

# **Introduction to Knowledge Graphs and the Semantic Web**

# Questions

- What are Knowledge Graphs
- What is the Semantic Web?
- How are they related?
- How are they being used today?
- What can we expect in the future?



# Web is our greatest knowledge source



But it has limitations





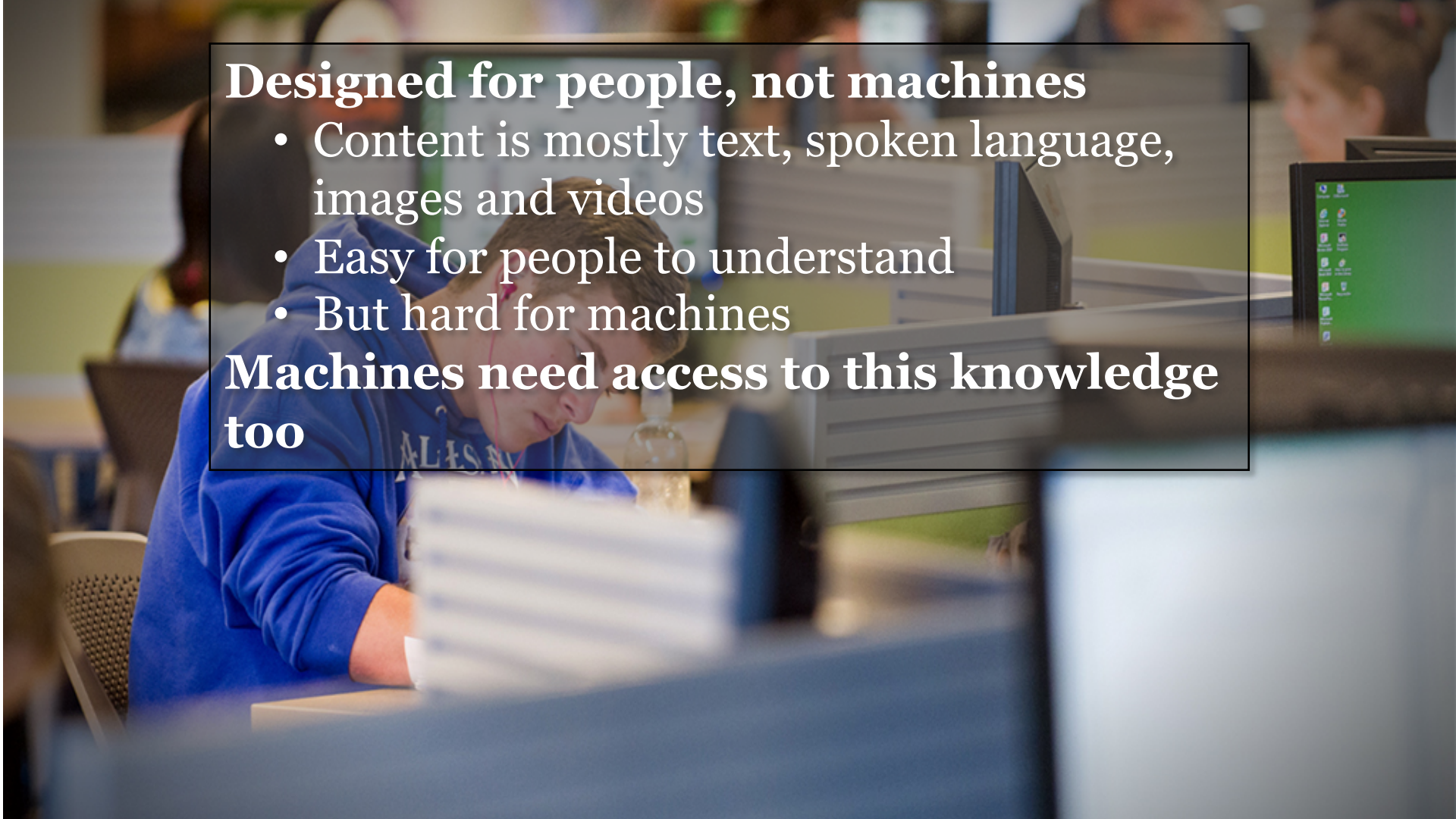
**Designed for people, not machines**



## **Designed for people, not machines**

- Content is mostly text, spoken language, images and videos
- Easy for people to understand
- But hard for machines

**Machines need access to this knowledge too**



# Access via information retrieval

A black and white photograph of Vannevar Bush, a prominent figure in the development of the modern computer. He is shown in a laboratory or office setting, wearing a suit and glasses, leaning over a large, complex mechanical device. The device consists of numerous parallel rods or tubes arranged in a grid-like pattern, which is a key component of his 'memex' concept for information storage and retrieval. The background is slightly blurred, showing other equipment and a window.

Vannevar Bush envisioned a hypertext/IR system in 1945





**Access is primarily via information retrieval**

- Key-word queries→ranked document list

- We still need to read the documents or watch the videos

- We often want an answer to a question:

*where is the Census Big Data Day event*

**And so do our machines and apps**

**Vannevar Bush envisioned a hypertext/IR**

We need to add knowledge graphs







# We need to add knowledge graphs

- High quality semi-structured information about entities and relations
- Represented and accessed via Web standards
- Easily integrated, fused and reasoned with



# State of the Art?



**Google** is a good example, but Microsoft, IBM, Apple and Facebook all have similar capabilities

- 2010 Google acquired MediaWeb and its **Freebase** KB
- 2014: Freebase: 1.2B facts about 43M entities
- 2015+: Google knowledge graph, updated by text IE

**DBpedia** open source RDF KB is another

- 800M facts about 4.6M subjects from English **Wikipedia**, data available in 21 other languages
- Helps integrate 90B facts from 1000 RDF datasets in the linked data cloud

# Ask: When was Tom Sawyer

when was tom sawyer written

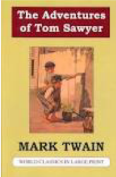
when was tom sawyer written

All Images Videos News Shopping More Settings Tools

About 501,000 results (0.56 seconds)

The Adventures of Tom Sawyer / Date written

1876



Aunt Polly (aunt), Sally Phelps (aunt), Mary (cousin), Sid (half-brother)  
Thomas "Tom" Sawyer is the title character of the Mark Twain novel *The Adventures of Tom Sawyer* (1876). He appears in three other novels by Twain: *Adventures of Huckleberry Finn* (1884), *Tom Sawyer Abroad* (1894), and *Tom Sawyer, Detective* (1896).

