# Using Semantic Ontology to Evaluate Tenders and Bidders for E-Government Applications

**( استخدام الدلالات في تقييم العطاءات او العروض في تطبيقات الحكومة الإلكترونية )**

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# DEDICATION

I dedicate this thesis to my father, brothers, dear friends, and for all who supported, encouraged, and prayed for me to be successful until I reached what I am now.

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# Abstract


إن علم الوجود ودلالة الألفاظ يعتبر من العلوم الواسعة والغنية في مجالات البحث العلمي, وقد أثبت استخدام علم الوجود ودلالة الألفاظ تقدما نوعيا في العديد من الأنظمة الالكترونية  حيث ساهم بشكل ملحوظ في آلية الربط بين المعلومات والبيانات بطريقة ذكية وذات معنى بعكس الأنظمةالأخرى التي تعتمد علي الاسترجاع الكلي أو الجزئي للبيانات.

ولذلك سنقوم في هذه الرسالة باستخدام وتوظيف علم دلالهاالألفاظ وعلم الوجود في تطبيق العطاءات والمناقصات في الحكومة الالكترونية وخاصة في مجال السيارات لذلك سوف نستخدم قياسات علمية ونربط العلاقات بين المفاهيملإثبات صحة العلاقة بين المواصفات المطلوبة من المؤسسة الحكومية والعروض المقدمة من الشركات، وذلك لوصف اقرب عطاء ملائم من بين المتقدمين للربح في تلك المناقصة.

The ontology and semantics field has proven its efficiency in the different information technology domains, it is mainly used to build smart and rational relationships among the concepts of a specific domain, so that the semantically related information are retrieved and queried whenever they are needed.

In this thesis we will use the components of the semantic ontology science, and we will propose new way of building semantic and accurate relationships that will eventually lead to more precise results, especially in the matching process between tenders' requirement and bidders' offers.

To prove our results we will use scientific relatedness measures in building semantic relationships whicharemain components of the ontology components.

# Chapter 1: Introduction

The e-government applications are increasingly used worldwide, nowadays the tendering and bidding applications are of the most important fields in the e-governments, in this thesis we will focus on enhancing the tendering and bidding processes by using the semantic ontology science, our domain will be constrained on vehicles, and if proven right it can be generalized on other domains. The importance of the e-government field, the United Nations made a survey for different countries worldwide to show the increasing interest of such applications in the entire world.

In this chapter we will precisely describe our problem definition, and the key contribution that is expected from this research. This chapter also mentions challenging questions that should be addressed in this research. The main objective is defined in this chapter so that we pursue our specific aim, and also the motivations that encourage us to choose this topic.

We will study similar approaches that use ontology and semantic concepts to filter the best offers among certain bids that semantically match the required specifications.
We will take advantage of an existing ontology framework(Ahmad Kayed, 2010), and will study similar approaches that use ontology and semantic concepts, to evaluate bids semantically.

## 1.1 The problem Definition

The key contribution of the work is to develop ontological means for specification for tenders and bids that enable compact representation of multi-attribute tenders and offers. Using ontology and deploying semantics to address the challenges that arise from an e-government environment in particular the tendering process. The research will develop and use ontology in the domain of e-government purchasing where the purchased items are describe in relational database format. This research will restrict the domain to vehicles related tenders with specific characteristics. After developing ontology for that domain, I will deploy and develop some measures that compute the semantic distance between the bidders and tenders according to the ontology. The aim is to find the bidder's offer that is most appropriate to the tender's specifications.

Given our assumption of heterogeneous market participants and global markets, it is quite likely that tender's specifications requests and bidders will use differentdescriptions for the same service or product.

## 1.2 Questions

This research will answer the following question:

1. What is the main challenge in describing bids and tenders in e-government applications.
2. How to build the domain ontology from existing resources and how to use and enhance the available ontology (if any) .
3. How can the ontology concepts improve the analysis and support the decision making process.
4. Generalizing the finding of study to other domains.

## 1.3 Objective

The main purpose of my work is to develop a semantic based on an ontology framework for e-government applications and more specifically for e-government bids and tenders. Thus, evaluating previous semantic models will be taken into account. My intended study will take two perspectives, first, to study the semantic and ontology main concepts and features and how they can be involved in e-government applications. Second, to study the current e-government semantic models,and to analyze their features, environmental factors, and concepts.

- A number of issues will be addressed in this research:

1) How could ontology and semantic concepts affect the bids and tenders selection process in the e-government applications?
2) The implementation and evaluation of the ontology and semantics for the e-government bidding and tendering
3) How will semantics and ontology help the governmental institutions to choose the best bidder and tender specifications?

## 1.4 Motivation

- The significance of the study comes from two perspectives,

1. The institutions that can benefit from the study.
    a. All governmental institutions that go through the bidding process could utilize the research study.
    b. If the study result is efficient and useful it could be applied to other non-governmental institutions with the required changes
2. The ideal use of the semantic and ontology concepts that in case proved effective could be used in other fields of study.

# Chapter 2: Literature Review

The semantic ontology field has many useful and valuable references, theses references were written by scientists and well-known researchers, we want to take advantage of these references for two reasons; the first is to make sure that we will reach a new and not used technology; the second is to utilize the already existed methods by studying them thoroughly.

In this chapter we will study different resources that are related to our research, for example some researchers used the opinion of experts to enhance their results, and some researchers focused on the e-governments issues that can be improved.

## 2.1 Related Articles and Research

**[Barbara Kitchenham, Lesley Pickard, Stephen Linkman and PeterJones,2002].**

In(Barbara Kitchenham, 2002)the researchers enhanced their results by the experts opinions, they developed an extended evaluation framework that will be used to evaluating their bidding model. Furthermore, they suggest the evaluation framework might be suitable for evaluating other models derived from expert opinion based influence diagrams. They use a simple process model to relate the evaluation framework to the model building process. The process model indicates the order in which different evaluation activities are performed and the role responsible for performing them. It also illustrates the difference between evaluating a generic bidding model and evaluating specialized bidding model.

**[ZakareyaEbrahim and ZahirIrani, 2005]**(Irani, 2005)proposed an organizational and structured framework to be used for the e-governments applications. The difficulties and barriers that have been experienced in public sector organizations which complicate the implementation process of e-government have been analyzed and then identified and presented in taxonomy.

**[E. William East, 2008]**(East, 2008)thispaper the researcher justifies the importance of the e-governments applications especially in the United States of America. It also describes the advantages of using e-governments applications in the public sector.

**[FathiaBettahar, Claude Moulin and Jean-Paul Barthès, 2009]**(Fathia Bettahar, 2009)The project concentrates on the governmental semantic features at different levels, locally, regionally, and internationally, needed to build flexible and interoperable tools to support the change towards e-Government services. They propose, within this project, ontology to present knowledge and to achieve the required level of semantic interoperability. They use the ontology to describe the domain knowledge of the organization and to index the resources from which civil servants may receive information. The key point of the system is a unique and multimodal ontology used simultaneously for describing domain knowledge, for adding semantics to agency services, for indexing various documents in knowledge bases used by civil servants and finally for supporting the interaction between the users and the system. They present in this paper the challenges of using ontology in e -government environments, such as the lack of expressivity of the formalism chosen for interoperability in the project and the risk of inconsistency when the ontology changes. They propose our solution to such challenges and They demonstrate the use of the ontology by the module in charge of managing complex tasks in the system.

**[Peter Salhofer, Bernd Stadlhofer and Gerald Tretter, 2009]**(Peter Salhofer, 2009)This paper presents an approach to model ontology for the e-Government domain as a basis for an integrated e-Government environment. Over the last couple of years the application of semantic methodologies and technologies in the e-Government domain has become an important field of research.

**[Nan Lin, Daifeng Li, Tianxi Dong, Zheng Qin, 2010]**(Nan Lin, 2010)The paper considers that a better solution is to apply business component theory and business component framework in the construction of e-government procurement, as it can solve the problems that block the development of e-government procurement in a more convenient way. The paper constructs the Business Component (BC) framework for the e-government procurement, analyzes the superiority of BC framework and describes a methodology for the application of BCs in e-government procurement. The paper utilizes semantic model for workflow by using ontology modeling tool Protégé, uses ontology model database to store and manage workflow model, and builds a permission-based and user-involved workflow.

**[Ahmad Kayed, Mohammad Nizar, and Mohammed Alfayoumi, 2010]**(Ahmad Kayed, 2010)

In this paper Dr. Kayed developed ontology (mainly concepts) in the domain of requirements engineering process for E-government applications. He contributed in enabling software engineers to find out shared, understandable and common concepts to describe requirements for different domain models used in E-government applications.

**[Martin Maillard, Philippe Cudré-Mauroux, Maria Sokhn, and Omar AbouKhaled, 2011]**In this paper, they address the problem of applying Semantic Web technologies to this domain, in order to enhance the access to public services information for the citizen. For this purpose, we propose architecture and ontology to describe public services. This ontology is used as a knowledge base for the building of a portal seeking to meet the citizen needs in the process of searching public services. As a proof-of-concept, a prototype is presented at the end of the paper.

**[Ahmad Kayed, NaelHirzalla, Hadeel Ahmad, and Enas Faisal, 2011]**(Ahmad Kayed, 2011)

Thispaper demonstrates several experiments to extract concepts to build ontology that improves the description process for software components embedded in document. In this paper they built ontology (mainly concepts) for some software components then used them to solve some semantic problems. They collected many documents that describe components in .Net and Java from several and different resources. Concepts were extracted and used to decide which domain of any given description (semantic) is close or belong to.

**[Jean Vincent Fonou-Dombeu, and Magda Huisman, 2011]**(Jean Vincent Fonou-Dombeu, 2011)In this paper the Uschold and King ontology building methodology is applied to develop semantic ontology models in a government service domain. Firstly, the Uschold and King methodology is presented, discussed and applied to build government domain ontology. Secondly, the domain ontology is evaluated for semantic consistency using its semi-formal representation in Description Logic. Thirdly, an alignment of the domain ontology with the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) upper level ontology is drawn to allow its wider visibility and facilitate its integration with existing metadata standard. Finally, the domain ontology is formally written in Web Ontology Language (OWL) to enable its automatic processing by computers.

**[Erwin Folmer& Paul Oude Luttighuis& Jos van Hillegersberg, 2011]**(Hillegersberg, 2011)The adoption of standards to improve interoperability in the automotive, aerospace, shipbuilding and other sectors could save billions. While interoperability standards have been created for a number of industries, problems persist, suggesting a lack of quality of the standards themselves. The issue of semantic standard quality is not often addressed. In this research they take a closer look at the quality of semantics standards, development processes, and survey the current state of the quality of semantic standards by means of questionnaire that was sent to standards developers. This survey looked at 34 semantic standards, and it shows that the quality of semantic standards for inter-organizational interoperability can be improved. Improved standards may advance interoperability in networked business. Improvement of semantic standards requires transparency of their quality. Although many semantic standard development organizations already have quality assurance in place, this research shows that they could benefit from a quality measuring instrument.

**[Jean Vincent FonouDombeu, Magda Huisman, and ZygmuntSzpak, 2011]**(Jean Vincent Fonou Dombeu, 2011)The Web Ontology Language (OWL) standard is increasingly being used to build e-government service ontologiesthat are integerable and interoperable in e-government environments. However, current works employing OWL ontology ine-government are more directed to the Semantic Web audience than to the broader e-government community. Furthermore, only a few of these works provide detailed guidelines for constructing OWL ontology from a business domain. This paper presents a framework for generating semantic model ontology in OWL syntax from a government service domain. Firstly, the government service domain is analyzed and domain ontology is constructed to capture its semantic content. Thereafter, a semiformal representation of the domain ontology is created with the ontology knowledge-based editor Protégé. Finally, the OWL ontology model is imported. This study aims at providing e-governmentdevelopers, particularly those from the developing world, with an easy to use framework for practicing semantic knowledge representation in e-government processes; thus facilitating the design of e-government systems that can be easily integrated and maintained.

**[Stamatios A. Theocharis, George A. Tsihrintzis, 2012]**(Stamatios A. Theocharis, 2012)In this context, the authors of this paper research the possibilities of the Semantic Web and the technologies that support it, as an extension of the existing Internet. The

Semantic Web is expected to provide effective solutions concerning a better exploitation of the information offered as well as producing and managing knowledge in the field of e-Government.

**[SalehAlshomrani, 2012]**(Alshomrani, 2012)This paper investigates the e-government development scenario in Saudi Arabia and to compare it with the USA The study is based on the e-government survey reports conducted by the United Nations between 2003 and 2010. From the experience of USA e-government, this report gave us some critical remarks related to Saudi Arabia e-government. This study also gave us suggestions and countermeasures to improve e-governmentin Saudi Arabia.

**[ShaZukang, 2012]** (Zukang, 2012)The increasing role of e-government in promoting inclusive and participatory development has gone hand-in-hand with the growing demands for transparency and accountability in all regions of the world. E-government has strongly shifted expectations of what governments can and should do, using modern information and communication technologies, to strengthen public service and advance equitable, people-centered development.

The report shows that with the right institutional framework, policies and capacity-building efforts, progress in enhancing the contributions of e-government to sustainable development is within reach. However, the report also explains that adequate funding is needed to enhance e-government.

Furthermore, it shows that there are challenges to reducing the digital-divide and increasing access to public services by vulnerable populations and distant communities.

More than ever, mobile services, crowd sourcing, cloud computing, e-service kiosk sand other innovations of this sort must be nurtured and supported and made available to all segments of society.

The steady diffusion of information and communication technologies and the bridging of the digital divide can help empower all stakeholders to translate commitments into action. He therefore encourages policymakers and public administrators everywhere to apply information and communication technologies and e-government as important tools in advancing sustainable development for all.

## 2.2 Summary about Semantic Matching and Using Ontology in Semantic

Ontology is a mean of representing semantic knowledge, and includes at least a controlled vocabulary of terms, and some specification of their meaning. Ontology matching consists in deriving an alignment consisting of correspondences between two ontologySignificances. Such an alignment can then be used for various tasks, including semantic web browsing, or merging of ontology significances from multiple domains.(AC., 2006)(Choi N, 2006)

Our main motivation lies in the use of ontology matching for the integration of information, especially in the field of vehicle related tenders and bidders for e-government applications. Nowadays there is a large, ever-growing, and increasingly complex body of vehicles specification data publicly available through the World Wide

Web. This wealth of information is quite varied in nature and objective, and provides immense opportunities to researchers, while posing significant challenges in terms of housing, accessing, and analyzing these data sets. The ability to seamlessly access and share large amounts of heterogeneous data is crucial towards the advancement of genetics research, and requires resolving the semantic complexity of the source data and the knowledge necessary to link this data in meaningful ways. Semantic representation of the information stored in multiple data sources is essential for defining correspondence among entities belonging to different sources, resolving conflicts among sources, and ultimately automating the integration process. Ontology holds the promise of providing a unified semantic view of the data, and can be used to model heterogeneous sources within a common framework. The ability to create correspondences between these different models of data sources is then critical towards the integration of the information contained in them.

Ontology matching is an active field of current research, with a vigorous community proposing numerous solutions. (Euzenat J, 2007)present a comprehensive review of current approaches, classifying them along three main dimensions: *granularity, input interpretation*, and *kind of input*. The granularity dimension distinguishes between *element-level* and *structure-level* techniques. The input interpretation dimension is divided into *syntactic*, which uses solely the structure of the ontology; *external*, which exploits auxiliary resources outside of the ontology; and *semantic*, which uses some form of formal semantics to justify results. The kind of input dimension categorizes techniques as *terminological*, which works on textual strings; *structural*, which deals with the structure of the ontologySignificances; *extensional*, which analyzes the data instances; and *semantic*, which makes use of the underlying semantic interpretation of ontology Significances.

Most work on ontology matching has focused on syntactic or structural approaches. Early work on ontology alignment and mapping focused mainly on the string distances between entity labels and the overall taxonomic structure of the ontology significances. However, it became increasingly clear that any two ontologies constructed for the same domain by different experts could be vastly dissimilar in terms of taxonomy and lexical features.

Corpus-based matching (Madhavan J, 2005) uses domain-specific knowledge in the form of an external corpus of mappings which evolves over time.

RiMOM(Tang J, 2006) discovers similarities within entity descriptions, analyzes instances, entity names, entity descriptions, taxonomy structure, and constraints prior to using Bayesian decision theory in order to generate an alignment between ontology significances, and additionally accepts user input to improve the mappings.

(Hu W, 2006)uses a linguistic matcher combined with a technique that represents the structure of the ontology significances to be matched as a bipartite graph.(Kalfoglou Y, 2003) matches two ontology significances by first examining their instances to see if they can be assigned to concepts in reference ontology, and then using formal concept analysis to derive an alignment. Similarity flooding(Melnik S, 2002) uses a technique of propagation of similarities along the property relationships between classes. (Euzenat J, 2004) uses weighted averages between matchers along multiple ontology features, and introduces a mechanism for computation of entity-set similarities based on numerical analysis; the approach used in ASMOV for the calculation of similarities at a lexical, structural and extensional level is similar to OLA, but affording more flexibility to the design of similarity measure calculations for different features.

Semantic techniques for ontology matching have received recent attention in the literature. Semantic reasoning is by definition deductive, while the process of ontology matching is in essence an inductive task (Euzenat J, 2007). Semantic techniques therefore need a preprocessing phase to provide an initial seeding alignment, which is then amplified using semantic methods. This initial seeding can be given by finding correspondences with an intermediate formal ontology used as an external source of common knowledge (Aleksovski Z, 2006). Deductive techniques for semantic ontology matching include those used in S-Match (Giunchiglia F, 2004), which uses a number of element-level matchers to express ontology significances as logical formulas and then uses a propositional certifiable solver to check for validity of these formulas; and CtxMatch(Bouquet P, 2006), which merge the ontology significances to be aligned and then uses description logic techniques to test each pair of classes and properties for sub-sumption, deriving inferred alignments.

Semantic techniques have also been used to verify, rather than derive, correspondences. The approach by (Meilicke C, 2007) uses model-theoretic semantics to identify inconsistencies and automatically remove correspondences from a proposed alignment. This model, however, only identifies those correspondences that are provably inconsistent according to a description logics formulation. The same authors have extended this work to define mapping stability as a criterion for alignment extraction (Meilicke C, 2008); the approach in ASMOV introduces additional rules that seek to find positive verification that consequences implied by an alignment are explicitly stated in the ontology significances.

# Chapter 3: How to build Ontology

Building an ontology goes through a life cycle that is similar to the systems development life cycle, in which the ontology goes through requirements or concepts gathering depending on the required domain, then comes the design process, after the design process, an implementation of the ontology is started depending on scientific and statistical measures, the last step is to evaluate the implemented procedures taking into account possible enhancements in the future.

Modern ontology significances share many structural similarities, regardless of the language in which they are expressed. Most ontology significances describe individuals (instances), classes (concepts), attributes, and relations, these common structural similarities are all used in our thesis.

There are common components of ontology significancesthat we implemented in our research:

- **Individuals**: instances or objects (the basic or "ground level" objects)
- **Classes**: sets, collections, concepts, types of objects, or kinds of things.
- **Attributes**: aspects, properties, features, characteristics, or parameters that objects (and classes) can have
- **Relations**: ways in which classes and individuals can be related to one another

## 3.1 Ontology Languages

In computer science and artificial intelligence, **ontology languages** are formal languages used to construct ontology significances. They allow the encoding of knowledge about specific domains and often include reasoning rules that support the processing of that knowledge.

## 3.2 Examples of ontology languages:

- Common Logic - and its dialects
- DOGMA (Developing Ontology-Grounded Methods and Applications)
- OKBC (Open Knowledge Base Connectivity)
- Web Ontology Language (OWL)
- Resource Description Framework (RDF)

## 3.3 Instances

Individuals or instances are the basic, "ground level" components of ontology. The instances in an ontology may include concrete objects such as people, animals, tables, automobiles, molecules, and planets, as well as abstract individuals such as numbers and words (although there are differences of opinion as to whether numbers and words are classes or individuals). Strictly speaking, ontology need not include any individuals, but one of the general purposes of ontology is to provide a means of classifying individuals, even if those individuals are not explicitly part of the ontology.(Wikipedia, 2012)

## 3.4 Concepts or Classes

Classes – concepts that are also called *type*, *sort*, *category*, and *kind*. The first definition of class results in ontology significances in which a class is a subclass of collection. The second definition of class results in ontology significances in which collections and classes are more fundamentally different. Classes may classify individuals, other classes, or a combination of both. Some examples of classes:

- ***Person***, the class of all people, or the abstract object that can be described by the criteria for being a person.
- ***Vehicle***, the class of all vehicles, or the abstract object that can be described by the criteria for being a vehicle.
- ***Car***, the class of all cars, or the abstract object that can be described by the criteria for being a car.
- ***Class***, representing the class of all classes, or the abstract object that can be described by the criteria for being a class.
- ***Thing***, representing the class of all things, or the abstract object that can be described by the criteria for being a thing (and not anything).(Wikipedia, 2012)

Ontology significances can have different rules on whether classes can contain other classes, whether a class can belong to itself, whether there is a universal class (that is, a class containing everything), etc. Sometimes restrictions along these lines are made in order to avoid certain well-known discrepancies.

For example, Vehicle subsumes Car, since (necessarily) anything that is a member of the latter class is a member of the former. The subsumption relation is used to create a hierarchy of classes, typically with a maximally general class like anything at the top, and very specific classes like 2002 Ford Explorer at the bottom.

The critically important consequence of the subsumption relation is the inheritance of properties from the parent (subsuming) class to the child (subsumed) class. Thus, anything that is necessarily true of a parent class is also necessarily true of all of its subsumed child classes.

In some ontology significances, a class is only allowed to have one parent (single inheritance), but in most ontology significances, classes are allowed to have any number of parents (multiple inheritance), and in the latter case all necessary properties of each parent are inherited by the subsumed child class. Thus a particular class of animal (HouseCat) may be a child of the class Cat and also a child of the class Pet.

## 3.5 Attributes or Properties

Objects in ontology can be described by relating them to other things, typically aspects or parts. These related things are often called *attributes*, although they may be independent things. Each attribute can be a class or an individual. The kind of object and the kind of attribute determine the kind of relation between them. A relation between an object and an attribute express a fact that is specific to the object to which it is related, the attributes are very necessary to express our concepts, as we will show laterin our research. For example the Ford Explorer object has attributes such as:

- <has as name> Ford Explorer
- <has by definition as part>*door* (with as minimum and maximum cardinality: 4)
- <has by definition as part one of>*{4.0L engine, 4.6L engine}*
- <has by definition as part>*6-speed transmission*

The value of an attribute can be a complex data type; in this example, the related engine can only be one of a list of subtypes of engines, not just a single thing.Ontology significancesare only trueontology significancesif concepts are related to other concepts (the concepts do have attributes). If that is not the case, then you would have either taxonomy or a controlled vocabulary. These are useful, but are not considered true ontology significances.

## 3.6 Relations

The relations are very important to define the semantic relationship among the concepts, our work depends mainly on this component of the ontology,and in our research we implemented a new way for defining our relationships.

Relations between objects in ontology specify how objects are related to other objects. Typically a relation is of a particular type (or class) that specifies in what sense the object is related to the other object in the ontology.(Wikipedia, 2012)

Relation types are sometimes domain-specific and are then used to store specific kinds of facts or to answer particular types of questions. If the definitions of the relation types are included in ontology, then the ontology defines its own ontology definition language.

## 3.7 Ontology Tools

### 3.7.1 Free Ontology Development Tools

There are many different free ontology frameworks, each one with specific features and specifications.

Protégé 2000, Oiled,Apollo,RDFedt,OntoLingua,OntoEdit,WebODE,KAON

ICOM , DOE and WebOnto

### 3.7.2 Commercial Tools

- Medius Visual Ontology Modeler
- LinKFactory Workbench
- K-Infinity

### 3.7.3The Chosen Tool

In this thesis the Protégé-Frames ontology editor and knowledge-base frameworkwill be used.

### 3.7.4 The Reason

According to the tables below, the Protégé ontology tool has many features that don't exist in other tools, for example, the only ontology tool that can store ontology as a file and as a database is the Protégé software ,we can infer this software is the best tool for our research.

| | Import format | Exportformat | Graph view | Consistency check | Multi-user | Web support | Merging |
|---|---|---|---|---|---|---|---|
| **Protégé 2000** | XML, RDF(S), XML Schema | XML,<br><br>RDF(S), XML Schema, FLogic, CLIPS, Java html | Via plug-ins like GraphViz and Jambalaya | Via plug-ins like PAL and FaCT | Limited<br><br>(Multi-user capability added to it in 2.0 version) | Via Protégé-OWL plug-in | Via Anchor-PROMPT plug-in |
| **OilEd** | RDF(S), OIL, DAML+OIL | RDF(S), OIL, DAML+OIL, SHIQ, dotty, html | No | Via FaCT | No | Very limited namespaces | No |
| **Apollo** | OCML, CLOS | OCML, CLOS | No | Yes | No | No | No |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RDFEdt** | RDF(S), OIL, DAML, SHOE | RDF(S), OIL, DAML, SHOE | No | Only checks writing mistakes | No | Via RSS (RDF Site Summary) | ? |
| **OntoLingua** | IDL, KIF | KIF, CLIPS, IDL, OKBC syntax, Prolog syntax | No | Via Chimaera | Via write-only locking,user access levels | Yes | ? |
| **OntoEdit (Free version)** | XML, RDF(S), FLogic and DAML+OIL | XML, RDF(S), FLogic and DAML+OIL | Yes | Yes | No | Yes | ? |
| **WebODE** | RDF(S), UML, DAML+OIL and OWL | RDF(S), UML, DAML+OIL,OWL, PROLOG, X-CARIN, Java/Jess | Form based graphical user interface | Yes | By synchronization, authentication and access restriction | Yes | Via ODEmerge |

| | Import format | Export format | Graph view | Consistency check | Multi-user | Web support | Merging |
|---|---|---|---|---|---|---|---|
| **KAON** | RDF(S) | RDF(S) | No | Yes | By concurrent access control | Via KAON portal | No |
| **ICOM** | XML , UML | XML, UML | Yes | Via FaCT | No | No | With inter-ontology mapping |
| **DOE** | XSLT, RDF(S), OIL, DAML+OIL, OWL and CGXML | XSLT, RDF(S), OIL, DAML+OIL, OWL and CGXML | No | Via type inheritance and detection of cycles in hierarchies | No | Load ontology via URL | No |
| **WebOnto** | OCML | OCML, GXL, RDF(S) and OIL | Yes | Yes | With global write-only locking | Web based | ? |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Medius VOM** | XML Schema,<br><br>RDF and DAML+OIL | XML Schema, RDF and DAML+OIL | UML diagrams via Rose | With a set of ontology authoring wizards | Network based | Via read-only browser support from Rose | Limited<br><br>(only native Rose model) |
| **LinKFactory** | XML, RDF(S), DAML+OIL and OWL | XML,<br><br>RDF(S),<br><br>DAML+OIL, OWL and html | No | Yes | Yes | Yes | Yes |
| **K-Infinity** | RDF | RDF | With Graph editor | Yes | Network based | No | ? |

| | Collaborative working | Ontology library | Inference engine | Exception handling | Ontology storage | Extensibility | Availability |
|---|---|---|---|---|---|---|---|
| **Protégé 2000** | No | Yes | With PAL | No | File & DBMS (JDBC) | Via plug-ins | Free |
| **OilEd** | No | Yes | With FaCT | No | File | No | Free |
| **Apollo** | No | Yes | No | No | Files | Via plug-ins | Free |
| **RDFEdt** | No | No | No | Yes | Files | No | Free |
| **OntoLingua** | Yes | Yes | No | No | Files | No | Free |
| **OntoEdit** | No | No | No | No | File | Via plug-ins | Free |
| **WebODE** | Yes | No | Prolog | No | DBMS (JDBC) | Via plug-ins | Free |
| **KAON** | ? | Yes | Yes | No | ? | No | Free |
| **ICOM** | No | ? | Yes | No | DBMS | Yes | Free |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **DOE** | No | No | Yes | No | File | No | Free |
| **WebOnto** | Yes | Yes | Yes | No | File | No | Free web access |
| **Medius VOM** | Yes | Yes (IEEE SUO) | Yes | ? | ? | Yes | Commercial |
| **LinKFactory** | Yes | Yes | Yes | No | DBMS | Yes | Commercial |
| **K-Infinity** | Yes | Yes | Yes | ? | DBMS | No | Commercial |

## Why the version 3.4.8

For working with **frames-based** ontology significances there is only one choice - Protégé 3.4 is built on a very mature and stable codebase, so other versions of the tool can only be useful for domains other than frame-basedonontology significances. Frames support is not currently available in P4.x version.(Protégé, 2012)

# Chapter 4: Related work

There are differentontology significances built into the vehicles domain, but each ontology significance has its own circumstances and constraints.But these ontology significances don't cover the tendering and bidding process,besides that some of the ontology significances are dedicated tospecific companies for the advertisement purposes. In this chapter we will study these ontology significances and see how other people build vehicle related ontology significances, and how we can take advantage of them.

This chapter covers examples of vehicles related to ontology significances, with references for each ontology significance.

## 4.1 Volkswagen Vehicles Ontology

(Hepp, 2012)

The ontology is a vocabulary for describing Volkswagen-specific features of automobiles.

The vocabulary is designed to be used in combination with:

- *GoodRelations*, a standard vocabulary for the commercial aspects of offers for sale, rental, repair, or disposal;
- *The Vehicle Sales Ontology*, a standard vocabulary for cars and other vehicles; and

- *The Car Options Ontology*, a standard vocabulary for buildability / configuration information for cars.

## 4.2 The Vehicle Sales Ontology

The Vehicle Sales Ontology is a Web vocabulary for describing cars, boats, bikes, and other vehicles for e-commerce. The vocabulary is designed to be used in combination with GoodRelations, a standard vocabulary for the commercial aspects of offers for sale, rental, repair, or disposal. GoodRelations is a language (also known as "schema", "data dictionary", or "ontology") for product, price, and company data that can

1. Be embedded into existing static and dynamic Web pages and that
2. can be processed by other computers

This increases the visibility of your products and services in the latest generation of search engines, recommender systems, and other novel applications.

### **Example:** Car Sales

**Scenario**: Miller Inc. sells the following car:

- *Make and Model:* 2002 Chevrolet Camaro
- *Price:* $ 11990
- *VIN:* 2G1FP22G522155049
- *Drivetype:* RWD
- *Mileage:* 42000
- *Stock No:* 155049
- *Transmission:* 6-Speed Manual

- *Engine:* 5.7L V8 OHV 16V
- *Exterior Color:* red

# Chapter 5: My work

After studying different scientific resources that are related to the semantic ontology significancesand how use them, it's time to make our own contribution and ideas in this domain.

In this research we are trying to find an efficient method to utilize semantics and ontology in choosing the convenient offers in terms of convenience and compliance to the requirements from the tendering e-government institutions. We applied the notion of ontology in the domain of e-government, then usedthisnotion to measure how much a tender is close (semantically) from its bids according to our new methodology.

In this chapter we will provide our methodology for building our new way for using ontology, our methodology is described in full details in this chapter, more technical details, for example, how to import our concepts from the database is mention in the appendix.

## 5.1 Methodology

- Determining our domain in the semantic evaluation of tenders and bidders for vehicles.
- Collecting the vehicle related data from trust-worthy manufacturers in the form of a soft copy files.

- Creating the concepts, attributes, instances from the real data that we got from the vehicles manufacturers.
- Choosing tools to import the vehicle concepts, attributes, instances into the Protégé ontology tool.
- Creating our ontology relationships in the Protégé ontology tool based on scientific measures that are already recognized and tested.
- Building mathematical formulas to determine the matching percentage between each bidder's offer and the tender's requirements.
- Generalize our findings to other domains.
- Evaluate our approach by comparing our results with actual tenders.
- Evaluation andFutureWork.

## 5.2 Study Constraints

The following constraints might prevent the generalization of the study results on the study place and domain.

