

**Deanship of Graduate Studies
Al-Quds University**



FRBR MARC Using the Web Ontology Language

Rana Zuhair Abdo

M.Sc. Thesis

Jerusalem – Palestine

1434 / 2013

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A thesis submitted in partial fulfillment of requirements for the degree of masters of computer science from computer science department of Al-Quds University

Jerusalem – Palestine

1434 / 2013



Thesis Approval

FRBR MARC Using the Web Ontology Language

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3-.....: External Examiner Signature

Dedication

*I dedicate this work to my son Abd-El-Ghaffar,
my daughters Deema, Lama and Lubna,
my brothers, sisters, and their families*

Declaration

I Certify that this thesis submitted for the degree of Master in computer science, is the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:

Rana Zuhair Abdo

Date:

Acknowledgments

First of all, I am so grateful to God for giving me the strength and patience to finish this thesis.

I sincerely thank Al-Quds University for giving me the opportunity to study the M.Sc.

I would like to express my sincere gratitude to Dr. Badie Sartawi, for his guidance throughout my years at the university. I would also like to thank all the computer science department staff; Dr. Nidal Kafri, Dr. Raed El Zaghal, Dr. Rasheed Jayousi and Dr. Wael Hassoneh.

Last, my endless thanks to my family for their encouragement and support.

Abstract

Libraries and librarians have a key role in delivering information. They have an interesting task in supporting information, supplying researchers with materials they need and help them to access information from multiple libraries at once. Therefore librarians are looking forward to communicate and merge their catalogues together in one union catalogue. Consequently it was a big deal for us to support the union catalogue by building bibliographic catalogue ontology.

On the one hand, most bibliographic catalogues based on *Machine Readable Catalogue* (MARC) format to integrate system which meets the needs of participating libraries to share their bibliographic records. On the other hand, the *International Federation of Library and Association* (IFLA) final report on *Functional Requirements for Bibliographic Record* (FRBR) represents *Entity Relationship* (ER) between items of the bibliographic record and brings major changes to cataloging, in order to facilitate accessing bibliographic catalogue. Thus building ontology could serve as a semantic layer over FRBR and MARC. Ontology provides vocabulary for representing knowledge about some concepts with its relationship with other terms explicitly and machine interpretability. In addition, *Ontology Web Language* (OWL) is the new formal language for representing ontologies in the semantic web. It is a new technology and a *World Wide Web Consortium* (W3C) recommendation. Therefore, depending on OWL which is basically an opening of the ER model to work on the web, FRBR data could live in OWL layer. The purpose of this study is to build an ontology which could serve as a semantic layer over FRBR and MARC. Besides, since many libraries catalogues depend on the most popular MARC; MARC 21 and UNIMARC; we adopt MARC 21 and UNIMARC as a sample to our study. Our model builds a semantic layer over the schema mapping between FRBR entities and attributes to its corresponding of MARC 21 and UNIMARC.

Finally, we design an interface to allow collaboration between variant libraries based on a web service. Our web service offers the data in *Resource Description Framework* (RDF) format (technical binding). Publishing RDF documents across applications is an effective way of data integration and exchange. It presents opportunities to employ

linked data to the authority file. In general our ontology represents a semantic layer to all bibliographic records to exist in one web service and one union catalogue.

المتطلبات الوظيفية للتسجيلات البليوجرافية للفهرسة المقروءة أليا باستخدام لغة (OWL) .

اعداد : رنا زهير عبده

اشراف : د. بديع سرطاوي

تلعب المكتبات دورا هاما في تقديم المعلومات إلى رواد المكتبات والباحثين، لذا فان المكتبات تتطلع الى ايجاد اطار تعاوني مشترك لتطوير التواصل بينها عبر فهرس موحد، الأمر الذي شكل حافزا قويا لدينا لدعم الفهرس الموحد وذلك من خلال بناء انطولوجيا تساهم في ايجاد لغة ومفاهيم مشتركة بين أكبر عد من المكتبات.

ان معظم المكتبات غنية بالبيانات التي تعتمد عليها من خلال تبادل البيانات مع المكتبات الاخرى عبر الفهرسة المقروءة أليا (المارك)، بالاضافة الى المتطلبات الوظيفية للتسجيلات البليوجرافية والتي هي عبارة عن نموذج يصف تجميع الكيانات على شكل علاقات داخل تلك التسجيلات لتوفير احتياجات المستفيدين، من جهة أخرى فان لغة (owl) هي تقنية جديدة وتوصية من (W3C) تستخدم لتمثيل الانطولوجيا في الويب الدلالي، حيث ان الانطولوجيا تعتبر البنية الاساسية للويب الدلالي وجسرا لتمثيل المعرفة ودلالات المفردات من خلال الوصف الدقيق للمفاهيم وعلاقتها مع مصطلحات اخرى لمساعدة الحاسبات في المشاركة في المعرفة.

لذا فاننا قمنا بتعزيز كل من المتطلبات الوظيفية للتسجيلات البليوجرافية والمارك بطبقة من الانطولوجيا تجعلها اكثر وضوحا ومعنى خلال تبادل البيانات بين المكتبات المختلفة، ونظرا لاعتماد أكبر عدد من المكتبات على كل من (MARC21) و (UNIMARC) ، فاننا قمنا من خلال هذه الانطولوجيا بتعريف مفاهيم المتطلبات الوظيفية للتسجيلات البليوجرافية بما يقابها مع كل من (MARC21) و (UNIMARC) .

في ختام هذا العمل قمنا ببناء صفحة خدمة ويب لتسهيل الاتصال ما بين المكتبات التي تستخدم المارك او مفاهيم المتطلبات الوظيفية للتسجيلة البليوجرافية ، والتي تم من خلالها اثبات صحة الفكرة والتي استطاعت أن تفي بالغرض المطلوب وتحقيق النتائج التي تبرهن على قدرة هذه الانطولوجيا في تبادل البيانات من قبل عدد من المكتبات بغض النظر عن المصطلحات المستخدمة أو نوع الفهرسة المقروءة أليا التي تتعامل معها.

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Chapter 1

Introduction

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1.1 Motivation

For the last decades, libraries were looking forward to cooperate and merge their catalogues together in one library and one union catalogue. This passion mainly appeared to eliminate multiplications of tasks within the libraries cataloging and to unify their authority file. Therefore, *Machine-Readable Cataloging* (MARC) was developed by the library of Congress as an initiative in the late 1960's. The main idea of MARC is to distribute cataloging records on magnetic tapes to make their catalog records available. Whereas, before the developing of MARC cataloging records, librarians need to duplicate the same work and task of the cataloging required more time and expertise. Thus MARC was able to accomplish a significant progress in supporting cooperation between libraries. However, MARC is a flat schema [1], it can't achieve the tendency of libraries of unification libraries authority file and cannot facilitate searching into records in terms of answering user need. For this reason, *The International Federation of Library Associations and Institutions* (IFLA) adopted a resolution called the commissioning of a study to define the functional requirements for bibliographic records. It produces a framework that would provide a clear and precisely understanding the purpose of bibliographic record and it's provided information. . In addition, IFLA provides information with the achieved expected record based on the user's needs. It follows by an agreement to publish the final report of *Functional Requirements for Bibliographic Records* (FRBR) in 1998 [2]. It implements a semantic relationship between items of the bibliographic record. FRBR is considered as a revolution into libraries. It supports many of them to implement FRBR in bibliographic information system. However, FRBR's limitations lie in the inability to exchange information between libraries, and isolate each library in a separate island. Thus, if FRBR become part of the semantic web, these limitations can be eliminated.

“Semantic Web” is the future web extended to the current web [3]. It supports a distributed web in terms of data rather than documents. It leads data to point to another instead of having web pages point to other using *uniform resource identifiers* (URIs). Thus to interchange the data, *Resource Description Framework* (RDF) have emerged, which is one of the basic building blocks that semantic web depends on. Therefore, semantic web

involves machine processing where computers can understand the meaning and property of information. It consists of the interoperable for linking, interchange, explanatory searching, and connecting people, communities, and knowledge on the web. It helps a human to understand his/ her needs actively. In addition, semantic web's structure underlying data is for the purpose of machine understanding. Consequently, semantic web is based on the ontologies, and the success of the Semantic web depends strongly on the presence of ontologies.

Ontologies are “metadata” that provides controlled vocabulary [4]. It affects the nature of being, entities, objects, concepts, and everything in the universe in Greek language. So, supporting these things in terms of ontologies for the web describing the relations between them adds more semantics. Therefore, this requires a language that can carry out the functions of ontology in terms of developing the current web, which led to the emergence of *Web Ontology Language (OWL)*. It is a *World Wide Web Consortium (W3C)* standard and it is considered a part of the semantic web vision. It is designed to provide a common way to process the content of web information and to be read by computer applications rather than humans. OWL can be considered the same as RDF but OWL is a stronger language with greater machine interpretability.

An important proposed method of ontology learning involves finding the semantic relations of items. At the same time, FRBR is about entities and relationships. Thus, it's necessary to employ FRBR as the first step in the transformation of a library data in the semantic web relying on the libraries rich metadata MARC. Therefore, the advantage of the availability of the Union catalogue - with the ontology- as part of the semantic web can help libraries to share and exchange authority files through links and URI's. Building ontology can facilitate the process of understanding between libraries regardless of what type of MARC -or language is used. MARC is highly used in a large number of libraries; thus, defining the terms of MARC to understandable concepts can solve the problem to many programmers. It can help the process of exchanging catalogues between libraries. In addition, it can take out many libraries from its isolation to form the union catalogue. This also can be applied for all variants of MARC and for all languages.

In this thesis, we propose to do the following:

- 1) Build an ontology defining vocabularies of the main classes in FRBR and their properties.
- 2) Mapping them with the corresponding properties in MARC, supported by OWL. Consequently, one of the most important basics to define concepts in OWL (besides classes, properties... etc.) is `equivalentProperty`, which represents identification between properties. It is useful when integrating or mapping between two different ontologies, thus with OWL all variants of MARC can be defined.
- 3) In this thesis we will deal only with MARC21¹ and UNIMARC² as example, in both Arabic and English languages. Then it can be developed to ontology, which can be merged to other ontologies that define other languages and other variants of MARC, providing access to this ontology through semantic web service. So as to manage multiple ontologies, to translate ontologies from one language to another and finally to form the union catalogue.
- 4) Build a web service supported with our ontology, to help different clients exchanging their cataloging records within it.
- 5) Check if our web service can facilitate searching and exchanging data between different clients.

1.3 Outline

This thesis is organized as follows:

Chapter 2: provides the needed background about digital libraries and the related work that concern the goal of union catalogue and exchanging data between libraries.

Chapter 3: is about building a cataloging ontology by presenting an analysis to FRBR with the attributes in both MARC21 and UNIMARC; foreword by presenting the FRBR relations in a semantic way using web ontology language.

Chapter 4: provides implementation to the ontology used in a web service.

Chapter 5: provides the evaluation. Finally chapter 6 provides the conclusion with future work.

¹ **MARC21** is a result of the combination of the United States and Canadian MARC formats in 1997; the Network Development and MARC standards office at the library of Congress maintains it.

² **UNIMARC** is created by IFLA in 1977; it is more popular in most European countries.

Chapter 2

Background

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2.1 State of the Art

Libraries have an interesting task in supporting information since the ancient library of Alexandria was constructed in the 3rd century BC [5]. Until recent years, they provided their researchers with the information they needed surrounding all the activities of lifecycle and facilitate lending [6]. One of the librarians' major functions is to avoid duplication in cataloging. Therefore they are looking to communicate and cooperate with other libraries in one union catalogue. Union catalogue has begun to serve librarians incorporating their cataloging records from multiple libraries. In addition, the union catalogue purpose is to supply all library users with materials they need and access information from multiple libraries at once.

The concept of Union Catalogue was widespread at the start of the 20th century. It emerged as an idea to meet the target that libraries seek to achieve by enabling library users to search easier, accurate and more efficient. At the same time union catalogue seek to meet librarians' efforts in cataloging by sharing resources, and uniform libraries authority file. Michael Gorman [7] represents the union catalogue as assemblage of more than two libraries catalogue records to facilitate its resource sharing system, and to provide listings of collections of libraries that are available to a distant library user. However the functions of the union catalogue have changed during the last few decades by the availability of the new technologies that have emerged. Advances in information technology have provided opportunities for development and improvement in the creation and use of union catalogue. One of the most important revolutions in cataloging was the creation of MARC format. MARC was the main factor behind the evolution of *Ohio college library consortium* (OCLC) in 1968 by Fred Kilgour, Then from Ohio to the whole world. In addition, computer technology was essential to the effectiveness of the OCLC, experiment. Another important revolution in cataloging was the final report on FRBR, which has changed the way the library world perceives the library catalogue and the interaction of records with one another.

Thus, union catalogue transmitted from getting access to a physical item in traditional union catalogue to the next generation of union catalogues. Consequently recent users can access items themselves, and can obtain accurate results easily and everywhere.

2.2 Specific concepts

In this section it is necessary to present some concepts that need to be defined in as follows:

2.2.1 The Semantic Web

In 2001, T.Berners-Lee *et al.* expressed the vision of the Semantic Web as follows:

“The semantic web is a highly interconnected network of data that could be easily accessed and understood by any desktop or handheld machine”, [8].

Recently, the semantic web is considered as an extension to the *World Wide Web* (WWW). It adds a new data and metadata to existing web documents, extending those documents into data. It is considered as a new form of web content. It demonstrates “things”³ in a way that helps computers to understand how “things” relate to each other in details. In addition, how do those “things” flow from one place to another in an orderly way, using a *Uniform Resource Identifier's* (URI's) to identify resources or “things”. On the one hand, in programming languages the word semantics refers to the mapping between the syntax of the language with the meaning of the languages. On the other hand, the word semantics in natural language is related to syntax or the meaning behind something in order to understand the utterance, the meaning behind the sounds and the letters of the language. Therefore, if we change the syntax of any concept, the meanings of this concept will still be the same. Whereas, the current web is a huge database that displays the structure of documents, ruled by languages like *Hypertext Markup Language* (HTML). It tells the computer how to display these documents. HTML describes which part of this document is a head or a body. The current web machines are ignorant and difficult to combine information or link data together. Otherwise, the information provided in the web of today tends to be distributed, while this information can be related and interconnected to each other through the semantic web. Therefore, a requirement is needed to exchange and merge data on the Semantic web and a need for new technologies. The idea of these technologies, which are behind the semantic web, is to enhance the web by linking data and providing ontologies, which serve as the backbone of the semantic web, defining the semantics of the data and web resources. Therefore, the semantic web builds on technologies or languages that are

designed specifically for data differ in their level of expressivity. They are organized in a way that each language builds consequently in layers, illustrated in the famous "Semantic Layer Cake"[9] such as XML, RDF, RDFS and OWL which is built on RDF and RDFS as shown in Fig. 2.1.

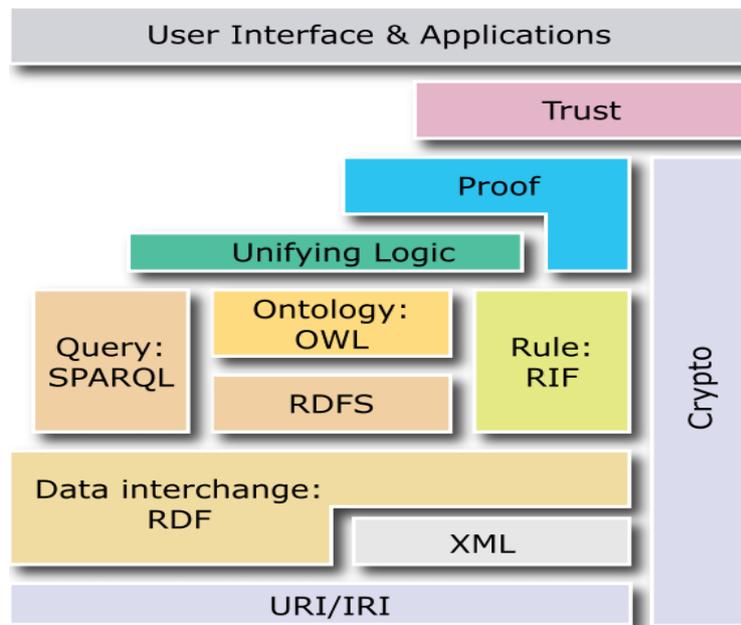


Figure.2.1 Semantic Layer Cake [9]

2.2.2 RDF and RDFS

Resource Description Framework (RDF) is a framework or a model for describing, connecting and accessing resources on the web. It is written in XML and it is part of the semantic web, designed to be read and understood by computers. RDF uses web identifiers (URIs) to identify resources and describes resources by property and property value. The combination of resource, a property, and a property value forms a Statement. It consists of:

- a) Subject (S).
- b) Predicate (P).
- c) Object (O).

The “S, P, O” are the basic building blocks of RDF and called the triple, as it illustrate in Fig.2.2. It can be viewed as labeled edge in a graph, object and subjects are the graph nodes and the properties are its edges.

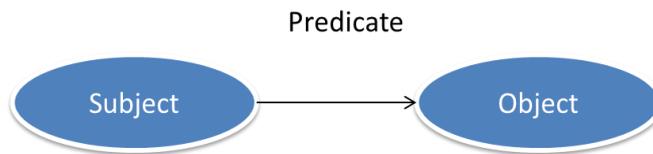


Figure.2.2 RDF statement (RDF triple) [3]

Triples become more interesting when more than one triple refers to the same thing. Triples can be viewed as a directed graph and each triple is an edge from its subject to its object, with the predicate as the label on the edge, as it discussed by D. Allemang and J. Hendler [3] in Fig .2.3. This triple -named by URI- is applying a notion which is a very powerful feature of RDF. It helps in merging data from multiples sources by merging one node from one graph with another node from another graph. However, this is conditioned to have the same URI as it discussed in Fig .2.4. by www-conference 2010 [10]. Fig.2.4.a represents a data in RDF, while Fig.2.4.b represents another RDF data from Revyu.com, whereas Fig.2.4.c shows another data published by J.Sequeda, and finally Fig.2.4.d shows the data linked together.

However, RDF needs a method to define application-specific classes and properties so RDF Schema (RDFS) emerged as an extension to RDF.

RDF Schema provides the framework to describe the application specific classes and properties. Classes in RDF-Schema are much like the classes in object oriented programming languages. Therefore, it allows the resources to be defined as instances of classes and subclasses of classes.

