Application of Data Mining Techniques for Analyzing Violent Criminal Behavior by Simulation Model

K. Zakir Hussain, M. Durairaj and G. Rabia Jahani Farzana

Abstract - **Crime is a major issue where the top priority has given by our government. Criminology is an area that focuses the scientific study of crime and criminal behavior and law enforcement and is a process that aims to identify crime characteristics. It is one of the most important fields where the application of data mining techniques can produce important results. Crime analysis, a part of criminology, is a task that includes exploring and detecting crimes and their relationships with criminals. The high volume of crime datasets and also the complexity of relationships between these kinds of data have made criminology an appropriate field for applying data mining techniques. Identifying crime characteristics is the first step for developing further analysis. The knowledge that is gained from data mining approaches is a very useful tool which can help and support in identifying violent criminal behavior. The idea here is to try to capture years of human experience into computer models via data mining and by designing a simulation model.**

Index Terms - Data Mining, Simulation Model, LEADSTO notations.

I. INTRODUCTION

Criminology is an area that focuses the scientific study of crime and criminal behavior and law enforcement and is a process that aims to identify crime characteristics. It is one of the most important fields where the application of data mining techniques can produce important results. Crime analysis, a part of criminology, is a task that includes exploring and detecting crimes and their relationships with criminals.

K. Zakir Hussain.,MCA.,M.Phil.,MBA., is with the Indian Air Force, Air Force Station, Thanjavur, India. (Corresponding author: Mobile: 94880–05244; e-mail: zakir_hus2006@yahoo.com).

M. Durairaj.,MCA.,Ph.D., was with the National Institute of Animal Nutrition and Physiology (ICAR), Bangalore, India. He is now with the Department of Computer Science and Engineering, Bharathidasan University, Tamil Nadu, India (e-mail: durairajum@gmail.com).

G. Rabia Jahani Farzana.,MBA.,M.Phil.,Ph.D.,M.Sc(Psy)., is with the Government Arts College, Tiruchirapalli, Tamil Nadu, India. (e-mail: rabiafarzana@yahoo.com).

Within criminology, the analysis of criminal behavior is a central issue. Very little attention has been paid to what it is that reinforces violent criminal behavior. A better understanding of this motivational process is critical. Emotions connect individuals to the social world and, hence, are the triggers of many social psychological phenomena, such as altruism, antisocial behavior, and aggression. To be able to identify and classify a behavior, one has to understand the behavior itself and the emotional states (e.g. happiness, sadness and anger) that pertain to it. Violent Criminal Behavior can be defined as any unconsidered action against others that may cause harm or distress to society. Violent Criminal Behavior has been linked to disruptive and impulsive behaviors, bullying, and in extreme cases, school shootings.

For persons with criminal behavior --particularly violent behavior--may be a source of meaning. There is a growing literature which indicates that violence is symbolically meaningful, and that it is used to influence others, to establish and protect valued identities, and/or to achieve justice and retribution. The role of aggression among violent criminals as it relates to their sense of self, their reputation, and their social world.

Social scientists have developed numerous theoretical and empirical models of crime. However dynamic microsimulation models to forecast criminal behavior are not currently available. This paper outlines a proposal for developing a special criminal behavior which would be linked to the determinants of criminal behavior. The main focus is on modeling the emotional states that characterize violent criminal behavior.

II. TYPES OF VIOLENT CRIMINALS

This research focuses on three types of violent criminals: the violent psychopath, the offender with an antisocial personality disorder (APD) and the offender who suffers from an intermittent explosive disorder (IED). Based on the research study by [2] - [4], all these three types of criminals are briefly introduced and their differences had been discussed.

A. Violent Psychopaths

This type of criminals would not be normal and would not have any feelings. The normal mechanisms of anxiety arousal is absent in them. The violence would be similar to predatory aggression, which is accompanied by minimal sympathetic arousal, and is purposeful and without emotion. Also, they like to exert power and have unrestricted dominance over others, ignoring their needs and justifying the use of whatever they feel compelling to achieve their goals. They do not have the slightest sense of regret.

B. Persons with Antisocial Personality Disorder

This type of criminals has characteristics that are similar to the psychopath. However, they may experience some emotions towards other persons, but these emotions are mainly negative: they are very hostile and intolerant [5].

