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Register here: https://uci.zoom.us/meeting/register/tJ0lde6urzojEtPWDHz_nLnAwqOq2dLuAXcd

Strategic Decisions in Agent-Based Freight Transportation Models: Methods and Data

Dr. Monique Stinson

Technical Manager, Freight Systems and Analytics, Argonne National Laboratory

Abstract

Freight transportation has significant impacts on energy, emissions, and the economy. High-fidelity, agent-based modeling tools, which accommodate the rich heterogeneity of the business environment, allow government agencies and researchers to study the impacts of freight transportation and its sensitivity to policies. However, no existing agent-based models address business strategy. This is a major gap, since strategy is well known to drive the behavior of firms as they make and align various decisions. With this in mind, my core thesis is that strategy unifies decisions that individual actors make, and that this consistency can be achieved in agent-based models through carefully constructed framework and model design. First, I present an innovative, theoretical foundation for freight transportation forecasting that uses firm strategy to unify agent behavior in upstream and downstream model components. I devise a novel mathematical system names SURTLV (for Seemingly Unrelated Regression of Tobit Equations with Latent Variables) that jointly considers firm strategy and numerous strategic decisions. The latent variables represent the unobserved strategies of interest. I solve the system using Gibbs Sampling. My concept is proven by modeling Logistical Sophistication and Customer Service strategies jointly with eight strategic decisions that involve private fleet ownership and distribution center (DC) control. The strategies are shown to impact the strategic decisions, and the connection of firm strategy to downstream decisions are demonstrated. Furthermore, I develop an innovative method to generate context-based measurements of strategy using natural text, which is a complete gap in the literature, leveraging recent Natural Language Processing (NLP) methods and Principal Components Analysis (PCA). My word2vec-w2vPCA algorithm creates measurements based on quantifying differences in word use. The Simple Scaled Bag-of-Words (SS-BOW) algorithm creates measurements of firm strategy based on relative frequency of word usage, and is used to develop baseline measurements for comparison. The concept is proven using large-scale text data, generated by my Attitudinal Data Development Engine (ADDE). A battery of evidence proves the value of the methods. The measurements are also input to the SUR model, which produces intuitive results. Finally, a global sustainability analysis, including a case study of automobile production strategy, demonstrate the importance of modeling agent strategies to predict the impacts of business activity on transportation flows, energy use and emissions.

Monique Stinson, PhD, is Technical Manager, Freight Systems and Analytics in Argonne National Laboratory's Vehicle and Mobility Systems Section and lead developer of CRISTAL (Collaborative, Informed, Strategic Trade Agents with Logistics) that is deployed in Argonne's flagship POLARIS agent-based software (large-scale transportation system simulation). Dr. Stinson has researched the energy, emissions, mobility, productivity and equity impacts of freight transportation systems in Chicago, Detroit, Atlanta, Phoenix, California and other areas for nearly 20 years. Her research spans the system-level effects of vehicle technologies, connectivity and automation, e-commerce, commodity flow growth, and other scenarios, to support stakeholders ranging from DOE to industry to local governments. Dr. Stinson is a member of the American Transportation Research Institute (ATRI) Research Advisory Committee (RAC), Transportation Research Board's (TRB) Freight Planning and Logistics Committee, and the TRB Freight Data Committee, and is a contributor to the 21st Century Truck Partnership (21CTP) Freight Operational Efficiency Tech Team.