

The Semantic Web, How Does It Work?

A Technological Overview & Applications to Electronic Commerce

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EECS 547

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In One Sentence

The Semantic Web is **a web of data.**

In One Sentence

The Semantic Web is **a web of data.**

- Machine readable
- Comprised of **Resources**
- Resources connected with *links*

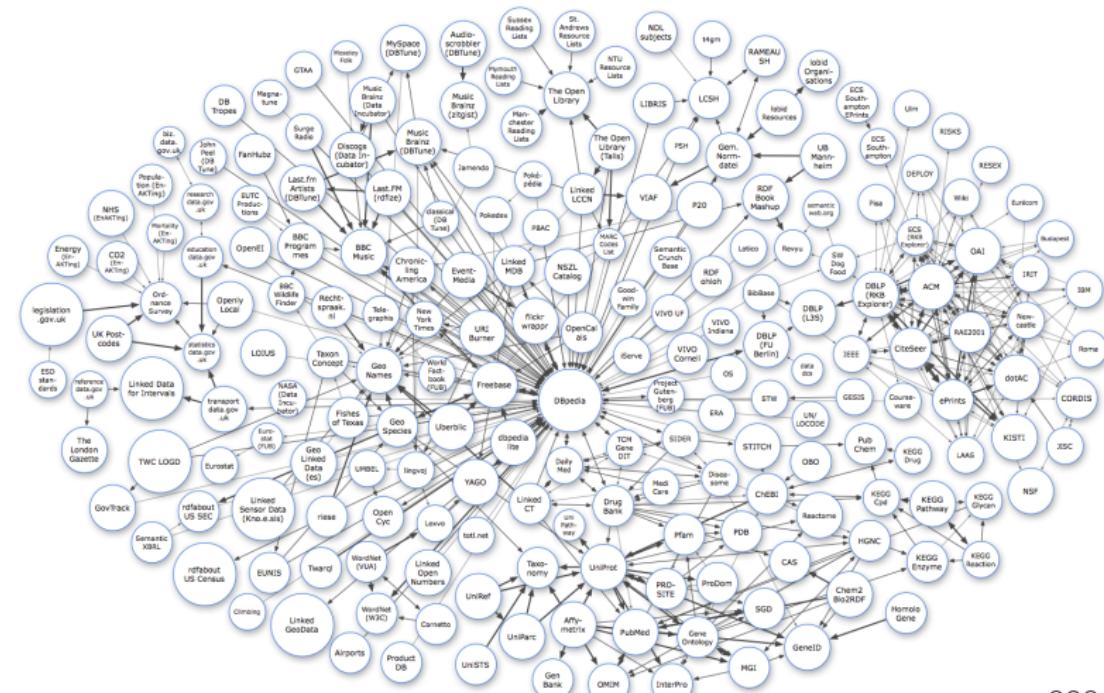
The Concept

"I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web the content, links, and transactions between people and computers. A Semantic Web, which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and our daily lives will be handled by machines talking to machines. The intelligent agents people have touted for ages will finally materialize."

–Tim Berners-Lee, Weaving the Web (1999)

Concept	In One Sentence
Technological Overview	The Concept
Applications	Linked Data
Summary	E-Commerce

Linked Data



Stephen Balaban

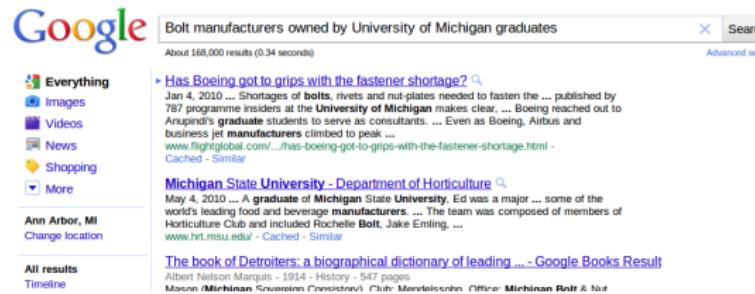
HDIW: The Semantic Web

E-Commerce Context

The semantic web helps automate the *Connection* facet of Electronic Commerce. The emergence of a Semantic Web will allow for the automated discovery of products and services and the people that need them.