C. Persons with Intermittent Explosive Disorder

In contrast to the previous two types, this type of criminals appears to function normally in their daily life. However, during some short periods, their brain generates some form of miniature epileptic fit. As a result, some very aggressive impulses are released and expressed in serious assault or destruction of property. After these episodes, IED persons have no recollection of their actions and show feelings of remorse

III. CHALLENGES

An ideal crime analysis tool should be able to analyze violent criminal behaviors quickly and in an efficient manner for future behavioral pattern detection and action. However, in the present scenario, the following major challenges are encountered.

- Crime information volume has been increased.
- Problem of identifying criminal behavior that can accurately and efficiently analyze these growing volumes of crime data.
- The data available is inconsistent and are incomplete thus making the task of formal analysis a far more difficult.

IV. FOCUS

The main aim consist of developing analytical data mining methods that can systematically address the complex problem related to various forms of criminal behavior. Thus, the main focus is to develop a criminal behavioral analysis tool that assists the police in:

- To perform criminal behavioral analysis to detect crime patterns.
- Provide information to formulate strategies for crime prevention and reduction.
- Identify and analyze common behavioral patterns to reduce further occurrences of similar incidence.
- Provide rehabilitation.

The present research work proposes the use of an amalgamation of data mining techniques that are linked with a common aim of developing such a criminal behavior analysis tool. For this purpose, the following specific objectives were formulated.

- To develop a data cleaning algorithm that cleans the crime dataset.
- To explore and enhance clustering algorithms to identify criminal behavioral patterns from historical data.
- To explore and enhance classification algorithms to predict future violent criminal behaviors based on previous crime trends.

V. FRAMEWORK

The data mining techniques used in the present research for modeling the simulation are clustering, classification and deviation detection. Clustering techniques group data items into classes with similar characteristics to maximize or minimize interclass similarity. Classification finds common properties among different crime entities and organizes them into predefined classes. Deviation detection uses specific measures to study data that differs markedly from the rest of the data, also called outlier detection. Apart from this, initially a preprocessing step that performs a cleaning process in two steps. The first step removes data records that are not important for analysis, while the second step implements a missing handling procedure to fill in missing data items or records in the crime dataset. By analyzing the vulnerability of the crimes, the behavioral pattern of the criminals are studied which are used to build a simulation model composed of various submodels.

VI. SIMULATION MODEL

A textual presentation of the Local Properties used for the simulation model is provided in both formal and in a informal (LEADSTO) notation. These properties are based on theories and experiments presented in the literature on criminal behavior. Some of the formulae and their specific values have been estimated in order to get an effect as qualitatively described in the literature, rather than that they are known from this literature. In the same manner, the model may be extended with probabilistic aspects, and more realistic timing parameters may be chosen.

The model is composed of the following submodels:

- a submodel to determine desires needed as input for the BDI-model_this model incorporates various physical and mental aspects and their interactions
- a submodel for reasoning about beliefs, desires and intentions, based on the BDI-model
- a submodel to determine how observations lead to beliefs in an opportunity as needed as input for the BDI-model_ this model is based on the Routine Activity Theory.

Each of these submodels is described by LEADSTO properties.

A. THE SUBMODEL TO DETERMINE DESIRES

This submodel covers many mental and physical elements, modeled by about LEADSTO properties, which can be grouped according to the following aspects:

- Development of a Theory of Mind
- Social-Emotional Attitudes
- Stimuli Assessment
- Consequences of Episodes
- The BDI-Submodel
- The Submodel for the Society

B. DEVELOPMENT OF A THEORY OF MIND

LP1
A certain level of me–other differentiation leads to the same level of empathy.
_x:SCALE
me_other_differentiation(x) —›› $_{0\_0\_1\_1}$ empathy(x)

LP1a
A certain level of empathy combined with a brain that is configured for a t heory of mind with regard to care of lead to the same level of theory of mind concerning other persons.
_x0,x1,x7,x8,z:SCALE _x,y:INTEGER _s1:SIGN
empathy(z) _ brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x7), emotional_attitudes_towards_others(neg,x8), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1)) —›› $_{0\_0\_1\_1}$ tom_care(x1)

