ISSN No. 0976-5697

Volume 2, No. 4, July-August 2011

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

Evaluation of Modern Crime Prediction Techniques

M.Vijaya Kumar*
Assent Professor,
K.S.R.College of Engineering
Tiruchengode,India
vij370@gmail.com

Dr .C.Chandrasekar
Associate Professor
Periyar University
Salem,India

Abstract: Police analysts are required to unravel the complexities in data to assist operational personnel in arresting offenders and directing crime prevention strategies. However, the volume of crime that is being committed and the awareness of modern criminals make this a daunting task. The ability to analyse this amount of data with its inherent complexities without using computational support puts a strain on human resources. This paper examines the current techniques that are used to predict crime and criminality. Over time, these techniques have been refined and have achieved limited success. They are concentrated into three categories: statistical methods, these mainly relate to the journey to crime, age of offending and offending behaviour; techniques using geographical information systems that identify crime hot spots, repeat victimisation, crime attractors and crime generators; a miscellaneous group which includes machine learning techniques to identify patterns in criminal behaviour and studies involving re-offending. The majority of current techniques involve the prediction of either a single offender's criminality or a single crime type's next offence. These results are of only limited use in practical policing. It is our contention that Knowledge Discovery in Databases should be used on all crime types together with offender data, as a whole, to predict crime and criminality within a small geographical area of a police force.

Key Words: crime hot spots, repeat victimisation, Crime Pattern Theory, Statistical Methods.

I. INTRODUCTION

Micro The role of computers has been increased in all walks of life from the finance sector to supermarkets. In recent years police forces have been enhancing their traditional method of crime reporting with new technological advancements to increase their output by efficiently recording crimes to aid their investigation (Adderley and Musgrove 1999). Data is not just a record of crimes, it also contains valuable information that could be used to link crime scenes based on the modus operandi (MO) of the offender(s), suggest which offenders may be responsible for the crime and also identify those offenders who work in teams (offender networks) etc. In today's world, computers are playing a major role in the investigation of all types of crime from those that are considered as volume crime (burglary, vehicle crime etc.) to major crime such as fraud, drug trafficking, murder etc.

It is not an easy task for a Police analyst to manually unravel the inherent complexities within police data and this problem is compounded when the analysis is undertaken by a team. The distribution of the data to the team may cause significant information, which could be useful to solve the crimes, to be missed as each member is not in possession of all relevant facts. For a long time, criminologists and statisticians have been applying their skills and knowledge trying to predict when and where the next set of crimes will occur, with varying degrees of success. The volume of crime and the greater awareness of modern criminals put a strain on the existing methods. Human reasoning fails when presented with millions of records. Therefore, there is clearly a requirement for a tool kit to assist in analyzing the data which will make the best use of limited resources. Knowledge Discovery in Databases (KDD) techniques can be used to reveal knowledge which is beyond intuition. The aim of this study is to examine the current techniques used in crime prediction.

A. Knowledge Discovery in Databases

KDD is a process that allows users to search for valuable information in large databases (Weiss and Indurkhya 1998). It combines statistical modeling, machine learning, database storage and AI technologies. In policing, the vital aim of KDD is the prediction of human behavior, which is by far its most common business application (Mena 2003); this can be tailored to cater for the needs of security forces to detect and deter the criminals. Since 9/11, the use of KDD has increased in the areas of criminal detection, security and behavioral profiling. Behavioral profiling is the ability to find the patterns of unlawful activity, to predict the likely location and time of crimes, and to identify their perpetrators (Mena 2003). The Home Office (Home Office 2000) has recognized the significance of spatial data analysis at local level to understand crimes. Generally, the information stored in police systems has been used to investigate mainly major serious crimes as described above; the primarily used techniques being specialized database management systems and data visualization systems (Adderley and Musgrove 2001). Surveys reveal that the use of mapping tools have increased in the security forces of USA and UK (Mamalian and LaVigne 1999; Corcoran and Ware 2001).

