Creating ontology chart of economic objects: The application of Menger’s ideas

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Processing data is one of the main concerns of almost every field of study which deals with information. But today with the growing data and information a new delicate problem arises: “processing” knowledge. One way to start solving it is by categorizing knowledge; then trying to manage these knowledge categories according to the interest of the field of study; and finally implementing them into a problem-solving platform such as a software program, a webpage or merely in a new algorithm. Ontologies come in handy in one of the key links of this chain: knowledge management. In this paper we show the how to use ontologies for data and knowledge management and how they can be applied in formalizing economic concepts. We did this classification according to Menger’s ideas.

Keywords: Knowledge management, ECOntology, economic concepts, categorization.

Introduction

Ontology defines the terminology of a domain: it describes the concepts that constitute the domain, and the relationships between those concepts. Any information system uses its own ontology, either implicitly or explicitly. As applications become increasingly complex we can observe a trend towards the explicit representation and management of ontologies. Ontologies have emerged as one of the key issues in the integration of information and the interoperability of systems, and their application to knowledge management. The existence of a common set of definitions of terminology, a common ontology, makes the interoperation of different information systems much easier. This is the approach taken by many researchers in information integration. Moreover, ontologies are useful in information retrieval, where the use of the right keywords is critical for the successful processing of a user query.

In philosophy, ontology is the study of existence, or a description of what exists. In information systems and artificial intelligence, the word ontology refers to the terminology of a system or, to be more precise, an explicit specification of a conceptualisation: “the objects, concepts and entities that are assumed to exist in some area of interest, and the relationships that hold among them”. As a minimum, ontology will define taxonomic relationships and some other constraints on terms. While the purpose of ontology is to define terminology, the form of ontology is that of a knowledge base or database conceptual schema.

The ontology we are going to present can be considered a kind of base ontology, since it starts from the very concepts of Economy. After we have built a base ontology we can include in it as many specific ontologies as we need. Ontology-based systems as every dynamic system expand continuously and need to merge different specific ontologies in one large ontology. This represents a real challenge for the ontology engineer. Nowadays the process of merging ontologies is a manual process which is very time-consuming. There are some techniques but they are still part of the theoretical scientific research.
Formal definition of ontologies and components

Generally we refer to ontologies as a graph composed of:
1. A set of concepts (vertices)
2. A set of relations that connect concepts (oriented edges)
3. A set of instances associated to concepts

Formally speaking, ontology is defined as the structure $O = (C, T, R, A, I, V)$. It consists of the set of concepts ($C$), types ($T$), relations ($R$), attributes ($A$), instances ($I$) and values ($V$). Such a theoretical framework can be used to treat ontologies as a function that associates a real number to the ontology $O$ (Fielding, Simon, Ceusters, and Smith, 2004).

### TABLE 1. ONTOLOGY COMPONENTS

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instance</td>
<td>Instances, or individuals (objects) are the basic components and the lowest level in the ontology anatomy. These objects can be people, tables, molecules, and numbers, in our case concepts.</td>
</tr>
<tr>
<td>Concept</td>
<td>In the ontology context, a concept (or class) is everything about which you can say something. This can be a false or a true entity. It can be concrete or abstract, a task, a process, a function, etc. For example, we have the concept Person, Molecule, Number, Class or Thing. Ontologies vary on the fact that classes can contain other classes or not, if a class belongs to itself, if there is a universal class (that contains everything), etc.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Every concept of the ontology can be described by attributes. These attributes enable the modeling of complex relations. If the ontology doesn’t contain attributes for her concepts, than it would not be an ontology but a taxonomy or dictionary. The attributes can be instance attributes, class attributes, local or global attributes. Every attribute at least has a name and a value to store information.</td>
</tr>
<tr>
<td>Relations</td>
<td>Even though ontologies are used widely to label classifying conceptual schemes, a true ontology must describe the entities with “semantic relations” which specify how a concept must relate to another. We say that a relation is an attribute which value is another object in the ontology. The power of ontologies stands in their ability to describe these relations. The set of all relations makes up the semantic of domain. The most used relations of all semantic relations are “part-of” and “is-a”.</td>
</tr>
<tr>
<td>Taxonomies and “the oriented acyclic graph”</td>
<td>After describing conceptual entities the obtained result is more like a “dictionary”. It is very important to add relations between them if we have to carefully “conceptualize” our domain of interest, in our case economic concepts. By adding the relation “is-a” creates a linear taxonomy. If we add the relation “part-of” we see that the simple structure of the tree turns out to be more complex and difficult to be interpreted manually.</td>
</tr>
<tr>
<td>Rules</td>
<td>Logic inferences of the form “if – then”.</td>
</tr>
<tr>
<td>Axioms</td>
<td>Logical forms that all together make up the whole theory that the ontology describes in its own application domain.</td>
</tr>
</tbody>
</table>

Source: Jurisica, Mylopoulos, and Yu, 1999.