[Tom Sawyer - Wikipedia](#)  
[https://en.wikipedia.org/wiki/Tom\\_Sawyer](https://en.wikipedia.org/wiki/Tom_Sawyer)

Feedback

People also ask

Where was *The Adventures of Tom Sawyer* first published? ▾

How old is Tom Sawyer in the book? ▾

What is the setting for *The Adventures of Tom Sawyer*? ▾

Who is Tom Sawyer in real life? ▾

Feedback

The Adventures of Tom Sawyer

Novel by Mark Twain

Preview book

Originally published: 1876

Author: Mark Twain

Text: *The Adventures of Tom Sawyer* at Wikisource

Cover artist: Created by Mark Twain

Characters: Tom Sawyer, Huckleberry Finn, Becky Thatcher, Aunt Polly, Joe Harper, Sid Sawyer

Genres: Bildungsroman, Picaresque Fiction, Satire, Folklore, Children's literature

Followed by: *Wuthering Heights*, *The Prince and the Pauper*

Feedback



BROWSE ▾

Find a recipe

Ingredient Search



Create a profile



Home > Recipes > Desserts > Pies > Fruit Pies

## Apple Pie by Grandma Ople



Grandma Ople's Apple Pie  
★★★★★ 1930

# Many commercial recipe sites on Web

26  
"This was my grandmother's apple pie recipe. I have never seen another one quite like it. It will always be my favorite and has won me several first place prizes in local competitions. I hope it becomes one of your favorites as well!"

Featured in Allrecipes Magazine

Save I Made It Rate it Share Print

Recipes Videos Categories Articles



Blueberry Pie  
★★★★★ 1K



All-Day Apple Butter  
★★★★★ 883

### SCHEMA.ORG (GooglePlus rich snippets)

```

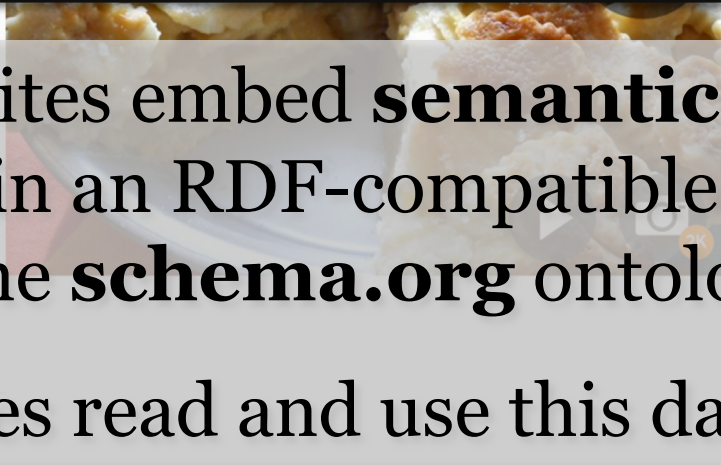
itemprop:url (6) itemprop:mainEntityOfPage (1) itemprop:title (5) itemprop:image (2) itemprop:video (1) itemtype:http://schema.org/VideoObject (1) itemprop:thumbnailUrl (1) itemprop:embedUrl (1) itemprop:name (2) itemprop:description (2) itemprop:interactionCount (1) itemprop:uploadDate (1) itemprop:aggregateRating (1) itemtype:http://schema.org/AggregateRating (1) itemprop:ratingValue (12) itemprop:reviewCount (1) itemprop:author (12) itemprop:recipeYield (1) itemprop:nutrition (2) itemtype:http://schema.org/NutritionInformation (2) itemprop:calories (1) itemprop:fatContent (1) itemprop:carbohydrateContent (1) itemprop:proteinContent (1) itemprop:cholesterolContent (1) itemprop:sodiumContent (1) itemprop:ingredients (7) itemprop:prepTime (1) itemprop:cookTime (1) itemprop:totalTime (1) itemprop:recipeInstructions (1) itemprop:review (11) itemtype:http://schema.org/Review (11) itemprop:itemReviewed (11) itemprop:reviewRating (11) itemtype:http://schema.org/Rating (11) itemprop:dateCreated (11) itemprop:reviewBody (11)

```

9K made it | 6969 reviews

Most recipe sites embed **semantic data** about their recipes in an RDF-compatible form using terms from the **schema.org** ontology

Search engines read and use this data to better understand the semantics of the page content



Related

Recipes Videos Categories Articles

Apple Butter

★★★★★ 1K

★★★★★ 883



# Conversational Bots

Voice-driven conversational systems like Amazon Echo and Google Home use knowledge graphs to help understand our requests



# Where does the knowledge come from?

- Knowledge graphs like *DBpedia* and *Freebase* started with **Wikipedia** data encoded in custom ontologies
- Semantic Web technologies are an open source way to encode the knowledge
- They are and will continue to evolve
- Current: extract data from text documents, e.g., articles, newswire, social media, etc.

# Who invented the Web?



# Who invented the Web?





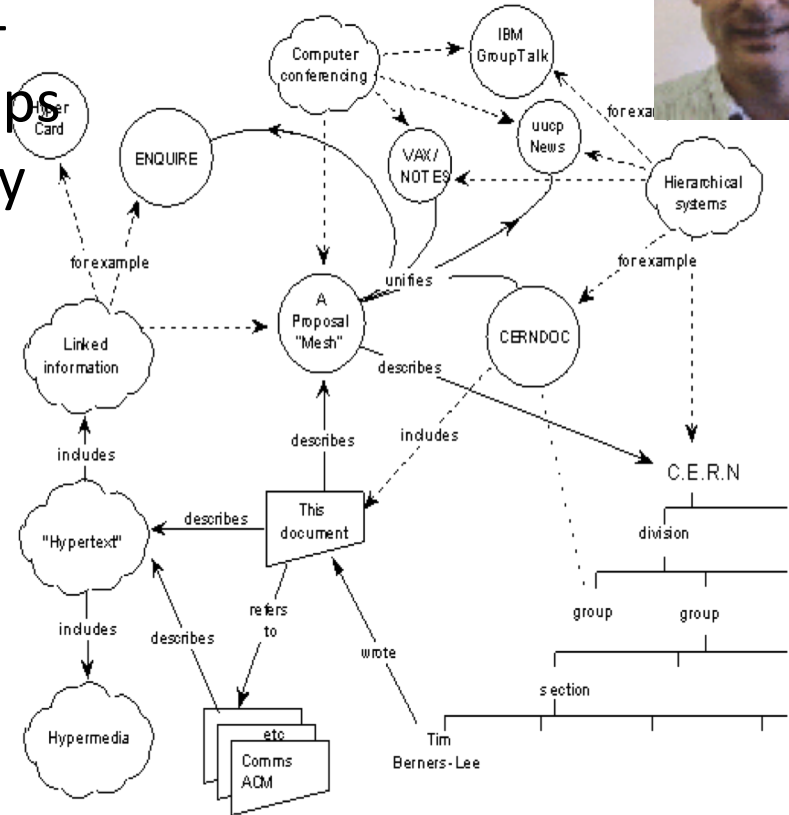
# Semantic Web Origin



Tim Berners-Lee's original 1989 proposal described a web of relationships among named objects unifying many information management tasks

## Capsule history

- Guha's MCF (~94)
- XML+MCF=>RDF (~96)
- RDF+OO=>RDFS (~99)
- RDFS+KR=>DAML+OIL (00)
- W3C's SW activity (01)
- W3C's OWL (03)
- ...



