Framework for Modeling Society Following a Nuclear WMD Event

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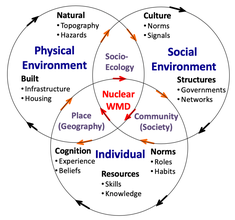
Research Goal

Characterize the reaction of the population of a megacity and surrounding region to a nuclear WMD event.

Agent-Based Model Design & Preparation

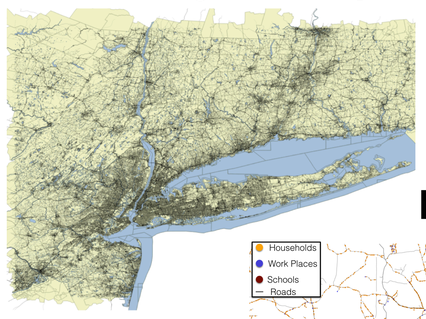


Disasters occur at the intersection of interacting Complex Adaptive Systems

Model	Charac-terization	Dataset	Granularity	Source
Space	Road	2010 U.S. Census Tiger Shapefiles	Primary, Secondary and Local Roads	www.census.gov/cgi-bin/geo/shapefiles/index.php
Population	Household Demographics	2010 U.S Census Tracks	Census Tracts	www.census.gov/cgi-geo/maps-data/data/tiger-data.html
Schools	Schools	U.S Environmental Protection Agency [EPA] Office of Environmental Information [DEI] Education US 2015, ORNL Freedom, SEGS	Geolocation Coordinates	www.geodata.epa.gov/arcgis/rest/services/OEI/ORNL_education/Mapserver
Workplaces	Establishment sizes	2010 U.S. Census County Business Patterns: Complete County File	County	www.census.gov/data/datasets/2010/econ/cbp/2010-cbp.html
Commutes	Commuting flows by tract	U.S Census Bureau's Longitudinal Employer-Household Dynamics [LEHD] Origin-Destination Employment Statistics [LOOES]	Census blocks aggregated to tracts	www.lehd.ces.census-gov/data/lodes/LODES7
Building Heights	Building height of all buildings in New York	Lidar from NYC, and other cities	Building height-Geolocation Coordinates	NYC GIS
Fire Stations	Fire stations	OSM, Fire station Sites	Geolocation Coordinates	Social Complexity Center WMD Project - My Contribution
Police Stations	Police Stations	OSM, Police Station Sites	Geolocation Coordinates	Social Complexity Center WMD Project - My Contribution

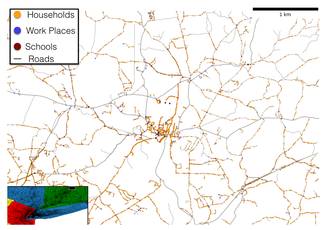
Empirical data for synthetic population and artificial environment

Implementation *Physical/ Spatial*

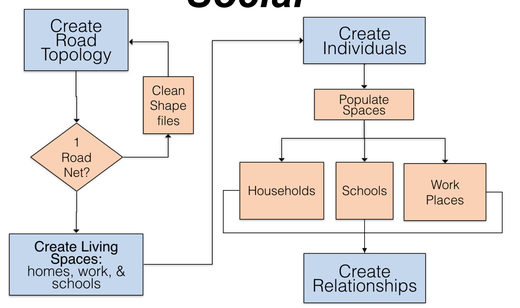


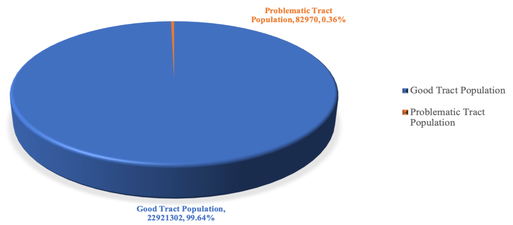
Physical Characteristics: Roads Census Tracts Workplaces & Schools Water

