Chapter XX
Varieties of Artificial Crime Analysis:
Purpose, Structure, and Evidence in Crime Simulations

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ABSTRACT

Since the beginnings of this millennium, there has been a burgeoning interest in the use of simulation methods for the study of crime. In a remarkably short period, crime researchers using simulations have applied the method in a wide variety of ways. Let us look at some of the first simulations—four simulations developed by three different teams working independently—to describe this diversity.

INTRODUCTION

Liang (2001) constructed the first crime pattern simulation for his dissertation, supervised by Liu and Eck, and publicly presented his analysis at the UCGIS Summer Assembly in 2001 (Liang, Liu, & Eck, 2001). His simulation implemented aspects of routine activity theory with two types of agents: store robbers and store managers. Managers were immobile, but updated their protection based on "news" of robberies transmitted using cellular automata. Robbers moved randomly around a street grid, copied from a small area of Cincinnati, and decided to rob a store they encountered based on a comparison of their capabilities with the store's protection level. The resulting pattern of robberies looked surprisingly similar to the actual pattern of robberies in the same geographic area (Liu, Wang, Eck, & Liang , 2005).

Following this simulation Wang (2005) developed a simulation of street robberies, also under Liu and Eck's supervision. In Wang's simulation both the targets of crimes (pedestrians) and the offenders were mobile and both types of agents learned their routes. Pedestrian agents assessed the costs of distance and crime risk in choosing their routes. Offender agents choose their routes by assessing the availability of pedestrians. Routine activity theory, crime pattern theory, and rational choice perspectives informed the construction of this simulation. Wang used agent based modeling to orchestrate agent mobility and used cellular automata to communicate crime risk.

Pieter van Baal (2004) was interested in examining the social structure of deterrence theory. In his simulation, developed for his doctoral dissertation under the supervision of Henk Elffers, van Baal created a virtual world where nonmobile agents made choices about whether to commit crimes based on their perceived chances of being "audited" by authorities and the rewards for committing crime. Agents formed their risk perceptions based on their experiences, and the experience of their neighbors, of being audited. Van Baals' simulation was only weakly spatial—a cellular automata model was used to describe agents' social networks. Though his cellular automata model had a two-dimensional arrangement, it was meant to mimic a social network rather than a real geographical arrangement.

These three simulations were constructed to explore theoretical problems in crime. Batty, Desyllas, and Duxbury (2003) were interested in a very practical problem. They simulated pedestrian movement patterns at London's Notting Hill Carnival to find ways to reduce crowding and threats to public safety at this festival. Their goal was to mimic a real event and provide policy guidance to planners of future events. The researchers had detailed information on the street patterns, obstructions to movement, destination points, and crowd size at these points. They used swarm intelligence to model pedestrian flow among these points, thus producing a picture of when and where crowding became problematic. The simulation allowed planners to examine how crowding responded to closing streets and erecting barriers.

Since 2001 a number of other individuals and teams have begun working on crime simulations, and many of these efforts are represented in this volume. Let us look at some of the differences among simulations, using the four examples to illustrate the differences. Some simulations are heavily information intensive (Batty, Desyllas, & Duxbury, 2003) while other simulations are data-sparse (Liang, 2001; Wang, 2005; van Baal, 2004): relying on deductive logic from a set of basic assumptions. Some simulations involve strong spatial arrangements (Batty, Desyllas, & Duxbury, 2003; Liang, 2001; Wang, 2005), while others do not (van Baal, 2004). Agent mobility varies from no mobility (van Baal, 2004), to limited mobility (Liang, 2001), to high mobility with search capability (Batty, Desyllas, & Duxbury, 2003; Wang, 2005). Some simulations are designed for policy planning (Batty, Desyllas, & Duxbury, 2003) while others are designed to examine theory (Liang, 2001; Wang, 2005; van Baal, 2004). In all cases, the researchers who create them believe that their simulations of artificial crime patterns provide information useful for understanding how actual crimes are committed.

In this chapter we organize this diversity of approaches, contrast simulation methods to other research methods, and look at the process and prospects of simulation methods for the study of crime and related phenomena. This chapter addresses six questions:

1. What are the purposes of artificial crime analysis?
2. What are the characteristics of crime simulations?
3. How does artificial crime analysis compare to other research methods?
4. When should simulations be used?