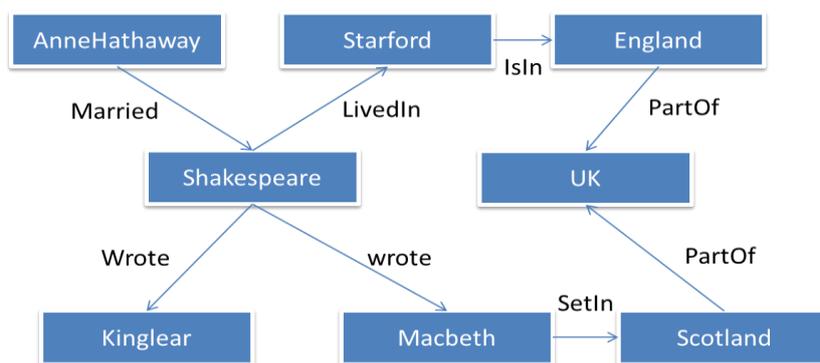


Figure.2.3. Directed graph triples [3]

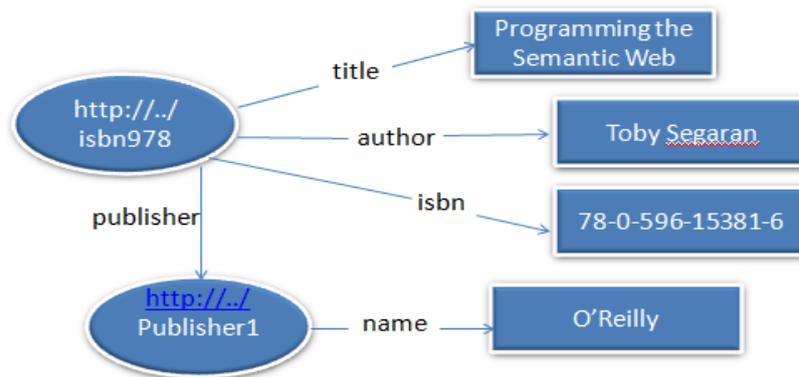


Figure.2.4.a RDF data [3]



Figure.2.4.b Revyu.com RDF data [3]

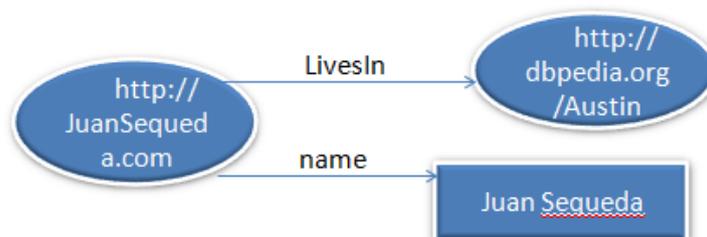


Figure .2.4.c RDF data published by Juan Sequeda [3]

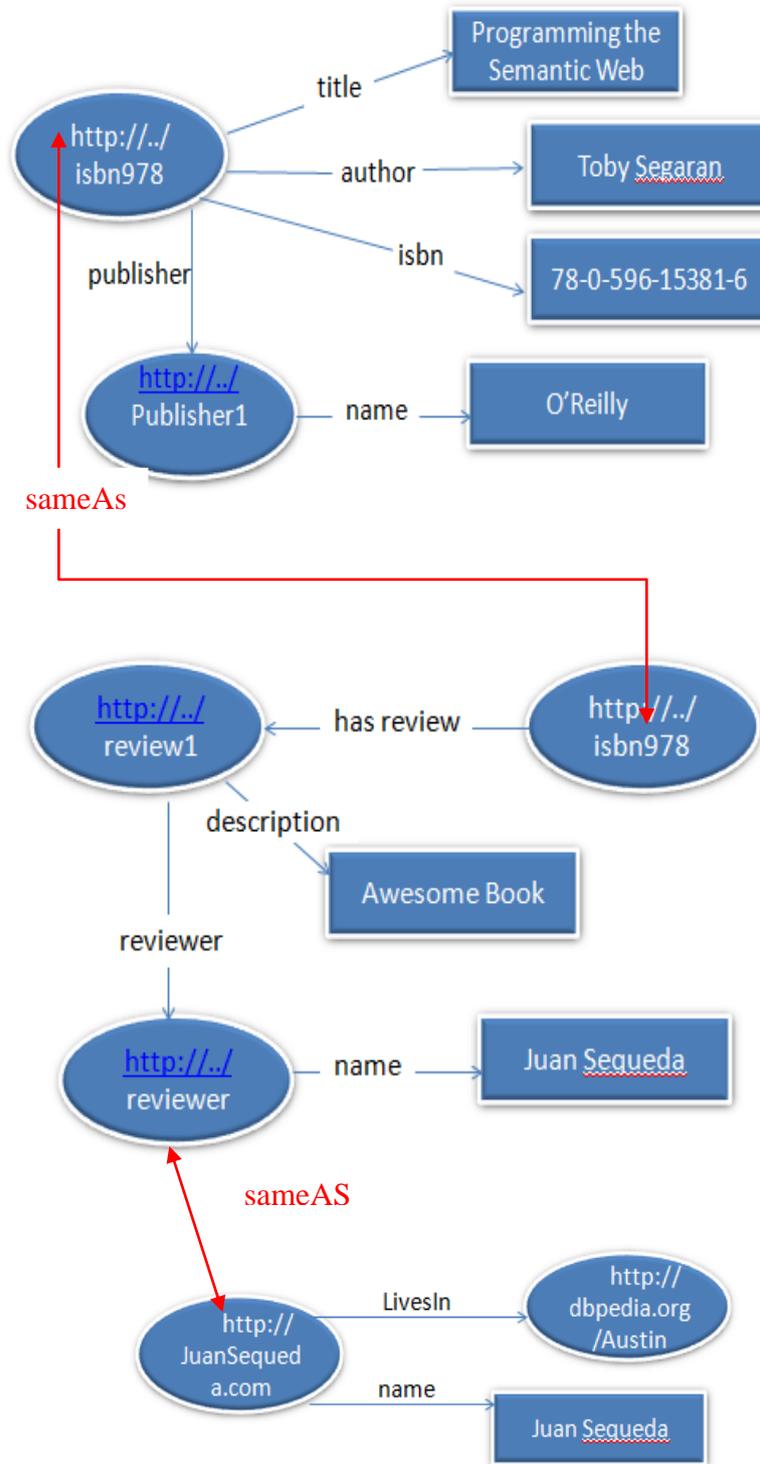


Figure .2.4.d Linked data [3]

2.2.3 Ontology and OWL

"Ontology" originally is an Greek word; it is the branch of metaphysics that studies the nature of existence. It is about the exact description of things and their relationships. For the web, ontology is about the exact description of web information and relationships between web information. Therefore, there was a need to a new technology, which can represent things as resources or URI to be understood by machines. This was the key-rule that evolves the appearance of OWL.

OWL was the W3C recommendation since 2004, and OWL2 became a W3C recommendation in 2009. It is one of the building blocks of the semantic web [11], and part of the Semantic web vision. Web information has a meaning and can be processed by computers. Thus, it is designed to be read by computer applications instead of humans. Therefore, OWL is the same as RDF and RDFS, with greater machine interpretability derived its strength from a larger vocabulary and stronger syntax. It is a family of knowledge representation languages for authoring ontologies. OWL ontologies are most commonly serialized using RDF/XML syntax. They result the information of OWL that easily can be exchanged through different types of operating systems and application languages. It provides three increasingly expressive sublanguages [12]. They are OWL Lite, OWL *Description Logic* (OWL DL), and OWL Full.

Here are some of OWL basics that can be defined as follows:

owl:Class: where a class may contain individuals, which are instances of the class.

owl:ObjectProperty : which represents a relation between instances of two classes.

owl:DataTypeProperty : represents the relation between instances of classes and literals, its range is of a literal datatype (use XML Schema datatypes

InverseOf : If a property P is tagged as the owl:inverseOf Q, then for all x and y, P(x,y) iff Q(y,x).

equivalentClass : states the equivalence (in terms of their class extension) of two named classes, it is useful when integrating or mapping between two different ontologies

SameAs : represents Identity between Individuals, this mechanism is similar to that for classes, but declares two individuals to be identical.

unionOf : describes an anonymous class for which the class extension contains those individuals that occur in at least one of the class extensions of the class descriptions in the list.

2.2.4 Protégé

Protégé is an ontology development tool [13]. It is a free open-source platform, based on Java and provides a plugin environment. It makes it flexible for rapid application development to facilitate building ontology for its users. It uses a suite of tools to construct domain models and knowledge-based applications with ontologies. It has an architecture based on two ways of modeling ontologies as follows:

- **The protégé-Frames editor:** It enables users to build ontologies that are frame-based, consisting of entities, organized in asserted hierarchy to represent classes describing their properties and relationships. It describes also a set of instances and individual of those classes.
- **The protégé-OWL editor:** Its enables users to build ontologies in accordance with the W3C's web ontology language (OWL).

2.2.5 Web service

A Web service [14] is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-process able format. Other systems interact with the Web service in manner prescribed by its description using *Simple Object Access Protocol* (SOAP) message, typically conveyed using *Hypertext Transfer Protocol* (HTTP) with *Extensible Markup Language* (XML) serialization in conjunction with other Web-related standards.

Over the years, web services technology have expanded to become more popular with representing an important way for business and clients to communicate with each other. This has happened by sharing data and processes through a programmatic interface across network, using HTTP for transmitting message. It provides a method of communication through a piece of software that exposes a set of operations between different software applications. These software applications run on various platforms, and describing a standardized way of integrating web-based applications using XML, SOAP, *Web Services*

Description Language (WSDL), and Universal Description, Discovery and Integration (UDDI). XML provides a language, which tag the data to be used between different platforms and programming languages. Thus web services are platform independent and language independent, leading to an interoperable interaction between windows applications and UNIX applications, such as java programming language and python or any other programming language. Web services allow creating client/server applications [15] as illustrated in Fig.2.5. For example if a client is looking for the forecast, he can send a request into a SOAP message; asking about the weather information; to the web service, the web service unpacks the SOAP request and converts it into a command that the application can understand. The web service packs up the response again into another SOAP message, the server sends the response back to the client and the client unpacks the SOAP message to obtain the result needed. SOAP is the short of Simple Object Access Protocol, which relies on XML for its message format to encode the information in a web service request and response message before sending it over the network. SOAP message is independent of any operating system and can be used over any transport protocol such as HTTP, Simple Mail Transfer Protocol (SMTP), or Transmission Control Protocol (TCP).

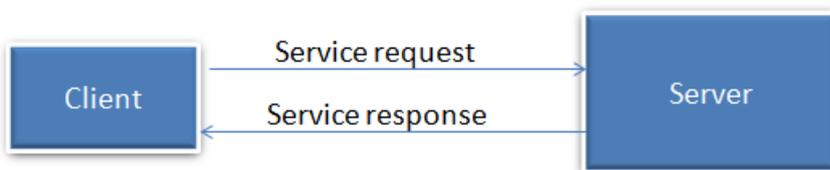


Figure.2.5 Web service application [15]

2.2.6 MARC

“MARC is the single most important factor in the growth of library automation in the United States and other countries”. [16]

MARC is a machine-readable cataloging record. Machines and computers can read and interpret the data in the cataloging record to provide sharing of bibliographic resources, they facilitate the exchange of the record between libraries avoiding duplication of work and exhausting much efforts and experts. However, since MARC is a cataloging record we need to place the nature and function of cataloging record in order to understand what MARC means and why it is necessary.

Cataloging record means bibliographic information on a catalog card to provide an access to library collection and resources for research and interpretation [17], the record includes:

- 1- Description of the item follows the rules in *Anglo-American Cataloging Rules* (AACR), including the title, statement of responsibility, edition, material specific details, publication information, physical description, series, notes, and standard numbers.
- 2- Access points to the record referred to the main entry and added entries following the rules of AACR, in which these access points are the retrieval points in the catalog where users should be able to look up the item.
- 3- Subject headings using the list of the *Library of Congress Subject Headings* (LCSH) for consistency and to ensure that all items on a particular subject are found under the same heading and therefore in the same place in the catalog.
- 4- Classification or call number places items on the same subject together on the same shelf in the library according to a Dewey decimal or library of congress classification schedule.

Libraries are rich of huge amount of information and cataloging records. They need hard work from librarians and experts. Librarians search to find a new way to share the results of their organization knowledge. They need to interpret the information found on the cataloging record to produce an automated catalog, which was the reason for revolution of MARC.

MARC appeared in the 1960s as an initiative by *library of congress* (LC), the record structure of MARC is an implementation of the *International Organization for Standardization for bibliographic descriptions and exchange of bibliographic information* (ISO 2709). At that time, MARC was the predominant format for exchanging cataloging data between libraries [18]. However, many adopters improve the original design which result was national variant MARC were developed, such as the AUSMARC in Australia, UKMARC in Britain, USMARC in USA, UNIMARC in Europe, and CANMARC in Canada. CANMARC cooperate with USMARC to evolve the activity result into MARC21 [19]. MARC21 and UNIMARC have become the standard used by most library computer programs in the world.

MARC contains a guide or little "signposts" to catalogue record data before each piece of bibliographic information as assistance for computers to read and interpret the bibliographic record. Each bibliographic record is divided logically into fields (a field for the author, a field for title information, etc.). These fields are subdivided into one or more subfields. Each field is associated with a 3-digit number called a "tag". A tag identifies the field, the kind of data that follows, for example in MARC 21 the number 100 is the tag, defining it as a personal name main entry (author) field as follows:

100 \$a Hendler, James

Hendler and James are referring to the last and first name of the author.

And the field for a book's physical description defined by the tag 300 includes a subfield \$a for the extent (number of pages), a subfield \$b for other physical details (illustration information), and a subfield \$c for dimensions (centimeters) as follows:

300 \$a 400 p. : \$b ill. ; \$c 22 cm.

Where 400 p is the number of pages, ill means illustrated, and 22 cm is the dimensions

A comparison of the same record with textual information is shown in Table.1.1. Whereas, MARC tags in Table.2 illustrates the same record with the MARC21 format, which makes the use of computer storage space more efficient .

| | |
|---|--|
| Main entry, personal name with a single surname: The name: | Bland, Martin |
| Title and Statement of responsibility area, Title proper: Statement of responsibility: | An introduction to medical statistics/ Martin Bland |
| Edition area: Edition statement: | 2nd ed. |
| Publication, distribution, etc., area: Place of publication: Name of publisher: Date of publication: | Oxford Oxford University Press 1995 |
| Physical description area: Pagination: Illustrative matter: Size: | XIV, 396 p. Ill; 24 Cm. |

Table.1.1 A record with textual information

| | |
|---------|--|
| 100 \$a | Bland, Martin |
| 245 \$a | An introduction to medical statistics/ |
| \$c | Martin Bland |
| 250 \$a | 2nd ed. |
| 260 \$a | Oxford |
| \$b | Oxford University Press |
| \$c | 1995 |
| 300 \$a | XIV, 396 p. |
| \$b | Ill; |
| \$c | 24 Cm. |

Table.1.2. The same record with MARC tags

2.2.7 Union Catalogue

Union catalogue is an assemblage of cataloging records from more than one library and a local, regional, national and international cooperation between libraries. To serve them bringing together all items available in their library catalogue [20]. It provides listings of the collections of libraries that are available to a distant library user, to supply every library user with all materials he or she needs in order to do research and facilitate inter-library lending. Although, it works with other libraries giving the maximum access to the human record, and this is can be effective by having two copies of all cataloging records. One of them exists in the library and the other exists in the union catalogue server.

Union catalogue began historically with three to twelve libraries [21] depending on the case of neighboring academic libraries in various localities. However, the development of technologies and machine readable systems make it easy to share and change sources. Many researchers, students, faculty, librarians and other information seekers use union catalogues. The first event in which librarian shared their catalogues was the creation of the MARC format which was a mean of communicating catalogue records between libraries. The beginning was between the LC and the British National Bibliography, until it rapidly grew into an international standard that is used by libraries throughout the world. The revolution of MARC was the major reason of generating the *Online Computer Library Center (OCLC)*, which its first experiment created by the Ohio college library consortium with the library of congress. It became one of the world's

largest union catalogues to obtain bibliographic, abstract and full-text information when and where they need it.

2.2.8 FRBR

FRBR was published by IFLA in 1998, and played an important role in the library world by supplying a clear understanding of the aim of bibliographic record and information to be provided. FRBR meets users' needs and provide them the opportunity to move from one single record to all the links and relations that is contained within this record. It is a conceptual model, a complex and a very specific conceptual *entity relationship* (ER) model that reminds us of the basic elements in describing materials in the bibliographic universe, the inter relationships, and the fundamental user tasks that we are trying to address when we create library catalogs. It is divided into three groups of entity relationships as follows:

- Group I consists of work, expression, manifestation, and item. These functions as the four levels of detail in actually showing relationships, with work being the overall bibliographic family, and the item being a specific holding.
- Group II is responsible for the work, expression, manifestation, or item, these can either be a person or corporate body, and they must have a role that defines their responsibility.
- Group III can include the entities from the previous two groups, as well as concept, object, event, and place.

These three groups of entities reflect the traditional descriptive elements that are used to catalogue a work. The group I entities are analogous to title, group II entities are analogous to the statement of responsibility, and group III is the subject as implemented and defined in Fig.2.6. defined by [2] IFLA's FRBR in 1998.

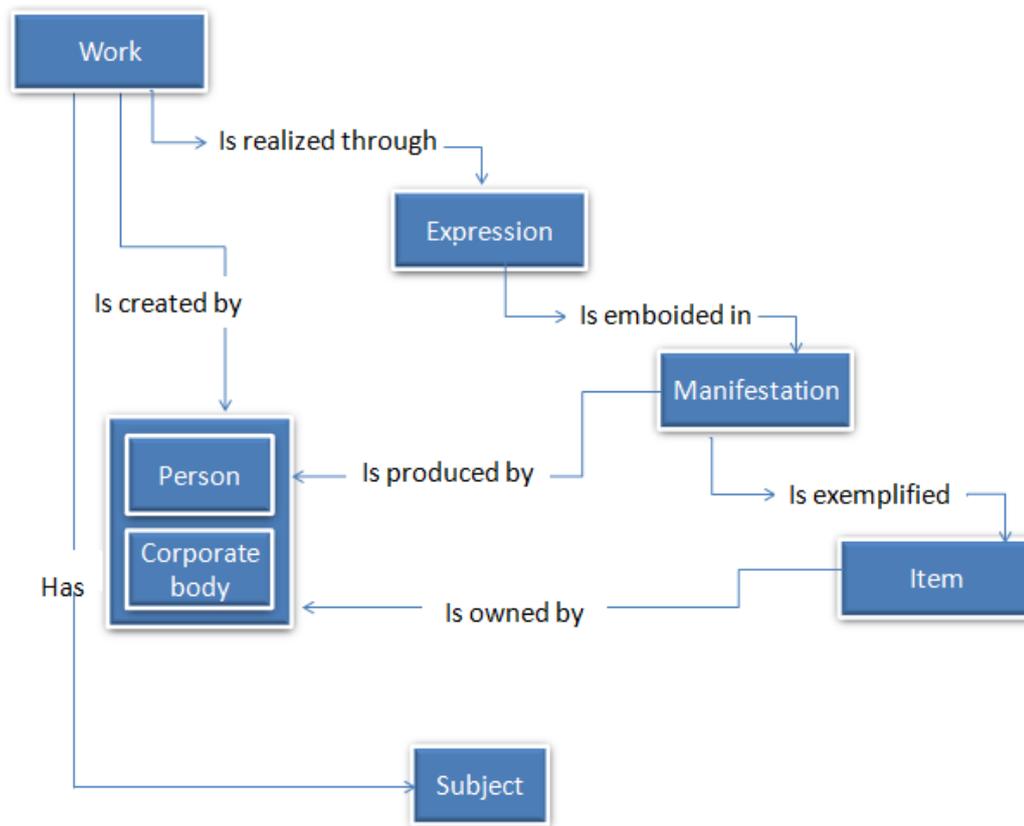


Figure .2.6. FRBR [2]

2.3 Related work

The main factors that helped in the success of librarians objectives in accessing bibliographic items and in exchanging cataloging between libraries includes the revolution of MARC as discussed in 2.2.1, then the revolution of FRBR as discussed in 2.2.2, and finally the revolution of Semantic Web as discussed in 2.2.3

2.3.1 Revolution of MARC

John Y. Cole [22] discussed in his subject of Publishing and developing the library of congress, how MARC project gave a large opportunity to libraries for sharing its knowledge within its specialists with other librarians to other citizens of the world. In this field the LC was the first who initiated and took a decision in 1901 to share the library bibliographic apparatus with other libraries. The project began with distributing cataloging cards, which led to a series of the concepts of subject heading lists,

classification schedules, union catalogues and other materials. This initiative was important in establishing the union catalogue at the library of congress in 1932. In the 1950's the library of congress began its investigation to automate the cataloging cards. In 1963 the library of congress published a study of the possibility of using automated techniques in order to automate cataloging, recommending the formation of a team working to design the procedures required to automate cataloging, searching, indexing and document retrieval functions. The study included methods for converting the library of congress cards into machine-readable form by computers. Therefore the project gave the availability of data on tapes in a standardized format, in order to let it possible for others to access to this data.

