# Chapter 7

# An Ontology-Based Expert System for Financial Statements Analysis

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## ABSTRACT

*Financial statements provide the main source of information for all parties who are interested in the performance of a company, including its managers, creditors, and equity investors. Although each of these parties may have different perspectives when viewing financial statements, all parties are concerned with the financial quality of an enterprise, which requires carefully analyzing financial statements to estimate and predict future conditions and performance. When analyzing financial statements, due to the complexity of the task, even professional analysts may be subject to constraints of subjective views, physical and mental fatigue, or possible environmental factors, and are not able to provide consistent appraisals. As a result, researchers and practitioners have resorted to expert systems to imitate the decision processes and inferencing logics of financial experts.*

## EXPERT SYSTEMS

An expert system is a computer program that is constructed by obtaining problem solving knowledge from a human expert and coding it into a form that a computer may apply to similar problems (Giarratano & Riley, 2005). The reliance on the knowledge of a human domain expert for the system's problem solving strategies is a major feature of expert systems. It was developed by researchers in Artificial Intelligence in the 60s and 70s and was commercialized in the 80s. There have been many innovative applications in handling knowledge in business, management, science, engineering, medicine, and military. One of the latest comprehensive studies in the

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applications and methodologies of expert systems can be found in Liao (2005). An expert system is generally structured to consist of knowledge base, database, and rule interpreter (inference engine). The knowledge base holds the set of rules of problem-solving that are used in reasoning, which contains both factual and heuristic knowledge. Factual knowledge is the knowledge of the task domain that is widely shared, typically found in textbooks or journals, and commonly agreed upon by those knowledgeable in the particular field. Heuristic knowledge is the less rigorous, more experiential, more judgmental knowledge of performance. In contrast to factual knowledge, heuristic knowledge is largely individualistic; it is the knowledge of good practice, good judgment, and plausible reasoning in the field. In the terms of Artificial Intelligence, the former is the domain knowledge of a problem domain, and the latter is the operational knowledge that uses domain knowledge to reason to generate new facts. Most systems use IF-THEN rules to represent both types of knowledge. The database provides the context of the problem domain and is generally considered to be a set of useful facts. These facts are used to satisfy the condition part of the action rules. The rule interpreter is often known as an inference engine and controls the application of knowledge base via the facts of database to produce even more facts.

One major issue with the traditional expert system methodology lies in the fact that all knowledge, whether it be domain knowledge or operational knowledge, is usually mixed together to form a "knowledge base". Thus, both types of knowledge are usually blended together in knowledge rules. Such a design, as reported in many cases, may hinder knowledge engineers' ability to express deeper relationships among knowledge items and, specifically, the knowledge that is semantic in nature. In addition, it may lead to inefficiency when the domain becomes large or the operational knowledge becomes complex (Lee & O'Keefe, 1996; Davis, 1990; Yao *et al*., 2003; Chan & Johnston, 1996). From the perspective of knowledge management and system management, it will be a better design by separating the domain knowledge from operational knowledge (Chan, *et al*., 2002; Bobillo *et al.,* 2009).

In the following section, we separate the inherent knowledge of financial statements from the knowledge of analytical process of rating assessment. The analytical process emphasizes very much on the "meaning" between accounting items, we thus recommend the application of Ontology methodology to develop the domain knowledge of financial statements. Ontology is more capable of establishing semantic relationships among accounting items, which are essential in addressing various managerial concerns during the reasoning process.

## ONTOLOGY

The word "ontology" was taken from philosophy, where it means a systematic explanation of beings. In the last decade, the Knowledge Engineering community has adapted the word "ontology" to refer to a systematic analysis and representation of knowledge of some domains of interest, so that it can be shared by others. The most often cited ontology definition is from Gruber, "… an ontology is a formal, explicit specification of a shared conceptualization" (Gruber, 1993). 'Conceptualization' refers to an abstract model of phenomena in the world by having identified the relevant concepts of those phenomena. 'Explicit' means that the type of concepts used, and the constraints on their use are explicitly defined. 'Formal' refers to the fact that the ontology should be machine readable. 'Shared' reflects that ontology should capture consensual knowledge accepted by the communities. While this is a very general definition, Noy *at al*. (2000) provide a more specification definition for application: "an ontology is a formal explicit representation of concepts in a domain, properties of each concept