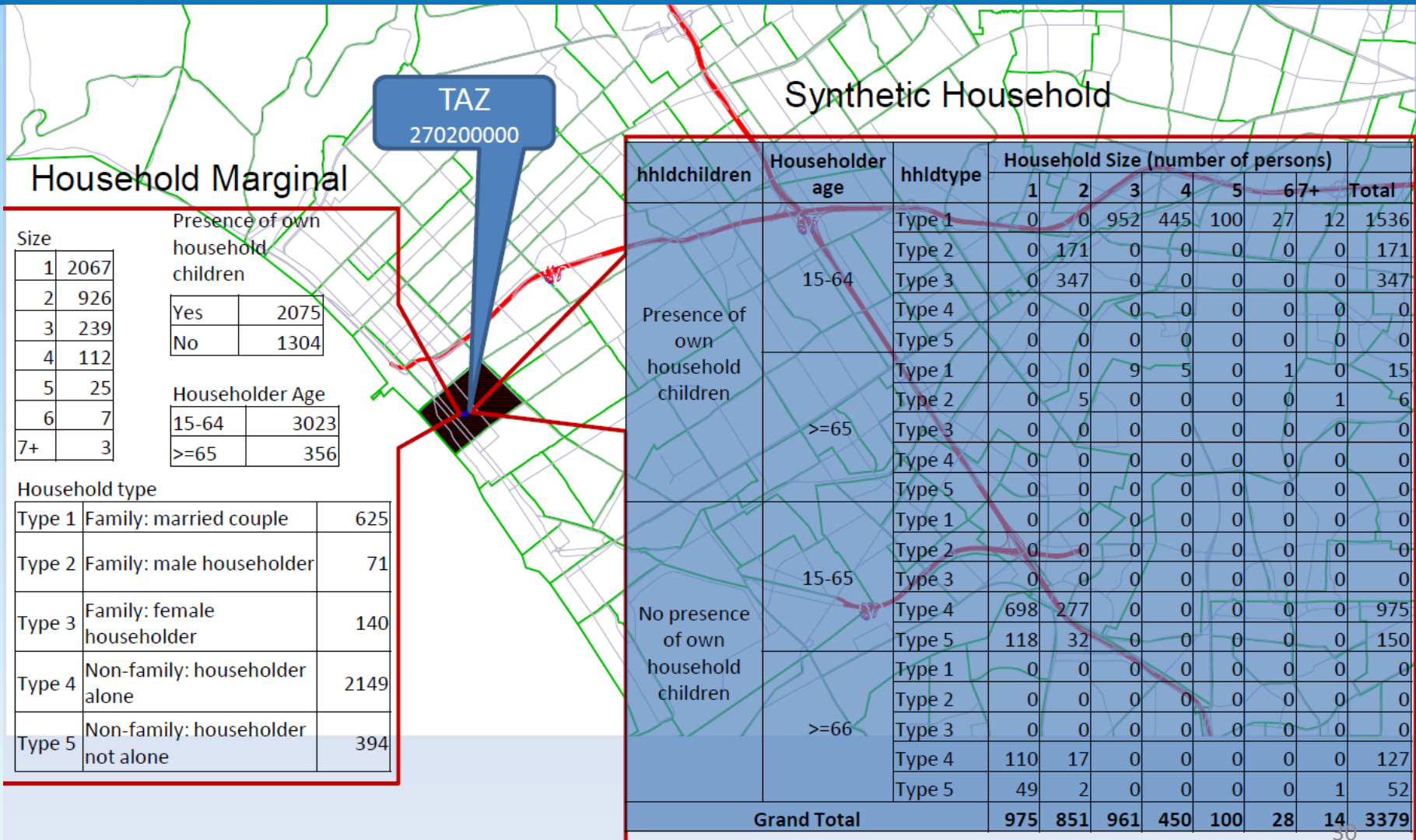
# Results – Example of Household Outputs



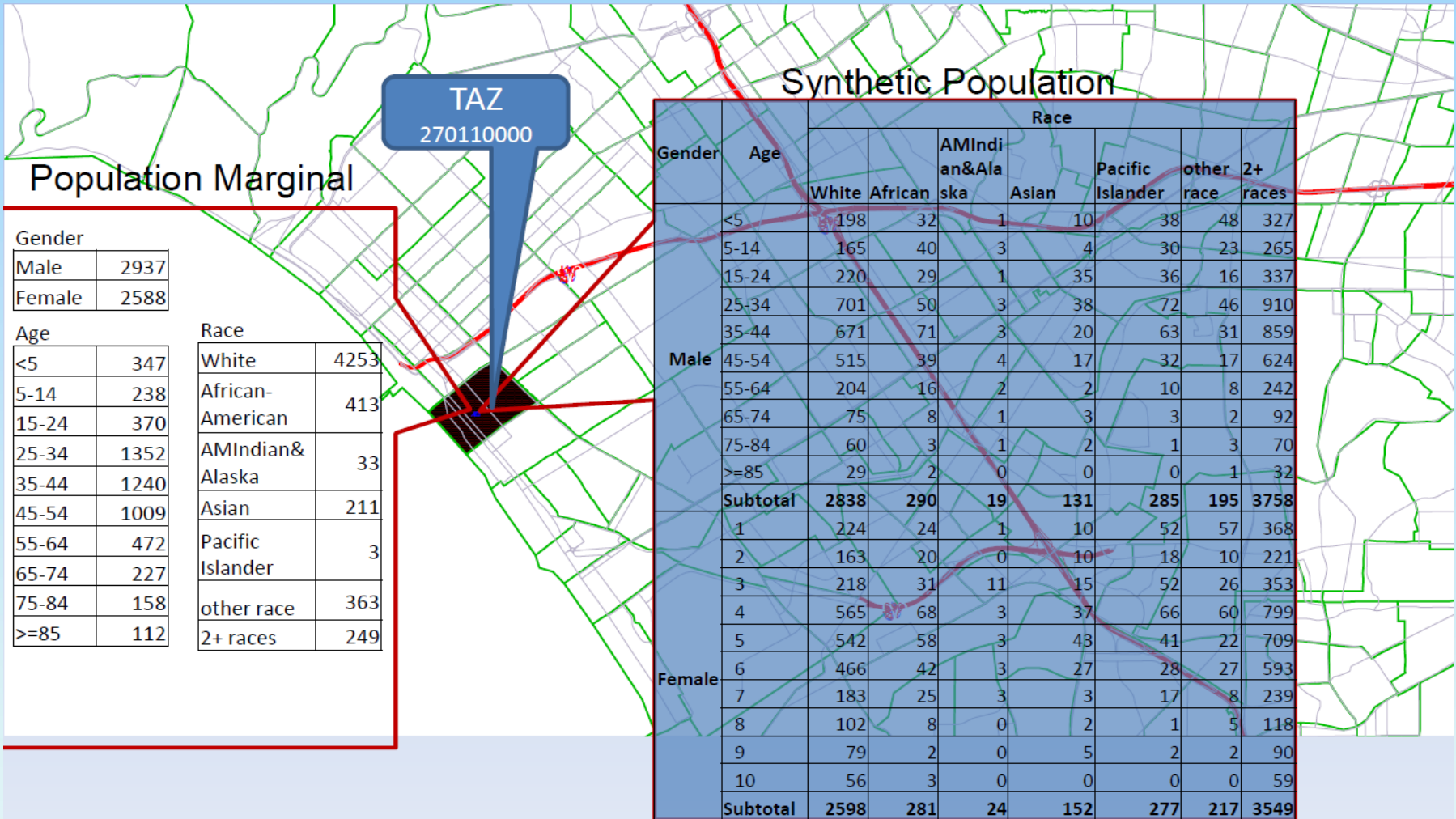
# Results – Example of Population Outputs



# Household Attributes

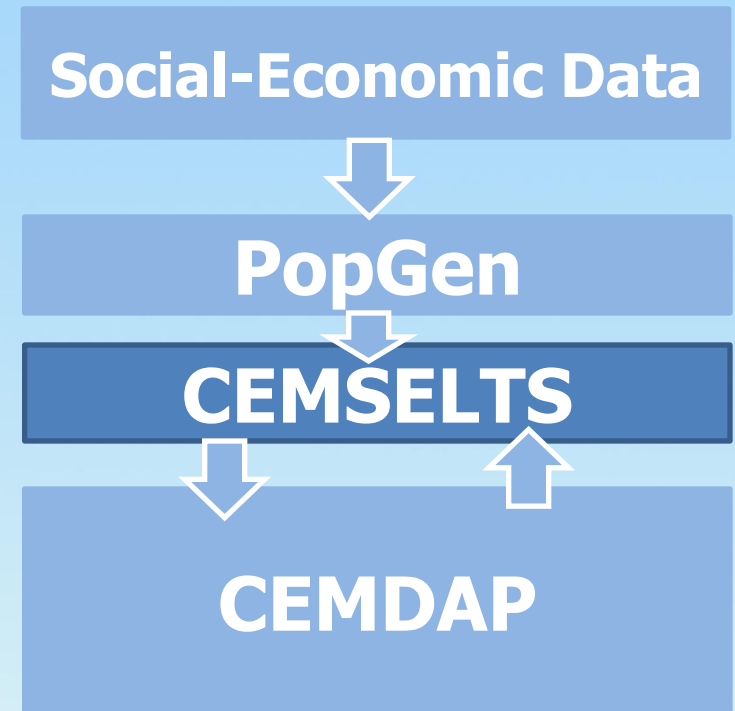


# Person Attributes



# Richer Set of ABM Inputs Is Needed

- Synthesizing huge populations reduces variances in population characteristics
- Many key socio-economic attributes that may explain people and household choices are needed