LP1b
When the brain is configured for a theory of mind with regard to self interest of x, then the theory of mind with regard to self interest is x.
_x0,x1,x7,x8,z:SCALE _x,y:INTEGER _s1:SIGN
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x7), emotional_attitudes_towards_others(neg,x8),anxiety_threshold(x), excitement_threshold(y),sensitivity_for_alcohol(s1)) —›› $_{0\_0\_1\_1}$ tom_selfinterest(x0)

C. SOCIAL-EMOTIONAL ATTITUDES

LP2
When the brain is configured for a positive emotional attitude towards others of x7, and the person does not have an episode, then the positive emotional attitude towards others is x7.
_x,y:INTEGER _s1:SIGN _x0,x1x7,x8:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos, x7), emotional_attitude_towards_others(neg, x8), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1)) _ not episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(pos, x7)

LP2a
An episode decreases the positive emotional attitude towards others.
_x,y:INTEGER _s1:SIGN _x0,x1x7,x8:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos, x7), emotional_attitude_towards_others(neg, x8), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1)) _ episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(pos, low)

LP2b
When the brain is configured for a negative emotional attitude towards others of x8, and the person does not have an episode, then the negative emotional attitude towards others is x8.
_x,y:INTEGER _s1:SIGN _x0,x1x7,x8:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos, x7), emotional_attitude_towards_others(neg, x8), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1)) _ not episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(neg, x8)

LP2c
An episode leads to a negative emotional attitude towards others.
_x,y:INTEGER _s1:SIGN _x0,x1x7,x8:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos, x7), emotional_attitude_towards_others(neg, x8), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1)) _ episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(neg, high)

D. STIMULI ASSESSMENT

LP3
Observation of a stimulus with an excitement level that is lower than the excitement threshold will lead to boredom.
_s1,s2,y:INTEGER
observes_stimulus(s1,s2) ^ excitement_threshold(y) _ s2_y —›› $_{0\_0\_1\_1}$ boredom

LP3a
Boredom leads to a high desire for actions with strong stimuli.
boredom —›› $_{0\_0\_1\_1}$ desire_for_actions_with_strong_stimuli(high)

E. CONSEQUENCES OF EPISODES

LP4

An episode will lead to a decreased anxiety threshold for someone with IED.
_x,y:INTEGER _s1:SIGN _x0,x1,x6,x7:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x6), emotional_attitude_towards_others(neg,x7), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1), ied(pos)) _ episode —›› $_{0\_0\_1\_1}$ anxiety_threshold(x-4)

LP4a
Someone diagnosed with IED is sensitive to alcohol during an episode.
_x,y:INTEGER _s1:SIGN _x0,x1,x6,x7:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x6), emotional_attitude_towards_others(neg,x7), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1), ied(pos)) _ episode —›› $_{0\_0\_1\_1}$ sensitivity_for_alcohol(pos)

LP4b

During an episode, someone with IED has a low positive emotional attitude towards others.
_x,y:INTEGER _s1:SIGN _x0,x1,x6,x7:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x6), emotional_attitude_towards_others(neg,x7), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1), ied(pos)) ^ episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(pos,low)

LP4c
During an episode, someone diagnosed with IED will have a high negative emotional attitude towards others.
_x,y:INTEGER _s1:SIGN _x0,x1,x6,x7:SCALE
brain_configuration(tom_selfinterest(x0), tom_care(x1), emotional_attitude_towards_others(pos,x6), emotional_attitude_towards_others(neg,x7), anxiety_threshold(x), excitement_threshold(y), sensitivity_for_alcohol(s1), ied(pos)) ^ episode —›› $_{0\_0\_1\_1}$ emotional_attitude_towards_others(neg,high)

F. THE BDI-SUBMODEL

LP5

A combination of values for theory of mind for care and self interest, aggressiveness, the desire to cope with anxiety, the desire to ignore anxiety, the desire for actions with strong stimuli, impulsiveness, emotional attitude towards others(pos) and emotional attitude towards others(neg) will lead to a specific composed

desire, represented as ‘d(x1, x2, x3, x4, x5, x6, x7, x8)’.

