
Agent-Based and Analytical Modeling to Evaluate the Effectiveness of Greenbelts

Environmental Modelling & Software 19: 1097-1109.

I think, therefore I am.
René Descartes (1596–1650)

Geographically speaking,....
• Global/trend factors
• Local/site factors
• Neighbor/interaction factors
• Scales & Interactions
Why ABM?

- New approach to scientific validation.
- ABM can represent spatial heterogeneity and incorporate complex model specifications.
- Deeper insights into processes.

Advantages of ABM

- Bottom up, decentralized autonomy
- Cross-scale capability
- Individual or aggregated interactions of agents/cells
- Dynamic
- Simplicity (simple rules can generate complex patterns)
- GIS ready
Major challenges of ABM

- Explanation vs. prediction
- Implementation
- Validation

Netlogo Disease Solo Simulation
http://ccl.northwestern.edu/netlogo/models/DiseaseSolo

Effectiveness of Greenbelt Zone in Preventing Sprawl

ABM Approach
• Agents: residents and service centers
  – Residents: aesthetic preference
  – Residents: service center preference
• Landscape: aesthetic quality (static)
• Constraint: greenbelt
• Utility functions: distance to SC
• Rules:
  – Cells can only be occupied by one agent
  – Move to location with the highest utility
  – Agents have perfect or incomplete information
  – New SC was created when new residents reached 100

Measuring Model Outcomes

• Tuned parameters
  – Weights between preference variables
  – Width and location of greenbelt
• Time to reach 300 sprawled agents
Results

- Left side cells were developed first in 1D model
- 2D models (Table 2)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>( w = 1 )</th>
<th>( w = 15 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( g = 20 )</td>
<td>( g = 40 )</td>
</tr>
<tr>
<td>2</td>
<td>39 (1)</td>
<td>61 (2)</td>
</tr>
<tr>
<td>3</td>
<td>113 (23)</td>
<td>275 (47)</td>
</tr>
<tr>
<td>4</td>
<td>36 (19)</td>
<td>194 (52)</td>
</tr>
<tr>
<td>5</td>
<td>131 (21)</td>
<td>320 (25)</td>
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<tr>
<td>6</td>
<td>44 (7)</td>
<td>71 (30)</td>
</tr>
<tr>
<td>7</td>
<td>77 (12)</td>
<td>171 (33)</td>
</tr>
<tr>
<td>8</td>
<td>90 (15)</td>
<td>160 (37)</td>
</tr>
</tbody>
</table>

ABM Tools

- Swarm
- RePast (ArcGIS Agent Analyst)
- Ascape
- Netlogo

- Programming skills are required
  - C, java, Python
Generative explanation for empirical validation

- For more information: Stephen Wolfram 2002. A New Kind of Science (1192 pages)
  http://www.wolframscience.com/nksonline/toc.html