**Next Step**



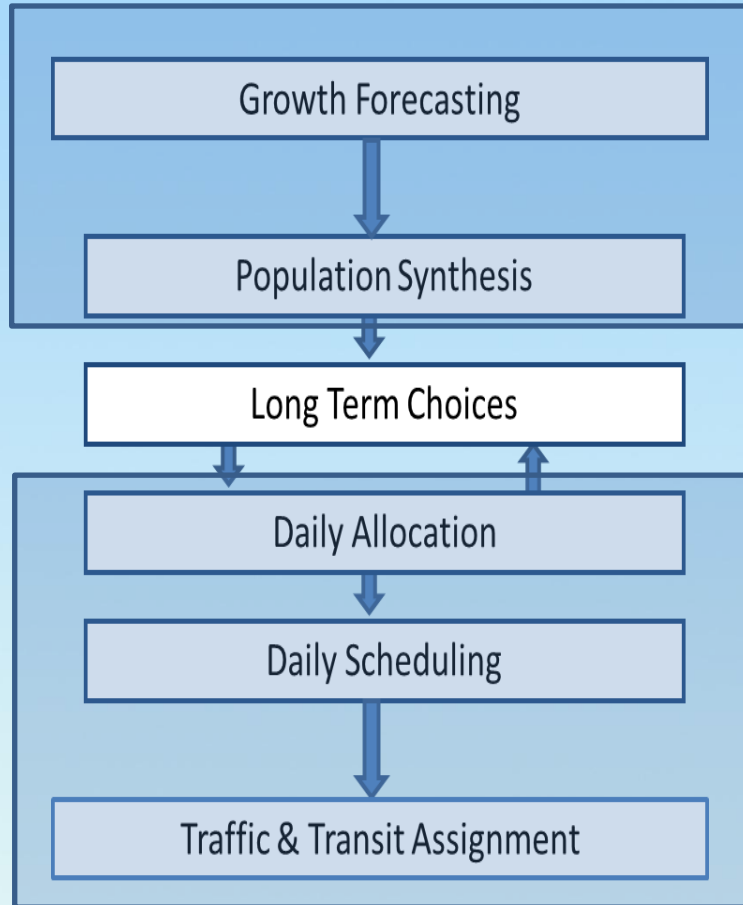
# CORE MODULES



## CEMSELTS

*Comprehensive **E**conometric **M**icrosimulator of **S**ocio-economics,  
**L**and-use, and **T**ransportation **S**ystem*

# CEMSELTS



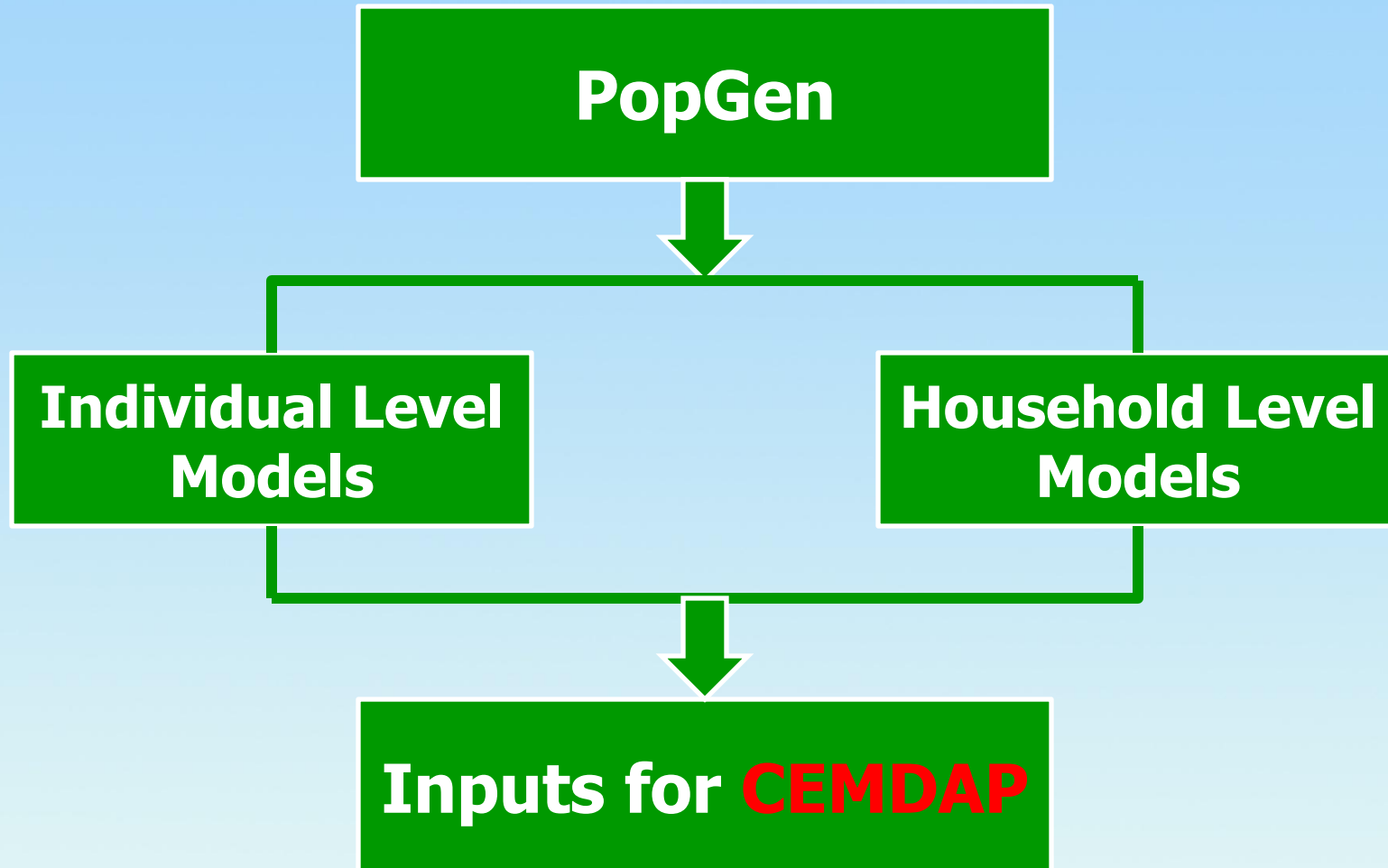
## ❑ Create additional variables for each individual:

- Education Attainment
- Job Status
- Household Income
- Housing Type

## ❑ Create Long-Term Choice Variables

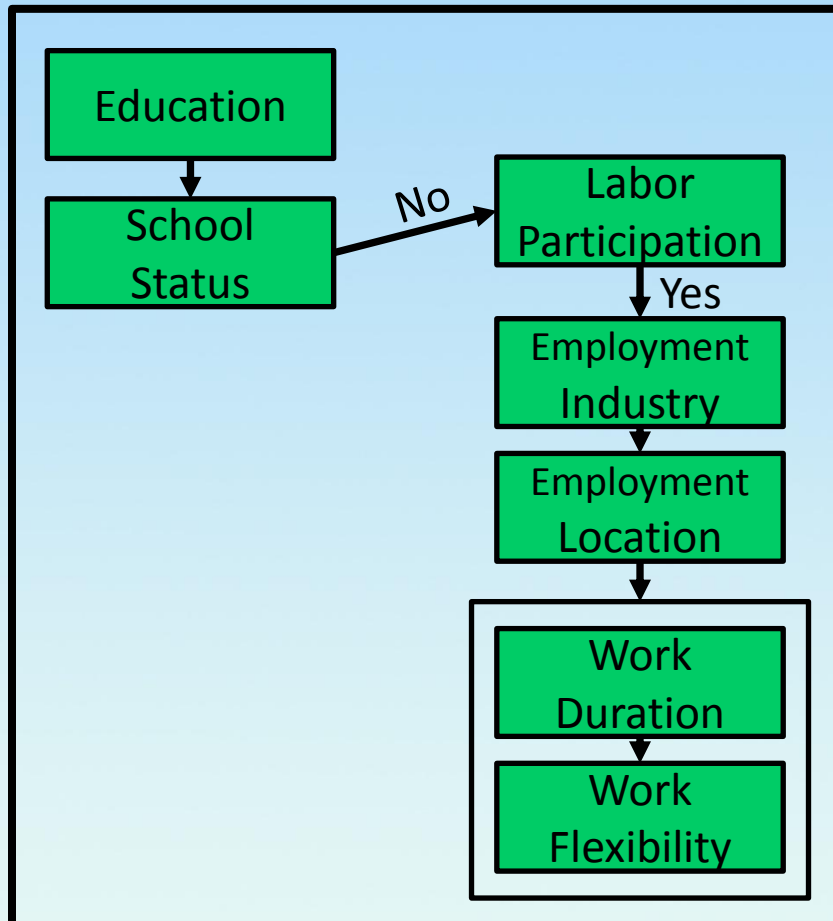
- Vehicle Ownership & Type
- Job/School Location Choice

