

B.Sc. in Computer Science and Engineering Thesis

## **Linking Through the Semantic Web**

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# **CERTIFICATION**

This thesis paper titled “**Linking through the Semantic Web**” is submitted by the group mentioned below has been accepted as satisfactory in partial fulfillment of the requirements for the degree B.Sc. in Computer Science and Engineering on December 2013.

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## **CANDIDATES' DECLARATION**

This is to certify that the work presented in this thesis paper is the outcome of the investigation and innovation carried out by the following students under the supervision of Dr. Muhammad Masroor Ali, Professor, Dept of CSE, BUET.

It is also declared that neither a part of this thesis paper nor any part thereof has been submitted in verbatim anywhere else for the award of any degree, diploma or other qualifications.

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## ABSTRACT

The main objective of this thesis is to provide a solution for linking people around a community with the help of Semantic Web and FOAF. The Friend of a Friend (FOAF) project is creating a Web of machine-readable pages describing people, the links between them and the things they create and do; it is a contribution to the linked information system known as the Web. The problem with the majority of data on the Web that is in this form at the moment is that it is difficult to use on a large scale, because there is no global system for publishing data in such a way as it can be easily processed by anyone. The Semantic Web can be seen as a huge engineering solution. But it is more than that. We will find that as it becomes easier to publish data in a repurposable form, so more people will want to publish data, and there will be a knock-on or domino effect. We may find that a large number of Semantic Web applications can be used for a variety of different tasks, increasing the modularity of applications on the Web. But enough subjective reasoning onto how this will be accomplished. In this thesis we described the Semantic Web as a medium of making resources more meaningful to the machine and thus how people can connect with each other more easily.

**Keywords:** Semantic Web, FOAF, linking, publishing information

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# List of Abbreviation

**XML** : Extensible Markup Language

**RDF** : Resource Description Framework

**OWL** : Web Ontology Language

**SWD** : Semantic Web Document

**FOAF** : Friend Of A Friend

**SHA** : Secure Hash Algorithm

**FTP** : File Transfer Protocol

**MOAT** : Meaning Of A Tag Ontology

**WBSN** : Web Based Social Networks

# INTRODUCTION

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Nowadays the world is becoming more and more dependent on the Web. We spend enormous amounts of time hunting for better information so we can make better decisions. That time could be better spent making more decisions and then acting on them. The concept of Semantic Web helps us in this purpose and also serves the purpose of linking people throughout the world.

## 1.1 Main Ideas

Web is a semi structured database that provides with vast amount of information. It is getting larger everyday. The tremendous growth in the volume of data and with the terrific growth of number of web pages, traditional search engines now a days are not appropriate and not suitable anymore. With ever-increasing information overload, we are facing new challenges for not only locating relevant information precisely but also accessing variety of information from different resources automatically. Efficient searching is required to get high quality results which are based on pertinent matching between well-defined resources and user queries. So here the concept of Semantic Web is introduced. Semantic Web is an extension of the traditional web in which information is given well-defined meaning. Semantic web technologies are playing a crucial role in enhancing traditional web search, as it is working to create machine readable data. But it will not replace traditional search engine. So Semantic Web can be considered as a mesh of information linked up in such a way as to be easily processable by machines, on a global scale [1].

While its critics have questioned its feasibility, proponents argue that applications in industry, biology and human sciences research have already proven the validity of the original

## 1.1. Main Ideas

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concept. Scholars have explored the social potential of the semantic web in the business and health sectors, and, of course, for social networking, which is the base of our thesis work. Yes, social networking plays a vital role in today's world. Let us first focus on what actually social networking is. It is the grouping of individuals into specific groups, like small rural communities or a neighborhood subdivision. Although social networking is possible in person, especially in the workplace, universities, and high schools, it is most popular online.

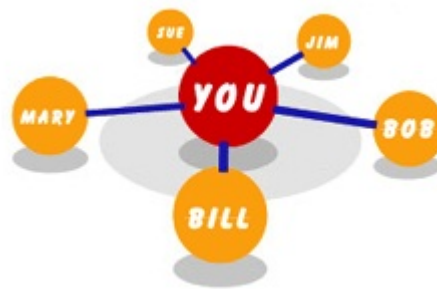


Figure 1.1: An Overview of Social Networking

Many people maintain accounts at multiple social networking websites. It is desirable, for example, to keep information intended for business networking separate from personal information. At the same time, users put significant effort into maintaining information on social networks. Multiple accounts are not just for compartmentalizing parts of their lives. A person may have one group of friends who prefer MySpace, another group on Facebook, and have an account on a religious website to stay connected to that community.

From the perspective of managing an entire set of social connections that are spread across sites, it is advantageous to merge all of those connections together into one set of data. In a merged social network, friends who have multiple accounts would be represented as a single person. Information about the user that is distributed across several sites also would be merged. The Friend-of-a-Friend (FOAF) Project is a potential solution to sharing social networking data among sites, and this section introduces how that is being done.

## **1.2. Brief Description of Work**

---

## **1.2 Brief Description of Work**

We used the basic concepts of Semantic Web and its linking power. The basics of Semantic Web are RDF, XML and Ontology which are used for storing data in the Web. We stored some data using the FOAF ontology. To be specific, we stored some personal information using the knowledge of FOAF ontology and then published it on the Web. For this we made our own example sites and linked them using the FOAF ontology which is shown in the later chapters.

## **1.3 Organization**

In this paper we have worked with Semantic Web and FOAF. In chapters 2 and 3, the ideas of Semantic Web and FOAF are described respectively. Chapter 4 and 5 describe our task while chapters 6 analyzes the result of the task. Finally Chapter 7 encapsulates the whole thesis work and also tells about the future enhancement of it.

# SEMANTIC WEB

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We use Internet for searching, integrating and Web mining. The first main activity, search, of the three major activities, is conducted by literally every user, irrespective of his or her level in computer science training. It is interesting that this activity in fact shows the difficulty of the current Internet in a most obvious way: whenever we do a search, we want to get only relevant results; we want to minimize human intervention in finding the appropriate documents. However, the conflict also starts here: The Internet is entirely aimed for reading and is purely display oriented. In other words, it has been constructed in such a way that it is oblivious to the actual information content; Web browsers, Web servers, and even search engines do not actually distinguish weather forecasts from scientific papers, and cannot even tell a personal homepage from a major corporate Web site. The real reason for our difficulty, therefore, is that the current Internet is not constructed well; computers can only present users with information, but they cannot “understand” the information well enough to display the data that is most relevant in a given circumstance.

As for the second activity, integration, we experience another difficulty: there is too much manual work involved and we need more automation. At first glance, this difficulty seems to be quite different from searching. Currently, this integration is hard to implement mainly because the discovery process of its components is far from efficient. The reason, again, is that although all the components needed to be integrated do exist on the Internet, the Internet is not programmed to remember the meaning of any of these components.

Now, about the last activity, namely, Web data mining. The difficulty here is that it could be very expensive. Again, this difficulty seems to be quite different from the previous two, but the underlying reason for this difficulty is precisely the same.

We have studied the three main uses of the Internet. For each one of these activities, there is

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something that needs to be improved: for searching activity, we want the results to be more relevant; for integration, we want it to be more automated; and for Web mining, we want it to be less expensive.

If the documents on the Web also contained information that could be used to guide the computers to understand them, all three main activities could be conducted in a much more elegant and efficient way. Today it is possible to reconstruct the Web by adding some information into the documents stored on the Internet so that the computers can use this extra information to understand what a given document is really about. By doing so, the traditional web can be changed into ‘Semantic Web’.

The Semantic Web is quite different in many ways from the World Wide Web that we are familiar with. The term was coined by Tim Berners-Lee for a web of data that can be processed by machines. According to the W3C, “The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.” By encouraging the inclusion of semantic content in web pages, the Semantic Web aims at converting the current web, dominated by unstructured and semi-structured documents into a ‘web of data’. The Semantic Web stack builds on the W3C’s Resource Description Framework (RDF).

Let us take a glance how the inventor of Semantic Web, Tim Berners-Lee describes it:

**“The Semantic Web is an extension of the current Web in which information is given well defined meaning, better enabling computers and people to work in cooperation. . . . a web of data that can be processed directly and indirectly by machines. [2]”**

At this point, the Semantic Web can be considered as a brand new layer built on the top of the traditional Web. The word ‘Semantic’ means ‘meaning’. It is related to the word syntax. Syntax is- how one says something where semantics is the meaning behind the words said. That is, we can say that a Semantic Web is a Web that makes machine understandable meanings to the current traditional Web. Thus the Semantic Web can be expressed very shortly as- ‘the Web of meanings’. But the Semantic Web is certainly much more than automatic data integration on a large scale.

---

Let us now proceed to the key concept of Semantic Web- 'Metadata'. A question arises here automatically that what metadata actually is. In general, metadata is defined as 'data about data'. metadata is a systematic method for describing resources. Thus they improve their access. In the Web world, *systematic* means *structured*. Structured data implies machine readability and understandability which is a key idea in the vision of the Semantic Web.

So metadata can be considered as the fundamental block of building the Semantic Web. It should have some standards to make it processed automatically by the machine. Dublin Core (DC) is such a standard. It has 13 elements (subsequently increased to 15), which are called Dublin Core Metadata Element Set (DCMES). It was developed in the March 1995 Metadata Workshop sponsored by the Online Computer Library Center (OCLC) and the National Center for Supercomputing Applications (NCSA). Some of these 13 elements are:

- Creator
- Publisher
- Contributor
- Title
- Date
- Identifier
- Description
- Language
- Format

The DC elements are described in the later sections of this paper. These metadata are not shown in the browser. Rather they are intended mainly to be read automatically by the tools or agents. Metadata helps in publishing the web documents and thus fulfill the concept of Semantic Web. The easiest way is to directly embed the metadata in the page when one creates it.



## 2.1. Preliminaries of Semantic Web

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So we can summarize our knowledge about the Semantic Web till now like this-

“The Semantic Web which can be considered as the Web with meanings is an extension of the current traditional Web. As its goal is to allow machine processing in a global scale, we can use metadata as its key concept by adding metadata to the Web page as metadata is structured, i.e. machine readable. One structure of this metadata is the DC Schema which is easy to use and can be embedded in the Web page for publishing it on the Web.”

## 2.1 Preliminaries of Semantic Web

Before we proceed with the linking using the Semantic Web, let us know about the basic elements of it which are: XML, RDF, OWL and SWD.

### 2.1.1 XML

Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. XML is designed to transport and store data [3]. It is defined in the XML 1.0 Specification produced by the W3C, and several other related specifications, all free open standards. XML is a markup language much like HTML. It was designed to carry data, not to display data. XML tags are not predefined. Tags can be defined on our own. XML is designed to be self-descriptive. XML is used in many aspects of web development, often to simplify data storage and sharing. XML format is required to write RDF.

