Discover Activity-Based Modeling Using Cube Voyager

Contents

About this Document

Cube Voyager is a flexible scripting language that you can use to build any type of transportation model. In addition to convenient functions for efficiently processing the square zone-to-zone matrices commonly found in traditional trip-based, or "four-step" travel demand models, Cube Voyager includes record processing and database manipulation commands that can be used to construct tour-based and activity-based models. For the release of Cube 5.1, Citilabs has added an example of an activity-based model implemented entirely using Cube Voyager to the Cubetown demonstration system.[1]

This document describes the activity-based model example in Cubetown. Topics include:

- Overview of structure and data

- Opening the activity-based model

- Running the activity-based model

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[1] Special thanks to Mark Bradley, who assisted Victor Siu, Ken Vaughn, and Colby Brown of Citilabs in implementing the activity-based model example in Cube Voyager script.

Overview of structure and data

Traditional travel demand forecasting models are usually "trip-based", meaning that they use a hypothetical **trip** from an origin zone to a destination zone as the unit of travel analysis. Such models are also often referred to as "four-step" models because they consist of four general process steps:

1. Trip Generation

2. Trip Distribution

3. Mode Split

4. Traffic Assignment

Modern variations on this framework may include network pre- or post-processing steps, detailed time-of-day analysis, a land use model prior to trip generation, incremental demand model formulations, and/or feedback of congested network costs from traffic assignment to earlier steps. The **Cube Voyager Demonstration Model** and **Land Use-Transport Interaction Model** included in the Cubetown demonstration system are both examples of trip-based travel demand forecasting models implemented using Cube Voyager.

While the trip-based approach is still widely used as of the release of Cube 5.1, some planning agencies have begun to implement models based upon alternative frameworks. These models have in common a shift away from the trip to the tour as the unit of travel analysis. Also known as a "trip chain", a tour consists of a sequence of trips made by a traveler, starting and returning at the same location, with stops at various intervening zones. For example, a home-based work "tour" might include stops at a daycare facility on the way to and from work, as well as work-based sub-tours to perform various errands during the day. Because travel patterns depend upon activity participation, some models that forecast tours are referred to as activity-based models.

In addition, tour-based models are typically also simulation-based, meaning that instead of forecasting the aggregate number of trips between zones belonging to various categories, with increasing refinement in trip classification through the model chain, they consider each decision-maker (e.g. a household, a worker, or a student) in turn and apply an integrated hierarchy of choice models to assess the probability of a particular pattern of behavior for that individual. Monte Carlo methods, using random draws from the computed probability distribution, are used to assign a likely tour pattern to each traveler.

While a variety of tour-based and activity-based models have been studied in the research literature and applied in practice, the framework used for the **Cube Voyager Activity-Based Model** is loosely based upon the work of John Bowman and Mark Bradley in California.[2] The choices considered by this model include:

- Household auto ownership

- Activity day-pattern structure

- Number and type of tours

- Time of day (activity scheduling)

- Joint mode & destination choice

Auto Ownership Model

Activity Day-Pattern Choice

Tour Generation & Time-of-Day

Joint Mode/Destination Choice
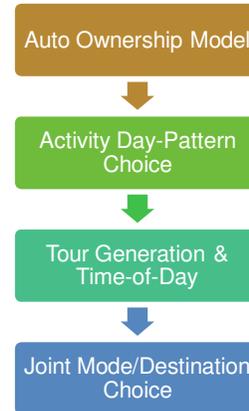
These integrated choices are modeled within a single MATRIX step, called the **activity and travel simulator**. In addition, the model system includes the following supporting processes:

- A **population synthesizer**, which creates a sample of individuals drawn from a table of survey records in such a manner as to match aggregate zonal characteristics,

- A **network analysis** process, which provides zone-to-zone travel costs by mode and time of day used in the activity and travel simulator,

- A **travel aggregator**, which converts the tour-based records produced by the activity and travel simulator into square origin- destination format vehicle-trip matrices, and

- A **traffic assignment** process, which performs multi-path assignment of highway and public transport trips by time of day and evaluates congestion.

