AGENT-BASED SIMULATION FOR URBAN EMERGENCY RESPONSE PLANNING

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Cities are complex systems, with many dynamically changing parameters and large numbers of discrete actors. The complexity inherent for urban emergency response brings lots of challenge for decision making. An effective test bed for analyzing the dynamics of emergency response for different scenarios and evaluating the strength of rescue strategies is crucial for improving disaster planning, preparedness and mitigation. Computer Simulation is becoming an increasingly important tool which provides an effective and low-cost approach to address this problem.

One powerful technique for computer simulation is agent-based modeling (ABM), which has seen an increasing number of applications in social science, economics and also biology. The agent-based paradigm facilitates easier transfer of domain specific knowledge into a model.ABM provides a natural way to describe systems in which the overall dynamics can be described as the result of the behavior of populations of autonomous components: agents with a fixed set of rules based on local information and possible central control.

This paper presents a Repast-based model for agent based simulation and modeling for urban emergency response. By incorporating vector GIS, parallel processing, temporal logic analysis, multi-objective evolution optimization and the rule engine, the framework provides a reality environment for analyzing emergency evacuation and resource allocation in a city. The plug-in architecture makes it scalable to define new agent models or edit behavior rules.

The model is written in Java, an object orientated programming language and extends a number of basic operating classes from the Repast library. Within the model Repast3.1 is primarily used for its display, scheduling, importing GIS vector data along with recording change class. The model also utilizes other Java based GIS libraries especially those from the Java Topology Suite which provide general 2D spatial analysis

functions such as line intersection algorithms and buffering ,Open Map provides a simple GIS display with panning and zooming and querying of the GIS layers. Also in order to handle a massive population of agents, the Proactive Java library is used to run each of the simulations in a cluster of computers to decrease the execution time. Then a multi-objective evolutionary algorithm, the Nondominated Sorting Genetic Algorithm II is used for exploration and optimization of the resultant search space and a Java Trace Analysis tool: XSSYS is employed to formulate queries about multiple traces in temporal logic, these traces reveal very insightful aspects of agent's behavior, and serve a good starting point for coming up with new policies to be tested. Finally, integration between the Repast toolkit and the rule engine JESS facilitates characterization of agent behavior with declarative rules and run-time modification.

The efficiency of our approach is shown through some experimental results based on classic Schelling's Segregation Model, which highlights how different theories and concepts can easily be abstracted within agent-based models, helping further our exploring different plans and getting a simulation-based optimized solution for decision-makers. Most importantly, the model integrates as many as public domain libraries, including Repast, ProActive, OpenMap, JTS, XSSYS, NSGA-II and JESS, which provide a more "close to reality", integrated and comprehensive platform for further our urban emergency planning simulation.

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