1. Different governmental institutions have different bidding procedures.
2. Governmental rules and regulations.
3. The ontology used might not be suitable for all scenarios in different institutions and countries.
4. The same vocabulary in different countries can have different meanings.

## 5.3 My work

In our work we will list the steps for building the ontology in general, then we explain in details how each step is implemented, and also we will create tables with the results we have from using the scientific measures and from consulting experts.

### 5.3.1 Building the Ontology

Building our ontology has the following major steps respectively

1. Gathering and extracting the concepts (raw data) related to the vehicles field that will be the basis for our ontology
2. Choosing the attributes for each concept
3. Filling the concepts with data (instances) according to the tenders' specifications
4. Storing the concepts, attributes, instances into a database then import the database into the ontology software (Protégé)
5. Creating ontological relationships according to scientific measures
6. Importing each bidders specifications to our ontology
7. Adding new relationships and making the semantic matching between the tender's requirements and the bidders' offers.

### 5.3.2 Ontology Concepts, Attributes and Instances

The concepts related to the vehicles domain is the corner stone for our ontology as it is for any ontology, now we got our ontology concepts (raw data) from different vehicles manufacturer companies, by asking for vehicles specifications from the company or by downloading the vehicle manual and specifications text files,from these files we willextract the concepts for our ontology.

For each concept there is a list of features, these features are the attributes for concepts, the features have also real data, and these data will be the instances for our concepts, so the concepts, attributes, instances of our ontology are extracted from real vehicles manufacturers' manuals and text files. Table 5.1 showsSample Concept, Attributes and Instances for the engine of 2013 Ford Taurus

**Concept**

| Engine | |
|---|---|
| **Attributes** | **Instances** |
| **Type** | 5.4-liter V8 FFV |
| **Manufacturing location** | Windsor Engine Plant, Windsor, Ontario |
| **Configuration** | Cast-iron block and aluminum heads |
| **Intake manifold** | Composite intake |
| **Exhaust manifold** | Cast-iron swept runner design |
| **Crankshaft** | Steel |
| **Redline** | 5,400 rpm |
| **Minimum idle speed in drive** | 550 rpm |
| **Throttle body** | 75 mm electronically controlled |
| **Valvetrain** | SOHC, three valves per cylinder, variable camshaft timing |

| | |
|---|---|
| **Valve diameter** | Intake, 33.8 mm; exhaust, 37.5 mm |
| **Pistons** | Strut-less modified barrel skirt; hypereutectic aluminum alloy with graphite skirt coating |
| **Connecting rods** | Powdered metal |
| **Ignition** | 12-volt coil-on-plug system |
| **Bore x stroke** | 3.55 x 4.17 in./90.2 x 105.8 mm |
| **Displacement** | 330 cu. in./5,408 cc |
| **Compression ratio** | 9.8:1 |
| **Horsepower** | 310 @ 5,100 rpm |
| **Horsepower per liter** | 55.5 |
| **Torque** | 365 lb.-ft. @ 3,600 rpm |
| **Recommended fuel** | 87 octane |
| **Fuel capacity** | 28.0 gallons 33.5 gallons |
| **Fuel injection** | Sequential multiport electronic |
| **Emission control** | Closed loop with catalyst |
| **Emissions(tailpipe/evaporation)** | Tier II, Bin 5/LEV II-ULEV II |
| **Oil capacity** | 7.0 quarts |
| **Recommended oil** | SAE 5W20 |
| **Coolant capacity** | 20.6 quarts, 23.2 quarts with auxiliary A/C |

**Table 5.1 Sample Concept, Attributes and Instances**

In the table,

- the *Engine* is the **concept**,
- Type, Manufacturing location, Configuration, etc. are the **attributes,**
- 5.4-liter V8 FFV, Windsor Engine Plant, Windsor, Ontario, Cast-iron block and aluminum heads etc. are the **instances**.

### 5.3.3 Creating the Ontology Concepts, Attributes and Instances

In the previous section we mentioned where do we get our concepts, attributes, and instances from, but these are just the raw material and we have to figure out the best way to create or use them in our ontology, first of all we will use these concepts in our ontology software Protégé, we demonstrated why to use this tool in chapter 3 the chosen tool section, now after studing all the features into the Protégé, we found that the best way to import our concepts is to import them from a relational database using a database tool mentioned in the following section, we will choose microsoft access 2007 relationl database to build our concepts, these concepts will be the tender's vehicle specifications or tenders' requirements, for each concept in our ontology, a table will be created, for each attribute for the concept a field will be creates, and for each instance a new table row will be inserted. Figure 5.1 shows an example, the figure shows a table created called engine, this table has many fields, e.g. type, horsepower, recomendded fuel, oil capacity etc., and for this table we have five rows of real data, now its important to mention that when we import this database into our ontology tool (Protégé), the following mapping will happen:

- The Database **Table** will be transformed to **Concept**
- The Table **Field** will be tranformed to **Attribute**
- The table **Row** will be transformed to **Instance**

A sample is shown in Figure 5.2 A and B

**Figure 5.1**

**Sample table with fields and rows**

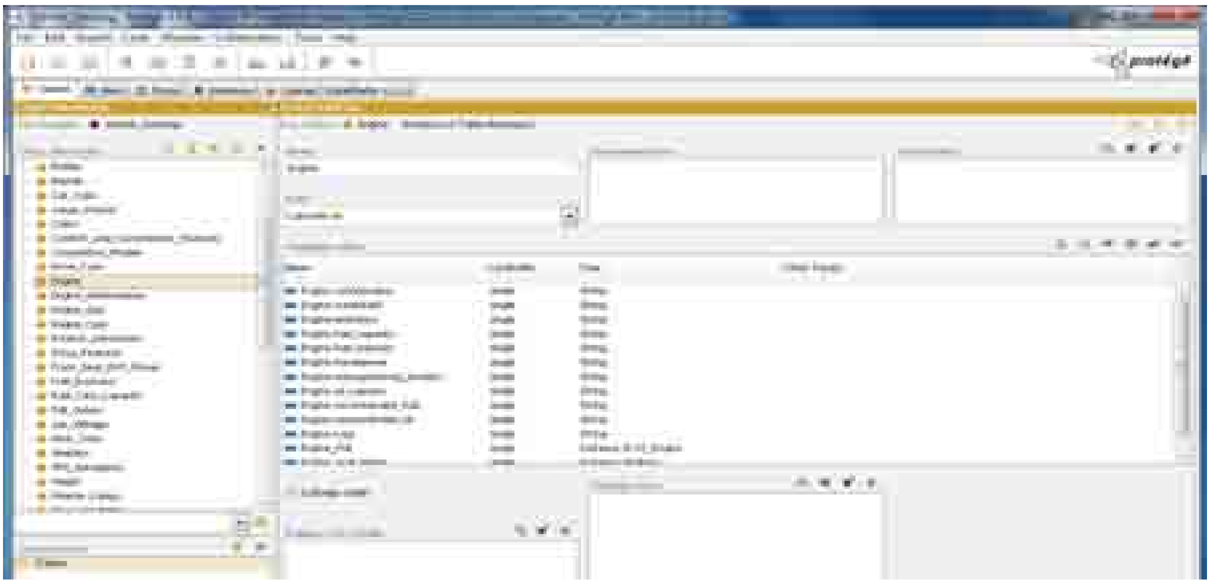

**Figure 5.2 A**

**Table Engine Transformed to Class Engine, and the Table Fields are Transformed to Slots**

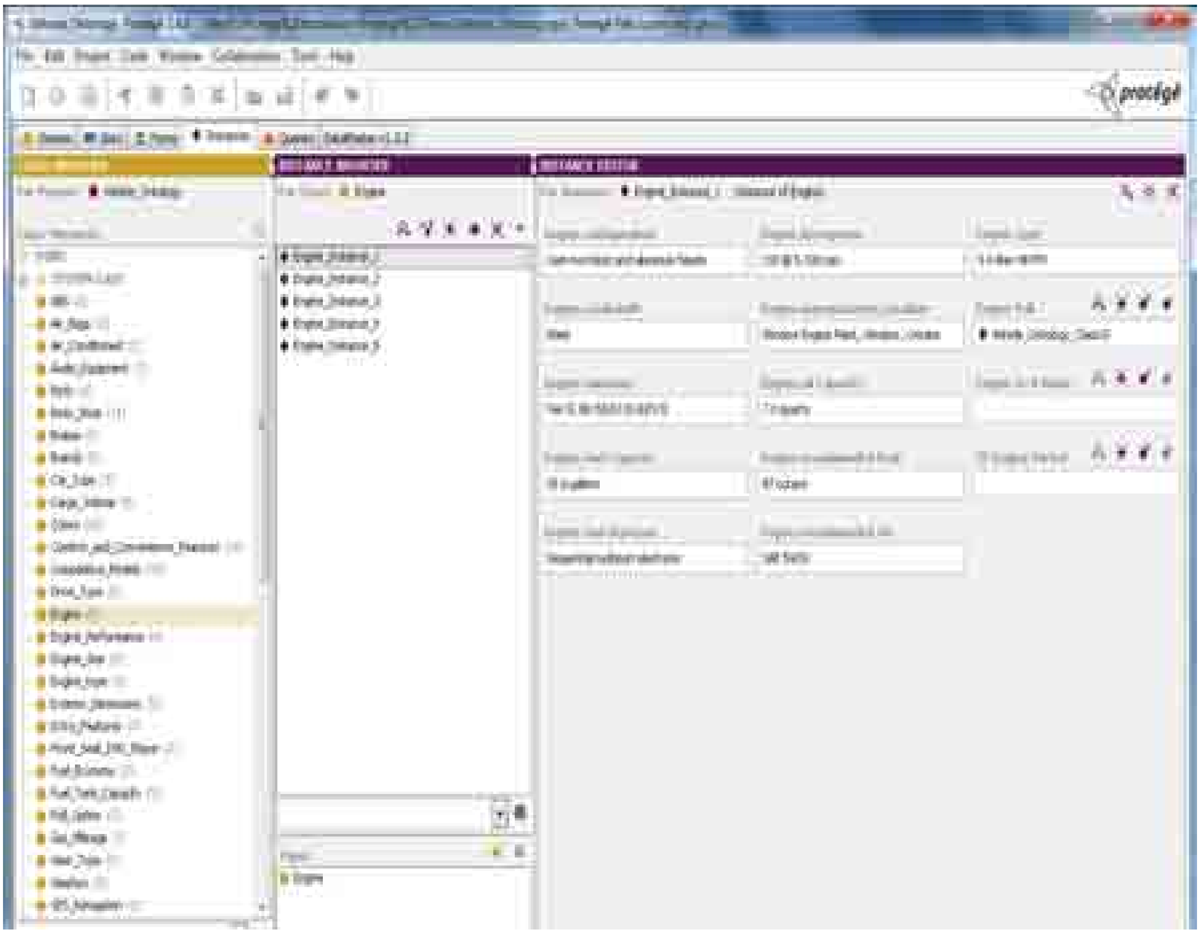

**Figure 5.2 B**

**Table Engine Row Transformed to Instance**

Figure 5.2 shows the concepts on the left pane, these are the concepts that we extracted of the raw data, and these raw data were extracted by the tender's requirements and according to experts recommendations, and also some of the raw data were taken from previous bids in the previous years. Comparing the concepts the tender desires with the concepts found in the previous bids, we found them very similar. The instances are shown for each attribute in the right pane.

### 5.3.4 Creating Ontological Relationships According To Scientific Similarity/Relatedness Measures

Reasoning about semantic relatedness is usually performed by humans but remains an obstacle for computers. Humans do not judge text relatedness merely at the level of text words. Words trigger reasoning at a much deeper level that manipulates concepts—the basic units of meaning that serve humans to organize and share their knowledge. Thus, humans interpret the specific wording of a document in the much larger context of their background knowledge and experience. (Markovitch, 2006)

In this thesis we will use semantic relatedness rather than semantic similarity, the semantic similarity simply checks how similar two concepts or words are, and if these two words are synonyms is-a relationship could be established, while the semantic relatedness can include the is-a, has-a, and other relationships, for the domain of evaluating tenders and bidders for e-government applications.

Studying the following similarity/relatedness measures,we can find the appropriatemeasures to define our relationship, these measures are adopted from(Ted Pedersen, 2013)

Before we go through these measures and apply them, we have to give a brief description about the wordnet ontology, the wordnet ontology is a lexical database that is designed for English language,it classifies the English words into a type of synonyms called synsets, which is a group of semantically related concepts for the purpose of matching and information retrieval.

a. **Wu & Palmer:** The Wu & Palmer measure (wup) calculates relatedness by considering the depths of the two synsets in the WordNet taxonomies, along with the depth of the LCS (Longest common substring problem). The formula is score = 2*depth(lcs) / (depth(s1) + depth(s2)). This means that 0 < score <= 1. The score can never be zero because the depth of the LCS is never zero (the depth of the root of a taxonomy is one). The score is one if the two input synsets are the same.

b. **Path Length:**A simple node-counting scheme (path). The relatedness score is inversely proportional to the number of nodes along the shortest path between the synsets. The shortest possible path occurs when the two synsets are the same, in which case the length is 1. Thus, the maximum relatedness value is 1.

c. **Lin:** The relatedness value returned by the lin measure is a number equal to 2 * IC(lcs) / (IC(synset1) + IC(synset2)). Where IC(x) is the information content of x. One can observe, then, that the relatedness value will be greater-than or equal-to zero and less-than or equal-to one. If the information content of any of either synset1 or synset2 is zero, then zero is returned as the relatedness score, due to lack of data.

d. **Gloss Vectors:** The Gloss Vector measure (vector) works by forming second-order co-occurrence vectors from the glosses or WordNet definitions of concepts. The relatedness of two concepts is determined as the cosine of the angle between their gloss vectors.

e. **Gloss Vectors (Pairwise):** The Gloss Vector (pairwise) measure (vector_pairs) is very similar to the "regular" Gloss Vector measure, except in the way it augments the glosses of concepts with adjacent glosses. From empirical studies, we have found that the regular Gloss Vector measure performs better than the pairwise Gloss Vector measure.

There many types of relationships among the concepts (classes), most of the relationships are derived from the inheritance technique in the object oriented programming, for example, the Is-A, and Has-Arelationships. The Is-A relationship is a relationship between two classes or concepts where the two concepts are almost the same with a slight different in meaning.

For the is-a relationship we will consider the Wu & Palmer and Lin Measures, by taking the average of the two measures, if the average is more than or equal 90% rounded to the first decimal place, then we consider the relationship as is-a, for example if we take the two concepts (engine and motor) we will find that according to the Wu & Palmer the relatedness similarity is 0.9524 and According to Lin the Relatedness similarity is 0.9788, the average of the two measures is 0.9656, so we can consider this an is-a relationship.

To prove that we can establish is-a relationship according to these two scientific measures we will take a sample of 204 synonyms in the domain of vehicles, the synonyms are taken from trusted English dictionaries, e.g. Oxford Dictionary, Dictionary.Com, The Free Online Dictionary, Google Translator, and Microsoft Office Word Synonyms.

| Synonyms | | Semantic Relatedness | | | Experts Matching | | $Error = \sqrt{(Exp-Avg)^2}$ | |
|---|---|---|---|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Lin** | **Average** | **Expert Matching Percentage (Honda)** | **Expert Matching Percentage (Toyota)** | **Avg / Expert1 Error** | **Avg /Expert2 Error** |
| Engine | Motor | 0.9524 | 0.9788 | 0.9656 | 1 | 0.95 | 0.03 | 0.01 |
| Engine | Cylinder | 0.8 | 0 | 0.4 | 0.1 | 0.5 | 0.3 | 0.1 |
| Brake | Restraint | 0.9474 | 0.8691 | 0.90825 | 1 | 0.9 | 0.1 | 0 |
| Brake | Hamper | 0.9 | 0.7737 | 0.83685 | 0.75 | 0.4 | 0.08 | 0.43 |
| Brand | Trademark | 1 | 0.7875 | 0.89375 ≈ 0.90 | 1 | 0.9 | 0.1 | 0 |
| Brand | Marker | 0.9333 | 0.8964 | 0.91485 | 0.9 | 0.9 | 0.01 | 0.01 |
| Brand | Emblem | 0.6 | 0.2937 | 0.44685 | 0.5 | 0.75 | 0.06 | 0.29 |
| Fuel | Petrol | 0.9231 | 0.9268 | 0.92495 | 0.9 | 0.9 | 0.02 | 0.02 |
| Capacity | Volume | 0.9091 | 0.9211 | 0.9151 | 1 | 0.9 | 0.09 | 0.01 |
| Capacity | Amplitude | 0.625 | 0.2184 | 0.4217 | 0.3 | 0.8 | 0.012 | 0.38 |
| Mileage | Milage | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| Mileage | Distance | 0.9412 | 0.7492 | 0.8452 | 0.5 | 0.9 | 0.34 | 0.06 |
| Performance | Execution | 1 | 1 | 1 | 1 | 0.9 | 0 | 0.1 |
| Performance | Act | 0.9412 | 0.9058 | 0.9235 | 0.85 | 0.8 | 0.07 | 0.012 |
| Color | Tinge | 1 | 1 | 1 | 0.8 | 0.9 | 0.2 | 0.2 |
| Color | Stain | 0.9333 | 0.9541 | 0.9437 | 0.8 | 0.9 | 0.014 | 0.04 |
| Color | Dye | 0.9333 | 0.9569 | 0.9451 | 0.8 | 0.9 | 0.14 | 0.03 |
| Color | Tint | 0.9333 | 0.8884 | 0.91085 | 0.8 | 0.9 | 0.011 | 0.01 |
| Door | Entry | 0.9474 | 0.9787 | 0.96305 | 0.6 | 0.9 | 0.36 | 0.06 |
| Door | Gate | 0.9091 | 0.8758 | 0.89245 ≈ 0.90 | 0.8 | 0.9 | 0.1 | 0 |
| Door | Egress | 0.4211 | 0.1903 | 0.3057 | 0.5 | 0.25 | 0.2 | 0.1 |
| Power | Vigor | 0.8571 | 1 | 0.92855 | 0.7 | 0.8 | 0.27 | 0.11 |
| Power | Force | 1 | 1 | 1 | 0.9 | 0.95 | 0.1 | 0.05 |
| Gas | Petrol | 1 | 1 | 1 | 1 | 0.9 | 0 | 0.1 |
| Gas | Kerosene | 0.9167 | 0.8578 | 0.88725 | 0.9 | 0.95 | 0.02 | 0.06 |
| Seat | Bench | 0.9524 | 0.8821 | 0.91725 | 0.9 | 0.85 | 0.01 | 0.6 |
| Seat | Lounge | 0.9524 | 0.8976 | 0.925 | 0.9 | 0.75 | 0.02 | 0.17 |
| Seat | Settee | 0.9091 | 0 | 0.45455 | 0.9 | 0.5 | 0.55 | 0.05 |
| Vehicle | Car | 0.9 | 0.8825 | 0.89125 ≈ 0.9 | 0.9 | 1 | 0 | 0.1 |
| Vehicle | Bus | 0.8421 | 0.6572 | 0.74965 | 0.9 | 1 | 0.15 | 0.25 |
| Vehicle | Truck | 0.8571 | 0.7858 | 0.82145 | 0.9 | 1 | 0.08 | 0.18 |
| Vehicle | Automobile | 0.8182 | 0.8825 | 0.85035 | 0.95 | 1 | 0.1 | 0.15 |
| Model | Pattern | 1 | 1 | 1 | 0.9 | 0.9 | 0.1 | 0.1 |
| Model | Mold | 1 | 1 | 1 | 0.8 | 0.9 | 0.2 | 0.1 |
| Model | Paradigm | 0.9412 | 0.9284 | 0.9348 | 0.9 | 0.95 | 0.03 | 0.02 |
| Height | Altitude | 1 | 1 | 1 | 1 | 0.9 | 0 | 0.1 |
| Height | Top | 1 | 1 | 1 | 0.9 | 0.9 | 0.1 | 0.1 |
| Height | Rise | 0.7059 | 0.5961 | 0.651 | 0.1 | 0.7 | 0.55 | 0.3 |
| Manufacturer | Producer | 1 | 1 | 1 | 1 | 0.95 | 0 | 0.05 |
| Manufacturer | Maker | 1 | 1 | 1 | 1 | 0.95 | 0 | 0.05 |
| Transmission | Dispatch | 0.75 | 0.2713 | 0.51065 | 0.6 | 0.75 | 0.09 | 0.24 |
| Safety | Security | 0.9333 | 0.9677 | 0.9505 | 0.9 | 0.95 | 0.05 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Safety** | **Integrity** | **0.7692** | **0.381** | **0.5751** | **0.6** | **0.5** | **0.02** | **0.07** |
| **Safety** | **Solidity** | **0.8** | **0.2798** | **0.5399** | **0.5** | **0.8** | **0.03** | **0.26** |
| **Safety** | **Protection** | **0.875** | **0.8255** | **0.85025** | **0.9** | **0.95** | **0.15** | **0.1** |
| **Suspension** | **Break** | **1** | **1** | **1** | **0.9** | **0.7** | **0.1** | **0.3** |
| **Suspension** | **Postponement** | **0.9231** | **0.9467** | **0.9349** | **0.9** | **0.8** | **0.03** | **0.13** |
| **Material** | **Substance** | **0.9091** | **0.9374** | **0.92325** | **0.9** | **0.9** | **0.02** | **0.02** |
| **Material** | **Matter** | **0.8** | **0.8669** | **0.83345** | **0.9** | **0.7** | **0.07** | **0.13** |
| **Warranty** | **pledge** | **0.9333** | **0.9677** | **0.9505** | **0.8** | **0.9** | **0.15** | **0.05** |
| **Warranty** | **assurance** | **0.9333** | **0.9677** | **0.9505** | **1** | **0.8** | **0.05** | **0.15** |
| **Feature** | **characteristic** | **1** | **1** | **1** | **0.85** | **0.95** | **0.15** | **0.05** |
| **Feature** | **Attribute** | **0.9474** | **0.9806** | **0.964** | **0.8** | **0.9** | **0.16** | **0.06** |
| **Audio** | **Sound** | **1** | **1** | **1** | **1** | **1** | **0** | **0** |
| **Audio** | **Voice** | **0.7273** | **0.5057** | **0.6165** | **0.9** | **0.8** | **0.28** | **0.19** |
| **System** | **Organization** | **1** | **1** | **1** | **0.9** | **0.85** | **0.1** | **0.15** |
| **System** | **Structure** | **0.9231** | **0.9573** | **0.9402** | **1** | **0.9** | **0.06** | **0.04** |
| **System** | **Order** | **0.7273** | **0.4374** | **0.80105** | **0.9** | **0.8** | **0.1** | **0** |
| **Cargo** | **Fright** | **1** | **1** | **1** | **0.9** | **0.95** | **0.1** | **0.05** |
| **Cargo** | **Loading** | **1** | **1** | **1** | **0.9** | **0.85** | **0.1** | **0.15** |
| **Cargo** | **Consignment** | **1** | **1** | **1** | **0.9** | **0.85** | **0.1** | **0.15** |
| **Cargo** | **Shipment** | **1** | **1** | **1** | **0.9** | **0.95** | **0.1** | **0.05** |
| **Cargo** | **Payload** | **1** | **1** | **1** | **0.9** | **0.85** | **0.1** | **0.15** |
| **Cargo** | **Capacity** | **0.3333** | **0.0584** | **0.19585** | **0.1** | **0.6** | **0.09** | **0.4** |
| **Cargo** | **Goods** | **0.875** | **0.7513** | **0.81315** | **0.8** | **0.95** | **0.01** | **0.09** |
| **Passenger** | **Occupant** | **0.7143** | **0.2013** | **0.4578** | **0.6** | **0.75** | **0.14** | **0.24** |
| **Passenger** | **Traveler** | **0.9231** | **0.7928** | **0.85795** | **0.9** | **0.85** | **0.04** | **0** |
| **Passenger** | **Rider** | **1** | **1** | **1** | **0.7** | **0.85** | **0.3** | **0.15** |
| **Passenger** | **Commuter** | **0.9333** | **0.9478** | **0.94055** | **0.9** | **0.85** | **0.04** | **0.09** |
| **Belt** | **Strap** | **0.8** | **0.2536.** | **0.5268** | **0.9** | **0.9** | **0.38** | **0.47** |
| **Belt** | **Band** | **0.9565** | **0.266** | **0.61125** | **0.6** | **0.75** | **0.01** | **0.14** |
| **Belt** | **Girdle** | **0.7273** | **0.2294** | **0.47835** | **0.4** | **0.6** | **0.07** | **0.12** |
| **Belt** | **Waistband** | **0.6316** | **0.2294** | **0.4305** | **0.8** | **0.6** | **0.37** | **0.17** |
| **Belt** | **Fasten** | **0.8889** | **0** | **0.44445** | **0.4** | **0.65** | **0.04** | **0.21** |
| **Belt** | **Restraint** | **0.7368** | **0.2846** | **0.5107** | **0.3** | **0.65** | **0.21** | **0.14** |
| **Belt** | **Cincture** | **0.6316** | **0.2294** | **0.4305** | **0.9** | **0.75** | **0.47** | **0.32** |
| **Tire** | **Tyre** | **1** | **1** | **1** | **1** | **1** | **0** | **0** |
| **Tire** | **Wheel** | **0.6** | **0.267** | **0.4335** | **0.8** | **1** | **0.37** | **0.57** |
| **Tire** | **Drain** | **0.5714** | **0.2536** | **0.4125** | **0.3** | **0.6** | **0.11** | **0.19** |
| **Price** | **Cost** | **1** | **1** | **1** | **1** | **1** | **0** | **0** |
| **Price** | **Value** | **0.9333** | **0.9094** | **0.92135** | **1** | **1** | **0.08** | **0.08** |
| **Price** | **Amount** | **0.625** | **0.5769** | **0.60095** | **1** | **0.95** | **0.4** | **0.25** |
| **Price** | **Fee** | **0.8** | **0.6192** | **0.7096** | **0.9** | **0.75** | **0.19** | **0.05** |
| **Price** | **Payment** | **0.8889** | **0.7195** | **0.8042** | **0.9** | **0.9** | **0.1** | **0.1** |
| **Price** | **Rate** | **0.8421** | **0.6542** | **0.74815** | **1** | **0.9** | **0.24** | **0.15** |
| **Price** | **Charge** | **0.8889** | **0.6768** | **0.78285** | **0.9** | **0.9** | **0.12** | **0.12** |
| **Dimension** | **Proportion** | **1** | **1** | **1** | **0.8** | **90** | **0.2** | **0.1** |
| **Dimension** | **Length** | **0.9333** | **0.9726** | **0.95295** | **0.9** | **0.85** | **0.05** | **0.1** |
| **Dimension** | **Aspect** | **0.9** | **0.9169** | **0.90845** | **0.7** | **0.8** | **0.5** | **0.1** |
| **Dimension** | **Distance** | **0.8** | **0.6111** | **0.70555** | **0.65** | **0.7** | **0.05** | **0** |
| **Dimension** | **Element** | **0.8421** | **0.6692** | **0.75565** | **0.5** | **0.7** | **0.21** | **0.05** |
| **Dimension** | **Measure** | **0.6154** | **0.4009** | **0.50815** | **1** | **0.9** | **0.49** | **0.1** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Window** | **Windowpane** | **1** | **1** | **1** | **0.9** | **0.95** | **0.1** | **0.05** |
| **Window** | **Pane** | **0.9474** | **0.9478** | **0.9476** | **0.9** | **0.85** | **0.05** | **0.08** |
| **Window** | **Glass** | **0.7273** | **0.3013** | **0.5143** | **0.8** | **1** | **0.29** | **0.49** |
| $\boldsymbol{Error\ Percentage\ Average} = \dfrac{\sum_{i=1}^{n} \text{Sqrt }(\text{Exp}i - \text{Avg}i)^2}{n}$ | | | | | | | **0.12996** | **0.12749** |

**Table 5.2 Synonyms Semantic Relatedness, Experts Matching, and Error Percentage Based on Wu & Palmer and Lin Measures**

The sample taken in the table will be processed by different aspects, table 5.2have four groups, the synonyms group which has two columns word1 and word2, the second group includes the scientific measures that will be used to build our ontology and their average, the third column shows the matching percentage of the synonyms according to experts from different vehicles companies (Honda & Toyota), and this is to enhance the credibility of the results found. We also added a formula to get the error percentageby taking the mean square of the differences between the average of the measures and the result from the expert, where Exp is the expert result and Avg is the average of the Wu & Palmer and Lin Measures, at the end of the table we calculated the average of the error percentages from the two experts for the concepts, where *i*represents the index for the combination of the two synonyms, *n* is the number of synonyms combinations, for example,$\boldsymbol{Error\ Percentage\ Average} = Sqrt\ ((\text{Exp1} - \text{Avg1})\text{^}2 + (\text{Exp2} - \text{Avg2})\text{^}2 + (\text{Exp3} - \text{Avg3})\text{^}2 + \ \ldots.)/\ n.$

As we can see from table 5.2 the most related words in the meaning have the highest relatedness, for example the words ( price and cost ) have semantic relatedness of 1 because they are very close in meaning, but the words price and amount have less semantic relatedness value, and we can also see that the matching results we had from the experts are very close to the results we found, and for the credibility of the results, the experts were not informed about the results we had from the scientific measures, according to the results in table 5.2 we can move on building our is-a relationship between the concepts according to **Wu & Palmer and Lin Relatedness Measures**.