KDD is the nontrivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data (Fayyad et al. 1996a). KDD refers to the overall process of discovering useful knowledge from data, and data mining refers to a particular step in this process (Fayyad et al. 1996b). Brachman and Anand (1995) has presented a methodology for KDD which has been enhances towards business by Chapman et al (1998) and further enhanced into clearly defined stages (Debuse et al. 1999):-

a. Problem Specification

b. Resourcing
c. Data Cleansing
d. Pre-Processing
e. Data Mining
f. Evaluation of results
g. Interpretation of results
h. Exploitation of results

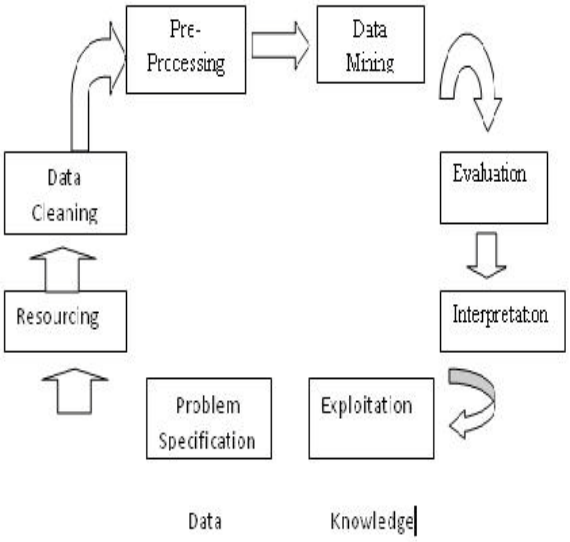

Figure 1: KDD Roadmap

II. CRIME INFORMATION'S

Crime is "An act committed or omitted in violation of a law forbidding or commanding it and for which punishment is imposed upon conviction".Recorded crime statistics have been collated since 1857. Police recorded crime statistics provide a good measure of trends in well-reported crime which could be used at local level to analyze the pattern of crime. However, they do not include crimes that have not been reported to police or that the police decided not to record. In contrast, the British Crime Survey (BCS) provides better trends on crime and includes crimes that are not reported to police. It is also unaffected by the changes in the levels of reporting to the police (Nicholas et al. 2005)

We have categorized crimes into two types:

a. Major crimes: Murders, rapes etc.
b. Volume crimes: Burglary, vehicle crime, robbery, theft, damage etc.

Property crimes such as burglary, theft and criminal damage account for the majority of both BCS (78 percent) and recorded crimes (75 percent) (Nicholas et al. 2005). Residential burglary is considered as one of the most distressing crimes, damaging physical and emotional peace of mind of the victims, which in 92% of incidents outweighs the value of the property stolen. Fear of repeat burglary often affects women in particular and such feelings of insecurity last up to 18 months after initial burglary, some of the victims even considered moving home to less affected crime areas. only 6% of burglary cases were solved and a third would be cleared up in the long run. However, most of the cases would not be solved and offenders will never be caught. The Promoter Apartments, Chennai Police area, whose data is used for this study, had a significantly higher percentage of people who were worried about burglary, vehicle and violent crime compared with average.

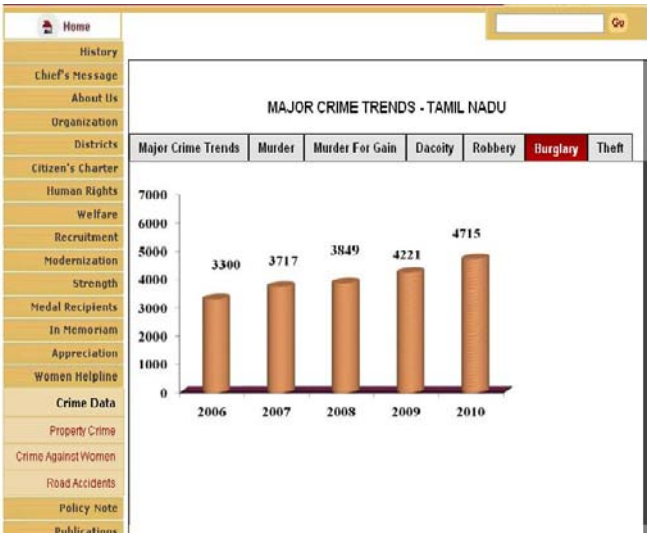

Figure2: Fear of Burglary crime by police force area,2006/2010 by http://www.tnpolice.gov.in/crimeprofile.html

A. Crime Recording Process

Whenever a crime is committed, a police officer visits the crime scene or the report is taken by telephone, which is known as the crime report. All Indian police forces record their crime reports in a similar way but in different computer systems. The variables stored may be known in a variety of ways but comprise the following: -

a. Time, day and date of the crime
b. Offence type (there are in excess of 800 different Home Office crime codes), contains unique crime classifications which would be difficult to analyze. For example burglary could be classified as one of the following:-

i. Burglary Dwelling
ii. Burglary Other Building
iii. Distraction Burglary
iv. Aggravated Burglary Dwelling
v. Aggravated Burglary Other Building

c. Location of crime to include post code and Ordnance Survey grid references
d. Victim information
e. Modus operandi (MO) identifies how the crime has been committed.

