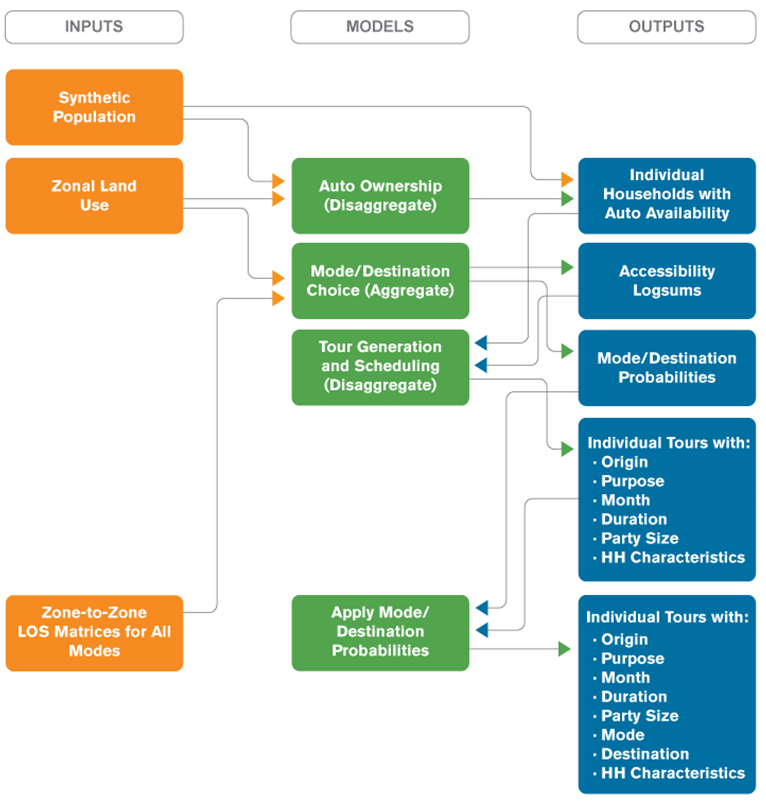
**X.1 MODEL STRUCTURE AND CODE**

The structure of the long-distance tour-based microsimulation model system used for the initial application is depicted in Figure X.1. The main inputs are a (a) a synthesized population representing every household in the US and all members of those households, (b) and land use file containing estimates of population, employment, and other key variables at the zone (NUMA) level, (c) zone-to-zone matrices containing travel times, costs, and other key origin-destination variables for auto, bus, rail and air, and (d) files with estimated/calibrated coefficients for each choice model. These input files are documented in section X-3.

The choice models include models of auto ownership, long distance tour generation, tour duration of stay, tour party size, tour destination choice and tour mode choice. The estimated models are documented in section X.5. Output records are written at both the household level and the tour level. Trip matrices can also be output, based on either mode/destination probabilities or stochastically simulated tours. The output file contents and formats are documented in section X.4.



A key aspect of the model structure is that the mode and destination probabilities and logsums are pre-calculated for all relevant combinations of income, auto availability, tour purpose, tour duration of stay and tour party size. The probabilities are stored in memory and used to predict the outcome for each simulated tour, which eliminates the need to apply the mode and destination choice models separately for each tour. This structure reduces the model run time by at least an order of magnitude, and makes it practical to predict long distance travel over the period of a year for the entire US population.

The model is currently coded in Delphi (Pascal), which was selected for its very fast run times. The Delphi language is very similar to C++, and in the future it may be advisable to translate the code to C++ or C#, which are more familiar to most younger programmers.

The program code is fairly compact, with only 1,750 lines of Delphi code.

Below are listed the main procedures (classes) in the code, and their order of execution and iteration:

* ***GetConfigurationSettings***: Reads in the user configuration file.
* ***InitializeSummaryOutput***: Empties all counters for summary output tables
* ***LoadZoneLandUseData***: Loads data from the zonal land use file into memory
* ***LoadRoadLOSMatrices***: Loads data from the auto and bus level-of-service file into memory
* ***LoadRailLOSMatrices***: Loads data from the rail level-of-service file into memory
* ***LoadAirLOSMatrices***: Loads data from the auto and bus level-of-service file into memory
* ***OpenHouseholdInputFile***: Opens the synthetic population file for sequential input
* ***OpenHouseholdOutputFile***: If specified by user, opens a new household level file for output
* ***OpenTourOutputFile***: If specified by user, open a new tour level file for output
* ***OpenTripMatrixOutputFile***: If specified, by user, open a new trip matrix file output
* ***Loop on households in synthetic population***
  + ***LoadNextHouseholdRecord:*** Reads the next household record into memory
  + ***Check if current household is from a new residence zone, if so…***
    - ***CalculateModeDestinationProbabilitiies:*** Applies the tour mode and destination choice models to calculate all probabilities and logsums from the new zone
  + ***Check if current household is to be simulated, according to user settings. If so…***
    - ***ApplyAutoOwnershipModel:*** Applies the auto ownership model and simulates a single choice
    - ***ApplyTourGenerationModel:*** Applies the tour generation models and simulates how many tours are made for each tour purpose on each simulated month and day
    - ***For each generated tour (if any)…***
      * ***SimulateNewTour:*** Sets some variables and runs tour-level models
      * ***ApplyTourNightsAwayModel:*** Applies the tour duration model and simulates a single choice.
      * ***ApplyTourPartySizeModel:*** Applies the tour party size model and simulates a single choice.
      * ***ApplyTourModeDestinationMode***l: Uses the mode/destination choice probabilities for the relevant income, car ownership, purpose, duration and party size segments to simulate a single mode and destination and/or add the probabilities to the predicted trip matrices, depending on user settings.
      * ***WriteTourRecord***: If specified by user, write a new tour record to output file
    - ***WriteHouseholdRecord:*** If specified by user, write a new household record to output file
* ***End of loop on households***
* ***CloseHouseholdInputFile***
* ***CloseHouseholdOutputFile***
* ***CloseTourOutputFile***
* ***WriteTripMatrixOutputFile:*** if specified by user, write the output trip matrix file
* ***WriteSummaryOutput:*** Writes summary prediction tables to the log print file

