Crowd Modeling in Downtown Settings

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Studying crowds in downtown settings

This is an exciting time to be studying crowds in downtown environments. A confluence of developments of relevance is forming. Technologies are being introduced with unprecedented rates of development and uptake and with unforeseen influence on the ways crowds interact with the city. Data and the dataware that generates them are available in new forms and in new quantities. New perspectives on old views are reshaping the way we theorize. A new policy environment exists for consideration of downtown environments, and crowds as their lifeblood—old topics of downtown revitalization are being revisited, and new foci related to homeland security and defense are coming to the fore. All of this is taking place under the umbrella of new emerging trends and behaviors in a larger societal context.

Nowhere is this more relevant than at the micro-scale, on the streets, in and around our downtowns, and among the crowds of people that populate and energize the urban core. A new appreciation of urban geography is gathering steam, an urban geography of the micro-scale, where pedestrians swarm in social and anti-social networks; where innovative Information and Communications Technologies (ICT) are being deployed at street-level, digitally-enabling crowds through networked computing. Embedded in urban infrastructure and in the very products we consume, the same technology allows cities to *think about*—and process—the people that pulse through them.

Downtown crowds as a research focus in geography

Yet, as these developments shape the cities that we call home, and alter the ways in which we perceive and interact with and within the urban fabric, we are, to a certain extent, struggling to keep pace as academics with these changes. There is much research to be done, and much to be discovered. Methodology, applications, tools, and theory are all up for inquiry. And geography, as a discipline, is well-placed to occupy a pivotal role.

Much of the technology that is having the largest impacts on crowds in downtown settings—wireless telecommunications, cellular telephony, Radio Frequency Identity tags, mobile computing, sensing and surveillance equipment—is spatial in nature. The engineering is largely geomatic, and much of it runs on geographic principles: Geographic Information Systems, Global Positioning Systems, Location-Based Services, telegeoprocessing, etc.

The methodology, likewise, is similarly geographical in nature. Much of the information that passes through these technologies is mediated by spatial databases; networks of digital connections fork through cities with distinct spatial topology; spatial simulation is used as a laboratory, *in silico*, for experimenting and testing the technology, and its potential influence in urban environments and populations.

The theories being explored and debated are spatial. How do people interact to form crowds in urban settings? How can urban environments be better designed or fitted as social, economically competitive, defensible spaces? And what is the role of cross-scale dynamics, human-environment interaction, location-specific and location-free processes in this consideration?

Moreover, the application of technology, methodology, and theory to consideration of urban environments for planning and management purposes is spatial. Everywhere and somewhere; geography matters. Transit-oriented design infuses declining neighborhoods with crowds of consumers and recreators in some places, but not others. Anchor stores may shift the downtown centers of gravity around which shoppers orbit. Congestion zones demarcate whole areas of downtown with an artificial and permeable barrier to pollutants and congestion.

Communication of these ideas and proposals to the public is taking on a geographic flavor. Geovisualization and cartography are informing the design of virtual and augmented realities, in which people can hypothesize about, explore, and interact with urban scenarios and settings, as physical or information spaces.

Simulation and modeling occupy a position in the middle of many of these ideas and inquiries; they are the glue that binds technology, methodology, theory, application, and communication. Technologies provide the dataware for collecting information in urban settings, feeding data-hungry spatial simulations. Methodology and theory are consumed and informed by models in equal measure. Ultimately, the models are developed for application in urban contexts, either for urban planning or management, or simply as tools to think with. Increasingly, our interaction with the models, and the communication of their output, is visual and visually-interactive in nature.

The research agenda for studying downtown crowds

And there are many questions that are open to exploration, or remain to be answered, in each of these spheres of consideration. Technologically, there are questions relating to the role of geography and interpretation of space in location-sensitive or location-aware devices. Other technology issues relate to the collection of data for crowds and infrastructure in downtown settings, and monitoring and tracking of entities in dynamic urban settings.

Methodologically, there are some interesting questions to be asked relating to the representation and reconstruction of third and fourth dimensions in urban simulation, normally attuned to handling two-dimensional planes. New and individual-based approaches to simulation, informed by agent-based modeling, are beginning to filter into consideration of downtown crowds, following recent developments in their use to model

urban traffic at micro-scales and in massively interactive contexts. This is both a by-product of, and a catalyst for, methodological consideration of urban environments and downtown crowds in terms of complex adaptive systems, with associated questions of feedback, scaling, phase shifts, self-organization, and path-dependency.

New and emerging phenomena necessitate new theories for explaining crowd behavior in dense urban settings. Smart mobs, mobilized through ICT, and interacting with cities synchronously in both tangible and cyberspace, are a striking example. All manner of topics might be investigated around such themes: the formation of urban social networks through such technology, whether for altruistic or nefarious purposes; civic participation in urban settings; issues of privacy and security for individuals and groups against a backdrop of urban surveillance. There are also some fresh perspectives on old ideas and much room for exploration remains in these areas: the role of complexity and non-linear dynamics in crowd formation, dynamics, and dispersal is just one example.

Of course, downtown settings have taken on a great deal of currency in public policy in recent months, with growing attention paid to issues of provision of emergency services in dense urban and densely populated environments; evacuation of these locations in emergency situations, and evaluation of contingency plans for emergency planning; initiatives to secure downtown infrastructure and population. Issues relating to homeland security are central in much of this policy debate. Can realistic and real-time simulations be built that can facilitate the evaluation of—and preparation for—emergency scenarios ahead of time? Can urban infrastructure be re-designed to better secure our cities? Can unusual and significant anomalies in crowd behavior be recognized and pre-empted? All of these questions require focus on crowd behavior and crowd dynamics, and their symbiosis in an infrastructure context. At the same time, more familiar issues are receiving continued attention: downtown revitalization amid New Urbanism, suburban sprawl, and smart growth policy sensibilities; planning and management of large-scale sporting, social, and economic events; protection of the health and safety of urban dwellers.

Communicating results and scenarios as new media also offers some avenues for inquiry. These include issues relating to the enabling of real-time dynamic three-dimensional—often virtual reality—environments as exploratory settings in their own right, through 3D GIS, three-dimensional spatial analysis, and dynamic database design. Engaging the public in the planning process, using animation and planning support systems, is another research stream.

At the University of Utah, my group is focused on a simulation-based approach to consideration of crowds in dense urban settings. We are tackling some of these issues, and making in-roads into others. We are approaching this from varied angles of inquiry.

We have developed new methodology for modeling urban systems in highly dynamic contexts, which comes into its own at an entity-based perspective but scales to higher levels of consideration. This methodology sits somewhere between cellular automata and multi-agent approaches as a simulation scheme, with geography at the very foundation. This Geographic Automata Systems framework enables the incorporation of GI Science, complexity principles, and an object-oriented approach directly into modeling methodology and we have begun to apply it to simulation of crowd activity in dense

urban settings. Some of that work is visual in nature and VR in form. Colleagues at Tel Aviv University are using the methodology as the basis for design of re-usable urban simulation software: Object-Based Environment for Urban Simulation (OBEUS).

Other aspects of this work have taken on a more theoretical flavor. Locally, in Salt Lake City, we are engaged in ongoing research, investigating and charting the digital landscapes that coexist with the urban fabric. Our focus is on exploring new theories relating to emerging urban geographies—geographies of distribution as well as behavior. To this end, we are mapping the urban data clouds that permeate the city, analyzing the relationship between geographically-dispersed data communication, urban activity, and tangibly-distributed urban infrastructure.