Mapping Heterogeneous Ontologies through Ontology Algebra View

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ABSTRACT

Ontology provides a shared and reusable piece of knowledge about a specific domain, and has been applied in many fields, such as Semantic Web, e-commerce and information retrieval, etc. The semantic web technologies, especially Ontologies, pave the way to enhance Knowledge Management (KM) solutions that are based on semantically related pieces of knowledge. Although the semantic web base KM approaches and solutions have shown the benefits of Ontologies and related method, there are many open research issues and problems that have to be addressed in order to make semantic web technologies fully effective when applied to KM solutions. However, building ontology by hand is a very hard and error-prone task. It is believed that the ontology engineering will be a major effort of any future application development. In this paper we describe new methodology for mapping heterogeneous ontologies using ontology algebra and both intermediate and transmit ontology as far as possible between hierarchy of ontologies. This solution has high quality for mapping heterogeneous ontologies when compared with other methodologies.

Key words: Ontology, Ontology algebra, Heterogeneous ontologies mapping, Semantic web.

ترابط الأنتولوجيات غير المنسجمة
من وجهة نظر جبر الأنتولوجيا

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الملخص

تزودنا الأنتولوجيا "Ontology" بإمكانية التشارك، و إعادة استخدام الجزء المعرفي في مجال معين. وقد طُبقت في مجالات عديدة مثل الشبكة العالمية الدلاليـة "Semantic web"، والتجـارة الالكترونيـة والحكومة الالكترونية التي تعد حقلاً تطبيقياً خصباً في هذا المجال، فضلاً عن نتائجه الملموسة في مجـال منهجيات استرجاع المعلومات "Information retrieval". وقد عزز مفهومـا الأنتولوجيـا والـشبكة العالمية الدلالية حلول إدارة المعرفة خصوصاً تلك التي تعتمد علـى المـستوى الـدلالي "Semantic Level"، وقد أظهرت الأنتولوجيا والمنهجيات المرتبطة معها الفوائد الجمة في المـساهمة فـي وضـع حلول مهمة جداً لتلك المسائل المفتوحة في مجال الشبكة الدلالية و نظم إدارة المعرفة.

في الواقع إن بناء الأنتولوجيا يدوياً مسألة ليست بسيطة وقد يشوبها الخطأ في كثير من الأحيان. إن كثيراً من الباحثين ينظرون إلى أهمية هندسة بناء الأنتولوجيا على إنها الجهد الأهم في تطوير أي نظـام مستقبلاً.

يقدم هذا البحث منهجية لربط أنتولوجيات غير منسجمة باستخدام جبـر الأنتولوجيـا " Ontology algebra" وكـلاً مـن الأنتولوجيـا الوسـيطية "Intermediate ontology" وأنتولوجيـا الترجمـة "Transmit ontology" عبر البنية الهيكلية للأنتولوجيا. تمتاز هذه المنهجية بأنهـا تتمتـع بدرجـة جودة عالية لربط الأنتولوجيات غير المنسجمة مقارنة بباقي المنهجيات المستخدمة.

الكلمات المفتاحية: أنتولوجيا، الشبكة الدلالية، جبر الأنتولويا، ربط الأنتولوجيا.