Depending upon the crime recording system used by each individual force the data fields will be a mixture of structured data fields that may be validated (or not) and free text fields. The free text may not even contain key words or phrases and will contain non standard abbreviations, mis-spellings and, on occasion, contradictory information. For example the structured fields may identify that for a domestic burglary offence the intruder gained entry via the front door but the free text may state that entry was gained via the front window.

The aim of collecting the data is both to solve the crime and to provide required performance information rather than to create a research database. Thus, the quantity and quality of information recorded varies considerably from case to case. It is often imprecise, and is almost certainly at times inaccurate. Crime data is very noisy (random error or variance in a measured variable) and contains lots of missing values. Unstructured and inconsistent data formats

make it very complicated to automate the analytical processes.

Field	% Complete	Valid Records	Null Value	Empty String	White Space	Blank Value
CRIME_REF	100	1580916	0	0	0	0
CRIME_NUM...	100	1580916	0	0	0	0
DATE_FIRST...	100	1580916	0	0	0	0
TIME_FIRST_...	100	1580916	0	0	0	0
DAY_FIRST_...	100	1580916	0	0	0	0
DATE_LAST_...	86.44	1366588	214328	0	0	0
TIME_LAST_...	86.44	1366588	214328	0	0	0
DAY_LAST_C...	86.44	1366588	214328	0	0	0
LOCN_STRE...	99.82	1578029	2887	0	0	0
LOCN_DISTR...	89.45	1414208	166708	0	0	0
LOCN_TOWN	97.23	1537090	43826	0	0	0
LOCN_POST...	72.73	1149784	429743	1389	1389	0
GRID_REF_N...	99.52	1573356	7560	0	0	0
GRID_REF_E...	99.52	1573344	7572	0	0	0
BEAT_NUMB...	100	1580916	0	0	0	0
BEAT_AREA	100	1580916	0	0	0	0
BEAT_NUMB...	100	1580916	0	0	0	0
SECTOR	89.89	1421131	159785	0	0	0
OFFENCE	100	1580916	0	0	0	0
ED_CODE	100	1580916	0	0	0	0
DETECTED	100	1580916	0	0	0	0
CUC_CODE	25.66	405664	1175252	0	0	0
NCR_CODE	4.4	69543	1511373	0	0	0
HOMC_CODE	100	1580916	0	0	0	0
HOOC_CODE	100	1580916	0	0	0	0

Figure 3: Statistical report of Anonymous crime dataset

B. Environmental Criminology

Understanding the behaviour of offenders plays a significant role in understanding and predicting crime and criminality (Adderley and Musgrove 2003). It would, therefore, be helpful to be familiar with the theories of environmental criminology.

a. Routine Activity Theory

According to Cohen and Felson (1979), the union of three elements in time and space are required for a crime to occur: a likely offender, a suitable target and the absence of a capable guardian against crime. This theory is summarized in Figure 4 below. Policing traditionally focuses upon the offender part of the triangle but crimes could be prevented or reduced by interacting with any aspect of the triangle.

Figure 4: Diagrammatic representation of routine activity theory

b. Crime Pattern Theory

This theory is helpful in establishing how people interact with their spatial environment and has three main notions: nodes, paths and edges (Policing and Reducing Crime Unit 1998, Brantingham and Brantingham 1991). 'Nodes' is a term from transportation which relates to where people travel to and from. A node is a base for oneself such as home, school, shopping centre etc. Such places can not only generate crime within but also nearby, for example, tight security at some place (Football ground, bar etc.) may generate more crimes and disorder outside of the enclosure/building.

