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Ontologies for intellectual property rights protection

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ABSTRACT

Pirating various forms of intellectual property (IP) causes great economic loss to intellectual property rights (IPR) holders. IPR protection is becoming a key issue in our highly networked world. In order to further deepen our understanding of how to protect IPR and enhance information interchange and knowledge sharing among related entities, ontologies for IPR protection are proposed. This study contains three parts, which are developed to deal with different perspectives in this domain. The first part presents a static ontology, i.e. a hierarchy framework for the domain language, including primarily classes of participants, classes of IP works, classes of activities, and relations between these classes. In the second part, a dynamic ontology is shown to illustrate the IPR protection process. Thirdly, a causal map is used to demonstrate how classes of IPR protection methodologies are causally related with classes of IP piracy methodologies. Finally, the case of Tomato Garden is offered to demonstrate how the proposed ontologies are used in the real world. In respect of the ontology, it is first helpful to gain a comprehensive understanding of domain knowledge of IPR protection; second, IPR protection systems' design and development in this domain are facilitated and supported by these ontologies; third, the proposed ontologies are united in the Ontology Web Language (OWL) and the OWL rules languages framework, both of which are machine readable.

1. Introduction

The World Intellectual Property Organization (WIPO), defines intellectual property (IP) as creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. IP is divided into two categories: Industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and Copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs (WIPO, 2004).

IP allows people to own their creativity and innovation in the same way that they can own physical property. The owner of IP can control and be rewarded for its use, and this encourages further innovation and creativity to the benefit of everyone. Often, more than one of the above protection types may apply to the same creation.

Innovation in information technologies and network communications offers people a great opportunity for the widespread and efficient utilization of IP works through various channels. As well as enjoying the convenience of worldwide information sharing, however, the entire society is faced with the issue of violation of IPR. IPR violation overlaps with issues of commercial domain, legal domain and technical domain – piracy of software, audio, database, books, reverse engineering of marketed hardware as well as theft of sensitive commercial designs by competing corporate entities. The piracy of IP works is a major form of IP violation. The International Intellectual Property Alliance (IIPA) estimated the annual loss of revenue in the US business software industry due to piracy at US$14273 million, and in the record and music industries at US$1486.9 million, for the financial year of 2009, as reported on 18 February 2010 (IIPA, 2010). It is also worth noting that a large portion of Internet bandwidth (approximately 30%) is consumed by users exchanging illegal copies of digital media (mainly video). It is certain that there will always be people with enough motivation to illegally use IP works by circumventing protection mechanisms (Vassiliadis & Fotopoulos, 2007).

It is the goal of our paper to propose ontologies that illustrate the domain knowledge about IPR protection. The paper is comprised of three parts. The first part, which is represented using the description logic variant of the Web Ontology Language (OWL DL), provides a static ontology, i.e. a hierarchy framework for the domain language, including primarily classes of participants, classes of IP works, classes of activities, and relations between these classes. It constitutes a specification of the domain-specific concepts of classes, entities, properties, and activities as a set of relationships that exist among these vocabulary terms. In the second part, a dynamic ontology is presented to illustrate

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the IPR protection process. Thirdly, a causal map is used to demonstrate how classes of IPR protection methodology are causally related with classes of IP pirate methodology, which can be written as rules using the OWL rules language (Horrocks, Patel-Schneider, Bechhofer, & Tsarkov, 2005). The ontology in the paper provides not only a formal description of objects in the domain knowledge and shared terminology, but also a formal basis for reasoning domain knowledge. Thus on the basis of the ontologies, it is first helpful to gain a comprehensive understanding of the domain knowledge of IPR protection; second, IPR protection systems' design and development in this domain are facilitated and supported by this ontology. The proposed ontologies are then united in the OWL and the OWL rules languages framework, both of which are machine readable, part of which is shown in Appendix A.

The rest of the paper is organized as follows: Section 2 illustrates the related techniques, i.e. ontology, OWL DL, and OWL rules language; the details of static and dynamic ontologies are presented in Section 3. The causal map in the domain will be proposed in Section 4. In Section 5, the Tomato Garden case is analyzed using the proposed ontologies. Finally, conclusions are presented in Section 6.

