# THE ANALYSIS OF SERIAL CRIME THROUGH THE USE OF DIFFERENT SOURCES OF DATA

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**ABSTRACT:** The analysis of serial crime is based on a broad variety of data coming from different sources; for instance, the analysis can be performed through the use of spatio-temporal reasoning processes, inferences that use forensic science data, as well as the evaluation of modus operandi. The computerised extraction of knowledge from databases (data mining) is often seen as a promising approach to treat the available data. It is argued that this will only succeed if a modelling process is initialised, primarily aimed at a better understanding of the real nature of crime analysis and of the complex environment in which such systems have to be integrated. Focusing on knowledge of investigators is proposed as a first useful approach in that perspective.

**KEY WORDS**: Burglary; Intelligence; Memory; Reasoning; Computing.

*Problems of Forensic Sciences, vol. XLVI, 2001, 93–100*
*Received 5 January 2001; accepted 15 September 2001*

## INTRODUCTION

The analysis of serial crime involves different communities of people working on problems of various nature. Especially psychology, sociology and criminology have entered the field by developing models, methods and computerised tools that support the analysis of such crimes as murder, rape, arson, or high volume crimes. The spatial dimension of serial crimes recently received a growing attention essentially through the implementation of Geographical Information Systems (GIS) that provide crime-mapping facilities. Computational statistical packages, computerised crime linkage systems, databases as well as few expert systems have also introduced other technical tools on the workplace of the analyst.

This resulted in cross-fertilisation and progress, but also in the proliferation of different approaches whose relative importance and extents (i.e. what they really cover) are difficult to understand. It is therefore difficult to see how to build a whole with those elementary blocks.

Most systems also suffer from fundamental weaknesses: academics propose methods often abstracted from political, legal and organisational constraints, whereas crime analysts and investigators feel more the economic and pragmatic constraints they are faced with. Furthermore each community see the resolution of crime from its own perspective, that poorly integrates the other's knowledge. This imply very few communication between what should be partners in crime solving. Forensic intelligence itself is very poorly integrated into the investigation process apart from "classical" databases such as DNA and fingerprint, despite its known evidential strength.

Worse, a frenetic commercial activity emphasises the role of press-button technology and deviates the attention to the computer rather than to the fundamental nature of crime analysis. Real practice within police agencies is thus poorly integrated and the high technology that is introduced is shown to be resource consuming with very few positive spin-off. This is the source of the very poor impact of computers on crime solving generally and of their bad perception by practitioners within their daily activity. It is therefore an uphill battle to convince the policemen that computers can be a rich source of help in the typical reasoning activities useful in the investigation of crime and that the proper integration of forensic science data is a critical factor to the efficiency of the investigation process.

The debate has to be set on the more fundamental issues if general and practical solutions are to be found and accepted in practice. This is part of an ongoing research at the University of Lausanne, successfully implemented in an operational environment of multi-state police services.

## OVERCOMING CONSTRAINTS AND COMPLEXITY

The first step is to recognise that crime analysis is carried out within a set of particularly restricting constraints that can be modelled (Figure 1).

Political constraints sets the main strenuous bounds to what can be done towards crime reduction:

1. Rules designed to safeguard the rights of the citizen severely regulate what data can be collected and exploited, as well as imply information splitting into various separate databases.
2. The defined amount of money dedicated to the fight against crime also determines the resources invested into crime analysis.
3. Finally, data is collected and treated by different people with various functions within the organisation; thus, data pass through a set of overlapping processes that often pursue goals other than crime analysis; it can dramatically impacts on the quality of the collected data.

Pragmatic constraints appear when it is realised that crimes occur in a complex society in permanent evolution that often involve organised people that commit offences on wide territories across legal and organisational barriers. Understanding this complex world in real time through the collec-