Moreover, and in order to be surethat the results are accurate and correct we used three measure percentages90%, 70%and 60%, Table 5.3 proves that when the average of two synonyms is almost 90% or more, these synonyms are almost the same words. Also the table shows that we can build our relationship Is-A using these results, note that the error margin is very low.

| **Synonyms** | | **Semantic Relatedness** | | | **Experts Matching** | | $Error = \sqrt{(Exp-Avg)^2}$ | |
|---|---|---|---|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Avg / Expert1 Error** | **Avg / Expert1 Error** | **Expert 1 Matching Percentage (Honda)** | **Expert 2 Matching Percentage (Toyota)** | **Avg / Expert1 Error** | **Avg /Expert2 Error** |
| Engine | Motor | 0.9524 | 0.9788 | 0.9656 | **1** | **0.95** | **0.03** | **0.01** |
| Brake | Restraint | 0.9474 | 0.8691 | 0.90825 | **1** | **0.85** | **0.1** | **0.05** |
| Brand | Trademark | 1 | 0.7875 | 0.89375 ≈ 0.90 | **1** | **0.85** | **0.1** | **0.05** |
| Brand | Marker | 0.9333 | 0.8964 | 0.91485 | **0.90** | **0.85** | **0.01** | **0.06** |
| Fuel | Petrol | 0.9231 | 0.9268 | 0.92495 | **0.90** | **0.90** | **0.02** | **0.02** |
| Fuel | Gas | 0.9231 | 0.9268 | 0.92495 | **0.90** | **0.90** | **0.02** | **0.02** |
| Capacity | Volume | 0.9091 | 0.9211 | 0.9151 | **1** | **0.90** | **0.09** | **0.01** |
| Mileage | Milage | 1 | 1 | 1 | **1** | **1** | **0.0** | **0.0** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Performance | Execution | 1 | 1 | 1 | **1** | **0.80** | **0.**0 | **0.2** |
| Color | Tinge | 1 | 1 | 1 | **0.60** | **0.90** | **0.**4 | **0.1** |
| Color | Stain | 0.9333 | 0.9541 | 0.9437 | **0.60** | **0.90** | **0.**34 | **0.04** |
| Color | Dye | 0.9333 | 0.9569 | 0.9451 | **0.80** | **0.88** | **0.**14 | **0.05** |
| Color | Tint | 0.9333 | 0.8884 | 0.91085 | **0.60** | **0.90** | **0.**31 | **0.**01 |
| Color | Paint | 0.9333 | 0.9557 | 0.9445 | **0.90** | **0.95** | **0.**04 | **0.**01 |
| Door | Entry | 0.9474 | 0.9787 | 0.96305 | **0.60** | **0.90** | **0.**36 | **0.06** |
| Door | Gate | 0.9091 | 0.8758 | 0.89245 ≈ 0.90 | **0.60** | **0.90** | **0.**3 | **0.**0 |
| Power | Vigor | 0.8571 | 1 | 0.92855 | **0.60** | **0.80** | **0.**32 | **0.**11 |
| Power | Force | 1 | 1 | 1 | **0.90** | **0.95** | **0.**1 | **0.**05 |
| Power | Strength | 0.9231 | 0.885 | 0.90405 | **0.90** | **0.85** | **0.**0 | **0.**05 |
| Gas | Petrol | 1 | 1 | 1 | **1** | **0.85** | **0.**0 | **0.**15 |
| Gas | Petroleum | 1 | 1 | 1 | **0.60** | **0.80** | **0.**40 | **0.2** |
| Seat | Chair | 0.9524 | 0.9624 | 0.9574 | **0.90** | **0.95** | **0.**05 | **0.**0 |
| Seat | Couch | 0.9524 | 0.8976 | 0.925 | **0.90** | **0.90** | **0.**02 | **0.**02 |
| Seat | Bench | 0.9524 | 0.8821 | 0.91725 | **0.90** | **0.80** | **0.**01 | **0.11** |
| Vehicle | Car | 0.9 | 0.8825 | 0.89125 ≈ 0.9 | **0.90** | **1** | **0.**0 | **0.**1 |
| Model | Pattern | 1 | 1 | 1 | **0.80** | **0.90** | **0.**2 | **0.**1 |
| Model | Mold | 1 | 1 | 1 | **0.80** | **0.90** | **0.**2 | **0.**1 |
| Model | Template | 0.9412 | 0.869 | 0.9051 | **0.90** | **0.80** | **0.**0 | **0.**1 |
| Height | Altitude | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Elevation | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Peak | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Top | 1 | 1 | 1 | **0.90** | **0.90** | **0.**1 | **0.**1 |
| Manufacturer | Producer | 1 | 1 | 1 | **1** | **0.95** | **0.**0 | **0.**05 |
| Manufacturer | Maker | 1 | 1 | 1 | **1** | **0.95** | **0.0** | **0.**05 |
| Ventilation | Airing | 1 | 1 | 1 | **0.80** | **0.80** | **0.**2 | **0.**2 |
| Safety | Security | 0.9333 | 0.9677 | 0.9505 | **0.90** | **0.95** | **0.**05 | **0.**0 |
| Suspension | Break | 1 | 1 | 1 | **0.70** | **0.60** | **0.**3 | **0.**4 |
| Warranty | assurance | 0.9333 | 0.9677 | 0.9505 | **1** | **0.80** | **0.**05 | **0.**15 |
| Feature | characteristic | 1 | 1 | 1 | **0.80** | **0.95** | **0.**2 | **0.**05 |
| Feature | Attribute | 0.9474 | 0.9806 | 0.964 | **0.80** | **0.90** | **0.**16 | **0.**06 |
| Audio | Sound | 1 | 1 | 1 | **1** | **1** | **0.**0 | **0.**0 |
| System | Organization | 1 | 1 | 1 | **0.90** | **0.85** | **0.**1 | **0.**15 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| System | Structure | 0.9231 | 0.9573 | 0.9402 | **1** | **0.90** | **0.**06 | **0.**04 |
| Passenger | Rider | 1 | 1 | 1 | **0.50** | **0.85** | **0.**50 | **0.**15 |
| Tire | Tyre | 1 | 1 | 1 | **1** | **1** | **0.**0 | **0.**0 |
| Price | Cost | 1 | 1 | 1 | **1** | **1** | **0.**0 | **0.**0 |
| Price | Value | 0.9333 | 0.9094 | 0.92135 | **1** | **1** | **0.**08 | **0.**08 |
| Window | Windowpane | 1 | 1 | 1 | **0.90** | **0.95** | **0.**1 | **0.05** |
| **The Average** | | | | **0.983985** | **0.86875** | **0.893333** | **0.11375** | **0.075208** |

**Table 5.3 Synonyms Semantic Relatedness, Experts Matching, and Error Percentage Based on the Average≈90% of Wu & Palmer and Lin Measures**

| **Synonyms** | | **Semantic Relatedness** | | | **Experts Matching** | | $Error = \sqrt{(Exp-Avg)^2}$ | |
|---|---|---|---|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Lin** | **Average** | **Expert 1 Matching Percentage (Honda)** | **Expert 2 Matching Percentage (Toyota)** | **Avg / Expert1 Error** | **Avg /Expert2 Error** |
| Mileage | Span | 0.8889 | 0.599 | 0.74395 | **0.30** | **0.60** | **0.**44 | **0.14** |
| Gear | Wheel | 0.96 | 0.5 | 0.73 | **0.90** | **0.60** | **0.**17 | **0.**13 |
| Gas | Oil | 0.875 | 0.6811 | 0.77805 | **0.30** | **0.80** | **0.**47 | **0.**02 |
| Vehicle | Bus | 0.8421 | 0.6572 | 0.74965 | **0.90** | **1** | **0.**15 | **0.**25 |
| Vehicle | Van | 0.8571 | 0.6663 | 0.7617 | **0.90** | **1** | **0.**14 | **0.**24 |
| Price | Fee | 0.8 | 0.6192 | 0.7096 | **0.90** | **0.75** | **0.**19 | **0.**05 |
| Price | Rate | 0.8421 | 0.6542 | 0.74815 | **1** | **0.90** | **0.**24 | **0.**15 |
| Price | Charge | 0.8889 | 0.6768 | 0.78285 | **0.90** | **0.90** | **0.**12 | **0.**12 |
| Dimension | Distance | 0.8 | 0.6111 | 0.70555 | **0.65** | **0.70** | **0.**05 | **0.**0 |
| Dimension | Element | 0.8421 | 0.6692 | 0.75565 | **0.50** | **0.70** | **0.**25 | **0.**05 |
| **The Average** | | | | 0.678219 | 0.704839 | 0.791935 | 0.237097 | 0.159032 |

**Table 5.4 Synonyms Semantic Relatedness, Experts Matching, and Error Percentage Based on the Average≈70% of Wu & Palmer and Lin Measures**

In the Table 5.4 we took the 70% to show the inaccuracy of the relationship between synonymous, for example, if you ask an expert what is the difference between the price and fees, of course, there is a difference between them butif we take the price and cost, the answer will be, they are almost the same.

| Synonyms | | Semantic Relatedness | | | Experts Matching | | $Error = \sqrt{(Exp-Avg)^2}$ | |
|---|---|---|---|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Lin** | **Average** | **Expert 1 Matching Percentage (Honda)** | **Expert 2 Matching Percentage (Toyota)** | **Avgas / Expert1 Error** | **Avg /Expert2 Error** |
| Brake | Stop | 0.9 | 0.4373 | 0.66865 | **1** | **0.75** | **0.34** | 0.08 |
| Capacity | Quantity | 0.8 | 0.4669 | 0.63345 | **1** | **0.95** | 0.37 | **0.32** |
| Gear | Instrument | 0.8421 | 0.5291 | 0.6856 | **0.50** | **0.75** | 0.18 | 0.06 |
| Gear | Machinery | 0.8 | 0.4366 | 0.6183 | **0.80** | **0.90** | 0.19 | 0.33 |
| Power | Potential | 0.8235 | 0.4845 | 0.654 | **0.50** | **0.80** | 0.15 | 0.14 |
| Height | Rise | 0.7059 | 0.5961 | 0.651 | **0.40** | **0.80** | 0.25 | 0.15 |
| Width | Range | 0.75 | 0.6001 | 0.67505 | **0.30** | **0.85** | 0.37 | 0.18 |
| Width | Area | 0.75 | 0.5542 | 0.6521 | **0.40** | **0.80** | 0.25 | 0.15 |
| Width | Ambit | 0.75 | 0.6001 | 0.67505 | **0.30** | **0.55** | 0.37 | 0.17 |
| Manufacturer | Company | 0.75 | 0.4762 | 0.6131 | **0.80** | **0.95** | 0.19 | 0.34 |
| Ventilation | Aeration | 0.8571 | 0.4172 | 0.63715 | **0.90** | **0.95** | 0.26 | 0.31 |
| Safety | Preventive | 0.9474 | 0.4195 | 0.68345 | **0.80** | **0.85** | 0.12 | 0.17 |
| Suspension | Stop | 0.8571 | 0.3843 | 0.6207 | **0.30** | **0.50** | 0.32 | 0.12 |
| Material | Article | 0.8571 | 0.3668 | 0.61195 | **0.50** | **0.60** | 0.11 | 0.01 |
| Material | Item | 0.7692 | 0.5813 | 0.67525 | **0.90** | **0.80** | 0.23 | 0.12 |
| Warranty | Security | 0.9412 | 0.3138 | 0.6275 | **0.90** | **0.70** | 0.27 | 0.07 |
| Feature | Attribute | 0.6316 | 0.3536 | 0.6694 | **0.90** | **0.70** | 0.24 | 0.16 |
| Audio | Voice | 0.7273 | 0.5057 | 0.6165 | **0.90** | **0.90** | 0.29 | 0.29 |
| System | Method | 0.4374 | 0.9211 | 0.67925 | **0.90** | **0.80** | 0.22 | 0.12 |
| Belt | Band | 0.9565 | 0.266 | 0.61125 | **0.60** | **0.75** | 0.01 | 0.14 |
| Price | Amount | 0.625 | 0.5769 | 0.60095 | **1** | **0.95** | 0.4 | 0.35 |
| **The Average** | | | | 0.645698 | 0.695238 | 0.790476 | 0.244286 | 0.18 |

**Table 5.5 Synonyms Semantic Relatedness, Experts Matching, and Error Percentage Based on the Average≈60% of Wu & Palmer and Lin Measures**

Table 5.5 assures the previous results, which means that the more the two words are close to each other in meaning the higher the average of the two measures, and the more they are irrelevant the lower the average

### 3.3.5 Full Scenario

In this section we will take a full scenario in which a tender will make an invitation to bid and we will assume that four bidders provide four offers to satisfy the tender's specifications, in our research the tender will be any governmental institution while the bidder could be any commercial company in the domain of vehicles.

#### Determining the Tender's Specifications

The tender can describe the features and specifications of the vehicles in full details, these requirements and concepts can easily change in the future, its important here to mention that each requirement will represent a class, and if the class has more details specifications these specifications will be attributes, and the real data for the attributes are the instances, for example, in the vehicle requirements below Engine is a class, Horse Power is an attribute, 3500 Horse Power is an instance, the concepts used in the ontology are the tenders requirements and bidders provided offers, and these concepts are extracted according to experts in the vehicles domain and according to previous bids.

#### *Tender's Vehicle Requirements*

- **Brand (s):** Mercedes, BMW, Peugeot, Cadillac, ORToyota
- **Body Style:**Sedan, OR Saloon
- **Engine:**
    - **Horse Power:** 2500, 3000, OR 3500

    - **Oil Capacity:** 3.0 quarts, 4.0 quarts, OR 5.0 quarts
    - **Fuel Capacity:** 20.0 gallons, 22.0 gallons, and 25.0 gallons
- **Color:** Off White, White, OR Beige
- **ABS (Anti-Lock Braking System):** YES
- **Air Bags:** 1,2,3,4, OR 5
- **Air Conditioned:** YES
- **Gas Mileage:** 26 mpg or more
- **Gear Type:** Manual or Automatic
- **GPS Navigation:** YES
- **Warranty:** 4 years or more
- **Full Option:** YES

### *Bidder's Offers*

### *Bidder 1*

- **Brand (s):** Mercedes, BMW, Cadillac, ORToyota
- **Body Style:** Saloon
- **Engine:**
    - **Horse Power:** 2500, OR 3000
    - **Oil Capacity:** 3.0 quarts, 4.0 quarts, OR 5.0 quarts
    - **Fuel Capacity:** 20.0 gallons, 22.0 gallons, and 25.0 gallons
- **Color:** White, OR Beige
- **ABS (Anti-Lock Braking System):** YES
- **Air Bags:** 2,3, OR 4
- **Air Conditioned:** YES
- **Gas Mileage:** 26 mpg or more
- **Gear Type:** Manual or Automatic
- **GPS Navigation:** No
- **Warranty:** 4 years or more
- **Full Option:** YES

### *Bidder 2*

- **Brand (s):**Toyota
- **Body Style:** Coupe
- **Engine:**
  - **Horse Power:** 2500, OR 3000
  - **Oil Capacity:** 3.0 quarts, 4.0 quarts, OR 5.0 quarts
  - **Fuel Capacity:** 20.0 gallons, 22.0 gallons, and 25.0 gallons
- **Color:** White, OR Beige
- **ABS (Anti-Lock Braking System):** YES
- **Air Bags:** 2,OR 4
- **Air Conditioned:** YES
- **Gas Mileage:** 26 mpg or more
- **Gear Type:** Manual or Automatic
- **GPS Navigation:** No
- **Warranty:** 4 years or more
- **Full Option:** YES

### *Bidder 3*

- **Brand (s):**BMW OR Cadillac
- **Body Style:** Saloon
- **Engine:**
  - **Horse Power:** 2500, OR 3000
  - **Oil Capacity:** 6 quarts
  - **Fuel Capacity:**30.0 gallons
- **Color:** White, OR Beige
- **ABS (Anti-Lock Braking System):** YES
- **Air Bags:** 3, OR 4
- **Air Conditioned:** YES
- **Gas Mileage:** 20 mpg or more

- **Gear Type:** Manual or Automatic
- **GPS Navigation:** No
- **Warranty:** 4 years or more
- **Full Option:** YES

### *Bidder 4*

- **Brand (s):** Mercedes, BMW, Cadillac, ORToyota
- **Body Style:** Saloon
- **Engine:**
  - **Horse Power:** 2500, OR 3000
  - **Oil Capacity:** 3.0 quarts
  - **Fuel Capacity:** 20.0 gallons OR 22.0
- **Color:** Beige
- **ABS (Anti-Lock Braking System):** NO
- **Air Bags:** 3 OR 4
- **Air Conditioned:** YES
- **Gas Mileage:** 26 mpg or more
- **Gear Type:** Manual or Automatic
- **GPS Navigation:** YES
- **Warranty:** 2 years or more
- **Full Option:** YES

The data provided by the bidders will be imported into our ontology the same way as we imported our concepts as mentioned in the section "*Creating the Ontology Concepts, Attributes and Instances*"

But we will organize these data and make simple modifications to distinguish the data provided from different bidders. And this will be done as the following:

- If the data provided from a bidder is in the form of a database then we will have to modify the table name to indicate that this table belongs to bidder 1 or 2
- If the data provided from a bidder is in a form other than relational database then we can copy and paste our existing concepts and just rename them to indicate whose bidder are these information

Either way we will continue our ontological matching considering each bidder's information are in the form of Class_BidderNumber, for example the class Engine_1 means that this class is provided from bidder 1 about the Engine specifications.

Most probably the bidders will use different terms than our concepts, so we will have to add some relationships according to the data provided from bidders, and these relationships will be created according to the measures' results found in Table 5.2, for example if bidder 1 provided the concept Motor instead of Engine, we can create Is-A relationship between the two concepts because the average of the measures used in Table 5.2 is0.9656 which is $\geq$ 0.90.

### Matching Tender and Bidders Specifications

According to the data provided in the previous section we start the matching process between tenders' specifications and bidders' information for each bidder.

Beginning with the class brands, we will compare all brands from the bidders to the required tender's brands. To compare the brands of bidder_1 we have to create a new slot in the class bidder_1 to connect it with the brands class Figure 5.3 shows the required relation for the matching process between brands.

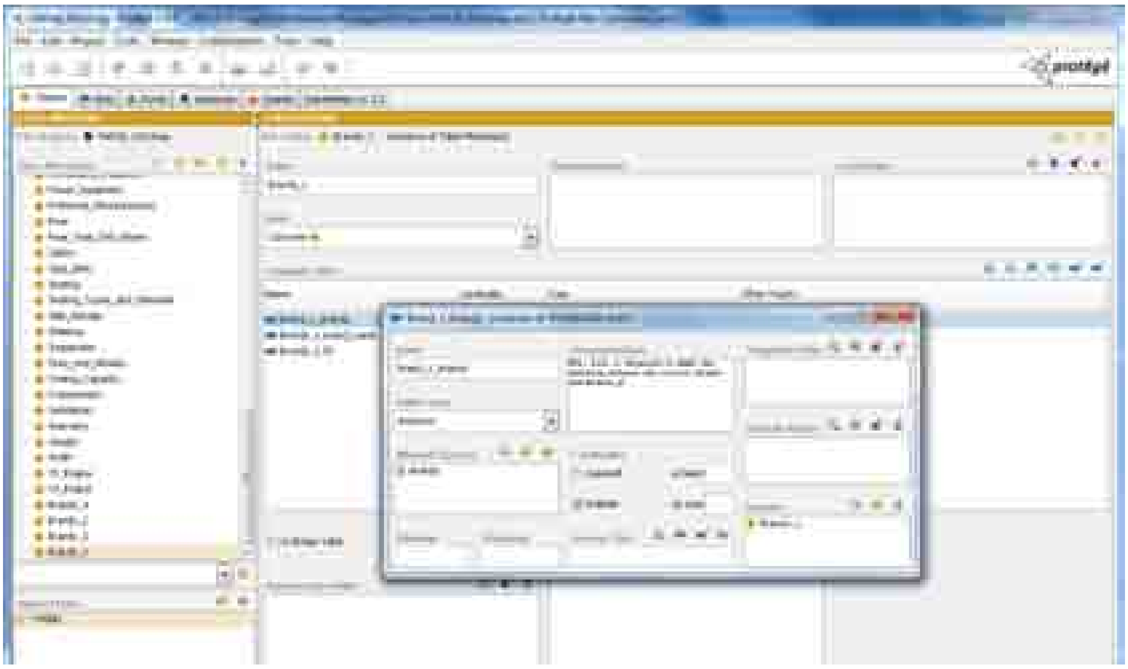

**Figure 5.3**

**Creating a Slot to Make the Matching Process between Tender and Bidderfor Brands Requirement**

This new slot was necessary for the matching process that we will make in the query tab, we want to match all the provided brands with all required brands, Figure 5.4, Since we have 5 required brands we used the new created Brand_1_Brands to compare brands provided by bidder 1 with all brands required from tender.

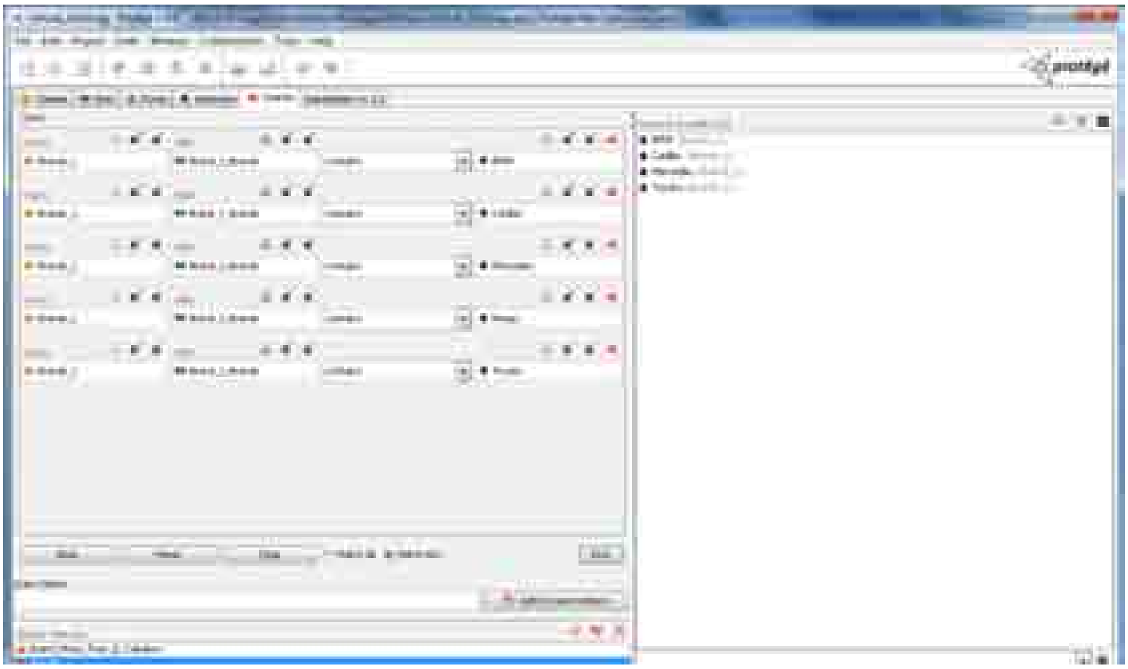

**Figure 5.4**

**Matching Bidder’s 1 Offered Brands with All Required Brands**

As the figure shows bidder 1 has four out of five matching brands, this is the result we can have from the Protégé, from this result we can infer that bidder 1 provided partial fulfillment of the Brands requirement but unfortunately there is no percentage showing a precise value of how close bidder 1 is to tenders brands, so we have to make this percentage manually. For any class we divide the number of provided matching instances by the number of required instances Formula 5.1,

$$Class\ Matching\ Percentage\ \frac{The\ number\ of\ provided\ matching\ instances}{\text{The number of required instances}}\quad \textbf{Formula 5.1}$$

For example, in Figure 5.4, the number of required brands is 5, and the number of provided matching brands is 4, so the matching percentage of class brands of bidder 1 is

$$Brand_1 Matching\ Percentage = \frac{4}{5} = \mathbf{0.8}$$

We will find this percentage for each class (tender's requirement) for each bidder, then we calculate the summation of percentages for all classes for each bidder dividing them by the total number of required classes (requirements) Formula 5.2, the bidder with the highest result will be the best matching bidder,

$$Bidder\ Matching\ Result\ \frac{The\ Summation\ of\ Requiremnts\ Percentages}{\text{The Total Number of Requiremnts}} \textbf{Formula 5.2}$$

We will take the rest of the requirement, as we did for the Brands requirement.

**Body Style**

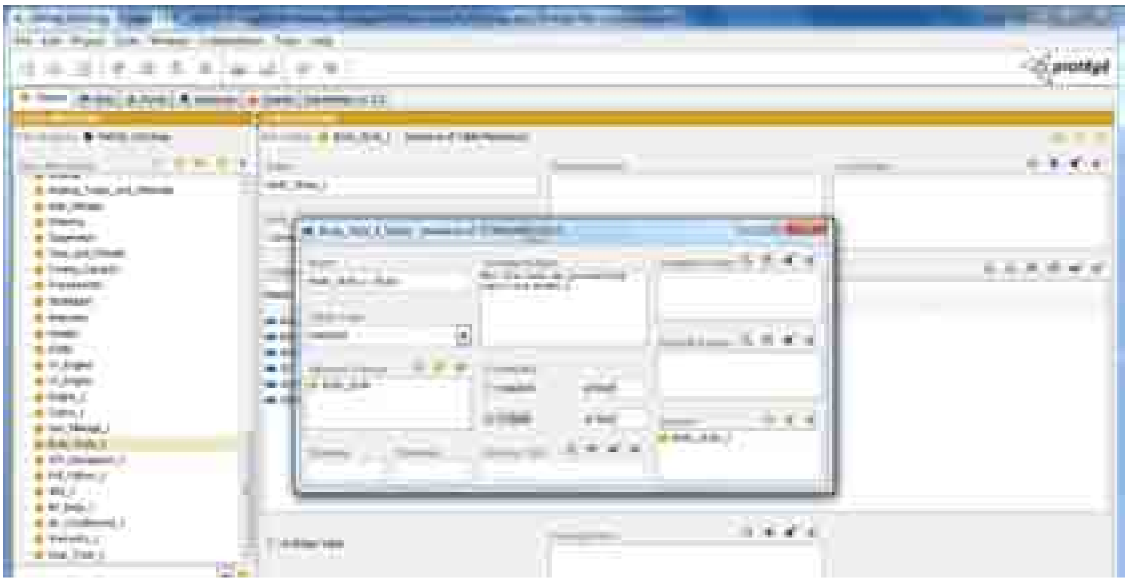

**Figure 5.5**

**Creating a Slot to Make the Matching Process between Tender and Bidder for Body Style Requirement**

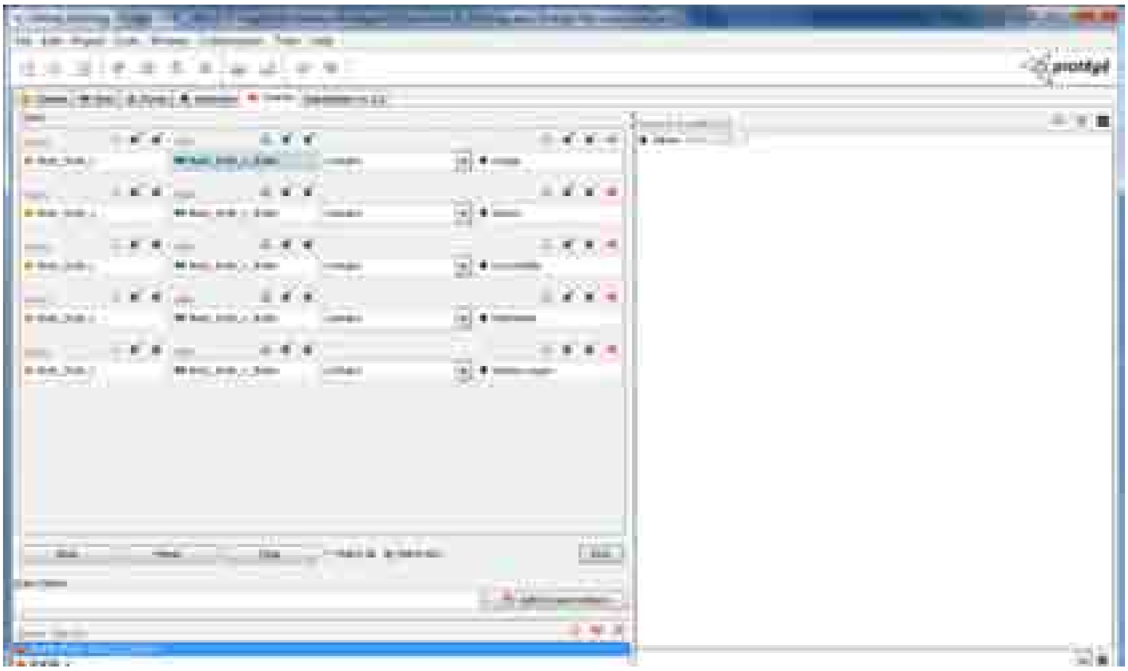

**Figure 5.6**

**Matching Bidder's 1 Offered Body Styles with All Required Styles**

According to formula 5.1

$$Body\ Style_1\ Matching\ Percentage = \frac{1}{5} = \mathbf{0.2}$$

**Engine**

Because we have three tender's requirements related to Engine, we will have to make three slots for the matching process

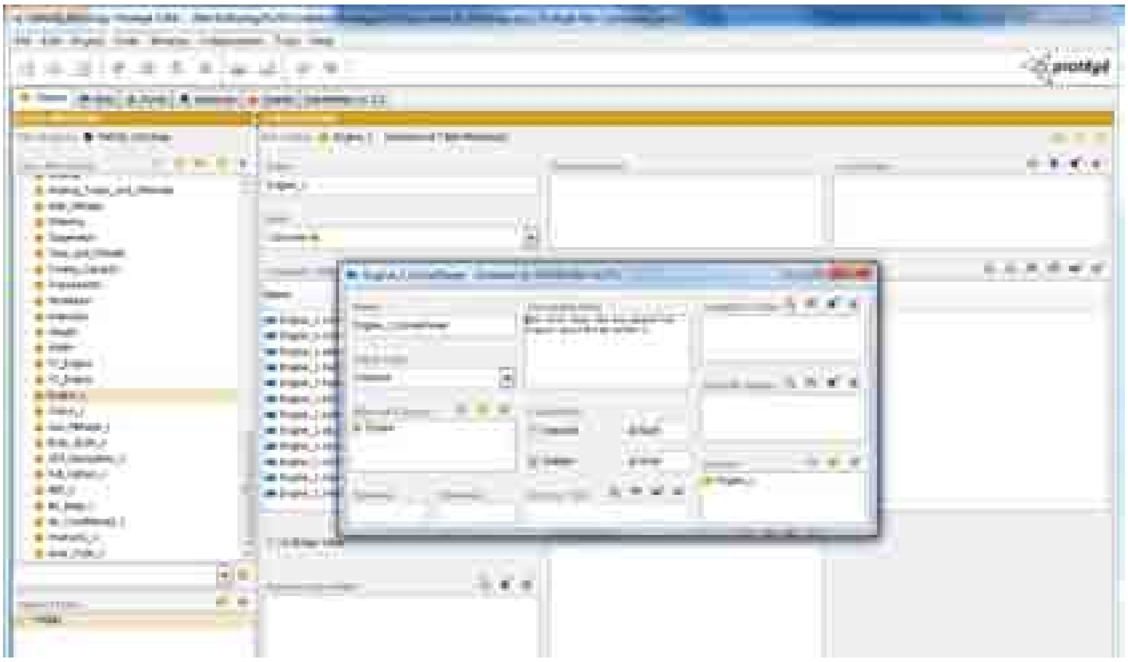

**Figure 5.7**

**Creating a Slot to Make the Matching Process between Tender and Bidder forEngine Horsepower Requirement**

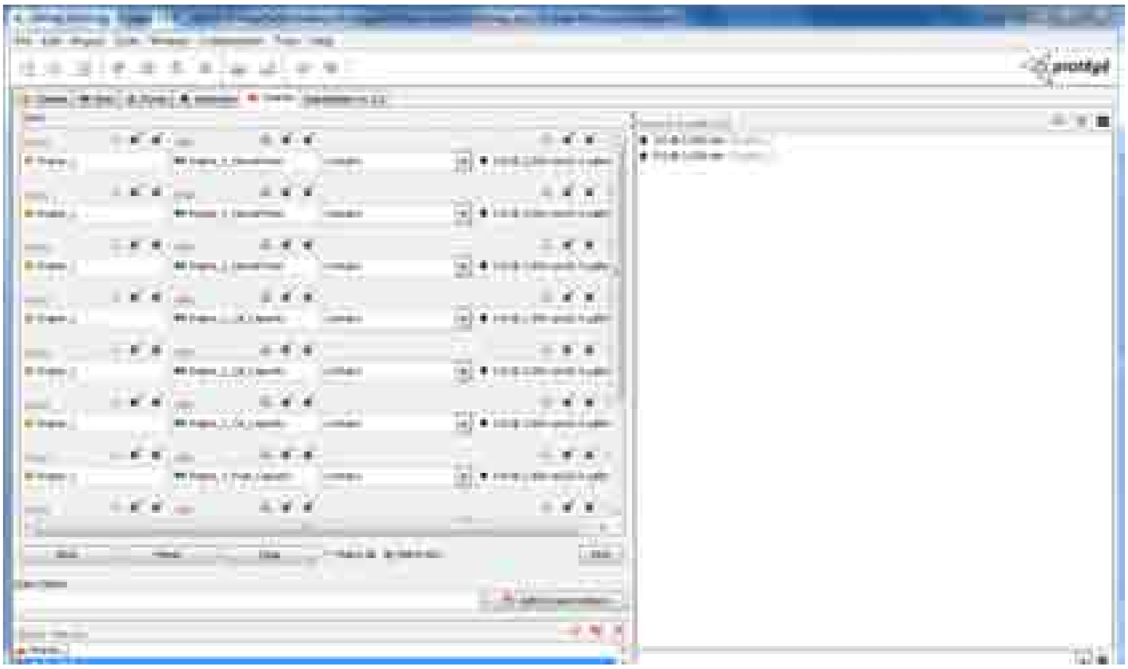

**Figure 5.8**

**Matching Bidder's 1 Offered Engines with All Required Engines**

According to formula 5.1

$$Engine\_1\ Matching\ Percentage = \frac{2}{3} = \mathbf{0.6666}$$

Now assume bidder 1 provided the *Term* motor instead of *Engine*, according to our results in table 5.2, we can create Is-A relationship between the terms Motor and Engine concepts since the average of the two measures is ≥ 0.90 more specifically is 0.9656.Because we have three tender's requirements related to Engine, we will have to make three Is-A Relationships for the matching process between the synonyms *Motor* and *Engine*