Henritte D. Avarm in [23] explained how in 1969 IFLA held an international meeting of cataloguing experts to discuss a standard bibliographic description. Thus in 1973 an international working group established the MARC format structure. It became an official national standard in 1971 and an international standard in 1973. For this reason the development of communicating bibliographic data in machine readable format by the library of congress was a major contribution in publishing information. In addition it was the issue that enabled the library of congress to achieve a great achievement to be the largest library in the world.

Dhrubajit Das [24] displayed the evolution of MARC into MARC 21 and other national variants of MARC. The LC started a MARC Pilot Project in 1965 establishing a format known as MARC1 format. The Council of British National bibliography had shown an interest of the MARC Pilot Project and developed its own MARC format. Then as a result of a co-operation between the US and UK a new format was developed in 1968 which is known as MARCII. Later MARCII divided into two versions as USMARC and UKMARC. Other countries showed interest in the format and developed their own format. The National library of Australia published its MARC format under the name AUSMARC, and Sweden published SWEMARC in 1980 and so on. While several formats were being developed, another effort were carried out by IFLA to establish international MARC which known as *Universal MARC Format* (UNIMARC), which was supported by the European countries to use it as their international formats, and is the technical standard used by *Online Public Access Catalogue* (OPAC). OPAC is the

famous union catalogue, which stimulates and facilitates interworking between libraries in Europe.

In Canada the MARC format published in 1979 under the name CANMARC, which harmonized with the USMARC to form new MARC known as MARC21. MARC21 became the standard used by most libraries which first edition was issued in 1987, and then other editions were published in 1990, 1994 and 2000. Many countries in the world are using now MARC21 for exchanging information with other countries, because MARC21 is updated and more comprehensive. For example the National library in India decided to move from UNIMARC format to the MARC 21 in 2003, by preparing conversion tables to support accurate mapping on UNIMARC data to MARC 21.

2.3.2 Revolution of FRBR

As IFLA's seminar on bibliographic records [2] recognized the objective of shared cataloging in reducing cataloging costs and minimizing duplicate cataloging efforts. Therefore they were aware of the importance of meeting user needs. Thus IFLA formed a study group to define the functional requirements of bibliographic record. The two objectives of this study were : First to define a clear understanding of what is the bibliographic record aims to provide information for, including the access points (title, author, subject, ... etc.) in a way that meets user needs. And the second objective is to recommend a level of functionality for records created by national bibliographic agencies. According to this the group's work continued his work from 1993 to 1997, approved in a final report in 1997, and formally published FRBR in 1998. It didn't encompass only library clients, but exceeded to publishers, providers, distributors and other information users outside traditional library. FRBR is a conceptual model defines entities among the bibliographic record with their attributes and defines the relationship between them. FRBR study is a critical issue enhances some of the objectives of the library catalogue. It identify four general user tasks, first to find materials, secondly to identify an entity distinguishing two entities that have the same title for example, then to select an entity which is appropriate to the user's need, and finally obtain access to the entity described. Thus FRBR looked at the user tasks in a new light considering the need of sharing concepts and vocabularies between libraries in one authority file. FRBR

report changes the way of interaction cataloging records together. Thus many libraries looked to implement support for the FRBR in existing bibliographic information system.

In 2001, the *Network Development and MARC standards office* (NDMSO) at the Library of Congress commissioned a study to examine MARC 21 from several perspectives; one of them is the FRBR model. It has affected in emerging a new concept called "FRBRizing" the catalogue. FRBRizing is based on accumulating MARC records and grouping them in FRBR entities work, expression and manifestation. Consequently this study generated the FRBR display tool [25]. A tool that was useful to analyze MARC data using the work, expression, manifestation and item FRBR entities. It is based on XML technologies, and work with a flat file of MARC stored in ISO2709. It generated a MARCXML document using an open source JAVA toolkit. The FRBR display tool provided enhanced displays of bibliographic records in their online catalogs. Trond Aalberg [26] presents a tool for the conversion of MARC records to a normalized FRBR implementation, considering the previous tools and experiments quite incomplete, his work based on steps needed for the conversion process and the tool that implements the process, the process first step identifies the entities described in the MARC record, the second step defines the set of attributes for these entities with each other, and then an establishment to the relationship of these entities is done with normalization to the output to avoid redundant information by determining the records that have the same work, this process is implementing through a conversion tool by the use of XSLT for transforming XML by a java program for creating the XSLT style sheets, the tool reads the MARC record in the MarcXchange format also by a java program and produces the FRBR entities with their attributes and relationships.

2.3.3 Revolution of Semantic Web

Semantic web based on linking data and information; therefore it can improve the exchange of authority file. Martin Malmsten in [27] describes the tools and techniques used to make the Swedish Union Catalogue part of the Semantic Web. Whereas the Swedish Union Catalogue contains about six million MARC21 bibliographic records distributed through 175 libraries using a single integrated library system (ILS) for cataloguing. Thus they created an RDF wrapper, which deliver the (ISO2709) records in

RDF with a unique number using SQL. To achieve the rule of linked data a persistent URI is created for each record using the unique number done by SQL for both bibliographic record and for the authority record. The endpoint in this research is to query the data using SPARQL for RDF to allow queries over HTTP.

Rob Styles, Danny Ayers, and Nadeem Shabir [28] discussed the possibilities of representing the most prevalent form of MARC, MARC21 as RDF for the Semantic Web. They matched the same URI for the same resource, which requires a query. Therefore they took a decision to create URIs algorithmically with a simple hashing algorithm to allow others processing their data. Consequently the set of URIs that could link have the ability to process huge number of records and access the same URIs. By representing the same resources on the same hashed value, and different resources on different hashed values. This research discussed the hashing algorithm of author names taking into consideration how RDF generated from MARC records can link to other resources on the web.

S.Aradmam [29] proposed a proposal for implementing FRBR as RDF-Schema. He described the observations resulting from this approach. One observation was that the library cataloguing records buried within the hidden web, which let librarian data models in most library automation system to have little potential for WWW transparency. Another observation is that implementing FRBR in a very traditional entity-relational model without using Internet technology. The advantages of this proposal in implementing FRBR as RDF-Schema would solve the approach of burying the cataloguing records in the hidden web, effecting in librarian data models WWW transparency. In addition, by `rdfs:frbr` a layered scenario integration achieved by exposing work elements for example to the WWW with expression/manifestation/item levels links. By these results a new service for metadata retrieval will generate,. This proposal will apply avoiding libraries wealth information to be hidden, and another positive influence with the ontology community would also create grounds for an integrated WWW global model for librarian bibliographic records.

A complete RDF namespaces and schema for FRBR [30] entities and relationships was created by Ian Davis and Richard Newman. Their works were a human-readable vocabulary and a machine-readable schema, using OWL. It includes classes for the

FRBR group's entities and the properties corresponding to the core relationships between those entities. Its first issue was in 2005 and then new changes done by Ian Davis in 2009.

The authors in [30] discuss an achievement of Variations/FRBR project in delivering FRBR-compliant metadata by communities interested in FRBR. Thus in order to get a large corpus of data experiment V/FRBR focused on the MARC bibliographic record into FRBRized structures. The first step of this work was releasing a FRBR-compliant XML schemas by the project team. Then the V/FRBR represented the FRBRized bibliographic data in RDF forwarded by designing ontology in OWL2. The outcome of this project is to support linked data representation for V/FRBR.

In another article in [31] the main purpose was to present a format for exchange of MARC information with the semantics of the FRBR model. The first step in this design criteria focuses on identifying entities of FRBR format, relationships of them and their attributes. Relationships between entities are linked into a hybrid approach between a hierarchical method and a reference method of the XML schema. On the other hand XML schema introduces the elements of FRBR to group MARCXML elements. The output of this transformation process includes a series of XML/XSL is employed to create the OWL ontology model. Whereas the article [32] objective is to explore the interpretation of the bibliographic information and migration to a new information model. Thus they presented a general framework, FRBR-ML for managing the conversion of MARC data into a representation that is based on the FRBR model. The format in FRBR-ML builds on the MarcXchange standard and it can be used as an intermediary format to easily transform from/to MARC, RDF/XML and OWL. In addition, they have designed new metrics to check the quantity and quality of the transformation. The results of experiments which run with a data-set of Norwegian national bibliography removed duplicate entities and reduced the size of the collection of the format.

An initial contacts [33] between IFLA community and *International council of Museums* (ICOM) form the International working group on FRBR/CRM harmonization. Where the *Conceptual Reference Model* (CRM) is core ontology aiming to integrate cultural heritage information accepted as ISO standard in 2006. The common goals of this

project are to express FRBR model with concepts and ontological methodology provided by CRM, and to merge the two objects oriented models thus obtained. The ontology harmonization model experimentally proved to be applicable to the experimental scientific record for the science applications.

2.4 Our Work

Union Catalogue in this thesis is part of the Semantic Web. All previous studies assist in building the union catalogue. However there are shortcomings in the unification all libraries together. MARC helps much in this objective and had a significant effect in exchanging cataloging records between libraries; however its flat schema cannot serve users to find what they want easily. Thus OCLC and other communities who share their data can work only with libraries that have the same MARC such as MARC21. This enforces all libraries to use the same MARC or to form many groups in several web services, disposing libraries to face difficulty in forming one authority file. The utilization of the FRBR is clear and accurate relations between cataloging records in FRBRizing cataloging records or MARC. It needs a semantic layer to be expressive and generalized. FRBRizing does not collect libraries together neither facilitate the communication between them. The weakness in supporting URIs cannot effect in linking data and in the creation of authority file.

The core idea of this thesis is to build ontology to avoid all problems, which prevent libraries from communicating and cooperating together. Using OWL to build ontology enriches data with additional meaning and provides people with the data syntax and semantic. Whereas RDF and OWL provide a structure for describing identified things in some unique way, in order to make meaningful statements.

The main objective of building this ontology is to be employed for the benefits of researchers, librarians and the authority file. Thus our core ontology defined the relationships into FRBR entities and their attributes in an inclusive and specific design of FRBR, with the correspondence concepts in both MARC 21 and UNIMARC. In addition, we create a web service to conduct the communications between libraries. Building a web service supported with the core ontology represents an interface to help libraries collaborate their bibliographic records together. It provides communication

between libraries regardless of using various types of MARC or FRBR concepts to facilitate exchanging their bibliographic records. On the other hand, our web service offers RDF documents by returning results of queries. Publishing RDF documents across applications is an effective way of data integration. It presents opportunities to enrich metadata as linked data -at the authority file. In general this core ontology represents a semantic layer to all bibliographic records to exist in one web service and one union catalogue.

Chapter 3

Building Cataloging Ontology

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3.1 Introduction

Libraries are a source of metadata that can be available in the library catalogue. This library catalogue is based on the use of MARC format, which has allowed libraries to exchange bibliographic data very successfully. However, MARC has different disadvantages that can be defined as follows:

1) MARC is a flat schema that suffers from the iteration of the same work, and it doesn't incorporate relations between records as shown in the following example:

| | |
|------------------------------------|------------------------------------|
| 100 \$a Petrucci,Ralph H. | 100 \$a Petrucci,Ralph H. |
| 245 \$a General chemistry : | 245 \$a General chemistry : |
| 250 \$a 9th ed. | 250 \$a 1st ed. |

In this example, we have two records for the same title "General chemistry", and the same author "Ralph H. Petrucci", with two different editions. On the one hand, "250 \$a 1st ed." implies that this record is a first edition. On the other hand "250 \$a 9th ed." is the ninth edition. In spite of that, there are no relations between these two bibliographic records.

MARC is a flat file where all data for any single record are stored separately from other records, thus MARC needs a semantic relationship between items. This can be solved through FRBR that can be considered as a conceptual entity-relationship model that relates user tasks of retrieval and access in online library catalogues and bibliographic databases.

2) MARC is still difficult to be understood by many people. In Fig.3.1, one can notice a typical MARC21 record in ISO2709 syntax by R.Styles [28].

3) There are different types of MARC which would be processed by different applications, such as CMARC, INERMARC, MARC21, UNIMARC, AUSMARC... etc.

Therefore, our objective is to build an ontology that can be part of the semantic web in order to facilitate the communications between the various types of MARC with the understandable attributes of FRBR. This is obtained using OWL. OWL is the expressive power of semantic web; it describes many types of semantics about data because of its

hierarchical information and its relation with others. It provides data to be self-described, and meaningful to computers.

```

00673nam a2200217 a 45040010033000000030009000330
0500170004200800410005901500190010002000170011903
5001700136040003100153082001600184100001900200245
0062002192600033002813000020003146500060003346500
031003946550030004259cbbe7fc3a7346d99c281979d45b6
79cUK-BiTAL20050705133033.0990831s1999 enk
j 000 ||eng|d aGB99Y57412bnb a0747542155 :
a()0747542155 aStDuBDScStDuBDSDUK-BiTAL04a823.
9142211 aRowling, J. K.00aHarry Potter and the pr
isoner of Azkaban /cJ.K. Rowling. aLondon :bBloom
sbury,c1999. a317p. ;c21 cm. 0aPotter, Harry (Fi
ctitious character)vJuvenile fiction. 0aWizardsvJ
uvenile fiction. 7aChildren's stories.2lcsH

```

Figure.3.1. A typical record of MARC21 in ISO2709 syntax [28]

The first step of building our ontology is to depend on the FRBR model, since FRBR is an ER diagram describes the semantic relations between items into cataloging record. Therefore, this yields to a result shows that both OWL and FRBR represent entities and their relationships. Therefore, the first step we analyze the FRBR in section 3.2, in section 3.3 we focus on manifestation which is one of the FRBR entities, in section 3.4 a conversion from FRBR to OWL is presented, in section 3.5 we matched between manifestation attributes in both English and Arabic with the most popular MARC, MARC21 and UNIMARC, and finally in section 3.6 we focus on the mapping between manifestation attributes with MARC by OWL.

3.2 FRBR Model Analyses

FRBR or (المتطلبات الوظيفية للتسجيلة البليوجرافية) is a conceptual model represents and describes the library bibliographic record. Its methodology based on the entity-relationship ER-Diagram, it consists of several entities grouping into three groups has been defined in section 1.2.8. Here we focus on the group one and two entities of FRBR, as they defined in English by IFLA [2], and in Arabic as they defied by A.Helmy [34] and H.Mikky[35], as shown in Table 3.1.

| FRBR entity name (English) | Definition in English | FRBR entity name (Arabic) | Definition in Arabic |
|----------------------------|---|---------------------------|--|
| Work | Distinct intellectual or artistic creation | العمل | هو الإنتاج الفكري المجرد من جميع صورته المادية |
| Expression | Intellectual or artistic realization of a work | التعبير | الوسيلة التعبيرية التي يصل العمل بها |
| Manifestation | Physical embodiment of an expression of a work | المظهر | هو التجسيد المادي للتعبير |
| Item | Single exemplar of a manifestation | المفردة | هي الكينونة الوحيدة المادية |
| Person | An individual | الفرد | هو المسؤول عن عمل أو تعبير أو مفردة أو أكثر |
| Corporate body | An organization or group of individual and/or organizations | الجهة المسؤولة | الجهات المسؤولة مسؤولة فكرية أو مادية عن العمل |

Table 3.1: FRBR Entities and definitions in English and Arabic

The first step of building our ontology is the analysis of FRBR as it shown in Fig.3.2 and Fig.3.3. in order to convert the ERD of FRBR to an ontology using OWL. Fig.3.2 depicted the relationship between the entities of group I and group II. Work is realized through one or more than one expression, in many-to-many relation. An expression is the realization of one or more than work in many-to-many relationship, and embodied in one or more than one manifestation in many-to-many relation. Manifestation is embody one or more than one expression in many-to-many relation, and it is exemplified by one or more than one item in many-to-many relation, where item is exemplify by one and only one manifestation in one to one relation. Whereas in group II the work and manifestation are created by body by one or more person or/and corporate in many-to-many relation. Person or/and corporate body is creator for one or more than work or manifestation in many-to-many relationship.

Fig.3.3. depicted converting the ERD of FRBR into physical database [36], where each entity is considered as a table with its primary key, concentrated on manifestation

attributes as example to build the ontology of this research, where carrier type is the primary key of manifestation table.