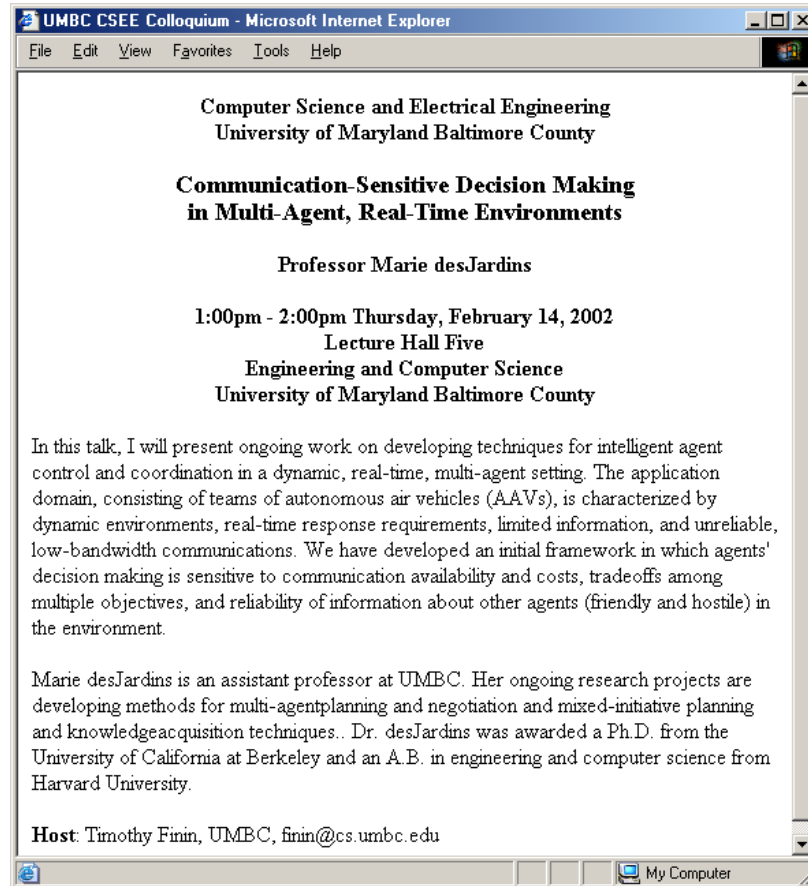
# W3C's Semantic Web Goals

## Focus on machine consumption:

*"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."*

-- Berners-Lee, Hendler and Lassila, The Semantic Web, Scientific American, 2001

# Why is this hard?



UMBC CSEE Colloquium - Microsoft Internet Explorer

File Edit View Favorites Tools Help

**Computer Science and Electrical Engineering**  
**University of Maryland Baltimore County**

**Communication-Sensitive Decision Making**  
**in Multi-Agent, Real-Time Environments**

**Professor Marie desJardins**

**1:00pm - 2:00pm Thursday, February 14, 2002**  
**Lecture Hall Five**  
**Engineering and Computer Science**  
**University of Maryland Baltimore County**

In this talk, I will present ongoing work on developing techniques for intelligent agent control and coordination in a dynamic, real-time, multi-agent setting. The application domain, consisting of teams of autonomous air vehicles (AAVs), is characterized by dynamic environments, real-time response requirements, limited information, and unreliable, low-bandwidth communications. We have developed an initial framework in which agents' decision making is sensitive to communication availability and costs, tradeoffs among multiple objectives, and reliability of information about other agents (friendly and hostile) in the environment.

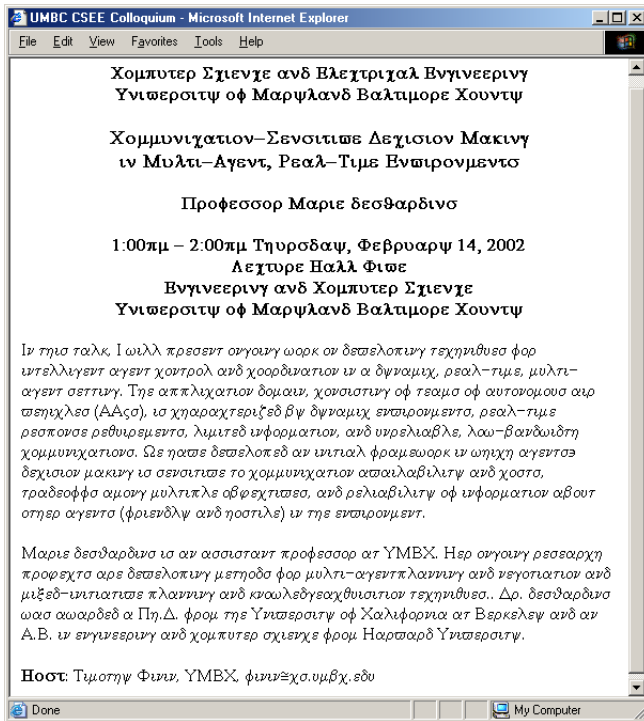
Marie desJardins is an assistant professor at UMBC. Her ongoing research projects are developing methods for multi-agent planning and negotiation and mixed-initiative planning and knowledge acquisition techniques. Dr. desJardins was awarded a Ph.D. from the University of California at Berkeley and an A.B. in engineering and computer science from Harvard University.

**Host:** Timothy Finin, UMBC, [finin@cs.umbc.edu](mailto:finin@cs.umbc.edu)

My Computer

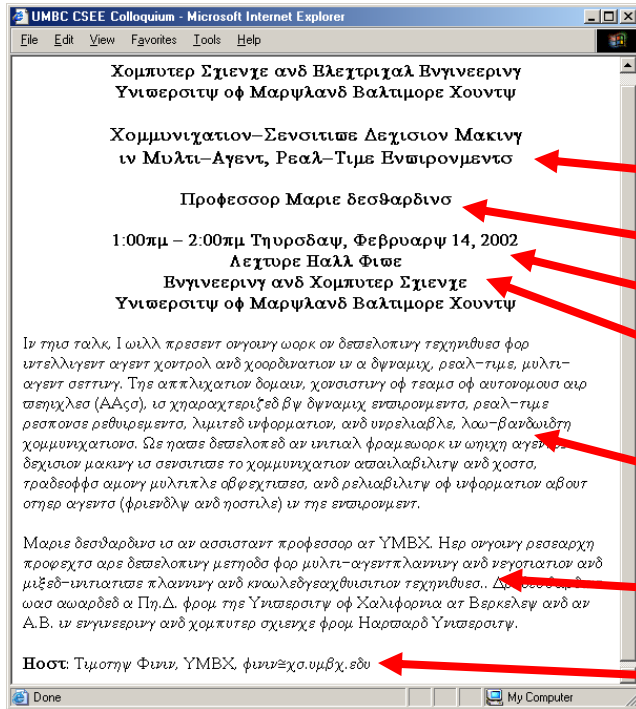
after Frank van Harmelen  
and Jim Hendler

# What this looks like to a machine...



after Frank van Harmelen  
and Jim Hendler

# OK, so HTML is not helpful



Maybe we can tell the machine what the different parts of the text represent?

title

speaker

time

location

abstract

biosketch

host

# XML to the rescue?

UMBC CSEE Colloquium - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Χομπυτερ Σχιενιχε ανδ Ηλεκτριχαλ Ενγνεερινγ  
Υνιωερσιτυ οφ Μαρψλανδ Βαλτιμορε Χουντυ

