

Chapter 11

Ontology Modelling for Metallurgy as a Domain and Retrieval Using Particle Swarm Optimization: Conceptualization, Modeling, and Retrieval

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1. INTRODUCTION

Ontology is a storehouse of knowledge that helps in various fields of life like Research, Education, Teaching, etc. This work intends to develop an ontology for the extraction of multiple metals from their constituent ores, which is also called as metallurgical extraction. Metallurgy is a critical science which perhaps enabled humans to civilize and use tools. The earliest metal use by humans is found to be gold, which was used in circa. 40,000 BC. At the beginning of the chalcolithic age, man began to use copper tools which were of great help as he no longer had to throw stones and also copper was sharper and had many more uses. A new era was established when man discovered the secret of making iron tools. History tells us that with the discovery of iron, there was no turning back. A new human era had been born where a man was smarter and knew how to defend himself wisely. This tells us how metals have turned the course of entire human history. From stone-throwing beasts, we became iron using humans. Metals are almost in everything we use, and yet, we do not acknowledge their importance. This work will be helpful to those who want to learn about metallurgical extraction processes.

Metallurgical processes differ from metal to metal because of the different types of ores involved. There are different processes for different metals due to the difference in their properties and the different types of ores. So, building an Ontology for Metallurgical processes is a difficult task due to the degree of variation in the domain and also the exceptions. Here, in this work, we use the Ontology Development 101 (Noy & McGuinness, 2001) model to develop the ontology. The domain knowledge is extracted from the various reliable sources of the metallurgical domain, and the concepts are accurately given the semantic description suitable to them and are included in the ontology. After completing the domain analysis, the semantic description of the concepts is studied, and they are modelled as prospective classes which are to be linked with each other through proper relation defining arrows. This enables the development of the taxonomy of the ontology which can be conceptualized and implemented in XML format. After strategically defining and implementing the classes, the objects for them are defined, and the entity graphs for the objects are generated by linking them to the respective parent classes and even defining the other properties of the objects. The ontology is modelled using some suitable ontology modelling software like Protégé and is visualized by using the WebVOWL tool. The ontology is retrieved using the concepts of machine learning tools and algorithms which are selected based on their efficiency to retrieve the particular topic. For the retrieval of Metallurgy based ontology, a hybrid form of the Particle Swarm Optimization algorithm is used, which is one of the best methods for the retrieval of Chemistry-based Ontologies. The retrieval method is evaluated, and the Precision, Recall, Accuracy and F-measure of the algorithm is

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