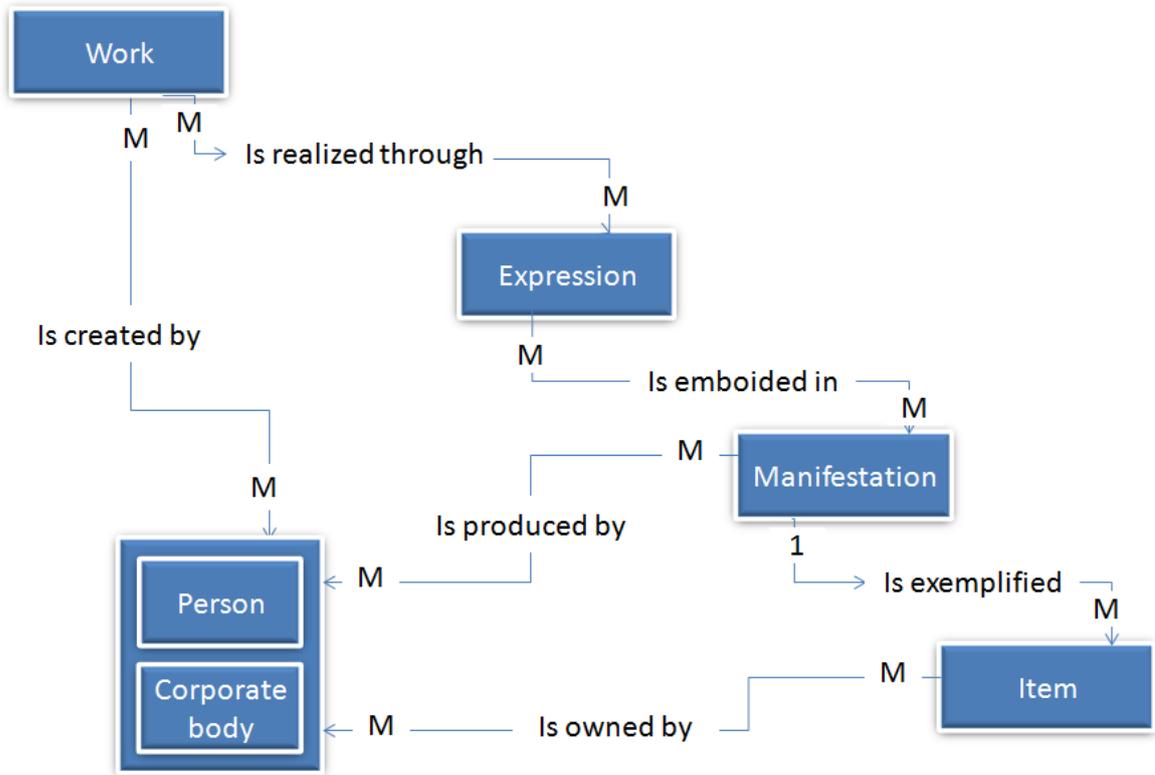


Figure.3.2. The ERD of FRBR

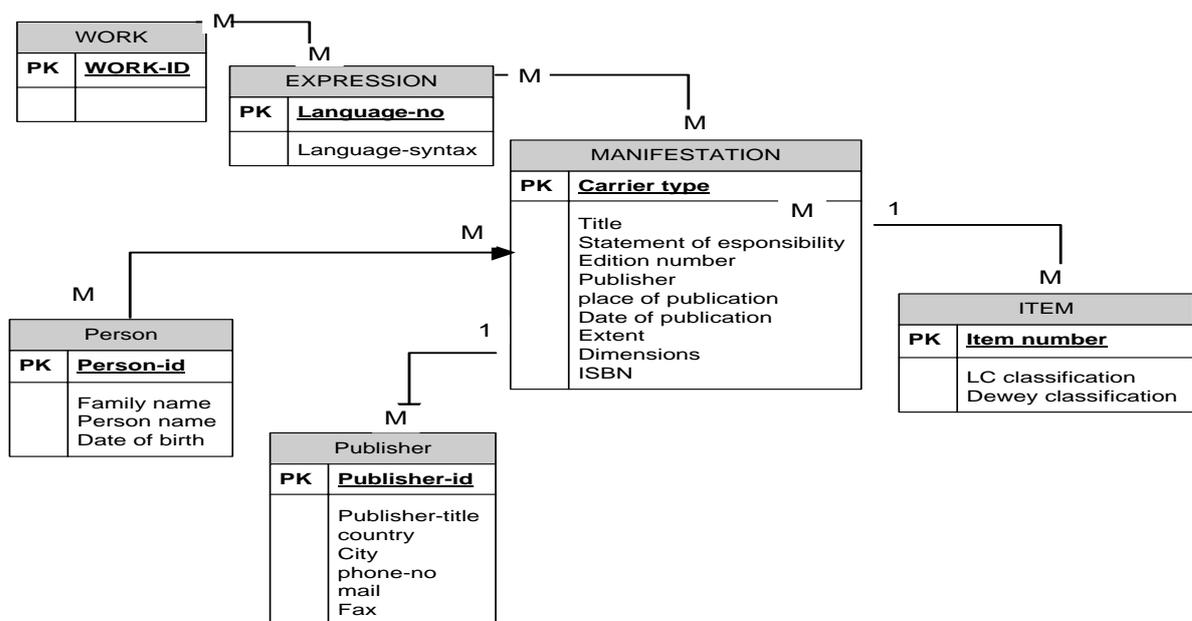


Figure.3.3. FRBR analysis

3.3 Defining entities:

One of the significant advantages of OWL is defining classes and subclasses. Thus it allows more descriptions to the FRBR to be placed in supporting the authority file. For example: a person and a corporate body in group are two responsible of the bibliographic record in group one can be considered as subclasses of the creator as depicted in Fig.3.4. Person and corporate body have access points recorded in authority records to be used in bibliographic records and in other authority records. Thus FRBR describe four categories of relationships reflected in authority data. The first category describes relationships between the entity types in the ER diagram of FRBR as depicted above in Fig.3.2. The second and third categories describe relations in the reference structure of the authority record as depicted in Fig.3.5. where person types are the classes : author, editor, translator and compiler, . Finally the fourth category describes the relations between specific instances of the entity controlled access points. The fourth category is presented as example when the relations between two corporate bodies are usually expressed in authority data through the hierarchical structure of the authorized form of name given to the subordinate body.

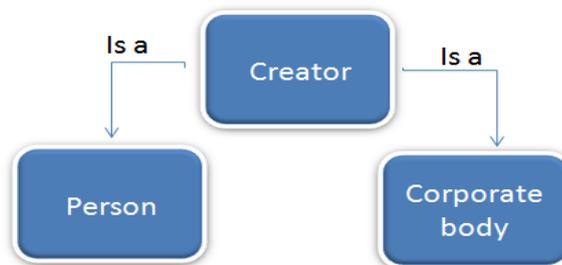


Figure.3.4. Entity subclass

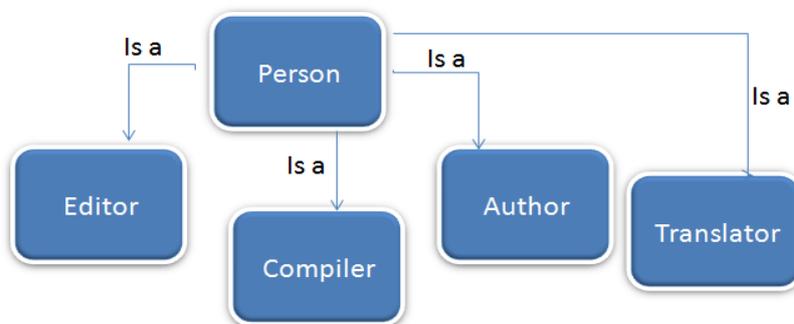


Figure.3.5. Person roles

Manifestation entity defined a wide range of materials including map, electronic resource, tactile material, microform, sound recording, video recording... etc. Manifestation materials can be considered as subclasses of manifestation as it depicted in Fig.3.6.

With an examples of some of the terms in Table

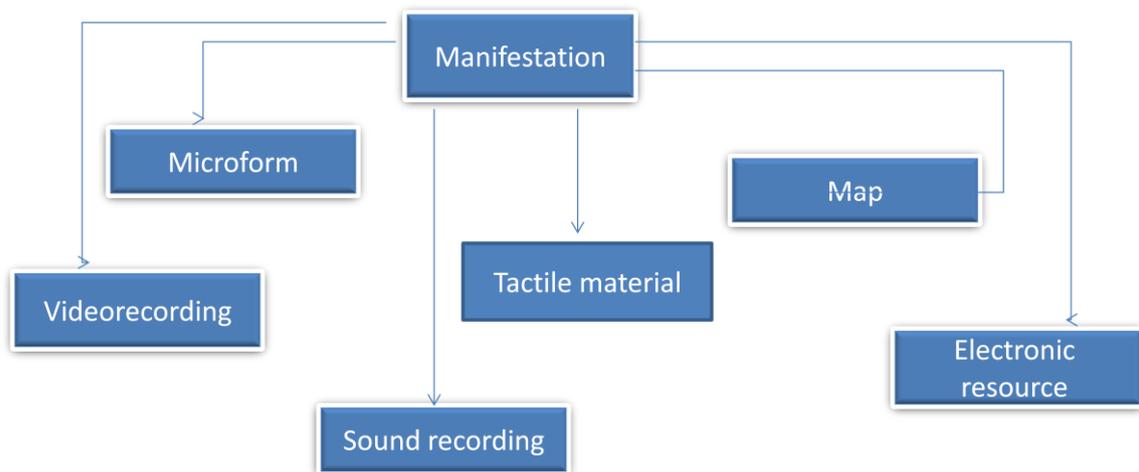


Figure.3.6. Manifestation subclasses

3.4 Defining Manifestation attributes

The purpose of this section is to define the attributes of FRBR manifestation entity of Group I, and the attributes of FRBR person entity of group II. Some of these attributes are the most common key words used in libraries by librarians and researchers.

These attributes are defined in our ontology the same as they defined by FRBR Final Report [2] as follows :

Title of Manifestation: is a group of characters naming the manifestation for the purpose of bibliographical control.

Statement of responsibility: denotes to the individuals or groups who are responsible for the creation of the content in the manifestation.

Edition/issue designation: indicates to a difference in either content or form between the manifestation and a related manifestation previously issued by the same publisher, or simultaneously issued by another publisher.

A sample of the manifestation subclasses terms

| Term | URI | Description |
|------------------|---|---|
| Manifestation | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestation | the physical embodiment of an expression of a work |
| Magnetic disk | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Magnetic_desk | a digital information storage medium usually consisting of a thin Mylar disk coated with a magnetic material that permits the recording of data. Magnetic disks come in various sizes. They are also known as floppy disks, stiffy disks, computer diskettes, or floppy diskettes.</rdfs:comment> </owl:Class> |
| Microform | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Microform | Microform is a generic term for any medium, transparent or opaque, bearing microimages. A microimage is a unit (e.g., a page) of textual, graphic, or computer-generated material that is contained on aperture cards, microfiche, microfilm, micro-opaques, or other microformats and that is too small to be read without magnification |
| Tactile material | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Tactile_material | Material that is intended to be read by touch |
| Tape cassette | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Tape_cassette | a removable module, somewhat like an audio cassette, that contains magnetic tape that can be written on and read from a tape drive |

Table 3.2.

Place of publication/distribution: is the city, town, or other locality associated in the manifestation with the name of the publisher.

Publisher/distributor: denotes to the individual, or group, or organization responsible for the publication.

Date of publication/distribution: is the year of public release of the manifestation, which can be either single date or a range of dates such as in the case of serials.

Form of the carrier: specifies class of material to which the physical carrier is belong such as sound cassette, microfilm... etc.

Extent of the carrier: is a quantification of the number of physical units making up the carrier such as the number of sheets.

Manifestation identifier: is a number or code uniquely associated with the manifestation that serves to differentiate that manifestation from any other manifestation.

These attributes can be classified either simple or composite; a simple attribute is defined as one component, whereas a composite attribute has multiple components. An example of composite attribute is the attribute publisher/distribution, where publisher refers to the publisher name in which we have to recognize it more by its location with the countries it exist on, the city, phone-no, mail and fax. Another classification of the characteristic attributes is single-valued or multi-valued. A single-valued entity holds one value for a particular entity, such more attributes like statement of responsibility, whereas, multi-valued attribute has more than one value for a particular entity. Such as edition/issue designation and publisher/distribution, where the carrier type term of the manifestation can hold more than one edition and more than one publisher of the same item.

3.5 Mapping of FRBR manifestation' attributes to MARC21 and UNIMARC elements

First, we have to define the accepted FRBR manifestation attributes, then determine the most standard and common vocabularies for these attributes in both English and Arabic languages, with the corresponding MARC21 and UNIMARC for them. As an example in this research, the attributes of manifestation are: The title of manifestation, statement of

responsibility, etc., with their corresponding in Arabic as they defined by [16]. Besides schema mapping between FRBR, MARC21 and UNIMARC as it is defined by (NDMSO) at the Library of Congress [37], which is shown in Table 3.3.

In general many researchers have started investigate and promote schema mapping. Whereas mapping MARC elements to FRBR was commissioned by the (NDMSO) in order to link MARC 21 elements with the FRBR model elements. In order to do schema mapping we cannot take into account a particular element of the FRBR without asking : where is this located in MARC and with which FRBR entities and attributes corresponds?. Unfortunately mapping MARC elements to FRBR entity attributes showed that some attributes that are present in FRBR are not defined in MARC. For example carrier type, media type and content type encountered challenges. The MARC working group identifies areas of MARC 21 that need modification and support FRBR activities. Therefore, the library of congress addressed issue in 2009 by introducing three new fields 336 (content type), 337 (media type); and 338 (carrier type) for the MARC standard. In contrast, in case of UNIMARC, field 203 was created in 2011. This field includes 3 subfields, \$a Content form; \$b Content qualification; \$c Media type.

In this research we also explain the details of the types of the carrier type term and carrier type code. Carrier type term can hold one of the lists of values in MARC21 as it shown in Table.3.4. For example, in the tag "338\$a videocassette \$b vf", 338\$a represents the carrier type term, which is videocassette, and 338\$b represents the carrier type code, where vf is the code that can be used instead of videocassette.

Consequently in section 3.5 we discuss how can we display and convert this to OWL taking MARC21 with both the Arabic and English Languages.

3.6 Converting FRBR to OWL

The idea of converting FRBR to OWL can be done as follows: [38], [39]

- Mapping entities.
- Mapping attributes (simple attribute, composite attribute, multi-valued attribute).
- Mapping relations.
- Mapping data types.
- Mapping constraints

Manifestation Attributes

| English-language | MARC21 | UNIMARC | Arabic |
|--------------------------------------|--------|---------|-------------------------------|
| Carrier type term | 338\$a | 203\$a | نوع الناقل/نوع الحامل |
| Carrier type code | 338\$b | 203\$b | رمز نوع الناقل/رمز نوع الحامل |
| Form of the carrier | 300\$a | 300\$a | شكل الوعاء |
| Title of manifestation | 245\$a | 200\$a | العنوان |
| Edition/issue designation | 250\$a | 205\$a | الطبعة/الإصدار |
| Statement of responsibility | 245\$c | 200\$f | بيانات المسؤولية |
| Publisher/distribution | 260\$b | 210\$c | الناشر/الموزع |
| Place of publication/distribution | 260\$a | 210\$a | مكان النشر/التوزيع |
| Date of Publication/distribution | 260\$c | 210\$d | تاريخ النشر/التوزيع |
| Extent of the carrier | 300\$a | 215\$a | امتداد الوعاء |
| Dimensions of the carrier | 300\$c | 215\$d | أبعاد الوعاء |
| Manifestation identifier | 20\$a | 20\$a | مصدر التزويد/إثبات الإتاحة |

Table 3.3.

Carrier type codes list

| Carrier type code | Carrier type term in English | Carrier type term in Arabic |
|-------------------|------------------------------|-----------------------------|
| Sd | Audio disc | اسطوانة سمعية |
| Ss | Audio cassette | شريط كاسيت صوتي |
| Cd | Computer disc | قرص/اسطوانة حاسوب |
| Cr | Online resource | المصدر على الإنترنت |
| Vf | Video cassette | شريط فيديو |

Table 3.4.

3.6.1 Mapping entities

Each entity in the FRBR model is mapped to a class in OWL, yields that work, expression, manifestation, and item entities are all defined as a class, an example of this appeared in Fig.3.6.

```
<owl:Class rdf:ID = "work"/>
<owl:Class rdf:ID = "expression"/>
<owl:Class rdf:ID = "manifestation"/>
<owl:Class rdf:ID = "item"/>
```

Figure.3.7. Mapping entities to OWL

However if the set of individuals in one class (A) are subset of another set of individuals in another class (B), then the class (A) is defined as a subclass of (B). Fig.3.7. example describes the relationship between the tape-cassete and the electronic-resource where tape-cassette is a subclass of the Electronic-resource. Electronic-resource is a subclass of manifestation.

```
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Tape_cassette<--
> owl:Class rdf:about="&Ontology1302861763836;Tape_cassette<"
> rdfs:subClassOf
rdf:resource="&Ontology1302861763836;Electronic_resource</"
> rdfs:comment xml:lang="en">a removable module, somewhat like an audio
cassette, that contains magnetic tape that can be written on and read from a tape
drive.</rdfs:comment<
/> owl:Class<
```

Figure.3.8. SubClass example

3.6.2 Mapping attributes

There are many types of attributes that belong to entities; this requires separate ways to map these attributes to OWL properties.

Simple attributes of an entity are mapped into data type property of the corresponding OWL class, where the domain of this data type property is the entity itself and the range is

the data type of this attribute taking into account that OWL uses XML Schema data types (XSD), as in Fig.3.8.

```
<owl:DatatypeProperty rdf:ID= "TitleofManifestation">  
<rdfs:domain rdf:resource = "#Manifestation"/>  
<rdfs:range rdf:resource = "&xsd:string"/>  
</owl:DatatypeProperty>
```

Figure.3.9. Mapping attributes with their data-types

However, an important point should be considered is if the attribute has only one value a special tag "functional" should be tagged with this data type property. An example is shown in Fig.3.9 where statement of responsibility holds one and only one value.

```
<owl:FunctionalProperty rdf:ID= "Statementofresponsibility">  
<rdfs:domain rdf:resource = "#Manifestation"/>  
<rdfs:type rdf:resource = "DatatypeProperty"/>  
< rdfs:range rdf:resource = "&xsd:string"/>  
</owl:FunctionalProperty>
```

Figure.3.10 Mapping single-valued attribute

In general composite attributes are mapped into OWL data type properties by two methods, either by mapping its simple component attributes to data type properties ignoring the original composite attribute, or by mapping the composite attribute to data type property, and map its simple component attributes to sub property of the corresponding data type property. In our thesis we defined publisher as a class related to manifestation class with published by relation, where its attributes are city, country and contact information. It is important in order to be documented in library's authority file, to do this in OWL; it can be clear by the example written in Fig.3.10.

Multi-valued attribute is mapped into a data type property but without "Functional" tag, because the tag "Functional" determines that this property has one value for the corresponding entity, and the Multi-valued attribute has many values for its corresponding entity. An example of this is the edition, since each item in manifestation may have more than one edition, this is can be written in OWL as in Fig.3.11.

```

<"owl:ObjectProperty rdf:about="&Ontology1302861763836;Produced_by>
</"rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation>
</"rdfs:range rdf:resource="&Ontology1302861763836;Publisher>
<owl:ObjectProperty/>

```

Figure.3.11.Mapping Publisher

```

<owl:DatatypeProperty rdf:ID= "Edition">
<rdfs:domain rdf:resource = "#Manifestation"/>
<rdfs:range rdf:resource = "&xsd:int"/>
</owl:DatatypeProperty>

```

Figure.3.12. Mapping multi-valued attribute

Attributes that are defined as unique key is mapped into data type property with "Functional" and "inverseFunction" tag, in the Manifestation table ISBN is primary key, thus we can convert it into OWL as shown in the example in Fig.3.12

```

<owl:InverseFunctionalProperty rdf:ID="ISBN">
<rdf:type rdf:resource="#FunctionalProperty"/>
<rdfs:range rdf:resource="&xsd:int"/>
<rdfs:domain rdf:resource="#Manifestation"/>
<rdf:type rdf:resource="#DatatypeProperty"/>
</owl:InverseFunctionalProperty>

```

Figure.3.13. Mapping unique key

3.6.3 Mapping relations

Each relationship in the ERD of FRBR of all the cases is an expanded case of one-to-one relationship, in which this relationship is mapped into two object Properties into OWL, one object property is the original relation between the two entities whereas, the other is the inverse relation, as shown in the example in Fig.3.13. The relationship between the

manifestation and person is many-to-many, however when converting this to OWL, the first step should be done is to deal with these relationships as one-to-one relationship.

```

<owl:ObjectProperty rdf:about = "IsCreatedBy">
    <rdfs:domain rdf:resource = "#Manifestation"/>
    <rdfs:range rdf:resource = "#person"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about = "CreatorOf">
<owl:inverseOf rdf:resource = "#IsCreatedBy"/>
</owl:ObjectProperty>

```

Figure 3.14. Mapping relations

However, this is not enough in both one-to-many relationships and many-to-many relationships. Therefore, in one-to-many relationship it is transformed into restrictions, where OWL allows us to place some restrictions on properties, divided into two kinds of property restrictions:

- **Value constraints**, which puts constraints on the range of the property.
- **Cardinality constraints**, which put constraints on the number of values.