**<title>** Χομμυνηχατιον-Σενσιτιβε Δεχισιον Μακινγ **</title>**  
ιν Μυλτι-Αγεντ, Ρεαλ-Τιμε Ενβαριονμεντο

**<speaker>** Προφεςσορ Μαριε δεσθαριντο **</speaker>**

**<time>** 1:00πμ - 2:00πμ Τηυροδαψ, Φεβρουαρη 14, 2002 **</time>**  
Λεχτυρε Χαλλ Φιωε

**<location>** Ενγνεερινγ ανδ Χομπυτερ Σχιενιχε **</location>**  
Υνιωερσιτυ οφ Μαρψλανδ Βαλτιμορε Χουντυ

**<abstract>** *Ιν τηισ ταλλκ, Ιωιλλ πρεσεντ ονγουνγ ωορκ ον δεσελοπινγ τεχηνηθεσ φορ  
μυλτι-αγεντ χοντρολ ανδ χοορδινατιον ιν α δυναμιχ, ρεαλ-τιμε, μυλτι-  
αγεντ σερβιτυ. Τηε αππλιχατιον δομαιν, χονοιστινγ οφ τεαμο οφ αυτονομουσ αιω  
σπειχλεσ (ΑΑςσ), ισ χηαραχτεριζεδ βγ δυναμιχ ενβαριονμεντα, ρεαλ-τιμε  
ρεσπονσε ρεθιουρεμεντα, λιμιτεδ ινφορματιον, ανδ υνρελιαβλε, λω-βανδωιδη  
χομμυνηχατιονα. Ωε ηαστε δεσελοπεδ αν ιντιαλ φοραμωορκ ιν ωηιχη αγεντασ  
δεχισιον μακινγ ισ σενσιτιβε το χομμυνηχατιον ασαιλαβιλιτυ ανδ χαστο,  
προδεοφοσ ομοργ μυλτιπλεσ οβφεχτιωεσ, ανδ ρελιαβιλιτυ οφ ινφορματιον αβουτ  
στηρε αγεντα (φοιενδλγ ανδ ηοστιλε) ιν τηε ενβαριονμεντ.* **</abstract>**

**<biosketch>** *Μαριε δεσθαριντο ισ αν ασισταντ προφεςσορ ατ ΥΜΒΧ. Ηερ ονγουνγ ρεσαορχη  
τεχηνηθεσ δεσελοπινγ μετηοδ φορ μυλτι-αγεντπλανινγ ανδ νεγοτιατιον ανδ  
μιξεδ-ιντιατιωεσ πλανινγ ανδ κνωλεδγεσραχθισιτιον τεχηνηθεσ.. Δο, δεσθαριντο  
ωασ ακωαρδεδ α Πη.Δ. φορμ τηε Υνιωερσιτυ οφ Χαλιφορνια οφ Βερμολεγ ανδ ατ  
Α.Β. ιν ενγνεερινγ ανδ χομπυτερ σχιενιχε φορμ Ηαρσαορδ Υνιωερσιτυ.* **</biosketch>**

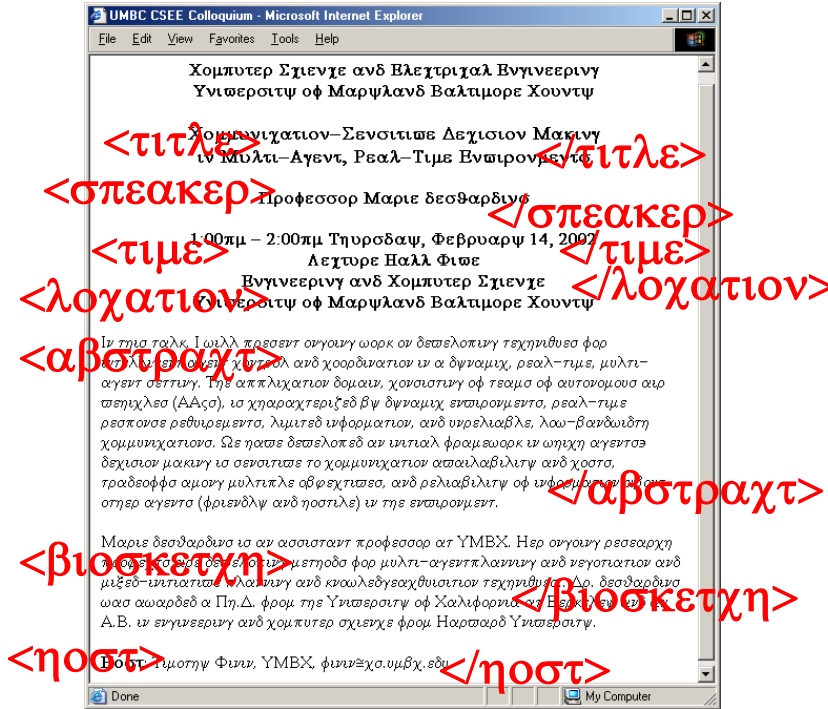
**<host>** Ηοστ: Τιμοτην Φιιν, ΥΜΒΧ, φιιννεχσ.υμβχ.εδυ **</host>**

Done My Computer

XML fans propose creating a XML tag set to use for each application.

For talks, we can choose **<title>**, **<speaker>**, etc.

# XML ≠ machine accessible meaning



But, to your machine,  
the tags still look like  
this....

The tag names carry  
no meaning.

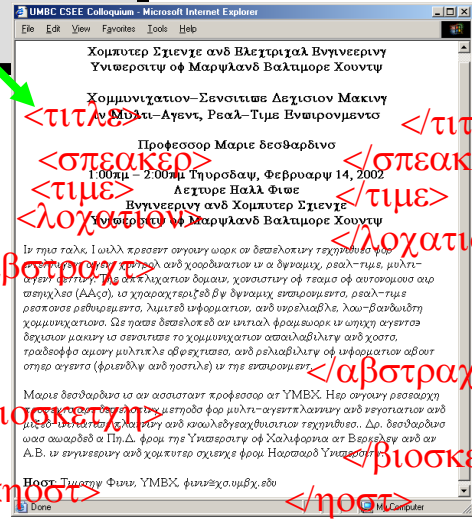
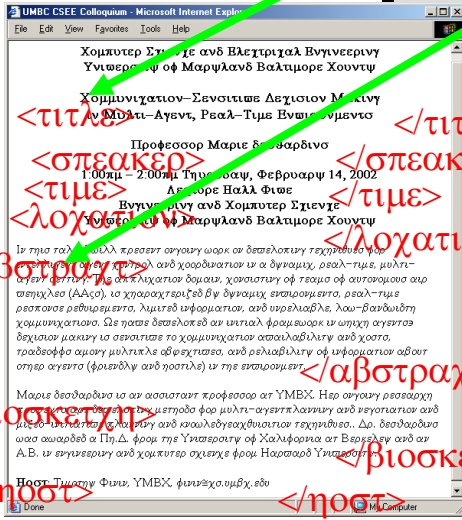
XML DTDs and  
Schemas have little or  
no semantics.