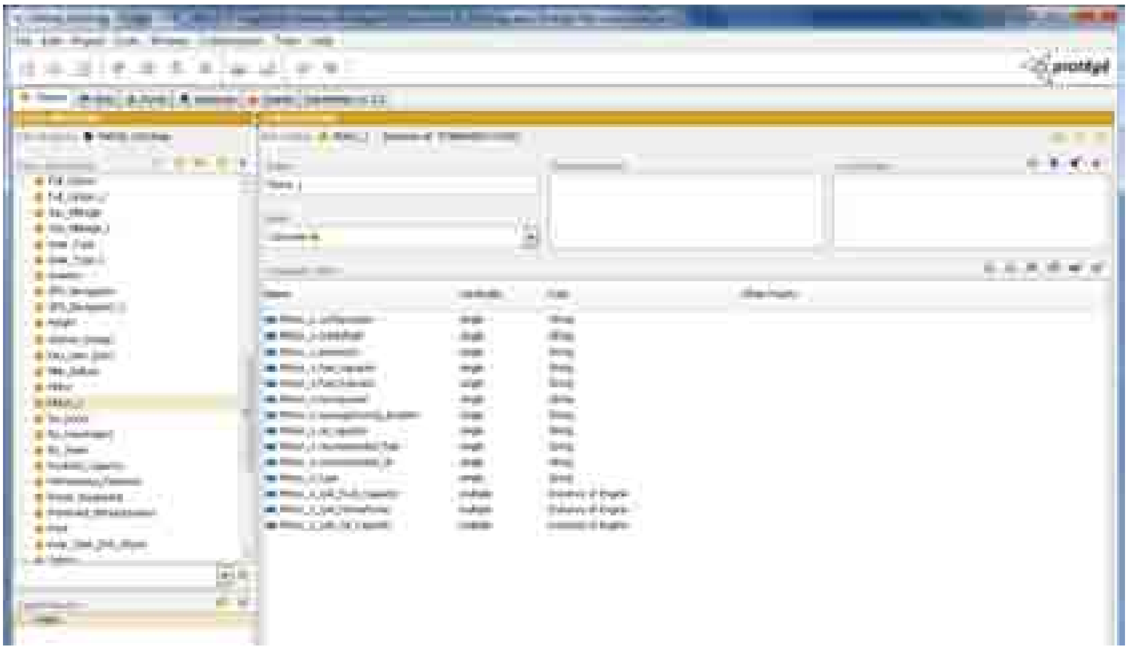

**Figure 5.9Creating a Is-A Relationships to Make the Matching Process between Tender and Bidder for Engine Requirements**

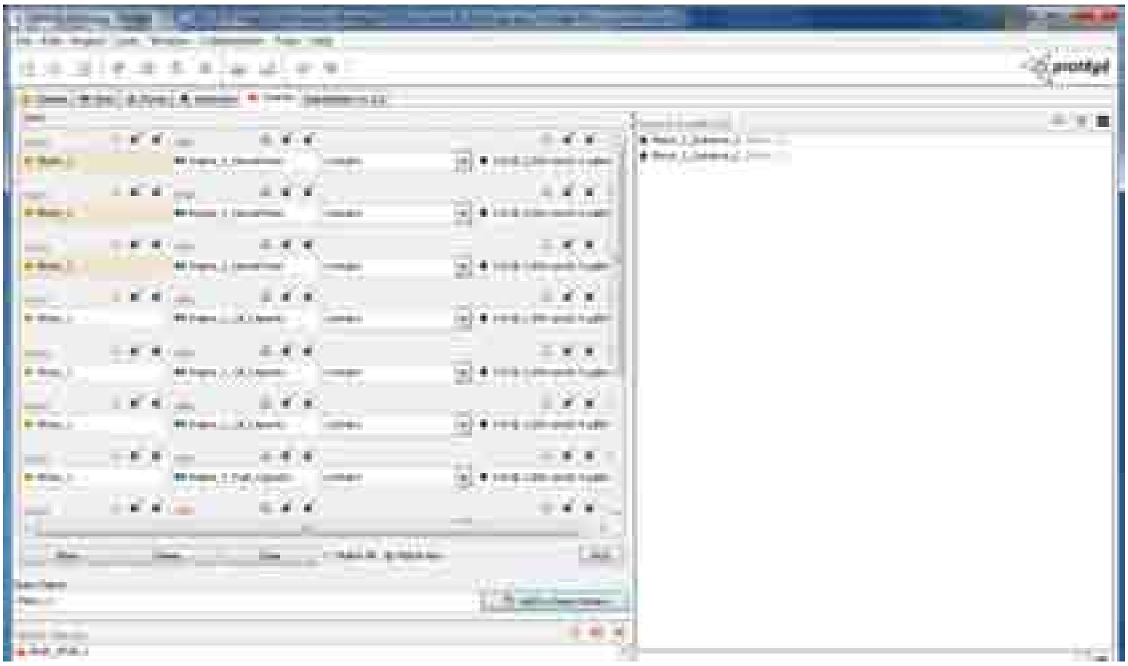

**Figure 5.10Matching Bidder's 1 Offered Motors with All Required Engines**

According to formula 5.1, we will have the same result as for engine_1 matching percentage

$$Motor\_1\ Matching\ Percentage = \frac{2}{3} = \mathbf{0.6666}$$

**ABS (Anti-Lock Braking System)**

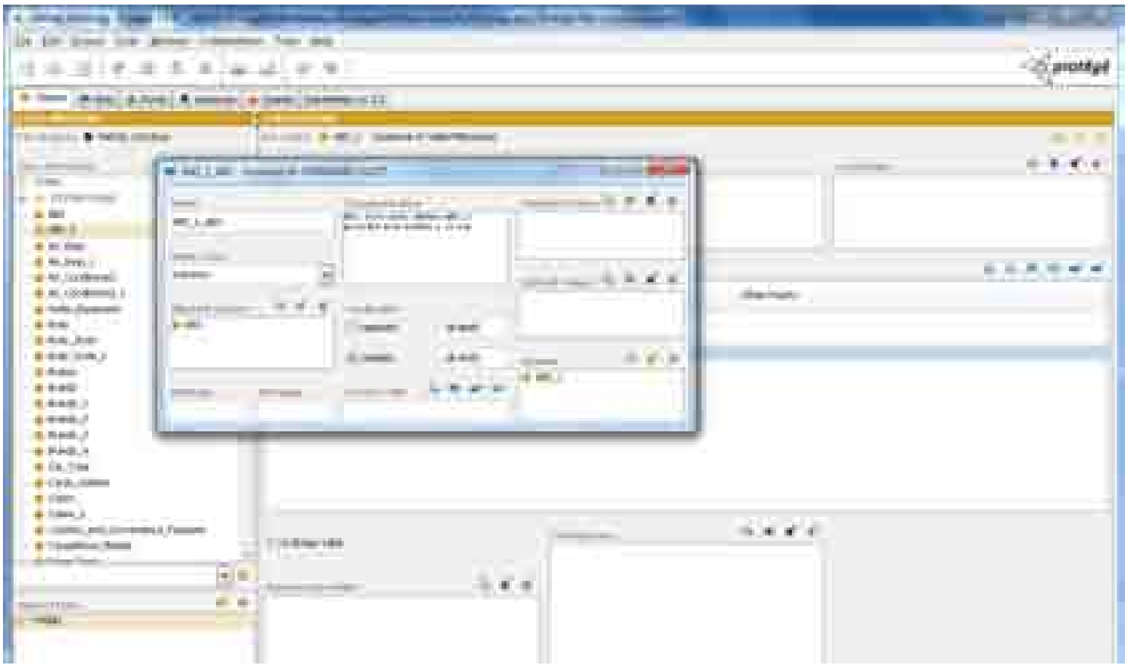

**Figure 5.11**

**Creating a Slot to Make the Matching Process between Tender and Bidder for ABS (Anti-Lock Braking System) Requirement**

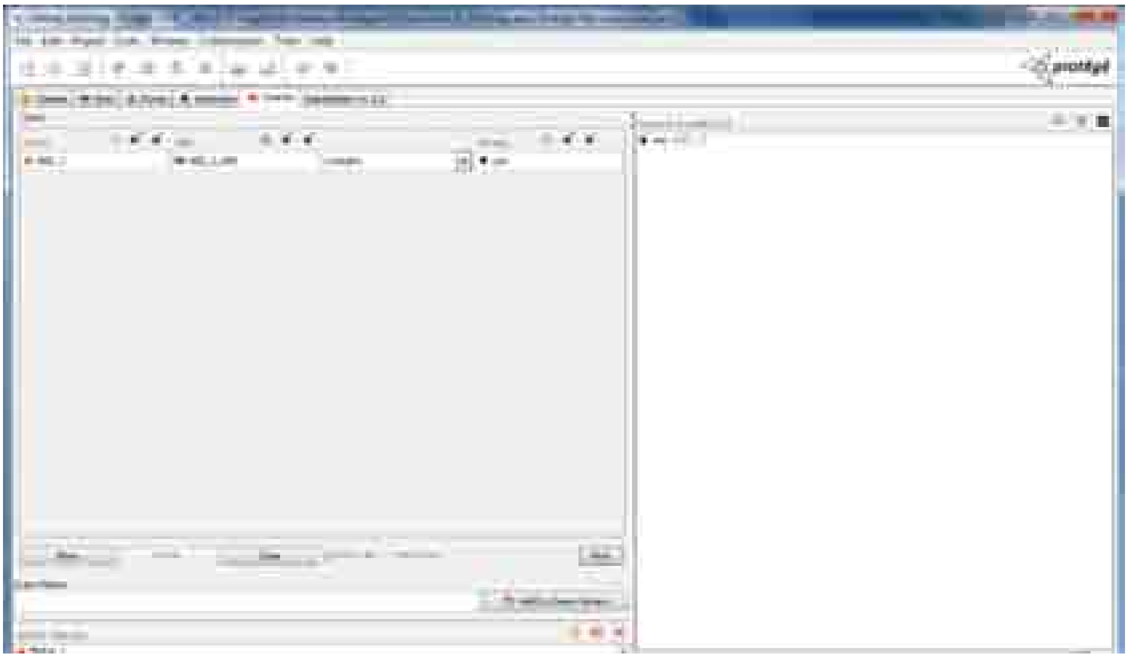

**Figure 5.12**

**Matching Bidder's 1 Offered ABS with Required ABS**

According to formula 5.1

To avoid repeating the same steps we calculated the matching percentages for the rest of the concepts.

| Concept | **Matching Percentage**<br>According to formula 5.1 |
|---|---|
| **Color** | $Colors\_1\ Matching\ Percentage = \frac{2}{3} = \mathbf{0.6666}$ |
| **ABS**<br>**(Anti-Lock Braking System)** | $ABS_1 Matching\ Percentage = \frac{1}{1} = \mathbf{1}$ |
| **Air-Bags** | $Air - Bags_1 Matching\ Percentage = \frac{3}{5} = \mathbf{0.6}$ |
| **Air-Conditioned** | $Air - Conditioned\_1\ Matching\ Percentage = \frac{1}{1} = \mathbf{1}$ |
| **Gas Mileage** | $Gas\ Mileage_1 Matching\ Percentage = \frac{1}{4} = \mathbf{0.25}$ |
| **Gear Type** | $Gear\ Type_1 Matching\ Percentage = \frac{2}{3} = \mathbf{0.6666}$ |
| **GPS Navigation** | GPS Navigation_1 $Matching\ Percentage = \frac{0}{1} = \mathbf{0}$ |
| **Warranty** | Warranty_1 $Matching\ Percentage = \frac{1}{1} = \mathbf{1}$ |
| **Full Option** | Full Option_1 $Matching\ Percentage = \frac{1}{1} = \mathbf{1}$ |

**Table 5.6**

**Concepts Matching Percentages**

**Now according to formula 5.2**

$$Bidder_1 Matching\ Result\ \frac{0.8 + 0.2 + 0.66 + 0.66 + 1 + 0.6 + 1 + 0.25 + 0.66 + 0 + 1 + 1}{12} = \mathbf{0.6525}$$

The result of the formula 5.2 is the semantic and ontological matching of bidder 1and tender, the same procedure followed for **bidder 1** will be applied for the rest of the bidders and the bidder with the highest matching result will be the most appropriate one.

This table shows the results of matching between tender's specifications and bidders' offers according the semantic ontology in this research, the table shows 19 bidders and the matching result for each one, also the table shows the matching results according to the committee specialized in tendering and bidding in the ministry of water and electricity in Kuwait, the table shows that our results are very close to the traditional committee way in

| All bidders | Percentage Matching with Tender | Our Rank | Committee Rank |
|---|---|---|---|
| **Bidder 1** | **0.6525** | **9** | **9** |
| **Bidder 2** | **0.4224** | **15** | **15** |
| **Bidder 3** | **0.7925** | **5** | **5** |
| **Bidder 4** | **0.6223** | **10** | **10** |
| **Bidder 5** | **0.6787** | **8** | **8** |
| **Bidder 6** | **0.5943** | **11** | **12** |
| **Bidder** 7 | **0.5078** | **13** | **13** |
| **Bidder** 8 | **0.8678** | **Third** | **Third** |
| **Bidder** 9 | **0.7244** | **7** | **7** |
| **Bidder** 10 | **0.5558** | **12** | **11** |
| **Bidder** 11 | **0.2547** | **19** | **None** |
| **Bidder** 12 | **0.2985** | **18** | **None** |
| **Bidder** 13 | **0.8545** | **4** | **4** |
| **Bidder** 14 | **0.4549** | **14** | **14** |
| **Bidder** 15 | **0.9534** | **first** | **first** |
| **Bidder** 16 | **0.8921** | **second** | **second** |
| **Bidder** 17 | **0.7754** | **6** | **6** |
| **Bidder** 18 | **0.3522** | **17** | **None** |
| **Bidder** 19 | **0.4125** | **16** | **None** |

the tendering and bidding processes.

**Table 5.7: Sample of Bidders Matching Results with the Tenders Specifications**

# Chapter 6: Evaluation and Future Work

The results we found in the my work in chapter five is very interesting, since our ontology combines new techniques and procedures that are never used before, we gathered our concepts from trusted sources in the vehicles domain, created a database with the concepts, attributes and instances for the vehicles requirements the tender needs, then we imported our database into an ontology environment (Protégé), then implemented scientific measures to create the ontological relationships among concepts, unfortunately the ontology development tools have some limitations, for example, in our case the matching process among tender and bidders with the exact percentages is not provided, this feature has to be calculated manually, this challenge make it burdensome to get the result of the best matching bidder, but the good thing is that all these challenges are related to the development of an ontological tools which is out of our scope in this thesis.

In our future wok we will try to avoid the limitations of the manual procedure we had to make in creating our ontology. In case we did not find an ontology tools that solve our problem we can think a computerized program that is designed specifically to make our ontology fully automated.

We can make our ontology bilingual, so that we can have two different languages, English and Arabic because usually Arabic language is used in our governments.

## 6.1More Relationships

We believe that our proposed method could be improved by adding more ontological relationships among different kinds of concepts, and these concepts not necessarily have to be synonyms , we decided to take advantage of the rest of the measures used in the proposed work in section (Creating Ontological Relationships According To Scientific Algorithms and Similarity/Relatedness Measures),

We will exclude the Gloss Vector pair wise measure because “From empirical studies, we have found that the regular Gloss Vector measure performs better than the pair wise Gloss Vector measure.” (Ted Pedersen, 2013), and we will use the result of the rest measures combined for other relationships, such as has-a relationships.

Before we can create our ontological relationships, we have to take sample words other than synonyms and find the average or other mathematical mean so that there is a meaningful relationship among the concepts.

Table 6.1 shows a sample of related words, the result of each measure, and the average of the four measures, we can infer from the results that when a concept is a component of another concept, the average is almost 0.4 percent or more, but for the results to be more precise we can exclude the measure that has zero result.

| Related Words | | Semantic Relatedness | | | | |
|---|---|---|---|---|---|---|
| Word 1 | Word 2 | Wu &Palmer | Lin | Path | Vector | Average |
| Car | Engine | 0.88 | 0.7077 | 0.25 | 0.484 | 0.58 ≈ 0.6 |
| Car | Door | 0.857 | 0.35 | 0.25 | 0.375 | 0.45 ≈ 0.5 |
| Car | Fuel | 0.37 | 0.08 | 0.09 | 0.3857 | 0.24 |
| Car | Window | 0.6667 | 0.3457 | 0.1429 | 0.5356 | 0.422725 |
| Car | Glass | 0.8421 | 0.6596 | 0.25 | 0.2809 | 0.50815 |
| Vehicle | Engine | 0.8571 | 0.6396 | 0.25 | 0.4398 | 0.546625≈ 0.6 |
| Vehicle | Door | 0.7059 | 0.3941 | 0.1667 | 0.306 | 0.3905 |
| Vehicle | Fuel | 0.8333 | 0.0884 | 0.3333 | 0.3088 | 0.39095 |
| Vehicle | Motor | 0.7368 | 0.4908 | 0.1667 | 0.2472 | 0.410375 |
| Vehicle | Wheel | 0.9 | 0.7052 | 0.3333 | 0.4723 | 0.6027 |
| Engine | Valve | 0.842 | 0.459 | 0.25 | 0.3041 | 0.46 ≈ 0.5 |
| Engine | Pistons | 0.7 | 0 | 0.1429 | 0.1709 | 0.25345 |
| Engine | Injection | 0.4615 | 0 | 0.125 | 0.0845 | 0.16775 |
| Engine | Oil | 0.5714 | 0.262 | 0.125 | 0.2166 | 0.29375 |
| Engine | Gas | 0.1667 | 0.3526 | 0.1667 | 0.4641 | 0.287525 |
| Engine | Crankshaft | 0.6667 | 0 | 0.125 | 0.2663 | 0.2645 |
| Engine | Filter | 0.8421 | 0.459 | 0.25 | 0.247 | 0.449525 |
| Engine | Pump | 0.7619 | 0.4537 | 0.1667 | 0.3371 | 0.42985 |
| Engine | Camshaft | 0.125 | 0 | 0.6667 | 0.4412 | 0.308225 |
| Engine | Ignition | 0.8 | 0 | 0.2 | 0.2922 | 0.32305 |

**Table 6.1 Related Words Semantic Relatedness According to Wu & Palmer, Lin, Path, and Vector Measures**

## 6.2 Generalizations

The results we found can be generalized on other domains in tendering and bidding, the differences will be only in the source of raw data, and the concepts used in the ontology, but of course the concepts will be related to that domain or area, table 6.2 shows a sample in the computers domain.

| **Synonyms** | | **Semantic Relatedness** | | |
|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Lin** | **Average** |
| Computer | Laptop | 0.88 | 0.0 | 0.44 |
| Computer | CPU | 0.70 | 0.0 | 0.35 |
| Computer | Device | 0.33 | 0.61 | 0.47 |
| Computer | Processor | 0.71 | 0 | 0.385 |
| Computer | Data pressing | 1 | 1 | 1 |
| Computer | Case | 0.77 | 0.39 | 0.58 |
| Computer | Machine | 0.95 | 0.84 | 0.895 |
| RAM | Memory | 0.89 | 0.96 | 0.92 |
| RAM | ROM | 0.84 | 0.0 | 0.42 |
| RAM | Flash Memory | 0.80 | 0.0 | 0.4 |
| Memory | Stock | 0.80 | 0.61 | 0.705 |
| Memory | Storage | 1 | 1 | 1 |
| Memory | Tablet | 0.63 | 0.24 | 0.435 |
| Screen | Monitor | 0.91 | 0 | 0.455 |
| Screen | Display | 0.95 | 1 | 0.975 |
| Mouse | Cursor | 0.80 | 0.0 | 0.4 |
| Power | Electricity | 0.87 | 0.52 | 0.695 |
| Power | Generator | 0.61 | 0.19 | 0.4 |
| generation | Conversion | 0.75 | 0.40 | 0.575 |
| Version | Edition | 1 | 1 | 1 |
| Version | Generation | 0.50 | 0.17 | 0.335 |
| Processor | CPU | 1 | 0.0 | 0.5 |
| Processor | Mainframe | 1 | 0.0 | 0.5 |
| Processor | Microprocessor | 0.6364 | 0.0 | 0.3182 |

| | | | | |
|---|---|---|---|---|
| Processor | microprocessor chip | 0.6667 | 0.0 | 0.33335 |
| Audio | Speakers | 0.70 | 0.46 | 0.58 |
| Audio | Volume | 0.60 | 0.30 | 0.45 |
| Audio | Sound | 1 | 1 | 1 |
| Audio | Headphones | 0.70 | 0.47 | 0.585 |
| Video | Display | 0.77 | 0.63 | 0.7 |
| Core | Gist | 1 | 1 | 1 |
| Core | Root | 0.80 | 0.56 | 0.68 |
| Speed | Advancement | 0.90 | 0.64 | 0.77 |
| Speed | Quickness | 0.88 | 0.87 | 0.875 |
| Speed | Pace | 0.93 | 0.98 | 0.955 |
| cable | Wire | 1 | 1 | 1 |
| cable | Telegraph | 1 | 1 | 1 |
| cable | Network | 0.76 | 0.35 | 0.555 |

**Table 6.2 Synonyms Semantic Relatedness According to Wu & Palmer and Lin Measures in Computers Domain**

Other fields of study can be involved in our future work, we can use the concepts of data mining and the concepts of the database, to automatically extract the concepts or the key words related to a specific field, for example, we will think of a way that can take raw data in the form of a soft copy file, then extract the key words from it, this will improve the ontology dramatically since it will solve a big limitation which is choosing the concepts manually or by experts, after that we can link the process of generating concepts with the process of making the relationships between them according to the scientific measures we mention in the proposed work, we believe that our new techniques could be enormously useful for almost all the domains, especially if we could make it fully automated. One of the most improvements that could be done is to build an ontology that can be adaptable to different domains, so that the only change needed to apply is to alter the source of the raw data.