XML documents form a Tree Structure. XML documents must contain a root element. This element is ‘the parent’ of all other elements. The elements in an XML document form a document tree. The tree starts at the root and branches to the lowest level of the tree. All elements can have sub elements (child elements):

**XML Syntax** The syntax rules of XML are very simple and logical. Below are some of the basic syntax rules:

- All XML Elements Must Have a Closing Tag

## 2.1. Preliminaries of Semantic Web

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```
<root>
  <child>
    <subchild>.....</subchild>
  </child>
</root>
```

Figure 2.1: XML Tree Structure

- XML Tags are Case Sensitive
- XML Elements Must be Properly Nested
- XML Documents Must Have a Root Element
- XML Attribute Values Must be Quoted
- White-space is Preserved in XML
- XML Stores New Line as LF

## 2.1. Preliminaries of Semantic Web

---

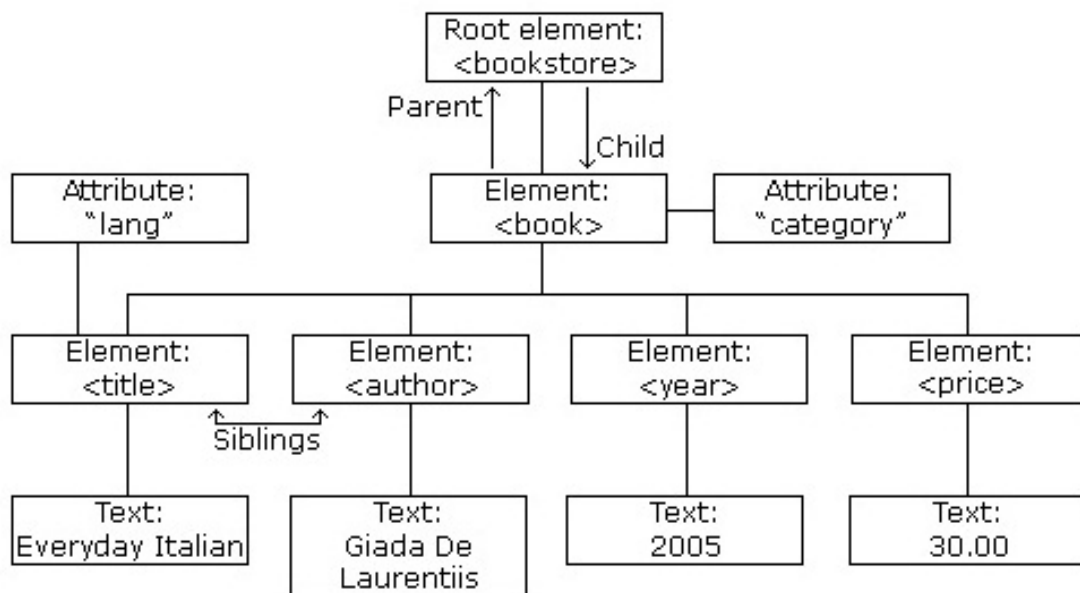


Figure 2.2: Example using the tree structure

## 2.1. Preliminaries of Semantic Web

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**XML Validator** XML validator checks if there is any error in an XML document.



Figure 2.3: XML Validator

The XML is pasted into the text area and syntax-checked by clicking the 'Validate' button. If there is any error, then a message box appears as Figure 2.4.

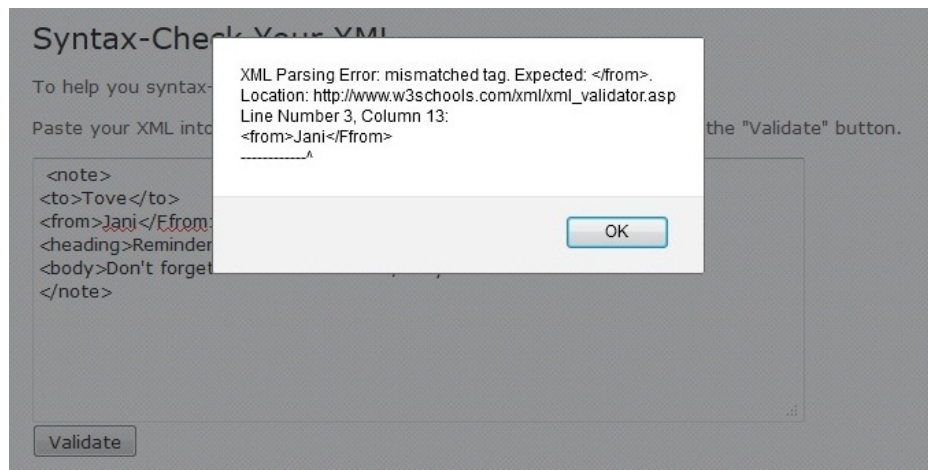


Figure 2.4: XML Parse Result with error

## 2.1. Preliminaries of Semantic Web

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If no error is found, we are notified with a 'No error' message as shown in Figure 2.5.

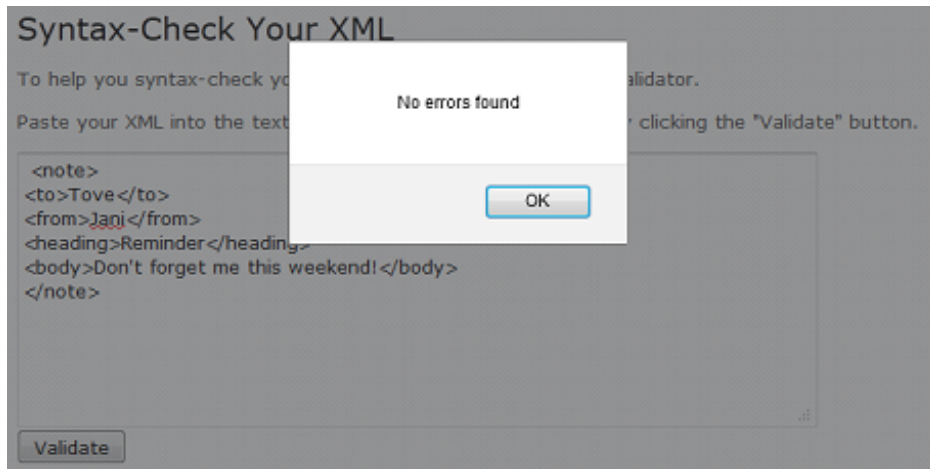


Figure 2.5: XML Parse Result without error

**XML Namespace** XML namespaces are used for providing uniquely named elements and attributes in an XML document. They are defined in a W3C recommendation. An XML instance may contain element or attribute names from more than one XML vocabulary. If each vocabulary is given a namespace, the ambiguity between identically named elements or attributes can be resolved. An XML namespace is declared using the reserved XML attribute `xmlns` or `xmlns:prefix`, the value of which must be a valid namespace name.

```
<root>
<h:table xmlns:h="http://www.w3.org/TR/html4/">
  <h:tr>
    <h:td>Apples</h:td>
    <h:td>Bananas</h:td>
  </h:tr>
</h:table>
<f:table xmlns:f="http://www.w3schools.com/furniture">
  <f:name>African Coffee Table</f:name>
  <f:width>80</f:width>
  <f:length>120</f:length>
</f:table>
</root>
```

Figure 2.6: Example representing `xmlns:prefix`

## 2.1. Preliminaries of Semantic Web

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Namespaces can be declared in the elements where they are used or in the XML root element:

```
<root xmlns:h="http://www.w3.org/TR/html4/"
xmlns:f="http://www.w3schools.com/furniture">

<h:table>
  <h:tr>
    <h:td>Apples</h:td>
    <h:td>Bananas</h:td>
  </h:tr>
</h:table>

<f:table>
  <f:name>African Coffee Table</f:name>
  <f:width>80</f:width>
  <f:length>120</f:length>
</f:table>

</root>
```

Figure 2.7: Example representing xmlns in root

### 2.1.2 RDF (Resource Description Framework)

RDF (Resource Description Framework) is the basic building block for supporting the Semantic Web. RDF is to the Semantic Web what HTML is to the Web. RDF language is needed to create a markup file. It is the language we use to construct the metadata files.

RDF is an XML-based language for describing information contained in a Web resource. A Web resource can be a Web page, an entire Web site, or any item on the Web that contains information in some form.

The RDF data model is similar to classic conceptual modeling approaches such as entity relationship or class diagrams, as it is based upon the idea of making statements about resources (in particular web resources) in the form of subject-predicate-object expressions. These expressions are known as triples in RDF terminology.

RDF uses Web identifiers (URIs) to identify resources. It describes resources with properties and property values. Below are the explanations of Resource, Property, and Property value:

1. A Resource is anything that can have a URI, such as “<http://www.w3schools.com/rdf>”
2. A Property is a Resource that has a name, such as “author” or “homepage”

## 2.1. Preliminaries of Semantic Web

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3. A Property value is the value of a Property, such as “Jan Egil Refsnes” or “http://www.w3schools.com” (note that a property value can be another resource)

```
<?xml version="1.0"?>
<RDF>
  <Description about="http://www.w3schools.com/rdf">
    <author>Jan Egil Refsnes</author>
    <homepage>http://www.w3schools.com</homepage>
  </Description>
</RDF>
```

Figure 2.8: Example showing of Resource, Property, and Property value

[4]

The combination of a Resource, a Property, and a Property value forms a Statement (known as the subject, predicate and object of a Statement).

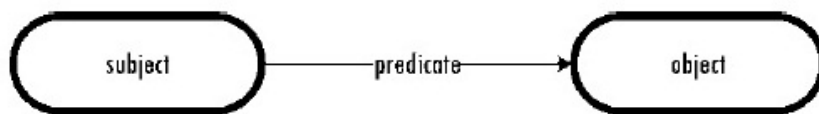


Figure 2.9: Graph structure of RDF statement

The main elements of RDF are the root element, <RDF>, and the <Description> element, which identifies a resource.

**The <rdf:RDF> Element** <rdf:RDF> is the root element of an RDF document. It defines the XML document to be an RDF document. It also contains a reference to the RDF namespace.

## 2.1. Preliminaries of Semantic Web

---

```
<?xml version="1.0"?>

<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
...Description goes here...
</rdf:RDF>
```

Figure 2.10: The <rdf:RDF> Element

**The <rdf:Description> Element** The <rdf:Description> element identifies a resource with the about attribute. It contains elements that describe the resource:

```
<?xml version="1.0"?>

<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:cd="http://www.recshop.fake/cd#"

<rdf:Description
rdf:about="http://www.recshop.fake/cd/Empire_Burlesque">
  <cd:artist>Bob Dylan</cd:artist>
  <cd:country>USA</cd:country>
  <cd:company>Columbia</cd:company>
  <cd:price>10.90</cd:price>
  <cd:year>1985</cd:year>
</rdf:Description>