**X.2. RUNNING THE MODEL**

The software is a simple console application that can be run by double-clicking on the ***rJourney\_1\_1.EXE*** file in Windows Explorer, in which case Windows will open up a console command window and ask the user to input the name of the relevant user configuration file. The user can also set up a batch file giving the name of the configuration file as a command argument and double click on that. For example, the batch file ***rJourney.BAT*** could be created with the single line:

***rJourney\_1.1.exe inputs\scenario5\_1\_config.txt***

Double clicking on that batch file would run the program and use the specified configuration file as input.

**Configuration file options**

In Table X-1 below is a list of all of the user configuration options currently recognized by the software. Each option is specified by a specific text label that is given in the first column of the table. (The labels are not case-sensitive – any combination of upper and lower case can be used.) If the user provides a configuration label that does not match one of these valid options in the table, the invalid input line is flagged for the user on the screen and also written to the log print file. Each configuration variable also has a default value that is used if the specific configuration label is not found in the configuration file (meaning that is not necessary to include a line for a specific option if one wishes to simply use the default value).

A sample configuration text file containing all the possible labels with the default values is provided along with the software, and the user can edit this file to create new configurations.

**Table X-1 Configuration file options (1)**

|  |  |  |
| --- | --- | --- |
| **Configuration file label** | **Default Value** | **Description** |
| RunTitle | National\_Long\_Distance\_Model | A text label identifying the run in the log print file - contains no spaces |
| RoadLOSFileName | inputs\zoneRoadLOS.dat | The path and filename of the input zonal auto and bus level-of-service data |
| RailLOSFileName | inputs\zoneRailLOS.dat | The path and filename of the input zonal rail level-of-service data |
| AirLOSFileName | inputs\zoneAirLOS.dat | The path and filename of the input zonal air level-of-service data |
| ZoneLandUseFileName | inputs\numa\_2010\_landuse.dat | The path and filename of the input zonal land use data |
| HouseholdFileName | inputs\us\_synpop\_hh3\_sorted.dat | The path and filename of the input synthetic population household file |
| DestChoiceCoefficientFile\_1 | inputs\pbusdest6\_bxc.F12 | The path and filename of the pers. business tour destination choice coefficients |
| DestChoiceCoefficientFile\_2 | inputs\vfardest6\_bxc.F12 | The path and filename of the visit f & r tour destination choice coefficients |
| DestChoiceCoefficientFile\_3 | inputs\leisdest6\_bxc.F12 | The path and filename of the leisure tour destination choice coefficients |
| DestChoiceCoefficientFile\_4 | inputs\commdest6\_bxc.F12 | The path and filename of the commute tour destination choice coefficients |
| DestChoiceCoefficientFile\_5 | inputs\ebusdest6\_bxc.F12 | The path and filename of the empl.business tour destination choice coefficients |
| ModeChoiceCoefficientFile\_1 | inputs\pbusmode13\_est.F12 | The path and filename of the pers. business tour mode choice coefficients |
| ModeChoiceCoefficientFile\_2 | inputs\vfarmode13\_est.F12 | The path and filename of the visit f & r tour mode choice coefficients |
| ModeChoiceCoefficientFile\_3 | inputs\leismode13\_est.F12 | The path and filename of the leisure tour mode choice coefficients |
| ModeChoiceCoefficientFile\_4 | inputs\commmode13\_est.F12 | The path and filename of the commute tour mode choice coefficients |
| ModeChoiceCoefficientFile\_5 | inputs\ebusmode13\_est.F12 | The path and filename of the empl.business tour mode choice coefficients |
| PartySizeCoefficientFile\_1 | inputs\pbus\_psize3.F12 | The path and filename of the pers. business tour party size choice coefficients |
| PartySizeCoefficientFile\_2 | inputs\vfar\_psize3.F12 | The path and filename of the visit f & r tour party size choice coefficients |
| PartySizeCoefficientFile\_3 | inputs\leis\_psize3.F12 | The path and filename of the leisure tour party size choice coefficients |
| PartySizeCoefficientFile\_4 | inputs\comm\_psize3.F12 | The path and filename of the commute tour party size choice coefficients |
| PartySizeCoefficientFile\_5 | inputs\ebus\_psize3.F12 | The path and filename of the empl.business tour party size choice coefficients |
| NightsAwayCoefficientFile\_1 | inputs\pbus\_dur3.F12 | The path and filename of the pers. business tour duration of stay choice coefficients |
| NightsAwayCoefficientFile\_2 | inputs\vfar\_dur3.F12 | The path and filename of the visit f & r tour duration of stay choice coefficients |
| NightsAwayCoefficientFile\_3 | inputs\leis\_dur3.F12 | The path and filename of the leisure tour duration of stay choice coefficients |
| NightsAwayCoefficientFile\_4 | inputs\comm\_dur3.F12 | The path and filename of the commute tour duration of stay choice coefficients |
| NightsAwayCoefficientFile\_5 | inputs\ebus\_dur3.F12 | The path and filename of the empl.business tour duration of stay choice coefficients |
| TourFreqCoefficientsFile\_1 | inputs\freqest3a.f12 | The path and filename of the primary tour generation coefficients |

