Analyzing Police Patrol Routes by Simulating the Physical Reorganization of Agents

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Abstract. In this article we describe a tool for assisting the investigation of different strategies for the physical reorganization of agents. We show how the tool was used in the public safety domain to help in the study of strategies of preventive policing. A society of agents that simulates criminal and police behavior in a geographical region was constructed. In this society, artificial agents representing the police are responsible for preventing crimes. The organizational structure of the police is characterized by the existence of a centralized command that has the task of distributing and redistributing the police force in a region according to an analysis on crime and the factors that influence it. The simulation of different strategies of physical reorganization is a first step to better understand the influence that different police patrol routes have on the reduction of crime rates.

1 Introduction

Multi-Agent Systems (MAS) must allow dynamic adaptation of organizations as changes occur in the environment. Typically, reorganizations are carried out by external intervention of a programmer, but for an MAS to be truly autonomous, mechanisms for dynamic reorganization must be available. The concept of *dynamic adaptation* refers to modifying the structure and behavior of an MAS, such as adding, removing, or substituting components, done while the system is running [13]. Dynamic adaptation demands that systems evaluate their own state and take action to preserve or recover it, by performing suitable integration and reconfiguration actions. Most existing approaches to reorganization consider only behavioral aspects affecting the agents [4] [9]. Recently [7], in addition to behavioral aspects, some approaches have proposed also considering situations in which the social structure of the society changes.

Our research work concentrates on a specific way of reorganization we call physical reorganization. This kind of reorganization is found in artificial agent societies in which the static or dynamic physical position of the agents is represented. In particular, such a representation is very important in geosimulation systems. Geosimulation is an urban phenomena simulation model that uses the multi-agent methodology to simulate discrete, dynamic, and event-oriented systems [3].

One of the crucial questions regarding the control of crime and violence in urban centers is how to gauge the actual impact of certain police management strategies

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upon the regulation of crime rates. This is indeed a difficult question to be answered, as it seems that the effectiveness of a certain public-safety policy on a given metropolitan region depends, directly or indirectly, upon an array of factors, ranging from the levels of concentration of wealth to the physical organization of the urban center under consideration. In such a context, it is quite consensual that police patrolling can be considered as one of the best known means for implementing preventive strategies towards the fight against crime.

In this article we describe a tool for assisting the investigation of different strategies of physical reorganizations. This tool has already been used to help in the understanding of behavioral and structural dynamic reorganization of agent societies [8]. Here we focus on how this tool can help in studying physical reorganization of agent societies. We show how the tool has been used in the public safety domain for helping in the study of strategies of preventive policing. A society of agents which simulates criminal and police behavior in a geographical region was constructed. In this society, artificial agents representing the police are responsible for preventing crimes. The organizational structure of the police is characterized by the existence of a centralized command that has the task of distributing and redistributing the police force in a region according to an analysis on crime and the factors that influence it. The simulation of different strategies of physical reorganization makes it feasible to better understand the influence that different police patrol routes have on the reduction of crime rates.

This article is structured as follows. Initially, we describe related works and present the problem domain. Next we describe the architecture of a simulation tool designed for use as a tool for analysis of different agent reorganization strategies. With the simulation, we aim at analyzing and comparing the effect of different reorganization strategies. In particular, we want to understand the effects of different dynamic physical reorganization strategies on criminal activity. We then describe some examples of the use of this tool and also describe some qualitative and quantitative results we obtained with its use.

2 Related Works

In order for an MAS to behave productively (i.e., coherently), some sort of coordination policies, protocols, and mechanisms must be properly configured and deployed. One such coordination mechanism comes in the format of organizations. Briefly speaking, an organizational structure can be simply perceived as a set of mutual restrictions adopted by a group of agents so that they can more easily achieve their local objectives towards the accomplishment of the group's overall objectives [11]. Despite its positive aspects, designing an effective multi-agent organization tailored to the peculiarities of a given application scenario is not a trivial task, mainly when the domain of study is like the one considered in this work, namely, multi-agent patrolling. Despite its potentially wide-ranging applicability, just a few studies have been conducted on the theme of multi-agent patrolling. One justification for such a fact is that existing approaches to dealing with some related problems, such as the traveling salesman problem–TSP [12], cannot be directly applied, or even adapted, for coping with the intricacies of the patrolling task.

One prominent research work in such context was recently developed by [1], having as basic motivation to provide answers to the following questions: Which kind of MAS architecture should be selected by the designer for tackling a given patrolling task? What are the means to properly evaluate an implemented MAS dedicated to patrolling? To what extent do parameters like size and connectivity influence the overall MAS performance? In such regard, different MAS architectures have been conceived and evaluated experimentally by the authors, making it possible to elicit some preliminary guidelines for the suitable design of MAS for patrolling. The devised methodology involves both the identification of some evaluation criteria and the definition of some dimensions of characterization of the MAS architectures.