Fig.3.14.a, display the relation of the item and Manifestation as an example of one-to-many relationship, whereas Fig3.14.b depicted how this relation can be written in OWL. Finally the relationship in the case of many-to-many is splitting up into two relationships, one-to-many relationship and many-to-one relationship. An example of many-to-many relationship is the relationship between the person and manifestation as shown in Fig.3.15.

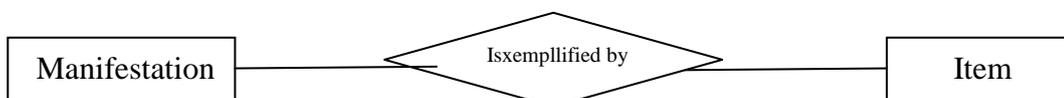


Fig.3.15.a Manifestation-item relation

```

<owl:class rdf:about = "#item">
  <rdfs:subClassOf>
  <owl:Restriction>
    <owl:onProperty rdf:resource = "Isexemplifiedby"/>
    <owl:allValuesFrom rdf:resource = "#Manifestation"/>
    <owl:maxCardinality rdf:datatype="int">1</owl:maxCardinality>
  </owl:Restriction>
</rdfs:subClassOf>
</owl:class>
<owl:ObjectProperty rdf:about = "#Isexemplifiedby">
  <owl:inverseOf rdf:resource = "#exemplifyby"/>
</owl:ObjectProperty>
<owl:class rdf:about = "#Manifestation">
  <rdfs:subClassOf>
  <owl:Restriction>
    <owl:onProperty rdf:resource = "exemplifyby"/>
    <owl:someValuesFrom rdf:resource = "#Item"/>
    <owl:minCardinality rdf:datatype="int">1</owl:minCardinality>
  </owl:Restriction>
</rdfs:subClassOf>
</owl:class>

```

Figure.3.15.b.Mapping one-to-many relation

```

<owl:Class rdf:about = "#Person"> <owl:ObjectProperty rdf:about = "#creator-of">
<rdfs:subClassOf> <owl:inverseOf rdf:resource = "#iscreatedby"/>
<owl:Restriction> </owl:ObjectProperty>
<owl:onProperty rdf:resource = "creator-of"/>
<owl:allValuesFrom rdf:resource = "#Manifestation"/>
<owl:maxCardinality rdf:datatype="int">1</owl:maxCardinality>
</owl:Restriction>
</rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:about = "#Manifestation">
<rdfs:subClassOf>
<owl:Restriction>
<owl:onProperty rdf:resource = "iscreatedby"/>
<owl:someValuesFrom rdf:resource = "#Person"/>
<owl:minCardinality rdf:datatype="int">1</owl:minCardinality>
</owl:Restriction> </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:about = "#Person">
<rdfs:subClassOf>
<owl:Restriction>
<owl:onProperty rdf:resource = "creator-of"/>
<owl:someValuesFrom rdf:resource = "#Manifestation"/>
<owl:minCardinality rdf:datatype="int">1</owl:minCardinality>
</owl:Restriction>
</rdfs:subClassOf> </owl:Class>
<owl:Class rdf:about = "#Manifestation"> <rdfs:subClassOf> <owl:Restriction>
<owl:onProperty rdf:resource = "iscreatedby"/>
<owl:allValuesFrom rdf:resource = "#Person"/>
<owl:maxCardinality rdf:datatype="int">1</owl:maxCardinality>
</owl:Restriction> </rdfs:subClassOf>
</owl:Class>

```

Figure.3.16. Mapping many-to-many relation

3.7 Semantic Mapping between manifestations attributes and MARC elements

One of the objectives of this thesis is mapping the components of FRBR in English and Arabic with both of MARC21, UNIMARC. Therefore, we take the advantage of the characteristics of OWL, such ontology mapping, equivalent between classes and properties, and identity between individuals. For instance, `equivalentClass` predicates that two classes are the same, thus, if we defined `العمل` as a class, then OWL allows denoting the quality between the two classes: `Work` and `العمل` as the example shown in Fig.3.16

```
<owl:Class rdf:ID = "العمل">  
<owl:equivalentClass rdf:resource="#Work"/>  
</owl:Class>
```

Figure.3.17 OWL "equivalentClass"

The mechanism of “`equivalentProperty`” is similar to “`equivalentClass`”, it predicates that two properties which is critical in this thesis to map between the attributes of FRBR entities with the corresponding elements in MARC21 and UNIMARC, Fig.3.17 displays an example where “`245$a`” in MARC21 represents the same meaning of statement of responsibility attribute in FRBR.

```
</owl:FunctionalProperty>  
<owl:FunctionalProperty owl2:ID= "245$c">  
<rdfs:domain rdf:resource = "#Manifestation"/>  
<rdf:type rdf:resource = "DatatypeProperty"/>  
<rdfs:range rdf:resource = "&xsd:string"/>  
<owl: equivalentProperty rdf:resource="#Statementofresponsibility" />  
</owl:FunctionalProperty>
```

Figure.3.18 OWL "equivalentProperty"

OWL supports the basic set operations namely union, intersection and complement. Union property named “owl:unionOf” and links a class to a list of class descriptions, an example of union is the set of values in Fig.3.18 that refer to the carrier code type such as “sd”, “ss”, “cd”, “cr” and “vf”.

```
<owl:Class rdf:ID="carrier-code-type">
  <owl:unionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#Sd" />
    <owl:Class rdf:about="#ss" />
    <owl:Class rdf:about="#cd" />
    <owl:Class rdf:about="#cr" />
    <owl:Class rdf:about="#vf" />
  </owl:unionOf>
</owl:Class>
```

Figure.3.19 OWL "unionOf"

Chapter 4

Implementation

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4.1 Introduction

In this chapter we implement a pilot project to address our objectives in this research. Therefore, we can display our ontology using a web service, to encourage communications between libraries, and enhancement exchanging their cataloging records, in order to achieve the libraries target of building the union catalogue.

It is well known that web services are networked applications and unit managed codes. These allow different applications to share their data and offer the ability for those applications to communicate to each other using HTTP requests. In that case the web services can be considered as an application platform, thus enabling some libraries, which have the same kind of MARC to exchange their data and information. However, building web services without considering ontology will construct a group of libraries that can communicate to each other if and only if they have the same bibliographic concepts (i.e. the same MARC format). In that case each group of libraries with the same bibliographic concepts is considered as an isolated group on their web services. Therefore, it is essential to import ontologies to web services, and thus achieve our purpose of building the union catalogue, and combine all groups of libraries in one web service.

This chapter includes a scenario to the pilot project of a web service; it includes the ontology built in this thesis. Thus, it is necessary to use a tool, which contributes in building the ontology. Here we propose to use “protégé”. In section 4.2, we implement this project using java-programming language supporting by Jena library. In section 4.3, we discuss about the objective of the web service. Section 4.4 describes how the web service access ontology. Finally we generate our project by building a web service and applications in section 4.5.

4.2 Tools needed to build and import the ontology to the web service

In pilot project we build an ontology needed to facilitate the communication between libraries. In this thesis we use the ontology development tool, and the free open-source platform of protégé_4.1_beta, which provides a comprehensive *Application Programming Interface* (API) for working with OWL and RDF models. It develops stand-alone semantic web applications. Protégé is based on java, which required installing the Java Development

Kit of version 1.5 or higher, accompanied by a Java compiler, thus due to this reason we install the version 1.6 of *Java Platform, Enterprise Edition* (Java EE), with version 7.0 of *Net-Beans integrated development environment* (IDE). In addition, libraries called “Jena” in conjunction with JenaBean package are required. Jena is a java framework for building semantic web applications and it is considered the basic, which based on Protégé. It makes it possible to quickly generate java classes for designing ontology applications. Here, we install the version 2.6.4 of Jena. Jena is an open source provides a programmatic environment for RDF, RDFS, and OWL. It has a number of command line programs to process RDF models and manipulate models held in relational databases. It includes RDF API and OWL API that reads and writes RDF in RDF/XML.

4.3 The objective of building the web service

The objective of building the proposed web service is to create a programmatic interface between clients or libraries across network. It helps the clients to search and exchange their data regardless of the kind of the used MARC, or even if there is no MARC and just are using one of the terms or terminology which are available in the hidden ontology of this web service. Thus, clients can search for the required information; either by title, author, publisher...etc., through list of values contains those terms in the languages available in this web service. However, in this pilot project both the Arabic and English languages library terms were added to this ontology to be applied as an example. Thus, the interface should have a list of values, which give the client the opportunity to send a request message. The client can choose the term such as (title, العنوان, author, المؤلف ...etc), after that a text box is used to insert the required data. Accordingly the web service should answer with a response message to give the client what he needs in conjunction with the same term he used. This is done by comparing the chosen term with the equivalent terms in the available ontology. Nevertheless, the responsibility of the web service is to search in both a union catalogue and client's database. This facilitates the searching process by searching on one page instead of browsing many pages. The web service responds with a message displays all the cataloging records of the required data. The client has an option to select the required cataloging record. After that, the client has the choice to import the

required record to his cataloging record. Whereas before doing that, the client has to copy this record to his cataloging record and repeating the same work again.

4.4 Web service access to ontologies

A key problem in [40] is using a standard web service description that has a syntactic definitions cannot be understood by software programs. Thus it requires providing access to ontologies through that software. On the one hand ontologies and semantic web services in [41] are the two core technologies of the semantic web. On the other hand ontologies provide the backbone of the semantic web. Thus allowing software programs by inserting calls to ontology web services is necessary to perform complex tasks.

Ontologies have the ability to facilitate research with the reuse of knowledge representation. Providing a query access to ontology, mapping and merging ontologies through a web service, enable applications to handle semantic heterogeneity. In this thesis we build one ontology where our web service is provided with the ability of accessing this ontology, taking into account merging and mapping multiple ontologies in the future. The below code is used to import and get all the classes, subclasses, object properties and data properties with their equivalent as follows:

```
OWLImporter O = new OWLImporter  
("http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl");  
OntModel model = O.readOntModel();  
Using
```

Developing web services using Jena technology in conjunction with JenaBean package provide a facility for supporting ontology. On the one hand, Jena provides an API for writing and reading RDF, which can be stored and persisted in various ways. It has the ability of constructing various types of Model. On the other hand, JenaBean with the annotation @ Id, It specifies a unique filed, where with the annotation @Namespace it provides a domain, and with the annotation @RdfProperty it maps java properties to RDF properties.

4.5 Building the web service and application

In this thesis we create a web service, with a multithread server, and multithread clients. The server in multithread server listens to a specific port from client for connections requests and process each requests in a separate thread. Therefore, the request from one client will not ever block a request from another client, and then dispatch those multiple threads to different clients for connections responses as in Fig.4.1. As well as the clients in multithread clients have two threads; the first thread sends a request to the server and wait a response (as a query request).

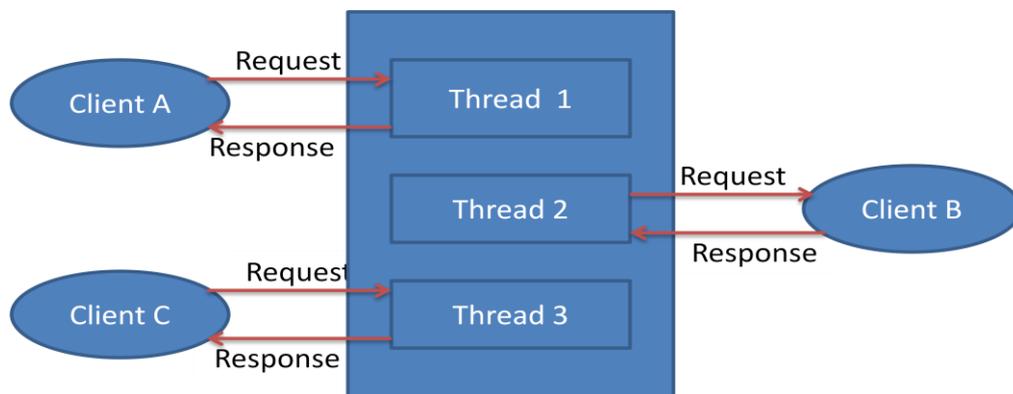


Figure.4.1. Multithread server

The second thread looks into the database and sends a response to the server if a request has been sent, as in Fig.4.2. These clients are in permanent contact with each other. When the server receives a query from any client, it sends this query to all clients as a request message. The second thread task invoked only if it received a request ordering it to search into its database and return a response either if it finds this result or not.

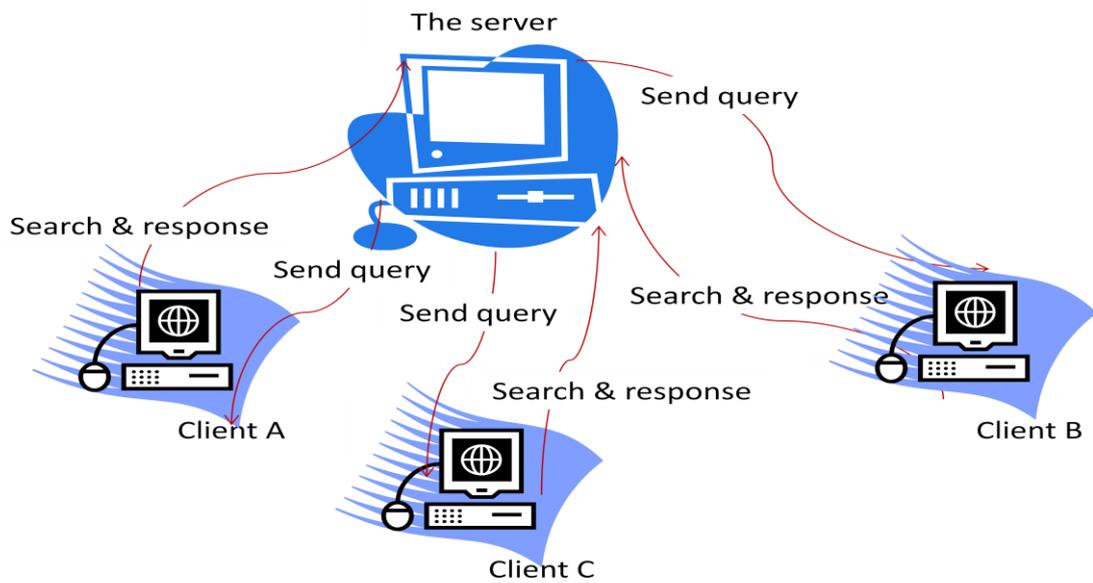


Figure.4.2. Multithread client

This web service is developed with a single java class that declares the methods, which, a client can invoke on the service. It is denoted by “@WebService” and it define the class as a web service to provide a programmatic interface. This single class has two major methods:

Method 1 it performs multiple tasks at a time allowing multiple clients programs to communicate with the same server program. The objective of this method is to help the clients to send a request to search for an information resource.

Method 2 exchanges the data or catalogue records they obtained as a result of the first method.

The first method has two options to search in, either by a simple search or an advanced search. Then the method invoked whenever provided with the values of its parameters. It has two kind of parameters, the first of parameters is a string representing one of the terms with its equivalent terms in other MARC or language, and the other parameter is also a string is intended to insert the required query of the first parameter.

Example if a client needs to look for a title, he must choose “title” from the first parameter. And insert its value in the second parameter in the text box. Immediately, the server will import the ontology and prepare the equivalent terms of the first parameters to all clients as shown in Fig.4.3. The ontology is identified using URI's, for example the URI of this ontology is

“<http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl>”.

All clients now are listening to a request. When the query is received, the server dispatch a request to all clients to search for this query, any client finds the result in his database send his response to the server with his location or specific port. The union catalogue client is considered as the main client that stores all cataloging records from all clients in the database. This client is used as a reference for all libraries and clients, and help them to united their authority file and fulfill the union catalogue project, where all clients are participating libraries joined to this web service. Therefore, this process takes the result (i.e. required data) and check whether it exists in the main library or not. If the required data does not exist in the main client the web service sends this query to all clients. If it is found, it will export this result with its full cataloging record as a URI temporarily to the union catalogue and pending the saving process. The admin who has to be an expert in libraries, should issue a decision to update or/and save the result or refuse it. This union catalogue aids clients to unite their authority files by mapping and linking their data.

The second major method is invoked whenever the client specifies the required results, as illustrated in Fig.4.4. This method has one parameter depending on the first algorithm. Whenever the first method displays the results of all the expected cataloging records, the user has the option to choose one cataloging record. The client can import the required cataloging record if it is suitable and agree with his requirements. Consequently, the server will export this cataloging record.