**Table X-1 Configuration file options (2)**

|  |  |  |
| --- | --- | --- |
| **Configuration file label** | **Default Value** | **Description** |
| TourFreqCoefficientsFile\_2 | inputs\fsecest3a.f12 | The path and filename of the secondary tour generation coefficients |
| AutoOwnCoefficientsFile | inputs\carown3.f12 | The path and filename of the household car ownership coefficients |
| HouseholdOutputFileName | outputs\household\_out\_1.dat | The path and filename of the output household records |
| TourOutputFileName | outputs\tour\_out\_1.dat | The path and filename of the output tour records |
| TripMatrixOutputFileName | outputs\trip\_out\_1.dat | The path and filename of the output trip matrix records |
| OutputFileDelimeter | 32 | The delimiter character used in the output files (32=space, 9=tab, 44=comma) |
| MonthOfYear | 0 | The month of the year to simulate (0=all months, 1=Jan, 2=Feb, … , 12=Dec) |
| EachDayOfTheMonth | FALSE | True/False switch to simulate each day of each month separately |
| RandomSeed | 12345 | Initial seed value to use for random number generator |
| Sample1inX | 1 | Subsampling factor (e.g. 100 selects every 100th household for simulation) |
| SampleOffset | 0 | Subsampling offset (e.g. in above example, 3 selects the 3rd out of every 100 HH) |
| WriteHouseholdRecords | TRUE | Whether or not to write out household-level records |
| WriteTourRecords | TRUE | Whether or not to write out tour-level records |
| WriteCarTripMatrix | TRUE | Whether or not to write out zone-to-zone trip matrix for car trips |
| WriteBusTripMatrix | FALSE | Whether or not to write out zone-to-zone trip matrix for bus trips |
| WriteRailTripMatrix | FALSE | Whether or not to write out zone-to-zone trip matrix for rail trips |
| WriteAirTripMatrix | FALSE | Whether or not to write out zone-to-zone trip matrix for air trips |
| UseProbabilitiesinMatrices | FALSE | If True, uses mode/destination probablilities rather than single choices for matrices |
| UseADTUnitsInMatrices | FALSE | If True, writes out trip matrices as daily trips rather than total trips |
| PersonTripsInMatrices | FALSE | If True, writes out person-trips in matrices rather than party/vehicle-trips |
| TripMatrixMinimumDistance | 50 | The minimum one-way trip distance to include in the trip matrices |
| ScenarioPercentIncomeChange | 0 | For scenario tests - changes all household incomes by specified percentage |
| ScenarioPercentAutoCostChange | 0 | For scenario tests - changes auto toll and operating costs by specified percentage |
| ScenarioPercentAutoTimeChange | 0 | For scenario tests - changes all auto travel times by specified percentage |
| ScenarioPercentAirFareChange | 0 | For scenario tests - changes all air fares by specified percentage |
| ScenarioPercentRailTimeChange | 0 | For scenario tests - changes all rail travel times by specified percentage |

The configuration options allow for several different ways of running the simulation, with some of the main options described below.

**Subsampling on households**: One way to limit run time in the simulation is to not simulate travel for every single household in the synthetic population, but only for a random subsample. The configuration settings ***Sample1inX*** and ***SampleOffSet*** facilitate subsampling. For example, if the values 20 and 7 are used, respectively, it would simulate only the 7th household out of every 20-households in the synthetic population file. So, the fraction sampled is equal to ***1 / Sample1inX*** , (a 5% sample in the example above). The household expansion factor for output is set equal to ***Sample1inX***.

**Subsampling on months and/or days:** Another way to influence run time and perhaps target the forecast to a particular month or season is to use ***MonthOfYear*** and ***EachDayOfTheMonth.*** By default, an entire year of travel is simulated by setting ***MonthOfYear*** to 0 to simulate all 12 months for each household. By default, only one representative travel day is simulated for each month by setting ***EachDayOfTheMonth*** to False. This means that the tour generation and subsequent models are only applied once for the month, and the expansion factor for each generated tour in the month is multiplied by the number of days in the month (31 for January, 28 for February, etc.). If ***EachDayOfTheMonth*** is set to true, every day of the month will be simulated separately, which will increase the number of tours simulated and tour records written by a factor of 30 or so, but will not increase the expanded number of tours. The reason to simulate each day separately may be to add more variability (and thus less random simulation error) in the output. However, since each day of the month is simulated using identical probabilities (there is no conditionality from one day of the month to the next, so no intra-household level consistency of travel scheduling), this does not add any true behavioral variability. In general, it is advisable to save run time by setting ***EachDayOfTheMonth*** to False rather than by subsampling households, since each household record is different and thus using more households in simulation does add some true behavioral variability.

**Options for generating trip matrices**: Our models, being a simplification of reality based on the limited data available, assume that all long-distance tours consist of exactly two trips, one trip from the residence zone to the destination zone, and a second one back to the residence zone. (In reality, a small percentage of long-distance tours contain three or more long distance trips connecting multiple destinations, other than simply stopping for gas or a meal, but simulating such complex tours would not be possible with this model structure, and would require a structure taking many times longer to run.)

