Chapter 2
Development of a Knowledge Based System for an Intensive Care Environment Using Ontologies

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ABSTRACT

In intensive care units (ICUs), clinicians must monitor patients' vital signs and make decisions regarding the drugs they administer. The patients' lives depend on the quality of these decisions but experts can make mistakes. Recent technological strategies and tools can decrease these errors. In this paper, the authors describe the development of a knowledge based system (KBS) to provide support to clinicians with respect to the drugs they administer to patients with cardiopathies in ICUs to stabilize them. To develop the system, knowledge from medical experts at the Meixoeiro Hospital in Vigo (Spain) has been extracted and formally represented as an ontology. As a result, a validated KBS has been obtained, which can be helpful to experts in ICUs and whose underlying knowledge can be easily shared and reused.

INTRODUCTION

During the past few decades, the development of new technological advances and tools in the field of medicine has helped clinicians to make complex decisions in critical situations. When a patient enters an intensive care unit (ICU), either after surgery or due to a serious clinical condition, his vital signs change continuously, forcing the medical expert to make rapid decisions, which frequently imply modifications on the dosage of drugs being supplied.

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This kind of care requires the intervention of highly specialized and trained health personnel, and particularly the continuous monitoring of the parameters on the monitors showing the patient's condition, due to the serious situation of the patient and the important repercussions these drugs cause.

According to the values of the patient's vital signs, the kind of drug is selected by the doctor and, on the basis of his evolution, the amount or type of drug may be modified. The decision making process to determine the variation of drug dosage necessary to stabilize the patient's clinical situation is a complex task that requires exhaustively (but rapidly) analyzing the evolution of a large set of parameters within a period of time. An intelligent tool may be useful to support clinicians in this process.

One of the multiple subareas of Artificial Intelligence (AI) is concerned with de development of a special class of computer systems that use expert knowledge to assist humans in performing specific intellectual tasks. This kind of systems, which were born in the 70s, are widely known as knowledge based systems (KBSs) or expert systems. Since KBSs were born, one of their main fields of application has been, and is medicine. Generation of real time alarms and notifications, diagnosis support, detection of errors and inconsistencies treatment plans, or recognition and interpretation of medical images, are some examples of the different roles that KBSs may play in medicine.

KBSs are very effective to analyze large amounts of data, interpret them and provide a recommendation on the basis of these data as soon as possible. However, one of the main problems of these systems is related to knowledge representation. Knowledge they use to make decisions is often represented using traditional strategies, which make it difficult to share with other experts around the world or to be reused by other similar systems.

At late 80s, ontologies started to gain popularity in the field of AI as a good way to share and reuse knowledge. The word *ontology* (from the Greek *ontos*=being and *logos*=science, study, theory) comes from Philosophy, where refers to "the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality" (Smith, 2003). Ontologies were originally used by ancient Greek philosophers to name and classify the things they saw in the universe and the relationships between them. Besides the philosophical point of view, towards the end of the 20th and the beginning of the 21st centuries, ontologies emerged as an important research field in computer science.

There are several definitions of ontology in AI, which have evolved over the years. However, one the most precise and complete definitions provided up to date is the one given by Studer and colleagues in 1998, who stated that "An ontology is a formal, explicit specification of a shared conceptualization" (Studer, Benjamins, & Fensel, 1998).

At present, ontologies are viewed as a practical way to conceptualize information that is expressed in electronic format, and are being used in a variety of applications, including the Semantic Web, bioinformatics and biomedicine, natural language processing, intelligent information integration or e-Commerce, promoting a better data interoperability and reuse.

The basic idea behind these applications is to use ontologies to reach a common level of understanding or comprehension within a particular domain (Gómez-Pérez, Fernández-López, & Corcho, 2004). In contrast to syntactic standards, understanding is not restricted to a common representation or structure. Ontologies go beyond, providing the support to reach a common understanding of the meaning of terms.

Unification of medical terminology is a well known problem. Nowadays, there are large amounts of medical information stored using different terminologies and formats all around the world, and it constitutes an important barrier to process and reuse it in an integrated manner. Due to this, developing methods and technologies to