Regarding the first of the above issues, each patrol agent tries to maximize the number of visits in the places to be patrolled in order to reduce their global "idleness". The idleness of a place refers to the average period of time elapsed between two consecutive visits of at least one member of the police patrol force. The worst node idleness value (among all the places) and the time necessary for all the police troops to visit all the patrol points, at least once, are then taken into consideration as evaluation criteria for assessing different patrolling strategies. Regarding the dimensions of characterization of a possible multi-agent patrol architecture, the authors have examined the following ones: agent type (reactive vs. cognitive); agent communication (allowed vs. forbidden); coordination scheme (central and explicit vs. emergent); agent perception (local vs. global), and decision-making (random selection vs. goal-oriented).

Following another direction, Winoto [14] has made use of the multi-agent paradigm for representing and characterizing some important crime features. In this work, an economic perspective upon crime is elaborated and the notion of impunity, which seems to be an essential factor for the increase/decrease of crime rates, is analyzed from the viewpoint of crime repression. The preventive aspect, however, is somewhat neglected by the author.

In our earlier work, we modeled the typical profiles of criminals and police officers in terms of artificial agents in order to develop an intelligent tutorial system [10]. The ExpertCop system comprehends a full-fledged geo-simulation environment focused on the analysis of criminal activity, which was conceived to support police managers in learning, through interactivity, how to properly allocate, on a given geographical map, the human resources currently available.

Despite their innovative ideas, all of the above-mentioned approaches do not systematically investigate one important issue underlying the multi-agent patrolling task: How to devise alternative ways leading to the design of police patrol routes in consonance with the peculiarities of the patrolling scenario under consideration.

3 The Public Safety Domain and the Police Allocation Task

The allocation of police-officer resources in urban areas in order to perform preventive policing is one of the most important tactical management activities for controlling criminal activity, which is usually decentralized among sub-sectors of the police departments covering different zones or neighborhoods of the territory. What it is intended from those tactical managers is that they periodically analyze the disposition of crime in their region and then perform the (re)allocation of the police force based on such analysis.

An underlying hypothesis of such allocation work is that, by knowing where the crime is currently happening and its associated reasons, it is possible to make a more optimized distribution of human resources and, consequently, to decrease the overall crime rate. However, the high volumes of information that police departments have to analyze is one of the main difficulties to provide society with effective answers. Tactical managers that perform police allocations, for instance, have difficulties in untangling the complex relationships between the different factors that influence the several types of crime occurrence.

In fact, understanding criminal mapping activities, even using geographic information systems, is a non-trivial task. In addition to that, real-life experiments in this domain cannot be performed without high risks, as they may result in loss of human lives. In this context, simulation systems for decision support come to be a prominent tool. Following this point of view, in this work we concentrate on the description of one such simulation-based tool focused on the investigation of alternative configurations (i.e., physical disposition) for police patrolling in an artificial environment that mimics a certain demographic region.

The conceptual basis for preventive approaches and the development of some pro-active policing strategies can be found in "*Routine Activities Theory*" Cohen and Felson [5], which attempts to explain the evolution of crime rates not only through the characteristics (psychological profiles) of the offenders, but also through the circumstances in which crimes occur. Basically, Cohen and Felson [5] point out that, in order for a criminal act to take place, three elements must coexist: a motivated offender; a suitable target, either an object or person that can be attacked; and the absence of capable guardians in charge of the preventive actions. The crime model derived by the authors is then based on an economic equation involving the aforementioned elements. A direct conclusion drawn from such work is that criminal offenses are related to the nature of everyday patterns of social interaction. Another is that the police force is, naturally, the central element for promoting public safety by means of diligence and dissuasion. Basically the goal of the police is to reduce or at least to keep crime under control. The main variable that police force has under control is the physical disposition of the patrol, which can be a static position or routes. Therefore, a tool for helping in the investigation of alternative configurations of police patrol in an artificial environment is very welcomed to the police. In this context, issues like the size of police patrol routes, the moment to reorganize these routes, and the triggers that motivate such reorganization, are still open.

3.1 The Agent Society

The agents that are part of the society are the following:

- Notable points: They are the commercial or entertainment establishments in the area such as drugstores, banks, gas stations, lottery houses, squares, and shopping centers.
- Police: Their function is to avoid the occurrence of crimes. Each police team should have at least one route[1], and with this route they will be accomplishing the preventive policing of the area they occupy.

[1] Routes are a set of points that police officer must go through during a determined period of time at a defined speed.

- Criminal: This is the person who executes the crimes. All criminals possess a vision that allows them to see cells (the environment is represented by a grid of cells) around them. They can see around them according to the value of the vision and the size of each cell. For example, with a vision of 1000 meters, if each cell has 100 meters, the criminal will be able to see 10 square cells around him.

There are two objects that are part of the simulation, but they are not characterized as agents. The police stations represent the police officers' initial point from where they proceed/arrive to/from their routes. The criminals' residence is the point where the criminals should be during the period that they are not committing crimes.