Paths are the travel routes which people take to go to their work, entertainment, and other daily activities; in a nutshell it joins nodes. Most people are creatures of habit; and follow the same route to go to the same place or nodes. These paths are closely related to where they fall victim to crime. The third concept of crime pattern theory, edges refers to the boundaries of areas where people live, work, and shop or seeks entertainment. These edges are prone to some crimes such as racial, robberies, shoplifting because people seldom know each other at edges so after committing crime they go back to their haven. Insiders usually commit crimes around their base (home, office etc) whereas outsiders commit crimes at edges.

c. Rational Choice Perspective Theory

This theory focuses upon the offender's decision making processes. Its main hypothesis is that offending is purposive behaviour which helps the offender in some way. It believes that an offender has an objective to commit a crime even if these goals are immediate and consider only a few benefits and risk at a time (Clarke and Felson, 1993).

d. Awareness Theory

(Brantingham & Brantingham 1991) has suggested that crime has four dimensions: victim, offender, geo-temporal and legal. Concentrating on the spatial element of crime is significant to understand the behaviour of offenders. A crime's space can be chosen either on purpose or accidentally by either the victim or the offender according to their life styles. Several things have an effect on the crime rate of an area. For example, what type of people live in particular space and what type of security is available.

III. CURRENT CRIME AND OFFENDING PREDICTION TECHNIQUES

The 'holy grail' in policing is to be able to predict when and where the next crime or set of crimes will occur. This, of course, in a holistic sense is not currently possible. Many attempts have been made in the crime prediction arena, each of which has had limited success. Most of these attempts have been either concerned with the crime and criminality relating to either a single offender or a single crime type. The sections below discuss the current crime prediction techniques.

A. Statistical Methods

Most burglary (69%) and violence (55%) offenders live within one mile of the scene of the crime. Only 8% of burglars and 15% of violence offenders live more than 5 miles away from the crime scene (Farrington and Lambert 2000). Canter (1994) also found that scene of a crime is a key feature to the address or home base of an offender. Crimes occur in close proximity to the offender's residence (Rossmo 2000) and there is a distance decay pattern for crime trips (Brantingham and Brantingham 1984).

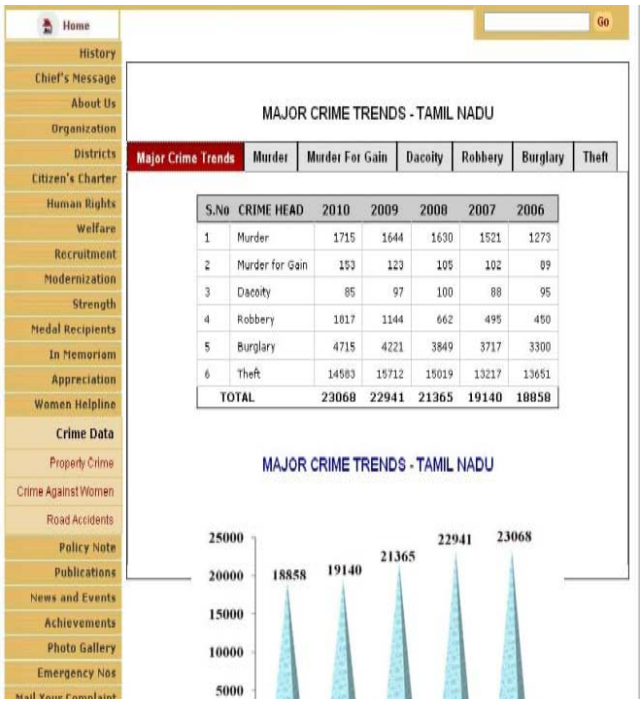

Figure5: Major Crime Trends - Tamil Nadu

B. Miscellaneous Methods

Crime prediction, prevention and detection with data mining is an exciting new area, which brings together the disciplines of statistics, machine learning, artificial intelligence, criminology, psychology and database technology. Adderley and Musgrove (2001) have documented the development of investigation tools that make the most of computing power as a mechanism to help the solution of both major and volume crime each of which require a different strategy for investigation. Several academic ventures have made an abortive attempt to use artificial intelligence (AI) to identify volume crimes such as burglary (Lucas 1986 and Charles 1998). In contrary to their prototype success, they could not transform into practical working systems because they were standalone systems requiring the duplication of data inputting, as they could not be easily integrated into existing police systems. They also lacked robustness and could not adjust to shifting environmental changes. This has engendered suspicion within policing regarding the usefulness of AI techniques (Adderley and Musgrove 2001). There are only few examples of using data mining on crime data (see Adderley 2004; Brown 1998).