# Appendix

## Synonyms Semantic Relatedness, Experts Matching, and Error Percentage Based on Wu & Palmer and Lin Measures

| Synonyms | | Semantic Relatedness | | | Experts Matching | | Error = \|Expert – Avg\| | |
|---|---|---|---|---|---|---|---|---|
| **Word 1** | **Word 2** | **Wu & Palmer** | **Lin** | **Average** | **Expert 1 Matching Percentage (Honda)** | **Expert 2 Matching Percentage (Toyota)** | **Average / Expert1 Error** | **Average /Expert2 Error** |
| Engine | Motor | 0.9524 | 0.9788 | 0.9656 | **1** | **0.95** | **0.03** | **0.01** |
| Engine | Cylinder | 0.8 | 0 | 0.4 | **0.10** | **0.50** | **0.3** | **0.1** |
| Engine | Piston | 0.7619 | 0 | 0.38095 | **0.10** | **0.60** | **0.28** | **0.22** |
| Engine | Turbine | 0.8462 | 0.9219 | 0.88405 | **1** | **0.30** | **0.12** | **0.58** |
| Engine | Mechanism | 0.8421 | 0.5447 | 0.6934 | **0.50** | **0.75** | **0.19** | **0.06** |
| Brake | Restraint | 0.9474 | 0.8691 | 0.90825 | **1** | **0.85** | **0.1** | **0.05** |
| Brake | Hamper | 0.9 | 0.7737 | 0.83685 | **0.75** | **0.40** | **0.08** | **0.43** |
| Brake | Stop | 0.9 | 0.4373 | 0.66865 | **1** | **0.75** | **0.34** | **0.08** |
| Brake | Hindrance | 0.6316 | 0 | 0.3158 | **0.30** | **0.40** | **0.01** | **0.08** |
| Brand | Trademark | 1 | 0.7875 | 0.89375 ≈ 0.90 | **1** | **0.85** | **0.1** | **0.05** |
| Brand | Marker | 0.9333 | 0.8964 | 0.91485 | **0.90** | **0.85** | **0.01** | **0.06** |
| Brand | Emblem | 0.6 | 0.2937 | 0.44685 | **0.50** | **0.75** | **0.06** | **0.29** |
| Brandss | Logo | 0.8235 | 0 | 0.41175 | **0.50** | **0.75** | **0.09** | **0.34** |
| Brand | Imprint | 0.8 | 0.2981 | 0.54905 | **0.50** | **0.60** | **0.04** | **0.05** |
| Fuel | Petrol | 0.9231 | 0.9268 | 0.92495 | **0.90** | **0.90** | **0.02** | **0.02** |
| Fuel | Gas | 0.9231 | 0.9268 | 0.92495 | **0.90** | **0.90** | **0.02** | **0.02** |
| Fuel | Ammunition | 0.6154 | 0.0751 | 0.34525 | **0.19** | **0.75** | **0.14** | **0.41** |
| Fuel | Combustible | 0.9231 | 0 | 0.46155 | **0.50** | **0.95** | **0.04** | **0.49** |
| Fuel | propellant | 0.8333 | 0 | 0.41665 | **0.50** | **0.35** | **0.09** | **0.06** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Capacity | Volume | 0.9091 | 0.9211 | 0.9151 | **1** | **0.90** | **0.**09 | **0.01** |
| Capacity | Amplitude | 0.625 | 0.2184 | 0.4217 | **0.0** | **0.80** | **0.**42 | **0.38** |
| Capacity | Quantity | 0.8 | 0.4669 | 0.63345 | **1** | **0.95** | **0.**37 | **0.32** |
| Capacity | Bulk | 0.625 | 0.2705 | 0.44775 | **0.50** | **0.60** | **0.**05 | **0.15** |
| Capacity | Mass | 0.7692 | 0.3411 | 0.55515 | **0.30** | **0.95** | **0.**24 | **0.39** |
| Capacity | Expanse | 0.5882 | 0.269 | 0.4286 | **0.40** | **0.60** | **0.**02 | **0.17** |
| Mileage | Milage | 1 | 1 | 1 | **1** | **1** | **0.**0 | **0.0** |
| Mileage | Distance | 0.9412 | 0.7492 | 0.8452 | **0.50** | **0.95** | **0.**34 | **0.1** |
| Mileage | Range | 0.5 | 0.0816 | 0.2908 | **0.50** | **0.75** | **0.**21 | **0.46** |
| Mileage | Length | 0.4615 | 0.0812 | 0.5427 | **0.30** | **0.75** | **0.**24 | **0.21** |
| Mileage | Span | 0.8889 | 0.599 | 0.74395 | **0.30** | **0.60** | **0.**44 | **0.14** |
| Mileage | Continuance | 0.4615 | 0.0792 | 0.27035 | **0.30** | **0.60** | **0.**03 | **0.34** |
| Performance | Execution | 1 | 1 | 1 | **1** | **0.80** | **0.**0 | **0.2** |
| Performance | Act | 0.9412 | 0.9058 | 0.9235 | **0.70** | **0.60** | **0.**22 | **0.32** |
| Performance | Achievement | 0.9412 | 0.7663 | 0.85375 | **0.70** | **0.95** | **0.**15 | **0.1** |
| Performance | Completion | 0.7368 | 0.4556 | 0.5962 | **0.30** | **0.75** | **0.**29 | **0.16** |
| Performance | Fulfillment | 0.6667 | 0.4143 | 0.5405 | **0.30** | **0.75** | **0.**24 | **0.21** |
| Performance | Attainment | 0.8889 | 0.7116 | 0.80025 | **0.90** | **0.75** | **0.**1 | **0.05** |
| Performance | Fruition | 0.6667 | 0 | 0.33335 | **0.30** | **0.30** | **0.**03 | **0.03** |
| Color | Tinge | 1 | 1 | 1 | **0.60** | **0.90** | **0.**4 | **0.1** |
| Color | Stain | 0.9333 | 0.9541 | 0.9437 | **0.60** | **0.90** | **0.**34 | **0.04** |
| Color | Dye | 0.9333 | 0.9569 | 0.9451 | **0.80** | **0.88** | **0.**14 | **0.05** |
| Color | Tint | 0.9333 | 0.8884 | 0.91085 | **0.60** | **0.90** | **0.**31 | **0.**01 |
| Color | Paint | 0.9333 | 0.9557 | 0.9445 | **0.90** | **0.95** | **0.**04 | **0.**01 |
| Color | Tincture | 0.9333 | 0.8162 | 0.87475 | **0.50** | **0.50** | **0.**37 | **0.**31 |
| Color | Pigmentation | 0.875 | 0 | 0.4375 | **0.80** | **0.30** | **0.**37 | **0.**13 |
| Color | Undertone | 0.875 | 0.0845 | 0.47975 | **0.80** | **0.35** | **0.**33 | **0.**12 |
| Gear | Machine | 0.9167 | 0.8393 | 0.878 | **0.90** | **0.90** | **0.**02 | **0.**02 |
| Gear | Instrument | 0.8421 | 0.5291 | 0.6856 | **0.50** | **0.75** | **0.**18 | **0.**06 |
| Gear | Transmission | 0.9524 | 0 | 0.4762 | **1** | **0.85** | **0.**53 | **0.**37 |
| Gear | Machinery | 0.8 | 0.4366 | 0.6183 | **0.80** | **0.90** | **0.**19 | **0.**33 |
| Gear | Wheel | 0.96 | 0.5 | 0.73 | **0.90** | **0.60** | **0.**17 | **0.**13 |
| Gear | Trundle | 0.9231 | 0 | 0.46155 | **0.20** | **0.30** | **0.**26 | **0.**16 |
| Gear | GearBox | 0.6 | 0 | 0.3 | **0.2** | **0.85** | **0.**1 | **0.**35 |
| Door | Entry | 0.9474 | 0.9787 | 0.96305 | **0.60** | **0.90** | **0.**36 | **0.06** |
| Door | Gate | 0.9091 | 0.8758 | 0.89245 ≈ | **0.60** | **0.90** | **0.**3 | **0.0** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 0.90 | | | | |
| Door | Egress | 0.4211 | 0.1903 | 0.3057 | **0.50** | **0.25** | 0.2 | 0.05 |
| Door | Aperture | 0.75 | 0.264 | 0.507 | **0.30** | **0.60** | 0.2 | 0.1 |
| Door | Exit | 0.75 | 0.2803 | 0.51515 | **0.90** | **0.90** | 0.39 | 0.39 |
| Door | Inlet | 0.75 | 0.0702 | 0.4101 | **0.80** | **0.50** | 0.39 | 0.9 |
| Power | Vigor | 0.8571 | 1 | 0.92855 | **0.60** | **0.80** | 0.32 | 0.11 |
| Power | Force | 1 | 1 | 1 | **0.90** | **0.95** | 0.1 | 0.05 |
| Power | Intensity | 0.7143 | 0.4536 | 0.58395 | **0.80** | **0.75** | 0.22 | 0.17 |
| Power | Strength | 0.9231 | 0.885 | 0.90405 | **0.90** | **0.85** | 0.0 | 0.05 |
| Power | Potential | 0.8235 | 0.4845 | 0.654 | **0.50** | **0.80** | 0.15 | 0.14 |
| Power | Effectiveness | 0.9231 | 0.8213 | 0.8722 | **0.30** | **0.85** | 0.57 | 0.02 |
| Gas | Petrol | 1 | 1 | 1 | **1** | **0.85** | 0.0 | 0.15 |
| Gas | Petroleum | 1 | 1 | 1 | **0.60** | **0.80** | 0.40 | 0.2 |
| Gas | Invader | 0.4348 | 0.126 | 0.5608 | **0.40** | **0.60** | 0.16 | 0.04 |
| Gas | Diesel | 0.5385 | 0 | 0.26925 | **0.50** | **0.80** | 0.23 | 0.53 |
| Gas | Oil | 0.875 | 0.6811 | 0.77805 | **0.30** | **0.80** | 0.47 | 0.02 |
| Gas | Kerosene | 0.9167 | 0.8578 | 0.88725 | **0.90** | **0.95** | 0.02 | 0.06 |
| Seat | Chair | 0.9524 | 0.9624 | 0.9574 | **0.90** | **0.95** | 0.05 | 0.0 |
| Seat | Couch | 0.9524 | 0.8976 | 0.925 | **0.90** | **0.90** | 0.02 | 0.02 |
| Seat | Bench | 0.9524 | 0.8821 | 0.91725 | **0.90** | **0.80** | 0.01 | **0.11** |
| Seat | Lounge | 0.9524 | 0.8976 | 0.925 | **0.90** | **0.75** | 0.02 | **0.17** |
| Seat | Office | 0.6316 | 0.3367 | 0.48415 | **0.30** | **0.75** | 0.18 | **0.27** |
| Seat | recliner | 0.8696 | 0 | 0.4348 | **0.60** | **0.50** | 0.17 | 0.07 |
| Seat | Settee | 0.9091 | 0 | 0.45455 | **0.80** | **0.50** | 0.45 | 0.05 |
| Vehicle | Car | 0.9 | 0.8825 | 0.89125 ≈ 0.9 | **0.90** | **1** | 0.0 | 0.1 |
| Vehicle | Bus | 0.8421 | 0.6572 | 0.74965 | **0.90** | **1** | 0.15 | 0.25 |
| Vehicle | Truck | 0.8571 | 0.7858 | 0.82145 | **0.90** | **1** | 0.08 | 0.18 |
| Vehicle | Automobile | 0.8182 | 0.8825 | 0.85035 | **0.95** | **1** | 0.1 | 0.15 |
| Vehicle | Van | 0.8571 | 0.6663 | 0.7617 | **0.90** | **1** | 0.14 | 0.24 |
| Vehicle | Wagon | 0.9 | 0.8016 | 0.8508 | **0.90** | **0.90** | 0.05 | 0.05 |
| Vehicle | Carriage | 0.9 | 0.7378 | 0.8189 | **0.90** | **0.90** | 0.09 | 0.09 |
| Model | Pattern | 1 | 1 | 1 | **0.80** | **0.90** | 0.2 | 0.1 |
| Model | Mold | 1 | 1 | 1 | **0.80** | **0.90** | 0.2 | 0.1 |
| Model | Paradigm | 0.9412 | 0.9284 | 0.9348 | **0.60** | **0.85** | 0.33 | 0.08 |
| Model | Form | 0.9524 | 0.8883 | 0.92035 | **0.70** | **0.85** | 0.22 | 0.07 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | Template | 0.9412 | 0.869 | 0.9051 | **0.90** | **0.80** | **0.**0 | **0.**1 |
| Model | Type | 0.9091 | 0.703 | 0.80605 | **0.90** | **0.90** | **0.**1 | **0.**1 |
| Model | Sample | 0.625 | 0.3397 | 0.48235 | **0.60** | **0.75** | **0.**12 | **0.**27 |
| Height | Altitude | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Elevation | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Peak | 1 | 1 | 1 | **1** | **0.90** | **0.**0 | **0.**1 |
| Height | Top | 1 | 1 | 1 | **0.90** | **0.90** | **0.**1 | **0.**1 |
| Height | Rise | 0.7059 | 0.5961 | 0.651 | **0.40** | **0.80** | **0.**25 | **0.**15 |
| Height | Crest | 0.2857 | 0 | 0.14285 | **0.60** | **0.70** | **0.**46 | **0.**56 |
| Height | Tip | 0.5333 | 0.3146 | 0.42395 | **0.60** | **0.80** | **0.**18 | **0.**38 |
| Width | Range | 0.75 | 0.6001 | 0.67505 | **0.30** | **0.85** | **0.**37 | **0.**18 |
| Width | Area | 0.75 | 0.5542 | 0.6521 | **0.40** | **0.80** | **0.**25 | **0.**15 |
| Width | Ambit | 0.75 | 0.6001 | 0.67505 | **0.30** | **0.55** | **0.**37 | **0.**17 |
| Width | Domain | 0.5 | 0.2694 | 0.3847 | **0.2** | **0.65** | **0.**18 | **0.**27 |
| Width | Amplitude | 0.8 | 0.0788 | 0.4394 | **0.30** | **0.80** | **0.**13 | **0.**36 |
| Width | Broadness | 0.9412 | 0 | 0.4706 | **0.95** | **0.50** | **0.**48 | **0.**13 |
| Manufacturer | Producer | 1 | 1 | 1 | **1** | **0.95** | **0.**0 | **0.**05 |
| Manufacturer | Maker | 1 | 1 | 1 | **1** | **0.95** | **0.0** | **0.**05 |
| Manufacturer | Industrialist | 0.5882 | 0.1816 | 0.3849 | **0.30** | **0.95** | **0.**08 | **0.**57 |
| Manufacturer | Former | 0.3333 | 0 | 0.16665 | **0.20** | **0.95** | **0.**04 | **0.**78 |
| Manufacturer | Creator | 0.8571 | 0.8095 | 0.8333 | **0.90** | **0.80** | **0.**07 | **0.**03 |
| Manufacturer | Company | 0.75 | 0.4762 | 0.6131 | **0.80** | **0.95** | **0.**19 | **0.**34 |
| Manufacturer | Constructor | 0.625 | 0.1985 | 0.41175 | **0.90** | **0.85** | **0.**49 | **0.**44 |
| Ventilation | Airing | 1 | 1 | 1 | **0.80** | **0.80** | **0.**2 | **0.**2 |
| Ventilation | Freshness | 0.4211 | 0.1587 | 0.2899 | **0.90** | **0.80** | **0.**61 | **0.**51 |
| Ventilation | Aeration | 0.8571 | 0.4172 | 0.63715 | **0.90** | **0.95** | **0.**26 | **0.**31 |
| Ventilation | Cooling | 0.7 | 0.4301 | 0.56505 | **0.80** | **0.95** | **0.**23 | **0.**33 |
| Ventilation | Oxygen | 0.4286 | 0.0834 | 0.256 | **0.70** | **0.90** | **0.**43 | **0.**65 |
| Transmission | Move | 0.7059 | 0.3525 | 0.5292 | **0..80** | **0.90** | **0.**28 | **0.**38 |
| Transmission | Switch | 0.8182 | 0.2713 | 0.54475 | **0.70** | **0.75** | **0.**16 | **0.**21 |
| Transmission | Transit | 0.7273 | 0.2673 | 0.4973 | **0.70** | **0.75** | **0.**2 | **0.**25 |
| Transmission | Movement | 0.8182 | 0.3525 | 0.58535 | **0.60** | **0.90** | **0.**01 | **0.**31 |
| Transmission | Dispatch | 0.75 | 0.2713 | 0.51065 | **0.60** | **0.75** | **0.**09 | **0.**24 |
| Safety | Security | 0.9333 | 0.9677 | 0.9505 | **0.90** | **0.95** | **0.**05 | **0.**0 |
| Safety | Integrity | 0.7692 | 0.381 | 0.5751 | **0.60** | **0.50** | **0.**02 | **0.**07 |
| Safety | Solidity | 0.8 | 0.2798 | 0.5399 | **0.50** | **0.80** | **0.**03 | **0.**26 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Safety | Protection | 0.875 | 0.8255 | 0.85025 | **0.90** | **0.95** | **0.**15 | **0.**1 |
| Safety | Preventive | 0.9474 | 0.4195 | 0.68345 | **0.80** | **0.85** | **0.**12 | **0.**17 |
| Safety | Precaution | 0.5833 | 0.461 | 0.52215 | **0.70** | **0.75** | **0.**18 | **0.**23 |
| Suspension | Break | 1 | 1 | 1 | **0.70** | **0.60** | **0.**3 | **0.**4 |
| Suspension | Postponement | 0.9231 | 0.9467 | 0.9349 | **0.90** | **0.50** | **0.**03 | **0.**42 |
| Suspension | Stay | 0.8571 | 0.2158 | 0.53645 | **0.30** | **0.65** | **0.**13 | **0.**12 |
| Suspension | Brake | 0.7 | 0.0649 | 0.38245 | **0.10** | **0.50** | **0.**28 | **0.**12 |
| Suspension | Amputation | 0.7 | 0 | 0.35 | **0.20** | **0.50** | **0.**15 | **0.**15 |
| Suspension | Stop | 0.8571 | 0.3843 | 0.6207 | **0.30** | **0.50** | **0.**32 | **0.**12 |
| Material | Substance | 0.9091 | 0.9374 | 0.92325 | **0.90** | **0.90** | **0.**02 | **0.**02 |
| Material | Matter | 0.8 | 0.8669 | 0.83345 | **0.90** | **0.50** | **0.**07 | **0.**33 |
| Material | Article | 0.8571 | 0.3668 | 0.61195 | **0.50** | **0.60** | **0.**11 | **0.**01 |
| Material | Item | 0.7692 | 0.5813 | 0.67525 | **0.90** | **0.80** | **0.**23 | **0.**12 |
| Material | Materiality | 0.5714 | 0.1063 | 0.33885 | **0.80** | **0.95** | **0.**46 | **0.**61 |
| Warranty | pledge | 0.9333 | 0.9677 | 0.9505 | **0.80** | **0.80** | **0.**15 | **0.**15 |
| Warranty | assurance | 0.9333 | 0.9677 | 0.9505 | **1** | **0.80** | **0.**05 | **0.**15 |
| Warranty | Security | 0.9412 | 0.3138 | 0.6275 | **0.90** | **0.70** | **0.**27 | **0.**07 |
| Warranty | Certificate | 0.5 | 0.3138 | 0.4069 | **0.60** | **0.85** | **0.**19 | **0.**44 |
| Warranty | Undertaking | 0.3529 | 0.0877 | 0.2203 | **0.80** | **0.90** | **0.**58 | **0.**68 |
| Feature | characteristic | 1 | 1 | 1 | **0.80** | **0.95** | **0.**2 | **0.**05 |
| Feature | Attribute | 0.9474 | 0.9806 | 0.964 | **0.80** | **0.90** | **0.**16 | **0.**06 |
| Feature | Quality | 0.9 | 0.8749 | 0.88745 | **0.60** | **0.80** | **0.**28 | **0.**08 |
| Feature | Attribute | 0.6316 | 0.3536 | 0.6694 | **0.90** | **0.70** | **0.**24 | **0.**16 |
| Feature | Trait | 0.4286 | 0.1232 | 0.2759 | **0.90** | **0.70** | **0.**62 | **0.**42 |
| Feature | Merit | 0.4 | 0.0931 | 0.24655 | **0.70** | **0.70** | **0.**45 | **0.**45 |
| Feature | Advantage | 0.375 | 0.1068 | 0.2409 | **0.80** | **0.85** | **0.**54 | **0.**61 |
| Audio | Sound | 1 | 1 | 1 | **1** | **1** | **0.**0 | **0.**0 |
| Audio | Voice | 0.7273 | 0.5057 | 0.6165 | **0.90** | **0.90** | **0.**29 | **0.**29 |
| Audio | Tone | 0.6154 | 0.3331 | 0.47425 | **0.80** | **0.90** | **0.**33 | **0.**43 |
| Audio | Resonance | 0.5714 | 0.0755 | 0.32345 | **0.70** | **0.35** | **0.**38 | **0.**03 |
| Audio | Hearing | 0.625 | 0.1242 | 0.3746 | **0.60** | **0.85** | **0.**23 | **0.**52 |
| System | Organization | 1 | 1 | 1 | **0.90** | **0.85** | **0.**1 | **0.**15 |
| System | Structure | 0.9231 | 0.9573 | 0.9402 | **1** | **0.90** | **0.**06 | **0.**04 |
| System | Order | 0.7273 | 0.4374 | 0.80105 | **0.90** | **0.80** | **0.**1 | **0.**0 |
| System | Method | 0.4374 | 0.9211 | 0.67925 | **0.90** | **0.80** | **0.**22 | **0.**12 |
| System | Framework | 0.7059 | 0.4532 | 0.57955 | **0.90** | **0.80** | **0.**32 | **0.**22 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| System | Regulation | 0.7368 | 0.4563 | 0.59655 | **0.80** | **0.85** | 0.20 | 0.25 |
| System | Coordination | 0.188 | 0.188 | 0.188 | **0.60** | **0.65** | 0.41 | 0.47 |
| Cargo | Fright | 1 | 1 | 1 | **0.90** | **0.95** | 0.1 | 0.05 |
| Cargo | Loading | 1 | 1 | 1 | **0.80** | **0.85** | 0.2 | 0.15 |
| Cargo | Consignment | 1 | 1 | 1 | **0.70** | **0.75** | 0.3 | 0.25 |
| Cargo | Shipment | 1 | 1 | 1 | **0.90** | **0.95** | 0.1 | 0.05 |
| Cargo | Payload | 1 | 1 | 1 | **0.90** | **0.85** | 0.1 | 0.15 |
| Cargo | Capacity | 0.3333 | 0.0584 | 0.19585 | **0.10** | **0.60** | 0.09 | 0.4 |
| Cargo | Goods | 0.875 | 0.7513 | 0.81315 | **0.80** | **0.95** | 0.01 | 0.14 |
| Passenger | Occupant | 0.7143 | 0.2013 | 0.4578 | **0.60** | **0.75** | 0.14 | 0.30 |
| Passenger | Traveler | 0.9231 | 0.7928 | 0.85795 | **0.90** | **0.85** | 0.04 | 0.0 |
| Passenger | Rider | 1 | 1 | 1 | **0.50** | **0.85** | 0.50 | 0.15 |
| Passenger | Commuter | 0.9333 | 0.9478 | 0.94055 | **0.90** | **0.85** | 0.04 | 0.09 |
| Belt | Strap | 0.8 | 0.2536. | 0.5268 | **0.90** | **0.90** | 0.38 | 0.38 |
| Belt | Band | 0.9565 | 0.266 | 0.61125 | **0.60** | **0.75** | 0.01 | 0.14 |
| Belt | Girdle | 0.7273 | 0.2294 | 0.47835 | **0.40** | **0.60** | 0.07 | 0.12 |
| Belt | Waistband | 0.6316 | 0.2294 | 0.4305 | **0.80** | **0.60** | 0.37 | 0.17 |
| Belt | Fasten | 0.8889 | 0 | 0.44445 | **0.40** | **0.65** | 0.04 | 0.21 |
| Belt | Restraint | 0.7368 | 0.2846 | 0.5107 | **0.30** | **0.65** | 0.21 | 0.14 |
| Tire | Tyre | 1 | 1 | 1 | **1** | **1** | 0.0 | 0.0 |
| Tire | Wheel | 0.6 | 0.267 | 0.4335 | **0.80** | **1** | 0.37 | 0.57 |
| Tire | Drain | 0.5714 | 0.2536 | 0.4125 | **0.30** | **0.60** | 0.11 | 0.19 |
| Price | Cost | 1 | 1 | 1 | **1** | **1** | 0.0 | 0.0 |
| Price | Value | 0.9333 | 0.9094 | 0.92135 | **1** | **1** | 0.08 | 0.08 |
| Price | Amount | 0.625 | 0.5769 | 0.60095 | **1** | **0.95** | 0.4 | 0.35 |
| Price | Fee | 0.8 | 0.6192 | 0.7096 | **0.90** | **0.75** | 0.19 | 0.05 |
| Price | Payment | 0.8889 | 0.7195 | 0.8042 | **0.90** | **0.90** | 0.1 | 0.1 |
| Price | Rate | 0.8421 | 0.6542 | 0.74815 | **1** | **0.90** | 0.24 | 0.15 |
| Price | Charge | 0.8889 | 0.6768 | 0.78285 | **0.90** | **0.90** | 0.12 | 0.12 |
| Dimension | Proportion | 1 | 1 | 1 | **0.70** | **90** | 0.3 | 0.1 |
| Dimension | Length | 0.9333 | 0.9726 | 0.95295 | **0.30** | **0.85** | 0.55 | 0.55 |
| Dimension | Aspect | 0.9 | 0.9169 | 0.90845 | **0.30** | **0.80** | 0.60 | 0.1 |
| Dimension | Distance | 0.8 | 0.6111 | 0.70555 | **0.65** | **0.70** | 0.05 | 0.0 |
| Dimension | Element | 0.8421 | 0.6692 | 0.75565 | **0.50** | **0.70** | 0.25 | 0.05 |
| Dimension | Measure | 0.6154 | 0.4009 | 0.50815 | **1** | **0.90** | 0.49 | **0.40** |
| Window | Windowpane | 1 | 1 | 1 | **0.90** | **0.95** | 0.1 | **0.05** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Window | Pane | 0.9474 | 0.9478 | 0.9476 | **0.90** | **0.85** | **0.**04 | **0.**09 |
| Window | Glass | 0.7273 | 0.3013 | 0.5143 | **0.80** | **1** | **0.**29 | **0.**49 |
| Window | Casement | 0.8571 | 0 | 0.42855 | **0.90** | **0.75** | **0.**47 | **0.**27 |
| Window | Frame | 0.9 | 0.8261 | 0.86305 | **0.80** | **0.75** | **0.**06 | **0.**11 |
| Window | Overture | 0.4286 | 0.0683 | 0.24845 | **0.30** | **0.65** | **0.**05 | **0.**41 |

## Ontology significances for Describing Database Schemas

There are a variety of ways of describing the schema of a database in ontology depending on the requirements of an application. For example, some applications will only require an import of the database content without needing a "live" connection to the database. In other cases, the mapping between the database structure and the ontology elements is more important, so that data reside in the database but are accessible to querying or reasoning through an ontology layer. They have designed four ontology significances (three OWL ontology significances and one Frames ontology) for describing database structures that are suitable for different types of applications and use cases.

### *Schema Structure Ontology for Protégé-Frames*

DataMaster may be used to import a relational database structure and the table data into a Protégé-Frames ontology. The ontology for describing the database structure (Figure 1) is the same as the one used by the DataGenie plug-in. All imported database tables are defined as Protégé classes that are instances of the Table Metaclass meta-class. Each column of the database table is represented by a template slot added to the newly created table classes. The column slots will have data types corresponding to the SQL types associated to the database columns.

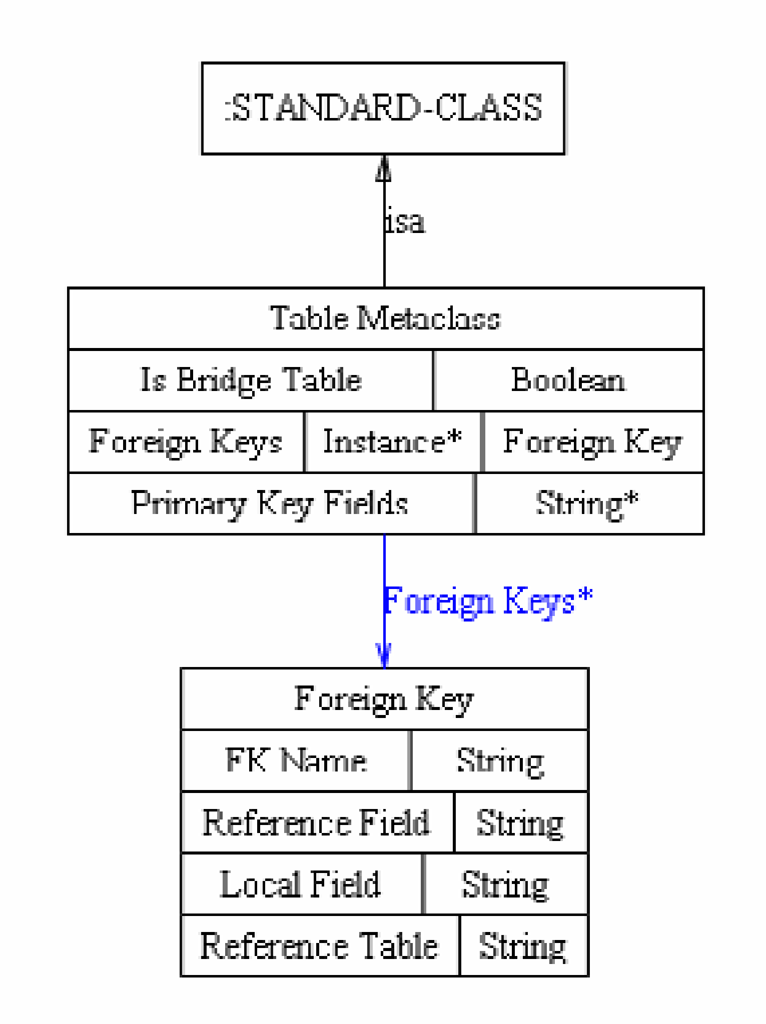


**Figure 1**

**Database Schema Ontology for Protégé Frames**

If there are foreign keys defined between the database tables, for each foreign key an instance of the `Foreign Key` class will be created that will be used to link the corresponding ontology classes. It is also possible to import the data from the tables in the database: for each row in the table an instance of the table class will be created, and the values of the own slots at these instances will be set with values contained in the table row corresponding to the table columns. An extra slot of type instance will be created for each foreign key defined in the table that will point to the instances corresponding to the referred rows.

### *Schema Structure Ontology for Database Tables as OWL Classes*

One of our goals when designing the schema structure ontology in OWL was to be able to use DL reasoning on it. This means that certain constructs used in the Frames approach had to be changed. However, certain combination of import options will result in OWL Full schema ontology.

The Protégé OWL schema ontology for importing tables as classes is the OWL version of the previously described ontology for Protégé Frames. There are only a few differences:

- The imported classes will not be instance of a common meta-class, because it would make the ontology OWL Full. Instead, all the template slots attached to `Table Metastasis` the Frames ontology have been defined as annotation properties on the imported table classes.
- The property and class names from the Frames ontology are using the camel notation and the space character in the class and property names have been avoided. E.g., `hasForeignKeys`instead of`Foreign Keys`, `ForeignKey`instead of `Foreign Key`, etc.

- For easier navigation and performance reasons, we have introduced four additional object propertiesattached to the ForeignKeyclass to refer the local and referenced table classes as well as the referringand referred column properties.

### *Schema Structure Ontology for Database Tables as OWL Instances using Relational.OWL*

Another way of representing the structure of a database in OWL ontology is the approach taken by Relational.OWL. The ontology used by Relational.OWL is shown in Figure 2. It defines four classes Database, Table, Column and PrimaryKey. The instances of these classes and their relationships can represent the schema structure of any relational database. One of the available configurations of DataMaster is to import the database structure as instances of the Relational.OWL ontology. However, the Relational.OWL ontology is OWL Full, because Relational.OWL defines the representation of the database column types by using the rdfs:rangeproperty on the Column class, which makes the Column class be an owl:Classand an rdf:Propertyat the same time. We have provided in DataMaster two OWL DL modeling alternatives to the OWL Full constructs in Relational.OWL for the representation of the column datatypes. One modeling alternative is to attach a property hasXSDTypeto the Columnclass. The second alternative is to define a class ColumnTypeand a property hasColumnTypethat relates a Column instance to a ColumnTypeinstance.

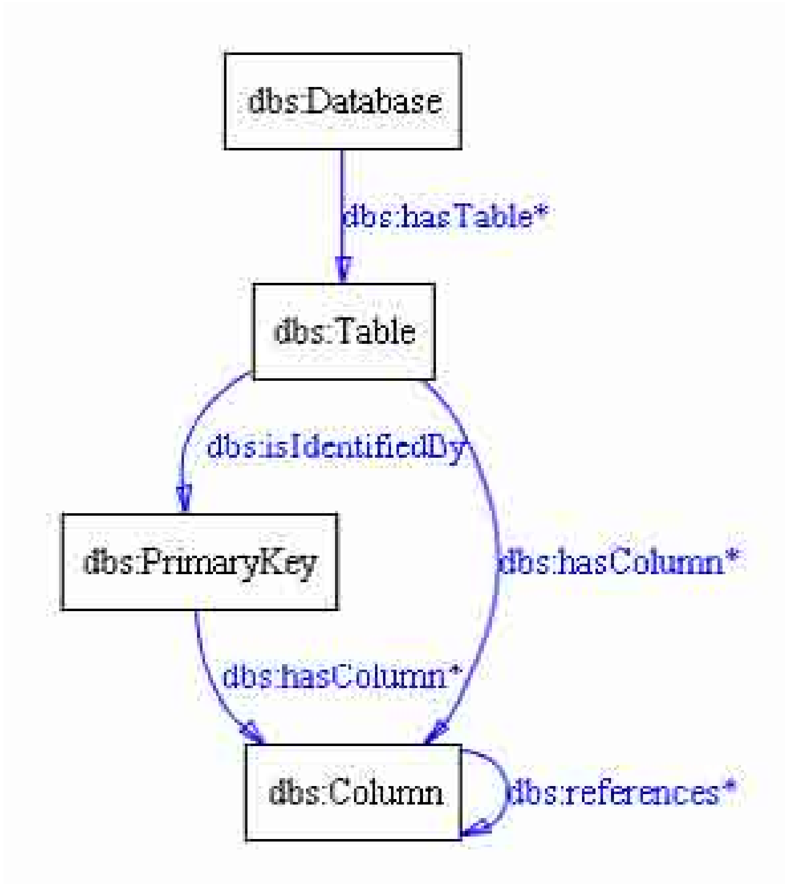


**Figure 2**

**Relational.owl ontology**

### *Schema Structure Ontology for Database Tables using meta-classes*

In the Relational.OWL schema representation, the database tables are represented as OWL individuals of the `Table` class. This representation is very useful if we are only interested in importing the database structure in the ontologyand not its data. This type of import is suitable for the case in which the data has to reside in the database but it can be accessed from an ontology layer by means of an OWL-database bridge. However, there are cases in which it is desirable to import also the database content into the ontology.Relational.OWL provides this functionality by making the `Table` class a meta-class. Its instances corresponding to the imported tables will be OWL classes and the rows in the database tables will be instances of the table classes. Ina similar way, the `Column` class will be a subclass of `owl:DatatypeProperty`and its instances corresponding to the database columns will be assigned to the row instances with values from the database.

### Make the Connection to the database

To connect to our database using Protégé, we have to follow the following steps first:

1. Start Menu -> Control Panel
2. Administrative tools
3. Data Sources (ODBC)
4. In the user DSN tab click Add (Figure 3)
5. In the Create New Data Source we should select the Microsoft Access Driver (*.mdb,*.accdb) (Figure 4)
6. Type the data source name you want to use in the Data Source Name text box (Figure 5)
7. Click the Select button under the database then the window in (Figure 6) will appear double click the folder containing your database under directories, then the database will appear in the left pane under Database Name.
8. Then click OK->OK
9. Open the Protégé, click the Project menu then click Configure, then click the DataMaster Tab, then click OK, (Figure 7)

