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Knowledge Representation Model for Crime Analysis

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Abstract

The knowledge representation model is a particular way in representing knowledge by using the knowledge and reasoning mechanism. Ontology is a kind of knowledge representation model that represents knowledge as a set of concepts within a domain and the relationship between these concepts. It is important to solve the problem of large amount of data in the crime investigation domain which is not well defined in a proper relation. The problems exist currently are how to develop an ontology model to represent the crime investigation information and how to make good use of the information represented by the model. These problems could be solved by developing an ontological-based case matching model, named CrimeAnalysis as a study prototype. In this study, an ontology model is developed using the selected semantic modelling tool, named TopBraid Composer Standard Edition in order to represent the crime information with the well-defined classes and relationships. This would help to save the investigation officer's effort in aiming and targeting the possible suspect within the shortest time interval.

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1. Introduction

Today, the ever-increasing amount of useful information is being created, either in textual or non-textual form. The useful information that is being retrieved could be potentially perceived as representing and transformed into knowledge. Knowledge is context enriched information that could be used or applied to solve problems in a domain. It could be represented using model, known as a knowledge representation model (KRM). KRM can be expressed as a particular way of representing knowledge that will allow the prediction of what a system knows and what is capable of with knowledge and reasoning mechanisms¹. There are many types of knowledge representation models such as distributed, symbolic, probabilistic, ruled based and ontology.

Ontology is a conceptual specification². It formally represents knowledge as a set of concepts within a domain. Ontology uses a shared vocabulary to denote the types, properties and interrelationships of those concepts. Ontology also offers a shared and common understanding of some domain that could be communicated across different application systems and people. It plays a major role in supporting information exchange process in various areas and is now widely used in artificial intelligence, biomedical informatics, the semantic web, system engineering, forensic data analysis and information architecture as a form of knowledge representation³.

Forensic data analysis is defined as the process of understanding, re-creating, and analyzing arbitrary events that have previously happened⁴. It is a process of searching the answer of how an incident happens and who is getting involved in the incident. Also, it is defined as the derivation of information for use in court for judgment. According to the study presented by Purdue University, there are seven (7) categories in the field of forensic analysis, namely entomologist, odonatologist, psychologist, anthropologist, cyber forensics, toxicologist and forensic engineering⁵. With the advancement of science and technology nowadays, many different types of forensic analysis are being discovered such as bloodstain patterns, deoxyribonucleic acid (DNA) and handwriting.

According to⁶, new ways of knowledge representation and information extraction are needed in the complex and dynamic crime investigation domain. In crime investigation, the data that pattern the criminal event and its investigation, known as the crime analysis information is very important in revealing the criminal offense. However, the current system of a recording nature only keeps the criminal records, card files and databases⁶. It does not construct the information meaningful and therefore it is insufficient in providing the information for crime investigation. As a result, without a proper KRM to represent the crime investigation knowledge in an organized and meaningful ways, it would be hard for the investigation officer (IO) to analyze the related information and make a proper decision during the investigation process.

Based on the problems described above, there is a great need to develop an ontological-based case matching model where the IO could first acquire the related motorcycle theft information from the ontology model with a well-structured form and understand the relationships between the information easily. Later, the output obtained from the ontology model could be applied into the prototype that consists of a case matching mechanism where the IO would be able to input the key data of a new case into the system. The system would match the newly input data with the data records in the ontology model. If the data match with previous cases, it would return the case id of the stored cases to the IO as a reference. This would help to save the IO's effort in aiming and targeting the possible suspect within the shortest time.

Therefore, in this research two problems have become the focus. The problems are: (i) how do we develop a knowledge representation model, (ii) to represent the crime investigation information and how could we make good use of the model's output to assist the investigating officers (IO) in aiming the targeted suspects based on the previous case records. So that, at the end of this study, it will present an ontological-based knowledge representation model and data analysis to be applied in the crime investigation domain. The rest of the paper is organized as follows. Some related works are discussed in Section 2. Section 3 discusses the materials and methods used, containing developing a framework and model used in this study. Section 3, the results produced are presented and discussed. Finally, the conclusion of the study is concluded in Section 4.

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