2. Background

2.1. Related works

In order to solve the problem of IPR violation, many digital rights management (DRM) systems are proposed in literature. Some significant references include: Camp (2003), illustrating first principles of copyright for DRM design; Torres, Serrao, Dias, and Delgado (2008), offering an analysis of the various methods for implementing interoperable digital rights management platforms; Jamkhedkar and Heileman (2008), analyzing the problems with current DRM environments and proposing an open layered framework for the development of DRM systems; Thomas, Emmanuel, Subramanyam, and Kankanhalli (2009) proposing a joint digital watermarking scheme using the Chinese remainder theorem for the multiparty multilevel DRM architecture; and Lee et al. (2005), for designing a contents distribution framework that supports transparent distribution of digital contents on the Internet as well as the copyright protection of participants in the contents distribution value chain. A useful analysis of DRM business models, standards, and core technologies can be found in Koenen, Lacy, MacKay, and Mitchell (2004), Ku and Chi (2004), Cohen (2003), and Felten (2003). The increasing use of mobile devices has also initiated research efforts for mobile DRMs (MDRMs); technological challenges in this area differ from classic DRM and include mobile device limitations, bandwidth, usability, among others (Chen, 2008; Lee, 2007). Many companies, organizations and administration-funded projects provide solutions for the implementation of DRM systems, which has given rise to a boom in commercial DRM systems, such as the Adobe e-book for pdf documents, the IBM cryptolope (Kaplan, 1996), the ambitious DigiBox technology by InterTRust (Kohl, Lotspiech, & Kaplan, 1997), Microsoft's Windows Media Player for audio/video, and Digimarc's family of products for video/audio and still images, to name a few. Nevertheless, although these solutions have several aspects in common, they are incompatible in terms of architecture and system components. Moreover, efforts that facilitate copyright management in closed domains experience great difficulty when they are forced to interoperate in an open domain like the World Wide Web. In order to facilitate interoperation and automation, DRM systems can be enriched with domain formalizations.

There are many other initiatives to build an IPR framework for the Internet-wide management of IP works; for instance, MPEG-21 (MPEG, 2002) or, in the W3C (World Wide Web Consortium) initiatives framework, the ODRL (Open Digital Rights Language) proposal (Iannella, 2002). Most of these initiatives have one thing in common: they work at the syntactic level. Their approach is to formalize XML DTDs (Document Type Definition) and Schemas that define a rights expression language (REL), such as the MPEG-21 REL (MPEG, 2003). In some cases, the semantics of these languages, i.e. the meaning of the expressions, are also provided but formalized separately as rights data dictionaries (RDD); for instance, MPEG-21 RDD (MPEG, 2003). Rights dictionaries define terms in natural language, solely for human consumption; for this reason it is not easy to automatically process those terms. However, the syntactic approach does not scale well in really wide and open domains like the Internet. The automatic processing of a huge amount of metadata coming from many different sources requires machine understandable semantics. The syntax is inadequate when unforeseen expressions are encountered, which is where semantics can assist with their interpretation to achieve interoperation.

Delgado, Gallego, Llorente, and García (2003), proposed an ontology for DRM which concentrates only on some aspects of IPR protection, in particular, the concepts of IPR Agreement, including Contract and License, and some specific rights, such as exploitation or moral rights. A copyright ontology is implemented in García and Gil (2006), using OWL DL. This approach facilitates the implementation of efficient usages against license checking, which is reduced to description logics classification. In order to support the whole copyrighted content value chain across enterprise or business niches boundaries, García and Gil (2010) provides a framework that accommodates copyright law and a rich creation model in order to cope with all the creation life cycle stages. The dynamic aspects of value chains are modeled using a hybrid approach that combines ontology-based and rule-based mechanisms. These ontologies were constructed from a rights management point of view; in particular, the concepts of Contract and License. Nevertheless, there is a need for a more comprehensive ontology to illustrate the IPR protection issue.

2.2. Ontology

As a branch of philosophy, ontology is the study of the kinds of things that exist. It is often said that ontologies 'carve the world at its joints' (an expression commonly attributed to Plato). In the artificial intelligence (AI) community, the term ontology is used to refer to a set of representation vocabulary, and, more precisely, it is the conceptualizations in a domain that the terms in the vocabulary are intended to capture (Chandrasekaran, Josephson, & Benjamins, 1999). According to Sowa, knowledge representation can be defined as the application of logic and ontology to the task of constructing computable models of a domain (Sowa, 2000). Concerning the nature and relations of being, ontologies can be used as critical components in knowledge management and have huge potential to improve information organization, management, and understanding.

In order to further deepen our understanding of IPR protection issues and enhance information and knowledge sharing among related entities, ontologies for IPR protection issues are proposed in this study. Jurisica, Mylopoulos, and Yu (2004), have classified ontologies into four broad categories: static, dynamic, intentional, and social. Two of these ontologies will be considered here: those that deal with static and dynamic aspects of IPR protection issues. Static ontologies represent the static aspect and define the basic concepts of IPR protection issues, while dynamic ontologies deal with knowledge regarding the IPR protection process. This paper will also discuss the implementation level at which OWL and OWL rules languages are used to represent these ontologies in a machine-readable form.