# XML Schema helps

XML Schema file

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="book">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="title" type="xs:string"/>
        <xs:element name="author" type="xs:string"/>
        <xs:element name="character" minOccurs="0" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="name" type="xs:string"/>
              <xs:element name="friend-of" type="xs:string" minOccurs="0"
                maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element name="date" type="xs:date"/>
        <xs:element name="qualification" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="isbn" type="xs:string"/>
</xs:schema>
```

XML Schemas provide a simple mechanism to define shared vocabularies.





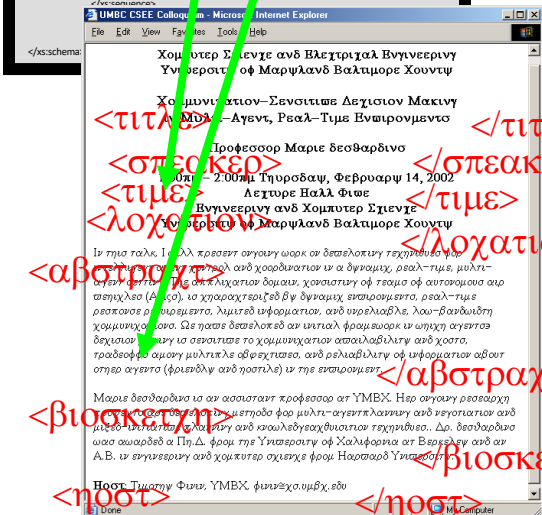
# But there are many schemas

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" >
  <xs:element name="book">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="title" type="xs:string"/>
        <xs:element name="author" type="xs:string"/>
        <xs:element name="character" minOccurs="0" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="name" type="xs:string"/>
              <xs:element name="friend-of" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
              <xs:element name="date" type="xs:date"/>
              <xs:element name="qualification" type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

XML Schema file 1

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" >
  <xs:element name="book">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="title" type="xs:string"/>
        <xs:element name="author" type="xs:string"/>
        <xs:element name="character" minOccurs="0" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="name" type="xs:string"/>
              <xs:element name="friend-of" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
              <xs:element name="since" type="xs:date"/>
              <xs:element name="qualification" type="xs:string"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

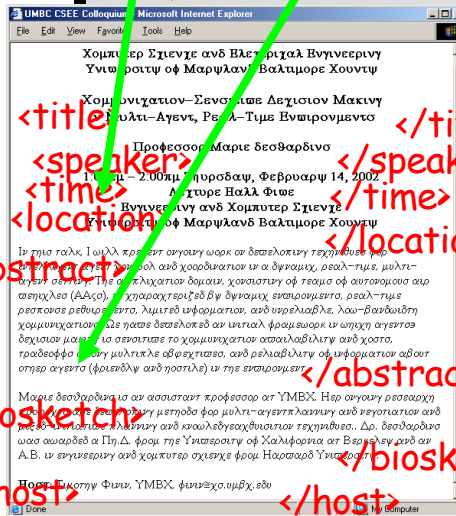
XML Schema file 2



<abstract>

<biosketch>

<host>



<abstract>

<biosketch>

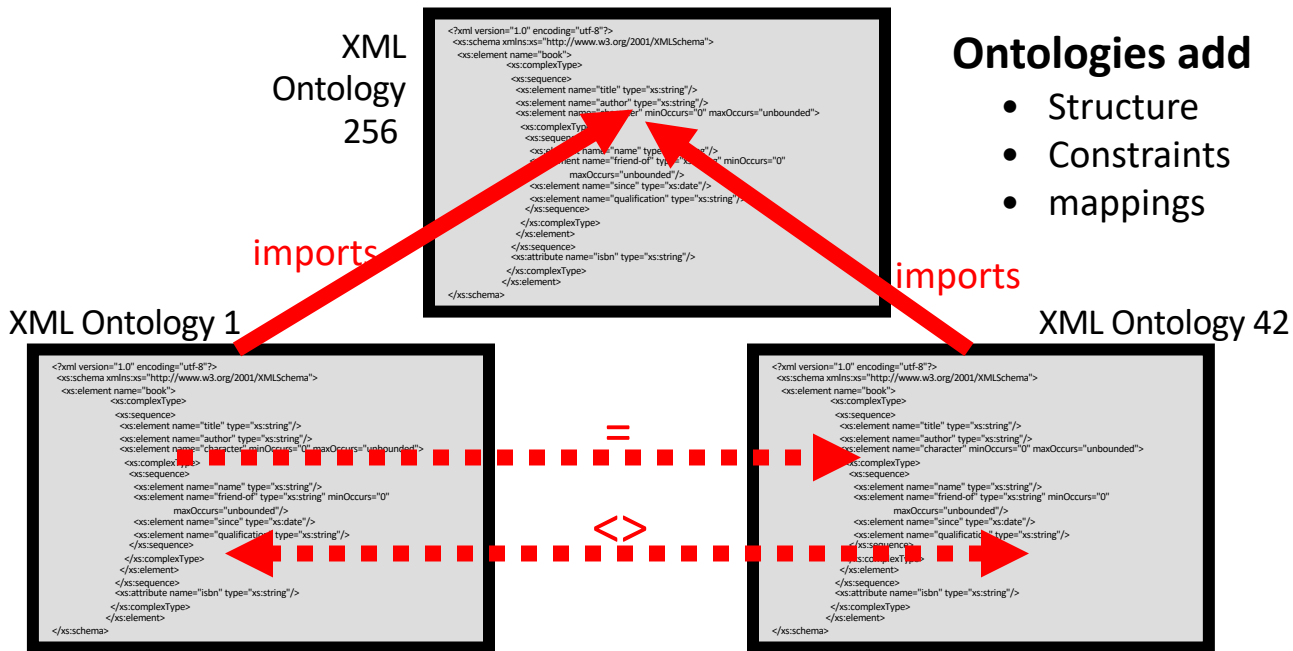
<host>

# There's no way to relate schema

The diagram illustrates the disconnect between XML Schema and semantic content. At the top, two XML Schema files are shown side-by-side, labeled 'XML Schema file 1' and 'XML Schema file 42'. A dashed line with two large red 'X' marks connects them, signifying that the schema files themselves do not contain or define semantic relationships. Below each schema is a screenshot of a browser window displaying the XML content rendered as text. Red annotations are overlaid on the rendered text, identifying semantic elements that are not explicitly defined in the schema files shown above. These annotations include: <title>, </title>, <speaker>, </speaker>, <time>, </time>, <location>, </location>, <abstract>, </abstract>, <biosketch>, </biosketch>, and <host>, </host>. The rendered text in the browser windows is in Greek and describes a presentation by Professor Marie Deschardis at YMBX.

Either manually or automatically.  
XML Schema is weak on semantics.

# An Ontology level is needed



**We need a way to define ontologies in XML**

So we can relate them

So machines can understand (to some degree) their meaning

# Semantic Web

Use Semantic Web Technology  
to publish shared data &  
knowledge

Semantic web technologies  
allow machines to share  
data and knowledge using  
common web language  
and protocols.

~ 1997

Semantic Web beginning

# Semantic Web => Linked Open Data

Use Semantic Web Technology  
to publish shared data &  
knowledge



Data is inter-  
linked to support inte-  
gration and fusion of knowledge

LOD beginning