10. Click the DataMaster v1.3.2 Tab, then click ODBC, then type the Data source name you entered in Figure 5

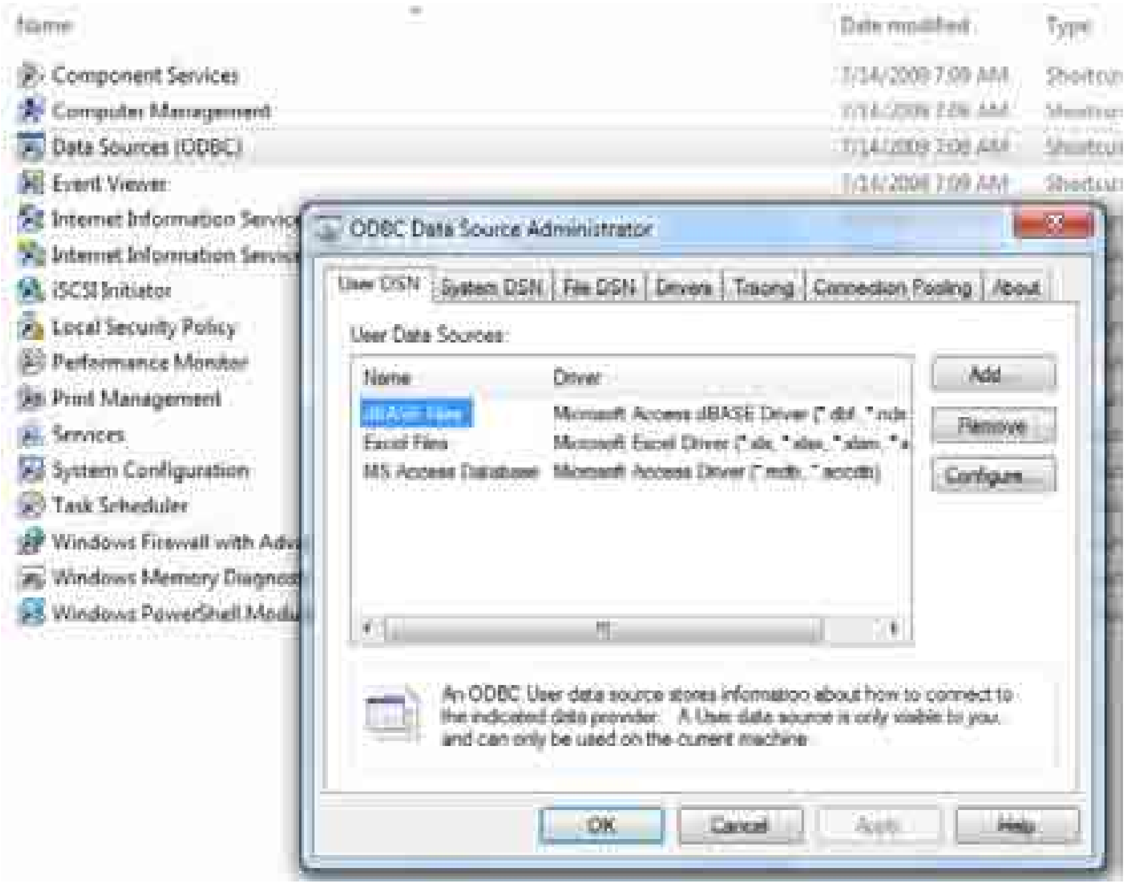


**Figure 3**

**Adding user DSN**

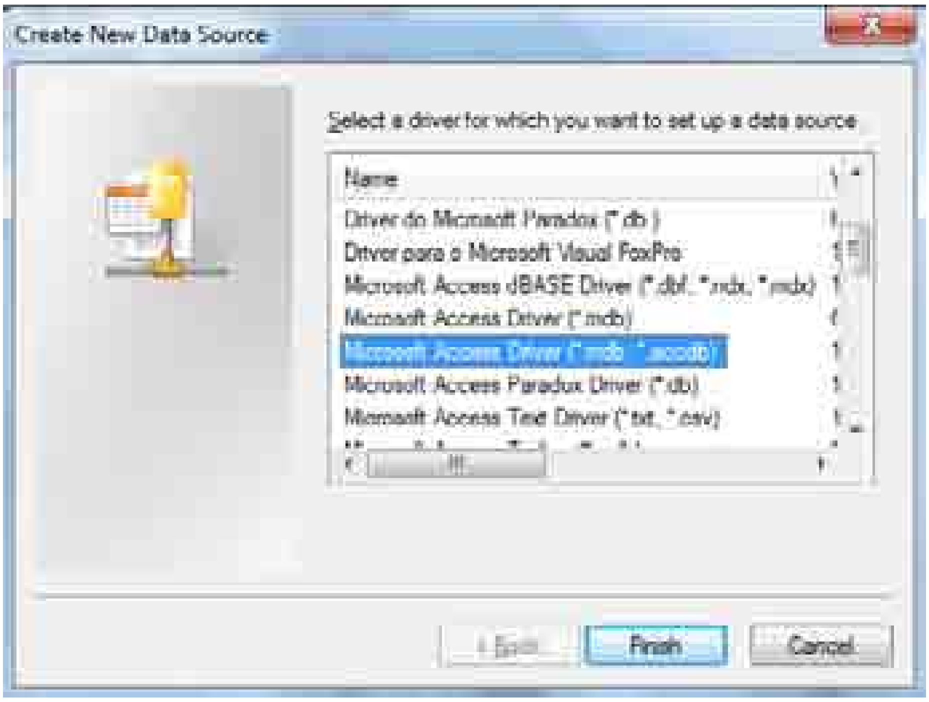


**Figure 4**

**Creating New Data source**

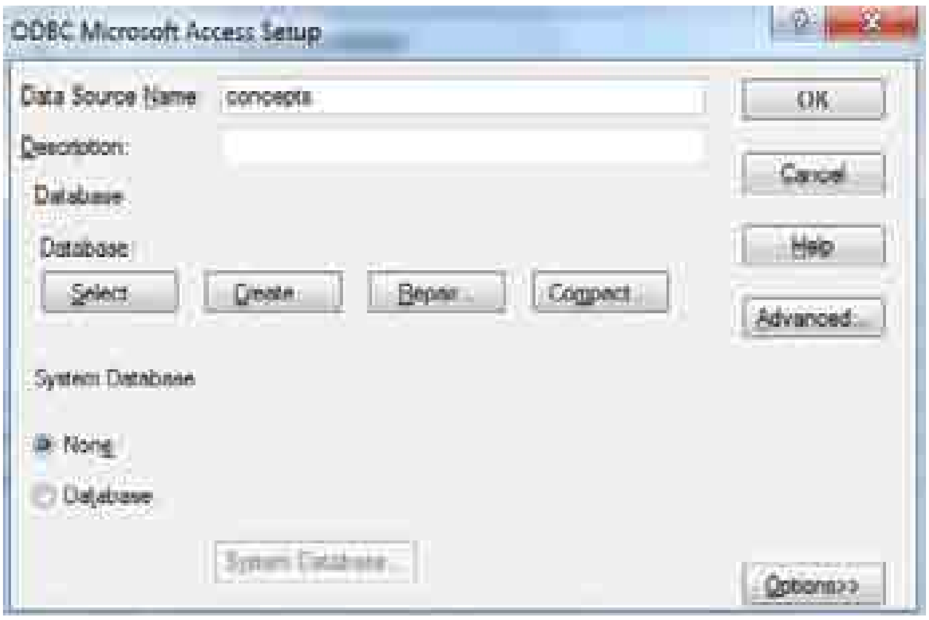


**Figure 5**

**Creating Data source Name**

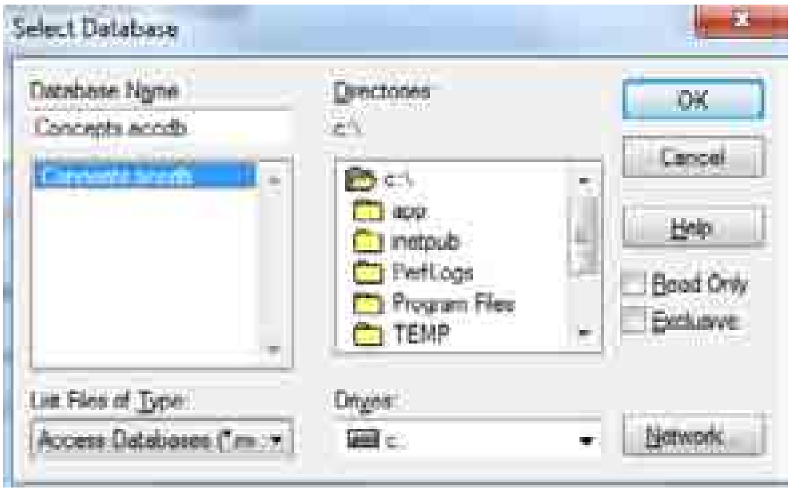


**Figure 6**

**Selecting the database**

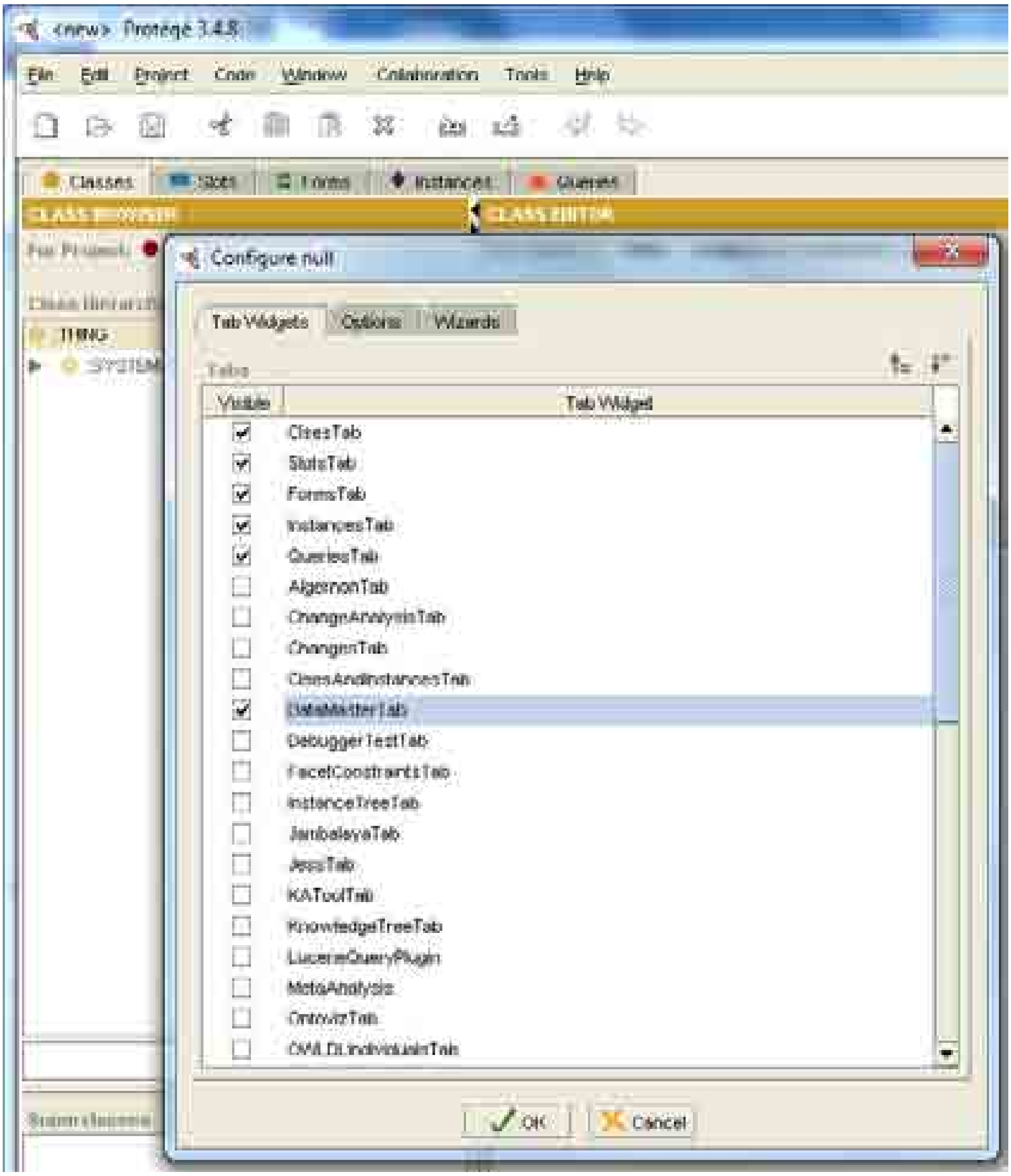


**Figure 7**

**Showing the DataMaster tab**

### The DataMaster User Interface

A screenshot of the DataMaster plug-in is shown in Figure 6. The graphical interface consists of several sub-panels. In the upper left *connection panel* the user can select the database connection type (ODBC or JDBC), specify the JDBC or JDBC/ODBC driver, the data source name, the user name and the password to access the database. Pressing the *Connect* button will open a JDBC connection to the database and will activate the *table selection panel***Figure 2. Relational.owl ontology** and the *preview panel*, where the user can select the tables to be imported into Protégé, and can get a preview of the selected tables. The *superclass selector panel* allows the user to select superclass(es) for the imported table classes. In this way, if the importing ontology already defines a class to represent database tables, the user can select this class in the superclass selector panel, and all the imported classes will be created as subclasses of that class.

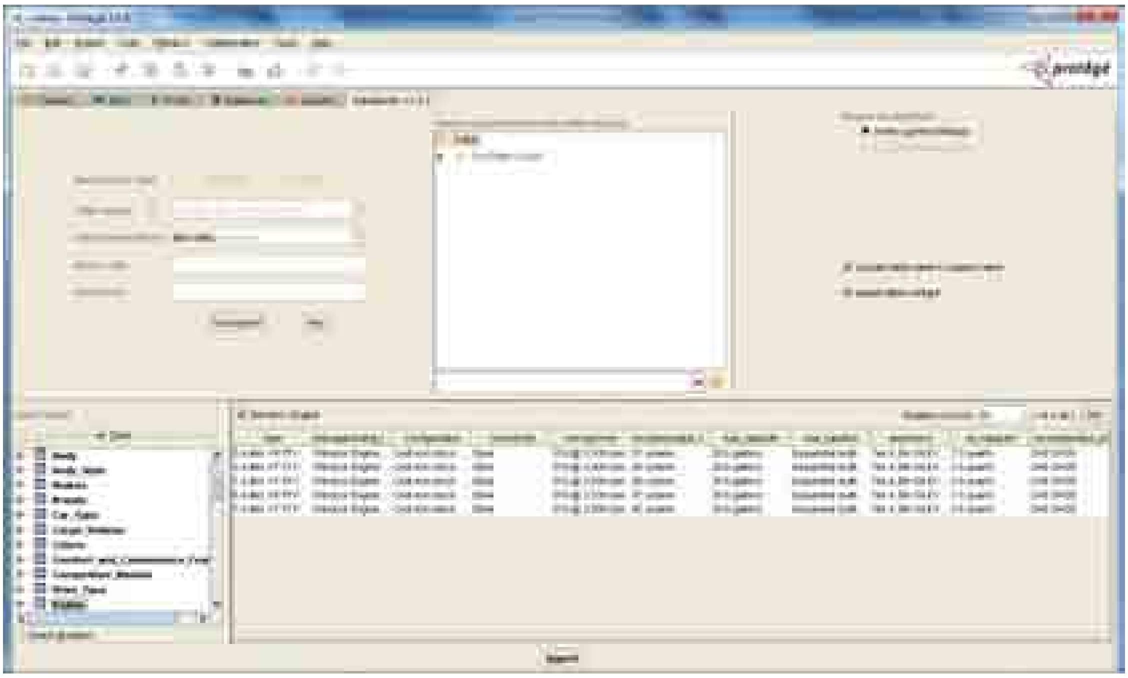

**Figure 8 Screenshot of the DataMaster plug-in**

In the upper right panel, the user can specify some important additional import options:

- The checkbox "*Include table name in column name*" is an option available when database tables are imported as classes. If selected, the column property names will be prefixed with the table name.

By selecting the "*Import table content*" checkbox the table data will be also imported. Note that importation of large databases may require increasing the Java VM heap size available for Protégé.

## Database Tool

As we stated at the beginning of this chapter we will start our proposed work by building our concepts and upon them our ontology will be built. We decided that we build our main concepts (classes) using a relational database then import them into the Protégé software, in another words using **DataMaster – a Plug-in for Importing Schemas and Data from Relational Databases into Protégé** then we will manipulate our classes using the Datamaster tool which is embedded in the Protégé software, according to (Csongor Nyulas, 2013)Importing data from relational databases into ontology significances is frequently required, especially when an ontology is used to describe semantically the data used by a software application. Another growing category of applications needs database-ontology integration and/or interoperation, where a mapping between the database schema structure and ontology concepts is the main focus. In the latter cases the import of the data residing in relational databases may not be necessary or desired. To meet these requirements, they have developed DataMaster, a Protégé plug-in that allows the user to import in a configurable way a relational database structure into a Protégé-OWL or

Protégé-Frames ontology. The plug-in also supports the optional importing of table contents. The development of DataMaster was necessary, because existing plug-ins developed for importing data from relational databases into Protégé, such as DataGenie [, do not support Protégé-OWL, schema-only import, and other import configurations available in DataMaster. The DataMaster plug-in has been developed in the BioSTORM project, which aims to develop a computational test bed that can draw on real-world data sources and that will allow users to configure, run, and evaluate alternative surveillance methods. The plug-in represents an important part of the semantic data-access layer, which annotates and integrates disparate data sources into a semantically uniform data stream.

### Classes, Relations and Instances

After importing our database into the Protégé program using the DataMaster Tab, we take a look about the changes happened, as shown in figure 9, all the tables exist in the relational database will be imported as classes into the Protégé, and these classes will be under the base built-in class :SYSTEM-CLASS, one important note here we have to mention is that we can imports other concepts or classes by importing another database and if we want these imported classes to be subclasses of some class then we select the class that we want to be the base class and then start the importing process.

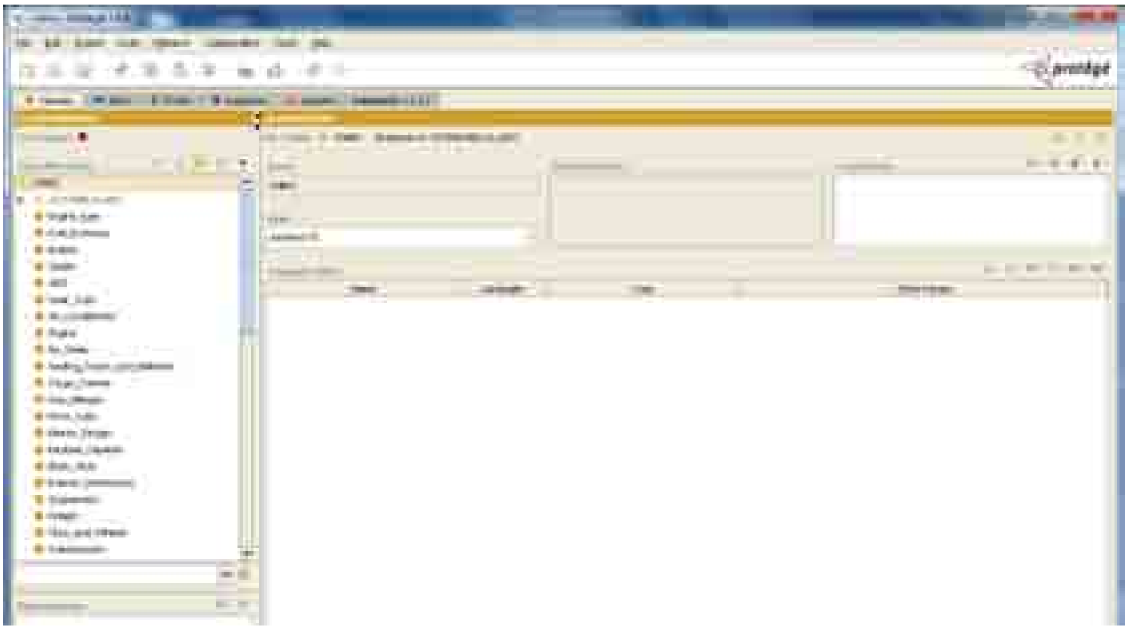

**Figure 9**

**Classes (tables) Imported from theDatabase**

The tables' fields defined when creating the database tables are all shown in the slots tab, since we might have tens or hundreds of attributes (database tables' fields) then it's a good idea to check the option include table name in column name when importing our database (Figure 8), returning to the slots tab we can see the details of any slot by clicking it then all the details for this slot will be shown to the right, Figure 10

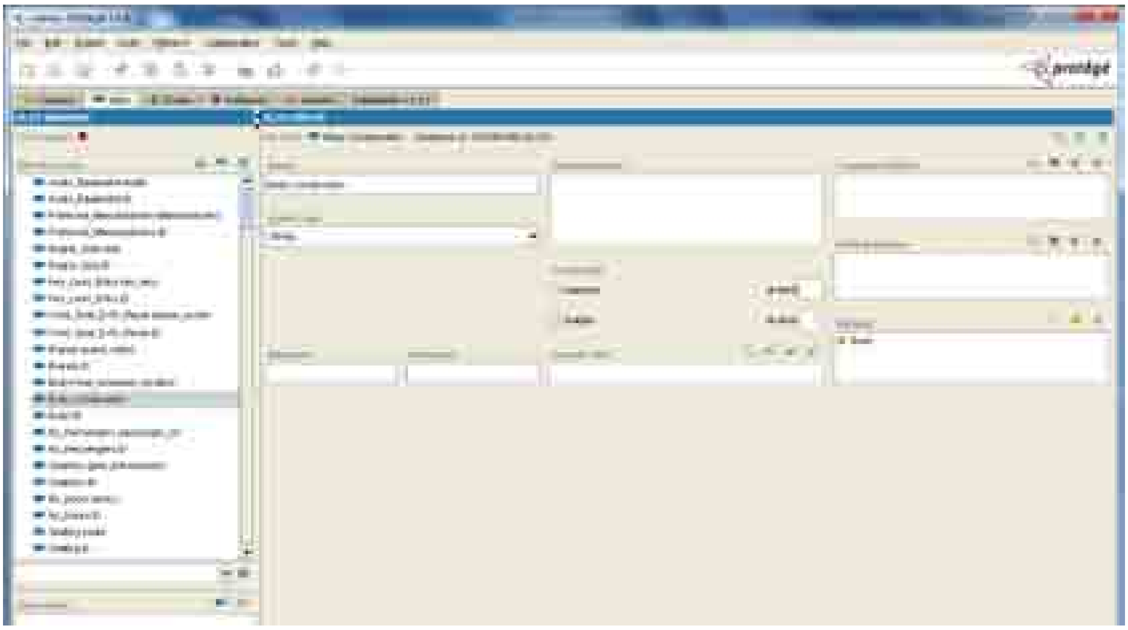

**Figure 10**

**Tables' Attributes Shown in the Slots Tab**

The Forms tab shown in Figure 11, is the form sign that will be shown when trying to inserting instances for a specific class.

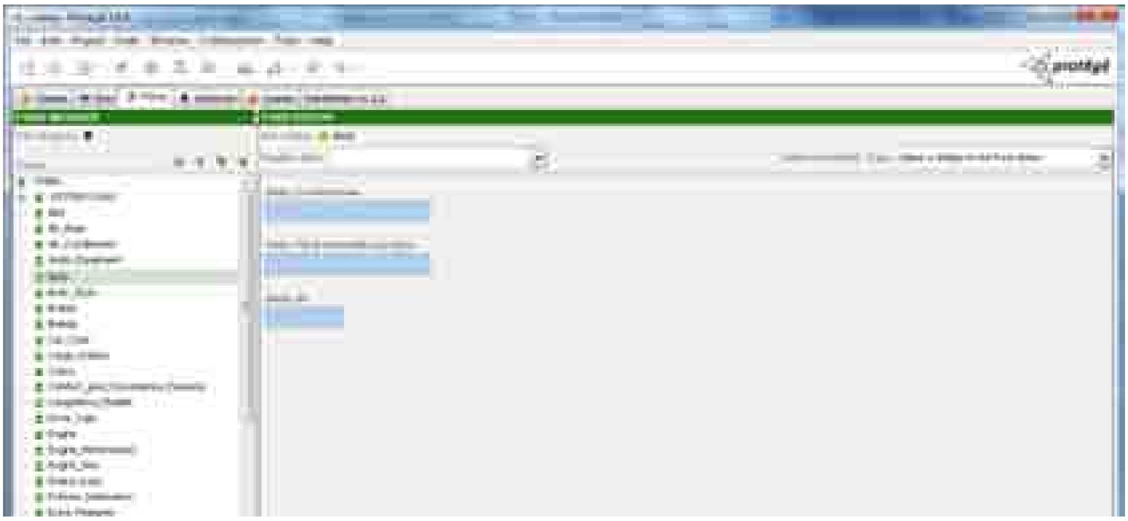

**Figure 11**

**Protégé Forms**

The instances tab is used to insert a new instance of a class, in object-oriented programming an **instance** is an occurrence or a copy of an object, whether currently executing or not. Instances of a class share the same set of attributes, yet will typically differ in what those attributes contain. For example, a class "Employee" would describe the attributes common to all instances of the Employee class. For the purposes of the task being solved Employee objects may be generally alike, but vary in such attributes as "name" and "salary". The description of the class would itemize such attributes and define the operations or actions relevant for the class, such as "increase salary" or "change telephone number." One could then talk about one instance of the Employee object with name = "Jane Doe" and another instance of the Employee object with name = "John Doe".

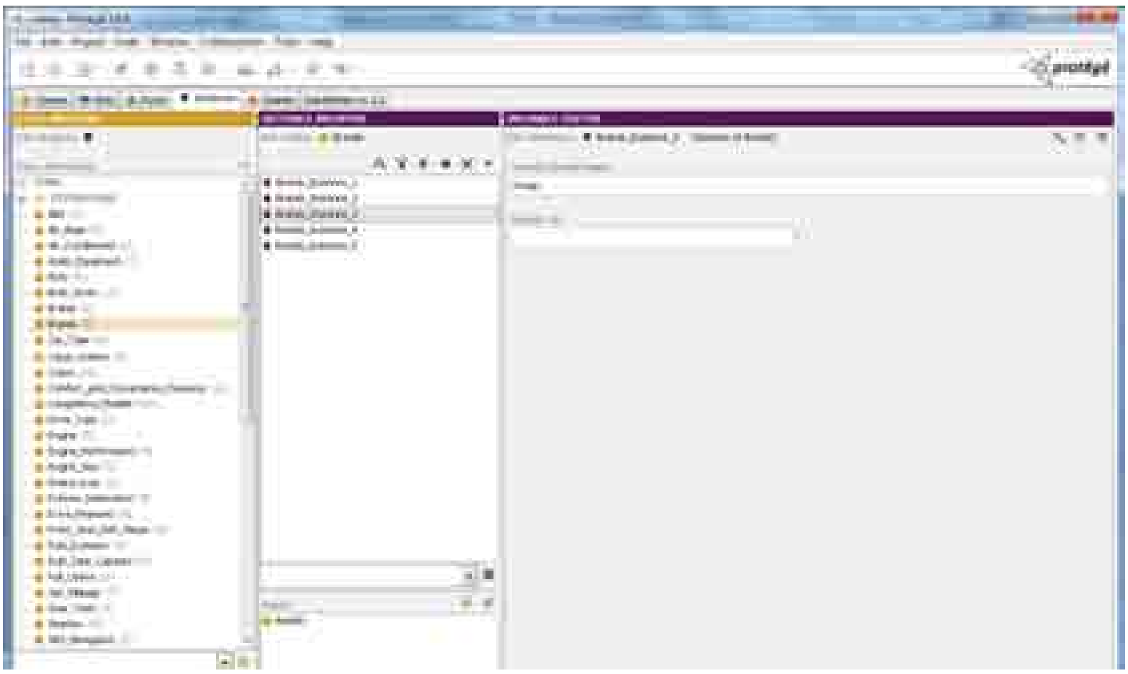

**Figure 12**

**Protégé Instances**

Now assume we want to query our classes to find some instances with specific criteria, obviously we can do this using the Query tab in the Protégé User Interface, assume we want to look up whether we have a Mercedes Brand in our concept brands or not then we click the Queries Tab, we click the + button above the Class textbox then we select the concept we want to search Figure 13, after selecting the class, the slots will related to the class will be shown when clicking the + sign above the slots textbox Figure 14

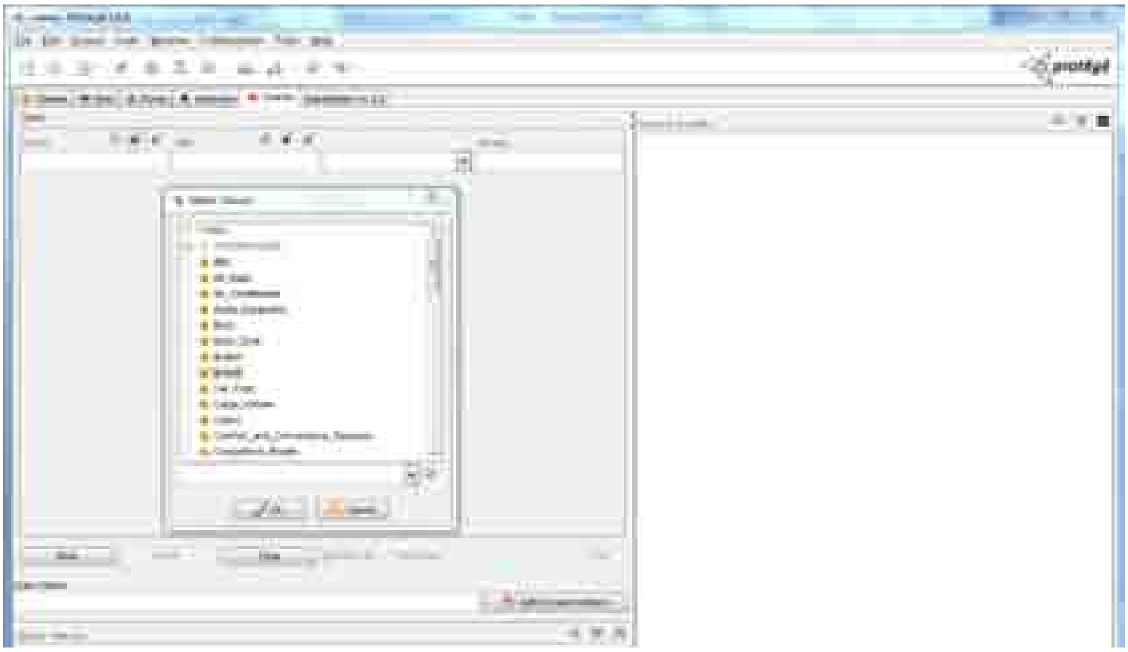

**Figure 13**

**Selecting the Class or Concept to Search its instances**

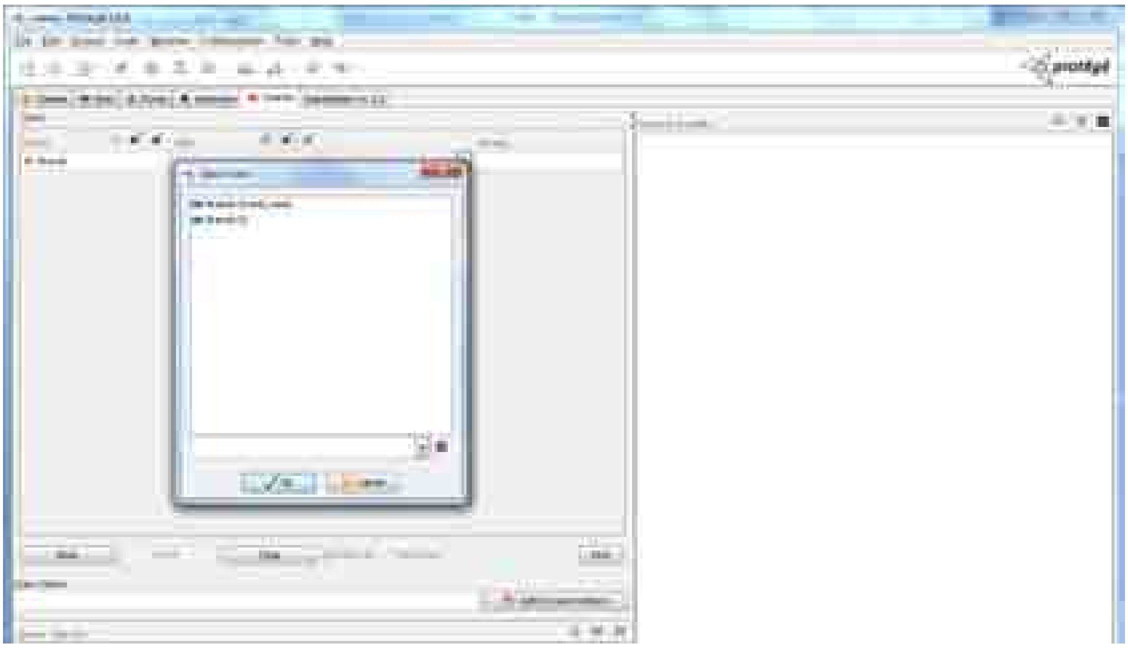

**Figure 14**

**Slots Related to the Class or Concept Selected**

After selecting the class and the slot desired we select the criteria, and these criteria are dependent on the data type of slot selected, so is the type of the slot is String we will find criteria like, contains, does not contain, begins with, ends with, and if the type of the slot is integer different criteria will be shown, like, less than and greater than, after we are done with the class, slot, and the criteria we click the find button and if there are results then they will be shown to the right of the window. (Figure 15)

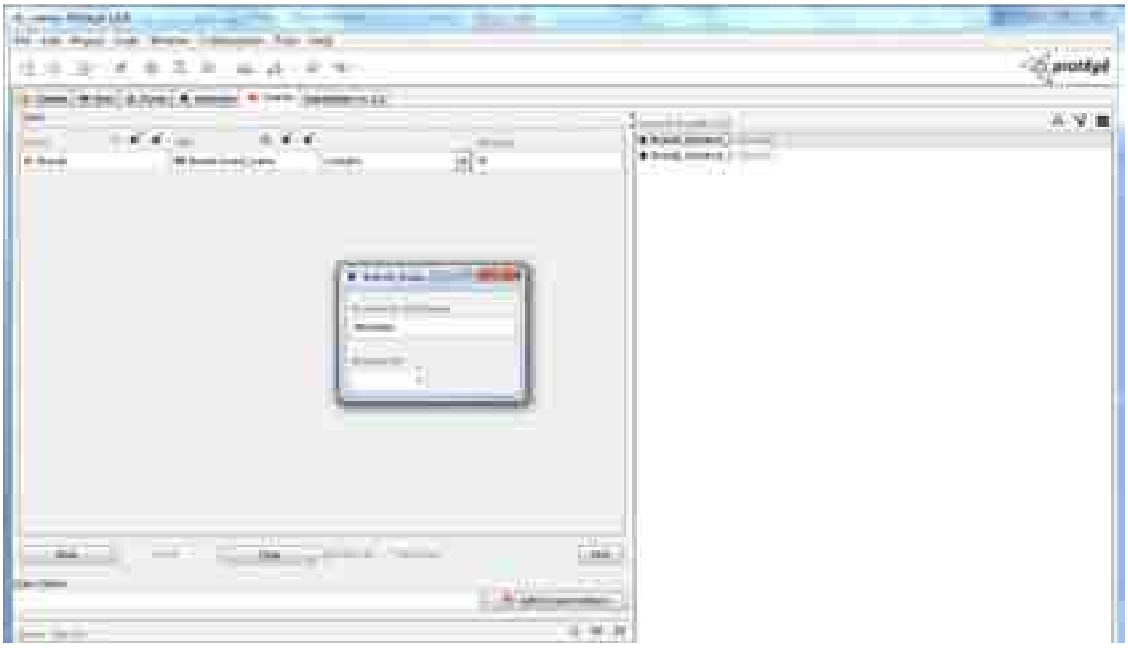

**Figure 15**

**Showing the Results of a Criteria**

now a specific relationships among the classes we imported can be created, assume we want to make an ontology relationship between two concepts, for example whether a specific brand different engine sizes (e.g. 4 Cylinders, 6 Cylinders) Or Not, to make this relationship in our ontology, we select the brands class then in the templates slot we click  , for the name of our relationship to be descriptive we want to name it Engine Sizes, in the value type we click instance, and in the cardinality we click multiple, so the relationship will be read as this Brand has many engine sizes (Figure 16).