3.2 Criminal Agent Behavior

Each criminal has four actions: to choose a target, to move, to evaluate whether a crime should or should not be committed, and to commit (or not) a crime. Criminal motivation is driven by their goals. The criminal's selection of the targets or objectives is made according to an estimate of the distribution of crimes in an area. We have characterized crime data over a 2-year period in the State of Ceará in order to estimate the probability of occurrence certain crimes in a specific police patrol area. In our studies, we have focused on six types of crimes against the property. Each one of these crime types has its corresponding target as those shown in Table 1.

Table 1. Probability of targeting

Prob.	Target type
10%	Square
15%	Drugstore
10%	Lottery House
15%	Gas Station
20%	Shopping Center
30%	Bank

After their objective is defined, all criminals ask the environment the route to the closest exemplar of the notable point selected as the objective. The time expended to reach to goal is calculated based on the distance to the target and the speed of the criminal, which, in our studies, is constant and the same for all the criminals. The shortest time is taken as a basis so all others move only during this time. In each tick of the simulation, a criminal moves in the direction of the selected target. Finally, the decision whether or not to commit a crime is made.

For the criminal decision, the following factors are analyzed in that sequence: the probability of a crime being successfully or unsuccessfully effectuated and the existence of police within the field of the criminal's vision at the moment. Such a probability involves the other aspects, besides police presence, that influence the criminal decision, such as target vulnerability, target value, escape route, and demographic density. All criminals have a probability of deciding to commit a crime that is based on their analysis of being successful or unsuccessful. This probability is defined from the criminal's life history. The experience η is measured by an expression that takes into account the committed crimes and the unsuccessful crimes as described bellow.

$$\eta = (NbU\ /TNbt\ ) \times \left(e^{-(NbS\ /TNbt\ )}\right)$$

Where *NbU* is the number of unsuccessful crimes, *TNbt* is the total number of crimes attempted by the criminal and *NbS* is the number of successful crimes.

This expression aims at capturing the experience level of a criminal. The idea is represent the fact that the more a criminal commits crimes, the greater the probability of being successful. This function also aims at representing the punishment that a criminal receives when he decides to commit a crime and such decision is unsuccessful. The probability of deciding to commit a crime is then a trade-off between the unsuccessful and successful experiences. The unsuccessful experiences have a greater weight because they represent the time of inactivity of the criminal after being caught.

There are two possible results for the function of decision: the first one is the criminal does not commit the crime, and will then select a new objective. The second result is to decide to commit the crime. In that case, if the criminal is within grasp of a police team in the region, then the crime is considered unsuccessful; otherwise a crime is committed.

3.3 Society Organization

In the society described above, it is only relevant to study the organization of the police[2]. The basic organization of the society of police agents is eminently hierarchical. This organization follows a military structure where ranks determine the degree of authority. For the purpose of this work, we opted to represent a simple hierarchy with only one level of command. A colonel has the responsibility of defining patrol routes for a certain area of the city. Each route possesses a police team that may be composed of one or more police officers. The organizational structure is thus hierarchical and the autonomy for reorganization only exists at the central level. We point out that our goal at the present is not to study reorganization with different strategies of coordination as a decentralized one. What we intend is to capture essential notions relative to reorganization strategies that will eventually be useful to implement different coordination schemes.

4 The Reorganization Tool

We have developed a simulation tool for studying different reorganization strategies in MAS. It is an extension of Repast developed at the University of Chicago [6].

The tool contemplates three types of reorganization: behavioral, structural, and physical. Each reorganization type can be configured in independent ways. Users can choose which one or which ones to use in their simulation. For each reorganization,

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[2] Although we may think about modeling criminal organizations, for the purpose of this work, we have concentrated on the police organization.

the behavior of the agent when making decisions concerning reorganization is represented in production rules (conditions and executions).

In Figure 1 we show one screen shot of two windows for the physical reorganization of the tool. The one on the left shows an example of how a behavioral rule of an agent can be built with the help of the tool. The condition of the rule can be a comparison between variables or a comparison of variables with a certain value, and could be a simple or composed statement. After the creation of the condition, the action that will be executed, if the rule is satisfied, should be included. It is important to highlight that the variables that compose the condition and actions are the properties and methods defined in the agent society. They are supplied by the simulation generalizing the reorganization tool so that it can be used by any domain. The window on the right side shows all the parameters that are used by the domain of public safety, such as the number of police teams, the number of criminals, the criminal's vision, among others.

Originally, each type of reorganization can be simulated through two reorganization strategies:

- The centralized strategy (role-based), assumes the existence of an agent who can have access to all of the information on the other agents at any moment, and may thus decide to provoke reorganization in the agent society.
- The shared strategy – all of the agents or a part of them will be performing the role of the centralized agent, however with no autonomy to execute the changes without beforehand putting them to a vote of the other agents that are part of the society.