# The node in the center is DBpedia



The screenshot shows a web browser window with the address bar containing the URL `dbpedia.org/page/University_of_Maryland,_Baltimore_Co...`. The page title is "About: University of Maryland, Baltimore County". The DBpedia logo is visible in the top left. Below the title, there is a description: "An Entity of Type : National Space Grant College and Fellowship Program, from Named Graph : http://dbpedia.org, within Data Space : dbpedia.org". A paragraph of text follows: "The University of Maryland, Baltimore County (often referred to as UMBC) is an American public research university, located in Baltimore County, Maryland, United States, mostly in the community of Catonsville, approximately 10 minutes (8.3 miles) from downtown Baltimore City and 30 minutes (33.5 miles) from Washington, D.C." Below this text is a table with two columns: "Property" and "Value". The table contains one row with the property `dbo:abstract` and a value that is a truncated version of the paragraph above.

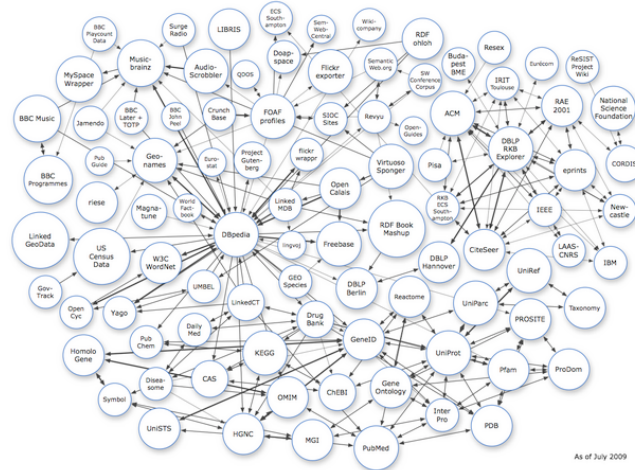
Property	Value
<code>dbo:abstract</code>	<ul style="list-style-type: none"><li>The University of Maryland, Baltimore County (often referred to as UMBC) is an American public research university, located in Baltimore County, Maryland, United States, mostly in the community of Catonsville,</li></ul>

[http://dbpedia.org/page/University\\_of\\_Maryland,\\_Baltimore\\_County](http://dbpedia.org/page/University_of_Maryland,_Baltimore_County)



# Semantic Web => Linked Open Data

Use Semantic Web Technology  
to publish shared data &  
knowledge



2009

Data is inter-  
linked to support inte-  
gration and fusion of knowledge

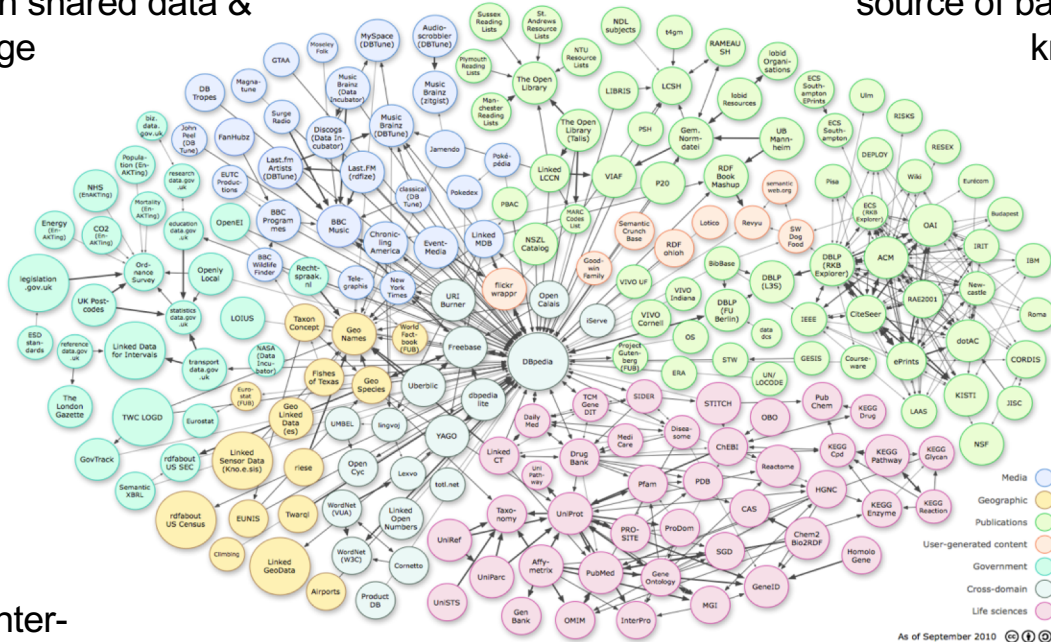
... and growing



# Linked Open Data

Use Semantic Web Technology to publish shared data & knowledge

LOD is the new Cyc: a common source of background knowledge



Data is inter-linked to support integration and fusion of knowledge

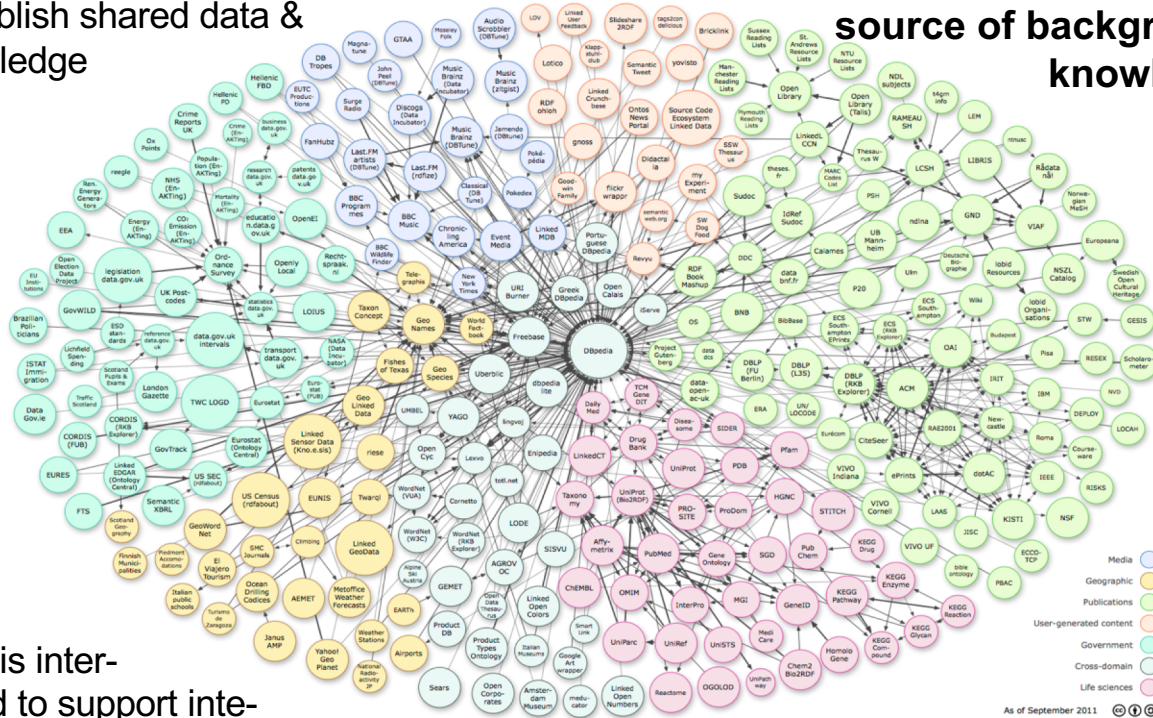
2010

...growing faster

# Linked Open Data

Use Semantic Web Technology to publish shared data & knowledge

LOD is the new Cyc: a common source of background knowledge



Data is inter-linked to support integration and fusion of knowledge

2011: 31B facts in 295 datasets interlinked by 504M assertions on [ckan.net](http://ckan.net)

# Semantic Web: 1, 2, 3

Languages typically divided into three parts:

- 1. Syntax:** legal forms that make up the sentences in a language
- 2. Semantics:** mapping of sentences to meaning (perhaps truth theoretic)
- 3. Pragmatics:** everything else (how to do things with language, knowledge of world, etc.)

# 1: Syntax

- **URIs** denote classes, properties, objects, relations
    - [http://live.dbpedia.org/resource/Alan\\_Turing](http://live.dbpedia.org/resource/Alan_Turing)
    - <http://schema.org/Person>
    - <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
  - Use strings for literals
  - Use **triples** to make statements
    - dbpedia:Alan\_Turing    rdfs:type    schema:Person .
    - “Alan Turing is a Person”
- \*URI = [Uniform Resource Identifier](#)

## 2: Semantics

- Semantics maps URIs to the things they denote in “the world”
- Some of this is in your mind or in how you write your program
- Meaning of some URIs allow **inference**
  - **parent** relation is **inverse** of the **child** relation
  - schema:parent owl:inverse schema:child

# 3: Pragmatics

- Semantics is more than just about truth (statements that assert things)
- Must account for commands, requests, questions, context, etc.
  - Some handled by Web protocols (GET, POST)
  - Some by special protocols (e.g., SPARQL queries)
  - Some by having reference KBs of the world (e.g., DBpedia) to help identify common entities

# Where are we

- The W3C version of the open semantic web has been growing steadily
- Languages and standards are being used in
  - BBC uses RDF to make up much of its content online
  - Google and Facebook detect AND MAKE USE OF (some) RDF embedded in html pages
  - Google, Yahoo, Microsoft and Yandex formed [Schema.org](http://Schema.org) to develop useful vocabularies
  - Data.gov has many datasets in RDF

Wikipedia data  
in RDF

# DBpedia

dbpedia.org/page/Alan\_Turing