In principle, one could simply post-process the tour file to generate trip matrices, accumulating one O-D and one D-O trip for each tour. To avoid the need for such post-processing, the software will accumulate and write out trip matrices for any specified modes. There are also a number user options provided for accumulating the trip matrices:

* ***UseProbabilitiesinMatrices:*** This is the most important option because it changes the ways that the mode/destination probabilities are used for the trip matrices. Instead of stochastically choosing a single mode and a single destination for each tour—which is done for the output tour records—this option simply adds the probability (times the expansion factor) to the matrix for every possible mode/destination alternative (4 modes times approximately 4,500 zones, or 18,000 alternatives). This is analogous to the way that 4-step models work. Rather than resulting in integer numbers of trips in each cell of the matrix, there are fractions of trips—often very tiny fractions. The advantage of this approach of generating matrices is that it adds variability—particularly spatial variability—and reduces random stochastic simulation error. The tradeoff is that it increases run times somewhat, and that the trip outputs will not exactly match the tour outputs in terms of mode and spatial distribution.
* ***PersonTripsInMatrices:*** In most cases, it makes sense to set this to True, since passenger counts for air rail and bus are in units of person-trips. The exception is when one wishes to generate vehicle-trip matrices for the auto mode, in which case this can be left as False (and in which case it makes sense to write out trip matrices only for the auto mode, which is the default setting.)
* ***UseADTUnitsInMatrices:*** If this is True, the matrices are simply scaled to units of average daily trips (ADT) instead of annual or monthly trips.
* ***TripMatrixMinimumDistance:*** Although the models use a (somewhat arbitrary) threshold of 50 miles one-way to define a long distance trip, it may be desirable to generate outputs that are comparable to other data sources that used a different threshold. For example, by setting this to 100, only trips between zones that are 100 or more miles apart (based on network auto distance) are counted in the matrices.

**The log print file**

Each time the software runs, it generates a log print file that is named automatically so as not to overwrite previous log files. For example, if ***inputs\test1\_config.txt*** is the name of the configuration settings file, then the print file the first time it is run will be named ***inputs\test1\_config\_01.log.*** If the same configuration file is used again, the print file will automatically be named ***inputs\test1\_config\_02.log,*** and so on.

The contents of the log file are the same as what appears on the screen during the run. The date and time the run starts and finishes are shown, along with an echo of all the configuration settings used for the run. In addition, a series of summary output tables are provided as a quick check on the results. An example of a log print file is provided in section X-6.

**Comparison of run times and output characteristics**

Table X-2 provides an idea of the model run times and file sizes using different combinations of configuration settings. The runs were done on an HP workstation with 16 GB of RAM and 4 processors. (The software itself uses only 2 GB of RAM and a single processor, since it is not yet written to use multi-threading on multiple processors.)

Run 1 uses ***Sample1inX*** = 100 to run only a 1% sample of households, so the expansion factors are 100. It simulates every month of the year and each day of the month separately and uses stochastic choices rather than mode/destination probabilities for the trip matrices. The run time is approximately 55 minutes. Out of a possible 20 million or so OD pairs in the trip matrices, there is a positive number of auto trips for 3.64 million, or 18% of possible OD pairs. There are 1.1 million household records in the output HH file, which is a size of 60 MB, and 17.5 million tour records, for a file size of just under 1 GB.

Run 2 uses ***Sample1inX*** = 1 to simulate every household, but uses ***EachDayOfTheMonth***= False to simulate only a single representative day per month. In this case, the expansion factors range from 28 to 31 depending on the month. Compared to Run 1, the run time increases slightly to 65 minutes, but the spatial coverage in the auto trip matrix increases by a factor of nearly two, with positive trips for 31% of possible OD zone pairs. Of course, the size of the output household file increases by a factor of 100 to 114.6 million records and almost 6 GB, while the size of the tour file increases by a factor of 3 or so,, to 55.1 million tour records and a 3.1 GB. (After expansion, the total numbers of households, tours, and trips are virtually identical in all runs. These are just different ways of generating them.)

**Table X-2: Comparison of run times and output characteristics under different settings**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Run** | **1** | **2** | **3** | **4** |
| HH sampling rate | 1% | 100% | 100% | 100% |
| Months simulated | All | All | All | All |
| Each day of month separately? | Yes | No | No | Yes |
| Use probabilities in trip matrix? | No | No | Yes | No |
| Expansion factors | 100 | 28-31\* | 28-31\* | 1 |
|  |  |  |  |  |
| Run time | 55 min | 65 min | 240 min | 105 min |
|  |  |  |  |  |
| O-Ds in car trip matrix (million) | 3.64 | 6.31 | 19.65 | 16.27 |
| % of possible ODs in matrix | 18% | 31% | 98% | 81% |
|  |  |  |  |  |
| Output HH records (million) | 1.1 | 114.6 | 114.6 | 114.6 |
| Output HH file size (GB) | 0.06 | 5.8 | 5.80 | 5.8 |
| Output Tour records (million) | 17.5 | 55.1 | 55.1 | 1,750 |
| Output Tour file size (GB) | 1.0 | 3.1 | 3.1 | 99.0 |
| \* Days in the month |  |  |  |  |

Run 3 is identical to Run 2, but the trip matrices use the mode/destination probabilities rather than stochastic trips. This extra computation of the matrices does increase run time by a factor of nearly 4, to 240 minutes, but the spatial coverage of the car trip matrices has also increased by a factor of more than 3, up to 98% of all OD pairs. . (The only zone pairs without car trips in this case are intra-zonals and trips to or from Hawaii and Alaska, which are not connected by car to the other 48 states in our networks). If household and/or tour files were written in this run, they would be identical to Run 2, since only the method of calculating trips matrices was changed.

Finally, Run 4 shows an alternative way of increasing spatial coverage of the trip matrices while reducing run time. Unlike Run 3, this method uses simulated integer trips instead of mode/destination probabilities to accumulate the trip matrices, but it also simulates each day of each month separately. This run is effectively the same as Run 1, but using a 100% household sample instead of a 1% sample. The resulting run time is about twice as long as Run 1, but less than half as long as Run 3. The car matrix OD coverage is 81% which is nearly as high as Run 3, and may be just as useful for assignment, considering the matrices for Run 4 have at least 1 trip in each cell (all integer numbers), while the matrices from Run 3 have many cells with small fractions of trips. If a tour file had been generated from Run 4, it would be 100 times the size of the tour file from Run 1, with roughly 1.75 billion tour records and a file size of nearly 100 GB. Thus the settings for Run 4 may be good for generating trip matrices, but not practical for generating and analyzing detailed tour records.