# CEMSELTS Sequence

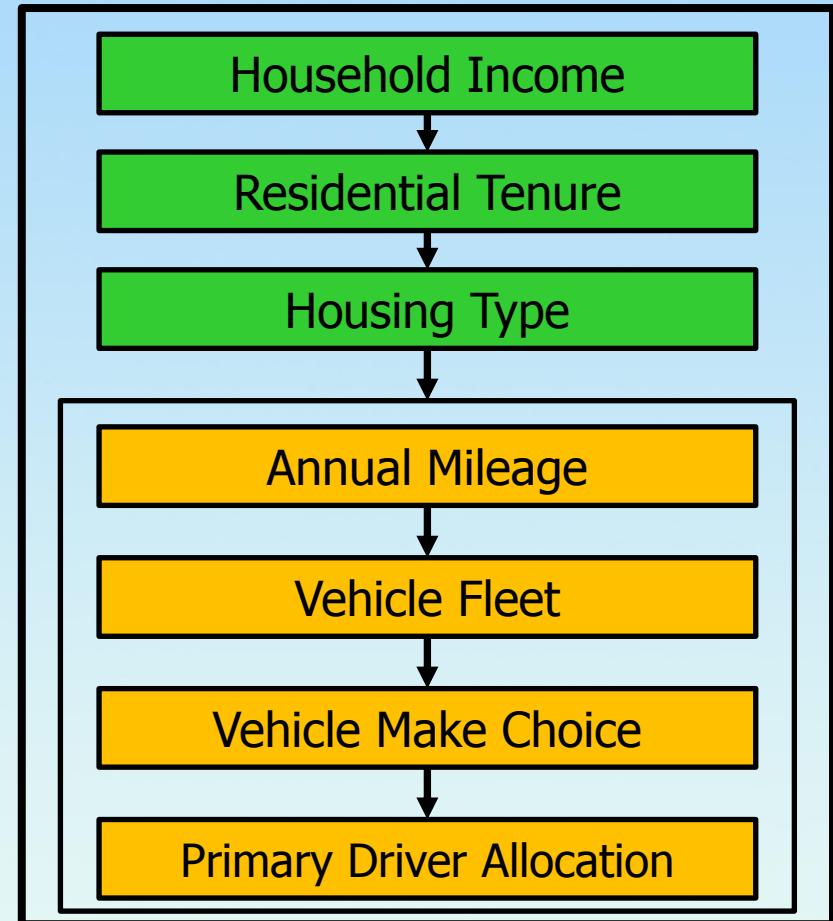


# CEMSELTS Models

## Individual Level Models



## Household Level Models



# CEMSELTS Individual Level Model Output

## Comparison with ACS 2003 and Census 2000

|   | Values in Percent |                    |                          | Values in Percent |                    |                          |
|---|-------------------|--------------------|--------------------------|-------------------|--------------------|--------------------------|
|   | ACS 2003          | CEMSELTS Predicted | Difference in Percentage | Census 2000       | CEMSELTS Predicted | Difference in Percentage |
| <b>Individual Socio-demographics</b>          |                   |                    |                          |                   |                    |                          |
| <b>Enrollment of Children (3 to 17 years)</b> |                   |                    |                          |                   |                    |                          |
| Preschool - Grade 3                           | 37.07             | 44.59              | 7.52                     | 41.17             | 44.59              | 3.42                     |
| Grade 4 - Grade 8                             | 41.64             | 42.16              | 0.52                     | 38.76             | 42.16              | 3.40                     |
| Grade 9 - Grade 11                            | 21.29             | 13.25              | -8.04                    | 20.07             | 13.25              | -6.82                    |
| <b>Educational Attainment (Adults)</b>        |                   |                    |                          |                   |                    |                          |
| Less than Grade 9                             | 11.58             | 2.23               | -9.35                    | 13.14             | 2.23               | -10.91                   |
| Grade 9 - Grade 12 (no diploma)               | 12.05             | 8.28               | -3.78                    | 14.71             | 8.28               | -6.44                    |
| Completed High School                         | 45.70             | 58.48              | 12.78                    | 44.00             | 58.48              | 14.48                    |
| Associate or Bachelors                        | 22.55             | 22.95              | 0.41                     | 20.77             | 22.95              | 2.18                     |
| Graduate Degree (Masters or Ph.D)             | 8.12              | 8.06               | -0.06                    | 7.37              | 8.06               | 0.69                     |
| <b>Labor Participation</b>                    |                   |                    |                          |                   |                    |                          |
| Employed                                      | 59.47             | 59.07              | -0.40                    | 56.81             | 59.07              | 2.26                     |
| Unemployed                                    | 40.53             | 40.93              | 0.40                     | 43.19             | 40.93              | -2.26                    |
| <b>Employment Industry</b>                    |                   |                    |                          |                   |                    |                          |
| Construction and Manufacturing                | 19.92             | 14.46              | -5.46                    | 20.67             | 14.46              | -6.21                    |
| Trade and Transportation                      | 4.94              | 7.32               | 2.38                     | 4.86              | 7.32               | 2.46                     |
| Personal, Professional and Financial          | 50.63             | 49.42              | -1.21                    | 49.34             | 49.42              | 0.08                     |
| Public and Military                           | 3.94              | 5.07               | 1.13                     | 4.04              | 5.07               | 1.03                     |
| Retail Trade                                  | 15.29             | 10.77              | -4.51                    | 15.60             | 10.77              | -4.83                    |
| Other   | 5.28              | 12.96              | 7.68                     | 5.49              | 12.96              | 7.47                     |

# CEMSELTS Household Level Model Output

## Comparison with ACS 2003 and Census 2000

|                                     | Values in Percent |                    |                          | Values in Percent |                    |                          |
|-------------------------------------|-------------------|--------------------|--------------------------|-------------------|--------------------|--------------------------|
|                                     | ACS 2003          | CEMSELTS Predicted | Difference in Percentage | Census 2000       | CEMSELTS Predicted | Difference in Percentage |
| <b>Household Socio-demographics</b> |                   |                    |                          |                   |                    |                          |
| <b>Number of Vehicles</b>           |                   |                    |                          |                   |                    |                          |
| Households with no vehicles         | 8.29              | 7.27               | -1.02                    | 10.07             | 7.27               | -2.79                    |
| Households with 1 vehicle           | 33.34             | 31.32              | -2.02                    | 34.85             | 31.32              | -3.55                    |
| Households with 2 vehicles          | 37.48             | 34.71              | -2.77                    | 37.16             | 34.72              | -2.44                    |
| Households with 3 vehicles          | 14.10             | 15.17              | 1.07                     | 12.59             | 15.17              | 2.59                     |
| Households with 4 or more vehicles  | 6.79              | 11.52              | 4.74                     | 5.33              | 11.52              | 6.19                     |
| <b>Number of Workers</b>            |                   |                    |                          |                   |                    |                          |
| Households with no workers          | 12.21             | 16.84              | 4.63                     | 11.31             | 16.84              | 5.53                     |
| Households with 1 worker            | 34.23             | 36.80              | 2.58                     | 32.98             | 36.80              | 3.82                     |
| Households with 2 or more worker    | 53.57             | 46.36              | -7.21                    | 55.71             | 46.36              | -9.35                    |
| <b>Household Income</b>             |                   |                    |                          |                   |                    |                          |
| \$0- \$9999                         | 8.08              | 8.09               | 0.01                     | 8.98              | 8.09               | -0.89                    |
| \$10,000-\$34,999                   | 28.85             | 40.45              | 11.6                     | 29.56             | 40.45              | 10.89                    |
| \$35,000-\$49,999                   | 15.05             | 14.47              | -0.58                    | 15.24             | 14.48              | -0.76                    |
| \$50,000-\$74,999                   | 18.53             | 13.58              | -4.95                    | 18.89             | 13.58              | -5.31                    |
| \$75,000 and more                   | 29.49             | 23.4               | -6.09                    | 27.32             | 23.40              | -3.93                    |
| <b>Household Tenure</b>             |                   |                    |                          |                   |                    |                          |
| Owner                               | 55.74             | 61.05              | 5.30                     | 54.78             | 61.03              | 6.25                     |
| Renter                              | 44.26             | 38.95              | -5.30                    | 45.22             | 38.97              | -6.25                    |

# CEMSELTS

## Work Flow Distribution by Destination

| Origin county  | Within Origin County |                   |             | Outside Origin County |                   |              | Total       |                   |             |
|----------------|----------------------|-------------------|-------------|-----------------------|-------------------|--------------|-------------|-------------------|-------------|
|                | ACS2003 (%)          | CEMSELTS 2003 (%) | Difference  | ACS2003 (%)           | CEMSELTS 2003 (%) | Difference   | ACS2003 (%) | CEMSELTS 2003 (%) | Difference  |
| Los Angeles    | 52.79                | 52.63             | -0.16       | 3.86                  | 5.29              | 1.43         | 56.65       | 57.92             | 1.26        |
| Orange         | 15.61                | 14.28             | -1.32       | 3.11                  | 3.45              | 0.35         | 18.71       | 17.74             | -0.98       |
| Riverside      | 6.57                 | 7.65              | 1.09        | 3.19                  | 1.85              | -1.35        | 9.76        | 9.50              | -0.26       |
| San Bernardino | 6.88                 | 7.58              | 0.70        | 3.18                  | 2.60              | -0.58        | 10.06       | 10.18             | 0.12        |
| Ventura        | 3.73                 | 3.67              | -0.06       | 1.09                  | 1.00              | -0.09        | 4.82        | 4.67              | -0.15       |
| <b>Total</b>   | <b>85.57</b>         | <b>85.81</b>      | <b>0.24</b> | <b>14.43</b>          | <b>14.19</b>      | <b>-0.24</b> | <b>100</b>  | <b>100</b>        | <b>0.00</b> |

*\*Imperial County data are missing due to small sample size in 2003 ACS.*

# CEMSELTS

## Vehicle Type Choice Model Results

| Body Type       | Survey Data | CEMSELTS |
|-----------------|-------------|----------|
| Sub-compact Car | 3.5         | 2.7      |
| Compact Car     | 18.2        | 23.9     |
| Medium Car      | 22.3        | 23.9     |
| Large Car       | 5.7         | 3.3      |
| Sports Car      | 5.6         | 4.1      |
| Medium SUV      | 9.5         | 9.9      |
| Large SUV       | 11          | 8.9      |
| Van             | 7           | 5.9      |
| Pickup          | 17.2        | 17.3     |



# Summary

- **CEMSELTS** is a software/module that contains a series of choice models estimates for long-term choices & other attributes (14 sub-models).
- Vehicle type choice determines vehicle fleet mix; critical to *energy* and *emission* analysis.
- The resulting richer set of output is then fed to CEMDAP, the core activity-based modeling engine within SimAGENT to simulate complete daily activity-travel patterns for the population of the region.

