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DaySim Overview
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1. DaySim software

DaySim is currently available as open source software without a license fee through a consulting business model. That is, if you engage one of the copyright holders (John L. Bowman, Mark A. Bradley or Resource Systems Group) for consulting services for its implementation, then you will be granted an open source license to the code. If you are considering acquiring DaySim and have questions, please email John_L_Bowman@alum.mit.edu.

DaySim is software that simulates a day of activity and travel for each person in each household of a synthetic population distributed throughout a given geographical area. It does this using an integrated set of econometric discrete choice models. DaySim uses up to nine activity purposes, represents activity locations as land parcels or microzones, and schedules activity and travel to the minute. DaySim works iteratively with any standard or custom software that is able to route the trips that DaySim generates between origins and destinations and provide back to DaySim matrices of travel times and costs.

DaySim includes two basic variations, 'Standard' (or 'Person') and 'Household', which share most of the DaySim code in a shared repository. While the Standard version includes household choices only for long term choices such as car ownership, the Household version also explicitly models many household interactions, such as joint tours, when simulating the day of the household members.

DaySim has built-in flexibility so that an implementation for a particular client can include unique aspects without requiring any software customization. For example, the exact modes that are included can vary somewhat, there is complete flexibility in the time periods for which distinct travel times and costs are supplied to DaySim, and model coefficients can be region-specific. DaySim also has built-in adaptability so that a unique feature needed for a particular implementation can be written and retained in the common repository, so that the implementation can share the same code base with all uncustomized Standard and Household implementations.

DaySim is written in fully object-based C# code. It runs as a multi-threaded batch process that is controlled by a configuration file. The configuration file tells DaySim which version to run and supplies all of the parameters needed by DaySim's built-in flexibility so that it runs properly for the particular situation.