1. Introduction

Mapping two ontologies allows combining the knowledge in the two ontologies in order to derive knowledge. On the other hand, interoperability among heterogeneous system remains a serious problem. Researchers in interoperability have been motivated by the growing heterogeneous of computing systems and the need to interchange information and processes among heterogeneous computing systems environment[23]. Sheth identifies systems, syntactic, structural and semantic levels of heterogeneity[18]. The system level includes incompatible hardware and operating systems; the syntactic level refers to different languages and data representations; the structural level includes different data models and the semantic level refers to the meaning of terms used in the interchange. A good example of semantic heterogeneity is the use of synonyms, where different terms are used to refer to the same concept. There are many more types of semantic heterogeneity and they have been classified in [21]. XML has gained acceptance as a way of providing a common syntax for exchanging heterogeneous information. A solution to the problems of semantic heterogeneity should equip heterogeneous and autonomous software systems with the ability to share and exchange information in a semantically consistent way. This can, of course, be achieved in many ways, each of which might be the most appropriate given some set of circumstances. One solution is for developers to write code which translates between the terminologies of pairs of systems. However, this solution does not scale as the development costs increase as more systems are added and the degree of semantic heterogeneity increases. This paper discusses ontology mapping, especially heterogeneous ontology mapping and using ontology algebra to build intermediate and transmit ontologies to solve mismatching of heterogeneous ontology mapping. The rest of this paper is structured as follows: Section 2 presents a background about ontologies and the main systems and techniques in solving mismatching of ontology mapping. Then we define the math meaning of ontology. Section 4 discusses the relationship between ontology and data sources. Section 5 explains the ontology mapping. Section 6 gives general ideas about the heterogeneous mismatching. Section 7 focuses on semantic mismatching. Section 8 discusses the main languages used for semantic web, the most important applications for ontologies mapping. Section 9 defines ontology algebra in view of the research. Section 10 explains the way of solving mismatching and solves heterogeneous ontology mapping. Section 11 compares this technique with others techniques to focus on the positive and negative points of this solution. Finally section 12 concludes the paper.

2. Ontology History and Background

There are many versions of Ontologies definitions, the popular one is :"*an ontology is an explicit, formal specification of shared conceptualization of a domain of interest.*" [9] The word ontology was taken from Philosophy. It is derived from the two Greek words (ontos) meaning "to be" and (logos) meaning "world"[22]. Ontology is the science or study of being. Ontology is the study of what actually is. This word has become relevant for the knowledge engineering community. One of the first definitions was given by Neches and colleagues[14], who defined ontology as follows: an ontology defines the basic terms and relations compression the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary. In general; ontology has strong implications for the conceptions of reality. In computer sciences, an ontology is the product of an attempt to formulate an exhaustive and rigorous conceptual schema about a domain. It is a hierarchical data structure containing all the relevant entities and their relationships and rules within that domain (e.g. a domain ontology), so that it may be a controlled vocabulary that describes objects and the relations between them in a formal way, and has grammar for using the vocabulary terms to express something meaningful within a specified domain of interest. The vocabulary is used to make queries and assertions. Ontologies can represent complex relationships between objects, and include the rules and axioms missing from semantic networks, Ontologies that describe knowledge in a specific area are often connected with systems for data mining and knowledge management. We will refer to the Ontology domain as: "*a domain is just a specific subject area or area of knowledge, like medicine real estate, automobile …etc.*". The problem of ontology matching in open distributed systems has been addressed in Bouquet, Magnini, Serafini, and Zanobini[6] and Doan, Madhavan, Domingos, and Halevy[11], where intelligent techniques based on a Description Logic approach are described, which compare the knowledge contained in different concept ontologies, by looking for semantic mappings denoting similar concepts. Recent research in P2P systems focuses on providing techniques for evolving from basic P2P networks supporting only file exchanges using simple filenames as metadata, to more complex systems like schema-based P2P networks, capable of supporting the exchange of structured contents (e.g., documents, relational data) by exploiting explicit schemas to describe knowledge, usually using RDF and thematic ontologies as metadata.[20]

• Piazza[11]. The Piazza system proposes a solution for the semantic integration of heterogeneous information sources in a distributed framework. Network nodes develop different functionalities according to their capabilities. In particular, nodes with high resource capabilities play the role of mediators in the network. The system implements a hybrid P2P solution: a mediator node receives a set of information sources schemas and executes the semantic integration step to derive an ontology view of the acquired information. A set of mediators can be organized in a hierarchy, unifying their ontologies in a global view. When a mediator receives a query from any host, it consults its own ontology and returns a list of sources eligible to offer an answer to the query. A query can be received and analyzed by more mediators.