At that moment in our studies, we focus on the centralized strategy. The tool also allows that the simulation to be made without any possibility of reorganization, and thus not considering any of the rules created by the user.
The simulation tool provides different manners for evaluating of the quality of the reorganization strategies. It makes it possible to store the results at the end of the simulation, and the data that was previously defined by the user as points of evaluation of his/her simulation can be accessed. Thus it will be possible to generate comparative graphics in several formats.

5 Empirical Evaluation of the Simulation Model

In this section we will show some experiments done with no strategies of reorganization which help us to verify some features of the simulation model.

The first aspect we would like to investigate in our simulations is the behavior of crime relative to the so-called impunity factor. In the model, one of the factors for the growth of crime is the increase of the criminals' "quality". This is represented by their experience in committing crimes that increase when they are successful in their initiatives. In other words, if there is no punishment (in this society represented by the prohibition of crime occurrence), the criminals tend to become more dangerous and thus commit more crimes. Simulations without reorganization of routes have shown that such a factor occurs in our model. We run 15 one-month simulations where the police patrol routes are randomly defined and stayed static during the month. We start by examining the following scenario: 15 criminals and 6 police teams and 40 notable

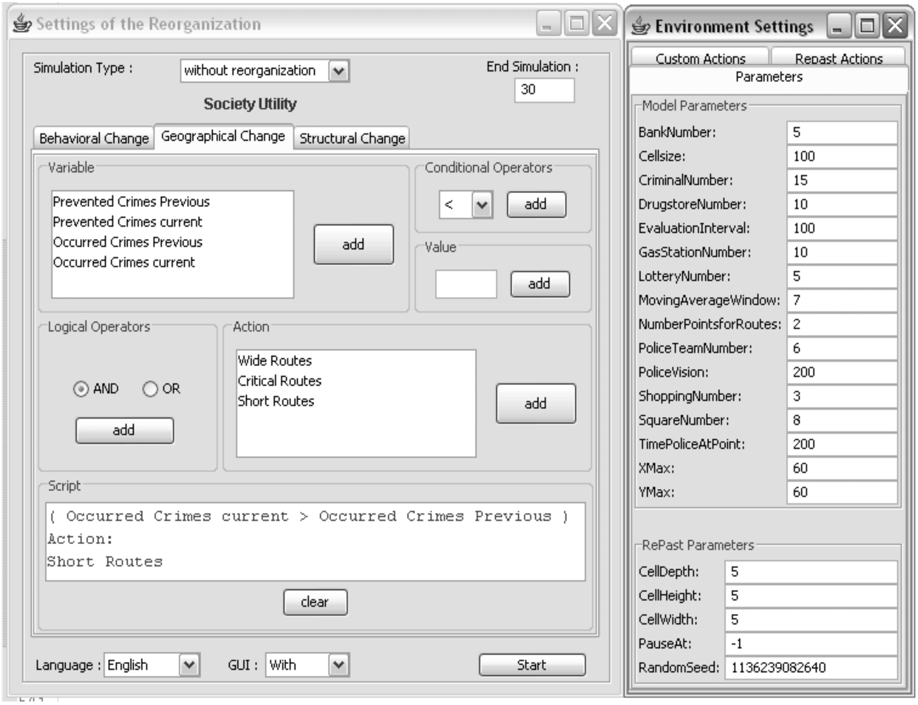

Fig. 1. Interface for configuring the reorganization exemplifies the manner that a logical expression for defining the police commander behavior can be created

points[3]. The probabilities for a criminal to find a certain target are those shown in Table 1 and the other parameters have the values shown in Figure 1.

Figure 2 shows the results for one simulation where no type of reorganization was applied, using these parameters. Several different kinds of interfaces are provided. Graphics show the number of crimes per notable point and the evolution of crimes for such points. The patrol routes are displayed in order to facilitate the accompanying of the reorganizations. In the window where the graphic of Occurred Crimes per Day is displayed, the top line represents the number of crimes that occur per day and the other line represents the moving average of the last 5 days of simulation. For the current example, it is observed that in the course of time, there is a tendency for growth in the number of crimes committed. This occurs due to the fact that with the elapsing of the simulation and with the occurrence of the crimes, the criminals become more experienced and tend to commit more crimes. This result was confirmed after running ten simulations, showing that static routes without reorganization are not enough to control crime. The moving average for all simulations and for different configurations can be seen in Figure 3. Each line represents different proportions of criminals and police teams in that sequence.

[3] This number of police teams and notable points corresponds to the number in a typical neighborhood in the city of Fortaleza from where the criminal data was based on.

