Chapter 4.16

Simulating Crime Against Properties Using Swarm Intelligence and Social Networks

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ABSTRACT

Experience in the domain of criminology has shown that the spatial distribution of some types of crimes in urban centers follows Zipf's Law in which most of the crime events are concentrated in a few places while other places have few crimes. Moreover, the temporal distribution of these crime events follows an exponential law. In order to reproduce and better understand the nuances of such crime distribution profile, we introduce in this chapter a novel multi-agent-based crime simulation model that is directly inspired by the swarm intelligence paradigm. In this model, criminals are regarded as agents endowed with the capability to pursue self-organizing behavior by considering their individual (local) activities as well as the influence of other criminals pertaining to their social networks. Through controlled experiments with the simulation model, we could indeed observe that self-organization phenomena (i.e., criminal behavior toward crime) emerge as the result of both individual and social learning factors. As expected, our experiments reveal that the spatial distribution of crime occurrences achieved with the simulation model provides a good approximation of the real-crime data distri-

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bution. A detailed analysis of the social aspect is also conducted here as this factor is shown to be instrumental for the accurate reproduction of the spatial pattern of crime occurrences.

INTRODUCTION

Recently, an extensive analysis conducted over real-crime data related to a large Brazilian metropolis (Cansado, 2005) has demonstrated that the spatial distribution of crimes as robbery, thefts, and burglaries follows a power law, specifically the Zipf's one (Zipf, 1949). This means that the frequency of crime occurrences per type of an attacked geographic area tends to scale according to the following rule: The number of crime occurrences at the most frequently attacked area would be roughly n times higher than the number of crime occurrences at the nth most frequently attacked area, which, in turn, would be n times higher than that of the n^2th most frequently attacked area, and so on. In the same work (Cansado, 2005) an analysis of the temporal aspect shows that these crimes follow an exponential distribution per period of analysis.

Although knowing the crime distribution profile for a given moment may be necessary for the better conduction of some police decision-making activities, it is not enough to help one gain further insights into crime in its totality. Crime is a dynamic process, and the decision of protecting a frequently attacked target in a moment will eventually lead to the exposure of other potential targets in the periods that follow due to a range of limitations in terms of resources availability (e.g., human resources).

In this sense, we advocate that a better understanding of the trends of crime activities as well as of the types of reactions criminals might potentially undertake is a crucial task to be pursued. In this context, the goal of the research we are conducting is to produce a crime simulation system that reproduces crime phenomena as realistically as possible.

In this chapter, we give one step in the direction of the aforementioned goal by introducing a dynamic model of crime against properties that evidences experimentally how this type of crime evolves spatially and in time. The main challenge behind this effort lies in the definition of a simulation model that could generate crimes according to a spatial Zipfian distribution, and at the same time be in agreement with the results brought forth by sociological and criminological studies on crime. For such a purpose, we have designed a multi-agent-based criminal model that mimics real-life criminal behavior (with respect to sociological studies), taking into account the following facts: (1) criminals improve their performance through time by creating preferences according to their experience in crime; and (2) social communication between criminals must also be properly modeled because criminal behavior depends not only on individual incentives but also on the behavior of their peers and neighbors (Sutherland, 1947), (Akers, Krohn, Lanza-Kaduce, & Radosevich,1979).

This criminal model resorts to concepts related to self-organizing systems inspired by the ant colony optimization algorithm (Bonabeau, 1999). The rationale behind this choice is also twofold. These systems account for both the individual and social aspects that we intend to consider in our crime simulation model, and, at the same time, as we have identified experimentally, their formal model is capable of generating spatial/temporal behaviors of a power-law nature. By this means, criminals are regarded as agents endowed with the capability to pursue self-organized behavior by considering their individual (local) activities as well as the influence of other criminals in the community they live in.

Through controlled experiments with the simulation model, we could have indeed observed that self-organization (i.e., criminal behavior toward crime) emerges as the result of both individual learning and social interaction factors. At the

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