**X.3 INPUT FILE DOCUMENTATION**

Model coefficient files

Variables on NUMA\_2010\_landuse.dat (based on 2010-2012 Census tract level population and employment data, aggregated to NUMA zones. Employment categories mutually exclusive, broken down by NAICS code)

1. ZoneID: NUMA ID
2. NTracts: The number of Census tracts in the zone
3. LandSqm” The land area in the zone (square miles)
4. NUMALat: The latitude of the NUMA centroid (degrees)
5. NUMALong: The longitude of the NUMA centroid (degrees)
6. StateFIP: The state FIP code
7. ParkSqm: The land area in public parks (square miles)
8. TotHH: The number of households living in the zone
9. UnivEnr: The number of university students enrolled in the zone
10. TotalEmp: The total number of jobs in the zone
11. AgricEmp: The number of agricultural jobs in the zone
12. MininEmp: The number of mining jobs in the zone
13. UtiliEmp: The number of utility jobs in the zone
14. ConstEmp: The number of construction jobs in the zone
15. ManufEmp: The number of manufacturing jobs in the zone
16. WholeEmp: The number of wholesale trade jobs in the zone
17. RetaiEmp: The number of retail trade jobs in the zone
18. TransEmp: The number of transportation services jobs in the zone
19. InforEmp: The number of information services jobs in the zone
20. FinanEmp: The number of financial services jobs in the zone
21. RealeEmp: The number of real estate service jobs in the zone
22. ProfeEmp: The number of professional services jobs in the zone
23. ManagEmp: The number of managerial jobs in the zone
24. AdminEmp: The number of administrative jobs in the zone
25. EducaEmp: The number of education jobs in the zone
26. MedicEmp: The number of medical jobs in the zone
27. EnterEmp: The number of entertainment jobs in the zone
28. AccomEmp: The number of accommodation jobs in the zone
29. OServEmp: The number of other service category jobs in the zone
30. PubAdEmp: The number of public administration jobs in the zone
31. StateEmp: The number of state government jobs in the zone
32. FederEmp: The number of federal government jobs in the zone
33. BusStats: The number of bus stations within 40 miles of the zone centroid
34. RailStats: The number of rail stations within 50 miles of the zone centroid
35. MinStDist: Distance from the zone centroid to the nearest rail station (miles)
36. Airports: The number of airports within 100 miles of the zone centroid
37. MinAPDist: Distance from the zone centroid to the nearest airport (miles)

Variables on **zoneRoadLOS.dat** (based on national road network)

1. OZoneID: Origin zone (NUMA ID)
2. DZoneID: Destination zone (NUMA ID)
3. CarTime: Car time (minutes, 0 indicates no road connection)
4. CarDist: Car distance (miles)
5. CarToll: Car toll (cents)
6. BusTime: Bus time (minutes, based on factoring car time)
7. BusFare: Bus fare (dollars, from equation based on car distance)

Variables in **zoneRailLOS.dat** (based on Amtrak schedules and fares, and road access network, Least generalized cost station-pair is used for each zone pair)

1. OZoneID: Origin zone (NUMA ID)
2. DZoneID: Destination zone (NUMA ID)
3. RailTime: Rail journey time, including stops (minutes, 0 indicates no rail connection)
4. RailXfers: Rail transfers \* 100
5. RailFreq: Rail frequency (departures per week)
6. RailEconFare: Rail economy fare (dollars, from equation based on distance)
7. RailBusiFare: Rail business fare (dollars, from equation based on distance)
8. RailAccDist: Rail access distance (miles from NUMA to station, maximum is 50)
9. RailEgrDist: Rail egress distance (miles from station to NUMA, maximum is 50)
10. RailOStationID: Rail origin station ID #
11. RailDStationID: Rail destination station ID #
12. RailOStationCode: Rail origin station 3-letter code
13. RaiDStationCode: Rail destination station 3-letter code

Variables in **zoneAirLOS.dat** (based on DB1B ticket database and on-time database, Least generalized-cost airport pair is used for each zone pair)

1. OZoneID: Origin zone (NUMA ID)
2. OzoneID: Destination zone (NUMA ID)
3. AirTime: Airport pair in-flight time (minutes, 0 indicates no air connection)
4. AXfers: Airport pair average transfers \* 100
5. AirFreqDirect: Airport pair frequency of direct flights (departures per week)
6. AirFreq1Stop: Airport pair frequency of routes with 1 stop (departures per week)
7. AirFreq2Stop: Airport pair frequency of routes with 2 stops (departures per week)
8. AirPctOnTime: Airport pair percent of flights within 30 minutes of scheduled arrival time
9. AirEconFare: Airport pair average economy fare paid (dollars)
10. AirBusiFare: Airport pair average business fare paid (dollars, from equation based on distance)
11. AirAccDist: Air access distance (miles from NUMA to airport, maximum is 100)
12. AirEgrDist: Air egress distance (miles from airport to NUMA, maximum is 50)
13. AirOAirportID: Air origin airport ID #
14. AirDAirportID: Air destination airport ID #
15. AirOAirportCode: Air origin airport 3-letter code
16. AirDAirportCode: Air destination airport 3-letter code

Variables on Synthetic Population File **us\_synpop\_hh2\_sorted.dat** (roughly 114 million households, sampled using the PopGen software with 2010 Census tract level controls, and sorted by residence zone ID)