</rdf:RDF>
```

Figure 2.11: The <rdf:Description> Element

**RDF Schema** RDF Schema (Resource Description Framework Schema, variously abbreviated as RDFS, RDF(S), RDF-S, or RDF/S) is a set of classes with certain properties using the RDF extensible knowledge representation language, providing basic elements for the description of ontologies, intended to structure RDF resources. It is an extension to RDF. RDF Schema provides the framework to describe application-specific classes and properties. Classes in RDF Schema are much like classes in object oriented programming languages. This allows resources to be defined as instances of classes, and subclasses of classes.



## 2.1. Preliminaries of Semantic Web

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**The RDF Validator** The RDF validator is an RDF tool provided by [www.w3.org](http://www.w3.org) at [www.w3.org/RDF/validator/](http://www.w3.org/RDF/validator/). It indicates whether the submitted RDF document is in proper RDF format or not. Any RDF document can be pasted into the document window and asked for the triples only (Figure 2.12).

After clicking the “parse RDF” key, we will get the result shown in Figure 2.13. So we know that this RDF document is in proper format. As we can see, the RDF statements are shown in the form of triples.



Figure 2.12: RDF document validator provided by [www.w3.org](http://www.w3.org)

## 2.1. Preliminaries of Semantic Web

W3C RDF Validation Results - Mozilla Firefox

http://www.w3.org/RDF/Validator/ARPServlet

Validation Results

Your RDF document validated successfully.

Triples of the Data Model

Number	Subject	Predicate
1	<a href="http://www.yuchen.net/rdf/NikonD70.rdf#Nikon-D70">http://www.yuchen.net/rdf/NikonD70.rdf#Nikon-D70</a>	<a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#type">http://www.w3.org/1999/02/22-rdf-syntax-ns#type</a>
2	<a href="http://www.yuchen.net/rdf/NikonD70.rdf#Nikon-D70">http://www.yuchen.net/rdf/NikonD70.rdf#Nikon-D70</a>	<a href="http://www.yuchen.net/photography/Camera#weight">http://www.yuchen.net/photography/Camera#weight</a>
3	genid:A50453	<a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#value">http://www.w3.org/1999/02/22-rdf-syntax-ns#value</a>
4	genid:A50453	<a href="http://www.iana.org/namespaces/units">http://www.iana.org/namespaces/units</a>

The original RDF/XML document

```
1: <?xml version="1.0"?>
2: <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
3:   xmlns:xon="http://www.iana.org/namespaces/"
4:   xmlns="http://www.yuchen.net/photography/Camera#">
5:
6: <rdf:Description rdf:about="http://www.yuchen.net/rdf/NikonD70.rdf#Nikon-D70">
7:   <rdf:type rdf:resource="http://www.yuchen.net/photography/Camera#SLR"/>
8:   <weight>
9:     <rdf:Description>
10:      <rdf:value rdf:datatype="http://www.w3.org/2001/XMLSchema#decimal">1.4</rdf:value>
```

Figure 2.13: Validation Result

## **2.1. Preliminaries of Semantic Web**

---

### **2.1.3 The Dublin Core**

To ensure metadata can be automatically processed by machines, some metadata standard is needed. Dublin Core (DC) is one such standard. It was developed in the March 1995 Metadata Workshop sponsored by the Online Computer Library Center (OCLC) and the National Center for Supercomputing Applications (NCSA). It has 13 elements (subsequently increased to 15), which are called Dublin Core Metadata Element Set (DCMES); it is proposed as the minimum number of metadata elements required to facilitate the discovery of document-like objects in a networked environment such as the Internet. Dublin Core Metadata can be used for multiple purposes, from simple resource description, to combining metadata vocabularies of different metadata standards, to providing interoperability for metadata vocabularies in the Linked data cloud and Semantic web implementations [5]. The Dublin Core elements are listed in Figure 2.14 each with description.

### **2.1.4 Ontology and OWL**

The Semantic Web aims to achieve better data automation, reuse and interoperability. The main advantage of Semantic Web is to enhance search mechanisms with the use of Ontology. Ontology is a general description of all concepts as well as their relationship. The Resource Description Framework /Schema (RDF(S)) and Web Ontology Language (OWL) are W3C recommended data representation models which are used to represent the ontology. For the web, ontology is about the exact description of web information and relationships between web information. The basic method for constructing the Semantic Web is to use the terms defined in ontology as metadata to markup the Web's content. It is generally accepted that ontology refers to a formal specification of conceptualization [7].

The Web Ontology Language (OWL) is a family of knowledge representation languages or ontology languages for authoring ontologies or knowledge bases. The languages are characterised by formal semantics and RDF/XML-based serializations for the Semantic Web. OWL is endorsed by the World Wide Web Consortium (W3C) and has attracted academic, medical and commercial interest. OWL is built on top of RDF. OWL and

## 2.1. Preliminaries of Semantic Web

---

Property	Definition
Contributor	An entity responsible for making contributions to the content of the resource
Coverage	The extent or scope of the content of the resource
Creator	An entity primarily responsible for making the content of the resource
Format	The physical or digital manifestation of the resource
Date	A date of an event in the lifecycle of the resource
Description	An account of the content of the resource
Identifier	An unambiguous reference to the resource within a given context
Language	A language of the intellectual content of the resource
Publisher	An entity responsible for making the resource available
Relation	A reference to a related resource
Rights	Information about rights held in and over the resource
Source	A Reference to a resource from which the present resource is derived
Subject	A topic of the content of the resource
Title	A name given to the resource
Type	The nature or genre of the content of the resource

A quick look at the table above indicates that RDF is ideal for representing Dublin Core information.

---

Figure 2.14: Element Examples in Dublin Core Metadata Schema

[6]

RDF are much of the same thing, but OWL is a stronger language with greater machine interpretability than RDF. OWL comes with a larger vocabulary and stronger syntax than RDF. It is written in XML.

### Why do we need OWL?

OWL is a part of the “Semantic Web Vision” - a future where:

- o Web information has exact meaning
- o Web information can be processed by computers
- o Computers can integrate information from the web

## 2.1. Preliminaries of Semantic Web

---

### 2.1.5 SWD

A **Semantic Web document (SWD)** is an atomic Semantic Web “data transfer packet” on the Web. It is both a Web page addressable by a URL and an RDF graph containing Semantic Web data. It can be a static or dynamic web page, for example one generated by a database query. In particular, SWDs can be divided into pure SWDs (PSWDs), which are completely written in Semantic Web languages, and embedded SWDs (ESWDs), which embed RDF graphs in their text content, e.g., HTML documents containing Creative Commons license metadata. Semantic Web documents (SWDs) are characterized by semantic annotation and meaningful references to other SWDs. Since conventional search engines do not take advantage of these features, a search engine customized for SWDs, especially for ontologies, is needed by human users as well as by software agents and services [8].

# AN INTRODUCTION TO FOAF

---

When it comes to online social networking, websites are commonly used. These websites are known as Social Networking Sites. The fundamental problems with today's SNSs block their potential to access the full range of available content and networked people online [9]. Here Semantic Web can be a solution. That is, building semantic social networking into the fabric of the next-generation Internet itself-interconnecting both content and people in meaningful ways. The semantic Web is a useful platform for linking and for performing operations on diverse person-and object-related data gathered from heterogeneous social networking sites. In the other direction, object-centered networks can serve as rich data sources for semantic web applications. So, it does not take much thought to realize that for the purpose of linking social networks, semantic web must have to store large set of instance data, distributed among many independent websites, where reasoning can be used to merge instances that would otherwise considered distinct. The base of the social networking on semantic web is FOAF, which is the abbreviation of Friend Of A Friend.

To understand what FOAF is, let us consider a Web page which contains some personal information of the author. This information can be his/ her email address, contact number, personal interests etc. These information are undoubtedly suitable for human beings but any automatic agent and tool cannot process them so easily. A question arises here that how they can be made machine readable and standard them. The answer is- using the RDF schema or OWL for creating an ontology about personal information. Then each personal Web page is marked up by connecting each page to an RDF statement document written using this ontology.

For this purpose FOAF project was started. The first step is to create an ontology called FOAF to include the basic terms normally used to describe personal information.

### 3.1. Basics of FOAF: Syntax and Semantics

---

The Friend of a Friend (FOAF) project is one of the largest projects on the Semantic Web. FOAF is an RDF based schema to describe persons and their social network in a semantic way. FOAF has become a widely accepted standard vocabulary for representing social networks, and many large social networking websites use it to produce Semantic Web profiles for their users. There are millions of FOAF profiles online, hosted at a wide range of websites. Because it is so successful in terms of use, FOAF is frequently used as an example of the success of the Semantic Web [10].

FOAF is about our place in the Web, and the Web's place in our world. FOAF is a simple technology that makes it easier to share and use information about people and their activities (eg. photos, calendars, weblogs), to transfer information between Web sites, and to automatically extend, merge and re-use it online [11].

The Semantic Web offers a promising solution to publishing information and services on the World Wide Web augmented with descriptions in a form that is easier for machines to process and understand. This will help Web agents to performing a variety of tasks on behalf of their users, such as *information discovery and integration* and *service negotiation and composition*. Information published in the Semantic Web languages (RDF and OWL) uses terms denoting classes and properties drawn from one or more *ontologies*. These ontologies are online RDF documents that declare a set of terms with unique URIs and further define them by asserting logical relationships and constraints among them.

FOAF provides an RDF/XML vocabulary to describe personal information, including name, mailbox, homepage URL, friends, and so on. FOAF documents then induces the “web of acquaintances” and thus an implicit trust network to support such applications as knowledge outsourcing and online communities.

### 3.1 Basics of FOAF: Syntax and Semantics

The advances in FOAF vocabulary and applications highlight several challenging issues that must be addressed. The current FOAF literature provides a vision and various models of how FOAF documents might be used to support Web-based information system under the

### 3.1. Basics of FOAF: Syntax and Semantics

---

assumption that FOAF documents are widely available.

The Syntax and semantic of the FOAF are discussed in this section.

#### 3.1.1 FOAF Vocabularies

Rather than a website or a software package, FOAF is a framework for representing information about people and their social connections. Written in OWL, FOAF contains terms for describing personal information, membership in groups, and social connections. The vocabulary of FOAF is reasonably expressive, although still in evolution, and allows expressing different types of information describing a person. People are described as instances of the foaf:Person class. There are many properties to describe attributes of people, including name, email address, and documents they produce.

foaf:Person class is one of the core classes defined in FOAF vocabulary, and it represents people in the real world. A definition of the person class is given below[2]:

```
<rdfs:Class rdf:about="http://xmlns.com/foaf/0.1/Person"
rdfs:label="Person"
rdfs:comment="A person."
vs:term_status="stable">
<rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class"/>
<rdfs:subClassOf>
<owl:Class rdf:about="http://xmlns.com/wordnet/1.6/Person"/>
</rdfs:subClassOf>
<rdfs:subClassOf>
<owl:Class rdf:about="http://xmlns.com/foaf/0.1/Agent"/>
</rdfs:subClassOf>
<rdfs:subClassOf>
<owl:Class rdf:about="http://xmlns.com/wordnet/1.6/Agent"/>
</rdfs:subClassOf>
<rdfs:subClassOf>
<owl:Class rdf:about=
```



### 3.1. Basics of FOAF: Syntax and Semantics

---

