



# Riot Dynamics Modeled

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Every day, all over the world, people assemble peacefully into crowds in places such as shopping malls, sporting events, concerts and tourist sites — but crowds can shift from peaceful to unruly, even riotous, in just a few minutes given the right conditions.

The factors that cause a "charged" crowd to reach a "tipping point" and erupt into violence are not well understood by scientists because crowd behavior is so difficult to study. No one wants to incite a riot for the sake of science and surveys of individuals about their behavior as part of a crowd have not been that reliable.

"Crowds are complex, adaptive systems that may seem chaotic but have an underlying order," said Paul Torrens, associate professor in the School of Geographical Sciences at Arizona State University, and director of its Geosimulation Laboratory. "They self-assemble in time and space and exhibit geometric patterns based on layer upon layer of human-to-human and human-to-environment interactions. They are almost impossible to model realistically."

But that is exactly what he and his colleagues are intent on doing.

Torrens and his research team, with funding from the National Science Foundation (NSF), are [developing a synthetic laboratory](#) populated with thousands of artificial agents to experiment with ideas and theories about crowd behavior and dynamics that would otherwise be impenetrable to academic inquiry. Of special interest are the geographic processes that occur for a crowd to become charged and then cross over the tipping point into a full-blown riot.

"People interact over space and time — socially, physically, verbally, and, increasingly, digitally — with each other, within groups, and between factions to cooperate and conflict in seditious crowds," Torrens said. "We model riot dynamics from the bottom-up, at the geography of individual crowd participants."

Each artificial agent in the synthetic laboratory possesses a "brain" that allows it to function as a distinctive individual within the broader group framework. Researchers can record and analyze each agent's behavior, activity, social and anti-social interactions, and explore how those behaviors adapt as conditions unfold.

One of the most significant findings from scenarios studied in the synthetic laboratory is the rapid exchange of nonverbal information in crowds through expressions, locomotion and individual interaction with other individuals.

Another finding is the phenomenon of "scaling," whereby the actions of a single individual can shape the dynamics of entire crowd. For example, an individual's subtle stop-and-start movement amid panicked crowds caused larger waves, which then washed through the crowd, causing further obstructions and ultimately large-scale congestion.

"The actions of a single individual can shape the dynamics of an entire crowd" he noted.

Torrens believes understanding the small-scale geographies of movement and body language can help identify the behavioral nuances that spark interactions within crowds.

His team is extracting motion-capture data from videos of crowds to hone the agents' small-scale geographies of movement and body language.

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"Every individual in the crowd brings social, environmental, cultural, gender and past-experience influences to the mix," Torrens said. "We also know individual behavior can be influenced negatively or positively by the crowd's collective psychology."

In the scenario depicted in the image above, the model is run with 14 different agent types, ranging from children to adults to seniors, males, females, agents with ambulatory difficulties, intoxicated agents, "pushy" agents, and "passive" agents. For each agent type, varying behaviors are programmed and the agents are endowed with diverse body language from motion capture data.

Read more in the National Science Foundation Discovery [article](#). For more information on the research, including videos of simulations, click [here](#) and [here](#).

— By *Diane Banegas*, NSF

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