Development of prototype UrbanSim models

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Outline

• Introduction
• Literature review
• Brief UrbanSim description
• Brussels case study
• Lausanne case study
• Developing a Prototype UrbanSim model
  – Familiarization
  – Data preparation
  – Sub-model estimation
  – Simulation and analysis
  – Evaluation

• Conclusions
Introduction

- Importance of integrated modeling
- UrbanSim: appealing platform
- Most implementations done by UrbanSim's developers
- Effort required to develop an operational model? (very high, probably)
- Prototype models help to evaluate the application of a fully implemented UrbanSim model
Literature review

- Descriptions of UrbanSim
- Computer science (software and user interface)
- Discrete choice innovations related to location choice (UrbanSim as a tool to test hypotheses)
- UrbanSim applications (by developers)
- Independent UrbanSim applications

Little information on how to evaluate UrbanSim as an integrated model
UrbanSim

Why UrbanSim?
- Open source
- Very disaggregate
- Dynamic disequilibrium approach

Disadvantages:
- High data requirements (because of disaggregation)
- Learning costs
- Complexity of model preparation, estimation and calibration
UrbanSim

How UrbanSim works?

- Economic transition model
- Development project transition model
- Employment and household relocation model
- Real-estate location choice model
- Accessibility model
- Transport model
- Land-price model
- Demographic transition model

New jobs ➔ Employment and household location choice model

Relocating agents ➔ Accessibility model

New households ➔ Transport system performance

Located real-estate supply ➔ Development constraints

Located agents ➔ Development constraints

access ➔ Development constraints

New buildings ➔ Development constraints
Fundamental Data

- Gridcells
- Households
- Jobs
- Buildings
- Development event history
- Development Constraints

“The Six Tables”
Two case studies

Brussels, Belgium

Lausanne, Switzerland
Brussels case study

- Data from an already implemented TRANUS model:
  - Households by zone and socio-economic cluster for 1991 and 2001
  - Employment by zone and economic sector (13) for 1991 and 2001
  - Land-value (3 land-uses) by zone for 2001
  - Interzonal travel time and logsums for 2001
  - GIS layer of road infrastructure
  - GIS layer of zoning
Brussels case study

- **Data preparation**
  - Standard gridcell of 150 x 150 meters
  - Households and jobs were disaggregated into gridcells
  - One building of each required type were created in each gridcell
  - Number of residential units and non-residential surface was adjusted to account for vacancy rates
  - Employment and population change between 1991 and 2001 was used to create a synthetic development event history
  - Development constraints were derived from “observed” development in the city
### Brussels case study

#### Results (Household Location Choice Model)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cost: Income</td>
<td>-0.0661</td>
<td>0.0307</td>
<td>-2.2</td>
</tr>
<tr>
<td>2 % High Inc. If High Inc.</td>
<td>0.0334</td>
<td>0.00150</td>
<td>22.3</td>
</tr>
<tr>
<td>3 % Low Inc. If High Inc.</td>
<td>0.00400</td>
<td>0.00138</td>
<td>2.9</td>
</tr>
<tr>
<td>4 % Low Inc. If Low Inc.</td>
<td>0.0603</td>
<td>0.00109</td>
<td>55.4</td>
</tr>
<tr>
<td>5 Travel Time to CBD</td>
<td>-0.000622</td>
<td>0.000148</td>
<td>-4.2</td>
</tr>
<tr>
<td>6 In Flanders</td>
<td>-0.0267</td>
<td>0.00856</td>
<td>-3.1</td>
</tr>
</tbody>
</table>

**Null Log-likelihood is:** -440982.247

**Log-likelihood is:** -439242.311

**LR Test:** 3479.871

**Number of observations:** 129655

**Convergence statistic is:** 7.617E-05
Brussels case study

Results
Lausanne case study

- Available data
  - Swiss census of households (2000)
  - Swiss census of enterprises (2001)
  - GIS layers for geographical data
  - Transportation model (EMME)

- No info on land prices
- Imperfect data on household income
Lausanne case study