•Edutella [15] . In the Edutella project, the P2P model is applied by using the JXTA protocol. The network is segmented into thematic clusters. In each cluster, a mediator semantically integrates source metadata. This approach is an example of hybrid P2P architecture، in that each source sends queries to the mediator of its own cluster, and the mediator returns a list of nodes eligible to offer semantically related information. The effective data access holds in direct network connections among peers. The mediator handles a request either directly or indirectly: directly, by answering queries using its own integrated schema; indirectly، by querying other cluster mediators.

•Swap [5]. The Swap system aims at overcoming the lack of semantics in current Peer-to-Peer systems. To this purpose, an RDF(S) metadata model for encoding semantic information is introduced, allowing peers to handle heterogeneous and even contradictory views on the domain of interest. Each peer implements an ontology extraction method to extract from its different information sources an RDFS (description (ontology) compatible with the metadata model). Such ontologies are used to perform query processing by means of the SeRQL Query Language: peers storing knowledge semantically related to a target concept are localized through SeRQL views defined on specific similarity measures. Views from external peers are integrated through an ontology merging method to extend the knowledge of the receiving peer according to a rating model.[19]

•Edamok [6]. Edamok is a P2P system aiming at realizing knowledge sharing among peer communities of interest federations. The system is based on the concept of context of a peer, to represent the interests of the peer. All peers are equal in functionalities, and every peer can act on the network as a Seeker (when looking for documents and information) or as a Provider (when answering to incoming queries). Peers that agree to appear as a unique entity to the other peers (e.g., if they provide homogeneous contents) can form a federation. In order to point out semantic mapping between concepts stored in distinct peers, the system exploits the Ctx-Match algorithm. This algorithm compares the knowledge contained in different contexts looking for semantic mappings denoting peers interested in similar concepts. These mappings are stored in order to assist the query resolution components to direct queries to peers that store relevant information.

•Chatty Web [1]. The Chatty Web project presents an approach that applies to any system which provides a communication infrastructure (e.g., networked systems, P2P systems) and offers the opportunity to study semantic interoperability as a global phenomenon in a network of information sharing communities. Each peer offers data that are organized according to some schema expressed in a data model (e.g., relational, XML, RDF). Semantic interoperability is accomplished by assuming the existence of local agreements provided as mappings between different schemas. Peers introduce their own schemas and exchanging translations between them; then peers can incrementally come up with an implicit consensus schema that gradually improves the global search capabilities of the system. The authors identify different methods that can be applied to establish global forms of agreement starting from a graph of local mappings among schemas and present the gossiping algorithm which is used to identify the sufficiently large set of peers capable of rendering meaningful results on a specified query.

•Hyperion [2]. The Hyperion project proposes an architecture for peer database management systems. These systems build a network of peers that coordinate most of the typical DBMS tasks such as querying, updating, and sharing of data. Such a network works in a way similar to conventional distributed databases. The proposed approach assumes total absence of any central authority, the absence of a global schema, transient participation of peer databases, and evolving coordination rules among different databases, but is not based on ontological description of the information sources.[19]

3. The Mathematic Ontology Definition[13]

The ontology structure is a 5-type $O=\{C,R,H^0,rel,A^0\}$, where C is a finite set of concepts; R is a finite set of relations; H^0 is called concept hierarchy or taxonomy, which is a directed relation $H^0 \subseteq C\times C$, for example, H^0 (C1, C2) specifies that C1 is a sub concept of C2; rel relates concepts non-taxonomically, for example, rel (R) = (C1, C2) specifies that C1 and C2 have relation R.; A^o is a set of axioms, which is expressed in an appropriate logical language, e.g. first order logic.

4. The Relationship Between Ontology and Data Resources

Figure (1) shows the relationships of ontologies, ER models and database schemas. Ontology is seen as domain oriented concepts. It includes abstract concepts and specifies domain-level constraints that can be used for knowledge-level reason ing. Ontology is suited to represent high-level information requirements. Schemas and classes are data-level concepts that are implementation dependent. They are designed to optimize procedural operations. Constraints at this level are operational constraints. Many domain constraints are not explicitly represented at this level. Terms of ontology are used to define database schema. One ontology can be used to define different schemas.

