Opus (the Open Platform for Urban Simulation) and UrbanSim 4

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ABSTRACT
This demo will give an introduction to Opus, the Open Platform for Urban Simulation, an Open Source platform for building simulations of land use, activity-based travel demand, and dynamic traffic assignment. It is a result of an international collaboration of research teams working on integrated land use, transportation and environmental modeling. We have developed a new version of UrbanSim – a simulation system for modeling urban development, originally demonstrated at the Digital Government 2004 Conference – as a component of Opus. We will demonstrate usage of UrbanSim for different stakeholder types, from modelers to policy makers.

Categories and Subject Descriptors
I.6.7 [**Simulation and Modeling**]: Simulation Support Systems. I.6.3 [**Simulation and Modeling**]: Applications – *land use and travel modeling*. K.4.m [**Computers and Society**]: Miscellaneous – *urban planning.*

General Terms
Experimentation.

Keywords
Urban planning, modeling systems.

1. INTRODUCTION
Opus, the Open Platform for Urban Simulation, is a recent international collaboration to develop a robust, modular and extensible open source framework for land use, transportation and environmental modeling. It is an initiative to put model systems of different areas under one roof, and thus support their integration, increase their quality, facilitate increased collaboration among developers and users in the evolution of the platform and its applications, and reduce the cost of building new model systems by leveraging a common framework [4].

Opus consists of independent packages, each of which usually represents a model system. Opus packages can, and usually do, use functionality of other Opus packages.

One of the main Opus packages is the urbansim package implementing the set of UrbanSim land-use models. UrbanSim (www.urbansim.org) is an open-source software-based simulation model for integrated planning and analysis of urban development, incorporating the interactions between land use, transportation, and public policy [2]. It is intended for use by Metropolitan Planning Organizations and others needing to interface existing travel models with new land use forecasting and analysis capabilities, and is planned to be the operational model for the Puget Sound Regional Council's four county area.

2. URBANSIM
Our previous version of UrbanSim, implemented in Java, was demonstrated two years ago at Digital Government Conference 2004 [3]. Since then, we rebuilt the entire system in order to address some significant shortfalls, and created a modular and extensible Opus package.

Here are some notable aspects of UrbanSim 4, the current version of the system:

- It is flexible, allowing people to easily experiment with the code, and construct new models by composing different parts.
- It is extensible. Adding a new model, variable, sampling method, estimator, data store, etc. can be done without touching the core code.
- It is scriptable, since it is written in Python.
- It is more accessible to modelers, since our experience so far is that they are much more open to using Python than Java.
- It is more transparent. For instance, the intermediate values are stored in a file system cache, which can later be mined to create indicator charts, maps, and tables (see Figure 1), or examined when debugging a problem.

- It has a fully integrated estimation process that shares code with the corresponding simulation procedure, and is almost completely automated (no more copying of results between an external estimation package and the simulation system). This eliminates a large and bothersome set of errors. It also dramatically reduces the time to estimate a model (hours instead of days). Re-estimating a model with different data takes just minutes or seconds.
- It has satisfactory performance, as a result of making extensive use of optimized C++ array and matrix manipulation libraries that are called from Python. For instance, as of this writing a 30-year simulation of the 16 UrbanSim land-use models over the Puget Sound Regional Council's dataset of 1.3 million households takes about 2 days (1 hour 40 minutes per year).
- It uses almost identical data as the prior version of UrbanSim, so only minor changes in the data structure are needed to convert UrbanSim 3.0 databases to work with the new UrbanSim.

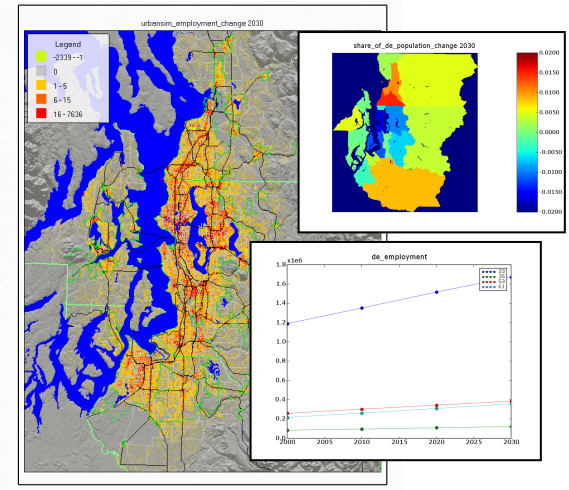

Figure 1 - Example indicators from UrbanSim.

3. OPUS COLLABORATIONS

The Opus version of UrbanSim is being transitioned into operational use for regional planning in our own region via our collaboration with Puget Sound Regional Council. As of this writing, several other Municipal Planning Organizations also are converting their data for the use of Opus.

As stated in the previous sections, Opus is designed as a platform that incorporates different kinds of simulation models from the land use, transportation and environmental area. For instance, we are collaborating with Professor Eric Miller's group at University of Toronto as they re-implement their Integrated Land Use Transportation Environment (ILUTE) modeling system to be used under the Opus umbrella**.** Professor Marina Alberti's group at the University of Washington has moved their land cover change model into Opus, and is planning on building additional environmental models in Opus. Furthermore, we are collaborating with Michele Bierlaire of the École Polytecnique Fédérale de Lausanne and the Massachusetts Institute of Technology to create an Opus interface to the Biogeme package, which is an object-oriented software package designed for the maximum likelihood estimation of Generalized Extreme Value (GEV) models [1]. Several other groups expressed their interest in a close collaboration.

4. THE DEMO

Our demo will demonstrate all of the aspects listed above. It will start with simple experimental datasets, to illustrate the facilities that Opus provides for manipulating and visualizing data and running models. Then it will move to datasets from the full Puget Sound Regional Council application, which consists of over a million of households, demonstrating the ease of use of UrbanSim models on such complex data. It will illustrate how simulation and estimation work seamlessly together as two sides of the same model.

In addition, the demonstration will present a way of using the models by stakeholders not trained in any programming languages. We show that the same Opus models or model systems can be used interactively (for experimental purposes) as well as via a GUI (in a production mode).

Finally, we will show how indicator charts and maps can be generated using a variety of packages, including R, matplotlib, and OpenEV (see Figure 1).

5. ACKNOWLEDGMENTS

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