# Household Evolution Model

- A model that progress resident population year after year using smooth transitions instead of abrupt adjustments based on externally provided demographic data.
- It enables user to link demographic transition to behavioral change.
- The project will complete at June, 2013.
  - by SCAG ABM consultants

# CORE MODULES

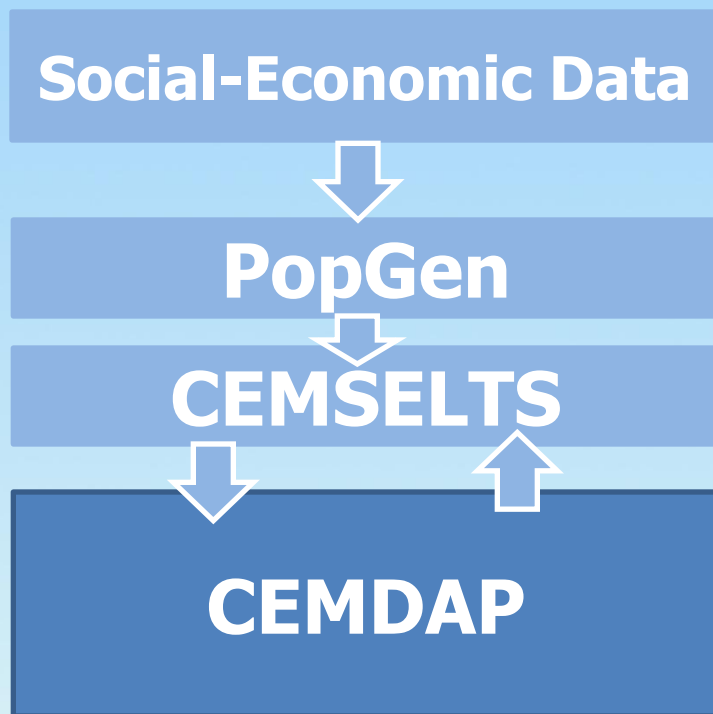


## CEMDAP

*Comprehensive Econometric Microsimulator of Daily Activity-Travel Patterns*

# CEMDAP Module

Comprehensive Econometric Microsimulator of Daily Activity-Travel Patterns



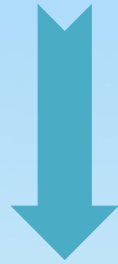
- Simulates activity schedule and travel characteristics for each individual of the region
- Core module of SimAgent
- 52 sub-models
- Developed by UT Austin

# Features of CEMDAP

- A policy responsive tool
- Continuous time scale
- Allows any number of zones
- Level of service data can be provided at any temporal resolution ( 5 time-of-day periods for SCAG ABM)
- Explicitly considers time-space constraints
- Changes in the activity-travel pattern of one individual in a household may bring about changes in activity-travel patterns of other household members
- **MDCEV** approach facilitates modeling activity participation at a household level with joint activity participation incorporated in a simple fashion

# Features of CEMDAP

## Recognizing Fixities



### Non-Workers

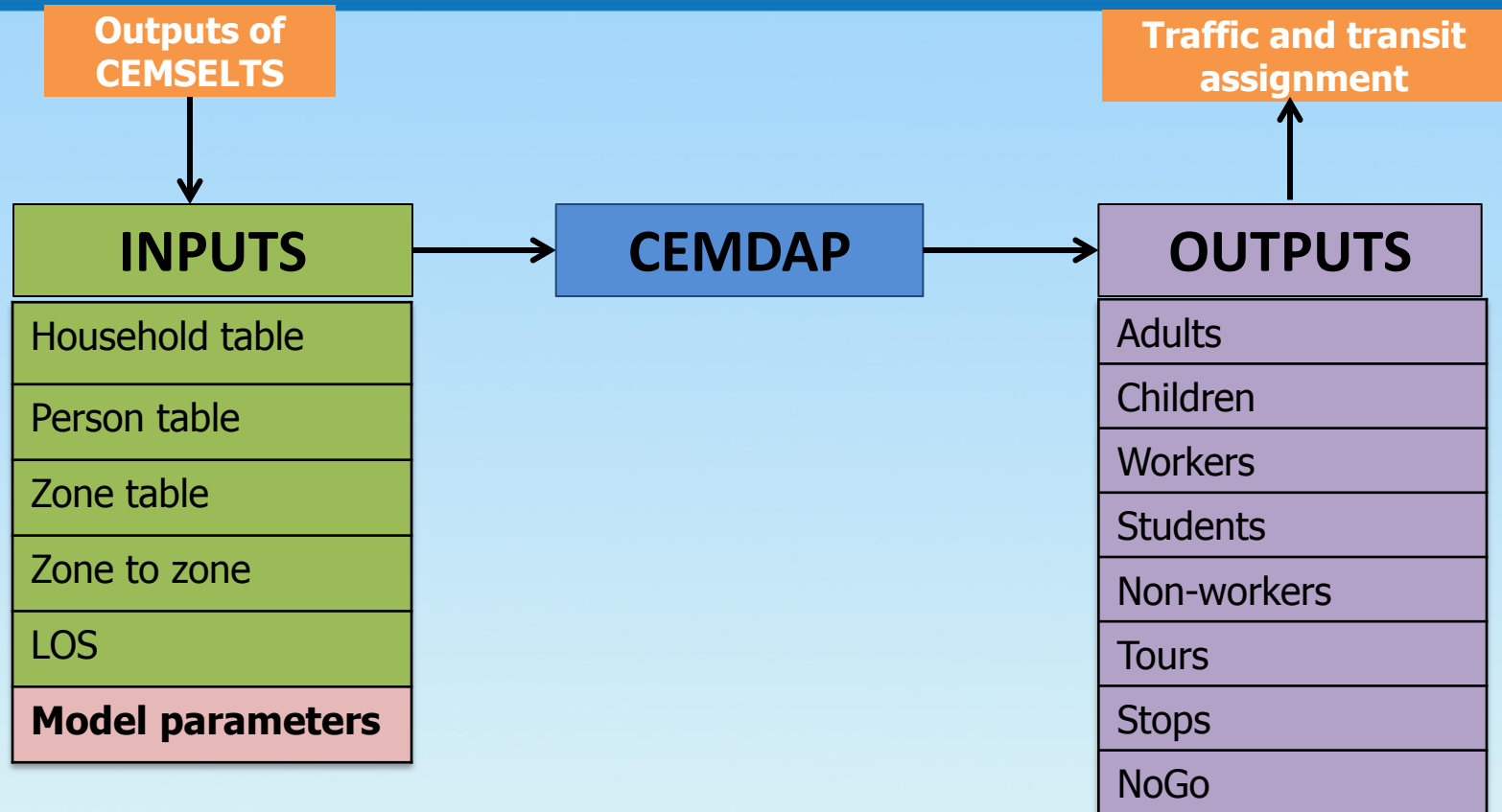
- No obvious activity with spatial and temporal fixities
- Person more flexible in scheduling his/her activities



### Workers

- The “work” activity has spatial and temporal fixities
- Person schedules his/her activities around the work activity

