THOUGHTFUL DISCUSSION ON DATA MINING TRENDS AND APPLICATIONS IN CRIMINAL SCIENCE AND INVESTIGATIONS

This chapter provides an overview of the various topics discussed in the chapters presented in this edited book, considering the fact that achieving crime reduction and criminal apprehension targets in resource-constrained settings require a paradigm shift in the minds of crime data mining researchers. Current trends indicate that several challenges, such as developing scalable programming models, as well as efficient and effective hybrid approaches for strategic or tactical crime analysis, persist in this domain and need to be addressed. Such challenges necessitate the development of more intuitive intelligence investigation techniques for crime pattern and situation recognition, in order to foster proactive safety solutions by the security agencies, public safety and law enforcement authorities.

The aim of producing an edited book on data mining trends and applications in criminal science and investigations is motivated by the need to understand the nature, scope and limitations of existing crime mining solutions across different domains and suggest new intervention strategies for a more inclusive solution for public safety improvement. This is particularly important for resource-constrained environments as it is noted, from observational evidence, that the ever growing population and assets, often times, tend to overshadow the available security and public safety agencies. In addition, the advancement in information and communication technology has led to the emergence of a wide set of applications, in order to meet up with daily operational needs across different domains. For example health-care applications, which sometimes exhibit significant security weaknesses as rightly pointed out by the authors, Ellouze et al., In Chapter 8. These applications also give room for offenders to perpetuate different kinds of crime such as cyber-crime, Denial of Service (DoS) and intrusion related offences. These developments have necessitated the need to develop more intuitive solutions for deterring crime across domains. Furthermore, empowering future criminal justice systems requires better insight into the Modus Operandi of criminals, as well as the dynamic mode of offenders behaviour as explained by Ghaziasgar et al. in Chapter 5. The authors
investigate the automatic detection of micro-expressions from a video feed, which have been reported to be strong indicators of deception, in order to empower the future criminal justice system.

More generally, applying data mining techniques in the field of criminal science and investigation has culminated into a field known as crime data mining. The crime data encompass textual, image, and multimedia data. The goal of crime data mining is to discover interesting, non-trivial and potentially useful information, which can assist in decision support, crime investigation, prediction and control across different domains of life. The ultimate safety goal is to reduce and/or deter criminal activities. There are two fundamental theories in environmental criminology, crime pattern theory and routine activity theory, which try to explain the motivation for perpetrating crime. However, it is crucial to further investigate other intrinsic factors that contribute to the different crimes committed, for actionable solutions. Therefore, this book presents solutions that take all of these important factors into consideration, in order to empower the future criminal justice system and promote the realisation of public safety targets. Effective interventions to promote public safety in resource constrained environments can be realised through rather unconventional approaches to public safety solution model.

In some scenarios depicted by some of the solutions presented in this book, one might note that actionable and viable solutions require slight modifications to some of the parameters in the solution model, while certain other instances require a completely different intervention strategy. More generally, a user’s application requirements and preferences determine the choice of appropriate methods or techniques to adopt in solving a crime problem. While actionable solutions could be derived from crime data information, it is important to recognise that in certain cases, a high level of missing data values may drastically affect crime prediction accuracy or the solution model. In other cases, the non-disclosure agreement constraint on releasing crime information to crime analysts or researchers makes it impractical to gain full access to real crime data. This has an implication of making the adoption of advanced, automated and computerised approaches of analysis to facilitate crime investigation and prediction in resource constrained settings conservative.

In public safety modeling and predictive policing, we note that there are several advantages to be derived in spatio-temporal related analysis, such as hotspots detection, for Knowledge support. This is noted in various related chapters such as in Chapter 3, where Ku et al. provide an insightful discussion on how the combination of visualization techniques with text and data mining tends to offer added benefits in crime data analysis. Moreover in Chapter 4, Eftelioglu et al. report on
a computational perspective to crime hotspot analysis and detection using spatial
scan statistics, with a focus on statistically significant hotspot detection techniques
that aim to remove chance patterns. We observe that while several research have
investigated hotspot and spatio-temporal related problems, there is still room for
exploring crime spree and/or series-like detection, which is a set of crime thought
to be committed by the same set of offender. This type of analysis takes a deeper
and more careful look into the modus operandi of offenders. Isafiade et al. gave
some insights into such an analysis in Chapter 6, through their discussion on the use
of Bayesian Network (BN) in crime suspect modeling and legal decision support.
Identifying an ongoing spree or series is of significant importance for predictive
policing and crime control.

In conclusion, we investigate intrusion detection challenges within dynamic en-
vironments and its contribution in digital investigation, as well as distributed denial
of service (DDoS) attack detection. These sought of challenges are prominent due
to the emergence and wide acceptance of Internet-of-things (IoT). In today’s world,
the IoT is of practical significance in the daily human activities and engagements.
The downside is that IoT has also created opportunities for offenders to perpetuate
related crimes. Authors in Chapter 9, Keyvanpour et al., note that the prevalence
of the online conversations have motivated the need for mitigating the undesirable
effects of child abuse in cyber space. Therefore they present a system for the auto-
matic identification of online predators in social networks, and further identified:

1. Detecting predators, and
2. Visualising and analysing predator criminal networks as two major predator
   identification problems in which data mining plays an important role.

Machaka et al., in Chapter 10, provide a discussion on data mining techniques
for DDoS attack detection. They focus on the characteristics and pervasiveness of
DDoS attacks, as well as motives, mechanisms and techniques used to execute a
DDoS attack.

Current state-of-the-art approaches to crime data mining are generally amenable
to scalable and efficient computational implementations, which researchers can
further explore. In public safety modeling, predictive policing and crime data min-
ing, the need to develop scalable solutions for massive geographical data coincides
with the need to develop solutions for incomplete, noisy or heterogeneous sources
of data, for crime situation recognition.

Potential avenues for future research in the domain of applying data mining
techniques in criminal science and investigations include the following:
1. Reassessing existing solutions for suitability and possible extensions to suit emerging dynamic scenarios.
2. Deriving more intuitive intelligence investigation solutions and framework, in order to gain insight into dynamic crime trends and promote the realisation of safety targets across different domains.
3. Developing scalable, effective and efficient solutions for strategic and/or tactical crime analysis.

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