The Cube Voyager Activity Based Model example shown in the Cubetown Demonstration system performs each of these steps in sequence and then writes the output network to a personal geodatabase for GIS analysis and mapping. However, in practice it is recommended that the congested costs produced by traffic

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[2] See Bowman, John and Mark Bradley. "Disaggregate treatment of purpose, time of day, and location in an activity-based regional travel demand forecasting model." Proceedings of the 2005 European Transport Conference, October 2005, Strasbourg, France.

assignment be fed back into the network analysis step so that the activity and travel simulator can be run iteratively.

- ## To open and examine the activity-based model

1. Open the Discover Cube catalog

    a. Start Cube.
       You can:

       - Double-click the Cube icon on your desktop.

       - Click the **Start** button, point to **All Programs**, point to **Citilabs**, and choose **Cube** (in Windows XP).

       Cube displays the Welcome to Cube dialog box.

    b. Select **Open Discover Cube catalog** and click **OK**.

       Cube opens the Discover Cube catalog in Scenario Manager. The catalog shows the scenarios, data, and applications used with the Cubetown demonstration models.
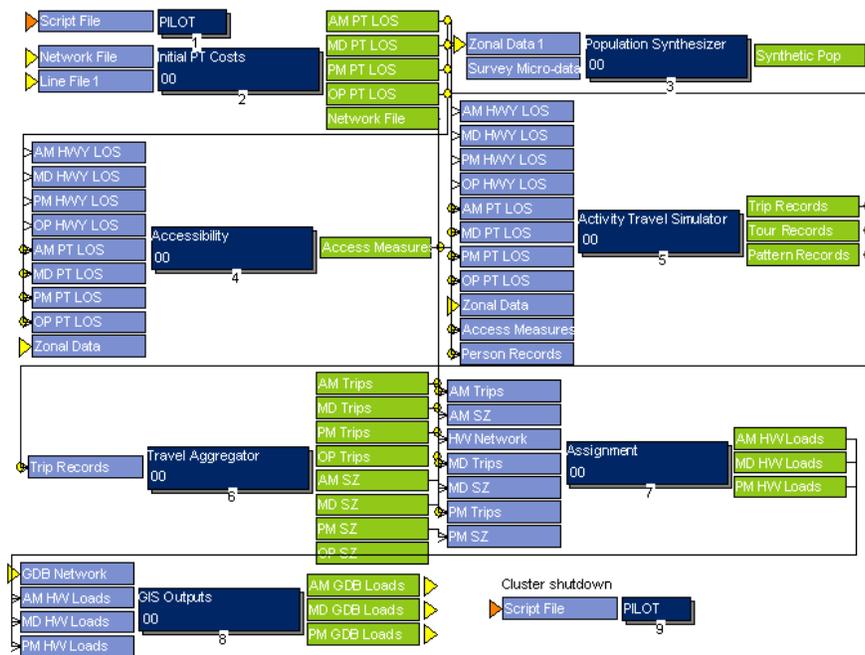
2. Under **Applications** in Scenario Manager, double-click **Cube Voyager Activity-Based Model** to open the activity-based model example application.
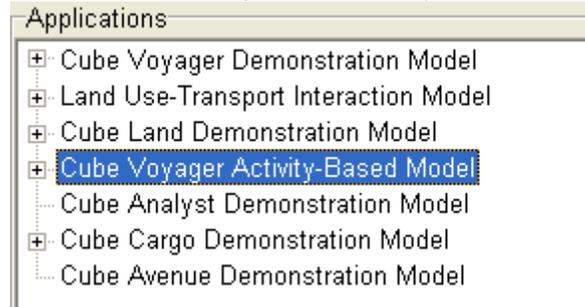
Cube opens the Activity-Based Model in Application Manager.

The dark blue boxes represent steps in the model, the light blue boxes show inputs to each step, and the green boxes show the outputs. Lines represent the links between outputs from one step and inputs to the next step. You can see the input and output data for the activity travel simulator, as well as the other supporting processes.