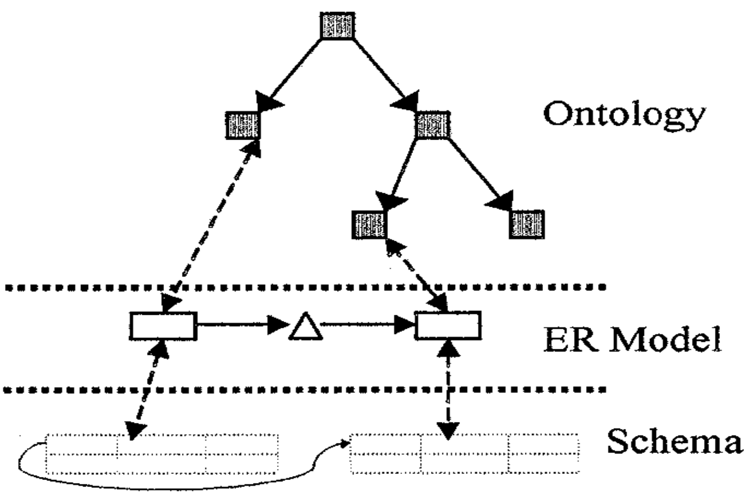

Figure 1

Figure (2) shows a hierarchy of ontologies. This is similar to the ontology clustering ideas discussed in Visser and Cui and Visser and Tamma, and Zahan.The parent ontology is inherited by child ontologies. Child ontologies understand concepts defined in their parent ontology even though some concepts may have been modified. Parent ontology is the minimum shared understanding of its child ontologies. We expect that every source or application will have an ontology. Similar resources or applications will have similar ontologies, Thus they share a common parent ontology. Ontologies closer in the hierarchy will share more knowledge than distant ontologies. The mappings between closer ontologies are expected to be straightforward and simple. The ontology hierarchy should be similar to the classification of domains and sub domains. This hierarchy idea is related strongly to the mathematical ontology definition.

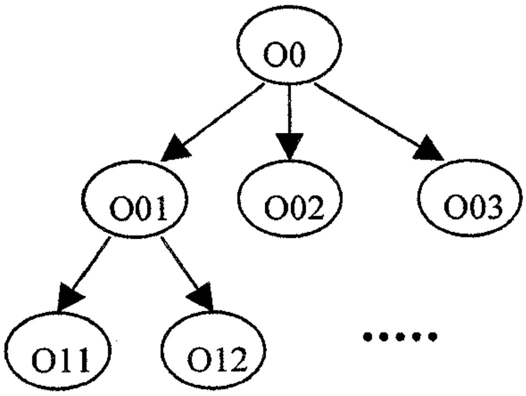

Figure 2

5. Ontology Mapping

Before introducing the main problems, there a number of questions that need to be answered. The first and most important question is why we need ontology mapping. The second question is that of whether we map the same kinds of Ontologies or different kinds. If it is possible; what are the effects. In general we refer to the same Ontologies mapping by Homogenous Ontology Mapping (HM^+), on the other hand we will refer to Heterogeneous Ontologies Mapping by (HM^-). This paper focuses on the last one. We can distinguish (HM^-) by the way it is related, so in some cases mapping is depending on concepts, relations, axioms,…etc. Distributed Description Logic

(DDL), First Order Logic, Predicate logic, and fuzzy logic all of them can advocate as the suitable formal tool to support ontologies mapping[12], especially DDL is designed to formalize multiple ontologies interconnected by semantic mapping.