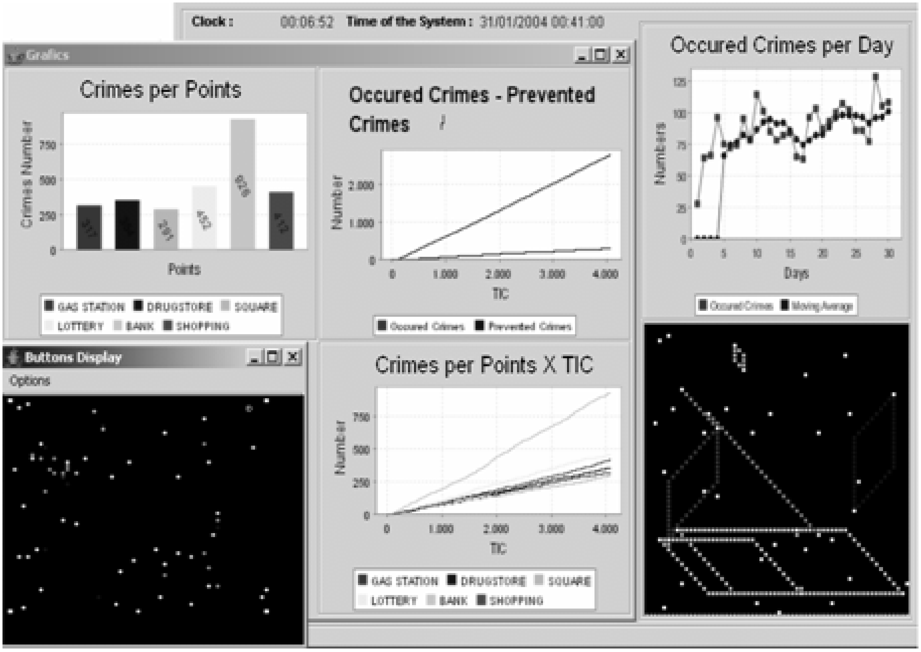

Fig. 2. Overview of the different interfaces. The graphic of crimes that occurred per day in a simulation without reorganization shows the tendency for the crime rate to grow.

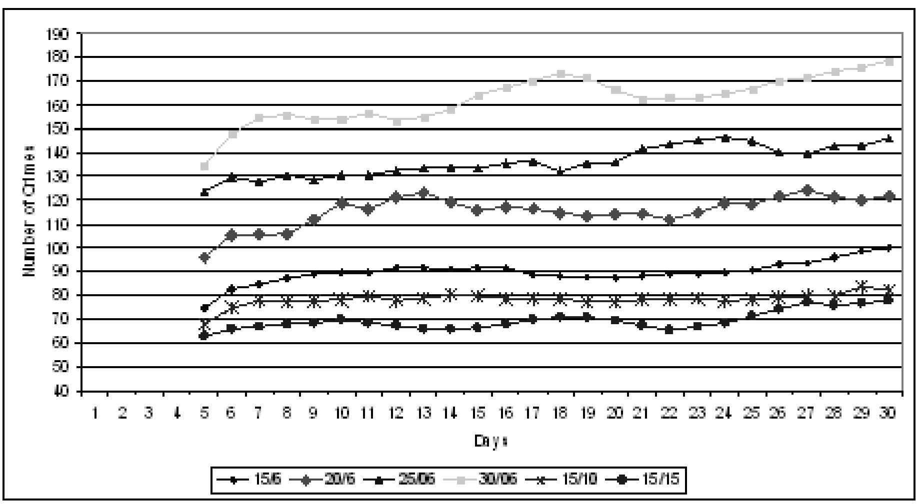

Fig. 3. Different configurations of criminal and police teams with no reorganization

In simulations in which the scenarios had increased the number of criminals, the crime rates are, as expected, higher. Also worth mentioning is that in scenarios where the proportion of criminals to police is less than the scenario initially proposed, even though the crime rates are reduced, the tendency for growth, even though slight, during the month still exists. These results indicate that the increasing of the number of police teams leads to low crime rates but allocating them in a static way is not enough to reduce crime tendency because the criminals tend to adapt their behavior. Such evidence is in accordance with several theories on crime [2] and makes the simulation model stronger.

6 Understanding Physical Reorganization of Agents in the Public Safety Domain

Physical reorganization is used whenever it is necessary to alter the position of the agents without necessarily altering their properties, behaviors, or structural organization. Within the public safety domain, the objective of the society of agents is to minimize the occurrence of crimes. For this, the society falls back upon police teams that organize themselves through routes of preventive patrolling. In this section, we investigate the impact of different strategies of reorganization on the crime rate. Our intent is two-fold. First, we aim at understanding some predefined strategies of reorganization for elaborating future variations of the model towards a more autonomous and decentralized process. Furthermore, by investigating these predefined strategies, we can validate some of the features of the actual model.