```
"http://www.w3.org/2000/10/swap/pim/contact#Person"/>
</rdfs:subClassOf>
<rdfs:subClassOf>
<owl:Class rdf:about=
"http://www.w3.org/2003/01/geo/wgs84_pos#SpatialThing"/>
</rdfs:subClassOf>
<rdfs:isDefinedBy rdf:resource="http://xmlns.com/foaf/0.1"/>
<owl:disjointWith
rdf:resource="http://xmlns.com/foaf/0.1/Document"/>
<owl:disjointWith
rdf:resource="http://xmlns.com/foaf/0.1/Organization"/>
<owl:disjointWith
rdf:resource="http://xmlns.com/foaf/0.1/Project"/>
</rdfs:Class>
```

As we can see, foaf:Person is defined as a sub-class of Person class defined in WordNet. WordNet is a semantic lexicon for the English language. It groups English words into sets of synonyms called synsets and provides short and general definitions, including various semantic relations between these synonym sets. Developed by Cognitive Science Laboratory of Princeton University, WordNet has two goals: first, to produce a combination of dictionary and thesaurus that is more intuitively usable and second, to support automatic text analysis and artificial intelligence applications.

Besides foaf:Person class, FOAF ontology has defined quite a few other classes; the goal is to include the main concepts that can be used to describe a person as a resource. You can read these definitions just as the way we have understood foaf:Person's definition. For example, foaf:Document represents the things which are considered to be documents used by a person, such as foaf:Image, a sub-class of foaf:Document, since all images are indeed documents.

For our research, we wrote some FOAF ontologies, one of which is given in Figure 3.1.

The property **foaf:knows** is used to create social links between people, that is one person

### 3.1. Basics of FOAF: Syntax and Semantics

---

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
  <rdf:Description rdf:about="http://www.semantest.tk/hanifa/hanifa.rdf#Hanifa">
    <foaf:family_name>Islam</foaf:family_name>
    <foaf:mbox rdf:resource="mailto:nabilacse10@yahoo.com"/>
    <foaf:knows rdf:nodeID="A0"/>
    <foaf:name>Hanifa Islam</foaf:name>
    <foaf:title>Student</foaf:title>
    <foaf:phone>0087637859</foaf:phone>
    <foaf:givenname>Hanifa</foaf:givenname>
    <foaf:schoolHomepage rdf:resource="http://www.mist.com"/>
    <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
    <foaf:member>CSE10</foaf:member>
    <foaf:topic_interest rdf:resource="http://dbpedia.org/resource/Semantic_web"/>
    <foaf:homepage rdf:resource="http://www.semantest.tk"/>
  </rdf:Description>
  <rdf:Description rdf:nodeID="A0">
    <foaf:member>CSE10</foaf:member>
    <foaf:homepage rdf:resource="http://www.dhrubotaara.tk"/>
    <foaf:mbox rdf:resource="mailto:tasnima65@gmail.com"/>
    <foaf:relation>Friend</foaf:relation>
    <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
  </rdf:Description>
</rdf:RDF>
```

Figure 3.1: FOAF Ontology

knows another person [12].

In Figure 3.1, we see there is written-

```
<foaf:knows rdf:nodeID="A0"/>
```

which means that the person (i.e. Hanifa) described in this FOAF ontology, knows another person who is defined using node A0. This node points to another person who is denoted by the foaf:member property and indicates that this person is a member of a specific group of which Hanifa is a member too.

Perhaps the most important use of foaf:knows property is to connect FOAF files together. Often by mentioning other people (foaf:knows), and by providing a rdfs:seeAlso property at the same time, we can link different RDF documents together. An example of using rdfs:seeAlso property with FOAF is given below[2]:

```
<rdf:RDF
1a: xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
2: xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
3: xmlns:foaf="http://xmlns.com/foaf/0.1/">
4:
5: <foaf:Person>
```

### 3.1. Basics of FOAF: Syntax and Semantics

---

```
6: <foaf:name>Liyang Yu</foaf:name>
7: <foaf:mbox rdf:resource="mailto:liyang910@yahoo.com"/>
8: <rdfs:seeAlso
8a: rdf:resource="http://www.yuchen.net/liyang.rdf"/>
9: </foaf:Person>
10:
11: </rdf:RDF>
```

Analyzing the set of properties describing a FOAF person entity, it becomes clear that the best identifier currently available is the unique code obtained by encoding a person's email address in the field (**foaf:mbox sha1sum**). Indeed, an email address is uniquely identifying a mailbox of a person. Furthermore, often people use the same email address for long periods of time and this fact make the email address useful to identify persons along this period. In our example, Hanifa and Tasnima have unique mail addresses.

#### 3.1.2 Reasoning

FOAF utilizes the semantics of the Web Ontology Language OWL. While the overall idea is straightforward- describe attributes of people - FOAF utilizes several features of OWL so interesting inferences can be made. Inverse roles are used several times. This allows a reasoned to infer some bi-directional relationships between instances of FOAF classes. An inverse functional property connects an instance to a unique identifier. Unique identifiers in FOAF are the following:

- foaf:aimChatID
- foaf:homepage
- foaf:icqChatID
- foaf:jabberID
- foaf:mbox

### 3.1. Basics of FOAF: Syntax and Semantics

---

- foaf:mbox sha1sum
- foaf:msnChatID
- foaf:weblog and
- foaf:yahooChatID

These properties are used as unique identifiers because it is rare that two people will share the same email address, chat account, or blog address.

From the given RDF in Figure 3.1, we see that foaf:homepage property is used for describing the person in node A0 writing-

```
<foaf:homepage rdf:resource="http://www.dhrubotaara.tk"/>
```

which differs him/ her from other persons.

Any FOAF file describing a person represents an RDF graph. Every single graph is supposed to be merged with other graphs collapsing the nodes identifying the same person. Namely, if in two graphs somewhere the same unique code derived by the mail address is used, then both graphs contain some kind of information about the same person, therefore the graphs can be merged enlarging the network of ‘friendship’. By means of this procedure it is possible to build a bigger graph containing all the information stated by the respective social network [13].

Any time two instances of **foaf:Person** have identical values for an inverse functional property, an OWL reasoner will infer that the instances represent the same person. This is the critical inference used in merging profiles that represent the same person.

When an OWL reasoner infers that two profiles represent the same person, the inference is always logically correct. However, it can be the case that the inference is incorrect in the real world. For example, two people may share an email address or a user may have a typo that makes their email the same as someone else’s. This potential for error is possible with every automated system, and short of having a human personally interview each member to confirm they are, in fact, the same person, there is no way to be 100% accurate.

## 3.2 FOAF-O-Matic: A Solution to the Identity Problem

An issue that is equally arising both from social networks and the Semantic Web is the fact that, without the consistent use of the same identifier for an object across systems, it is unnecessarily hard to perform information integration. We are addressing this issue where both fields intersect, namely in the context of FOAF profiles, which describe the social network of a person with Semantic Web technology. A new web application has been developed for this which is state-of-the-art for the generation of FOAF profiles. This is known as Foaf-O-matic. It has the integral characteristic of making use of the OKKAM([14]) Infrastructure. This infrastructure enables the systematic, global use of unique identifiers for entities, and thus aims to solve the identity problem that exists in FOAF today. The OKKAM project aims at enabling the Web of Entities, namely a virtual space where any collection of data and information about any type of entities (e.g. people, locations, organizations, events, products etc) published on the Web can be integrated into a single virtual, decentralized, open knowledge base. Foaf-O-matic combines the open standard FOAF and globally unique identifiers provided by OKKAM ENS in a simple and easy to use interface. Thus it is an online FOAF generator.

The FOAF-a-Matic is being provided as a quick and easy way for one to create his/her own FOAF description. One can work through the forms on the page(<http://www.ldodds.com/foaf/foaf-a-matic.html>) and complete whichever details he/she would like to add to their description.

As we can see from Figure 3.2, the person named John Doe simply added his name and email address and some other information that describes him. He also adds a friend named Lee and supplies his homepage url.

We have had this knowledge by now that FOAF connects people, thus by adding the information of a friend he tells the FOAF generator that he knows the person. So when clicked on the “FOAF me” button, the generator gives the foaf:knows property indicating that John knows Lee. Thus we get the rdf/xml file generated automatically using the FOAF-O-Matic(Figure 3.3).

## 3.2. FOAF-O-Matic: A Solution to the Identity Problem

---

### The Forms

#### Personal

Some information about you, and how people can contact you.

Title (Mr, Mrs, Dr, etc)	<input type="text" value="Mr"/>
First Name	<input type="text" value="John"/>
Last Name (Family/Given)	<input type="text" value="Doe"/>
Nickname	<input type="text" value="John"/>
Your Email Address	<input type="text" value="john123@ymail.com"/>
Homepage	<input type="text" value="www.jdoe.com"/>
Your Picture	<input type="text"/>
Phone Number	<input type="text"/>

#### Work

Information about the place you work.

Work Homepage	<input type="text" value="www.abdoc.org"/>
Page describing what you do at work	<input type="text"/>

#### School

Where did you go to school?

School Homepage	<input type="text" value="www.aschool.com"/>
-----------------	--

#### People You Know

Tell FOAF-a-matic about some people you know. Click "Add Friend" to add space to add more people. If you friend already has a FOAF description, then place a link to it in the 'seeAlso' field.

Friend-- Name	<input type="text" value="Lee"/>	Email	<input type="text" value="l24e@gmail.com"/>	See Also	<input type="text"/>
Friend-- Name	<input type="text"/>	Email	<input type="text"/>	See Also	<input type="text"/>
Friend-- Name	<input type="text"/>	Email	<input type="text"/>	See Also	<input type="text"/>

Figure 3.2: Adding information to FOAF Forms

## 3.2. FOAF-O-Matic: A Solution to the Identity Problem

---

### Generate Results

Now you've filled in the details you're ready to be turned into FOAF...

Protect email addresses from spammers

FOAF me!

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/"
  xmlns:admin="http://webns.net/mvcb/">
<foaf:PersonalProfileDocument rdf:about="">
  <foaf:maker rdf:resource="#me"/>
  <foaf:primaryTopic rdf:resource="#me"/>
  <admin:generatorAgent rdf:resource="http://www.1dodds.com/foaf/foaf-a-matic"/>
  <admin:errorReportsTo rdf:resource="mailto:leigh@1dodds.com"/>
</foaf:PersonalProfileDocument>
<foaf:Person rdf:ID="me">
<foaf:name>John Doe</foaf:name>
<foaf:title>Mr</foaf:title>
<foaf:givenname>John</foaf:givenname>
<foaf:family_name>Doe</foaf:family_name>
<foaf:nick>John</foaf:nick>
<foaf:mbox_sha1sum>72ebd33e46a8b93414c65a0cab9406d7d23f9477</foaf:mbox_sha1sum>
<foaf:homepage rdf:resource="www.jdoe.com"/>
<foaf:workplaceHomepage rdf:resource="www.abdoc.org"/>
<foaf:schoolHomepage rdf:resource="www.aschool.com"/>
<foaf:knows>
<foaf:Person>
<foaf:name>Lee</foaf:name>
<foaf:mbox_sha1sum>a9b906735d0987083e532edb1dbafb4db72c2ba2</foaf:mbox_sha1sum>
</foaf:Person></foaf:knows></foaf:Person>
</rdf:RDF>
```

Figure 3.3: The RDF file generated by FOAF-O-Matic

# LINKING THROUGH SEMANTIC WEB USING FOAF

---

The main strengths of the FOAF ontology, stemming from its RDF/Semantic Web nature, are simplicity and extensibility. In fact, the basic FOAF vocabulary specification intentionally provides a limited set of properties for representing profile information and only one property (the generic property “knows”) for representing social relationship information. In this chapter we will discuss about the role of FOAF in social context and the way of linking people using FOAF.

## 4.1 FOAF and the Social Networks

Web-based social networks (WBSN) have grown quickly in number and scope since the mid-1990s. They present an interesting challenge to traditional ways of thinking about social networks. There are about 250 websites dedicated to social networking, i.e. they have explicit support for users to build and browse lists of friends. This includes websites like MySpace, Facebook, Orkut, and CyWorld but does not include many dating sites, like Match.com, and other online communities that connect users, such as Craig’s List or MeetUp.com. The latter group of sites also contain social network information, but we do not consider them to be “Web-based Social Networks”.

The purposes of the WBSNs can be listed as below:

- Blogging
- Business



## 4.1. FOAF and the Social Networks

---

- Social and Entertainment
- Dating
- Pets
- Religious
- Photos and Videos

The number of sites almost doubled over the two year period from December 2004 to December 2006, growing from 125 to 223. Over the same period, the total number of members among all sites grew four-fold from 115 million to 490 million [15].

There are 11 active social networking websites that output FOAF files, with an approximate total of 13,120,000 members among them (see 4.1).

Network	Purpose	Members Studied	Avg. Degree
Advogato	Business	2,778	13.51
Buzznet	Photos	208,324	1.00
DeadJournal	Blogging	9,801	3.74
eCademy	Business	61,242	3.08
FilmTrust	Social/Entertainment	1,250	1.06
GreatestJournal	Blogging	36,862	33.36
InsaneJournal	Blogging	1,410	13.36
LiveJournal	Blogging	3,563,267	8.38
Minilog.com	Blogging	119	1.63
Rossia.org	Blogging	4,180	9.65
Tribe	Social/Entertainment	218,694	9.93

Figure 4.1: The web-based social with available FOAF

[15]

Six of the eleven websites on this list are blogging websites based on the open-source LiveJournal code. FOAF output is built into LiveJournal, so it is automatically produced when a website implements it. As such, blogging accounts for a disproportionate percentage of our data. Overall, blogging websites account for 19 of the 226 (or 8.4%) known social networks,

## 4.1. FOAF and the Social Networks

---

and only 2.7% of the total membership. Thus, if FOAF were available on a more representative set of social networking websites, the results of a study like this may be different.

**An Example: Linking to a Twitter Account** The illustration in this section shows is how to use the FOAF vocabulary to point to one's Twitter account, which will make it easy to build tools that will allow people to follow a person with one click[16]. The first thing to do is create a relationship called foaf:holdsAccount, which will connect our 'person object' with an online account object. To connect two objects we use the HTML rel attribute:

```
<div about="#me" typeof="foaf:Person">
  <span property="foaf:name">Mark Birbeck</span>
  <a rel="foaf:weblog" href="http://internet-apps.blogspot.com/">
    XForms and Internet Applications</a>
  <a rel="foaf:knows" href="http://www.w3.org/People/Ivan/#me">
Ivan Herman</a>
  <span rel="foaf:img">
  </span>
  <span rel="foaf:holdsAccount">
    ...
  </span>
</div>
```

Next we create an object of type foaf:OnlineAccount, in exactly the same way that we did when creating a person earlier:

```
<span rel="foaf:holdsAccount">
  <span typeof="foaf:OnlineAccount">
    ...
  </span>
</span>
```

## 4.2. Getting into the Circle

---

Finally, we indicate that the particular type of account we're dealing with is a Twitter account (using foaf:accountServiceHomepage), and also provide our account name (using foaf:accountName):

```
<span rel="foaf:holdsAccount">
  <span typeof="foaf:OnlineAccount">
    <a rel="foaf:accountServiceHomepage"
href="http://twitter.com/">Twitter</a>
    <span property="foaf:accountName">markbirbeck</span>
  </span>
</span>
```

## 4.2 Getting into the Circle

The goal of our work is to utilize the linking power of FOAF. As FOAF plays a vital role in social networks, we developed a small task for publishing documents containing the information of a person in the Web with the help of FOAF. For this, we were to follow some steps and work accordingly.

**Step 1: Creation of FOAF Document** As user, we needed to create a FOAF document at first by using the FOAF vocabulary as we discussed in the previous section. For this purpose, the only thing that is needed to remember is the use of foaf:knows property together with rdfs:seeAlso property to connect our document with the documents of other friends.

**Step 2: Building the Homepage** We then needed to build our homepage that would contain the FOAF document. As we needed to test and validate the FOAF document, we decided to build at least two Homepages, i.e. Web pages so that they could be linked using FOAF.

**Step 3: Linking the Homepage to the FOAF Document** The next task needed to be done was to link the homepage(s) to the FOAF document(s). And once we have finished this step, we are done, it is now up to the FOAF project to find us, i.e. our homepage(s).

## 4.2. Getting into the Circle

---

**Step 4: Finding the FOAF Document** As the FOAF document is an SWD, so FOAF uses its crawler to visit the Web and collect all the FOAF documents.

**Step 5: Maintaining a Centralized Database** FOAF maintains a central repository and is also responsible for keeping the information up to date. To keep the database up to date, it has to run the scutter (A) periodically to visit the Web.

**Step 6: Getting into the Friend Circle** This is the aim of our task: to find our friends and link with them. FOFA provides a user interface so that we can find our friends and conduct other interesting activities. FOAF offers some tools one can use to view the friends in the circle, which further defines the look and feel of the FOAF project. Among these tools, FOAF explorer is quite popular, and one can find this tool as the following location:  
<http://xml.mfd-consult.dk/foaf/explorer/>

# METHODOLOGY

---

## 5.1 Creating the FOAF Document

The easiest way to create a FOAF document is to use the FOAF-O-Matic tool in the following link:

<http://www.ldodds.com/foaf/foaf-a-matic.html>

We have shown an example form in Figure 3.2. To use this form, one doesn't have to know any FOAF terms, he/ she just needs to follow the instructions to create your FOAF document. As we already know, this form allows to specify a person's name, e-mail address, homepage, picture and phone number, and other personal information like work home page and other details that describes a person.

On the other hand the most straightforward way to create a FOAF document is to use a simple text editor. This requires to directly use the FOAF vocabulary. Given the self-explanatory nature of the FOAF ontology, this is not difficult to do. Also we need to validate the final document, just to make sure its syntax is legal. We, instead of generating the FOAF document using the FOAF-O-Matic tool, chose to write the document using the text editor. We have already shown the document in Figure 3.1. We have written another one as we needed to connect the FOAF documents. The second one is given below:

```
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:foaf="http://xmlns.com/foaf/0.1/"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
```

## 5.2. Building the Test Page and Publishing the FOAF Document

---