There are several other techniques that have been used by several researchers. Chau et al (2002) has used entity extraction to discover the patterns that identify person names, their addresses, vehicles and other characteristics. Some of the approaches, such as string comparator, social network analysis and deviation detection are described in Chen et al (2004) to use on crime data in understanding criminal behaviour. Hauk et al (2002) have used the concept space algorithm on crime data to detect abnormal activities. Once these activities are identified it may be possible to predict the next occurrence of such activity. Several algorithms have been used by Oatley et al (2004) to match and link burglary crimes together into a crime series. Having ascertained that a series is occurring it is possible to suggest, from that data, where the next crime in that series will occur.'

Criminal histories have been used traditionally in criminology to predict reconviction and re-offending. This convention began by 'Ernest W. Burgess' in the 1920s by trying to identify those who would be most appropriate to parole (Mannheim 1965). If forensic and physical evidence is available then it is easy to link the crimes or classify the crimes and attribute them to a single offender. "When such evidence is unavailable, analysis of offence behaviour may be used to identify a linked series of crimes" (Grubin 2001). Repeat victimisation has also be used to assist the prediction (Ewart and Oatley 2003).

There is a strong association between past and present criminal behaviour (Nagin and Paternoster, 2000). Future events are based on the past events, which has helped in the prediction of crime (Johnson and Bowers 2004).

C. Geographical Information System Methods

(Brantingham & Brantingham 1995) propose that crime hot spots are developed in areas of the community that can be labelled as crime generators, such as entertainment areas and shopping malls. However, unsteady hot-spots are probably to be the outcome of prolific offenders targeting one area at irregular intervals (Townsley 2000). The techniques used by police forces to identify hot-spots are not always consistent. Crime problems in areas designated as hot-spots may be momentary, and may disappear before resources are officially allocated to those areas. Other than being a crime generator, there are a variety of reasons why a particular geographical area is regarded as a hot-spot. For example, the crime rate could be caused by a prolific offender being released from prison or due to a particular community event occurring. These hot-spots can be used as good predictors of crime and criminality.

As stated above, several researchers have found that prior victimization is a good predictor of future risk (Polvi et al, 1991; Farrell and Pease 1993; Anderson et al. 1995); repeat victimization (RV), when it occurs, tends to occur swiftly (e.g. Polvi et al. 1991; Anderson et al., 1995; Johnson et al., 1997). Deprived regions are more affected by repeat victimization (Johnson et al. 1997), in regions with high crime event rates (Trickett et al. 1995), and in regions designated as hot-spots (Johnson et al. 1997, Townsley et al. 2000). Several researchers have interviewed offenders and established that they target the same property repeatedly because they know their way around and know the remaining property or what property is likely to have been replaced that they can steal again (Winkel 1991; Gill and Matthews, 1994; Ericsson, 1995). Johnson and Bowers, (2004) suggests that burglary offences cluster in space and time. They have made an analogy with optimal foraging theory (Krebs and Davies 1987; 64 – 6) which minimizes the rate of being caught and amount of time while maximizing the reward. This reasoning would imply short-run outbreaks or spates of burglary in a neighbourhood are possibly the result of a single criminal or a team of criminals' activity. On the basis of optimal foraging theory, domestic burglaries shift over time, such that the location of clusters is not predictable over periods of three or more months. However, although clusters do not remain in the same location over time, they tend to move in a 'slippery' manner, moving to nearby areas at successive points in time (Johnson and Bowers, 2004). Different types of geographical area suffer from different levels of victimization and re-victimization (Johnson et al. 1997). The

central conclusion is that, in affluent areas, "a burglary event is a predictor of significantly elevated rates of burglary offences within 1-2 months and within a range of up to 300-400 meters of a burgled home" (Johnson and Bowers 2004). Targets or potential victims are very unevenly distributed across space and time. For instance, street robbery requires the presence of victims on the street. Certain parts of cities (at certain times of day) have many pedestrians. In other parts of cities and at other times of day, the streets may be deserted. Auto theft obviously requires that the offender locate an automobile in time and space. Clearly automobiles are unevenly distributed in space and the distribution of them changes radically between working and nonworking hours. All this information would be useful in the prediction process.