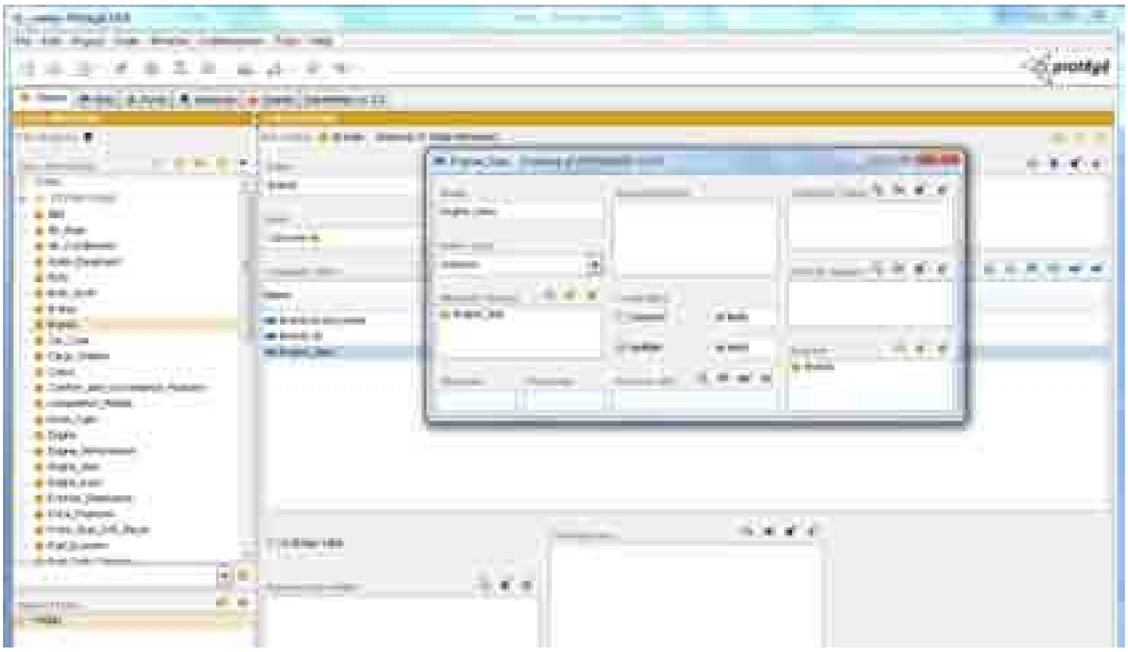

**Figure 16**

**Creating a Relationship between the concepts Brands and Engine_Size**

Now after we added this relationship to our concepts we should add some real data to check the relationship we just created, first to check that our relationship has been created successfully, we click the Instances Tab, the we click the class Brands, now when we click any of the brands instances we can see the relationship is attached with the instance at the bottom, Figure 17

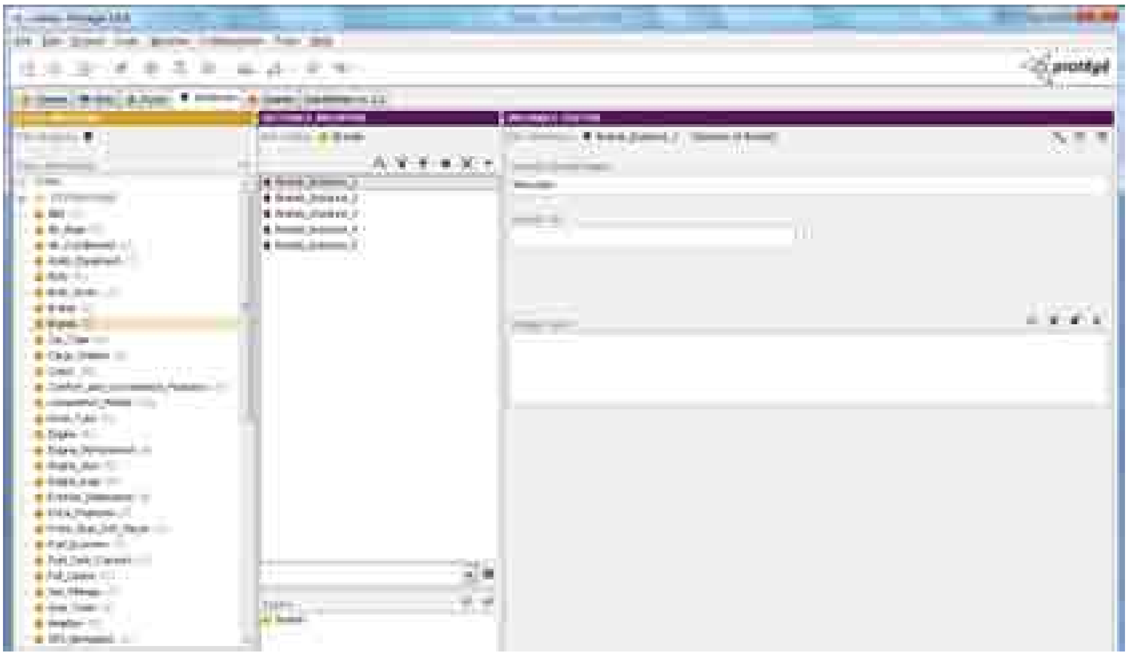

**Figure 17**

**The Relationship Slot Attached to the Brands Instance**

Now to attach real data to the new relationship we click on the  then all the instances exist in the Engine_Size concept will be shown, Figure 18, we can hold the Ctrl key and click the instances we want, and tocheck the values for the instance we double click it, Figure 19.

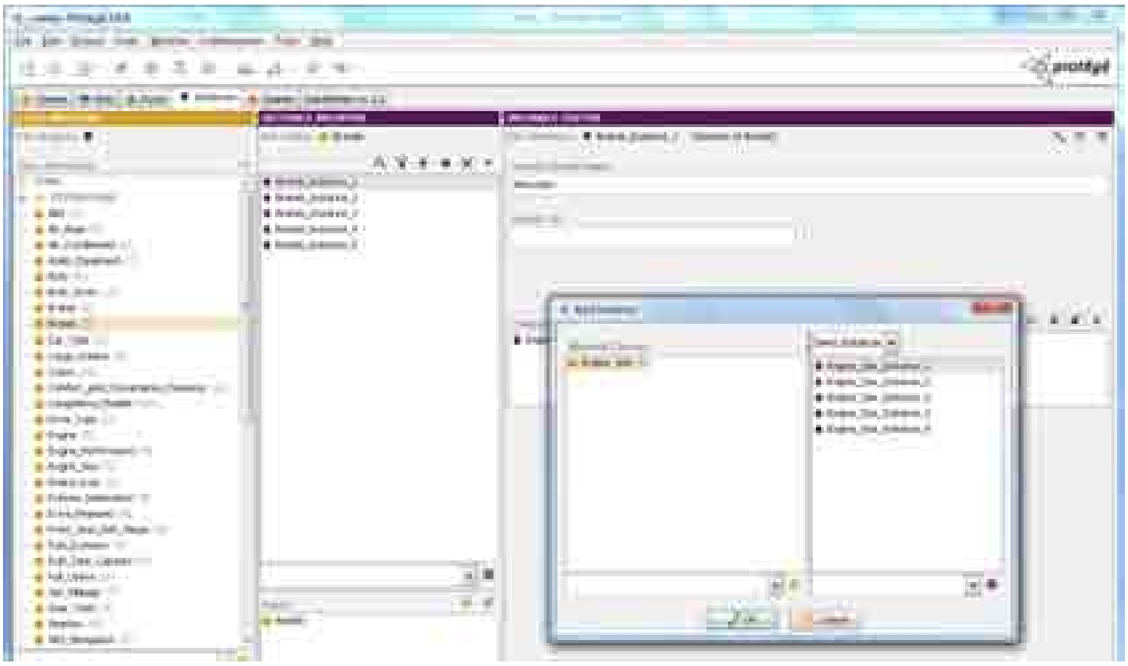

**Figure 18Adding Instances to the Relationship**

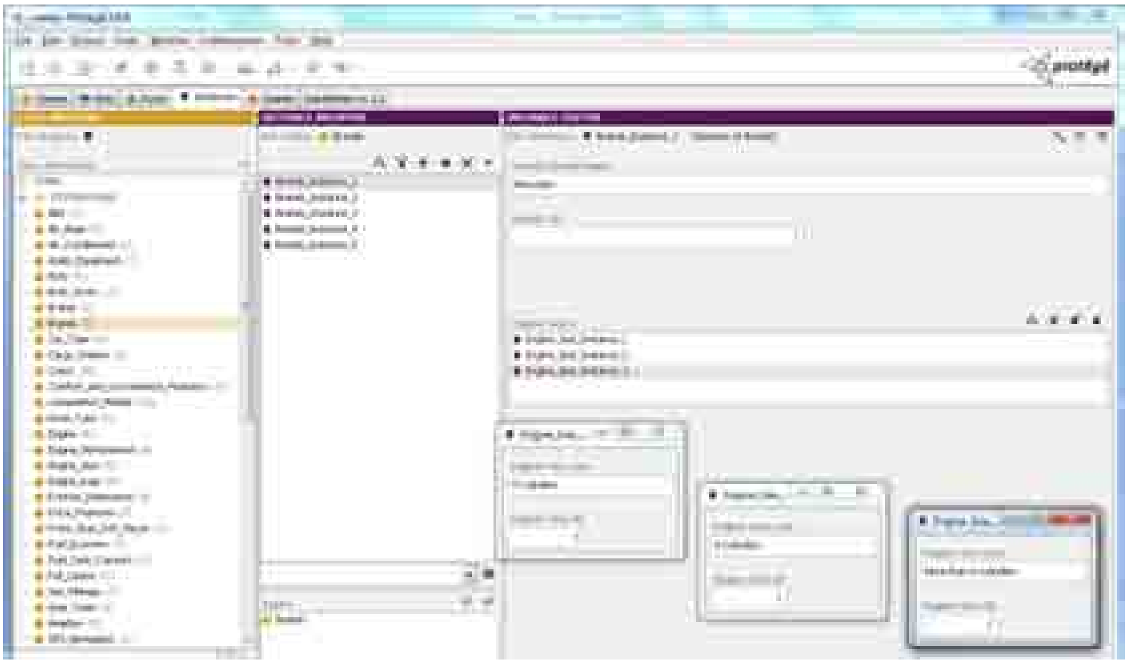

**Figure 19**

**Checking Instances Values**

Now the question that comes to mind is how we take advantage of the relationship we just created. To see how important the relationship we just created let’s assume we want to find the Vehicle brand that has an engine with 8 Cylinders or more, so we click the Queries tab, the we select the class brand, and from the slot we select the relationship Engine Sizes, from the criteria we choose contains, because this slot is a relationship we can’t just type the value for the criteria but instead we have to select an instance, so we select the instance Engine_Size_Instance_2 (More than 8 Cylinders), then we click find, the result will be show to the right of the window showing that the Brand that satisfies this criteria is the Mercedes Brand, Figure 19

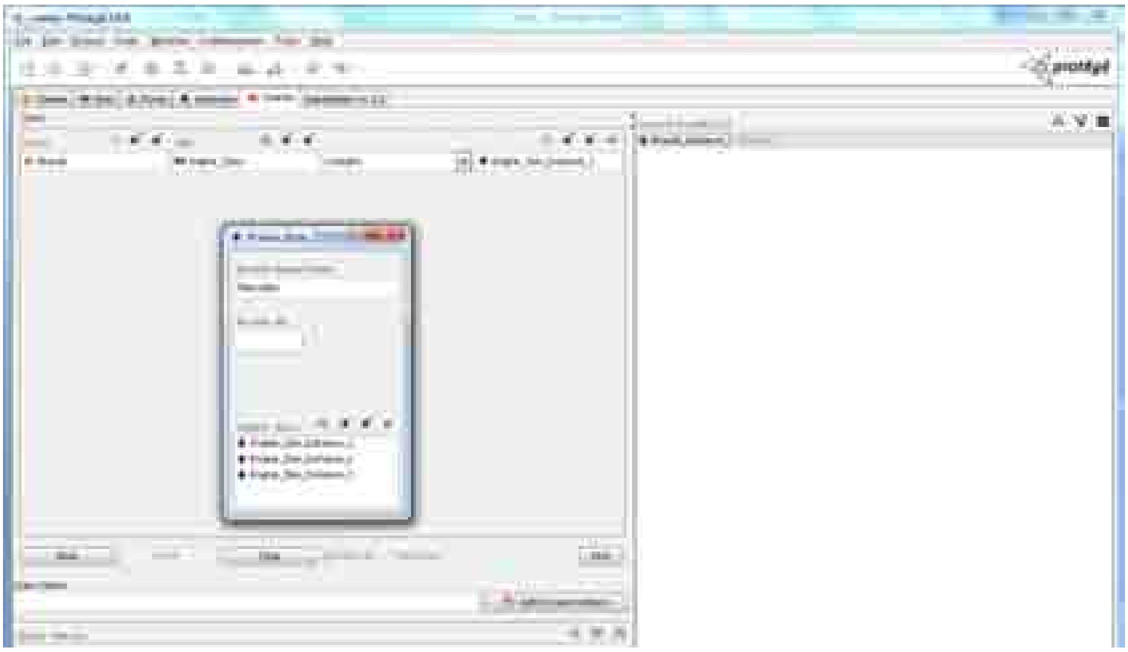

**Figure 20**

**Query Two Concepts Based on a Relationship**

As a good habit we will save each query that has a relationship to the query library to avoid repeating the steps, and to retrieve the same query later so Quickly, Figure 20

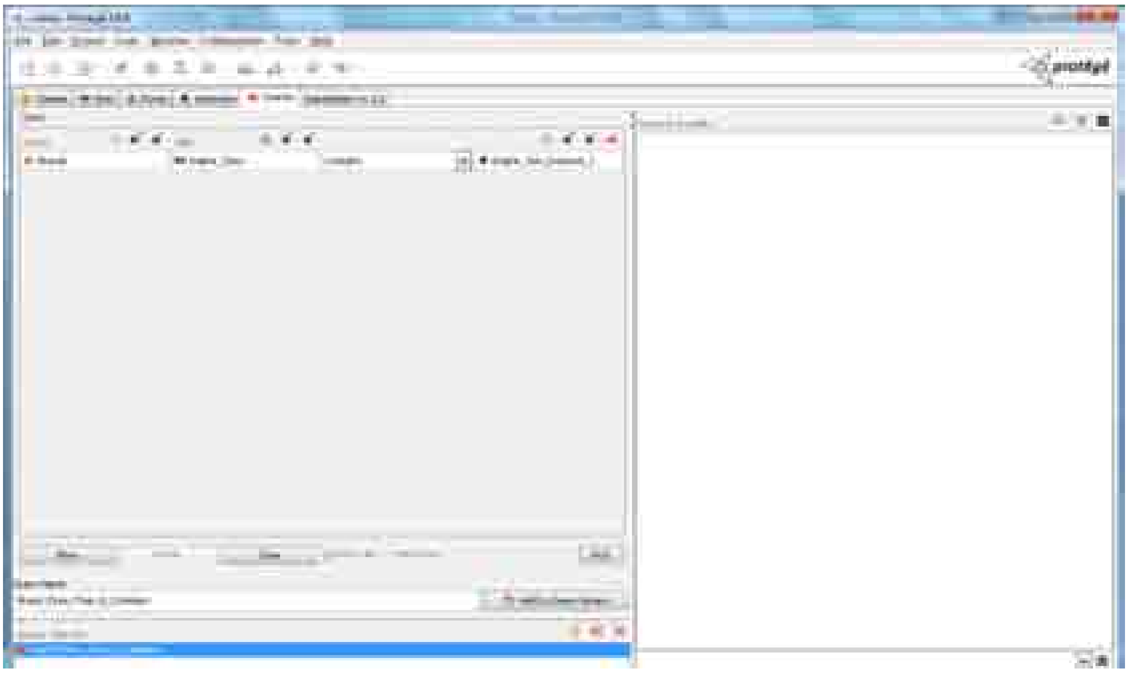

**Figure 21**

**Saving the Queries to the Query Library**

## Sample Scenario

Now in the proposed method we will build our ontology and concepts and all the relationships that cover all the requirements in the vehicles domain for tenders and bidders for e-government applications, to decide which bid is the most convenient for the e-government tenders, first we build our complete ontology that is very specific to the vehicles specifications we want, after building the concepts, ontology significances, and the relationships, we will add the instances for each class with the data representing the required specifications and then we will import the bidders specification to our ontology, most probably the bidders will use different terms than our concepts, so we will have to add some relationships according to the data provided from bidders.

Assume the tender wants a vehicle with specific brands (e.g. Mercedes, BMW, Peugo, Cadilac, and Toyota); we add this concept to our ontology with the brands required, Figure 22

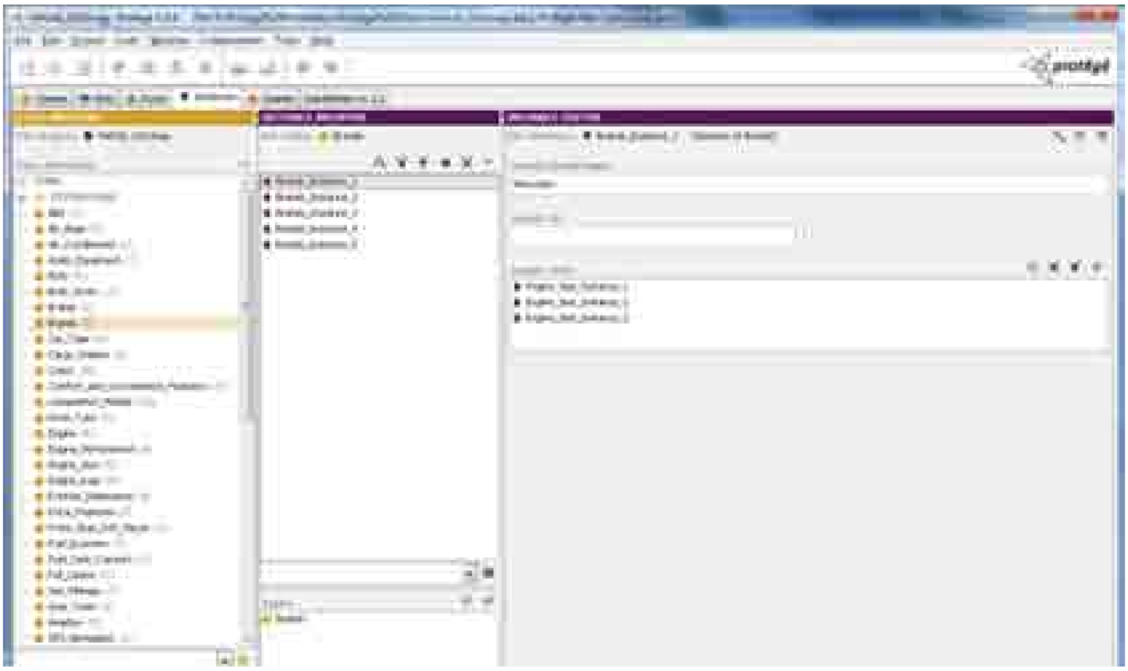

**Figure 22**

**Adding Concepts with The Instances**

We will do the same procedure for all the requirements required in the invitation for bid, so each single requirement will be translated into a class (concept), and the desired specifications will be the instances for that concept, after we set the concepts desired with instances, we import the bidders offers, now an ontological comparison will be done for each bidder, the question is how to make the comparison between the tenders specifications and bidders offers?, assume the bidder sent certain engine specifications, but the feature was entitled Motor instead of engine, in this case we will have to create a relationship in our ontology indicating that this feature (Motor) is the same as the concept we already have which is Engine, we can represent this relationship as Is-A relationship, but before we create the relationship we will have to create or import the vehicles feature with the same slots we have for the Engine concept, of course it will be much easier to inform the bidder about the appropriate format for importing features, but in case this is difficult for some reason, we can add the concept to our ontology, and then just add the existing slot for the engine concept, Figure 23. If the provided offer is exactly the same as the tender's requirement we can simply add the Is-A Relationship Figure 24

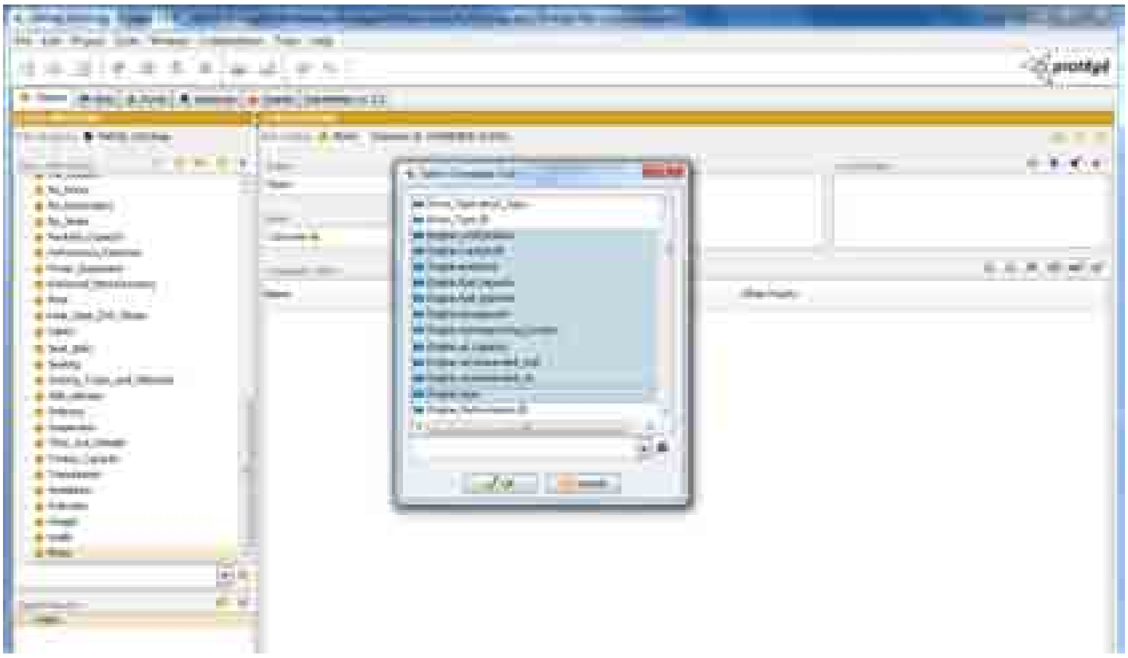

**Figure 23**

**Adding Existing Slots for New Concept**

We do the same procedure for each requirement from each bidder, for example, assume bidder XY has a different offer for the engine with partial fulfillment for our requirement then we can add this by adding a new concept for XY bidder with partial_Motor relationship, first we add the concept with the slots required, Figure 24, as we can see from the figure we added a new concept but we used the same slots for concept Engine. Then we create a relationship indicating that this bidder engine partially fulfils our requirements, Figure 24

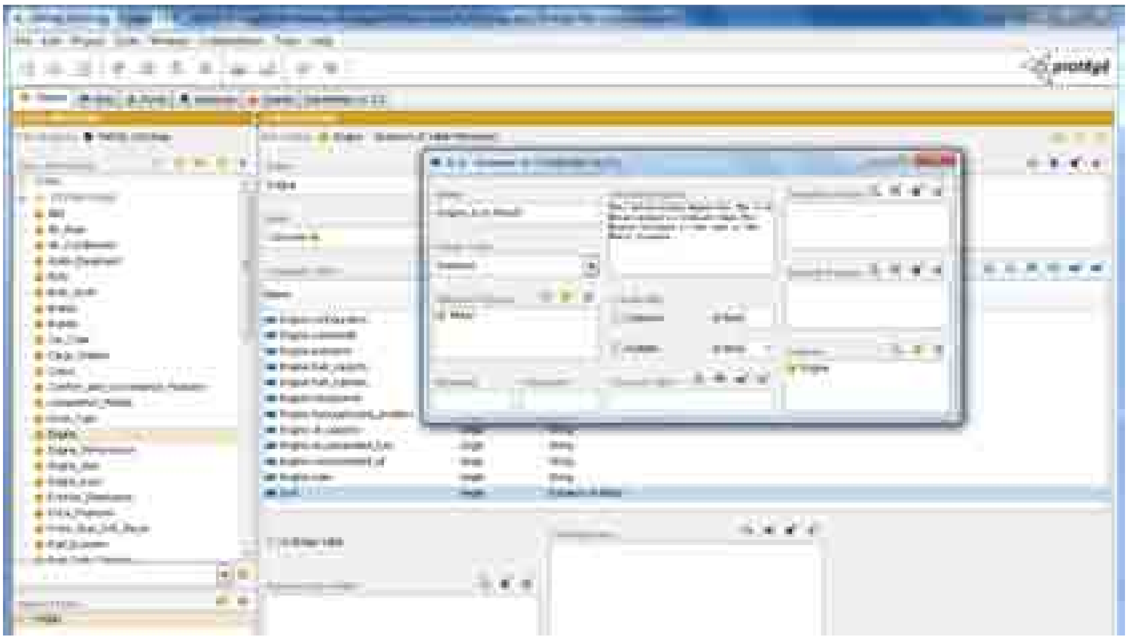

**Figure 24**

**Engine Is-A Motor Relationship**

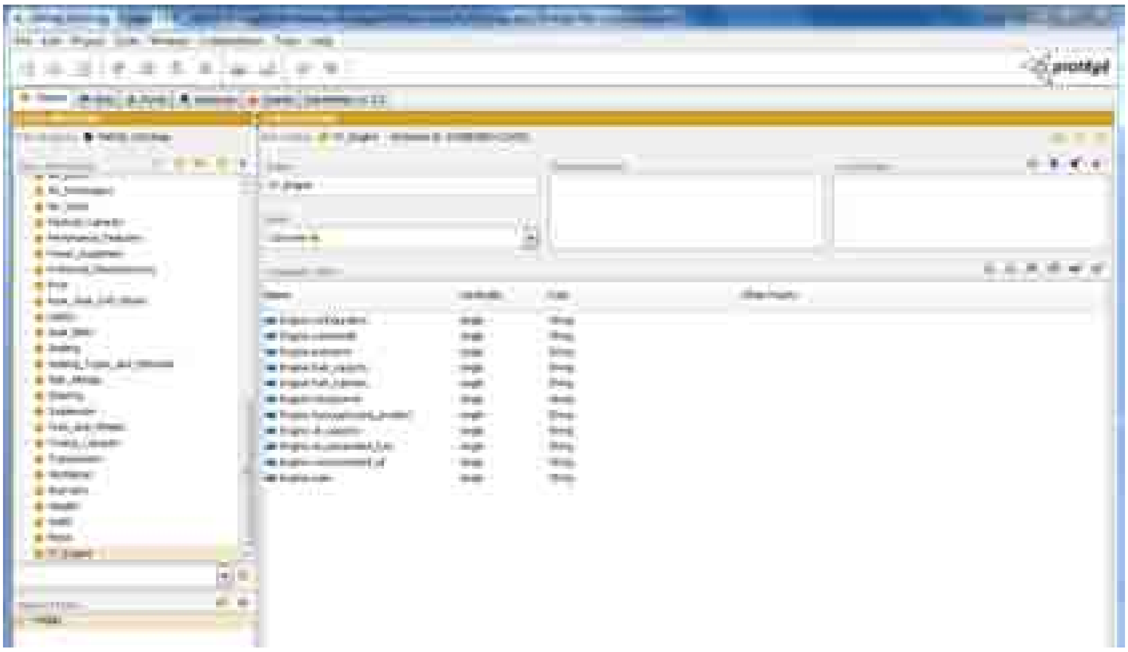

**Figure 25New Bidder Concept with the Slots Required**

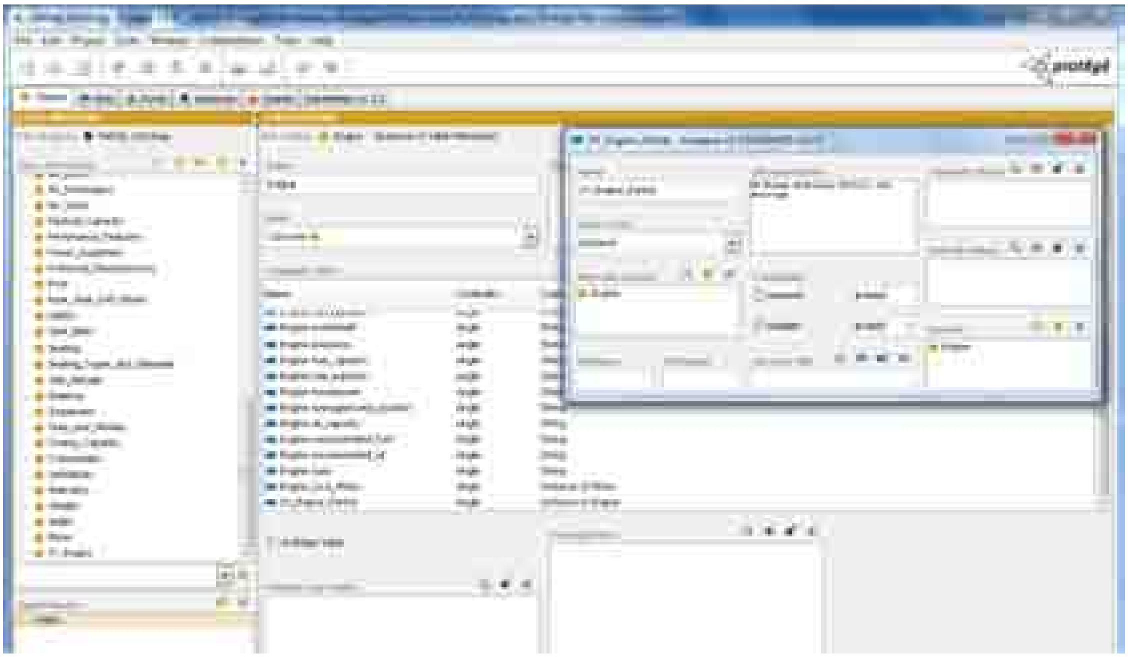

**Figure 26Partial Fulfillment Relationship**

Again we will add a bidder that satisfies our engine requirements fully in the same previous procedure, Now if We Move to the instances tab, and click our concept Engine we can see the relations that we created, Figure 27, as we can see in the figure we have three relationships, namely, Engine Is-A Motor, XY Engine Partial, and Engine Full.