▪ To run the Activity-Based Model

1. Under **Scenarios** in Scenario Manger, double-click on **Base**.
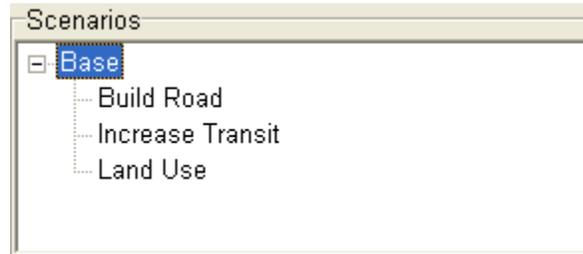
Cube opens the Scenario Editing window for the Base scenario. Just as in a standard trip-based model, you can analyze different highway networks, public transit services, and socio-economic assumptions. In addition, the example application shows how distributed processing can be used to speed up model runs on computers with more than one processor. You can also perform a select zone analysis. Unlike traditional select zone analysis, this will consider all trips made by *residents* of a given zone.
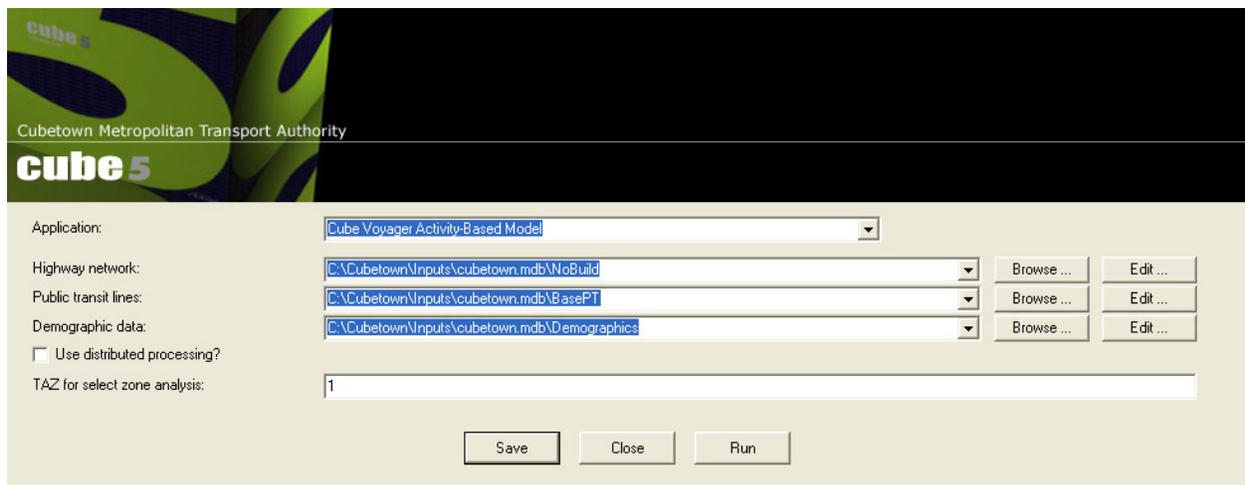

1. Run the model.

   a. Click **Save**, then **Run** in the Scenario Editing window.
      The Task Monitor window opens, showing the progress of the run. When complete, a Task Run Result dialog box opens.

   b. Click **OK**.

2. View the model outputs.

   a. Click **Close** to hide the Scenario Editing window and return to the Application Manager view.

b. Double-click on the **AM GDB Loads** output network produced by the **GIS Outputs** process (step 8).
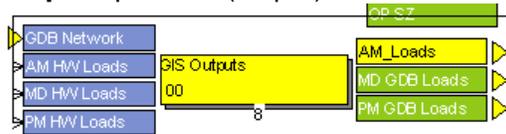
Cube opens the AM_Loads network in the GIS Window.

c. Click on the **Bandwidth Settings** button in the toolbar.