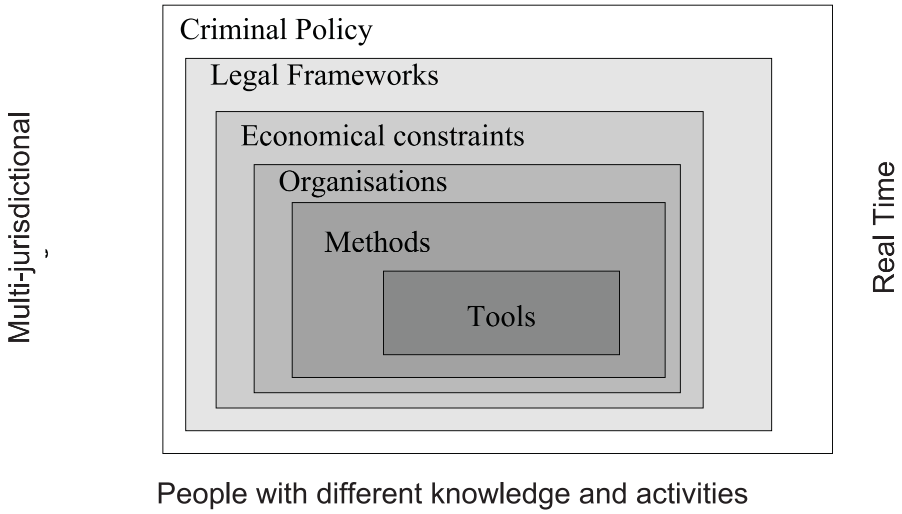


Fig. 1. Contraints.

tion and treatment of data is generally intractable to the human brain, whether it is helped by a computer or not.

The real challenge for crime analysis is the discovery of methods that overcome those constraints.

## METHOD: FOCUSING ON INVESTIGATORS KNOWLEDGE

The reluctance of policemen confronted to new technologies is sometimes seen as a main reason for projects failure when computers are introduced. But, if one considers that police organisations constitute a complex environment in which changes are not easily integrated, this is primarily due to the fact that policemen, investigators and crime analysts are at the forefront of crime detection and observation and, as such, have developed implicit and efficient methodologies to tackle serial crime within a set of constraints very difficult to capture for people coming from outside the police world. Computerised systems that poorly integrates these constraints and knowledge has indeed little chance to survive in such an environment!

For instance, forensic science data is recognised to efficiently provide links (associative evidence) through the use of databases. This potential is obviously used to build series of crimes. However, it has been shown that, when taking the point of view of the investigator or the crime analyst, forensic science data can be used along complex inference patterns in a co-ordinated way with other sources of data [7]. Other kinds of intelligence could be provided by such data, but poor integration within agencies lead to a net loss of available information. This has to be overcome by imaginative forensic scientists willing to develop real co-operation and understanding with investigators. Without such interaction forensic science data cannot be used at its full potential, and the lack of true understanding will result in a loss of motivation.

The lack of models representing investigator's knowledge is certainly one of the reasons why forensic science data is only used in its simplest way. Building such models is a prime step to design a solid methodology for crime analysis. This, in turn, would allow to demonstrate the relative participation and strength of different disciplines in treating data of a specific type in the global resolution of problems. One difficulty with the methodology arises because "good" experienced investigators are already heavily solicited by their colleagues and have little time to dedicate to such a "modelling" project, which is also often perceived as too theoretical to bring about useful progress. Kind, in 1987, already regretted that experienced and competent investigators were reluctant in discussing basic concepts of crime investigation. This lead to very limited reading material where solutions could be found. A specific deciphering process had to be carried out to bridge the gap.

The rapid development of a useful program, or prototype [5], which animates some part of the model, has been shown to be an efficient communication and validation tool which does increase the involvement of investigators. The prototype itself might become an operational system developed in an iterative way. Such a system is operational interstate in the whole of the French speaking part of Switzerland and has been developed to deal with a specific type of high volume crime: burglary [4].

The full computerisation of the process is not an aim, but the derivation of appropriate computerised systems is an important spin-off of modelling.

## MODELLING: THREE PERSPECTIVES

This study focuses on serial burglary and theft even if this is being extended to other types of crime such as arson [3] and drug intelligence [8]. The analysis can be seen as a process that accepts new cases and distribute them into a structured memory. Ultimately, that memory is investigated in order to infer new information and to design police operations (Figure 2). Three related components are suggested in our approach (Figure 3).