Now if we want to search which bidder fully fulfill specific requirements we can use the Query tab, selecting the class engine in the class field, then in the slot field we select the Engine_Full relationship, then we choose contains or does not contain criteria, in the last field we select an instance that satisfies the relationships (Note: this instance was added in the instances form for the Engine Concept), as shown in Figure 28

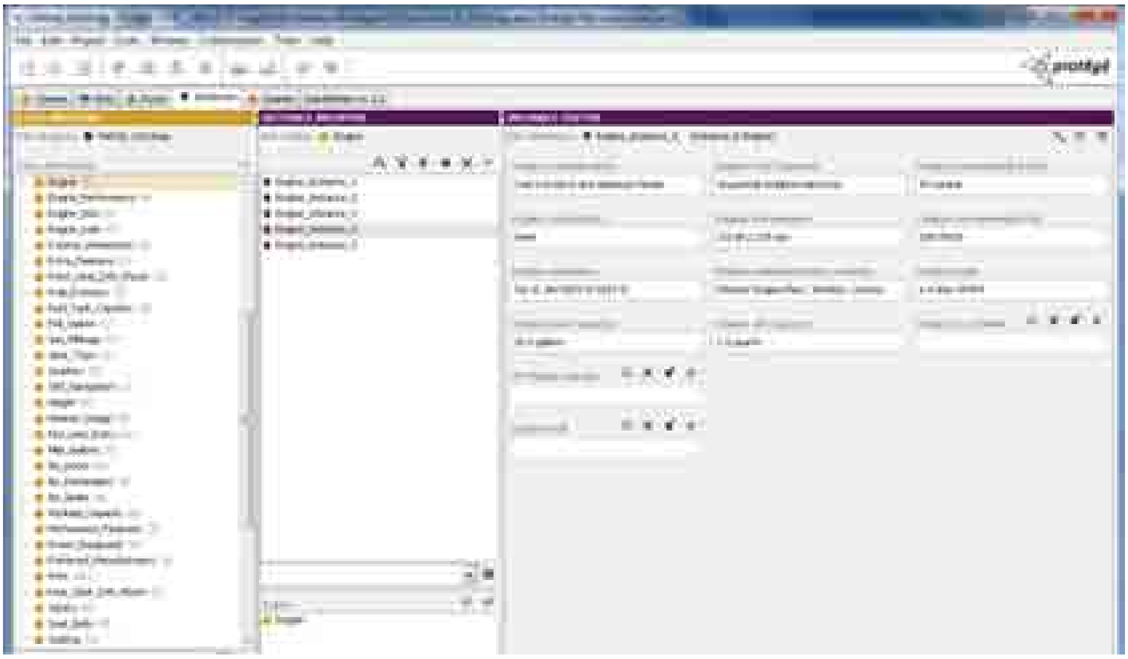

**Figure 27**

**Full Fulfillment Relationship**

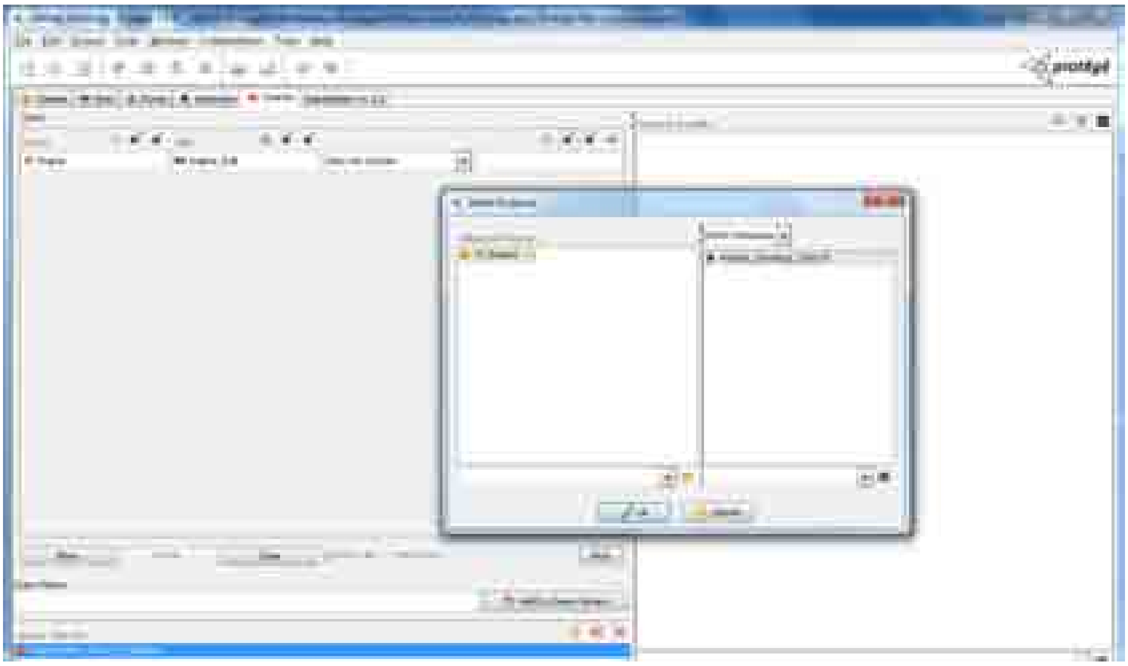

**Figure 28**

**A Full Fulfillment Relationship Query**

## Experts Matching Percentages

## Ministry of Electricity and Water (Kuwait)

| Semantics | | Semantic Relatedness | | | |
|---|---|---|---|---|---|
| Word 1 | Word 2 | Average (Palmer & Lin) | Expert Matching Percentage % | Expert (0/1) | Error |
| Engine | Motor | | 100 | | |
| Engine | Cylinder | | 10 | | |
| Engine | Piston | | 10 | | |
| Engine | Turbine | | 100 | | |
| Engine | Mechanism | | 50 | | |
| Brake | Restraint | | 100 | | |
| Brake | Hamper | | 75 | | |
| Brake | Stop | | 100 | | |
| Brake | Hindrance | | 75 | | |
| Brake | Restraint | | / | | |
| Brand | Trademark | | 100 | | |
| Brand | Marker | | 90 | | |
| Brand | Emblem | | 50 | | |
| Brand | Logo | | 70 | | |
| Brand | Imprint | | 50 | | |
| Fuel | Petrol | | 40 | | |
| Fuel | Gas | | 90 | | |
| Fuel | Ammunition | | 19 | | |
| Fuel | Combustible | | 50 | | |
| Fuel | propellant | | 50 | | |
| Capacity | Volume | | 100 | | |
| Capacity | Amplitude | | 0 | | |
| Capacity | Quantity | | 100 | | |
| Capacity | Bulk | | 50 | | |
| Capacity | Mass | | 30 | | |
| Capacity | Expanse | | 40 | | |
| Mileage | Mileage | | 100 | | |
| Mileage | Distance | | 50 | | |
| Mileage | Range | | 50 | | |
| Mileage | Length | | 70 | | |
| Mileage | Span | | 70 | | |
| Mileage | Continuance | | 20 | | |
| Performance | Execution | | 100 | | |
| Performance | Act | | 70 | | |
| Performance | Achievement | | 70 | | |
| Performance | Completion | | 70 | | |
| Performance | Fulfillment | | 70 | | |
| Performance | Attainment | | 90 | | |
| Performance | Fruition | | 70 | | |

| | | | | | |
|---|---|---|---|---|---|
| Color | Tinge | | 60 | | |
| Color | Stain | | 60 | | |
| Color | Dye | | 50 | | |
| Color | Tint | | 60 | | |
| Color | Paint | | 90 | | |
| Color | Tincture | | 30 | | |
| Color | Pigmentation | | 80 | | |
| Color | Undertone | | 50 | | |
| Gear | Machine | | 90 | | |
| Gear | Instrument | | 50 | | |
| Gear | Transmission | | 100 | | |
| Gear | Machinery | | 50 | | |
| Gear | Wheel | | 90 | | |
| Gear | Treadle | | 20 | | |
| Gear | Gearbox | | 20 | | |
| Door | Entry | | 60 | | |
| Door | Gate | | 60 | | |
| Door | Egress | | 50 | | |
| Door | Aperture | | 70 | | |
| Door | Exit | | 90 | | |
| Door | Inlet | | 60 | | |
| Power | Vigor | | 60 | | |
| Power | Force | | 80 | | |
| Power | Intensity | | 30 | | |
| Power | Strength | | 90 | | |
| Power | Potential | | 50 | | |
| Power | Effectiveness | | 30 | | |
| Gas | Petrol | | 100 | | |
| Gas | Petroleum | | 60 | | |
| Gas | Invader | | 60 | | |
| Gas | Diesel | | 50 | | |
| Gas | Oil | | 30 | | |
| Gas | Kerosene | | 90 | | |
| Seat | Chair | | 90 | | |
| Seat | Couch | | 90 | | |
| Seat | Bench | | 90 | | |
| Seat | Lounge | | 90 | | |
| Seat | Office | | 70 | | |
| Seat | recliner | | 60 | | |
| Seat | Settee | | 80 | | |
| Vehicle | Car | | 90 | | |
| Vehicle | Bus | | 90 | | |

| | | | | | |
|---|---|---|---|---|---|
| Safety | Security | | 90 | | |
| Safety | Integrity | | 60 | | |
| Safety | Solidity | | 80 | | |
| Safety | Protection | | 90 | | |
| Safety | Preventive | | 80 | | |
| Safety | Precaution | | 70 | | |
| Suspension | Break | | 70 | | |
| Suspension | Postponement | | 90 | | |
| Suspension | Stay | | 30 | | |
| Suspension | Brake | | 10 | | |
| Suspension | Amputation | | 20 | | |
| Suspension | Stop | | 10 | | |
| Material | Substance | | 90 | | |
| Material | Matter | | 90 | | |
| Material | Article | | 90 | | |
| Material | Item | | 40 | | |
| Material | Materiality | | 90 | | |
| Warranty | pledge | | 70 | | |
| Warranty | assurance | | 100 | | |
| Warranty | Security | | 95 | | |
| Warranty | Certificate | | 60 | | |
| Warranty | Undertaking | | 30 | | |
| Feature | characteristic | | 80 | | |
| Feature | Attribute | | [illegible] | | |
| Feature | Quality | | 60 | | |
| Feature | Attribute | | 90 | | |
| Feature | Trait | | 90 | | |
| Feature | Merit | | 70 | | |
| Feature | Advantage | | [illegible] | | |
| Audio | Sound | | 100 | | |
| Audio | Voice | | 90 | | |
| Audio | Tone | | 30 | | |
| Audio | Resonance | | 30 | | |
| Audio | Hearing | | 20 | | |
| System | Organization | | 90 | | |
| System | Structure | | 100 | | |
| System | Order | | [illegible] | | |
| System | Method | | 30 | | |
| System | Framework | | 90 | | |
| System | Regulation | | 60 | | |
| System | Coordination | | 60 | | |
| Cargo | Freight | | 90 | | |

| | | | | | |
|---|---|---|---|---|---|
| Cargo | Loading | | 80 | | |
| Cargo | Consignment | | 70 | | |
| Cargo | Shipment | | 90 | | |
| Cargo | Payload | | 90 | | |
| Cargo | Capacity | | 10 | | |
| Cargo | Goods | | [illegible] | | |
| Passenger | Occupant | | 60 | | |
| Passenger | Traveler | | 40 | | |
| Passenger | Rider | | 50 | | |
| Passenger | Commuter | | 90 | | |
| Belt | Strap | | 95 | | |
| Belt | Band | | 60 | | |
| Belt | Girdle | | 40 | | |
| Belt | Waistband | | 80 | | |
| Belt | Fasten | | 40 | | |
| Belt | Restraint | | 35 | | |
| Belt | Cincture | | 70 | | |
| Tire | Tyre | | 100 | | |
| Tire | Wheel | | [illegible] | | |
| Tire | Drain | | 30 | | |
| Price | Cost | | 100 | | |
| Price | Value | | 100 | | |
| Price | Amount | | 100 | | |
| Price | Fee | | 70 | | |
| Price | Payment | | 95 | | |
| Price | Rate | | 100 | | |
| Price | Charge | | 90 | | |
| Dimension | Proportion | | 70 | | |
| Dimension | Length | | 35 | | |
| Dimension | Aspect | | [illegible] | | |
| Dimension | Distance | | 75 | | |
| Dimension | Element | | 50 | | |
| Dimension | Measure | | 100 | | |
| Window | Windowpane | | 95 | | |
| Window | Pane | | 90 | | |
| Window | Glass | | 80 | | |
| Window | Casement | | 90 | | |
| Window | Frame | | 80 | | |
| Window | Overture | | 70 | | |

| | | | | | |
|---|---|---|---|---|---|
| Vehicle | Truck | | 80 | | |
| Vehicle | Automobile | | 95 | | |
| Vehicle | Van | | 90 | | |
| Vehicle | Wagon | | 90 | | |
| Vehicle | Carriage | | 90 | | |
| Model | Pattern | | 80 | | |
| Model | Mold | | 80 | | |
| Model | Paradigm | | 60 | | |
| Model | Form | | 70 | | |
| Model | Template | | 80 | | |
| Model | Type | | 70 | | |
| Model | Sample | | 60 | | |
| Height | Altitude | | 100 | | |
| Height | Elevation | | 100 | | |
| Height | Peak | | 100 | | |
| Height | Top | | 90 | | |
| Height | Rise | | 40 | | |
| Height | Crest | | 50 | | |
| Height | Tip | | 60 | | |
| Width | Range | | 30 | | |
| Width | Area | | 40 | | |
| Width | Ambit | | 20 | | |
| Width | Domain | | 20 | | |
| Width | Amplitude | | 30 | | |
| Width | Broadness | | 95 | | |
| Manufacturer | Producer | | 100 | | |
| Manufacturer | Maker | | 100 | | |
| Manufacturer | Industrialist | | 70 | | |
| Manufacturer | Farmer | | 20 | | |
| Manufacturer | Creator | | 90 | | |
| Manufacturer | Company | | 95 | | |
| Manufacturer | Constructor | | 90 | | |
| Ventilation | Airing | | 80 | | |
| Ventilation | Freshness | | 90 | | |
| Ventilation | Aeration | | 90 | | |
| Ventilation | Cooling | | 80 | | |
| Ventilation | Oxygen | | 70 | | |
| Transmission | Move | | 80 | | |
| Transmission | Switch | | 80 | | |
| Transmission | Transit | | 70 | | |
| Transmission | Movement | | 60 | | |
| Transmission | Dispatch | | 70 | | |

## Toyota Company (Kuwait)

| Synonym | | Semantic Relatedness | | | |
|---|---|---|---|---|---|
| Word 1 | Word 2 | Average (Pointer & Lin) | Expert Matching Percentage % | Expert R1 | Error |
| Engine | Motor | | 95 | | |
| Engine | Cylinder | | 50 | | |
| Engine | Piston | | 60 | | |
| Engine | Turbine | | [illegible] | | |
| Engine | Mechanism | | [illegible] | | |
| Brake | Restraint | | [illegible] | | |
| Brake | Hamper | | 40 | | |
| Brake | Stop | | 75 | | |
| Brake | Hindrance | | 40 | | |
| Brake | Restraint | | | | |
| Brand | Trademark | | 75 | | |
| Brand | Market | | 85 | | |
| Brand | Emblem | | 75 | | |
| Brand | Logo | | 70 | | |
| Brand | Imprint | | 60 | | |
| Fuel | Petrol | | 70 | | |
| Fuel | Gas | | 90 | | |
| Fuel | Ammunition | | 75 | | |
| Fuel | Combustible | | 95 | | |
| Fuel | propellant | | 85 | | |
| Capacity | Volume | | [illegible] | | |
| Capacity | Amplitude | | 30 | | |
| Capacity | Quantity | | 95 | | |
| Capacity | Bulk | | 60 | | |
| Capacity | Mass | | 95 | | |
| Capacity | Expanse | | 65 | | |
| Mileage | Milage | | 1 | | |
| Mileage | Distance | | 95 | | |
| Mileage | Range | | 75 | | |
| Mileage | Length | | 75 | | |
| Mileage | Span | | 60 | | |
| Mileage | Continuance | | 60 | | |
| Performance | Execution | | 80 | | |
| Performance | Act | | 60 | | |
| Performance | Achievement | | 95 | | |
| Performance | Completion | | 75 | | |
| Performance | Fulfillment | | 75 | | |

| | | | | | |
|---|---|---|---|---|---|
| Performance | Attainment | | 75 | | |
| Performance | Fruition | | 80 | | |
| Color | Tinge | | 90 | | |
| Color | Stain | | 90 | | |
| Color | Dye | | 85 | | |
| Color | Tint | | 90 | | |
| Color | Paint | | 95 | | |
| Color | Tincture | | 80 | | |
| Color | Pigmentation | | 80 | | |
| Color | Undertone | | 85 | | |
| Gear | Machine | | 90 | | |
| Gear | Instrument | | 75 | | |
| Gear | Transmission | | 85 | | |
| Gear | Machinery | | 90 | | |
| Gear | Wheel | | 80 | | |
| Gear | Crankle | | 80 | | |
| Gear | Gearbox | | 85 | | |
| Door | Entry | | 90 | | |
| Door | Gate | | 95 | | |
| Door | Egress | | 75 | | |
| Door | Aperture | | 80 | | |
| Door | Exit | | 90 | | |
| Door | Inlet | | 80 | | |
| Power | Vigor | | 80 | | |
| Power | Force | | 95 | | |
| Power | Intensity | | 75 | | |
| Power | Strength | | 75 | | |
| Power | Potential | | 60 | | |
| Power | Effectiveness | | 75 | | |
| Gas | Petrol | | 85 | | |
| Gas | Petroleum | | 80 | | |
| Gas | Invader | | 60 | | |
| Gas | Diesel | | 80 | | |
| Gas | Oil | | 80 | | |
| Gas | Kerosene | | 95 | | |
| Seat | Chair | | 85 | | |
| Seat | Couch | | 90 | | |
| Seat | Bench | | 80 | | |
| Seat | Lounge | | 75 | | |
| Seat | Office | | 75 | | |

| | | | | | |
|---|---|---|---|---|---|
| Seat | Recliner | | 50 | | |
| Seat | Settee | | 50 | | |
| Vehicle | Car | | 1 | | |
| Vehicle | Bus | | 1 | | |
| Vehicle | Truck | | 1 | | |
| Vehicle | Automobile | | 1 | | |
| Vehicle | Van | | 1 | | |
| Vehicle | Wagon | | 90 | | |
| Vehicle | Carriage | | 90 | | |
| Model | Pattern | | 90 | | |
| Model | Mold | | 90 | | |
| Model | Paradigm | | 85 | | |
| Model | Form | | 85 | | |
| Model | Template | | 80 | | |
| Model | Type | | 70 | | |
| Model | Sample | | 75 | | |
| Height | Altitude | | 90 | | |
| Height | Elevation | | 90 | | |
| Height | Peak | | 90 | | |
| Height | Top | | 70 | | |
| Height | Rise | | 80 | | |
| Height | Crest | | 70 | | |
| Height | Tip | | 80 | | |
| Width | Range | | 75 | | |
| Width | Area | | 80 | | |
| Width | Ambit | | 55 | | |
| Width | Domain | | 85 | | |
| Width | Amplitude | | 80 | | |
| Width | Broadness | | 50 | | |
| Manufacturer | Producer | | 95 | | |
| Manufacturer | Maker | | 75 | | |
| Manufacturer | Industrialist | | 75 | | |
| Manufacturer | Former | | 70 | | |
| Manufacturer | Creator | | 80 | | |
| Manufacturer | Company | | 95 | | |
| Manufacturer | Constructor | | 85 | | |
| Ventilation | Airing | | 80 | | |
| Ventilation | Freshness | | 80 | | |
| Ventilation | Aeration | | 75 | | |
| Ventilation | Cooling | | 95 | | |

| | | | | | |
|---|---|---|---|---|---|
| Ventilation | Oxygen | | 90 | | |
| Transmission | Move | | 90 | | |
| Transmission | Switch | | 75 | | |
| Transmission | Transit | | 75 | | |
| Transmission | Movement | | 90 | | |
| Transmission | Dispatch | | 75 | | |
| Safety | Security | | 95 | | |
| Safety | Integrity | | 60 | | |
| Safety | Solidity | | 80 | | |
| Safety | Protection | | 95 | | |
| Safety | Preventive | | 85 | | |
| Safety | Precaution | | 75 | | |
| Suspension | Break | | 60 | | |
| Suspension | Postponement | | 50 | | |
| Suspension | Stay | | 60 | | |
| Suspension | Brake | | 50 | | |
| Suspension | [illegible] | | 50 | | |
| Suspension | Stop | | 60 | | |
| Material | Substance | | 90 | | |
| Material | Matter | | 50 | | |
| Material | Article | | 60 | | |
| Material | Item | | 80 | | |
| Material | Materiality | | 95 | | |
| Warranty | pledge | | 80 | | |
| Warranty | assurance | | 80 | | |
| Warranty | Security | | 60 | | |
| Warranty | Certificate | | 65 | | |
| Warranty | Undertaking | | 90 | | |
| Feature | characteristic | | 95 | | |
| Feature | Attribute | | 90 | | |
| Feature | Quality | | 80 | | |
| Feature | Attribute | | 70 | | |
| Feature | Trait | | 70 | | |
| Feature | Merit | | 70 | | |
| Feature | Advantage | | 85 | | |
| Audio | Sound | | | | |
| Audio | Voice | | 90 | | |
| Audio | Tone | | 90 | | |
| Audio | Resonance | | 55 | | |
| Audio | Hearing | | 85 | | |

| | | | | | |
|---|---|---|---|---|---|
| System | Organization | | 85 | | |
| System | Structure | | 70 | | |
| System | Order | | 80 | | |
| System | Method | | 80 | | |
| System | Framework | | 80 | | |
| System | Regulation | | 85 | | |
| System | Coordination | | 65 | | |
| Cargo | Freight | | 95 | | |
| Cargo | Loading | | 85 | | |
| Cargo | Consignment | | 75 | | |
| Cargo | Shipment | | 75 | | |
| Cargo | Payload | | 85 | | |
| Cargo | Capacity | | 60 | | |
| Cargo | Goods | | 15 | | |
| Passenger | Occupant | | 75 | | |
| Passenger | Traveler | | 85 | | |
| Passenger | Rider | | 85 | | |
| Passenger | Commuter | | 85 | | |
| Belt | Strap | | 90 | | |
| Belt | Band | | 76 | | |
| Belt | Girdle | | 60 | | |
| Belt | Waistband | | 60 | | |
| Belt | Fasten | | 65 | | |
| Belt | Restraint | | 65 | | |
| Belt | Closure | | [illegible] | | |
| Tire | Tyre | | 1 | | |
| Tire | Wheel | | 1 | | |
| Tire | Drain | | 60 | | |
| Price | Cost | | 1 | | |
| Price | Value | | 1 | | |
| Price | Amount | | 95 | | |
| Price | Fee | | 75 | | |
| Price | Payment | | 90 | | |
| Price | Rate | | 90 | | |
| Price | Charge | | 90 | | |
| Dimension | Proportion | | 90 | | |
| Dimension | Length | | 85 | | |
| Dimension | Aspect | | 80 | | |
| Dimension | Distance | | 70 | | |
| Dimension | Element | | 70 | | |

| Dimension | Measure | | | | |
|---|---|---|---|---|---|
| Window | Windowpane | | 95 | | |
| Window | Pane | | 85 | | |
| Window | Glass | | 1 | | |
| Window | Casement | | 75 | | |
| Window | Frame | | 74 | | |
| Window | Overture | | 65 | | |

## Sample of Bids in the Ministry of Electricity and Water (Kuwait)

شركة محمد ناصر الشمري وأولاده للسيارات
Mohammed Nasser Al-Shehri & Sons Co.
Rent, Sales & Buy Car بيع وشراء وتأجير السيارات

الشمري

P.O. Box: 90 Al
92551 Kuwait
C.R.No. 94508
Tel.: 24849342
24849385
24849302
Fax: 24829591

السادة / وزارة الكهرباء والماء المحترمين
السيد / وكيل وزارة الكهرباء والماء المحترم
بعد التحية

**الموضوع / المناقصة رقم / و ك م 74- 2009- 2010**
**5 – 2 الجزء الثاني الخاص بالسيارات مع سائق**

بالإشارة إلى الموضوع أعلاه نقدم لسيادتكم السيارات الخاصة بالمناقصة المذكورة أعلاه .

| م | الشكل | النوع | الصنع | مواصفات | ملاحظات |
|---|---|---|---|---|---|
| 1 | صالون 4 سلندر | جالانت | ميتسوبيشي | حجم الماكينة 2300cc | |
| 2 | بوكس استيشن | كيا كارنيفال | كيا | حجم الماكينة 2600cc | |
| 3 | جيب شاصي قصير 4 سلندر | باجيرو | ميتسوبيشي | حجم الماكينة 3000cc | |
| 4 | وانيت 4 سلندر غمارتين | هايلكس | تويوتا | 2500cc | حمولة 1 طن |
| 5 | وانيت 8 سلندر | سييرا | جي ام سي | حجم الماكينة 5200cc | حمولة لا تقل عن 1.5 طن |
| 6 | وانيت 8 سلندر 4x4 | سييرا | جي ام سي | حجم الماكينة 5200cc | حمولة لا تقل عن 1.5 طن |
| 7 | وانيت 4 سلندر | هايلكس | تويوتا | حجم الماكينة 2500cc | حمولة 1 طن |
| 8 | باص 19 راكب | كوستر | تويوتا | 22 راكب | |
| 9 | ميكروباص | هاي اس | تويوتا | 10 راكب | |
| 10 | هاف لوري | فاير كانتر | ميتسوبيشي | حمولة 5 طن | |
| 11 | نصف قلاب | IPT613 | تاتا | حمولة 3 طن | |

نقر بأن جميع المواصفات المذكورة صحيحة ونتعهد بتقديم نفس المواصفات وأنواع السيارات المذكورة عند طلبها.

كما نقر بأن جميع المواصفات المذكورة مطابقة لنفس المواصفات المطلوبة بوثائق المناقصة المذكورة أعلاه .

المدير العام
جاسم محمد ناصر الشمري

وزارة الكهرباء والماء
الرقم: ٣٠٧٠٤٨٨
التاريخ: ٢٠١٠/١٠/١٢

وارد
الرقم: ٥٨٦
التاريخ: ٢٠١٠/١٠/١٢

مرفق (٤)


شركة مصطفى كرم وأولاده للتجارة العامة والمقاولات ذ.م.م

MUSTAFA KARAM & SONS GEN. TRAD. & CONT. CO. W.L.L.

برقياً : قرمكو - ص.ب : ٢١٩٨ - صفاة 13032 - الكويت

ص.ب : ٩٠٤٣ - الأحمدي - 61001 الكويت

تلفون : ٢٢٩٨٨٩٦٦ - ٢٢٩٨٩٦٦٦

فاكس : ٢٢٩٨٧٣٦٩ - ٢٢٩٧١٨٥٨


التاريخ : ٢٠١٠/١٠/١٨

إشارتنا : م ك ت/ ١٠/٣٢٢

**السـادة / وزارة الكهرباء والماء المحترمين**

**عناية السيد / وكيل الوزارة المساعد للتخطيط والتدريب المحترم**

**الكويت**

١٠/١٩

تحية طيبة وبعد ،،،

**الموضوع : مناقصة رقم و ك م/٧٤ - ٢٠٠٩/٢٠١٠**

**بخصوص استئجار سيارات متنوعة [مع سائق / بدون سائق]**

بالإشارة إلى موضوع المناقصة أعلاه ، وإلى الاجتماع الذي تم في مقر وزارتكم الموقرة مع السادة / لجنة دراسة هذه المناقصة المنوه عنها - برئاسة سيادتكم - بشأن بحث بعض الإيضاحات المقدمة منكم والمتعلقة بأنواع السيارات المقدمة ومدى مطابقتها المواصفات الواردة في مستندات هذه المناقصة ، وتم أثناء هذا الاجتماع التأكيد للجنتكم الموقرة أن جميع أنواع السيارات التي سيتم تزويد وزارتكم بها مستوفاة لكافة المواصفات المطلوبة بمستندات المناقصة وهي على النحو التالي :-

| البند رقم | العدد | نوع السيارة المقدمة | ملاحظات |
|---|---|---|---|
| ١ | ١٥ | صالون لكزس LS460L (11X01L-5H) | مطابقة المواصفات المطلوبة (كافة المواصفات) |
| ٢ | ٢٩٨ | صالون سوزوكي كيزاشي ٤ سلندر - ٢٤٠٠ سي سي | مطابقة المواصفات المطلوبة |
| ٣ | ٩ | بيكب شفروليه تاهو - T L ٤×٢ ٨ سلندر - ٥٣٠٠ سي سي | مطابقة المواصفات المطلوبة |
| ٤ | ٢٣٢ | جيب هيونداي فيراكروز ٤×٤ ٦ سلندر - ٣٨٠٠ سي سي | مطابقة المواصفات المطلوبة |
| ٥ | ١٩٠ | جيب سوزوكي جراند فيتارا ٤×٤ ٤ سلندر - ٢٤٠٠ سي سي | مطابقة المواصفات المطلوبة |
| ٦ | ١٠ | جيب تويوتا لاندكروزر - GX ٤×٤ ٨ سلندر - ٤٧٠٠ سي سي | مطابقتها للمواصفات المطلوبة |

# التقرير الفني لدراسة عطاءات

## ( مناقصة رقم 74 / 2009 – 2010 )

## استئجار سيارات متنوعة ( مع سائق / بدون سائق )

==============================

**1. التمهيد :-**

بالإشارة إلى الموضوع أعلاه وإلى القرار الإداري رقم 2010/721 بتاريخ 2010/9/28 ( مرفق رقم 1 ) الخاص بتشكيل لجنة لدراسة عروض مناقصة رقم 47/2009–2010 استئجار سيارات متنوعة ( مع سائق / بدون سائق ) ، وإلى كتاب لجنة المناقصات المركزية رقم ل م م 16856/60/13 بتاريخ 22 /9/ 2010 ( مرفق 2 ) المتضمن أصلية وثائق العطاءات المقدمة وكشف الأسعار للمناقصة المذكورة أعلاه لدراستها وتقديم التوصية بشأنها ، فقد قامت اللجنة بدراسة العروض المقبولة كما وردت في كشف العطاءات والخاص بالجزء الأول وهو استئجار سيارات متنوعة بدون سائق وبيانها كما يلي :-

| اسم الشركة | السعر ( د.ك ) | رقم العطاء |
|---|---|---|
| شركة مصطفى كرم وأولاده للتجارة العامة والمقاولات ذ.م.م ( أرخص الأسعار ) | 4,402,951/159 | 4 |
| شركة محمد ناصر الهاجري وأولاده للسيارات ذ.م.م ( ثاني أرخص الأسعار ) | 4,839,213/800 | 3 |
| شركة أعيان للإجارة والاستثمار ش.م.ك ( ثالث أرخص الأسعار ) | 5,323,754/160 | 6 |

| اسم الشركة | السعر ( د.ك ) | رقم العطاء |
| --- | --- | --- |
| - الشركة الكويتية لاستئجار السيارات ش.م.م ( رابع أرخص الأسعار ) | 5,814,126/000 | 1 |
| - شركة أوتوماك للسيارات ش.م.ك.م ( خامس أرخص الأسعار ) | 6,279,533/000 | 5 |
| - شركة رابطة الكويت والخليج للنقل ش.م.ك.م ( سادس أرخص الأسعار ) | 6,415,920/000 | 2 |

وفيما ما يخص الجزء الثاني من المناقصة باستئجار سيارات متنوعة مع سائق وبيانها كما يلي :

| اسم الشركة | السعر ( د.ك ) | رقم العطاء |
| --- | --- | --- |
| - شركة محمد ناصر الساير وأولاده للسيارات ذ.م.م (أرخص الأسعار) | 4,613,245/000 | 3 |
| - شركة مصطفى كرم وأولاده للتجارة العامة والمقاولات ذ.م.م ( ثاني أرخص الأسعار ) | 5,446,480/706 | 4 |
| - شركة رابطة الكويت والخليج للنقل ش.م.ك.م ( ثالث أرخص الأسعار ) | 9,737,100/000 | 2 |

2- **نتيجة الدراسة :-**

وبدراسة العطاءات المذكورة أعلاه وتقويمها حسب المواصفات الفنية والمالية وشروط المناقصة الخاصة والعامة ، انتهت اللجنة إلى أن أرخص العطاءات المقدمة للمناقصة 2009/74 – 2010 ( استئجار سيارات متنوعة مع سائق – وبدون سائق ) كالتالي :

الجزء الأول : سيارات متنوعة بدون سائق : على العطاء رقم "4" شركة مصطفى كرم وأولاده للتجارة العامة والمقاولات ذ.م.م بمبلغ وقدره 4,402,951/159 د.ك ( أربعة ملايين وأربعمائة واثنان ألفاً وتسعمائة وواحد وخمسون دينار وفلس 195 فلساً فقط لا غير ) .

والجزء الثاني : سيارات متنوعة مع سائق على عطاء رقم " 3 " شركة محمد ناصر الشهري وأولاده للسيارات ذ.م.م بمبلغ وقدره 4,613,245/000 ( أربعة ملايين وستمائة وثلاثة عشرة ألفاً ومئتان وخمسة وأربعون دينارا فقط لا غير ) .

وحيث أن هذه العطاءات المقدمة تحتاج إلى المزيد من الإيضاح والاستفسار من مقدميها ، لذا قامت اللجنة باستدعاء ممثلي هذه الشركات وذلك بتاريخ 2010/10/4 وتم توضيح الاستفسارات الخاصة بكل عطاء وقد تقدمت شركة محمد ناصر الشهري وأولاده بكتابها الوارد بسجل الوزارة رقم 37288 بتاريخ 2010/10/12 ( مرفق 3 ) لتوضيح جميع الاستفسارات المطلوبة من قبل الوزارة .

وكذلك تقدمت شركة مصطفى كرم وأولاده للتجارة العامة والمقاولات بكتابها رقم م.ك.ت /10/322 بتاريخ 2010/10/18 ( مرفق 4 ) .

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