6.1 Strategies for Reorganization

The simulation tool allows the execution of different dynamic reorganizations in the routes of police teams. For this, three possible versions for the alteration of the routes were made:

- Short routes are those where notable points are selected and the police teams are designated to these points so that the route of these teams may be the shortest possible. The commander chooses the most vulnerable point and creates a route that leads to this point and n others closest to it. The process is repeated until all the police teams are allocated. With this measure, the notable point will have more time with a police team close to it.
- Wide routes have police teams designated to visit notable points so that the route of these teams may be the longest possible. The commander chooses, from the list of points to be patrolled, the most vulnerable point and creates a route that leads to this point and the n others farthest from such a point. The process is done until all the police teams are allocated. The idea of this strategy is to make the police team cover a larger physical space.
- Critical routes (high criminal activity) have police teams designated to cover notable points identified as the most critical (high crime rate). For each police team to be allocated, the commander chooses the n most vulnerable points and creates a route that lead to them.

The number n of points to be patrolled is a parameter of the simulation, but the new routes to be generated should patrol at least two notable points. In each reorganization, all the police teams are available to be reallocated by the commander. The notable point keeps two related factors "in mind": the number of crimes occurred and the number of crimes that were prevented at this point. These properties are useful to characterize the level of vulnerability of the notable point. The notable points that are candidates for having a police team patrolling its surroundings are those where a greater number of crimes have occurred than have been prevented.

6.2 Applying Reorganization

In this section we exemplify how the reorganization tool is used to aid the understanding of the quality of police routes for the reduction of crime. We start by examining the same scenario that was used when no reorganization was evaluated, namely 15 criminals and 6 police teams and 40 notable points. The probabilities for a criminal to find a certain target are those shown in Table 1.

Figure 4 displays only one graphic of crimes that occurred for a simulation where centralized reorganization was applied and based on a short route strategy. The police patrol covers 2 points and an evaluation of the reorganization is taken every seven days. It is observed here that, over the course of time, there is a tendency for decrease in the number of crimes. We may verify, by analyzing the moving mean line of the simulation, that with the application of reorganization (around days 10, 16 and 23), there was a decrease in the number of crimes and in the growth tendency. This is due to the greater presence of policing at the notable points where crime occurred more often.

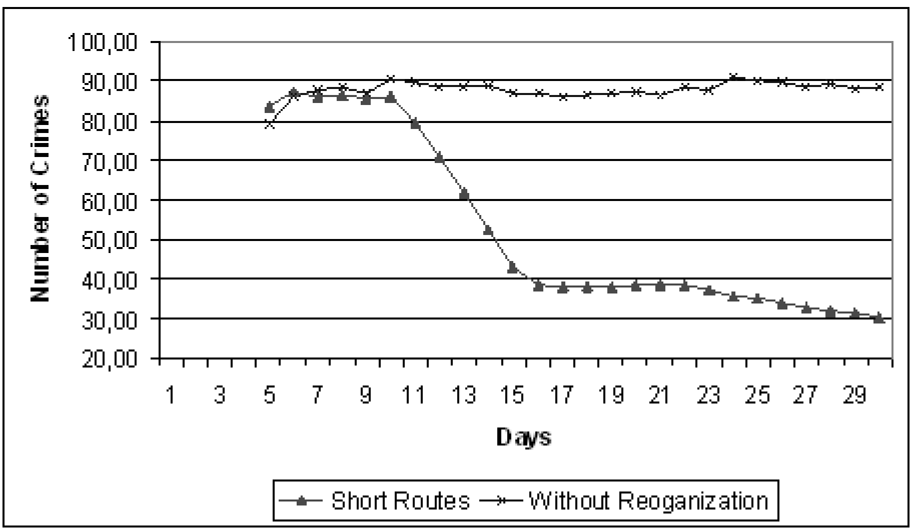

Fig. 4. Crimes occurred with reorganization following the strategy of short routes

6.3 Comparing Patrol Reorganization Strategies

To evaluate the three predefined types of routes, we decided to keep constant the values of several variables so that some comparative results may be obtained. Initially, the only variation was for the type of route. For each type of route, we ran 10 simulations. We started by testing the simulator without any type of reorganization, so that we could better identify the performance of the reorganizations. Later we carried out the same tests with the other three proposed forms of reorganization (short routes, long routes, and critical routes).

The best result obtained for a one-month simulation was a 2-point short route with reorganization evaluation on each day. Figure 5 shows these results. It is possible to observe that all the options with reorganization lead to better performance in terms of crime rate decrease. Crime is under control in all of them and the total number of crimes is also reduced. Figure 5 also shows the crime average total number over the one-month simulation period. The short route strategy leads to the fewest number of crimes in addition to leading the tendency of crime rates to decrease during the month.