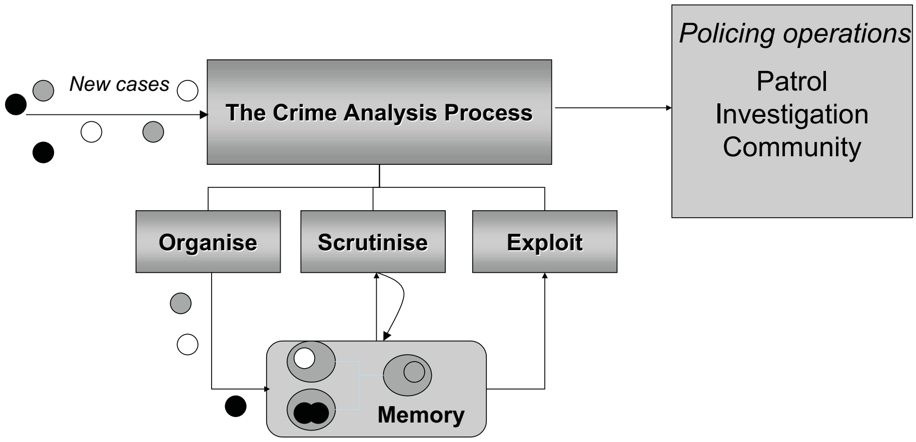


Fig. 2. The crime analysis process.

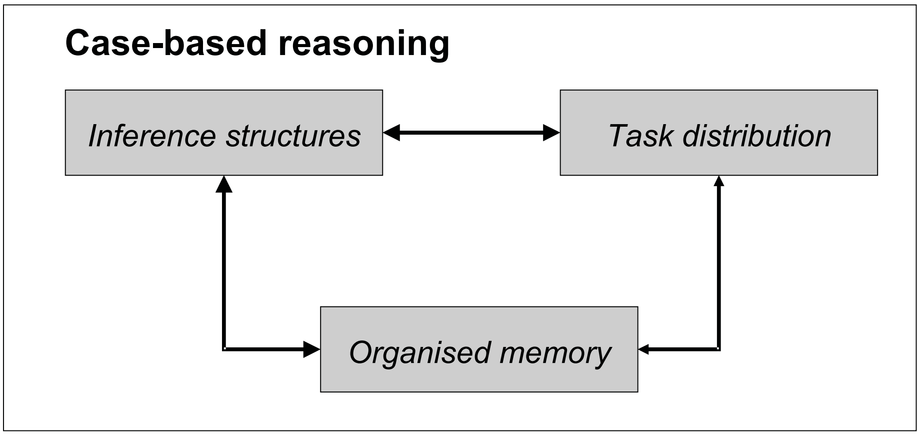


Fig. 3. Three perspectives.

### Inference structures

Inference structures result from the study of the reasoning processes underlying the analysis of serial burglary and theft. A description and examples can be found in [7].

### Memory

A complementary perspective can be the description of a structured memory, borrowing the case-based reasoning paradigm, which is extensively studied in cognitive science and artificial intelligence [2]. The overall structure is shown in Figure 4.

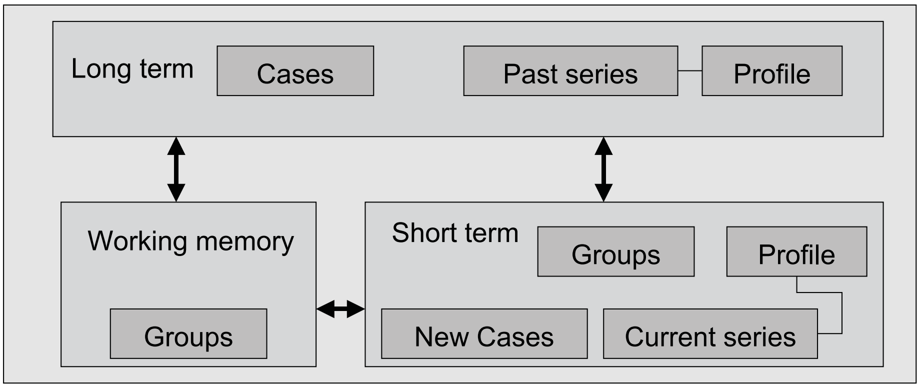


Fig. 4. Organisation of the memory.

At a given point in time, the analyst is aware of a certain number of series where the offender or group of offenders is supposed to be currently active. That greatly influences the analysis process as, when a new case occurs, it should be considered whether it is part of an active series.