```
<rdf:Description rdf:about="http://www.dhrubotaara.tk/foaf.rdf#Anika">
<foaf:family_name>Mansoor</foaf:family_name>
<foaf:mbox rdf:resource="mailto:tasnimacse10@yahoo.com"/>
<foaf:knows rdf:nodeID="A0"/>
<foaf:name>TAsnima Mansoor</foaf:name>
<foaf:title>Student</foaf:title>
<foaf:givenname>Tasnima</foaf:givenname>
<foaf:schoolHomepage rdf:resource="http://www.mist.com"/>
<rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
<foaf:member>CSE10</foaf:member>
<foaf:interest rdf:resource="http://dbpedia.org/resource/Semantic_Web"
/>
<foaf:homepage rdf:resource="http://www.dhrubotaara.tk"/>
</rdf:Description>
<rdf:Description rdf:nodeID="A0">
<foaf:mbox rdf:resource="mailto:karim@gmail.com"/>
<foaf:relation>Father</foaf:relation>
<rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
</rdf:Description>
</rdf:RDF>
```

## 5.2 Building the Test Page and Publishing the FOAF Document

The next step was to building the test Web page(s) in which we could embed the FOAF documents. For this we first needed to reserve the domains for the pages/ sites. As it is a test site, so we looked for a domain in which we can experiment whenever we want. A free domain serves this purpose perfectly. The Dot tk domain providers allow people to register

## 5.2. Building the Test Page and Publishing the FOAF Document

---

domains free of cost. So we registered a domain in the name of semantest.tk in the following link:

<http://www.dot.tk/en/index.html?lang=en>

After this, we needed a cPanel (A), i.e. a server for hosting our domain. Again for the need of testing now and then, we went for free servers. There are many servers in the Web who provide free hosting. Some of them are listed below:

- Serversfree (<http://www.serversfree.com/>)
- 2FreeHosting (<http://www.2freehosting.com/>)
- Host33 (<http://www.ho33.com/>)

We reserved a server in <http://www.serversfree.com>, linked the domain semantest.tk to it by setting the nameservers (A) properly and got a cPanel like Figure 5.1

## 5.2. Building the Test Page and Publishing the FOAF Document

My Profile    Hosting    Domains    Invoices    Knowledge Base    News    Help Desk    Referrals    Logout

✓ Ad muted. [Undo](#) We'll do our best to show you more relevant ads in the future. Help us show you better ads by updating your [ads settings](#).

✓ Ad muted. [Undo](#)  
We'll do our best to show you more relevant ads in the future.  
Help us show you better ads by updating your [ads settings](#).

**Accounts**

Details    Getting Started    Change Password    Change Language

Get Website Templates!    Link to us    Facebook    Upgrade to PRO!

FREE SEO Tools    Free Google Adwords

**Emails**

Manage Emails    Manage Forwarders    Edit MX Record    Webmail

Configure GMAIL    Mail Service Control    Sent Mail Logs

**Domains**

Subdomains    Parked Domains    Addon Domains    Redirects

**Website**

Import Website    Import Database    Auto Installer    Statistics

Latest Visitors    Error Pages    Website Templates    Analyze Website

Website Builder

**Files**

FTP Access    FTP Accounts    Backups    FTP Login History

Error Logs    File Manager

**Advanced**

MySQL Databases    phpMyAdmin    Cron Jobs    SSH Console

DNS Zone Editor    PHP Info    Cron Output    PHP Configuration

**Other**

Password Protect Directories    IP Deny Manager    Hotlink Protection    Folder Index Manager

Fix File Ownership    Reload Account    Delete Account

**Account Information**

Domain: semantest.tk  
IP Address: 185.28.21.16  
Username: u109896228  
Password: .....

Disk Usage: 0.16 / 10000 MB  
Bandwidth: 0.00 / 100000 MB

Home Root: /home/u109896228  
Server Name: server27.serversfree.com  
Server IP: 31.170.166.31

Server Load: 1.97  
MySQL Server Load: 0.06  
Apache Version: Apache/2.2.17  
PHP Version: 5.3  
MySQL Version: 5.1.58  
Activated: 2013-09-11 14:46:39  
Status: **Active**  
Hosting Plan: ServersFree.com - FREE  
Feature Set: ServersFree.com - Free & No Ads

✓ Ad muted. [Undo](#)  
We'll do our best to show you more relevant ads in the future.  
Help us show you better ads by updating your [ads settings](#).

**Customer Details**

Name: Tasnima  
E-mail: tasnimamansoor@...  
Registration: 2013-09-11  
Status: **Active**  
Last Login Time: 2 weeks ago  
Last Login From: 180.149.20.240  
Location: Bangladesh

Figure 5.1: cPanel for the test site http://www.semantest.tk



## 5.2. Building the Test Page and Publishing the FOAF Document

Next we needed an FTP(A) client for getting connected to the server and uploading the FOAF document in the Webpage. Although the Web server provides with some FTP facilities, we preferred another FTP client other than the ones built in the server. Filezilla is one of the best FTP solutions that allows the users uploading to and downloading from the servers. It is a free, open-source FTP client for Windows, Mac, and Linux. Due to its price tag (or lack thereof), cross-platform support, and ease of use, FileZilla is a go-to option for many users new to FTP. Users stick around because FileZilla is a fast, full-featured (it also has remote file editing), and reliable FTP client in constant development. So we at first connected with the domain named semantest.tk with the help of Filezilla and uploaded our code for a basic Web page in the “public\_html” folder residing in the server (see Figure 5.2 and Figure 5.3).

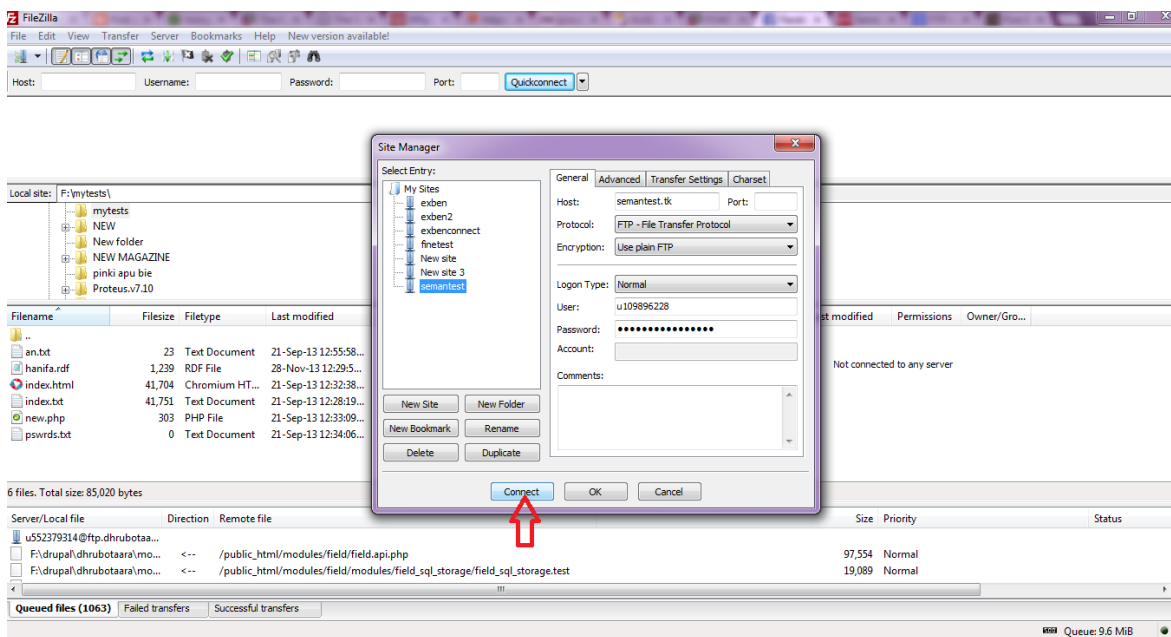


Figure 5.2: Getting with <http://www.semantest.tk> with the Help of FTP client

## 5.2. Building the Test Page and Publishing the FOAF Document

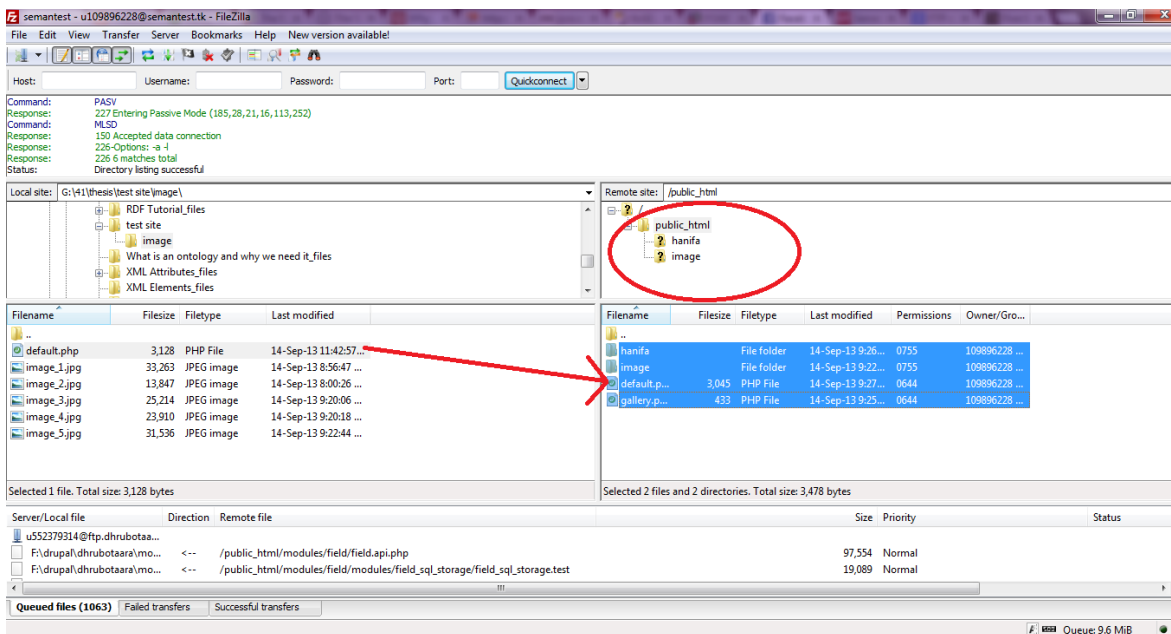


Figure 5.3: Uploading Files to the Server with Filezilla

## 5.2. Building the Test Page and Publishing the FOAF Document

Thus we got our homepage <http://www.semantest.tk> ready.

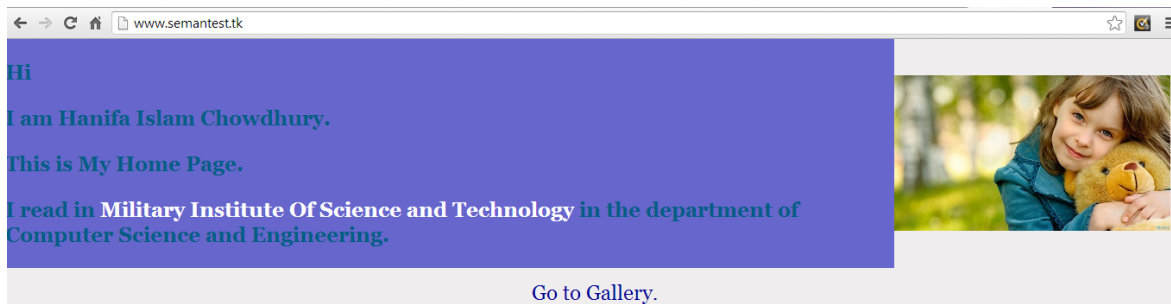


Figure 5.4: Homepage of Hanifa

Then we also uploaded our FOAF document of Figure 3.2 to the server in the same process as described above.

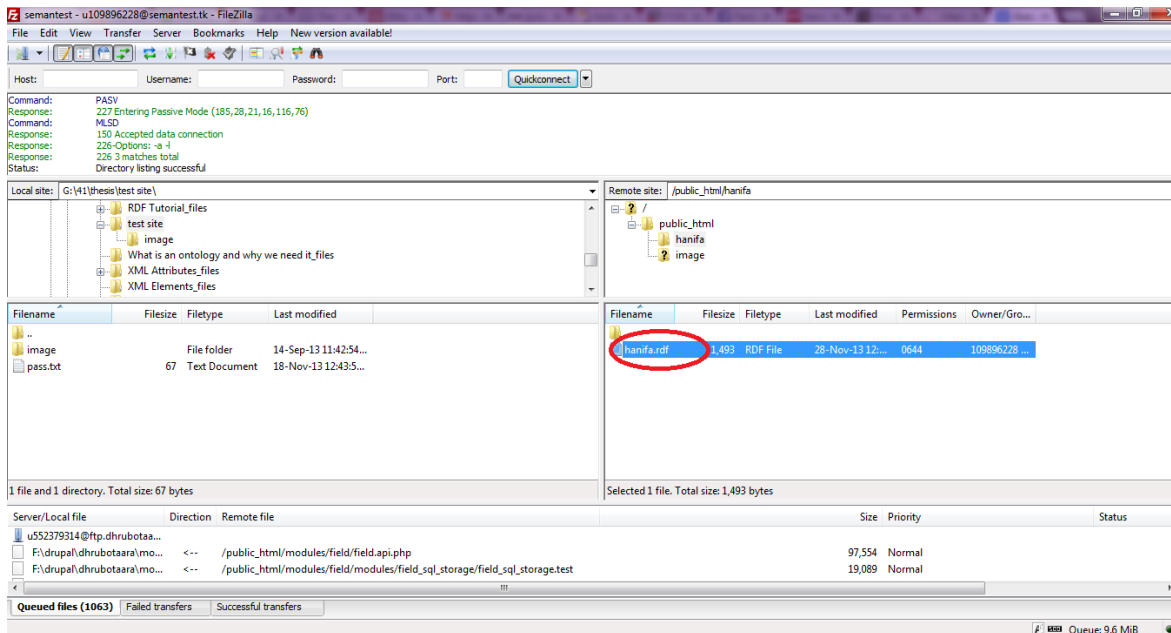


Figure 5.5: Uploading FOAF document to <http://www.semantest.tk>

So now the Web page contains the information of its owner stored in a RDF file. In the same process described above we built another test site <http://www.dhrubotaara.tk/> using the Drupal(A) Framework: we registered another free domain, connected it to serversfree.com

### **5.3. Getting Linked with People**

---

account and uploaded the second FOAF document of the given code above to the server.