Road Networks



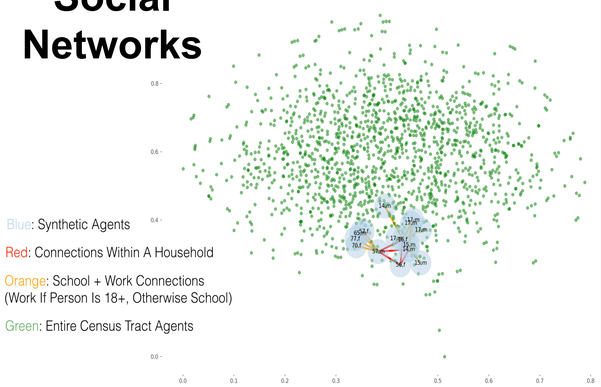
Population Synthesis *Social*



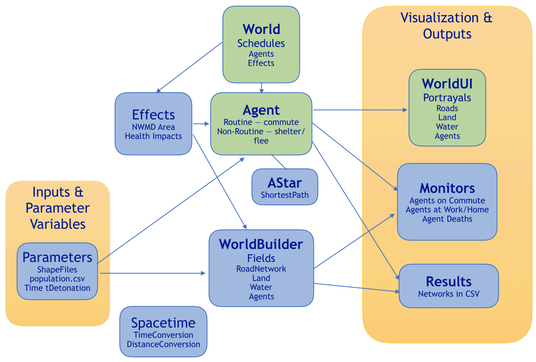


Synthesized Population Verification & Validation

Social Networks

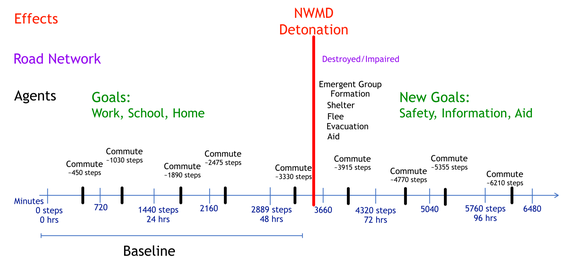


Model

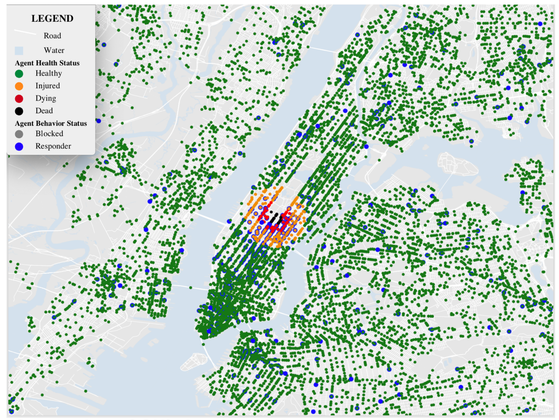


Agent-Based Model Architecture for Experimentation

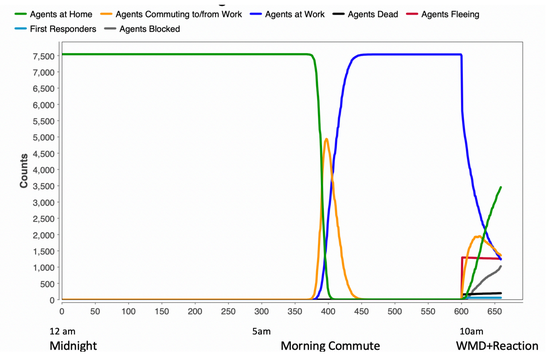
Simulated Behavior



Nuclear WMD Event Timeline 1 Minute = 1 Step



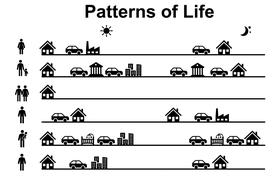
Screenshot of GUI showing 23K agents post NWMD Detonation in the New York City Commuter Region



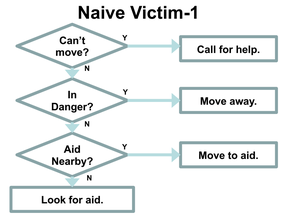
23K Agent Locations in One Run

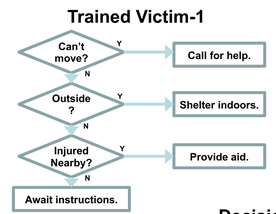
23K Agents Locations in 25 Runs

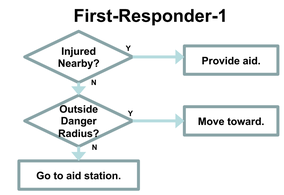
Individual Behaviors



Daily routines and activities of individual agents







Decision Trees

Preliminary Results

- Demonstrated, benchmarked, and verified a population synthesis & synthetic social networks generation method and dataset of 23M.
- Integrated household social networks explicitly into a spatially explicit models.
- Demonstrated and benchmarked agent commuting patterns for the New York City Commuter Region with a population of 260K.
- Demonstrated and benchmarked agent initial reactions post NWMD detonation with a population of 23K.

Next Steps

- Refine agent modeling to include additional health effects, communication, and shift schedules.
- Extend infrastructure modeling to include damaged road network and communications as well as additional transportation modes.
- Add parameter-driven Electromagnetic Pulse (EMP) effects.
- Validate model and conduct experimentation.

Publications

Burger, A., Oz, T., Crooks, A.T. and Kennedy, W.G. (2017), Generation of Realistic Mega-City Populations and Social Networks for Agent-Based Modeling. The Computational Social Science Society of Americas Conference (CSSSA-2017), Tempe, AZ, 19-22 Oct. 2017.

Crooks, A.T., Burger, A., Yuan, X. and Kennedy W.G. (2018), The Generation and Application of Large Scale Synthetic Populations for Disease Outbreaks and Disasters, The Association of American Geographers (AAG) Annual Meeting, 10-14 April, New Orleans, LA.

Burger, A., Oz, T., Kennedy, W.G. and Crooks, A.T. (2019), Computational Social Science of Disasters: Opportunities and Challenges, Future Internet, 11(5): 103.

Acknowledgements

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