
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>
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<th>Experiment</th>
<th>$w=1$</th>
<th>$w=15$</th>
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</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>86 (19)</td>
<td>194 (52)</td>
</tr>
<tr>
<td>5</td>
<td>131 (21)</td>
<td>320 (25)</td>
</tr>
<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