E-Commerce Context

Doing entity-specific queries using text is currently difficult.



Google search results for the query "Bolt manufacturers owned by University of Michigan graduates". The results page shows a search bar with the query, a link to the search history, and a link to advanced search options. Below the search bar, it says "About 168,000 results (0.34 seconds)". The first result is a link to a news article from FlightGlobal.com about Boeing's fastener shortage, mentioning the University of Michigan. The second result is a link to the Michigan State University Department of Horticulture website, which includes a mention of a graduate named Ed. The third result is a link to Google Books for "The book of Detroiters: a biographical dictionary of leading ... - Google Books Result", which includes a mention of Michigan Bolt & Nut.

Bolt manufacturers owned by University of Michigan graduates

About 168,000 results (0.34 seconds)

Advanced search

Everything Images Videos News Shopping More

Ann Arbor, MI Change location

All results Timeline

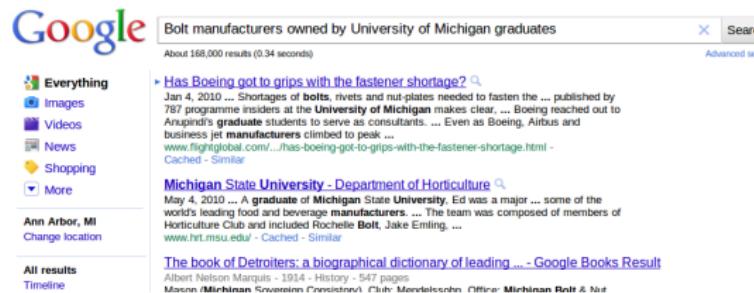
Has Boeing got to grips with the fastener shortage? [Q](#)
Jan 4, 2010 ... Shortages of bolts, rivets and nut-plates needed to fasten the ... published by 787 programme insiders at the **University of Michigan** makes clear, ... Boeing reached out to Arupind's graduate students to serve as consultants. ... Even as Boeing, Airbus and business jet manufacturers climbed to peak ...
www.flighgtglobal.com.../has-boeing-got-to-grips-with-the-fastener-shortage.html - Cached - Similar

Michigan State University - Department of Horticulture [Q](#)
May 4, 2010 ... A graduate of Michigan State University, Ed was a major ... some of the world's leading food and beverage manufacturers. ... The team was composed of members of Horticulture Club and included Rochester Bolt, Jake Emeling, ...
www.hrt.msu.edu - Cached - Similar

The book of Detroiters: a biographical dictionary of leading ... - Google Books Result
Albert Nelson Marquis - 1914 - History - 547 pages
Mason /Michigan Wolverine Chronicle Club; Mendelsohn Office; Michigan Bolt & Nut

E-Commerce Context

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A fully Semantic Web might allow you to execute this query:
"Return me a list of all bolt manufacturers owned by graduates of University of Michigan–Ann Arbor."

Technological Overview

Four main technologies:

- ① Uniform Resource Identifiers (URIs)
- ② Resource Description Framework (RDF)
- ③ Web Ontology Language (OWL)
- ④ SPARQL Protocol and RDF Query Language (SPARQL)

Uniform Resource Identifiers (URIs)

Links to Resources (More than just URLs)

URI	Resource
http://www.stephenbalaban.com/	My Homepage
mailto:sabalaba@umich.edu	My Mailbox
http://www.stephenbalaban.com/#me	Myself (Person)

Resource Description Framework (RDF)

RDF/XML syntax:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
           xmlns:contact="http://www.w3.org/2000/10/swap/pim/contact#">
  <contact:Person rdf:about="http://www.whitehouse.gov/people/alincoln/#me">
    <contact:fullName>Abraham Lincoln</contact:fullName>
    <contact:mailbox rdf:resource="mailto:abraham@whitehouse.gov"/>
    <contact:personalTitle>Pres.</contact:personalTitle>
  </contact:Person>
</rdf:RDF>
```

Resource Description Framework (RDF) - FOAF

Source RDF (Friend Of A Friend Vocabulary):