1. HHId: Household identification number
2. HHTract: 2010 residence Census tract FIPS code
3. HHZone: Residence zone # (NUMA ID)
4. HHSize: The number of persons in the household
5. HHWorkers: The number of employed persons in the household (full or part time)
6. HHNonWkrs: The number of non-employed adults (age 18+) in the household
7. HHHasKids: Whether or not the household has kids under age 18 (1=yes, 2=no)
8. HHHeadAge: The age of the head of the household, in years
9. HHIncome: The previous year total gross income, in dollars
10. HHExpFactor: The household expansion factor (always equals 1 on input)

**X.4 OUTPUT FILE DOCUMENTATION**

***The Household File***: A record written for each simulated household, if specified by the user.

1. HHId: Household identification number
2. HHZone: Residence zone # (NUMA ID)
3. HHState: Residence state (FIP code)
4. HHSize: The number of persons in the household
5. HHWorkers: The number of employed persons in the household (full or part time)
6. HHNonWkrs: The number of non-employed adults (age 18+) in the household
7. HHhHasKids: Whether or not the household has kids under age 18 (1=yes, 2=no)
8. HHHeadAge: The age of the head of the household, in years
9. HHIncome: The previous year total gross income, in dollars
10. HHVehicles: The number of vehicles predicted by the auto ownership model (4 = 4 or more)
11. HHPersBusTours: The number of personal business tours simulated for the household
12. HHVisitTours: The number of visit friends/relatives tours simulated for the household
13. HHLeisureTours: The number of leisure tours simulated for the household
14. HHCommuteTours: The number of commute tours simulated for the household
15. HHEmplBusTours: The number of employer’s business tours simulated for the household
16. hhExpOut: The household expansion factor for output (depends on subsampling)

***The Tour File***: A record written for each simulated household, if specified by the user.

1. HHId: Household identification number
2. trNo: The tour sequence number for the household (1,2,3, etc.)
3. trMonth: The month the tour was generated (1=Jan, …., 12=Dec)
4. trPurpose: The main tour purpose (1=Pers.Bus, 2=Visit, 3=Leisure, 4=Commute, 5=Emp.Business)
5. trPartySize: The tour travel party size (1=1, 2=2, 3=3, 4=4 or more)
6. trNightsCategory: The tour duration (1=day trip, 2=1-2 nights, 3=3-6 nights, 4=7 or more nights)
7. trMode: The main tour mode (1=Car, 2=Bus, 3=Rail, 4=Air)
8. trOState: The tour origin state (FIP code)
9. trDState: The tour destination state (FIP code)
10. trOZone: The tour origin zone (NUMA ID)
11. trDZone: The tour destination zone (NUMA ID)
12. trAutoDistance: The tour round trip distance if it were made on the auto network (miles)
13. trTravelTime: The tour round trip travel time by the chosen main mode (minutes)
14. trTravelCost: The tour round trip travel cost by the chosen mode (dollars, per person for non-auto)
15. trExpFactor: The tour expansion factor
16. trOrigStation: The tour origin rail station or airport ID #
17. trDestStation: The tour destination rail station or airport ID #

***The Trip Matrix File:*** A record written for each zone-pair with a non-zero number of trips, if specified by the user for a given mode

1. OrigZone: The trip origin zone (NUMA ID)
2. DestZone: The trip destination zone (NUMA ID)
3. Mode: The main trip mode (1=Car, 2=Bus, 3=Rail, 4=Air)
4. Trips: The number of trips predicted for the origin/destination/mode