We vary the parameters to evaluate routes with different patrol points and a different threshold of reorganization evaluation. The latter parameter defines the moment the commander decides to evaluate whether a reorganization can be done or not. We

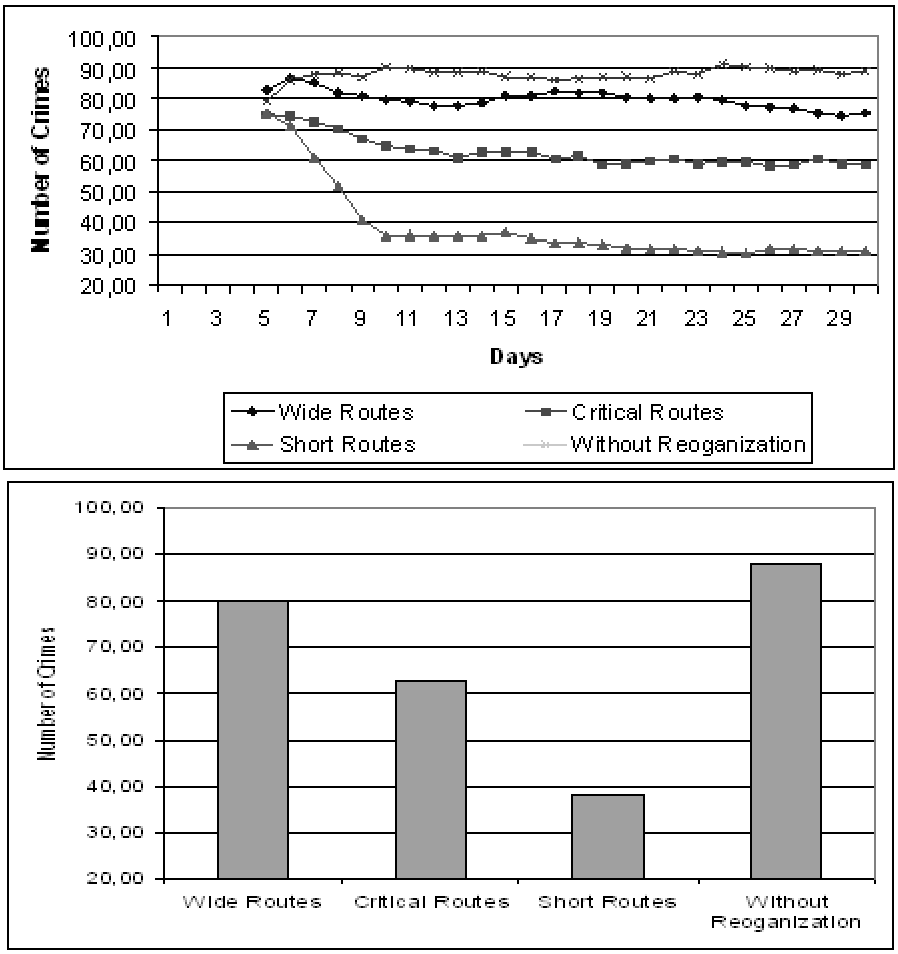

Fig. 5. Comparison of routes

evaluate routes with 2, 4, 6, and 7 points. As for the reorganization evaluation, we ran simulations with 1, 3, 5, and 7 days of delay, i.e. for each 3 days[4] of simulation, the commander analyses the trigger for reorganization and decides whether it should be done or not. The results of these simulations are shown in Figure 6. Moreover, we evaluated the size of the routes for each different time span of evaluation. The results of this comparison are depicted in Figure 7. Figures 6 and 7 refer to the same data but show a different perspective of them. In the x-axis represents the number of points per route and the delay (in ticks) between evaluations of reorganization (i.e. *2-100* corresponds to two-point routes that evaluation of reorganization is done each and every 100 ticks).

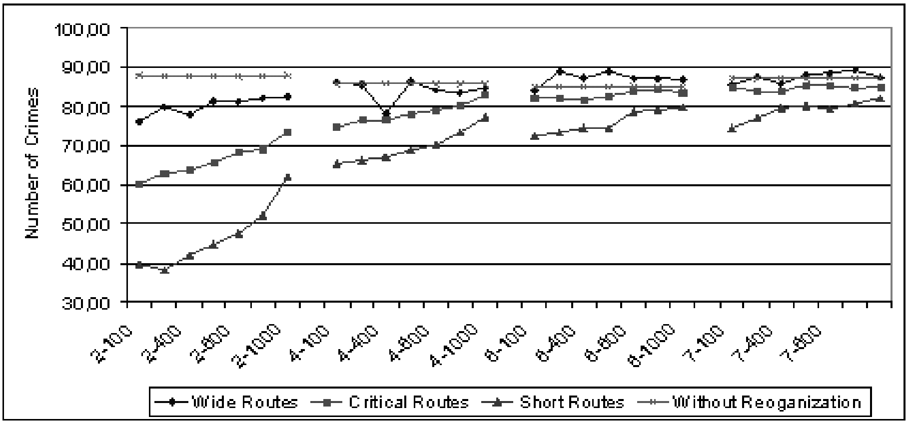

Fig. 6. Comparison of routes for different route size varying the time span for evaluating whether reorganization must be done or not