6. Heterogeneous Mismatching

Creating mappings is a major engineering work where re-use is desirable. A declaratively-specifying mapping allows the ontology engineer to modify and reuse mappings. Such mappings require a mediator system that is capable of interpreting them in order to translate between different ontologies. There are many ways to solve heterogeneous mismatching:

- It may be useful to include a library of mappings and conversion functions as there are many standard transformations which could be reused. But this solution is so costly, because it uses more heterogeneous as more systems added.[25]
- Another solution to the problems of semantic heterogeneity is the ability to share and exchange information in a semantically consistent way. This can of course be achieved in many ways, each of which might be the most appropriate given some set of circumstances. But this solution may causes loss of information between applications, which may be not necessary in this domain but it is so important for another.[25]
- Zhan Cui solves the problem of semantic heterogeneity by DOME (Domain Ontology Management Environment) system. DOME formally specifies the meaning of the terminology of each system and to define a translation between each system terminologies and an intermediate terminology. It specifies the system and intermediate terminologies using formal ontologies and it specifies the translation between them using ontology mappings. A formal ontology consists of definitions of terms. It usually includes concepts with associated attributes, relationships and constraints defined between the concepts and entities that are instances of concepts.[3]

7. Semantic Mismatching

In order to resolve the problems of semantic mismatches, we will often need to translate between different terminologies. There must be some human intervention in the process of identifying correspondences between different ontologies. Although machines are unlikely to derive mappings, it is possible for them to make useful suggestions for possible correspondences and to validate human-specified correspondences. Heterogeneity is not new. It has been studied in the database integration context for many years. The semantic mismatches of the modeled realities are caused by the choice of terms and a fixed set of attributes. In the modeling process, we have committed to model particular properties of the entities; the main difference is that the former is independent of languages while the latter is dependent on languages. According to this distinction, we classify the semantic heterogeneity as follows.

7-1 Semantically Equivalent Concepts:[24]

- Different terms are used to refer to the same concept by two models. These terms are often called synonyms. However, synonyms in their common usage do not necessarily denote semantically equivalent concepts,
- Different properties are modeled by two systems. For example, for the same product, one catalogue has included its color but the other has not. This heterogeneity is not a bad thing.
- Property type mismatches. For example, the concept 'length' may be in meter or mile.

7-2 Semantically Unrelated Concepts:[24]

Conflicting terms - the same term may be chosen by two systems to denote completely different concepts. For example, apple is used to denote fruit or computer

7-3 Semantically Related Concepts:[24]

- Generalization and specification. One system has only the concept fruit, but the other has the concepts of apple, orange, etc. Another example is that student in one system refers to all students, but the other only to PhD students.
- Definable terms or abstraction - A term may be missing from one ontology, but can be defined in other terms in the ontology.
- Overlapping concepts. For example, kids in one ontology means persons aged between 5 to 12 years, but in the other means persons aged between 3 and 10 years, and in yet another ontology, young persons means persons aged between 10 and 30 years.
- Different conceptualization. For example, one ontology classifies person as male, female, the other person as employed, unemployed.

8. Ontology Languages for The Semantic Web

Guarino [10], considers an ‘ontology’ as: A logical theory, which gives an explicit, partial account of a conceptualisation, where conceptualisation is basically the idea of the world that a person or a group of people can have. We will provide a brief description of the most widely used standards, namely RDF, DAML+OIL and OWL.

The Resource Description Framework (RDF) is a language for representing information about resources in the WWW. It is particularly intended for representing metadata about Web resources, such as the title, author, and modification date of a Web page. However, by generalizing the concept of a "Web resource", RDF can also be used to represent information about things that can be identified on the Web, even when they cannot be directly retrieved on the Web. RDF provides a way to express simple statements about resources, using named properties and values. However, RDF user communities also need the ability to define the vocabularies (i.e., terms or taxonomies in ontology community) they intend to use in those statements, specifically, to indicate that they are describing specific kinds or classes of resources, and will use specific properties in describing those resources. The structure of any expression in RDF is a triplet (Figure 3), consisting of a subject, an object, and a predicate (also called property).