The design of an informatical ontology is tightly connected to its philosophical and logical concepts. Building ontology firstly means investigating in details the domain of interest,
defining uniquely its subjects and objects and understanding and analyzing well object attributes and relations between them. At this level it is important to mention that the categorizing moment is a purely formal process.

Today’s ontologies have similar structures independently of the language they use. Let’s see some of the common parts of the ontology ‘body’. It is important to mention that ontologies “do nothing”. The functionality of a computational system that uses ontologies depends not only on the data structures inside the ontology, but also on the software implementation. In the Table 1 we can see the most important parts of the ontologies (Jurisica, Mylopoulos, and Yu, 1999).

**What is an ontology chart?**

One of the significant characteristics of ontology is the hierarchical relationship between classes, as well as looping or cycling of these classes. Looping in this case means a path which ends at the node where it began. The connection between nodes within ontology can represent as a graph where the nodes might be completed or might not be completed.

Ontology charts are a graphical representation of partially order set graph. The major characteristic of ontology chart is hierarchical. The ontology chart can be represented in a acyclic graph pattern. It typically began with drawing trees to represent hierarchies of categories. However, more general acyclic graphs are needed to represent an arbitrary partial ordering, such as the supertype-subtype relation between categories. Figure 1 is a simple acyclic graph, in which some nodes have more than one parent. Such graphs support multiple inheritances, since a node can inherit properties from any or all of its parents. A common convention is to omit the arrows that show the direction of the ordering and to assume that the lower node represents a subtype of the higher node (Poernomo and Tsaramirsis, 2009).

By definition, “Ontology charts are a graphical representation of semi-lattice structures” (Poernomo and Tsaramirsis, 2009). “The nodes of an Ontology chart represent universal affordances and rarely represent particulars. The exception is the Root which is a particular agent often labeled ‘Society’ or “Thing” and located on the extreme left of an Ontology chart, or in the middle. The Root is often dropped in practice but is implied in every Ontology chart” (Siricharoen, 2008). They also describe the concept of ontological dependency as “a relationship known mathematically as a partial order set relation.

**FIGURE 1. THE SIMPLE DIRECTED ACYCLIC GRAPH (DAG)**

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Ontologies can be reused easily since they might be provided online as an ontology library or through a semantic search engine. However, ontologies are mostly found in description or text version in XML or OWL syntax. Since ontologies can be difficult to understand by non-expert users, this paper makes use of economy concept as an example to draw out an ontology class.

Another benefit of ontology is that it can be shared, reused through the development of domain knowledge. Currently, there are many ontologies editor available; however, Protégé might be the tool that is easiest to understand among other ontology editors such as OntoEdit, Ontolingua, and Chimaera. As explained by the Protégé official web site, “Protégé is an open-source tool developed at Stanford Medical Informatics. Protégé is one of the most widely used ontology editors with currently. Its extensible open-source platform supports several ontology file formats including CLIPS (Protégé’s native format), various XML dialects, databases, DAML + OIL (DARPA Agent Markup Language + Ontology Inference Layer), and RDF(S). Very recently, storage plug-ins or the Unified Modeling Language UML and OWL have been added”. Protégé is an open source ontologies editor and knowledge-base framework. “Protégé can represent ontologies consisting of classes, properties (slots), property characteristics (facets and constraints), and instances. And it can be used to load, edit and save ontologies in various formats, including RDF, XML, UML, relational databases, and OWL” (Fergerson, Noy, and Musen, 2004). Currently, Protégé serves more than 150,000 community users.

Categorical entities

One thing is for sure: the whole world is a very large set of objects and in this set, there is a variety of object categories. By means of proper relational operations we can extract formally defined structures of a higher order and by doing so we are creating new objects. To our point of view the world matter serves as a basis for categorizing objects. This process can be repeated and so we get other categorical entities. These new categories may form new relations or operations. For example, the electron is an element of the category “Particle”. In this category we have also other elements such as neutrons and protons. Particles are part of the category “Matter” and so on. At the end of our categorizing process the object from where we started is not present any mire. Categorical shaping is a totally intellectual matter even though it deals not with objects from the intellectual world.

Categories play another important role in organizing and simplifying a Knowledge base (Becker, Rosemann, and Úthmann, 2000). First order logic is a key element in the categorical process because it brings near objects and categories by means of these definitions:
- An object is element of a category
- A category is a subclass of another category
- All elements of a category have some properties
- The elements of a category are identified by some properties
- The category as a whole has some properties

Menger’s six categories of economic objects

As we mentioned before, to build ontology we need to have a clear view of the domain of interest. In our case the domain are the economic concepts. Let us see deeper these concepts and try to get a grasp of their meaning, conditions, relations and interactions.

