An Agent-based Transportation Simulation of the UCF Campus

Rahmatollah Beheshti and Gita Sukthankar, Department of EECS, University of Central Florida

Urban simulations are an important tool for analyzing many policy questions relating to the usage of public space, roads, and communal transportation; they can be used to predict the long-term impact of new construction projects, traffic restrictions, and zoning laws. One of the common ways to build such simulations is by using agent-based models. However, developing realistic models that govern the agents' behavior and accurately model human populations can be challenging. We addressed this problem by proposing a technique for initializing an ABM from survey data. Due to their cheap development costs and ease of deployment, surveys and questionnaires are useful tools for gathering information about the activity patterns of a large group and can serve as a valuable supplement to tracking studies done with mobile devices. However in raw form, general survey data is not necessarily useful for answering predictive questions about the behavior of a large social system. In our project, we described a method for generating agent activity profiles from survey data for an agent-based model (ABM) of transportation patterns of 47,000 students on a university campus. We compared the performance of our agent-based model against a Markov Chain Monte Carlo (MCMC) simulation based directly on the distributions fitted from the survey data. A comparison of our simulation results against an independently collected dataset revealed that our ABM can be used to accurately forecast parking behavior over the semester and is significantly more accurate than the MCMC estimator.

Generally, it seems unwise to rely upon predictions from a single model since each technique possesses different strengths and weaknesses and can be highly sensitive to the choice of parameters and initial conditions. Accordingly, we came up with a hybrid approach for combining agent-based and stochastic simulations (Markov Chain Monte Carlo) to improve the accuracy and reduce the variance of long-term predictions. The MCMC family of methods form a valuable part of the toolbox of social modeling and prediction techniques, enabling modelers to generate samples and summary statistics of a population of interest with minimal information. It has been used successfully to model changes over time in many types of social systems, including patterns of disease spread, adolescent smoking, and geopolitical conflicts. In MCMC an initial proposal distribution is iteratively refined until it approximates the posterior distribution. However, the selection of the proposal distribution can have a significant impact on model convergence. In our proposed approach, the agent-based model was used to bootstrap the proposal distribution for the MCMC estimator. The UCF case study was again used to demonstrate the applicability of our modeling technique, describing the usage of our hybrid simulation method for forecasting transportation patterns and parking lot utilization on a large university campus. A comparison of our simulation results against an independently collected dataset revealed that our hybrid approach accurately predicts parking lot usage and performs significantly better than other comparable modeling techniques. The simulator is publicly available at: http://code.google.com/p/ucf-abm/

References

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