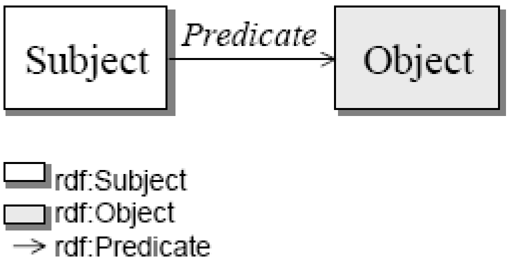

Figure 3

DAML+OIL is also a semantic markup language for Web resources. It builds upon earlier W3C standards such as RDF and RDFS, and extends these languages with richer modeling primitives (e.g., in terms of class subsupmtion or object properties). It adds the familiar ontological primitives of object-oriented and frame-based systems, and the formality of a very ex preserve description logic (i.e., an ALC Description Logic language).[3]

OWL is a semantic markup language for publishing and sharing ontologies on the World Wide Web. OWL is intended to be used when the information contained in documents needs to be processed by applications, as opposed to situations where the content only needs to be presented to humans. OWL cannot only be used to explicitly represent the meaning of terms in vocabularies and the relationships between those terms, but also may serve implicitly representing inferred terms or whole taxonomies by means of logical reasoners based on Description Logics axioms that provide inferred knowledge with respect to certain First Order Logic algorithms, such as Structural Subsupmtion and Tableau algorithms. OWL has more facilities for expressing meaning and semantics than XML, RDF, and RDFS, and thus OWL goes beyond these languages in its ability to represent machine interpretable content on the Web. OWL is an enhanced revision of DAML+OIL Web ontology language. OWL provides three increasingly expressive sublanguages designed for use by specific communities of implementers and ontology developers. The OWL class (i.e., Concepts and conceptual formulas in Description Logics) expressions are built with Knowledge Representation primitives that are properties. These will be organized in two groups. The first group includes primitives defined for OWL Little while the second group includes primitives defined for OWL DL and OWL Full.

9. Ontology Algebra

Consider Figure 2, we can think of the hierarchy of ontologies. This is similar to the ontology clustering ideas discussed in (Visser and Cui, Visser and Tamma and Zahan), The parent ontology is inherited by child ontologies. Child ontologies understand concepts defined in their parent ontology even though some concepts may have been modified. Parent ontology is the minimum shared understanding of its child ontologies. We expect that every resource or application will have an ontology. Similar resources or applications will have similar ontologies. Thus they share a common parent ontology. Ontologies closer in the hierarchy will share more knowledge than distant ontologies. The mappings between closer ontologies are expected to be straightforward and simple. The ontology hierarchy should be similar to the classification of domains and sub domains. According to the last discussion we will define algebra between the ontologies across the ontology hierarchy. We assume that there are many simple relationships between the parent and child ontologies. If we generalize that across the hierarchy ontologies we will define algebra between the ontology hierarchies. We think, if the kind of ontologies is homogenous so the relationships will be obvious and easy. Figure 4 shows the definitions between ontologies. On the other hand in the heterogeneous ontologies, it will depend on the relations, concepts, axioms and taxonomies. The main problem to solve the mismatch between heterogeneity between ontologies is by defining ontology between the ontologies across the hierarchy at the second, third and so on….levels. Figure5 shows the difficulties in defining algebra across the hierarchy of ontologies.