```
<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:Person rdf:ID="me">
    <foaf:name>Stephen Balaban</foaf:name>
    <foaf:depiction>http://www.stephenbalaban.com/me.jpg</foaf:nick>
    <foaf:givenname>Stephen</foaf:givenname>
    <foaf:family_name>Balaban</foaf:family_name>
    <foaf:nick>sabalaba</foaf:nick>
    <foaf:mbox_sha1sum>89040ec96143df2fa32843b671b99f2f83704b4d</foaf:mbox_sha1sum>
    <foaf:homepage rdf:resource="http://www.stephenbalaban.com/" />
    <foaf:schoolHomepage rdf:resource="http://www.umich.edu/" /></foaf:Person>
</rdf:RDF>
```

Resource Description Framework (RDF) - FOAF

Entity Type: Person



Depiction:

Name: Stephen Balaban

First Name: Stephen

Family Name: Balaban

Nickname: sabalaba

Email SHA1: 89040ec96143df2fa32843b671b99f2f83704b4d

Homepage: <http://www.stephenbalaban.com/>

School: University of Michigan

School Homepage: <http://www.umich.edu/>

Web Ontology Language (OWL)

Definition: An ontology is the formal representation of knowledge as a set of concepts within a domain, and the relationships between those concepts.

Web Ontology Language (OWL), cont.

In the Semantic Web, ontologies provide the vocabulary and grammar with which we manipulate resources. Ontologies, and the axioms they set up, allow us to come to logical conclusions about the data we are given.

Web Ontology Language (OWL), cont.

We have two RDF files describing:

- EECS 547 Winter 2011
- Stephen Balaban.

Web Ontology Language (OWL), cont.

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The Ontology provides the ‘rules of operation’ by which we can infer certain things from the data at hand.

Web Ontology Language (OWL), cont.

We have two RDF files describing:

- EECS 547 Winter 2011
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The Ontology provides the ‘rules of operation’ by which we can infer certain things from the data at hand.

$C(x, y) : x \text{ is a class at } y$

$T(x, y) : x \text{ took the class, } y$

$A(x, y) : x \text{ attended } y$

$C(x, y) \wedge T(z, x) \rightarrow A(z, y)$ s is Stephen Balaban, e is EECS 547 and m is UofM

$C(e, m) \wedge T(s, e) \rightarrow A(s, m)$

$\therefore A(s, m)$

Because I took EECS 547, a class at University of Michigan
We can conclude that I attended University of Michigan

The Triple

Subject - Predicate - Object



=



(Abraham Lincoln)

(isA)

(President)

The Triple

Subject - Predicate - Object



\subseteq



(President)

(subclassOf)

(Politician)

SPARQL Protocol and RDF Query Language (SPARQL)

SPARQL is to the Semantic Web what SQL is to Relational Database Management Systems.

SPARQL Protocol and RDF Query Language (SPARQL)

A basic SPARQL query:

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
      gr: <http://purl.org/goodrelations/v1#/>
SELECT ?name ?mbox
WHERE {
  ?person a foaf:Person.
  ?person foaf:name ?name.
  ?person foaf:mbox ?mbox.
  ?person foaf:schoolHomepage http://www.umich.edu/.
  ?person gr:seeks "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations"
}
```

SPARQL Protocol and RDF Query Language (SPARQL)

A basic SPARQL query:

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
      gr: <http://purl.org/goodrelations/v1#/>
SELECT ?name ?mbox
WHERE {
  ?person a foaf:Person.
  ?person foaf:name ?name.
  ?person foaf:mbox ?mbox.
  ?person foaf:schoolHomepage http://www.umich.edu/.
  ?person gr:seeks "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations"
}
```

This query states:

“Return the names and emails of all people who go to University of Michigan who seek to buy *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*”.

Electronic Commerce Applications

- RDFa
- Good Relations Ontology
- hProduct & Microformats

RDFa (Resource Description Framework - in - attributes)

How you can start being 'Semantic' today (microformats):