IV. DISCUSSION

Current prediction techniques have had limited success in operational policing. Many researches have spent time analysing large amounts of police related data with a view to predicting either where the next crime or set of crimes will occur. There are two main areas where these prediction techniques have been concentrated: -

a. An individual crime type
b. An offender's movements

There are two subsidiary areas where these techniques have been concentrated:-

a. Repeat victimization
b. Hot-spot analysis

In our view by limiting the research to a single crime type or offender or geographical area the ability to predict has limited value to operational policing. In order to effectively prevent crime and arrest offenders, it is necessary to effectively target the geographical area where crimes are occurring or will occur. This is ALL crime and not just an individual crime type. Therefore, we suggest that KDD could be and should be used on all crime types together with offender data, as a whole, to predict crime and criminality.

V. REFERENCES

[1]. Adderley, R. (2004) The Use of Data Mining Techniques in Operational Crime Fighting, Intelligence and Security Informatics, Second Symposium on Intelligence and Security Informatics. Springer, ISBN: 3-540-22125-5

[2] Adderley, R., and Musgrove, P.B., (1999) Data Mining at the West Midlands Police: A Study of Bogus Official Burglaries, BCS Specialist Group on Expert Systems, ES99, London, Springer – Verlag, pp191-203, 1999.

[3] Adderley, R., and Musgrove, P.B., (2001) General review of Police crime recording and investigation systems. A user's view. Policing: An International Journal of Police Strategies and Management, 24(1).

[4] Adderley, R., and Musgrove, P.B., (2003) Modus operandi modeling of group offending: a data mining case study, Accepted by: The International Journal of Police Science and Management, 2003.

[5] Anderson, D., Chener y, S. and Pease, K. (1995) Biting Back: Tackling Repeat Burglary and Car Crime. Crime Detection and Prevention Series Paper No 58. London : Home Office.

[6] qBrachman, R.J. and Anand, T. (1995) The Process Of Knowledge Discovery In Databases: A Human – Centered Approach in Fayyad, U., Piatetsky-Shapiro, G., Smyth, P., and Uthurusamy, R. (eds) Advances In Knowledge Discovery And Data Mining, AAAI Press, Menlo Park.

[7] Brantingham, P., Brantingham, P., (1984) Patterns in crime. New York: Macmillan. Brantingham, P., Brantingham, P., (1991), Notes on the geometry of crime, in Environmental Criminology, USA: Wavelend Press Inc.

[8] Brantingham, P, Brantingham, P., (1995) Criminality of place: Crime generators and crime attractors. European Journal on Criminal Policy and Research 3,3, special issue on Crime Environments and Situational Prevention, 5-21.

[9] Brown, D.E. (1998) The Regional Crime Analysis Program (RECAP): A Framework for Mining Data to Catch Criminals. in IEEE International Conference: Systems Man and Cybernetics Society.

[10] Canter, D.V. (1994) Criminal Shadows London: Harper Collins. Chapman, P., Clinton, J., Hejlesen, J. H., Kerber,R., Khabaza, T., Reinartz, T. and Wirth, R., (1998) The Current CRISP-DM Process Model For Data Mining. Distributed at a CRISP-DM Special Interest Group meeting.

[11] Charles, J., (1998) AI and Law Enforcement, IEEE Intelligent Systems, pp77-80. Chau, M., Xu, J., and Chen, H (2002) Extracting Meaningful Entities from Police Narrative Reports. In: Proceedings of the National Conference for Digital Government Research (dg.o 2002), Los Angeles, California, USA.

[12] Chen. H., Chung, W., Xu. J. J, Qin. G. W. Y, Chau. M (2004), Crime Data Mining: A General Framework and Some Examples. IEEE Computer Society. 50-56.

[13] Clarke, R.V., Felson M. (1993), Introduction: Criminology, Routine activity, and rational choice in Routine activity and rational choice: Advances in criminological theory, volume 5. Clarke, R.V., Felson, M. (eds.) New Jersey, USA: Transaction Publishers.

[14] Cohen, L.E. and Felson, M., (1979), Social Change and Crime Rate Trends: A Routine Activity Approach. American Sociological Review, Vol 44, 588-608.