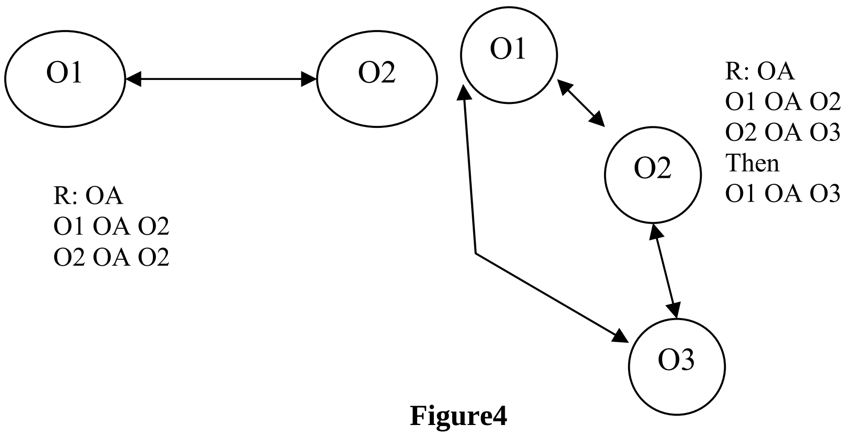

Figure4

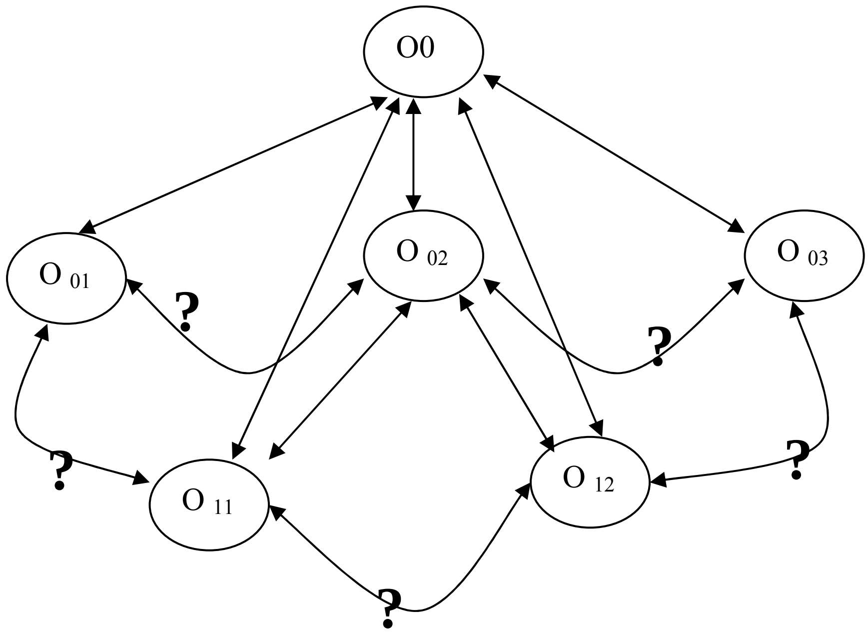

Figure 5

10. Building Intermediate and Transmit Ontologies to Solve Mismatching of Heterogeneous Mapping Using ontology Algebra

In the previous section, we have discussed ontology algebra and explained the main problem in mapping heterogeneous ontology. Question marks on Figure 5 focus on the difficulties to map ontologies through the hierarchy. We think if we use ontology algebra between the ontology and building intermediate and translate ontology between ontologies which are referred to by question marks, for instance, between O_{01} and O_{11}, also between O11 and O12…. etc., this may help to map heterogeneous ontologies. Intermediate and transmit ontologies are dependent on concepts, axioms, relations or taxonomy.

To solve the semantic mismatching between ontologies, to reduce the loss of information when the machine builds the transmitting between two concepts in two ontologies across the ontology hierarchy, and to avoid the high cost of building a library of mapping and conversion function, the intermediate and transmit ontologies are introduced as a new methodology which depends on the mathematical ontology definition. This methodology simulates the human technique in matching and adding new ontology across the ontology hierarchy at the same or deferent levels. According to the mathematical definition, each ontology has its concepts, axioms, and taxonomies. Intermediate and transmit ontology builds the suitable relations between the related ontologies. For example, if the new ontology has subconcepts in the hierarchy, the intermediate and transmit ontology will use "H^0" to map them, while it will use "rel" to map new ontology which has non-taxonomical related to other ontologies. Intermediate and transmit ontologies will use the logical rule to express the axioms in the suitable kind of logic. First order logic is the simplest logic to use. We think that description logic can pave the way and strongly help machine mapping or adding new ontology across the hierarchy.

According to previous discussions, it is obvious that this solution is directly related to the concepts, axioms, relations, and taxonomies. In fact, this methodology has high quality by reducing the cost of query because it depends on the mathematical definition of ontology. It also builds on the logical rules according to the kind of logic used to matching ontologies. Query engine will use the same logic rules to build up any new query from different ontologies across the hierarchy.