# CEMDAP System

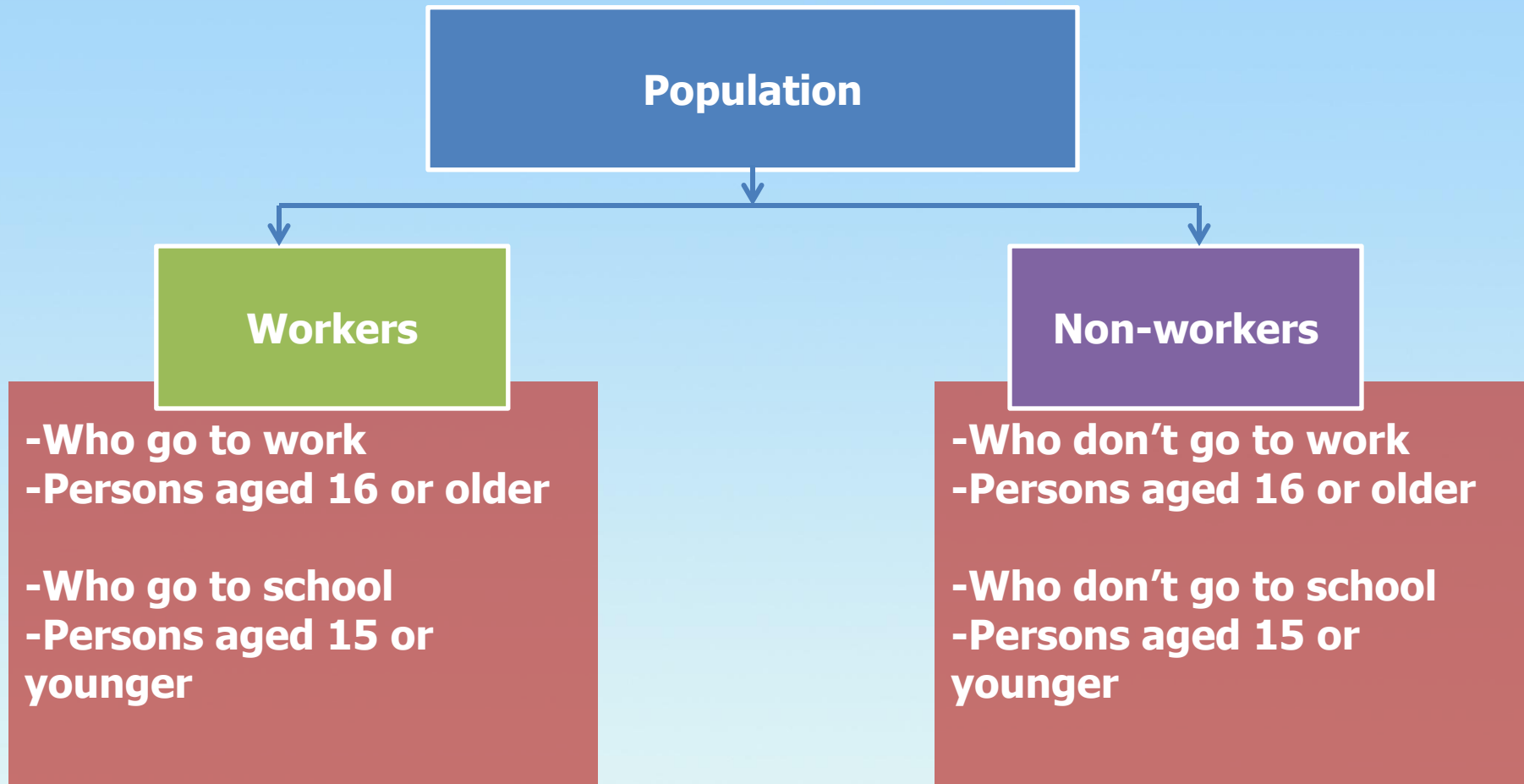


# Tools for CEMDAP

- CEMDAP includes 52 sub-models
- The econometric structure for each sub-model falls under one of the eight econometric model categories:
  1. Multiple Discrete Continuous Extreme Value (MDCEV)
  2. Fractional split
  3. Binary logit
  4. Multinomial logit
  5. Hazard-duration
  6. Regression
  7. Ordered probit and
  8. Spatial location choice

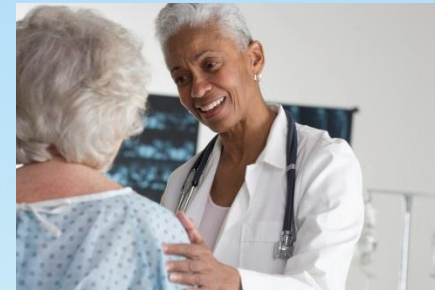


# Person type

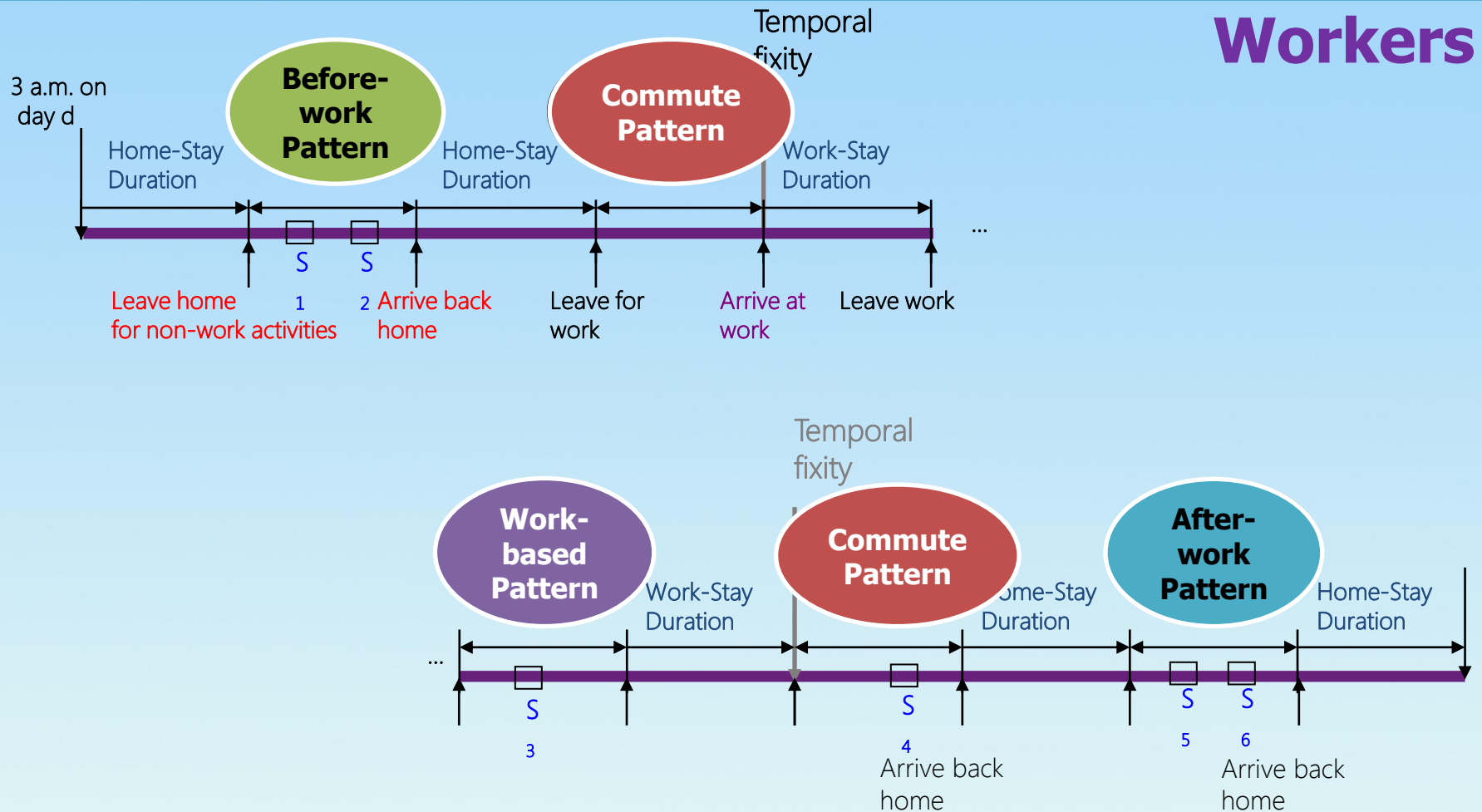


# Activities/Travel purposes

- Home
- Mandatory
  - Work
  - School
- Maintenance
  - Drop-off at school
  - Pick-up from school
  - Other serve-passenger
  - Shopping
  - Work-related
  - Household/personal business
- Discretionary
  - Joint discretionary
  - Children discretionary
  - Social recreation
  - Eating out

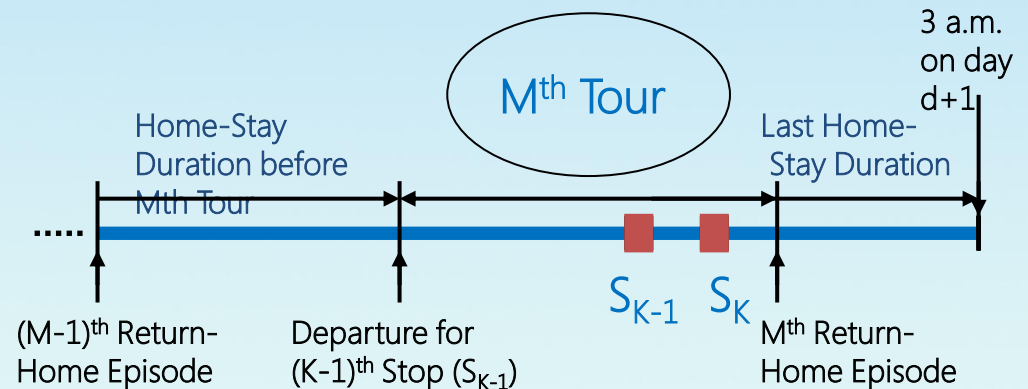
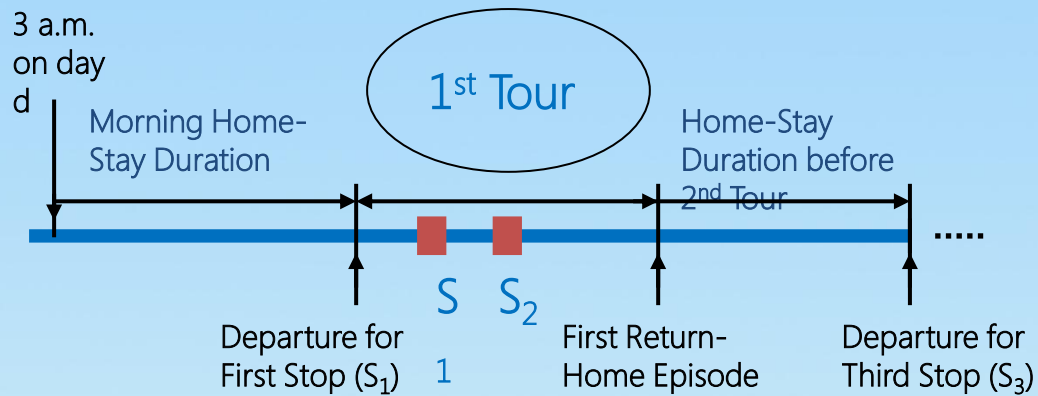