dbpedia-owl:almaMater	<ul style="list-style-type: none"><li>dbpedia:King's_College,_Cambridge</li><li>dbpedia:Princeton_University</li></ul>
dbpedia-owl:award	<ul style="list-style-type: none"><li>dbpedia:Royal_Society</li><li>dbpedia:Order_of_the_British_Empire</li><li>dbpedia:Fellow_of_the_Royal_Society</li><li>dbpedia:Officer_of_the_Order_of_the_British_Empire</li></ul>
dbpedia-owl:birthDate	<ul style="list-style-type: none"><li>1912-06-23 (xsd:date)</li><li>1912-06-23 (xsd:date)</li></ul>
dbpedia-owl:birthName	<ul style="list-style-type: none"><li>Alan Mathison Turing</li></ul>
dbpedia-owl:birthPlace	<ul style="list-style-type: none"><li>dbpedia:Paddington</li><li>dbpedia:Maida_Vale</li></ul>
dbpedia-owl:deathDate	<ul style="list-style-type: none"><li>1954-06-07 (xsd:date)</li></ul>
dbpedia-owl:deathPlace	<ul style="list-style-type: none"><li>dbpedia:Wilmslow</li></ul>
dbpedia-owl:doctoralAdvisor	<ul style="list-style-type: none"><li>dbpedia:Alonzo_Church</li></ul>
dbpedia-owl:doctoralStudent	<ul style="list-style-type: none"><li>dbpedia:Robin_Gandy</li></ul>
dbpedia-owl:field	<ul style="list-style-type: none"><li>dbpedia:Computer_science</li><li>dbpedia:Mathematics</li><li>dbpedia:Cryptanalysis</li></ul>
dbpedia-owl:individualisedPnd	<ul style="list-style-type: none"><li>118802976</li></ul>
dbpedia-owl:knownFor	<ul style="list-style-type: none"><li>dbpedia:Turing_machine</li><li>dbpedia:Cryptanalysis_of_the_Enigma</li><li>dbpedia:Automatic_Computing_Engine</li><li>dbpedia:Turing_test</li></ul>

dbpedia:Alan\_Turing    dbpedia-owl:doctoralAdvisor    dbpedia:Alonzo\_Church .



# Wikidata

- [Wikidata](#) aims to create an rdf-like KG that can be read/edited by humans & machines
  - Wikimedia project started in April 2012
- Wikidata clients use the repository, e.g., to populate Web pages or Wikipedia infoboxes
- Based on ideas from [Semantic MediaWiki](#) and [Freebase](#)

Open source  
since 2005

# Semantic Media Wiki

Store infobox  
info in a KB

The screenshot shows the Semantic MediaWiki website in a browser window. The address bar displays "semantic-mediawiki.org/wiki/Semantic\_MediaWiki". The page features a navigation sidebar on the left with sections for "Navigation", "Links", "Download SMW", and "Toolbox". The main content area includes a description of Semantic MediaWiki as a free, open-source extension to MediaWiki, a "More about Semantic MediaWiki" section with links to introduction, FAQ, talks, and testimonials, a "Wiki of the Month - January 2013" section for Triple A wiki, and sections for "Installation", "Usage", "User community", and "The SMW project". A "Download" button highlights the current version, SMW 1.8. The browser's toolbar and search bar are also visible.

semantic-mediawiki.org/wiki/Semantic\_MediaWiki

Create account Log in

Page Discussion View View source History Search

## Semantic MediaWiki (SMW) is a free, open-source extension to MediaWiki – the wiki software that powers Wikipedia – that lets you store and query data within the wiki's pages.

Semantic MediaWiki is also a full-fledged framework, in conjunction with many spinoff extensions, that can turn a wiki into a powerful and flexible “collaborative database”. All data created within SMW can easily be published via the [Semantic Web](#), allowing other systems to use this data seamlessly.

### More about Semantic MediaWiki

- Introduction to SMW
- FAQ
- Talks and publications
- Testimonials

### Wiki of the Month - January 2013

**triple A**  
wiki

**Triple A** is a site that provides IT architecture information for educational organizations. It supports *MBO-scholen* (Dutch secondary schools) wanting to innovate educational processes.

### Installation

## Download

Current version: SMW 1.8

- Semantic MediaWiki 1.8
- Administrator manual
- Installation
- Configuration
- Related extensions

### Usage

- [User manual](#)
- [SMW reference](#)
- [Try out SMW online](#)
- [Reporting bugs and wishes](#)

### User community

- Getting support
- [SMW Community Wiki](#)