**X.5 ESTIMATED MODEL COEFFICIENTS**

**Mode impedance weights**

**Mode choice models**

**Destination choice models**

**Tour party size models**

**Tour duration of stay models**

**Tour generation models**

**Auto ownership model**

**X-6 SAMPLE LOG PRINT FILE**

Reading configuration file inputs\test3\_config.txt

RunTitle FHWA\_Long\_Distance\_Model\_Test\_Run

RoadLOSFileName inputs\zoneRoadLOS.dat

RailLOSFileName inputs\zoneRailLOS.dat

AirLOSFileName inputs\zoneAirLOS.dat

ZoneLandUseFileName inputs\numa\_2010\_landuse.dat

HouseholdFileName inputs\us\_synpop\_hh3\_sorted.dat

DestChoiceCoefficientFile\_1 inputs\pbusdest6\_bxc.F12

DestChoiceCoefficientFile\_2 inputs\vfardest6\_bxc.F12

DestChoiceCoefficientFile\_3 inputs\leisdest6\_bxc.F12

DestChoiceCoefficientFile\_4 inputs\commdest6\_bxc.F12

DestChoiceCoefficientFile\_5 inputs\ebusdest6\_bxc.F12

ModeChoiceCoefficientFile\_1 inputs\pbusmode13\_est.F12

ModeChoiceCoefficientFile\_2 inputs\vfarmode13\_est.F12

ModeChoiceCoefficientFile\_3 inputs\leismode13\_est.F12

ModeChoiceCoefficientFile\_4 inputs\commmode13\_est.F12

ModeChoiceCoefficientFile\_5 inputs\ebusmode13\_est.F12

PartySizeCoefficientFile\_1 inputs\pbus\_psize3.F12

PartySizeCoefficientFile\_2 inputs\vfar\_psize3.F12

PartySizeCoefficientFile\_3 inputs\leis\_psize3.F12

PartySizeCoefficientFile\_4 inputs\comm\_psize3.F12

PartySizeCoefficientFile\_5 inputs\ebus\_psize3.F12

NightsAwayCoefficientFile\_1 inputs\pbus\_dur3.F12

NightsAwayCoefficientFile\_2 inputs\vfar\_dur3.F12

NightsAwayCoefficientFile\_3 inputs\leis\_dur3.F12

NightsAwayCoefficientFile\_4 inputs\comm\_dur3.F12

NightsAwayCoefficientFile\_5 inputs\ebus\_dur3.F12

TourFreqCoefficientsFile\_1 inputs\freqest3a.f12

TourFreqCoefficientsFile\_2 inputs\fsecest3a.f12

AutoOwnCoefficientsFile inputs\carown3.f12

HouseholdOutputFileName outputs\household\_out\_13.dat

TourOutputFileName outputs\tour\_out\_13.dat

TripMatrixOutputFileName outputs\trip\_out\_13.dat

OutputFileDelimeter 32

MonthOfYear 0

EachDayOfTheMonth T

RandomSeed 12345

Sample1inX 100

SampleOffset 0

WriteHouseholdRecords T

WriteTourRecords T

WriteCarTripMatrix T

WriteBusTripMatrix T

WriteRailTripMatrix T

WriteAirTripMatrix T

UseProbabilitiesinMatrices F

UseADTUnitsInMatrices F

Run started at 5/24/2015 1:25:00 PM

Loading Zone Land Use Data from inputs\numa\_2010\_landuse.dat

Loading Road LOS Matrices from inputs\zoneRoadLOS.dat

Loading Rail LOS Matrices from inputs\zoneRailLOS.dat

Loading Air LOS Matrices from inputs\zoneAirLOS.dat

Total expanded households simulated = 114736800

Household car ownership distribution by income group

Income> Total 0-35 $k 35-65$k 65-100k 100-150 Over150

0 cars 5.13% 11.67% 2.97% 1.43% 0.89% 0.56%

1 car 29.75% 51.44% 28.56% 16.28% 10.47% 7.51%

2 cars 40.92% 26.06% 44.37% 49.70% 51.21% 53.61%

3 cars 15.53% 7.71% 16.04% 20.45% 22.59% 23.09%

4+ cars 8.67% 3.12% 8.06% 12.13% 14.84% 15.23%

Household tour rates by purpose and income group (for simulated period)

Income> Total 0-35 $k 35-65$k 65-100k 100-150 Over150

PersBus 2.7827 2.5804 2.8464 2.9167 2.9035 2.9062

VisitFR 6.4060 5.2268 6.5070 6.9750 7.3120 8.0412

Leisure 4.6567 2.6680 4.3955 5.5243 6.5317 8.3446

Commute 1.0016 0.4280 0.9643 1.3101 1.5545 1.8222

EmplBus 2.6798 0.7904 2.2291 3.4815 4.6272 6.5755

Total expanded tours simulated = 2010968300

Tour nights away distribution by purpose

Purpose Total PersBus VisitFR Leisure Commute EmplBus

Daytrip 50.71% 68.49% 40.11% 46.43% 78.12% 54.76%

1-2 nts 28.34% 20.45% 35.87% 27.87% 11.53% 25.65%

3-6 nts 15.07% 8.01% 17.30% 17.35% 8.16% 15.68%

7+ nts 5.88% 3.04% 6.71% 8.36% 2.19% 3.92%

Tour party size distribution by purpose

Purpose Total PersBus VisitFR Leisure Commute EmplBus

1 pers 30.36% 21.87% 26.28% 12.55% 79.77% 61.40%

2 pers 35.91% 39.73% 38.43% 41.14% 13.96% 25.03%

3 pers 13.81% 17.58% 15.27% 15.96% 3.45% 6.55%

4+ pers 19.92% 20.81% 20.02% 30.35% 2.82% 7.02%

Tour distance band distribution by purpose

Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 42.36% 47.40% 35.27% 43.38% 74.57% 40.30%

100-149 18.50% 20.35% 19.94% 18.83% 8.96% 16.15%

150-249 14.34% 12.95% 17.35% 14.51% 3.73% 12.27%

250-499 10.66% 8.34% 13.85% 9.35% 1.81% 11.05%

500-999 9.03% 8.16% 9.09% 8.27% 8.89% 11.16%

-1999 m 3.32% 2.03% 3.05% 3.74% 1.39% 5.32%

2000+ m 1.78% 0.78% 1.47% 1.91% 0.66% 3.75%

Tour mode choice distribution by purpose

Purpose Total PersBus VisitFR Leisure Commute EmplBus

Car 90.80% 95.03% 92.63% 90.83% 94.48% 80.62%

Bus 1.33% 1.53% 0.74% 2.44% 1.24% 0.64%

Rail 1.28% 0.88% 0.83% 1.16% 3.16% 2.24%

Air 6.59% 2.56% 5.80% 5.57% 1.13% 16.49%

Tour distance band distribution by mode and purpose

Mode = Car

Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 45.24% 48.58% 37.33% 46.04% 75.29% 48.19%

100-149 19.90% 20.97% 21.19% 20.06% 9.20% 19.43%

150-249 14.84% 13.13% 18.09% 14.93% 3.64% 12.70%

250-499 10.93% 8.43% 14.35% 9.60% 1.79% 11.21%

500-999 7.29% 7.37% 7.43% 7.09% 8.75% 6.53%

-1999 m 1.64% 1.40% 1.48% 2.06% 1.28% 1.69%

2000+ m 0.17% 0.13% 0.14% 0.21% 0.06% 0.23%

Mode = Bus

Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 37.37% 43.63% 34.37% 35.64% 48.81% 33.32%

100-149 15.24% 16.42% 17.52% 15.38% 5.07% 12.39%

150-249 15.47% 12.41% 14.02% 17.48% 13.54% 15.07%

250-499 9.82% 7.45% 9.98% 10.65% 5.70% 12.70%

500-999 18.20% 16.71% 19.91% 17.13% 23.41% 20.53%

-1999 m 3.57% 3.12% 3.85% 3.40% 3.24% 5.26%

2000+ m 0.34% 0.26% 0.34% 0.32% 0.22% 0.73%

Mode = Rail

Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 55.65% 61.15% 47.67% 49.97% 89.50% 47.82%