# Representing Activity-Travel Patterns



# Representing Activity-Travel Patterns

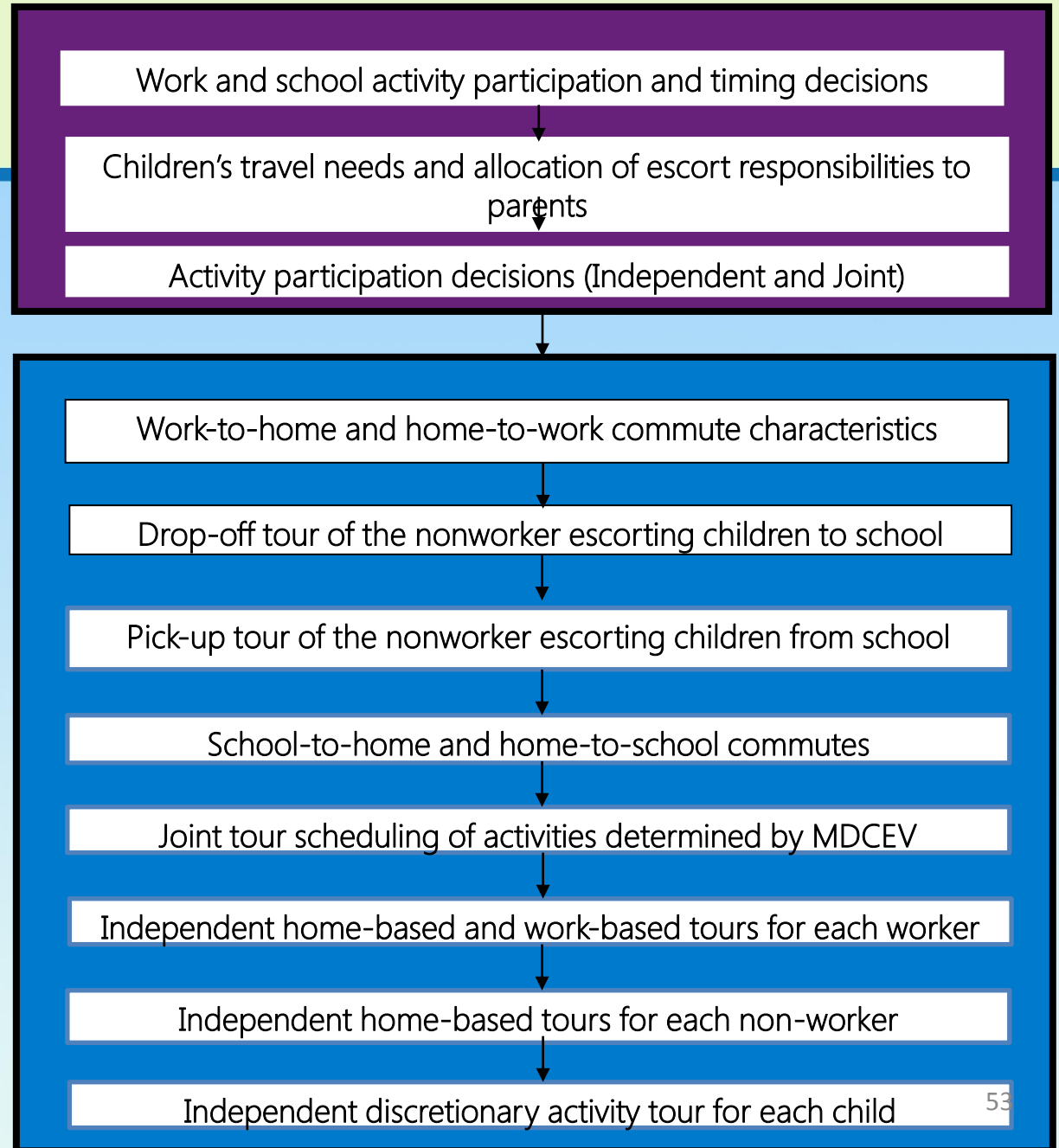
## Non-Workers



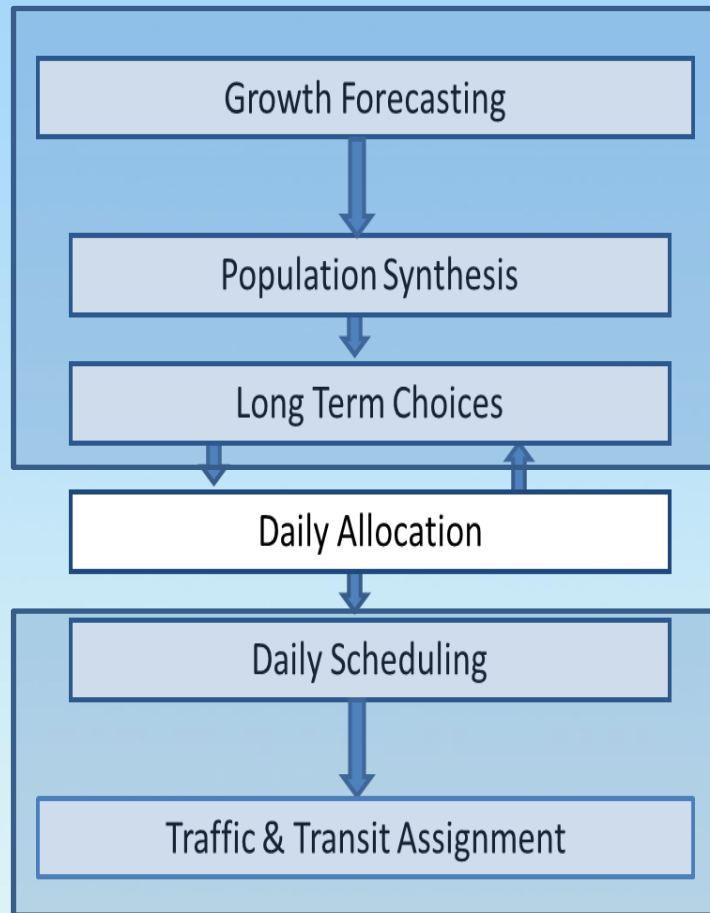
# CEMDAP Modeling Framework

## Two major steps:

1. **Generation Allocation**
2. **Scheduling**



# Activity Generation & Allocation



- **Determine each person's decision on daily activities:**
  - **Workers:** Commute
  - **Children:** Go to School
  - **Non-workers:** Non-work Activities
  - **Parents:** Pick up/Drop off
  - **All Household Members:** Joint Activity