_x0,x1,x2,x3,x4,x5,x6,x7,x8:SCALE
tom_selfinterest(x0) _ tom_care(x1) ^ aggressiveness(x2) _ desire_to_cope_with_anxiety(x3) ^ desire_to_ignore_anxiety (x4) ^ desire_for_actions_with_ strong_stimuli(x5) ^ impulsiveness(x6) ^ emotional_attitude_towards_others(pos,x7) ^ emotional_attitude_towards_others(neg,x8) —›› $_{0\_0\_1\_1}$ desire(d(x1, x2, x3, x4, x5, x6, x7, x8))

LP5a
Desire d(x0, x1, x2, x3, x4, x5, x6, x7, x8) combined with the belief that a certain action will lead to the fulfillment of that desire will lead to the intention to perform that action.
_x0,x1,x2,x3,x4,x5,x6,x7,x8:SCALE _a:ACTION
desire(d(x0,x1, x2, x3, x4, x5, x6, x7, x8)) ^ belief(satisfies(a, d(x0,x1, x2, x3, x4, x5, x6, x7, x8))) —›› $_{0\_0\_1\_1}$ intention(a)

LP5b

The belief that there is an opportunity to perform a certain action combined with the intention to perform that action will lead to the performance of that action.
_a:ACTION
belief(opportunity(a)) ^ intention(a) —›› $_{0\_0\_1\_1}$ performed(a)

G. THE SUBMODEL FOR THE SOCIETY

LP6

When there is a certain stimulus for the excitement threshold and there is an assault, then the stimulus for the excitement threshold will increase by 25.
_s1,s2:INTEGER
stimulus(s1,s2) ^ performed(assault) —›› $_{0\_0\_1\_1}$ stimulus(s1,s2+25)

LP6a

When the stimulus for the excitement threshold is 1 or higher and there is no assault, then the stimulus for the excitement threshold will decrease by 1.
_s1,s2:INTEGER
stimulus(s1,s2) ^ s2_=1 ^ not performed(assault) —›› $_{0\_0\_1\_1}$ stimulus(s1,s2-1)

LP6b

When the stimulus for the excitement threshold is 0 and there is no assault, then the stimulus for the excitement threshold stays 0.
_s1:INTEGER
stimulus(s1,0) ^ not performed(assault) —›› $_{0\_0\_1\_1}$ stimulus(s1,0)

LP6c

Each stimulus is observed.

$\forall$ s1,s2:INTEGER
stimulus(s1,s2) _
$_{0\_0\_1\_1}$ observes_stimulus(s1,s2)

VII. CONCLUSION

As information science and technology progress, sophisticated data mining and artificial intelligence tools are increasingly accessible to the law enforcement community. These techniques combined with state-of-the-art Computers can process thousands of instructions in seconds, saving precious time. This paper focuses on developing a violent criminal behavioral analysis tool for present scenario using different data mining techniques that can help law enforcement department to efficiently handle criminals.

REFERENCES

[1] Abraham, T. and de Vel, O. Investigative profiling with computer forensic log data and association rules, Proceedings of the IEEE International Conference on Data Mining -ICDM'02, (2002) pp. 11-18.
[2] Keyvanpour, M.R., Javideh, M. and Ebrahimi, M.R. Detecting and investigating crime by means of data mining: a general crime matching framework, Procedia Computer Science, World Conference on Information Technology, Elsvier B.V., Vol. 3 (2010) 872-830.
[3] Ozkan, K. Managing data mining at digital crime investigation, Forensic Science International, Vol. 146 (2004) S37-S38.
[4] Paul Ekman. 1992. An Argument for Basic Emotions.Cognition and Emotion, 6:169-200.
[5] Roy F. Baumeister, Nathan C. DeWall, Kathleen D. Vohs and Jessica L. Alquist. 2009, Does Emotion Cause Behavior (Apart from Making People Do Stupid, Destructive Things)? In Christopher R. Agnew, Donald E. Carlston, William G. Graziano, and Janice R. Kelly (eds.). Then a Miracle Occurs: Focusing on Behavior in Social Psychological Theory and Research. 119-137. Oxford University Press, New York, USA.
[6] Bosse, T., C.M. Jonker, and J. Treur. 2007. Simulation and analysis of adaptive agents: an integrative modelling approach. Advances in Complex Systems Journal 10, 335–357.
[7] Tibor Bosse, Charlotte Gerritsen & Jan Treur, "Towards integration of biological, psychological and social aspects in agent-based simulation of violent offenders," Simulation, vol. 85(10), pp. 635 - 660.