```
<div xmlns:foaf="http://xmlns.com/foaf/0.1/"  
      xmlns:dc="http://purl.org/dc/elements/1.1/"  
      version="XHTML+RDFa 1.0" xml:lang="en">  
  <h1>Stephen Balaban's Home Page</h1>  
  <p>My name is <span property="foaf:name">Stephen Balaban</span> and I like  
    <a href="http://www.hackerne.ws/" rel="foaf:interest"  
      xml:lang="en">Hacker News</a>.  
  </p>  
</div>
```

Renders As:

Stephen Balaban's Home Page

My name is Stephen Balaban and I like [Hacker News](http://www.hackerne.ws/).

Good Relations: Electronic Commerce Ontology



<http://www.heppnetz.de/projects/goodrelations/>

Good Relations: Electronic Commerce Ontology



<http://www.heppnetz.de/projects/goodrelations/>

Core Classes:

- gr:BusinessEntity – **Business** providing offer
- gr:Offering – **Offer** to sell product or provide service
- gr:ProductOrServiceModel – **Description** of product
- gr:LocationOfSalesOrServiceProvisioning – **Location** of offer

hProduct & Microformats

hProduct – for product and offers (Similar to Good Relations)

Example courtesy http://www.google.com/support/webmasters/bin/answer.py?answer=146750product_page

```
<div itemscope itemtype="http://data-vocabulary.org/Product">
  <span itemprop="brand">ACME</span>
  <span itemprop="name">Executive Anvil</span>
  
  <span itemprop="offerDetails" itemscope itemtype="http://data-vocabulary.org/Offer">
    <meta itemprop="currency" content="USD" />
    $<span itemprop="price">119.99</span>
  </span>
</div>
```

Other Microformats

- hCard – for people/contact info
- hCalendar – for events
- hMedia – for audio/video content
- hNews – for news content
- hReview – for reviews

Learn more at <http://www.microformats.org/>

Good Relations + RDFa or hProduct: Good right now!

Google's 'Rich Snippets' use RDFa/hProduct and GoodRelations.

RDFa or hProduct

+



=

[The Cheesecake Factory - Union Square - San Francisco, CA](#)

1090 reviews - Price range: \$\$

1090 [Reviews](#) of The Cheesecake Factory "We come here when we are in the city. The view from the outside is pretty cool. The wait is PRETTY LONG!"

www.yelp.com/biz/the-cheesecake-factory-san-francisco-2 - Cached - Similar

The Future of the Semantic Web

- **Microformats popular**
- **Industry incumbent support**
- **Popularity of smart mobile devices**
- **Automated Agents**

Resources Used:

Concept:

- <http://www.w3.org/DesignIssues/LinkedData>
- <http://www.w3.org/2001/sw/SW-FAQ#swgoals>
- <http://linkeddata.org/>
- <http://ilamont.blogspot.com/2010/09/encounter-with-tim-berners-lee-and.html>
- <http://www.mpi-inf.mpg.de/yago-naga/yago/demo.html>
- <http://webscience.org/about/people/>
- http://richard.cyganiak.de/2007/10/lod/lod-datasets_2010-09-22.html
- <http://www.w3.org/2001/sw/SW-FAQ>

Technology:

- http://en.wikipedia.org/wiki/Dereferenceable_Uniform_Resource_Identifier
- <http://www.w3.org/RDF/>
- <http://www.w3.org/TR/rdf-sparql-query/>
- <http://www.w3.org/TR/owl-ref/>

Applications:

- <http://www.ebusiness-unibw.org/wiki/GoodRelationsQuickstart>
- <http://www.heppnetz.de/ontologies/goodrelations/v1>
- <http://www.google.com/support/webmasters/bin/answer.py?answer=186036>
- <http://en.wikipedia.org/wiki/HCard>
- <http://microformats.org/>

Other:

- FOAF-o-Matic: <http://www.ldodds.com/foaf/foaf-a-matic>