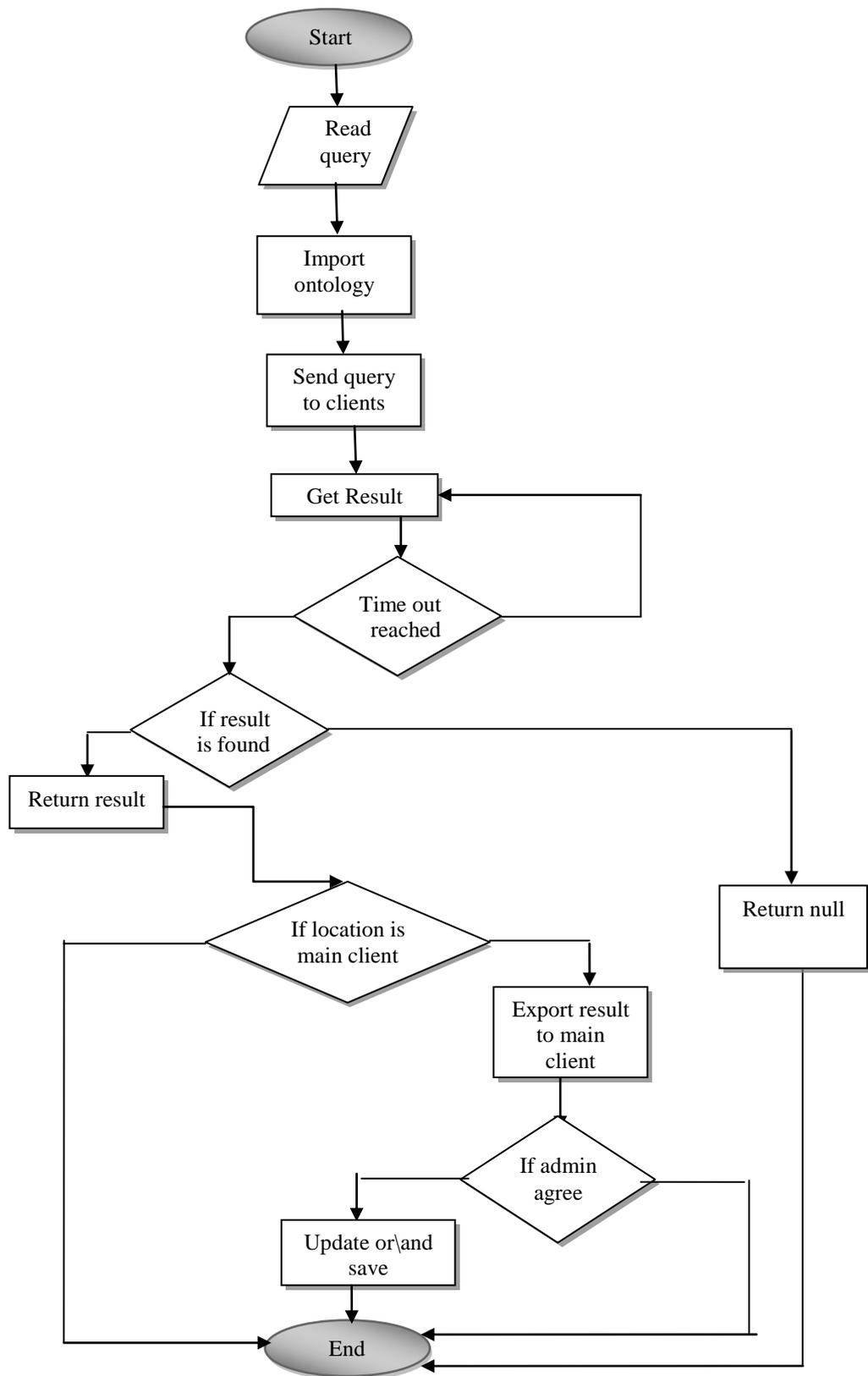


Figure.4.3.Web service-first method flowchart

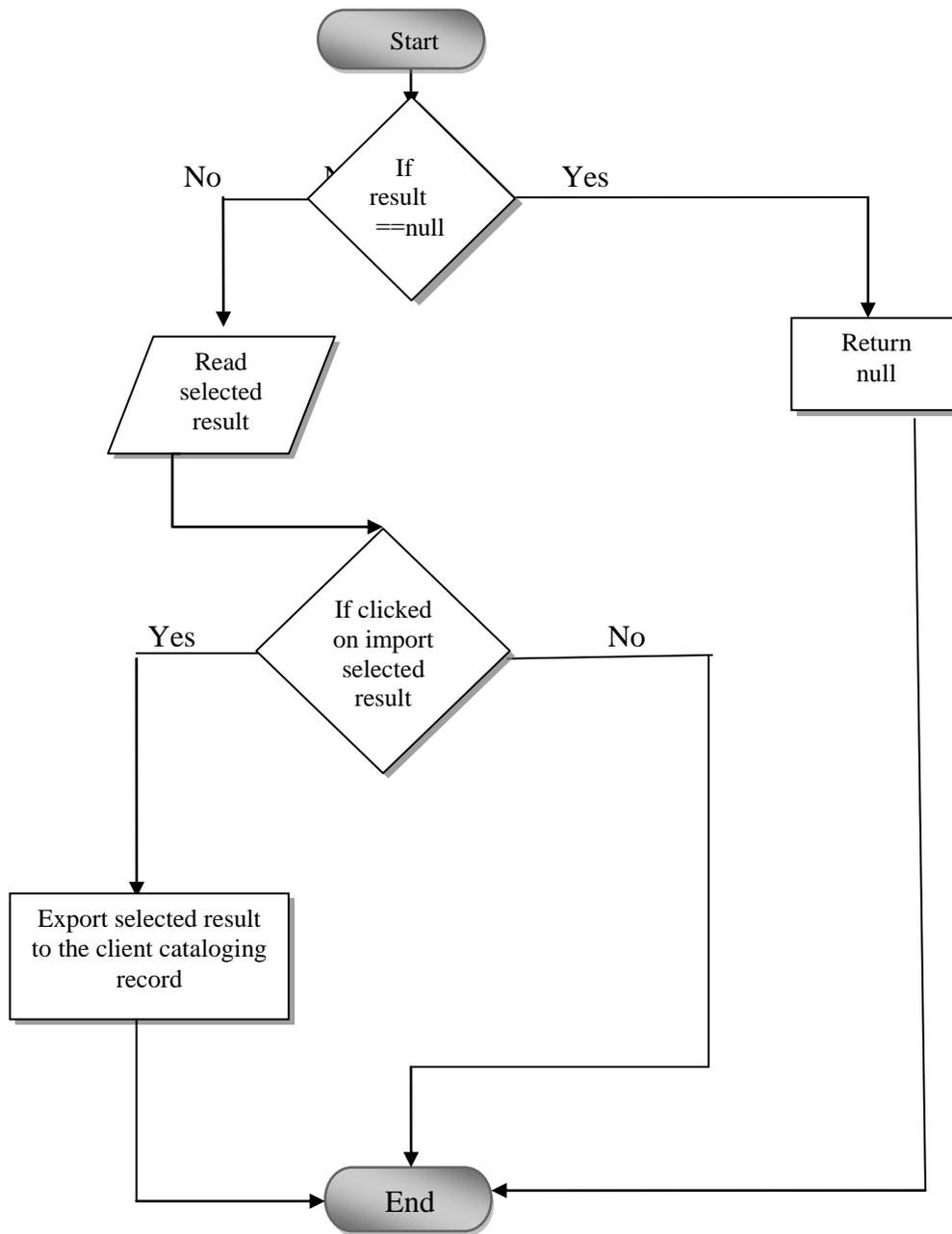


Figure.4.4.Web service-second method flowchart

Chapter 5

Evaluation

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5.1 Introduction

For the evaluation of this thesis, we can divide our work into four sections, in section 5.2 we can summarize the opinions and results of how we build our ontology, in section 5.3 we summarize the idea and the results of the connection between the client applications and the web service, and finally in section 5.4 we conclude the outcome of this thesis with testing and results.

5.2 Union Catalogue ontology

The building block of the union catalogue ontology in this thesis is to construct a semantic mapping of FRBR standard concepts of FRBR with its corresponding terms in both MARC21 and UNIMARC using OWL. FRBR is a semantic expression and a very specific type of a conceptual model [42]. It is an ER model specifies the relationships between items in the library catalogue and an approach to semantic modeling.

We use an open source platform of protégé_4.1_beta, defining classes, object properties and data properties with their definitions in both Arabic and English. This is done to enhance our ontology concepts vocabularies. A sample of an ontology graph can be illustrated in Fig.5.1. One can notice clearly that “Manifestation” is a subclass of “Thing”, defined in English by “The physical embodiment of an expression of work”, created by a “Person or الشخص” and equivalent to المظهر المادي with the URI:

“<http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestation>”

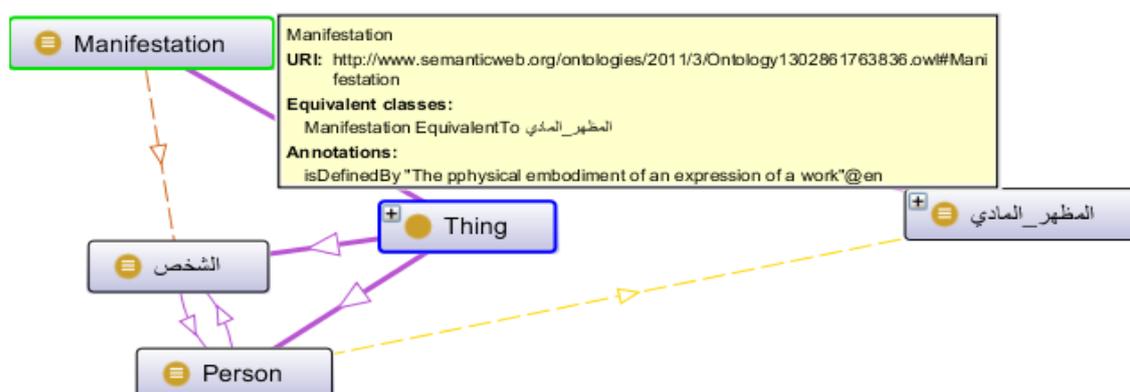


Figure.5.1. Protégé ontology sample

In addition, using the W3C RDF Validation Service “<http://www.w3.org/RDF/Validator/>”, triples and graph can be displayed as it shown in the example in Fig.5.2, and Fig.5.3.

| Subject | Predicate | Object |
|---|---|---|
| http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#ISBN | http://www.w3.org/2000/01/rdf-schema#domain | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestation |
| http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#ISBN | http://www.w3.org/2002/07/owl#equivalentProperty | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestation_identifier |
| http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#ISBN | http://www.w3.org/2002/07/owl#equivalentProperty | http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#مصدر_التزويد |

Figure.5.2. Ontology triples

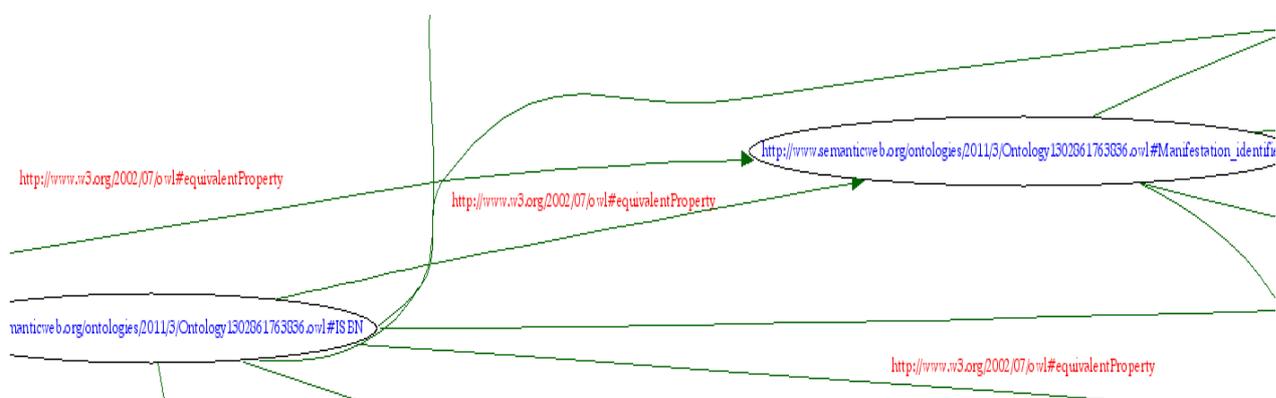


Figure.5.3. Ontology graph

5.3 Web Service/Web applications

The aim of this web service is to help clients and libraries to collaborate and exchange their library catalogue records through one web page, even if they have variant kinds of MARC or standard terms in libraries. Therefore, we create a web service and deploy to a server domain. Then we connect the java clients to the web service. This is applied by designing ontology for the purpose of enabling knowledge sharing, reuse and defining vocabularies between libraries. Therefore, this web service has the union catalogue ontology to achieve the desired goal of this service. The methods in web service are invoked while inserting method parameters, as it appears clearly as in Fig.5.4. Web service allows testing our web service implementation with a WSDL file link. While trying to test our web service, the method in this figure is a search method within “UnionCatalogue”

class and “org.me.catalogue” package. In this method the web service received a query from clients to look for a record in clients’ database invoking the ontology to send each client with its equivalent data property. Taking into account the result of the first method, another method can be displayed to facilitate the exchanging of data between clients, according to the desired result submitted within the web service, which is maybe considered the core objective of MARC revolution, which is a method of recording the information needed in the client cataloging record such as title, statement of responsibility, publisher, call number and other access points.

```
public abstract java.lang.String org.me.catalogue.UnionCatalogue.search(java.lang.String)
search (  )
```

Figure.5.4. Deploying web service

By running this web service it navigates to:

localhost:8080/Union-Catalogue/UnionCatalogueService address with a WSDL link: **localhost:8080/Union-Catalogue/UnionCatalogueService?wsdl** to have a look at the WSDL, and this gives the clients the opportunity to connect with this web service, where each clients has to activate with this web service while running its application to this web service. As mentioned in section 4.4 each client has two threads, one thread is waiting a query request within the web service with the vocabulary and concepts of this client, and another thread to look into its database records searching for the query.

5.4 Testing and results

As a test we implement our thesis on two thousands bibliographic records distributed through four clients, where each client has its own concept available in each database. We assume that there exist one client has its own concepts in MARC21, the second one in UNIMARC, the third one is using English standard FRBR concepts, and the last one is using Arabic FRBR terms as in Fig.5.5. Now each client needs to look for any cataloging record will search by its own terms, it uses the web service interface as in Fig.5.6. In this section we prove the validity of this ontology by the examples shown below.

| 45Sa | 245Sc | 260Sb | 205a | 300S |
|---|--|---|------------|------------------|
| Medical microbiology & immunology : examination & review | Williams Levinson | Prentice-Hall | | |
| Gianni Battista Tiepolo 1696-1770 | Chantal Eschenfelder | Koenemann | | |
| The general theory of transformational growth : Keynes | Edward J. Nell | Cambridge University Press | | 052159006X |
| Selected by Peter Brennan and Harry | | Oxford University Press | | |
| Physiology coloring book | Wynn Kapit | Robert I. Macary | | Ernal Meisar |
| The theories of revolution : a commentary on the views | Rajis Debray and Herbert Marcuse | Jack Woddis | | Lawrence and |
| Nelson contemporary English dictionary | General editor : W. T. Cunningham | Thomas Nelson | | |
| Medical microbiology | Cedric Mims ... [et al] | Mosby | | |
| Robbins pathologic basis of disease | Ramzi S. Cotran ; Vinay Kumar | Stanley L. Robbins ; Managing editor Fredrick J. Schoen | | W. B. Saunde |
| Indian mythology | By George Every | Hamlyn Paperbacks | | |
| Economic history of the silk industry 1830-1930 | | Giovanni Federico | | Cambridge Uni |
| Biological Science 1 and 2 | N. P. O. Green | G W Stout | | D. J. Taylor ; E |
| OS/2 : a guide to OS/2 version 2.1 : learn to navigate the open | | John C. Dvorak | | David B. Whit |
| Superpowers and the Middle East | Alan R. Taylor | Syracuse University Press | | 0-8156-2543-X |
| DS : images of the epidemic | World Health Organization | World Health Organization | | 92-4-156163-7 |
| Ecology of microorganisms | Thomas D. Brock | Prentice-Hall | | |
| Money and capital markets : financial institutions and | Peter S. Rose | McGraw-Hill / Irwin | | |
| Bruegel | 1525/1530-1569 | Christian Vhringer ; [translation from German: Paul Aston | | Koenemann |
| النبات | مصطفى عبد العزيز و آخرون | مكتبة الأجلو المصرية | | Koenemann |
| شرح المعلمات العشر وأخبارها | تحقيق محمد الفاضلي | أحمد بن الأمين الشنقيطي ؛ تحقيق محمد الفاضلي | | J. A. Shaw |
| الصحاح : ناح اللغة و صحاحها | تحقيق أحمد عبد الغفور عطار | دار العلم للملايين | | |
| أثر أو إصلاح الوجه والنظائر في القرآن | تحقيق عبدالعزیز سيد الأهل | دار العلم للملايين | | |
| جامع المسانيد و السنن الهادي لأقرب | أخرجه عبد المعطي أمين قلججي | دار الكتب العلمية | | King |
| المحرر الوحيد في تفسير الكتاب | تحقيق عبد السلام عبد الشافي محمد | دار الكتب العلمية | | brief biographi |
| المستقصى في أمثال | محمود بن عمر الرمخشري | دار الكتب العلمية | | xford Univers |
| المنتظم في تاريخ الملوك و | تحقيق محمد عبد القادر عطا | دار الكتب العلمية | | xford Univers |
| الوايل الصيب من الكلم | محمد بن أبي بكر بن قيم الجوزية | دار الكتب العلمية | | 07-100860-8 |
| أفراد من حديث الرسول صلى الله عليه و | محمود محمد محمود نصار | دار الكتب العلمية | 2745122045 | |
| بقية الوعاة في طبقات اللغويين و | تحقيق محمد أبو الفضل إبراهيم | الرحمن السبوطي ؛ تحقيق محمد أبو الفضل إبراهيم | | |
| أسس الجغرافية | تأليف دولت صادق ؛ علي البنا ؛ نبيل سيد إسماعيل | [د.ت.] | | D.ت. |
| المدخل إلى الجغرافية الطبيعية و الب | تأليف علي سالم إحصيدات الشوارة ، جابر الحلاق | [د.ت.] | | design |
| بين الشريعة الإسلامية و القوانين الو | شفيق موسى عباس | [د.ت.] | | ason, Ha |
| رسائل البر | جمع وترتيب محمود أبو رية | دار إحياء الكتب العربية | | scientific, |
| كل ما يحب أن تعرفه عنه ؛ بدء الحياة الب | الطفل : | دار الشروق الأوسط | | ations, I |
| مصراع قلب | فيلم بطرس عودة عودة | حافظ صندوق إخوان | | el J. Qui |
| كتاب معرفة علوم الب | فيلم بطرس عودة عودة | أخي الجديدة | | |

Figure.5.5. Clients database records

Search for

Search in

Sea...

Figure.5.6. Web service interface

Example.5.1:

In Fig.5.7 one client is searching for the publisher “Prentice-Hall” by using 210\$c in UNIMARC which refers to the publisher term. The web service imports all the synonyms

of the search query "210\$c" from the union catalogue ontology while processing the query as it shown in Fig.5.8.

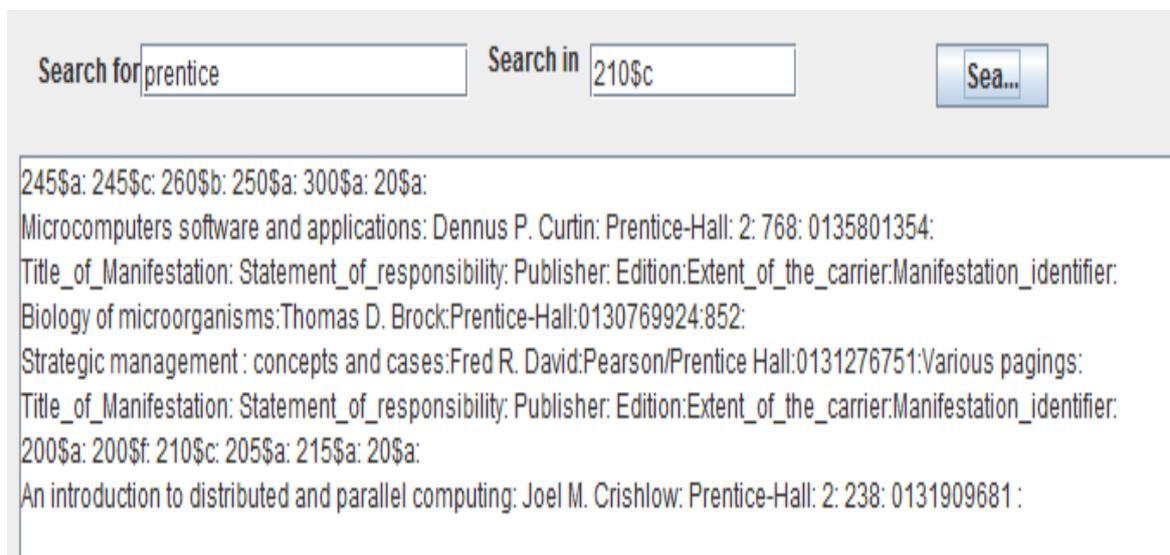


Figure.5.7. UNIMARC client example

Example 5.2:

In Fig.5.9 another two clients are also searching for the publisher "Prentice-Hall", one client is using "260\$b" in MARC21 and the second client is using "Publisher" in English FRBR concepts, where "260\$b" refers to the term publisher. We obtain the same results in all clients either they used UNIMARC as in Example 5.1, or MARC21 or English language as in this example.