100-149 15.12% 17.96% 18.91% 15.67% 6.57% 14.59%

150-249 14.65% 11.29% 14.61% 18.66% 2.01% 19.07%

250-499 5.44% 3.48% 6.64% 6.03% 0.47% 7.24%

500-999 7.18% 5.05% 9.79% 7.16% 1.25% 8.86%

-1999 m 1.65% 0.99% 2.01% 2.01% 0.18% 2.03%

2000+ m 0.32% 0.08% 0.36% 0.50% 0.02% 0.39%

Mode = Air

Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 1.13% 1.09% 0.69% 2.02% 0.86% 0.99%

100-149 0.55% 0.50% 0.41% 0.97% 0.10% 0.43%

150-249 7.23% 7.38% 6.22% 5.52% 5.41% 9.12%

250-499 8.15% 7.09% 7.38% 5.40% 3.16% 10.70%

500-999 31.59% 33.44% 34.16% 23.99% 25.34% 33.75%

-1999 m 26.79% 25.03% 28.14% 31.59% 12.19% 23.49%

2000+ m 24.56% 25.47% 23.00% 30.51% 52.92% 21.52%

Daily tours by mode and O-D Census divisions (thousands)

Mode = Car

O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI

New Eng 160.6 83.4 4.2 0.8 8.9 1.1 0.6 0.3 0.3 0.0

Mid Atl 80.5 456.8 43.8 3.8 103.2 6.3 2.5 0.9 0.6 0.0

NE Cent 3.4 40.7 660.7 71.2 37.8 47.9 12.6 3.8 1.0 0.0

NW Cent 0.6 3.0 57.7 259.0 6.9 11.2 31.2 13.0 1.5 0.0

Sou Atl 7.8 86.1 38.3 7.4 797.7 72.8 14.1 1.7 1.0 0.0

SE Cent 1.0 5.4 46.8 12.2 70.9 182.7 32.6 1.5 0.5 0.0

SW Cent 0.4 1.7 9.2 26.8 12.3 28.7 440.6 15.0 1.8 0.0

Mountn 0.1 0.4 1.8 7.7 1.0 0.8 11.3 224.6 18.3 0.0

Pacific 0.2 0.4 0.8 1.3 1.0 0.4 2.5 46.3 539.8 0.0

AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 5.4

Mode = Bus

O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI

New Eng 2.1 1.7 0.2 0.0 0.3 0.0 0.0 0.0 0.0 0.0

Mid Atl 1.5 7.7 1.3 0.2 2.0 0.2 0.1 0.0 0.0 0.0

NE Cent 0.1 1.1 9.0 1.2 1.1 0.8 0.4 0.1 0.0 0.0

NW Cent 0.0 0.1 0.9 2.1 0.2 0.2 0.5 0.2 0.0 0.0

Sou Atl 0.2 1.7 1.1 0.2 9.7 1.1 0.4 0.0 0.0 0.0

SE Cent 0.0 0.2 0.8 0.2 0.9 1.5 0.6 0.0 0.0 0.0

SW Cent 0.0 0.1 0.3 0.4 0.4 0.5 5.2 0.3 0.1 0.0

Mountn 0.0 0.0 0.1 0.1 0.0 0.0 0.2 2.0 0.3 0.0

Pacific 0.0 0.0 0.0 0.0 0.0 0.0 0.1 1.0 7.8 0.0

AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Mode = Rail

O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI

New Eng 2.3 2.0 0.1 0.0 0.2 0.0 0.0 0.0 0.0 0.0

Mid Atl 7.2 21.7 1.3 0.2 5.1 0.1 0.1 0.0 0.1 0.0

NE Cent 0.1 0.5 5.4 0.5 0.2 0.1 0.1 0.1 0.0 0.0

NW Cent 0.0 0.0 0.2 0.3 0.0 0.0 0.0 0.0 0.0 0.0

Sou Atl 0.2 1.9 0.2 0.0 5.0 0.1 0.1 0.0 0.0 0.0

SE Cent 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

SW Cent 0.0 0.0 0.1 0.0 0.0 0.0 1.4 0.0 0.0 0.0

Mountn 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.3 0.1 0.0

Pacific 0.0 0.0 0.0 0.0 0.0 0.0 0.1 0.5 11.6 0.0

AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

Mode = Air

O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI

New Eng 0.4 2.7 2.3 0.9 3.9 0.6 1.5 1.8 5.3 0.1

Mid Atl 3.3 4.0 8.2 3.0 13.7 2.2 4.6 4.6 12.0 0.3

NE Cent 1.9 5.7 7.4 4.4 11.6 2.3 5.9 4.7 5.7 0.3

NW Cent 0.6 1.8 3.1 1.5 3.5 0.9 2.9 2.7 2.4 0.1

Sou Atl 3.0 8.8 10.6 4.2 16.9 3.3 7.5 5.0 11.1 0.3

SE Cent 0.5 1.5 2.1 1.1 3.5 0.7 2.1 1.0 1.4 0.1

SW Cent 1.0 2.7 4.3 2.8 6.3 1.7 8.8 4.6 4.6 0.2

Mountn 0.9 2.0 2.6 1.8 3.3 0.6 3.2 4.7 5.5 0.2

Pacific 4.7 8.9 6.0 3.0 12.4 1.4 6.0 11.3 13.5 1.1

AK & HI 0.2 0.4 0.5 0.2 0.6 0.2 0.4 0.4 0.4 0.0

Run finished at 5/24/2015 2:18:53 PM with 114736859 households processed