[15] Corcoran, J. and Ware.J.A., (2001), Data Clustering using Artificial Neural Networks as a Precursor to Crime Hot Spot Prediction, Proceedings of GISRUK, University of Glamorgan, Wales, Hackman Printers Ltd., 249-253.

[16] Coupe, T and Griffiths, M. (1996) Solving Residential Burglary, Crime Detection and Prevention Series, Paper 77
http://www.homeoffice.gov.uk/rds/prgpdfs/fcdps77.pdf

[17] Davies, A. (1992) Rapists Behaviour: A three aspect model as a basis for analysis and the identification of serial crime. Forensic Science International, 55, 173-194.

[18] `Debuse, J. C. W., de la Iglesia, B., Howard, C.M., Rayward-Smith, V.J., (1999) A Methodology for Knowledge Discovery: A KDD roadmap. Technical Report SYS-C99-01, School of Information Systems, University of East Anglia, Norwich.

[19] Ericsson, U. (1995) Straight from the Horse's Mouth. Forensic Update, 43, 23-25.

[20] Ewart, B. W., and Oatley, G.C. (2003) Applying the concept of revictimization: Using burglars' behaviour to predict houses at risk of future victimization. International Journal of Police Strategies and Management, Vol.5 (2).

[21] Farrington, D. P. and Lambert, S. (2000) Statistical Approaches to Offender Profiling. Offender Profiling Series: IV – Profiling Property Crimes. Edited by Canter, D. and Alison, L. Ashgate Publishing. Pp233-273.

[22] Farrell, Graham and Ken Pease (1993) Once Bitten, Twice Bitten: Repeat Victimisation and its Implications for Crime Prevention. Crime Prevention Unit Series Paper No 46London: Home Office.

[23] Fayyad, U., Piatetsky-Shapiro, G. and Smyth, P., (1996a) From Data Mining to Knowledge Discovery: An Overview in Fayyad, U., Piatetsky-Shapiro, G., Smyth, P. and Uthurusamy, R., (eds) Advances in Knowledge Discovery and Data Mining Menlo Park, Califf: AAAI Press.

[24] Fayyad, U., Piatetsky-Shapiro, G., and Smyth, P., (1996b) From Data mining to Knowledge Discovery in Databases, AI Magazine, 1996.

[25] Grubin, D., Kelly, P., and Brunsdon, C. (2001) Linking serious sexual assaults through behaviour. Home Office Research Study 215. ISBN 1-84082-560-X Gill, M. and Matthews, R. (1994) Raids on Banks. Centre for the study of Public Order: University of Leicester.

[26] Hauk, R.V., Atabaksh, H., Ongvasith, P., Gupta, H., and Chen, H. (2002) Using Coplink to analyze criminal justice data, IEEE Computer, 35(3), pp. 30-37.

[27] Home Office (2000) Review of crime statistics: A discussion document.

[28] http://www.homeoffice.gov.uk/crimprev/crimstco.htm. Johnson, S.H. and Bowers, and Hirschfield, F.G. (1997) New Insights into the Spatial and Temporal Distribution of Repeat Victimisation. British Journal of Criminology, 37(2), 224-241.

[29] Johnson, S.H. and Bowers, K.J. (2004) The Burglary as Clue to the Future: The Beginnings of Prospective Hot-Spotting, European Journal of Criminology, Vol 1 (2): 237-255: 1477-3708.

[30] Krebs, J. R. and Davies, N.B. (1987). An introduction to behavioural ecology; 2nd edn. Oxford: Blackwell.

[31] Lucas, R. (1986) An Expert System to Detect Burglars using a Logic Language and a Relational Database, 5th British National Conference on Databases, Canterbury.

[32] Mannheim, H. (1965) Comparative Criminology (Volume 1). London: Routledge and Kegan Paul. Mamalian, C.A. & LaVigne N.G. (1999) The Use of Computerised Crime Mapping by Law Enforcement: Survey Results. National Institute of Justice Research Preview.

[33] Mena, J. (2003) Investigative Data Mining for Security and Criminal Detection. Butterworth Heinemann Publishers, ISBN 0 – 7506 – 7613 – 2, 2003.

[34] Major Crime Trends – Tamil Nadu http://www.tnpolice.gov.in/crimeprofile.html