The new cases (cases from the last 8 to 12 hours) compose an interesting group because a burglar or a thief is frequently active on different locations during the same night or day. Thus, associative evidence is likely to be found among those cases if they are indeed linked; their temporal proximity should also favour the comparison of physical traces as the accessories and clothes can have only evolved slightly.

The analyst must often interrupt the course of an analysis for different reasons. As the reasoning processes are complex, intermediate steps are memorised through groups that can be recalled quickly when the analysis is continued. Active series, new cases and intermediate groups belong to the short time memory

However, old organisations and recidivists can perpetrate the same type of offences years after their first series. Moreover, series sometimes stop and start again after a certain period; they should be kept within the memory to be reconsidered as an active series depending on emerging crime patterns. Those elements can be seen as belonging to a long term memory.

Finally, all the analysis process is about to generate and test hypothesis. That is done within a working memory where every set of case can be "copied" and worked out.

Series and groups can be best described through their profile that synthesise all relevant information across the cases.

A description of the memory and how it functions will be provided in [6].

The structure of the memory is a representation of the perceived situation at a given time. This entails the use of imperfect data, uncertainties linked to each case and the way they are combined into series and groups. Deductions obtained from the constructed structures constitute hypotheses that can be revised when new knowledge enters the process. This is known as non monotonic reasoning.

### Multi-agent perspective

Crime analysis is a difficult task involving co-ordination across organisational boundaries that is actually far from satisfactory, and particularly with regard to the exploitation of forensic intelligence.

In order to analyse serial burglary and theft, information of various nature is collected and treated: forensic science data, modus operandi, time related information, and other sources of data. Subtasks are physically distributed implying the simultaneous intervention of several agents (policemen, specialists) at different locations and the analysis has to be carried out through the combination of all sources of data, at every geographical scale, involving groups of people operating in different organisations or structures. If uncoordinated and poorly understood, these processes do result in unacceptable overall organisation performance, even if individual units are operating efficiently.

Designing models that formalise an adequate task distribution between the different partners is not straightforward. A possible approach is the use of the multiagent paradigm studied in Artificial Intelligence [1]. It concerns the distribution of task over a society of specialised interacting abstract entities (called agents) that co-operate in order to solve a global problem. The concept of abstract entity does not designate specifically organisational units, specialised people or computer systems, but rather provide a conceptual framework within which problems can be objectively discussed, implementation compared and new solutions derived.

A possible model is shown in figure 5. It particularly emphasises the role of forensic intelligence in providing and confirming hypotheses for crime scenes linking.

## CONCLUSION

This framework aims at representing some important aspects of serial crime analysis, as seen by crime analysts and investigators. It is based on the specific analysis of serial burglary. The deciphering process must continue by analysing further some aspects of the available knowledge, like the specific treatment of uncertainties, and generalising and adapting concepts across different types of crime.

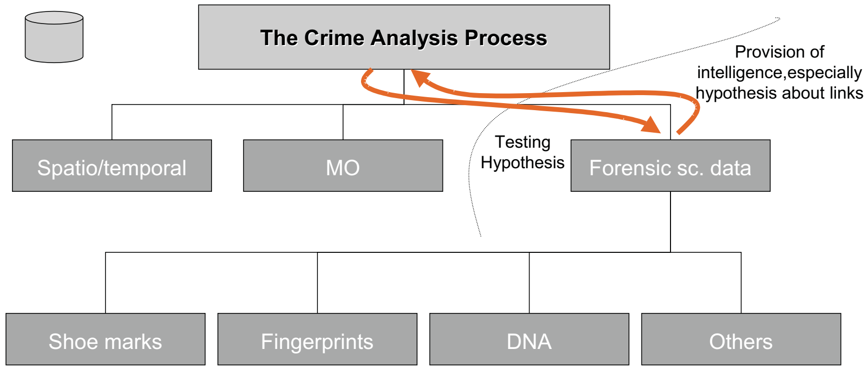


Fig. 5. Task distribution.

This formalisation also helps to understand how to integrate the developments coming from the broad variety of academic and operational domains that participate in the study of crime.

The distribution of the work among different specialities in order to carry out the global process of serial crime analysis is particularly critical because each operation must be performed under tight time constraints. For instance, each comparison must be fast, if not computerised, and only the most promising comparisons must be carried out, i.e. those that potentially have the most valid information content. This emphasises the need for a proper integration of forensic science data within this process.

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