On the other hand, intermediate and transmit ontologies have strong back experience to choose the best way to add or match new ontology at the same level or sub levels in the systems. This back experiences will guide the ontologies to choose the best and suitable concepts, axioms, and taxonomies in the same or different domains. These benefits gave this methodology the strength to re-learning feature. By re-using mapping definitions and relation across hierarchy of ontology, re-learning reduces the cost of the semantic matching machine procedures to map ontologies across the ontology hierarchy. The next section compares this solution with other solutions to solve mismatching mapping of ontologies. The comparison shows the positive and negative aspects of this solution.

11. Comparison with Other Techniques

We consider a comparison with other ontology-based techniques that are relevant to information integration and semantic interoperability such as integrated ontology, Contextual Ontology, and P2P ontology. These techniques are summarized as follows:

- **Integrated Ontology**: is a representation of global semantics. It defines a global understanding based on an established consensus [16]. The consensus is needed for the common integrated ontology, which needs to be renewed each time an update occurs. It suffers from the loss of original understanding or loss of information in the profit of the unified representation. Regrettably, to reach the consensus, a considerable effort, cost, methodology, and update time is needed. Therefore, this solution does not conform to the dynamic aspect of Enterprise Information Systems, which needs to make accessible as fast as possible (even without any consensus) the business system with new functionalities.[17]
- **Contextual Ontology**: provides local and global semantics. It allows a global view without losing original representation. Indeed, it adapts the models to coexist through the contexts relationships. The contexts are related to an interpretation with a predefined structure. Thus, contextual ontology provides a dynamic consensus, rather than a static consensus, which is offered by integrated ontology [17].
- **P2P Ontology**: considers that nodes (ontologies) are equivalent in terms of functionalities and capabilities. Each peer has different amounts of knowledge that depend on the interactions it has performed in the network of available ontologies. Each peer can acquire new knowledge and/or extend its knowledge only by querying peers, which have this information [7]. Therefore, P2P ontology offers autonomy and low cost updating, but no global view can be reached with this technique.

- **Locally Independent Ontologies**: offers local semantic and interpretation where each system is viewed as being separated from others. Note that no global view can be expected from independent ontologies.
- **Intermediate & Transmit Ontologies**: using ontology algebra theory which provides high quality and trusted mapping for different kinds of ontologies, at the same time, it works on semantic level that support Semantic web applications.

Table (1) Shows a comparison between the previously mentioned techniques.

	Global view	Local view	Consensus	Updating complexity	Autonomy	Cost of adding new ontology	Query answering	Reusability	Interoperability	<u>Re -Learning</u>
Integrated ontology	**Yes**	**No**	**Yes**	**High**	**Very low**	**Very high**	**High**	**Low**	**Fair**	**No**
Contextual ontology	**Yes**	**Yes**	**No**	**Fair**	**High**	**Fair**	**High**	**High**	**Fair**	**Yes**
Peer2Peer ontology	**No**	**Yes**	**No**	**Fair**	**Very high**	**Fair**	**Fair**	**Low**	**Fair**	**No**
Locally independent ontology	**No**	**Yes**	**No**	**Low**	**Very high**	**Low**	**Local(High) Global None**	**Low**	**Low**	**No**
Intermediate & Transmit Ontologies	**Yes**	**Yes**	**No**	<u>**Low**</u>	**High**	<u>**New define (High) Other (Very Low)**</u>	**High**	**High**	**High**	<u>**Yes**</u>

12. Conclusion

This paper discusses the mapping of heterogeneous ontologies through ontology algebra view. We have tried to show that this issue is so important to support semantic web applications. The complexity of semantic level of heterogeneity requires such quality solutions to manage successful mapping. Our solution has quality in making the updating complexity low and the cost of adding new ontology for new definition high but by using re-learning it will be very low. To support this solution we think that if we use the logic description, this will help in defining the relation and building the intermediate and transmit ontology across the hierarchy of ontologies.

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