# GA module: Generation of Work and School Activity Participation

For each child student

Decision to go  
to School

School Start &  
End Time

For each employed adult

Decision to go  
to Work

Work Start &  
End Time

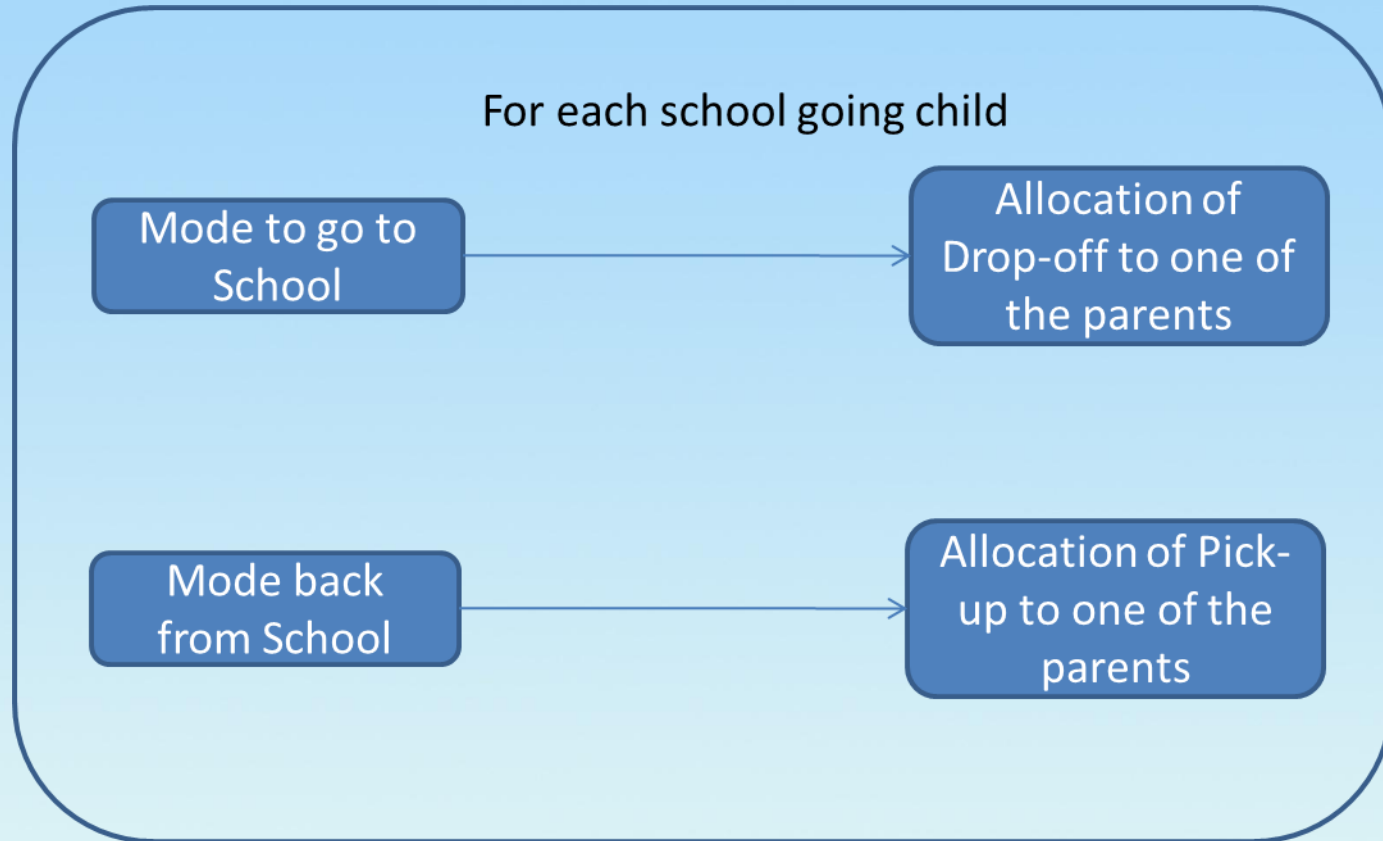
For each adult student

Decision to go  
to School

School Start &  
End Time

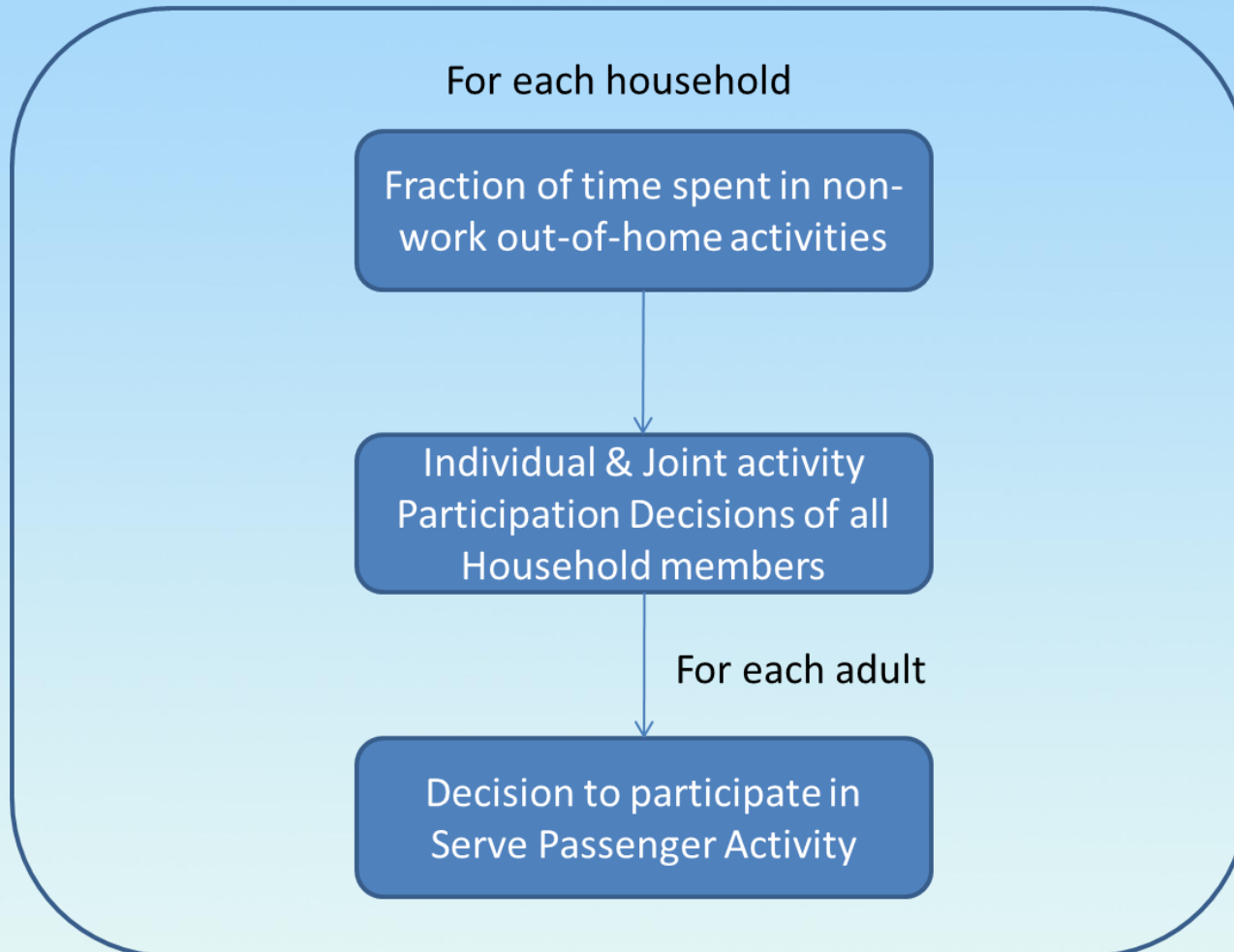
- ❑ Work and school activities are the greatest *space-time constraints* for most individuals
- ❑ Participation in these activities significantly influences an individual's participation in all other activities during the day

# GA Module: Children's Travel Needs & Allocation of Escort Responsibilities

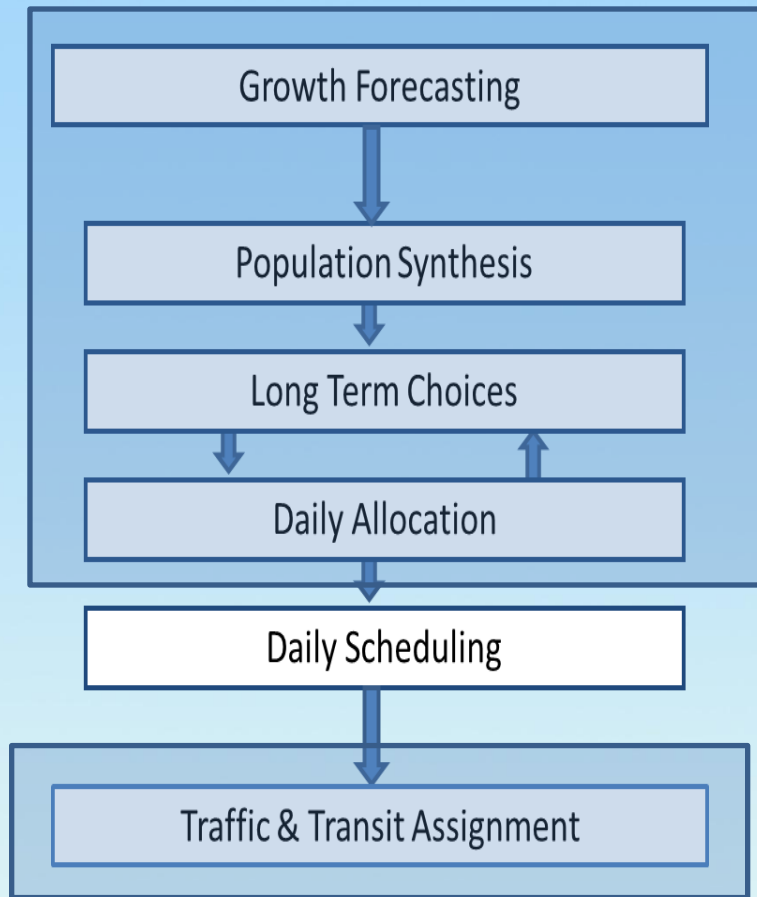




# GA Module: Generation of Independent Activities for Personal and Household Needs



# Activity & Travel Scheduling



- **Three level structure**
  - **Pattern-level model system**  
sequence of tours undertaken during the day
  - **Tour-level model system**  
chains of stops with home and/or work as anchor point (duration, number of stops, time of day)
  - **Stop-level model system**  
Out of home activity episodes that individual or household participate in (activity, duration(s), travel time, location)

# Worker Scheduling Model System

| Model ID | Model Name                                 | Econometric Structure   | Choice Alternative                                 |
|----------|--|-------------------------|--|
| WSCH1    | Commute mode                               | MNL                     | Solo driver, Driver with passenger,                |
| WSCH2    | Number of before-work tours                | Ordered probit          | 0 or 1   |
| WSCH3    | Number of work-based tours                 | Ordered probit          | 0, 1 or 2  |
| WSCH4    | Number of after-work tours                 | Ordered probit          | 0, 1 or 2  |
| WSCH5    | Before-work tour mode                      | MNL                     | Solo driver, Driver with passenger,                |
| WSCH6    | Work-based tour mode                       | MNL                     | Solo driver, Driver with passenger,                |
| WSCH7    | After-work tour mode                       | MNL                     | Solo driver, Driver with passenger,                |
| WSCH8    | Number of stops in a tour                  | Ordered probit          | 1,2,3,4, or 5                                      |
| WSCH9    | Home or work stay duration before the tour | Regression              | Continuous time                                    |
| WSCH10   | Activity type at a stop                    | MNL                     | 10 Activity purposes                               |
| WSCH11   | Activity duration at stop                  | Regression              | Continuous time                                    |
| WSCH12   | Travel time to a stop                      | Regression              | Continuous time                                    |
| WSCH13   | Location of a stop                         | Spatial Location Choice | Choice alternatives based on estimated travel time |