Received search query from server:
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210\$c:prentice;http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الناشر:prentice;http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الموزع:prentice;http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Publisher-Name:prentice;http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Publisher:prentice;http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260\$b:prentice;
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210\$c:prentice
Searching in column: 210\$c
Searching for value: prentice
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الناشر:prentice
Searching in column: الناشر
Searching for value: prentice
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الموزع:prentice
Searching in column: الموزع
Searching for value: prentice
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Publisher-Name:prentice
Searching in column: Publisher-Name
Searching for value: prentice
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Publisher:prentice
Searching in column: Publisher
Searching for value: prentice
Processing
request:http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260\$b:prentice
Searching in column: 260\$b
Searching for value: prentice
RECIEVED RESULT:
Title_of_Manifestation: Statement_of_responsibility: Publisher:
Edition:Extent_of_the_carrier:Manifestation_identifier;;Biology of
microorganisms:Thomas D. Brock:Prentice-Hall:0130769924:852;;Strategic
management : concepts and cases:Fred R. David:Pearson/Prentice
Hall:0131276751:Various pagings:;;|200\$a: 200\$f: 210\$c: 205\$a: 215\$a: 20\$a;;An
introduction to distributed and parallel computing: Joel M. Crishlow: Prentice-Hall:
2: 238: 0131909681 :;||

Figure.5.8. Processing search query

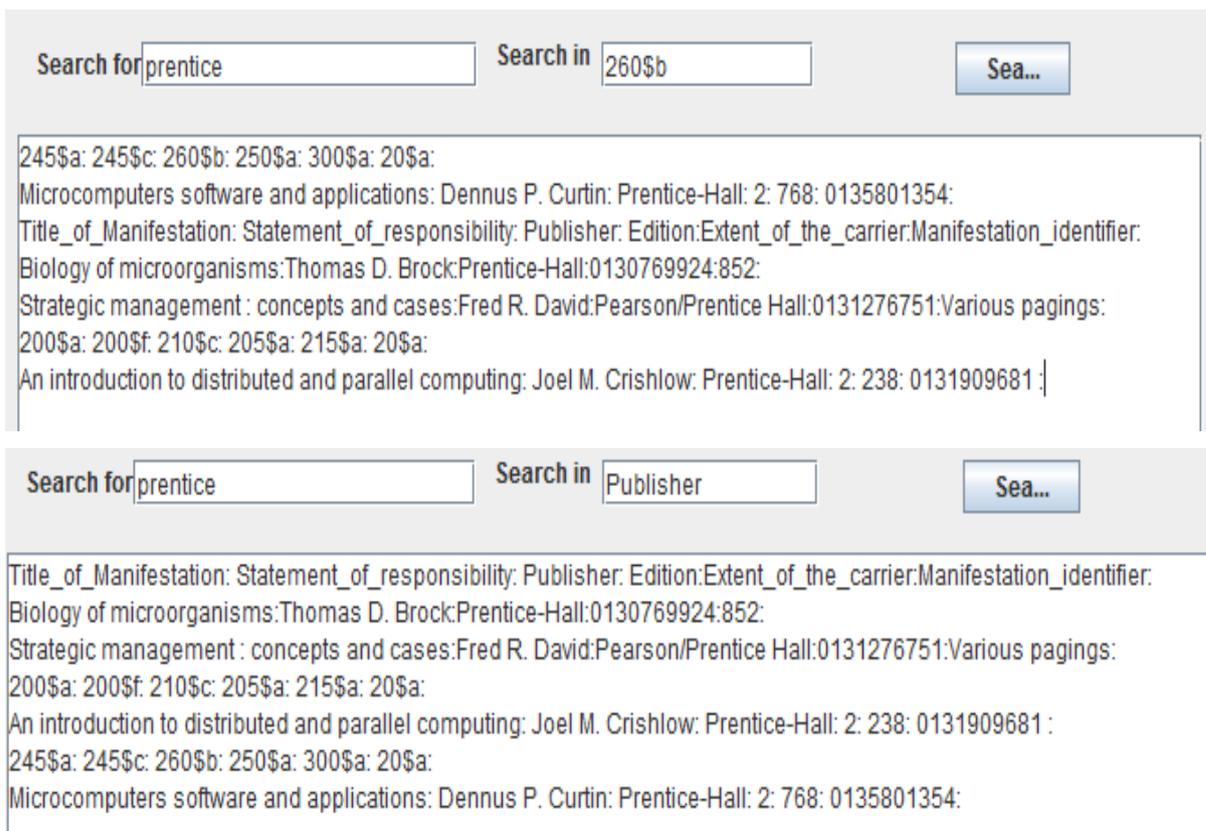


Figure.5.9 Publisher search query

Example.5.3:

In Fig.5.10.a, a client is searching for title “chemistry” by using "245\$a" in MARC21 which refers to a title term. The web service returns a result with more than one record has the title “chemistry”. Then we obtained the same result as in Fig.5.10.b by another client used the term "Title_of_Manifestation", which ensures that the ontology in the web service returns back results regardless if this client can communicate directly with other clients or not.

Search for Search in

Title_of_Manifestation: Statement_of_responsibility: Publisher: Edition:Extent_of_the_carrier:Manifestation_identifier:
 General chemistry principles and modern applications: Ralph H. Petrucci: Macmillan: 2: 790: 0029795400:
 General chemistry: Linus Pauling: Dover: 1: 959: 0486656225:
 General chemistry: P.W. Atkins: J. A. Beran: Scintific American: 2: 900: 0716722348:
 245\$a: 245\$c: 260\$b: 250\$a: 300\$a: 20\$a:
 Introduction to modern inorganic chemistry: K. M. Mackay and R. A. Mackay: International textbook: 3: 349: 0700202781:
 General chemistry principles and modern applications: Ralph H. Petrucci: Macmillan: 2: 790: 0029795400:

Figure.5.10.a. Client A results

Search for Search in

245\$a: 245\$c: 260\$b: 250\$a: 300\$a: 20\$a:
 Introduction to modern inorganic chemistry: K. M. Mackay and R. A. Mackay: International textbook: 3: 349: 0700202781:
 General chemistry principles and modern applications: Ralph H. Petrucci: Macmillan: 2: 790: 0029795400:
 Title_of_Manifestation: Statement_of_responsibility: Publisher: Edition:Extent_of_the_carrier:Manifestation_identifier:
 General chemistry principles and modern applications: Ralph H. Petrucci: Macmillan: 2: 790: 0029795400:
 General chemistry: Linus Pauling: Dover: 1: 959: 0486656225:
 General chemistry: P.W. Atkins: J. A. Beran: Scintific American: 2: 900: 0716722348:

Figure.5.10.b Client B results

Example.5.4:

In Fig .5.11, two clients are looking for the same ISBN or Manifestation _identifier. The web service returns back the same result regardless the client is dealing with UNIMARC or FRBR English concepts.

Search for Search in

200\$a: 200\$f: 210\$c: 205\$a: 215\$a: 20\$a:
 An introduction to distributed and parallel computing: Joel M. Crishlow: Prentice-Hall: 2: 238: 0131909681 :

Search for Search in

title_of_Manifestation, Statement_of_responsibility, Publisher, Edition,Extent_of_the_carrier,Manifestation_identifi
 n introduction to distributed and parallel computing: Joel M. Crishlow: Prentice-Hall: 2: 238: 0131909681 :

Figure.5.11. ISBN search query

5.5 Comparison study

Union catalogues have embraced the web by providing users with the ability to perform searching of information from multiple institutions and library catalogues. However in all popular union catalogues, clients need to have the same form of concepts or items in order to exchange their catalogues together. For example, OCLC members follow MARC21 as the technical standard in their record cataloging. At the same time Swedish union catalogue which is part of the semantic web is also based on MARC21, while OPAC members follow UNIMARC in their cataloging. On the other hand, some researches such as "Semantic MARC, MARC21 and the semantic web", is represented MARC as RDF for the semantic web without the possibilities of exchanging other forms of MARC in one web service and one union catalogue. In addition, other researches discussed the way of representing FRBR to be part of the semantic web ignoring MARC.

Whereas , in this thesis all clients search through one web service to any record, and the web service provide them with the result they need regardless if other clients used the same form of items or not.

Chapter 6

Conclusion and Future Work

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6.1 Conclusion

The goal of this thesis is to bring largest number of libraries together and aggregate all their cataloging records and authority files in one union catalogue. Union catalogue provides users of information they need, and encourage librarians to exchange their cataloging records easily. However union catalogue in the past and nowadays can facilitate communication between libraries if and only if they share the same vocabulary items and protocols. This motivates us to present a proposal implement communications between libraries. Thus we build a union catalogue ontology contains the library cataloging record terms in different vocabularies to serve the purpose of this research.

Consequently we build a web service in order to collect libraries and users together in one web page to cooperate, search, and exchange data simply. First of all we create initially a virtual union catalogue on the web service server with a copy of all cataloging records of all the precipitant libraries in this web service. On the other hand we build ontology to play the role of a mediator or translator to keep all libraries in touch with each other. This web service depends on designing a small ontology model for MARC21, UNIMARC, and the IFLA's FRBR terms in both Arabic and English languages. We focus on the FRBR relationships between library items to be the basic rule of building our ontology and determining the semantic relations of MARC and IFLA's FRBR terms.

The entity relationship of FRBR model is formalized to an OWL. The reason of this is the similarities between FRBR and OWL. OWL is a web language defines ontology, whereas ontology is indentified as the limits of the data model and the inter-relationships of elements within it. Therefore if we apply this definition on the web we can define the web ontology as an exact description of web information, which needs accordingly a web ontology language to process the content of this web information. Thus OWL could serve as a semantic layer to the FRBR relations to be part of the semantic web. In this research we convert entity-relationship of FRBR schema to OWL by a set of mapping rules that capture the FRBR schema semantics. Then we adopt an analytical study mapping MARC21 records using the FRBR model with the corresponding terms in each UNIMARC, and Arabic and English FRBR terms. Finally we construct union catalogue ontology using the utilization of protégé tool, which its core is customized to provide support for creation and manipulation ontologies.

The outcome of this thesis can be summarized as follows:

1 - Supporting ontologies will not be a replacement to MARC21, UNIMARC, or FRBR terms. Ontology acts as an enhancement to all variant types of MARC, FRBR terms and even any library catalogue terms. It extracts libraries from all the problems that prevent them to communicate with others. Who form and work in their own group only which agrees with them with the same type of MARC they used.

2 – Union catalogue can be considered as reference to all libraries to get information they need. It can aggregate all cataloging records in all libraries, in addition to the existence of two copies of each cataloging record. One of them in the union catalogue of the web service and another is a local copy in the local library to protect the loss of data even if the local server is down.

3 – Using one site collects several libraries to participate in their cataloging records. Thus it provides users with less effort in searching and moving from one site to another looking for the information they need. In addition it helps users to find information description with its location easily and quickly.

4- Using RDF and OWL participate in presenting the cataloging record MARC and FRBR to be part of the semantic web which can help users to find what they want easily and quickly.

6.2 Future Works and recommendations

In our work in this thesis we designed a small ontology reviewed only some of the FRBR attributes in both of Arabic and English languages with their equivalent attributes in MARC21 and UNIMAR. My recommendations are to build huge ontology, by importing and merging ontologies to our ontology forming a huge ontology.

Since ontologies are identified using URI's and OWL, it supports reuse of ontologies. Therefore it is possible for one ontology to import another ontology by OWL statement `< owl:imports rdf:resource = " URI of an ontology " >`.

We applied the idea of union catalogue in a pilot project in our research. Therefore our recommendation also is to apply it with real library systems. This research will contribute in the unification of the authority file in one web service. It can aggregate all libraries

authority file with the principle of linking data through HTTP URIs by people or agents. This research depends on cataloging records in RDF and OWL in one web service. Thus if different URIs refer to the same object such as title, author, publisher...etc, the statement owl:sameAs can link these URLs together.

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Appendix

```
?> <?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY owl "http://www.w3.org/2002/07/owl#" >
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
  <!ENTITY Ontology1302861763836
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#" >
  <!ENTITY Ontology13028617638366
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#20$" >
  <!ENTITY Ontology13028617638367
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#205$" >
  <!ENTITY Ontology13028617638368
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#250$" >
  <!ENTITY Ontology13028617638362
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#338$" >
  <!ENTITY Ontology130286176383613
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#700$" >
  <!ENTITY Ontology13028617638363
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#245$" >
  <!ENTITY Ontology13028617638369
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#215$" >
  <!ENTITY Ontology13028617638364
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#200$" >
  <!ENTITY Ontology130286176383614
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210$" >
  <!ENTITY Ontology130286176383612
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#100$" >
  <!ENTITY Ontology130286176383611
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260$" >
```

```

<!ENTITY Ontology13028617638365
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#300$" >
  <!ENTITY Ontology130286176383610
"http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#106$" >
] >
<rdf:RDF
xmlns="http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#"
ml:base="http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl"
  xmlns:Ontology130286176383611="&Ontology1302861763836;260$"
  xmlns:Ontology13028617638365="&Ontology1302861763836;300$"
  xmlns:Ontology13028617638366="&Ontology1302861763836;20$"
  xmlns:Ontology130286176383610="&Ontology1302861763836;106$"
  xmlns:Ontology13028617638363="&Ontology1302861763836;245$"
  xmlns:Ontology13028617638364="&Ontology1302861763836;200$"
  xmlns:Ontology13028617638362="&Ontology1302861763836;338$"
  xmlns:Ontology130286176383614="&Ontology1302861763836;210$"
  xmlns:Ontology130286176383613="&Ontology1302861763836;700$"
  xmlns:Ontology130286176383612="&Ontology1302861763836;100$"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"

xmlns:Ontology1302861763836="http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:Ontology13028617638369="&Ontology1302861763836;215$"
  xmlns:Ontology13028617638368="&Ontology1302861763836;250$"
  xmlns:Ontology13028617638367="&Ontology1302861763836;205$">
  <owl:Ontology
rdf:about="http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl"
>

```

<rdfs:comment rdf:datatype="&rdfs;PlainLiteral">The objective of union_catalogue ontology is to facilitate the exchange of bibliographic record between libraries regardless if they have Marc or not.</rdfs:comment>

</owl:Ontology>

<!--

//

//

// Annotation properties

//

//

-->

<owl:AnnotationProperty rdf:about="&rdfs;isDefinedBy"/>

<owl:AnnotationProperty rdf:about="&rdfs;comment"/>

<!--

//

//

// Datatypes

//

//

-->

<!-- <http://www.w3.org/2001/XMLSchema#date> -->

<rdfs:Datatype rdf:about="&xsd;date"/>

<!--

//

//

// Object Properties

//

//

-->

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Published_
by -->
<owl:ObjectProperty rdf:about="&Ontology1302861763836;Published_by">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <rdfs:range rdf:resource="&Ontology1302861763836;Publisher"/>
</owl:ObjectProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#creator_of
-->
<owl:ObjectProperty rdf:about="&Ontology1302861763836;creator_of">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Person"/>
  <rdfs:range rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
</owl:ObjectProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#embodied_
in -->
<owl:ObjectProperty rdf:about="&Ontology1302861763836;embodied_in">
  <rdfs:domain rdf:resource="&Ontology1302861763836;التعبير"/>
  <rdfs:range rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
</owl:ObjectProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#is_created_
by -->
<owl:ObjectProperty rdf:about="&Ontology1302861763836;is_created_by">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:inverseOf rdf:resource="&Ontology1302861763836;creator_of"/>
  <rdfs:range rdf:resource="&Ontology1302861763836;الشخص"/>
</owl:ObjectProperty>

```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#is_embod  
-->
```

```
<owl:ObjectProperty rdf:about="&Ontology1302861763836;is_embody">  
  <owl:inverseOf rdf:resource="&Ontology1302861763836;embodied_in"/>  
  <rdfs:range rdf:resource="&Ontology1302861763836;التعبير"/>  
  <rdfs:domain rdf:resource="&Ontology1302861763836;المظهر_المادي"/>  
</owl:ObjectProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#is_exempli  
fied_by -->
```

```
<owl:ObjectProperty rdf:about="&Ontology1302861763836;is_exemplified_by">  
  <rdfs:range rdf:resource="&Ontology1302861763836;Item"/>  
  <owl:inverseOf rdf:resource="&Ontology1302861763836;is_exemplify_by"/>  
  <rdfs:domain rdf:resource="&Ontology1302861763836;المظهر_المادي"/>  
</owl:ObjectProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#is_exempli  
fy_by -->
```

```
<owl:ObjectProperty rdf:about="&Ontology1302861763836;is_exemplify_by">  
  <rdfs:range rdf:resource="&Ontology1302861763836;المظهر_المادي"/>  
  <rdfs:domain rdf:resource="&Ontology1302861763836;المفردة"/>  
</owl:ObjectProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#is_realized  
_through -->
```

```
<owl:ObjectProperty rdf:about="&Ontology1302861763836;is_realized_through">  
  <rdfs:domain rdf:resource="&Ontology1302861763836;Work"/>
```

```

    <owl:inverseOf rdf:resource="&Ontology1302861763836;realizaton_of"/>
    <rdfs:range rdf:resource="&Ontology1302861763836;التعبير"/>
  </owl:ObjectProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#realizaton_
of -->

```

```

  <owl:ObjectProperty rdf:about="&Ontology1302861763836;realizaton_of">
    <rdfs:range rdf:resource="&Ontology1302861763836;Work"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;التعبير"/>
  </owl:ObjectProperty>
  <!--
////////////////////////////////////
//
// Data properties
//
////////////////////////////////////
-->
  <!--

```

```

http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#100$a -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;100$a">
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;700$a"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Name_of_person"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اسم_الشخص"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
    <rdfs:range rdf:resource="&xsd:string"/>
  </owl:DatatypeProperty>
  <!--

```

```

http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#100$d -->

```

```

<owl:DatatypeProperty rdf:about="&Ontology1302861763836;100$d">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;700$f"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Dates_of_person"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;التواريخ"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
  <rdfs:range rdf:resource="&xsd;date"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#106\$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;106$a">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;338$b"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Carrier_type_code"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;رمز_نوع_الناقل"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#20\$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;20$a">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;ISBN"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Manifestation_identifier"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اثبات_الإتاحة"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مصدر_التزويد"/>
  <rdfs:range rdf:resource="&xsd;long"/>

```

```

</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#200$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;200$a">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;245$a"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Title"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Title-E"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Title_of_Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;العنوان"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#200$f -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;200$f">
  <rdfs:type rdf:resource="&owl;FunctionalProperty"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;245$c"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Respon"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Statement_of_responsibility"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;بيانات_المسؤولية"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#205$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;205$a">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;250$a"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Book-No"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Edition"/>

```

```

<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty
rdf:resource="&Ontology1302861763836;issue_designation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;الإصدار"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
<rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;210$a">
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;260$a"/>
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Place_of_distribution"/>
<owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Place_of_publication"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_التوزيع"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_النشر"/>
<rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210$d -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;210$d">
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;260$c"/>
<owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Date_of_distribution"/>
<owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Date_of_publication"/>
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_التوزيع"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_النشر"/>

```

```

    <rdfs:range rdf:resource="&xsd:date"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#215$a -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;215$a">
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;300$a"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Extent"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Extent_of_the_carrier"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;امتداد_الوعاء"/>
    <rdfs:range rdf:resource="&xsd:int"/>
  </owl:DatatypeProperty>

  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#215$d -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;215$d">
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;300$c"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Dimensions_of_the_carrier"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;أبعاد_الوعاء"/>
    <rdfs:range rdf:resource="&xsd:int"/>
  </owl:DatatypeProperty>

  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#245$a -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;245$a">
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Title"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Title-E"/>

```

```

    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Title_of_Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;العنوان"/>
    <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#245$c -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;245$c">
    <rdf:type rdf:resource="&owl;FunctionalProperty"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Respon"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Statement_of_responsibility"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;بيانات_المسؤولية"/>
    <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#250$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;250$a">
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Book-No"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Edition"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;issue_designation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الإصدار"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
    <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260$a -->

```

```

<owl:DatatypeProperty rdf:about="&Ontology1302861763836;260$a">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Place_of_distribution"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Place_of_publication"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_التوزيع"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_النشر"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260$c -->

```

```

<owl:DatatypeProperty rdf:about="&Ontology1302861763836;260$c">
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Date_of_distribution"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Date_of_publication"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_التوزيع"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_النشر"/>
  <rdfs:range rdf:resource="&xsd:date"/>
</owl:DatatypeProperty>
<!--

```

```

http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#300$a -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;300$a">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Extent"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Extent_of_the_carrier"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;امتداد_الوعاء"/>

```

```

    <rdfs:range rdf:resource="&xsd:int"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#300$c -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;300$c">
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Dimensions_of_the_carrier"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;أبعاد_الوعاء"/>
    <rdfs:range rdf:resource="&xsd:int"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#338$a -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;338$a">
    <rdfs:type rdf:resource="&owl;FunctionalProperty"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Carrier_type_term"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;نوع_الحامل"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;نوع_الناقل"/>
    <rdfs:range rdf:resource="&xsd:string"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#338$b -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;338$b">
    <rdfs:type rdf:resource="&owl;FunctionalProperty"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Carrier_type_code"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;رمز_نوع_الناقل"/>
    <rdfs:range rdf:resource="&xsd:string"/>

```

```

</owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#700$a -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;700$a">
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Name_of_person"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اسم_الشخص"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
    <rdfs:range rdf:resource="&xsd:string"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#700$f -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;700$f">
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Dates_of_person"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;التواريخ"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
    <rdfs:range rdf:resource="&xsd:date"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Audio_cass
ette -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;Audio_cassette">
    <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Ss"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;شريط_كاسيت_صوتي"/>
  </owl:DatatypeProperty>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Audio_disc
-->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Audio_disc">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Sd"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اسطوانة_سمعية"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Book-No --
>
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Book-No">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Edition"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;issue_designation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الإصدار"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
  <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Carrier_type
e_code -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Carrier_type_code">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;رمز_نوع_الناقل"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Carrier_type_term -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Carrier_type_term">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;نوع_الحامل"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;نوع_الناقل"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#City -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;City">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;Country"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Publisher"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Country --
>
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Country">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Publisher"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Date_of_distribution -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Date_of_distribution">
  <rdfs:isDefinedBy xml:lang="en">&quot;Date of publication/distribution : The date
of publication/distribution of the manifestation is the date normally a year of public release

```

of the manifestation. The date may be a single date of publication or release, or a range of dates such as in the case of a serial publication.