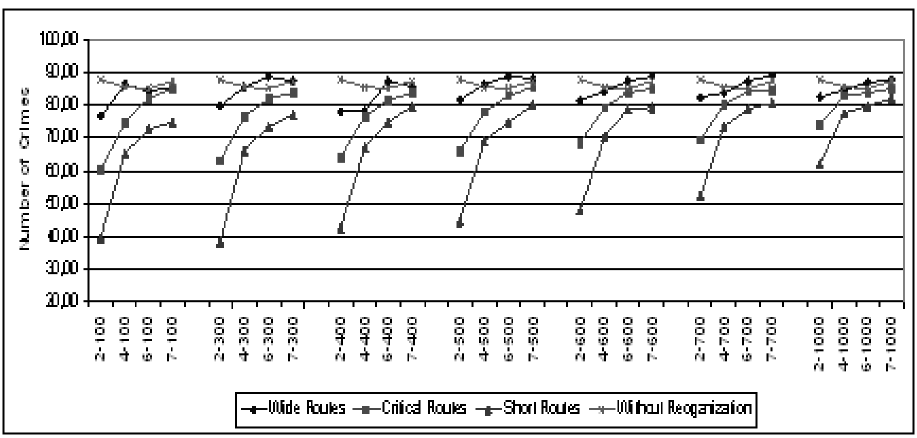

Fig. 7. Comparison of routes for each time span of evaluation varying the police patrol size

[4] One day corresponds to approximately 300 ticks.

In Figure 6, we organize the data by fixing the number of points per route and varying the interval of reorganization evaluation. In Figure 7, we fix the interval of evaluation and vary the number of points per route. These figures make us to understand that the longer the time to evaluate reorganization the greater the number of crimes is, undependably of the route size.

6.4 Discussion

Basically the results of our tests suggest relevant, although preliminary, findings. Regardless of the type of routes, reorganization reduces the crime rates. The fewer the routes, the better the results will be in terms of crime rates as well as in terms of tendency changing. This occurs because we have focused on crimes against properties with fixed targets. So this requires a police strategy that must visit the targets as much as possible. In that case, the time of displacement is very low productive. Experts in policing disagree about the ideal size of police routes. However some heuristics are shared by most of them. Police teams cannot be totally static. They must move in order to be visible and then to bring a feeling of safety. However, when routes are too large and need to be performed with vehicles, this sensation of safety is ephemeral because police pass by but do not stay.

As for the decision to reevaluate it must be as frequent as possible, suggesting that a police team must have a high level of mobility. To reorganize in a time span less than a day was shown unproductive sometimes, even though we did not consider it any cost associated with reorganization. This occurred because the criterion of triggering the reorganization was the increasing of the number of crimes which is a very sensitive one and, if done too often, can provoke unnecessary reorganizations. In real life, reorganization involves a cost of management and displacement, so reorganizing more than once a day is unfeasible. We intend to consider the cost notion in future works.

7 Conclusion and Future Work

In this article, we describe a tool to aid the configuration of agent reorganization strategies. This tool allows for the implementation of behavioral, structural, and physical reorganization strategies. In particular, the article concentrates on physical reorganizations and exemplifies its use in the public safety domain. A society of artificial agents in this domain was modeled, inhabited by criminals and police teams. The health of the society is measured by the number of crimes that occur. Police patrol routes are the main variables for crime to be kept under control. The tool supplies functionalities for the configuration of different reorganization strategies, allowing an analysis of the relationship between the environments that compose the society and the policing strategies. Examples of how reorganizations can influence crime rates are given. The ideas made explicit in the article are the fruits of an ongoing work, where new fronts are being explored. The first front refers to automatic learning of when and how to restructure. In the current version of the tool, these decisions are strongly influenced by information supplied by the user and/or by the designer. Genetic algorithms are being investigated with the intention of supplying more autonomy to the society of agents. By resorting to evolutionary computation resources, our main objective is to automatically uncover effective police patrol routes for coping with certain preconceived scenarios of crime occurrences that typically arise in large urban centers. That is, the idea is not to design such routes by hand, but to let them emerge as a direct result of the application of a customized genetic algorithm approach.

The second investigation front refers to the application of the tool in deeper analyses of criminal issues. A study on the several factors foreseen in the society of agents and how these factors interrelate with the patrolling strategies is being carried out. Specialists in the area of public safety are participating in the project and are being consulted on the generated results. We are investigating how the swarm intelligence concept can be useful to model the experience of a criminal and the attractiveness of a target. We concentrate our studies on strategies that demonstrate some level of self-organization on the modeling of criminal activities. The idea is to model the criminals to make stochastic decisions about the points to attack based on the point's proximity as well as their level of experience about the specific points. Finally, we are studying the impact of the cost on the reorganization process. In public safety, reorganizations cannot be carried out at any time or too frequently.

Artificial society, in the way it is represented, also allows for the investigation of the effect of impunity, although this is not directly represented in the society of agents. Actually, the growth of criminal activity comes from the increase of the criminals' "quality". This is represented by their experience in committing crimes whereby the "quality" increases when they are successful in their initiatives. In other words, if there is no punishment (in this society represented by the prevention of occurrence of crime) the criminals tend to become more dangerous and thus commit more crimes.

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