# Non-Worker Scheduling Model System

| Model ID | Model Name   | Econometric Structure   | Choice Alternatives  |
|----------|--|-------------------------|--|
| NWSCH1   | Number of independent tours  | Ordered probit          | 1, 2, 3, or 4  |
| NWSCH2   | Decision to undertake an independent tour before the pick-up or joint discretionary tour | Binary logit            | Yes, No  |
| NWSCH3   | Decision to undertake an independent tour after the pick-up or joint discretionary tour  | Binary logit            | Yes, No  |
| NWSCH4   | Tour mode  | MNL                     | Solo driver, Driver with passenger, Passenger, and Walk/bike |
| NWSCH5   | Number of stops in a tour  | Ordered probit          | 1, 2, 3 4, or 5  |
| NWSCH6   | Number of stops following a pick-up/drop-off stop in a tour                              | Ordered probit          | 0 or 1   |
| NWSCH7   | Home stay duration before a tour   | Regression              | Continuous time  |
| NWSCH8   | Activity type at stop  | MNL                     | 10 Activity purposes   |
| NWSCH9   | Activity duration at stop  | Regression              | Continuous time  |
| NWSCH10  | Travel time to stop  | Regression              | Continuous time  |
| NWSCH11  | Stop location  | Spatial Location Choice | Choice alternatives based on estimated travel time           |

# Children Scheduling Model System

| Model ID | Model Name   | Econometric Structure      | Choice Alternatives                        |
|----------|--|----------------------------|--|
| CSCH1    | School to home commute time  | Regression                 | Continuous time                            |
| CSCH2    | Home to school commute time  | Regression                 | Continuous time                            |
| CSCH3    | Mode for independent discretionary tour  | Binary logit               | Drive by other,<br>Walk/bike               |
| CSCH4    | Departure time from home for independent discretionary tour (time from 3 a.m.) | Regression                 | Continuous time                            |
| CSCH5    | Activity duration at independent discretionary stop                            | Regression                 | Continuous time                            |
| CSCH6    | Travel time to independent discretionary stop                                  | Regression                 | Continuous time                            |
| CSCH7    | Location of independent discretionary stop                                     | Spatial Location<br>Choice | Predetermined subset<br>of the 4,109 zones |

# Joint Discretionary Tour Scheduling Model System

| Model ID | Model Name                             | Econometric Structure   | Choice Alternative                           |
|----------|--|-------------------------|--|
| JASHCH01 | Decision of Joint or Separate Travel   | Binary Probit           | Yes or No                                    |
| JASHCH02 | Joint Activity Start time              | Regression              | Continuous                                   |
| JASHCH03 | Joint Activity travel time to stop     | Regression              | Continuous                                   |
| JASHCH04 | Joint Activity location                | Spatial Location Choice | Predetermined subset of the 4,109 zones      |
| JASHCH05 | Vehicle Used For Joint Home-Based Tour | MDCEV                   | Vehicle types based on body type and vintage |

- Joint activities of **workers** scheduled in [work-to-home commute](#) or [After-work period](#)
  - Determined by the Joint Activity Start Time
- For **non-workers** participating in joint activities
  - Decision to undertake independent tour before pick-up or joint tour
  - Decision to undertake independent tour after pick-up or joint tour

# CEMDAP Simulation Output

- ❑ **CEMDAP** produces *complete activity-travel patterns* for a day for every individual in the population of interest
- ❑ There are **nine** output files:
  - Adults: decisions to undertake activities of different types for adults
  - Children: decisions to undertake activities of different types for children
  - Workers: pattern-level attributes of the workers' (including adult students)
  - Students: pattern-level attributes of the child students
  - No-Go: list of people who stayed at-home the whole day
  - Non-workers: pattern-level attributes of non-workers
  - Tours: tour-level attributes
  - Stops: stop-level attributes
  - Activities: activity episode attributes

# Initial validation results

## CEMDAP



## Average Number of Trips Per Household

| Type of Trips       | SimAGENT | Survey | SimAGENT<br>(85% Work<br>Scenario) |
|---------------------|----------|--------|------------------------------------|
| Home Based Work     | 1.27     | 1.33   | 1.68                               |
| Home Based Non-work | 5.13     | 4.90   | 4.94                               |
| Non-home based      | 2.31     | 2.59   | 2.69                               |
| <b>Total</b>        | 8.71     | 8.82   | 9.30                               |

# Distribution of Number of Tours (Workers)

| Number of Tours | Before Work |          | Work Based |          | After Work |          |
|-----------------|-------------|----------|------------|----------|------------|----------|
|                 | Survey      | SimAGENT | Survey     | SimAGENT | Survey     | SimAGENT |
| 0               | 94.26       | 96.69    | 81.03      | 76.67    | 79.48      | 81.36    |
| 1               | 5.74        | 3.31     | 16.59      | 18.01    | 17.86      | 17.17    |
| 2               | --          | --       | 2.38       | 5.32     | 2.66       | 1.47     |

## Distribution of Number of Tours (Non-Workers)

| <b>Number of Tours</b> | <b>Survey</b> | <b>SimAGENT</b> |
|------------------------|---------------|-----------------|
| <b>1</b>               | 58.81         | 55.51           |
| <b>2</b>               | 27.53         | 24.79           |
| <b>3</b>               | 9.49          | 12.55           |
| <b>4</b>               | 4.17          | 7.15            |

## Average Number of Stops by Tour Type

| Average number of stops     | Survey | SimAGENT |
|-----------------------------|--------|----------|
| <b>Work Based tours</b>     | 1.37   | 1.36     |
| <b>Before work tours</b>    | 1.41   | 1.34     |
| <b>After work tours</b>     | 1.40   | 1.36     |
| <b>Work-to-home commute</b> | 0.40   | 0.35     |
| <b>Home-to-work commute</b> | 0.26   | 0.18     |
| <b>Non-worker tour</b>      | 1.78   | 1.66     |

# Chaining Propensity

|                            | Survey | SimAGENT |
|----------------------------|--------|----------|
| <b>Worker</b>              |        |          |
| <b>Chaining Propensity</b> | 0.85   | 0.86     |
| <b>Non Worker</b>          |        |          |
| <b>Chaining Propensity</b> | 0.71   | 0.76     |

# Tour Mode Shares

|                           | Work-to-home |        | Work based |        | Before work |        | After work |        | Non-Worker |        |
|---------------------------|--------------|--------|------------|--------|-------------|--------|------------|--------|------------|--------|
|                           | ABM          | Survey | ABM        | Survey | ABM         | Survey | ABM        | Survey | ABM        | Survey |
| <b>Drive alone</b>        | 77.7         | 78.2   | 64.2       | 69.3   | 56.5        | 44.0   | 55.0       | 56.2   | 51.9       | 39.8   |
| <b>Drive as passenger</b> | 8.9          | 9.8    | 15.9       | 13.8   | 26.2        | 39.1   | 35.3       | 31.7   | 28.8       | 36.7   |
| <b>Shared ride</b>        | 8.1          | 6.6    | 6.0        | 6.3    | 4.0         | 2.5    | 3.9        | 5.1    | 12.2       | 14.1   |
| <b>Walk or bike</b>       | 2.7          | 2.9    | 13.7       | 10.1   | 12.7        | 13.9   | 4.9        | 6.3    | 5.7        | 7.5    |
| <b>Transit</b>            | 2.6          | 2.5    | 0.2        | 0.5    | 0.6         | 0.5    | 0.9        | 0.7    | 1.4        | 1.9    |

# Stage 2

## **ABM Development & 2012 Model Validation**

for 2016 RTP/SCS

# Schedule

**March, 2013**

**Consultants  
RFP**

**Feb. 2014**

**TMIP  
Webinar  
Presentation**

**Dec. 2014**

**Year 2012  
Model  
Validation  
Report**

**June, 2014**

**Peer Review**



# Model Estimation

- **Model Estimation**

- Data Based on

- 2012 Statewide Travel Survey,
    - American Community Survey (ACS),
    - 2010 Census, and
    - Transit and SP Surveys

- **Complete by December 2013**

# Model Calibration & Validation

- Model Calibration, September 2013 – April 2014
- Year 2012 Model Validation, January 2014 – June 2014
- Sensitivity Testing & Analysis
- Additional Data Support
  - Land Use and Growth Forecast
  - Screenline Traffic Counts, Auto and Trucks
  - HOV/HOT/Toll Road Data
  - External Traffic Counts and Forecast
  - Transit LOS
  - Speed Inventory
  - HPMS VMT

# Model Implementation

- Modeling System Integration
  - Trucks and Freight
  - Airports and Seaports
  - Interregional Travel
- Software Design and Optimization
- Model Coding and Testing
- Model Peer Review

# Thank You

For more information, please contact  
Modeling and Forecasting Department

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