2. DaySim models

As depicted on the left in Figure 1, the DaySim models consist of long-term choice models, models at the day level that identify the tours and stop purposes for the day, and tour and trip models that model the details of each tour. The day level models constrain and condition the tour models, and are also impacted by accessibility arising from them. Also, in the course of the simulation, when a model at the day or tour & trip level determines that an activity or travel spans a particular period of time, that period becomes unavailable for other activities and travel.
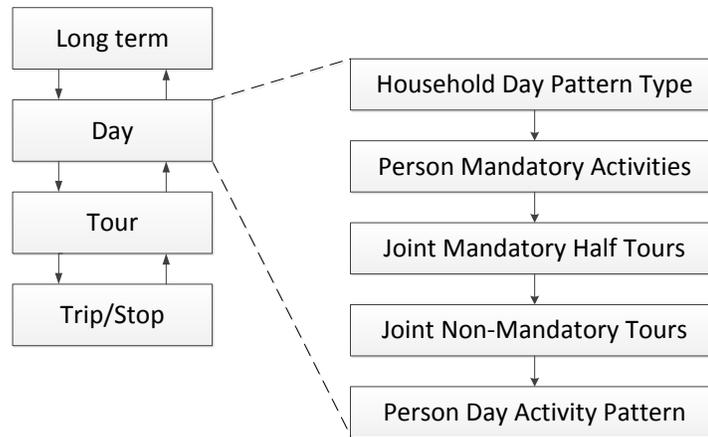
```
Long term
   │ ↑
   ↓ │
  Day ─────────────────────►  Household Day Pattern Type
   │ ↑                                    │
   ↓ │                                    ↓
  Tour                          Person Mandatory Activities
   │ ↑                                    │
   ↓ │                                    ↓
 Trip/Stop ──────────────►     Joint Mandatory Half Tours
                                          │
                                          ↓
                               Joint Non-Mandatory Tours
                                          │
                                          ↓
                               Person Day Activity Pattern
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Figure 1: DaySim model structure with details of the day level structure

2.1. Long term models
DaySim Standard and Household version long-term models include models for usual work location, usual school location, car ownership, public transport pass ownership, and whether a worker must pay to park at work.

2.2. Day level models
In the Household version, the day level models consist of numerous models in five main groups that operate in conditional sequence, according to a priority hierarchy, as shown in Figure 1 on the right. The household day pattern type model determines the highest priority aspects of the day from the perspective of the household, namely a pattern type for each person, determined simultaneously for all members. For each person, the pattern type identifies whether they travel for work, school or business (mandatory type), travel only for other purposes (non-mandatory type), or stay home all day (at-home type).

In the customized Copenhagen implementation of the Household version, a Primary Family Priority Time (PFPT) participation model participation is inserted into the hierarchy as a household choice immediately above the household day pattern type, modelled jointly with the household's choice of whether to conduct one or more joint tours for non-mandatory purposes. Also, given that PFPT participation occurs, a PFPT schedule model determines the start time and duration of the PFPT activity.

Given the household's day pattern type, the next group of models determines the specific mandatory activities for each person in the household, including the participation in in-home work activity for each worker, the number of work, business and/or school tours for each person with a mandatory pattern type, and whether they have any intermediate stops for work or school in their day.

Given the needs within the household for travel to work and school, the next set of models determines joint travel to and/or from those mandatory activities. Joint travel to work and school is only modelled for persons travelling to their usual work or school location. It can take the form of half tours, either to (Half Tour 1) or from (Half Tour 2) work and/or school. These half tours can be either paired or unpaired, where paired half tours are symmetrical, involving the same participants traveling together in both directions. They can also be either partially joint, in which one person drops off one or more others on their way to work or school, or fully joint, in which the destination for all participants is the same place. In fully joint half tours it is possible that one participant serves as a chauffeur and returns home after dropping off the other(s). The following examples illustrate the half tour definitions. In example 1, the household includes 2 workers (A, B) and two school children (C, D). In the morning, worker A drops both children C&D. In the afternoon, worker B picks-up child C, while child D returns home on her own. This household's day includes two unpaired partially joint half tours; Half Tour 1 with A, C and D, and Half Tour 2 with B and C. In example 2, the children (C & D) travel to and from the same school together, while the parents go to and from work separately. In this case the household's day involves two paired fully joint half tours conducted jointly by C and D.

To model joint half tours, a generation model determines for the household whether a joint half tour occurs and what type it is. This is followed by a participation model that determines, simultaneously for all eligible household members, which ones participate. This pair of models is repeated until the generation model determines that no more joint half tours occur.

Once the joint travel for mandatory activities has been determined, the next set of models determines the number of joint tours for non-mandatory purposes conducted by members of the household, and the purpose of each one. This is modelled via a tour generation model followed by a participation model, repeating until the generation model determines that there are no more joint tours to be conducted.

The last of the day level models is the person day activity pattern. In the Standard version of DaySim these are the only day level models. Constrained by all the prior model outcomes, this pair of models determines, for each person, the number of tours in the day, the purpose of each tour, and the purposes for which intermediate stops are to be made, if any. First, the pattern model determines the presence of tour and stop purposes. Second, the generation model determines the number of tours for each purpose that the pattern model determined to be present. The number of intermediate stops for each purpose is left to be determined subsequently as the tours determined here are being simulated.

2.3. Tours and trips
DaySim Household version simulates the details of each household's tours in the following priority order:
1. household's partially joint half tours
2. household's fully joint half tours
3. aspects of each person's mandatory tours that have not been determined by joint half tour simulation

4. household's joint non-mandatory tours
5. each person's remaining non-mandatory tours

The Standard version simulates only groups 3 and 5 above, treating all tours individually.

As each tour and trip is simulated, the outcomes are recorded for each participant, including the updating of their available time windows, so that subsequent models are properly constrained. For partially joint half tours, the pickup and/or drop-off sequence is determined, the tour mode is modelled, and the timing of all work and school arrivals and departures is modelled. For fully joint half tours, the tour mode and timing are modelled, and intermediate stops are generated—and the location, mode and timing of each stop are modelled—iteratively for both half tours. For person mandatory tours, the destination is modelled if it is a business tour, work-based sub-tours are generated, the tour mode and timing are modelled, and intermediate stops are generated and modelled as described above. For the household's joint non-mandatory tours and each person's remaining non-mandatory tours, the destination is modelled, and intermediate stops are generated and modelled, as described above.