- Data preparation
  - Households: directly from census
  - Jobs: a record for each job in each enterprise
  - Buildings: from households and jobs tables
  - Development event history: directly from census
  - Development constraints were derived from observed development in the city
## Results (Household Location Choice Model)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cost: Income</td>
<td>-5.935</td>
<td>0.747</td>
<td>-7.9</td>
</tr>
<tr>
<td>2 Retail Employment WWD</td>
<td>0.0298</td>
<td>0.00328</td>
<td>9.1</td>
</tr>
<tr>
<td>3 % High Inc. If High Inc.</td>
<td>0.0298</td>
<td>0.000616</td>
<td>48.4</td>
</tr>
<tr>
<td>4 % Low Inc. If Low Inc.</td>
<td>0.0236</td>
<td>0.00113</td>
<td>21.0</td>
</tr>
<tr>
<td>5 High Density if Young</td>
<td>0.428</td>
<td>0.0177</td>
<td>24.1</td>
</tr>
<tr>
<td>6 Mixed Use if Young</td>
<td>0.454</td>
<td>0.0217</td>
<td>21.0</td>
</tr>
<tr>
<td>7 Res. Units with Children</td>
<td>-0.00472</td>
<td>0.000103</td>
<td>-45.6</td>
</tr>
<tr>
<td>8 Accessibility to Population</td>
<td>0.400</td>
<td>0.0455</td>
<td>8.8</td>
</tr>
<tr>
<td>9 Travel Time to CBD</td>
<td>-0.0211</td>
<td>0.00259</td>
<td>-8.1</td>
</tr>
<tr>
<td>10 Travel Time to Station</td>
<td>0.0320</td>
<td>0.00210</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Log-likelihood is: -440830.606
Null Log-likelihood is: -444383.444
LR Test: 7105.676
Number of observations: 130655
Convergence statistic is: 5.398E-04
Lausanne case study

Results
Developing a Prototype UrbanSim model

Familiarization
- UrbanSim Example (e.g., Eugene)
  - Data Requirements
  - Local Data

Implementation
- Data Preparation
- Submodel Estimation
- Transport Model Integration
- Simulation
  - Qualitative & Quantitative Analysis

Evaluation
- Requirements for Full Model
  - Effort/Cost for Full Model
  - Go, No-go Decision
Developing a Prototype UrbanSim model

- **Familiarization**
  - With UrbanSim
  - With local data
    - Run simulations with provided example (Eugene)
    - Explore data of provided example
    - Identify required data
    - Analyze “fit” between required and available data
Developing a Prototype UrbanSim model

- Data preparation
  - Concentrate on the “six tables”
  - Build tables starting from available examples
  - Focus on readily available data
  - Identify missing data
  - If necessary, use simulated data or simplifying assumptions
Developing a Prototype UrbanSim model

- **Submodel estimation**
  - Quality of models is difficult to evaluate without seeing simulation results
  - Estimate quickly in order to be able to run simulations soon (models can be improved later)

- **Transport model integration**
  - Continual interaction is not strictly necessary
  - Clearly identify inputs and outputs of the transport model
Developing a Prototype UrbanSim model

- **Simulation**
  - Start to run simulations early, even if data is incomplete (helps to identify possible errors and improvements)
  - Use the latest stable release

- **Analysis**
  - Population growth by area?
  - Simulation results comply with expectations?
  - Problems with data?
  - Problems with submodels?
Developing a Prototype UrbanSim model

**Evaluation**
- Desired characteristics of the operational model
  - Level of disaggregation (Data requirements)
  - Interaction with transport model
- Effort required to implement a complete model
  - Data gathering
  - Submodel estimation
  - Transport model (Is there an appropriate, available model?)
- Priority identification
  - Disaggregate projections ➔ UrbanSim
  - Aggregate projections ➔ Other models may be better (easier)
Conclusions

- Best way to evaluate UrbanSim is developing a prototype model
- Even with incomplete data results can be reasonable
- Developing a prototype model is possible within 3 – 5 months of one person’s effort
Conclusions

- Recommendations:
  - Learn by doing
  - Start with provided examples and available data
  - Concentrate on the “six tables”
  - Continual interaction with transport model is not strictly necessary
  - Run simulation early, even if data is incomplete
  - Concentrate on general results
  - Identify desired characteristics and data requirements for an operational model
Questions?