Computational Simulation Applied to Public Policies

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The MITRE Corporation
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  - National Security Engineering Center
  - Center for Advanced Aviation System Development
  - Center for Enterprise Modernization
  - Homeland Security Systems Engineering and Development Institute

Where do I sit?
Modeling and Simulation ->
  Interdisciplinary Modeling ->
    Rapid Prototyping and Visualization
Thinking in Terms of Systems

Commerce

Gov’t
- Standards
- Regulation
- Infrastructure
- Influence

Individual
- Choice
Thinking in Terms of Systems

Gov't Services

<table>
<thead>
<tr>
<th>Gov't</th>
<th>Individual</th>
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<tr>
<td>Standards</td>
<td>Choice</td>
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<td>Influence</td>
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Policy Efficiency

- Cost-effective policies that serve all constituents
- Make good decisions and avoid unintended consequences
- How do they do that in a world with interconnected elements?

There are be many optimal outcomes given a relaxing constraint.

[Clustering Under Approximation Stability; Balcan, Blum, and Gupta, Anupam, 2013]
Capturing Variance

Aggregating individual level data to larger representative blocs can lose useful information. In this example, the first level of aggregation misses the covariance between red shirts and blue pants. The second level misses the distribution.
Modeling These Systems

Often, low-level decomposition is used to express the dynamics.
Interactions and influences are naturally described at the individual or component-level.
Population-Level Characteristics

Rich, synthetic data sources are freely available
Massive Agent Based Models

+100M Agents

Python tools for distributed computing¹

[1] “Synchronization Methods for Distributed Agent Based Models”. Harvey & Gentile; Abstract Submitted to WinterSim
Massive Amount of Data

Data should be reported at the lowest-granular level

100M agents, 4 primitives, 10 parameter values, 30 repetitions, 30 time steps:

3.6 trillion data elements
Visualization

High-throughput simulations require high-bandwidth communication.

Thought must be given to how simulation results are presented to stakeholders. Minding their interests, salience and experience.

Promote ad-hoc data exploration because it facilitates model verification, validation and knowledge discovery.
IVML.js

Provides a set of directives for making browser-based visualizations: http://mitre.github.io

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  <error-bars data="data" xfunction="x" yfunction="y"/>
  <rectangles data="data" xfunction="x" yfunction="y"/>
</plot>
</body>
</html>
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[1] “Interactive Visualization Markup Language”- Gentile, Meyers, & Page; Abstract Submitted to WinterSim
Outcome uncertainty needs to be properly communicated to policy makers.
Concluding Remarks

Modeling and simulation have a role in informing policy in concert with other technologies.
Thanks!