d. Set up a Highway Layer Link Band Width display for the **V3_1** output variable, which is the select zone volume set, as shown below. Click **OK** when done.
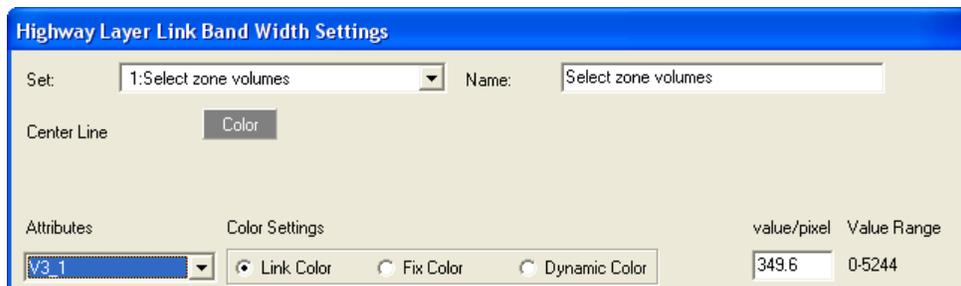
Cube displays the select zone volume bandwidth in the GIS Window.
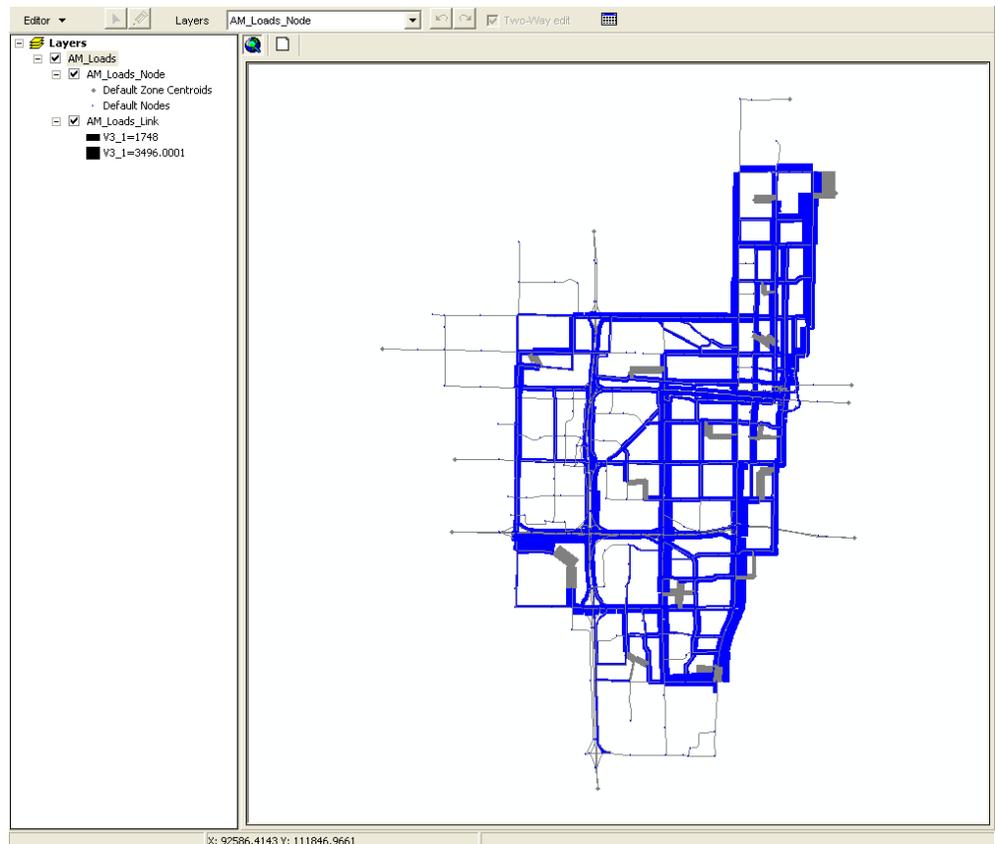
The width of each link in this map is proportional to the number of trips on that link made by residents of the zone selected for analysis (Zone 1 by default). Note that this includes trips made by selected zone residents that do not have the selected zone as either the origin or the destination (i.e. non-home based trips). Therefore, this analysis will capture more information about the travel patterns of selected zone residents than would a typical select zone analysis.