In the absence of a date designated as the date of publication or release, a copyright date or a date of printing or manufacture may serve as a substitute

```
</rdfs:isDefinedBy>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Date_of_publication"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_التوزيع"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_النشر"/>
  <rdfs:range rdf:resource="&xsd:date"/>
</owl:DatatypeProperty>
<!--
```

```
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Date_of_publication -->
```

```
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Date_of_publication">
  <rdfs:isDefinedBy xml:lang="en">Date of publication/distribution : The date of
publication/distribution of the manifestation is the date normally a year of public release of
the manifestation. The date may be a single date of publication or release, or a range of
dates such as in the case of a serial publication.
In the absence of a date designated as the date of publication or release, a copyright date or
a date of printing or manufacture may serve as a substitute.
```

```
</rdfs:isDefinedBy>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_التوزيع"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_النشر"/>
  <rdfs:range rdf:resource="&xsd:date"/>
</owl:DatatypeProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Dates_of_p  
erson -->
```

```
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Dates_of_person">  
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;التواريخ"/>  
  <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>  
  <rdfs:range rdf:resource="&xsd:date"/>  
</owl:DatatypeProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Dimension  
s_of_the_carrier -->
```

```
<owl:DatatypeProperty  
rdf:about="&Ontology1302861763836;Dimensions_of_the_carrier">  
  <rdfs:isDefinedBy xml:lang="en">&quot;The dimensions of the carrier are the  
measurements of the physical components and/or the container of the manifestation. The  
dimensions may comprise measurements of height such as 18 cm bound volume, and like  
width 8mm film, or height x width 5 x 5 cm slide, or diameter like 30 cm  
disc&quot;.</rdfs:isDefinedBy>
```

```
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>  
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;أبعاد_الوعاء"/>  
<rdfs:range rdf:resource="&xsd:int"/>  
</owl:DatatypeProperty>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Edition -->
```

```
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Edition">  
  <rdfs:isDefinedBy xml:lang="en">&quot;Edition/issue designation : The edition or  
issue designation of the manifestation is a word or phrase appearing in the manifestation  
that normally indicates a difference in either content or form between the manifestation  
and a related manifestation previously issued by the same publisher/distributor such as  
second edition, version 2.0... etc, or simultaneously issued by either the same
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publisher/distributor or another publisher/distributor such as large print edition, British edition... etc. The edition/issue designation pertains to all copies of a manifestation produced from substantially the same master and issued by the same publisher/distributor or group of publishers/distributors

```

</rdfs:isDefinedBy>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;issue_designation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الإصدار"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
  <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Extent -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;Extent">
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Extent_of_the_carrier"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الامتداد_الوعاء"/>
  <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Extent_of_
the_carrier -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;Extent_of_the_carrier">
  <rdfs:isDefinedBy xml:lang="en">&quot;The extent of the carrier is a quantification
of the number of physical units making up the carrier such as number of sheets, discs,
reels, etc&quot;.
</rdfs:isDefinedBy>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الامتداد_الوعاء"/>

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```

    <rdfs:range rdf:resource="&xsd:int"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#ISBN -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;ISBN">
    <rdf:type rdf:resource="&owl;FunctionalProperty"/>
    <rdfs:isDefinedBy xml:lang="en">The manifestation identifier or the ISBN is a
number or code uniquely associated with the manifestation that serves to differentiate that
manifestation from any other manifestation. A manifestation may have one or more
identifiers associated with it. The identifier may be assigned as part of an international
numbering or coding system like ISBN, as part of a national system legal deposit number,
or it may be assigned independently by the publisher or distributor of the manifestation
like government publication number, music publisher's number, clearinghouse inventory
number... etc. A manifestation identifier may also be assigned by a bibliographer,
musicologist, etc. The manifestation identifier may comprise both a numeric component
and a textual or coded component identifying the system under which it was assigned
and/or the agency or individual that assigned the number, so as to render the identifier
unique to the manifestation.</rdfs:isDefinedBy>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Manifestation_identifier"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;إثبات_الإتاحة"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مصدر_التزويد"/>
    <rdfs:range rdf:resource="&xsd;long"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestati
on_identifier -->
  <owl:DatatypeProperty
rdf:about="&Ontology1302861763836;Manifestation_identifier">
    <rdf:type rdf:resource="&owl;FunctionalProperty"/>

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<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;اثبات_الإتاحة"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;مصدر_التزويد"/>
<rdfs:range rdf:resource="&xsd;long"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Name_of_
person -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Name_of_person">
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اسم_الشخص"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Place_of_d
istribution -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;Place_of_distribution">
    <rdfs:isDefinedBy xml:lang="en">The place of publication/distribution of the
manifestation is the city, town, or other locality associated in the manifestation with the
name of the publisher/distributor. The place of publication may comprise the name of the
state, province, territory, and/or country as well as the local place name. A manifestation
may be associated with one or more places of publication/distribution.
</rdfs:isDefinedBy>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Place_of_publication"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_التوزيع"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_النشر"/>
    <rdfs:range rdf:resource="&xsd;string"/>
  </owl:DatatypeProperty>

```

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<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Place_of_p
ublication -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Place_of_publication">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_التوزيع"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_النشر"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Respon -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Respon">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Statement_of_responsibility"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;بيانات_المسؤولية"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Sd -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Sd">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;اسطوانة_سمعية"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Ss -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Ss">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;شريط_كاسيت_صوتي"/>

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</owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Statement_
of_responsibility -->
  <owl:DatatypeProperty
rdf:about="&Ontology1302861763836;Statement_of_responsibility">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:isDefinedBy xml:lang="en">: A statement of responsibility is a statement
appearing in the manifestation that names one or more individuals or groups responsible
for the creation or realization of the intellectual or artistic content embodied in the
manifestation. An individual or group named may be directly responsible for the work
embodied in the manifestation like the author, composer... etc, or indirectly responsible
like the author of a novel on which a film script is based. Other individuals or groups
named in the statement may include those responsible for the expression of the work
contained in the manifestation such as translators, performers...etc, or those responsible
for the compilation of works contained in the manifestation such as the editor, compiler...
etc. A statement of responsibility may name an organization responsible for sponsoring or
issuing the work contained in the manifestation. The statement may also indicate the role
or function performed by each of the individuals, groups, or organizations responsible. The
names appearing in the statement of responsibility in the manifestation may or may not be
those of the persons and corporate bodies actually responsible for the creation or
realization of the intellectual or artistic content embodied in the manifestation. Similarly,
the stated functions may or may not reflect the actual relationship that exists between the
individuals and groups named and the intellectual or artistic content.</rdfs:isDefinedBy>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;بيانات_المسؤولية"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>

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<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Title -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Title">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;Title-E"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Title_of_Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;العنوان"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Title-E -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;Title-E">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty
rdf:resource="&Ontology1302861763836;Title_of_Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;العنوان"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Title_of_Manifestation -->

  <owl:DatatypeProperty
rdf:about="&Ontology1302861763836;Title_of_Manifestation">
  <rdfs:isDefinedBy xml:lang="en">The title of the manifestation is a group of
characters naming the manifestation, where there may be one or more titles associated
with a manifestation. Titles associated with a manifestation include all those that appear in
the manifestation itself, as well as those that have been assigned to the manifestation for
purposes of bibliographic control such as , key title, expanded title, translated title,
supplied title...etc.</rdfs:isDefinedBy>

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<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;العنوان"/>
<rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#issue_designation -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;issue_designation">
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;الإصدار"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
<rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#أبعاد_الوعاء -
->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;أبعاد_الوعاء">
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<rdfs:range rdf:resource="&xsd;int"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#اثبات_الإتاحة
-->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;اثبات_الإتاحة">
<rdf:type rdf:resource="&owl;FunctionalProperty"/>
<rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
<owl:equivalentProperty rdf:resource="&Ontology1302861763836;مصدر_التزويد"/>
<rdfs:range rdf:resource="&xsd;long"/>
</owl:DatatypeProperty>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#
اسطوانة_سمعية -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;اسطوانة_سمعية">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#اسم_الشخص
-->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;اسم_الشخص">
  <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الإصدار -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;الإصدار">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;الطبعة"/>
  <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#التواريخ -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;التواريخ">
  <rdfs:domain rdf:resource="&Ontology1302861763836;الشخص"/>
  <rdfs:range rdf:resource="&xsd;date"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الطبعة -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;الطبعة">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>

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    <rdfs:range rdf:resource="&xsd;integer"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#العنوان -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;العنوان"/>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#امتداد_الوعاء -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;امتداد_الوعاء">
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <rdfs:range rdf:resource="&xsd;int"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#
بيانات_المسؤولية -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;بيانات_المسؤولية">
    <rdfs:type rdf:resource="&owl;FunctionalProperty"/>
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <rdfs:range rdf:resource="&xsd;string"/>
  </owl:DatatypeProperty>
  <!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#تاريخ_التوزيع -->
  <owl:DatatypeProperty rdf:about="&Ontology1302861763836;تاريخ_التوزيع">
    <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
    <owl:equivalentProperty rdf:resource="&Ontology1302861763836;تاريخ_النشر"/>
    <rdfs:range rdf:resource="&xsd;date"/>
  </owl:DatatypeProperty>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#تاريخ_النشر -
->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;تاريخ_النشر">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <rdfs:range rdf:resource="&xsd;date"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#
رمز_نوع_الناقل -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;رمز_نوع_الناقل">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <rdfs:range rdf:resource="&xsd;string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#
شريط_كاسيت_صوتي -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;شريط_كاسيت_صوتي">
  <rdfs:subPropertyOf rdf:resource="&Ontology1302861763836;338$b"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#
مصدر_التزويد -->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;مصدر_التزويد">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <rdfs:range rdf:resource="&xsd;long"/>
</owl:DatatypeProperty>

```

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<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#مكان_التوزيع
-->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;مكان_التوزيع">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;مكان_النشر"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#مكان_النشر --
>
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;مكان_النشر">
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#نوع_الحامل -
->
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;نوع_الحامل">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
  <owl:equivalentProperty rdf:resource="&Ontology1302861763836;نوع_الناقل"/>
  <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#نوع_الناقل --
>
<owl:DatatypeProperty rdf:about="&Ontology1302861763836;نوع_الناقل">
  <rdf:type rdf:resource="&owl;FunctionalProperty"/>
  <rdfs:domain rdf:resource="&Ontology1302861763836;Manifestation"/>

```

```

    <rdfs:range rdf:resource="&xsd:string"/>
</owl:DatatypeProperty>
<!--
////////////////////////////////////
//
// Classes
//
////////////////////////////////////
-->
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#210$c -->
<owl:Class rdf:about="&Ontology1302861763836;210$c">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;Publisher"/>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#260$b -->

<owl:Class rdf:about="&Ontology1302861763836;260$b">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;Publisher"/>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Chip_cartridge -->

<owl:Class rdf:about="&Ontology1302861763836;Chip_cartridge">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;Electronic_resource"/>
  <rdfs:comment xml:lang="en"> a removable module containing a miniaturized
electronic circuit, mass-produced on a tiny chip or wafer of silicon, designed to provide
additional processing or memory capacity to a computer.</rdfs:comment>
</owl:Class>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Electronic_
resource -->
<owl:Class rdf:about="&Ontology1302861763836;Electronic_resource">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Expression
-->
<owl:Class rdf:about="&Ontology1302861763836;Expression">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;التعبير"/>
  <rdfs:isDefinedBy xml:lang="en">the intellectual or artistic realization of a
work</rdfs:isDefinedBy>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Item -->
<owl:Class rdf:about="&Ontology1302861763836;Item">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;المفردة"/>
  <rdfs:isDefinedBy xml:lang="en">a single exemplar of a
manifestation</rdfs:isDefinedBy>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Magnetic_
desk -->
<owl:Class rdf:about="&Ontology1302861763836;Magnetic_desk">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;floppy_disks"/>
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;Electronic_resource"/>
  <rdfs:comment xml:lang="en">a digital information storage medium usually
consisting of a thin Mylar disk coated with a magnetic material that permits the recording

```

of data. Magnetic disks come in various sizes. They are also known as floppy disks, stiffy disks, computer diskettes, or floppy diskettes.</rdfs:comment>

```
</owl:Class>
```

```
<!--
```

```
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Manifestation -->
```

```
<owl:Class rdf:about="&Ontology1302861763836;Manifestation">
```

```
<owl:equivalentClass rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
```

```
<rdfs:isDefinedBy xml:lang="en">the physical embodiment of an expression of a work</rdfs:isDefinedBy>
```

```
</owl:Class>
```

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<!--
```

```
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Map -->
```

```
<owl:Class rdf:about="&Ontology1302861763836;Map">
```

```
<rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
```

```
</owl:Class>
```

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<!--
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```
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Microform -->
```

```
<owl:Class rdf:about="&Ontology1302861763836;Microform">
```

```
<rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
```

```
<rdfs:comment xml:lang="en">Microform is a generic term for any medium, transparent or opaque, bearing microimages. A microimage is a unit (e.g., a page) of textual, graphic, or computer-generated material that is contained on aperture cards, microfiche, microfilm, micro-opaques, or other microformats and that is too small to be read without magnification.</rdfs:comment>
```

```
</owl:Class>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Person -->  
  
<owl:Class rdf:about="&Ontology1302861763836;Person">  
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;الشخص"/>  
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;creator"/>  
  <rdfs:isDefinedBy xml:lang="en">an individual</rdfs:isDefinedBy>  
</owl:Class>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Publisher -  
->  
  
<owl:Class rdf:about="&Ontology1302861763836;Publisher">  
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;الناشر"/>  
</owl:Class>
```

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<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Sound_rec  
ording -->  
  
<owl:Class rdf:about="&Ontology1302861763836;Sound_recording">  
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>  
</owl:Class>
```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Tactile_ma  
terial -->  
  
<owl:Class rdf:about="&Ontology1302861763836;Tactile_material">  
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>  
  <rdfs:comment xml:lang="en"> Material that is intended to be read by  
touch.</rdfs:comment>  
</owl:Class>
```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Tape_cas
tte -->
<owl:Class rdf:about="&Ontology1302861763836;Tape_cassette">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;Electronic_resource"/>
  <rdfs:comment xml:lang="en">a removable module, somewhat like an audio cassette,
that contains magnetic tape that can be written on and read from a tape
drive.</rdfs:comment>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Video_reco
rding -->
<owl:Class rdf:about="&Ontology1302861763836;Video_recording">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;المظهر_المادي"/>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#Work -->
<owl:Class rdf:about="&Ontology1302861763836;Work">
  <owl:equivalentClass rdf:resource="&Ontology1302861763836;العمل"/>
  <rdfs:isDefinedBy xml:lang="en">a distinct intellectual or artistic
creation</rdfs:isDefinedBy>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#corporate_
body -->
<owl:Class rdf:about="&Ontology1302861763836;corporate_body">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;creator"/>
</owl:Class>

```

```

<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#creator -->
<owl:Class rdf:about="&Ontology1302861763836;creator"/>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#floppy_disks -->
<owl:Class rdf:about="&Ontology1302861763836;floppy_disks">
  <rdfs:subClassOf rdf:resource="&Ontology1302861763836;Electronic_resource"/>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#التعبير -->
<owl:Class rdf:about="&Ontology1302861763836;التعبير">
  <rdfs:isDefinedBy xml:lang="ar">الوسيلة التعبيرية التي يصل العمل بها</rdfs:isDefinedBy>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الشخص -->
<owl:Class rdf:about="&Ontology1302861763836;الشخص">
  <rdfs:isDefinedBy xml:lang="ar">هو المسؤول عن عمل أو تعبير أو مفردة أو أكثر</rdfs:isDefinedBy>
</owl:Class>
<!--
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#العمل -->
<owl:Class rdf:about="&Ontology1302861763836;العمل">
  <rdfs:isDefinedBy xml:lang="ar">هو الإنتاج الفكري المجرد من جميع صورته المادية</rdfs:isDefinedBy>
</owl:Class>

```

```
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#  
المظهر_المادي -->  
  
<owl:Class rdf:about="&Ontology1302861763836;المظهر_المادي">  
  <rdfs:isDefinedBy xml:lang="ar">هو التجسيد المادي للتعبير</rdfs:isDefinedBy>  
</owl:Class>  
  
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#المفردة -->  
  
<owl:Class rdf:about="&Ontology1302861763836;المفردة">  
  <rdfs:isDefinedBy xml:lang="ar">هي الكينونة الوحيدة المادية</rdfs:isDefinedBy>  
</owl:Class>  
  
<!--  
http://www.semanticweb.org/ontologies/2011/3/Ontology1302861763836.owl#الناشر -->  
  
<owl:Class rdf:about="&Ontology1302861763836;الناشر"/>  
</rdf:RDF>
```