Main concerns of economists deal with macroeconomic phenomena such as unemployment, inflation, etc. There are many conditions that define the state of affairs in the world which need making several economic decisions. At this moment, individuals
view their world as composed of economic objects and facts. A certain individual shapes the world according to the role that these objects have in his plans. Actually the contribution of economists in describing the theory of economics and categorizing economic objects and concepts is poor. An exception is the work of Carl Menger in his “Principles of Economics”, published in 1871. His theory describes six economic objects and laws governing them. According to him, these categories are: economic good, commodity, money, value, price and exchange.

“Economic good”

An economic good exists as such by virtue of putative features that an individual attaches to a thing in relation to an end the individual has in mind. With this end in mind, the thing is either the mediate or immediate means. A good, which can be a consumption or production good, has to fulfill its good character. This character has to do basically with urgency, importance and utility.

“Commodity”

A thing is a good if an agent perceives it to be in direct connection with the fulfillment of a want or need. This is, however, only one side of the coin for, on the other side, a thing must also be supplied in order for it to be acquired. This other side of the coin is what describes the commodity-character of a thing: its availability for sale, exchange, or acquisition, regardless of its “tangibility, mobility, or character” as either a consumption or a production good.

“Money”

In the ‘Principles of Economics’, Menger describes the historical emergence of money. Money is considered a universal medium of exchange as well as a commodity for storing exchangeable wealth.

“Value”

Value is a thorny category because the term ‘value’ is often used in conflicting ways. Of all theories of value, however, economic value theory stands out as the most coherent theory. Ever since the publication of Menger’s ‘Principles of Economics’, economic value has been described as subjective. This category is described by some properties and also has to fulfill the value conditions which are significance, recognition, instantiation.

“Price”

Since price is attached to a commodity, many modern economists refer to price as an objective measure of value. This is somewhat misleading, however, because the objectivity to which they refer is not a feature of price. Menger about this problem writes, “since prices are the only phenomena of the process that are directly perceptible, since their magnitude can be measured exactly, and since daily living brings them unceasingly before our eyes, it is easy to commit the error of regarding the magnitude of price as the essential feature of an exchange, and as a result of this mistake, to commit the further error of regarding the quantities of goods in an exchange as equivalents.” Price, then, is merely an objective magnitude of numerical value. But the putative value of the commodity tagged at a particular price is not equivalent to the price. The putative value is subjectively evaluated by the agent.

“Exchange”

All of the above categories come into definite relations in the category of economic concepts called exchange. Namely, an individual will perceive a thing as a good if it will satisfy a need or want. This evaluation results in the good acquiring significance to the individual which instantiates its economic value. Since the thing is perceived as a good,
then it is available as a commodity offered in exchange for a price. The asking price for
the commodity is an objective magnitude which is expressed in terms of a quantity of
money as the economic term of the transaction. As such, money is the medium for the
exchange. The exchange requires at least two participants (the seller of the commodity,
and an agent who perceives the commodity as a good), a thing (perceived by the potential
buyer as a good, and perceived by the seller as a commodity) with an assigned price, and a
monetary transaction (Smith, 1989).

Creating ontology chart of economic objects

Using ontologies in classifying economic concepts, we bring an approach which is very
delicate since these concepts cannot be formalized so easily. They are very dependent on
the approach of different economic researchers.

According to the above classification of economic concepts we show below these
categories and their properties. All solid connections are relations of the type “part-of”
and all dashed connections are “is-a” relations. We start from the general category “thing”
or “economic object” and then place these categories and their entities in the structural
form shown in Figure 2.
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Doing so we lay the groundwork for the ontological description of economic reality. The objectives of building ECOntology as a fundamental ontology are:

1. To have a common understanding of the information structure between people and agents
2. To process and manage economic knowledge
3. To allow the extension of other economic topics and creating an all-embracing platform
4. To have the possibility of reusing economic knowledge
5. To establish standards that allow interaction and transaction

Conclusions and future work

In this paper we showed what an ontology is, starting from its historical background to its place in Computer Science and then its implementation in a certain domain of interest. Our domain of interest is that of economic concepts. Illustrating ontologies with this kind of domain was not an easy task. This is because of the non-formal nature that field of economy has in general. But by exploring in details how ontologies work, what components do they have and also by having a clear approach of the categories of the domain, we build the first step: the design of the ECOntology. Certainly, from this point and forward is a long way in building a complete and functional ontology of economic objects. This ontology can be extended with many specific ontologies, such as business ontologies, organization ontologies, human resource ontologies, etc., trying to serve mainly as a formal economic ontology or fundamental economic ontology.

This ontology, starting from this simple design to a complete economic ontology can be implemented in a software program and serve in a plethora of ways in all economic topics. Since Albania is currently moving toward the digital era and the process of informatization is one of the main concerns now, this new technology that we propose overpasses current objectives and helps not only public sector but even SMEs because ontologies are nowadays the most effective way of processing data, information and most importantly knowledge.

References


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