### **5.3 Getting Linked with People**

Now as the two FOAF documents are embedded in the Web pages, they need to be linked with each other. For this, we decided to use the FOAF-Explorer. The FoaF Explorer tries to present the information and assertions in a human-readable format, currently by way of direct transformations of the raw RDF/XML to XHTML with XSLT.

# RESULT AND ANALYSIS

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## 6.1 Result of the Task Done

An important feature about the FOAF scutter is that it has to know how to handle `rdfs:seeAlso` property. Whenever the scutter sees this, it will follow the link to reach the document pointed by `rdfs:seeAlso` property. This is the way FOAF uses to construct a network of FOAF documents.

Another important fact about scutter is that it has to take care of the data merging issue. To do so, the scutter has to know which FOAF properties can uniquely identify resources. More specifically, `foaf:mbox`, `foaf:mbox_sha1sum` and `foaf:homepage` are all defined as inverse functional properties; therefore, they can all uniquely identify individuals that have one of these properties. In the real operation, one solution the scutter can use is to keep a list of RDF statements which involve any of these properties, and when it is necessary, it can consult this list to merge together different triples that are in fact describing the same individuals.

The FOAF-Explorer thus checks if there are any these properties of FOAF ontology. If it gets any of these properties in a Web page, it shows the information stored into the RDF file. Now as we have linked both our test sites with their owner's personal information containing RDF files, we would now like to check if the FOAF-Explorer can find them. For this, we first went to the FOAF-Explorer located at <http://xml.mfd-consult.dk/foaf/explorer/>. There, we can see a section named "Explore a FoaF neighbourhood" that has a field called "Location". In this field we gave the URL of our first test site: <http://www.semantest.tk>.

## 6.1. Result of the Task Done

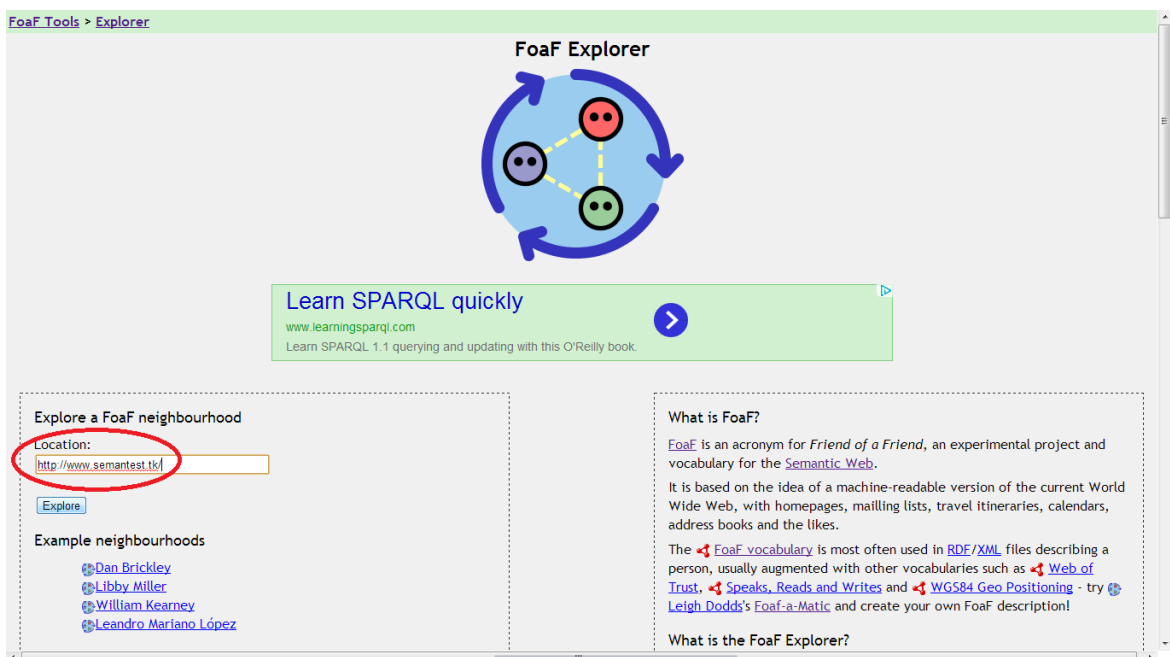


Figure 6.1: Entering the Location in FOAF-Explorer

## 6.1. Result of the Task Done

After clicking on the “Explore” button, we see that it returns the information of Hanifa and also shows the name of the FOAF document in the location field. As a prove of the document being a FOAF document, we see that the first information of Hanifa shows whom she knows. The second information is the address of her homepage, i.e. <http://www.semantest.tk>.

The screenshot shows the FoaF Explorer interface. At the top, there is a navigation bar with "FoaF > Explorer" and a "Location:" field containing the URL "http://www.semantest.tk/hanifa/hanifa.rdf". A red circle highlights this field, with a red arrow pointing to a red text annotation: "Change in the Location field shows the existence of the FOAF document in the Web page". Below the location field is the name "Hanifa Islam" and a list of "Knows". The "Knows" list includes "tasnima65" (Person: karim) and "relation: Friend". The homepage is listed as "http://www.dhrubotaara.tk" and the member as "CSE10".

Figure 6.2: Result of FOAF-Explorer

The other information we get about Hanifa are her topic of interest, phone number, family name and membership(6.3). It is to be noted that her mailbox information is hidden because the foaf:mbox\_sha1sum property is used. The foaf:mbox\_sha1sum property uses the SHA1 (A) algorithm for encrypting the mailbox address.

Now, as Hanifa knows tasnima65 as we can see from the FOAF document in her page, so if we click on tasnima65, we should be redirected to the homepage of tasnima65. Let us see if that happens or not.

From Figure 6.4 we see that the two documents are linked successfully.

## 6.1. Result of the Task Done

---

**topic\_interest:**  
[http://dbpedia.org/resource/Semantic\\_Web](http://dbpedia.org/resource/Semantic_Web)

**member:**  
CSE10

**schoolHomepage:**  
<http://www.mist.com>

**Given name:**  
Hanifa

**phone:**  
0087637859

**title:**  
Student

**personal mailbox:**  
[hidden]

**family\_name:**  
Islam

Figure 6.3: Information about Hanifa



# 6.1. Result of the Task Done

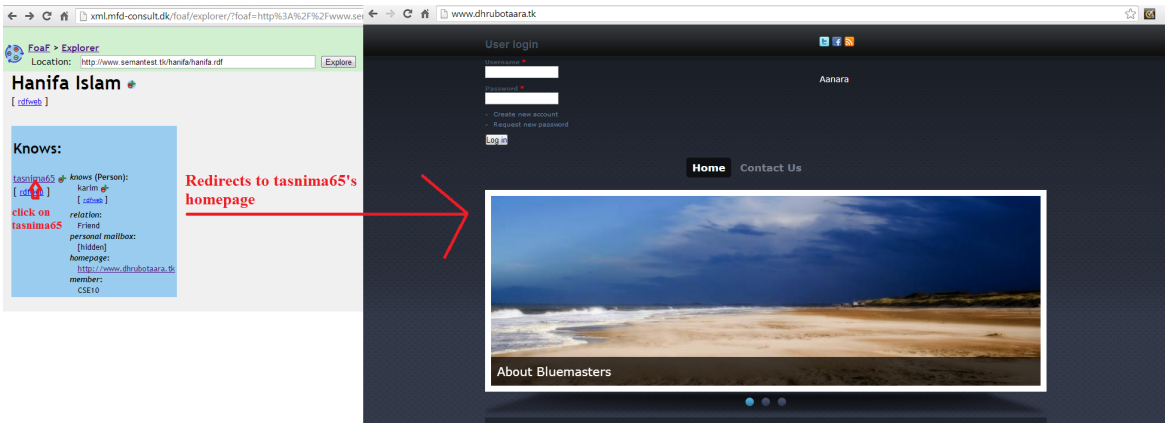


Figure 6.4: Linking Succeeds between two FOAF documents

## 6.2. Analyzing the Result

---

If we give the address of `tasnima65`'s homepage (`http://www.dhrubotaara.tk`) instead of Hanifa's one in the location field of the FOAF-Explorer, we will see that she knows Hanifa and we can be redirected to Hanifa's homepage from there.

## 6.2 Analyzing the Result

Let us talk about what kind of analysis can be done with the FOAF development we have done. A FOAF Document can be analyzed keeping some points in mind, that are:

1. Structure of the FOAF document
2. How the FOAF document can be discovered
3. Is the document using a standard Person ontology or an adapted one.
4. How the FOAF document can be used for practical purposes in a particular perspective.

In this section we are going to analyze our FOAF document regarding these four points.

**Structure of the FOAF document** In order to give a formal definition of FOAF document, we analyze the characteristic patterns which are implied by the ontological semantics and the empirical usage of FOAF vocabulary. Therefore, we consider a strict FOAF document `D` with the following four characteristic patterns:

- `D` is a valid RDF document. This can be validated by a RDF parser.
- `D` uses the FOAF namespace.
- `D` contains an RDF graph pattern as shown in Figure 6.5. In this figure, `X` and `Z` are two different instances of `rdfs:Resource` and `Y` is an instance of `rdf:Property` using FOAF namespace.

## 6.2. Analyzing the Result

---

- D defined only one instance of foaf:Person without referencing it as object in any triples within D. D may additionally has some other instances of foaf:Person; however, each of them must be referenced as an object in at least one triple in D.

The above patterns, especially the fourth pattern, are quite strict and exclude many documents not dedicating to a person. Therefore, by removing the fourth pattern, we define a general FOAF document as long as it contains instances of foaf:Person [17].

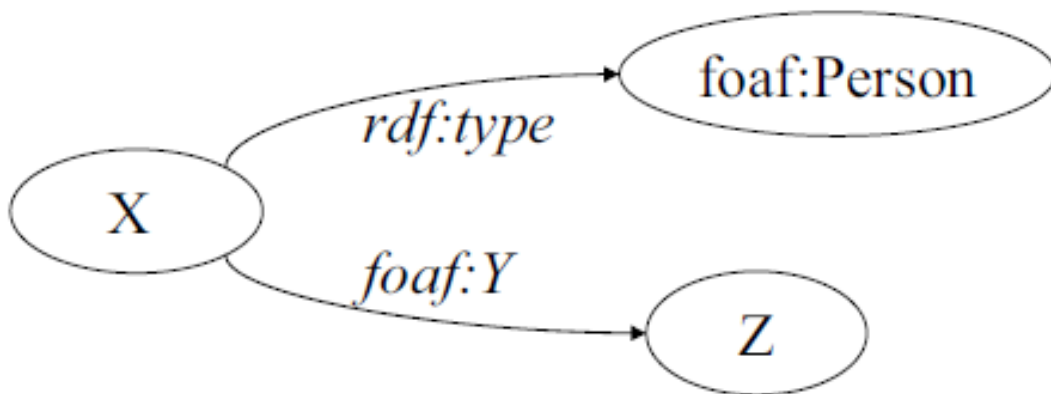


Figure 6.5: FOAF Document Pattern

Now coming to our FOAF document, it can be validated by a RDF Parser, so it is a valid document. The validation result of hanifa.rdf by W3C Validation Service (<http://www.w3.org/RDF/Validator/ARPServlet?URI=http://www.semantest.tk/hanifa/hanifa.rdf>) is attached in Figure 6.6

Again, it uses the FOAF namespace

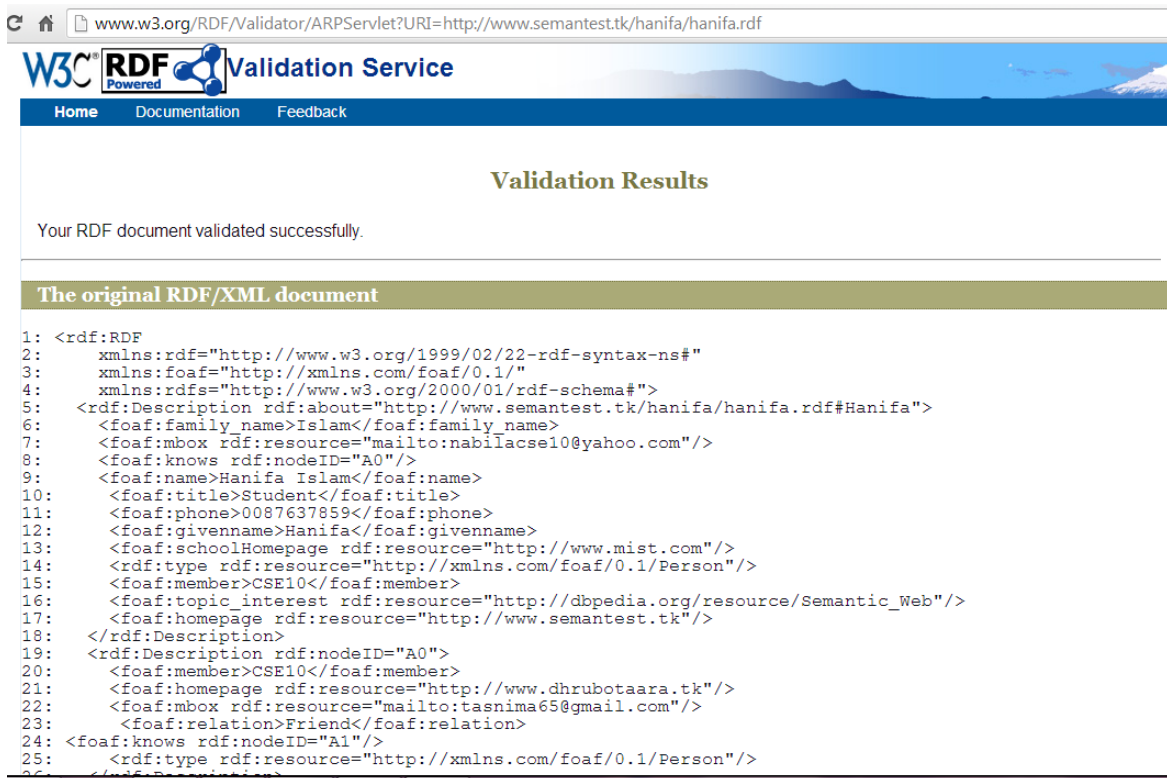
```
xmlns:foaf="http://xmlns.com/foaf/0.1/"
```

It also contains an RDF graph pattern, that is:

```
<foaf:mbox rdf:resource="mailto:nabilacse10@yahoo.com"/>
```

So the document is valid.

## 6.2. Analyzing the Result



The screenshot shows a web browser window with the URL [www.w3.org/RDF/Validator/ARPServlet?URI=http://www.semantest.tk/hanifa/hanifa.rdf](http://www.w3.org/RDF/Validator/ARPServlet?URI=http://www.semantest.tk/hanifa/hanifa.rdf). The page title is "W3C RDF Validation Service" and it includes navigation links for "Home", "Documentation", and "Feedback". The main heading is "Validation Results" and the message states "Your RDF document validated successfully." Below this, a section titled "The original RDF/XML document" displays the following code:

```
1: <rdf:RDF
2:   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
3:   xmlns:foaf="http://xmlns.com/foaf/0.1/"
4:   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
5:   <rdf:Description rdf:about="http://www.semantest.tk/hanifa/hanifa.rdf#Hanifa">
6:     <foaf:family_name>Islam</foaf:family_name>
7:     <foaf:mbox rdf:resource="mailto:nabilacse10@yahoo.com"/>
8:     <foaf:knows rdf:nodeID="A0"/>
9:     <foaf:name>Hanifa Islam</foaf:name>
10:    <foaf:title>Student</foaf:title>
11:    <foaf:phone>0087637859</foaf:phone>
12:    <foaf:givenname>Hanifa</foaf:givenname>
13:    <foaf:schoolHomepage rdf:resource="http://www.mist.com"/>
14:    <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
15:    <foaf:member>CSE10</foaf:member>
16:    <foaf:topic_interest rdf:resource="http://dbpedia.org/resource/Semantic_Web"/>
17:    <foaf:homepage rdf:resource="http://www.semantest.tk"/>
18:  </rdf:Description>
19:  <rdf:Description rdf:nodeID="A0">
20:    <foaf:member>CSE10</foaf:member>
21:    <foaf:homepage rdf:resource="http://www.dhrubotaara.tk"/>
22:    <foaf:mbox rdf:resource="mailto:tasnima65@gmail.com"/>
23:    <foaf:relation>Friend</foaf:relation>
24:  <foaf:knows rdf:nodeID="A1"/>
25:  <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
26:  </rdf:Description>
```

Figure 6.6: Validation Result of Our FOAF Document

**How the FOAF Document Can Be Discovered** The FOAF document discovery is an iterative process consisting of two steps: (i) using web search engines to discover potential URLs of FOAF documents; and (ii) running the crawler to validate and discover new links according to FOAF vocabulary semantics. As we have seen in the previous section, our FOAF can be discovered using crawler in a FOAF search engine- <http://xml.mfd-consult.dk/foaf/explorer/> and it returns the following result when searched using our test site's name(<http://www.semantest.tk>): <http://xml.mfd-consult.dk/foaf/explorer/?foaf=http%3A%2F%2Fwww.semantest.tk>. Now, as it is only a test site and it has been accessed by only a few of us, so the traditional search engines like google, yahoo etc can't find it currently. If the citing number was huge, we think it could be found using traditional search engines. Now coming to Swoogle, we have submitted our URL there and they told that it would take several days for crawling around the existing

## 6.2. Analyzing the Result

---

SWDs in a site. So now the result at our hand that can be seen at present is the one from the FOAF Explorer which is mentioned above.

**Findings on Properties of Person** In order to examine the properties of foaf:Person, FOAF documents can be divided into two groups: 1) FOAF documents from blog websites. These are generated automatically from information entered via a online form or stored in a database. Documents from one host or website use the same vocabulary and syntactic structures. Such FOAF documents account for over million files. 2) FOAF documents from non-blog websites. These are normally written by humans, and use a variety of vocabularies and structures. There are approximate 5,000 documents from non-blog websites.

Our FOAF documents fall in the second category. We used a standard Person Ontology with a variety of vocabularies.

**How the FOAF Document Can Be Used for Practical Purposes in a Particular Perspective** Let us consider the perspective of our institution, MIST, for using the FOAF document for practical purposes. It can be used in MIST for sending “GROUP SMS” to the students of a particular criteria without saving huge number of phone numbers in the mobile. The required information (phone number) can be obtained using the stored foaf documents of the students(ours is a sample) and then all the messages can be sent at a time to all the students matching a particular set of attributes.

# CONCLUSION

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FOAF is a powerful section of making the Web more meaningful and effective. There can be much more improvements in future regarding the task like we mentioned in the previous chapter: group sms.

## 7.1 Future Enhancements

As we mentioned in the previous chapter, FOAF can be used for group messaging. Shared Personal Information such as interests and other characteristics are a common method to discover people. By spidering the Swoogle(A) Semantic Web and collecting the information contained in FOAF files, we can build a large collection of data about people and their personal information. But there is a problem that is faced by the methods that depend on personal information, it is hard to extract the representative information from the FOAF properties because it is represented by URLs. There are two techniques for sending Semantic SMSs, that are:

1. Extracting the group(s) process (SEGROUP) that combines the content network and social network, and boosts Semantic Web technologies in current Web. Therefore we use the Friend-of-a-Friend (FOAF) ontology that is a first attempt at a formal, machine process-able representation of user profiles and friendship networks. FOAF profiles are created and controlled by the individual user and shared in a distributed fashion. Also the Meaning-of-a-Tag (MOAT) (A) ontology that provides a Semantic Web framework to publish semantically-annotated content from free-tagging using URIs of Semantic Web resources in a unique and non-ambiguous way. Those two Semantic Web Projects FOAF and MOAT can be combined to enable data portability between social media sites to al-

## 7.2. Conclusion

---

low us to create and extract the group(s) - the mailing list(s) - that define the SMS recipients.

2. Sending SMS to the selected group process. Sending SMS is no matter how it done, it can be from the mobile device directly or from joining a web site to send the messages. For this we need to build a server that deal with mobile program for sending [18].

The proposed technique uses a GUI based on J2ME(A) to set the criteria to collect the group(s) of recipient for the SMS. These criteria will send to a server build in Java. First, the server collects FOAF documents and its associated MOAT documents from the Semantic Web. Second, the server use the criteria send by the sender mobile to query the FOAF and MOAT documents for persons satisfy these criteria.

## 7.2 Conclusion

We presented a novel perspective of the Semantic Web by linking machine-readable descriptions of people, i.e. FOAF documents, with published personal relationships. The collection of FOAF documents itself can become valuable resource for researchers to study the (social) network structure in the Semantic Web. More work is needed in analyzing FOAF documents and discovering patterns in connected components. We worked with only one small part of FOAF, by linking two or more persons using their personal information. In this purpose we constructed two test sites and linked them using FOAF. If utilized perfectly, the linking power of the Semantic Web, i.e. the FOAF project can be of great benefit in relating people throughout the world.

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# Glossary of Terms

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**Algorithm:** An algorithm is a mathematical function that is used to encrypt and decrypt information.

**cPanel:** cPanel is a Unix based web hosting control panel that provides a graphical interface and automation tools designed to simplify the process of hosting a web site.

**Crawler:** A Crawler or Web crawler is an Internet bot that systematically browses the World Wide Web, typically for the purpose of Web indexing.

**Drupal:** Drupal is a free and open-source content management framework written in PHP and distributed under the GNU General Public License. It is used as a back-end framework for at least 2.1% of all websites worldwide ranging from personal blogs to corporate, political, and government sites including [whitehouse.gov](http://whitehouse.gov) and [data.gov.uk](http://data.gov.uk)

**Extensible Markup Language(XML):** Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

**FTP:** File Transfer Protocol (FTP) is a standard network protocol used to transfer files from one host to another host over a TCP-based network, such as the Internet. FTP is built on a client-server architecture and uses separate control and data connections between the client and the server.

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**Infrastructure:** Infrastructure is basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function.

**Integrity:** Protection against unauthorized modification or destruction of information. A state in which information has remained unaltered from the point it was produced by a source, during transmission, storage, and eventual receipt by the destination.

**J2ME:** Java Platform, Micro Edition (Java ME) provides a robust, flexible environment for applications running on mobile and embedded devices: mobile phones, set-top boxes, Blu-ray Disc players, digital media devices, M2M modules, printers and more.

**Meaning Of A Tag(MOAT):** A lightweight Semantic Web framework that provides a collaborative way to let Web 2.0 content producers give meanings to their tags in a machine-readable way.

**Nameserver:** A name server is a computer server that hosts a network service for providing responses to queries against a directory service. It maps a human-recognizable identifier to a system-internal.

**OKKAM Project:** The OKKAM project aims at enabling the Web of Entities, namely a virtual space where any collection of data and information about any type of entities (e.g. people, locations, organizations, events, products, ...) published on the Web can be integrated into a single virtual, decentralized, open knowledge base.

**Resource Description Framework(RDF):** The Resource Description Framework (RDF) is a general framework for how to describe any Internet resource such as a Web site and its content. An RDF description (such descriptions are often referred to as metadata, or "data about data") can include the authors of the resource, date of creation or updating, the organization of the pages on a site (the sitemap), information that describes content in terms of audience or content rating, key words for search engine data collection, subject categories, and so forth.

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**Scutter:** In the context of FOAF project, a crawler is called a scutter. Its basic task is not much different from a crawler: it visits the Web and tries to find RDF files.

**SHA1 Algorithm:** A 160bit hash function which resembles the earlier MD5 algorithm. This was designed by the National Security Agency (NSA) to be part of the Digital Signature Algorithm. Cryptographic weaknesses were discovered in SHA1, and the standard was no longer approved for most cryptographic uses after 2010.

**Swoogle:** Swoogle is a search engine for Semantic Web ontologies, documents, terms and data published on the Web.

**Web Ontology Language(OWL):** OWL is a Web Ontology language. Where earlier languages have been used to develop tools and ontologies for specific user communities (particularly in the sciences and in company-specific e-commerce applications), they were not defined to be compatible with the architecture of the World Wide Web in general, and the Semantic Web in particular.