- List of SMW-using wikis
- [SMWCon](#), the Semantic MediaWiki Conference

### The SMW project

- About the project
- Version history
- Development roadmap
- Programmer's guide

### News

[RSS](#) [Atom](#)

- 10 January 2013: Survey: What do you want from SMW?

# Freebase

Acquired by  
Google in 2010

The screenshot shows the Freebase website interface. At the top, there's a navigation bar with the Freebase logo, a search bar, and links for Data, Schema, Apps, and Docs. The main content area is for the profile of Alan Turing. On the left, there's a sidebar with a 'Scroll to:' menu listing various categories like People, Literature Subject, Influence Node, etc. The main profile section includes a portrait of Alan Turing, a biographical paragraph, and a list of key facts such as Date of birth, Date of death, Profession, and Country of nationality. Below this is a 'People' section with a table listing related individuals. On the right side, there are sections for 'These people have edited this topic' and 'Related Topics'.

**Alan Turing**

*Scroll to:*

- People
- Literature Subject
- Influence Node
- Computers
- Name source
- Academic
- Chivalric Order Member
- Inventor
- Author
- Person Or Being In Fiction
- Organization member
- Film subject
- TV subject
- More...

**Alan Mathison Turing, OBE, FRS** (/ˈtʃɔːrni/ TEWR-ing; 23 June 1912 – 7 June 1954), was a British mathematician, logician, cryptanalyst, and computer scientist. He was highly influential in the development of computer science, giving a formalisation of the concepts of "algorithm" and "computation" with the Turing machine, which can be considered a model of a general purpose computer. Turing is widely considered to be the father of computer science... [More](#)

[W](#) [Read article at Wikipedia](#)

**Date of birth:** Jun 23, 1912

**Date of death:** Jun 7, 1954 (age 41 years)

**Profession:** [Mathematician](#), [Philosopher](#), [Computer Scientist](#), [Logician](#)

**Country of nationality:** [United Kingdom](#)

**Also known as:** [Alan Mathison Turing](#)

**People**

<b>Place of birth:</b>	<a href="#">Maida Vale, United Kingdom</a>
------------------------	--

**Alan Turing Quotes**

« *Mathematical reasoning may be regarded...* »

« *No, I'm not interested in developing a powerful brain...* »

**These people have edited this topic:**

- [\[Profile\]](#)
- [\[Profile\]](#)
- [\[Profile\]](#)
- [\[Profile\]](#)
- [\[Profile\]](#)

[Edit this topic](#)

Last edited Dec 12, 2012 [See all topic history](#)

**Related Topics**

- [Edward Thomas Hall](#)
- [Alan Turing](#)
- [William Kingdon Clifford](#)
- [Ada Lovelace](#)

**Alan Turing elsewhere on the web**

- [★ Official Website](#)
- [Wikipedia](#)

“An entity graph of people, places and things, built by a community that loves open data”

# Google Knowledge Graph



The screenshot shows the Google Knowledge Graph interface. At the top, the Google logo and "Inside Search" are visible. Below the navigation bar, a large graphic displays a network of interconnected nodes, including a portrait of Leonardo da Vinci, a globe, and various icons. To the right, a detailed profile for Leonardo da Vinci is shown, including his name, a brief biography, and key dates and locations.

**Google** Inside Search

Home Tips & Tricks **Features** Search Stories Playground Blog Help

**The Knowledge Graph**  
Learn more about one of the key breakthroughs behind the future of search.

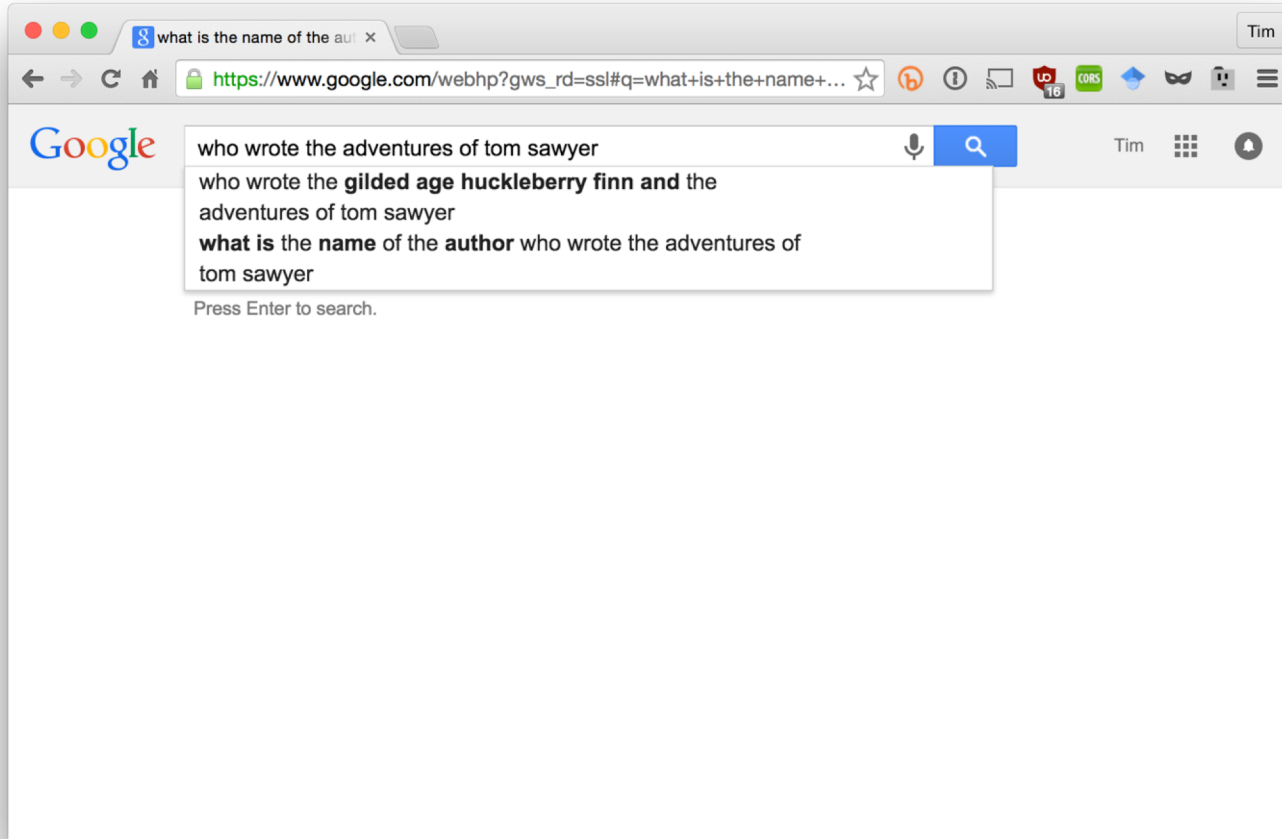
**See it in action**  
Discover answers to questions you thought to ask, and explore collections.

**Leonardo da Vinci**  
Leonardo di ser Piero da Vinci was an Italian Renaissance polymath, painter, sculptor, architect, musician, scientist, mathematician, engineer, inventor, anatomist, geologist, cartographer, botanist, and writer. [View profile](#)

Born: April 15, 1452, Anchiano  
Died: May 2, 1519, Clos Lucé  
Buried: Château d'Amboise  
Parents: Caterina da Vinci, Piero da Vinci  
Structures: [Vespaem Sansi Da Vinci Project](#)

Google's slogan for the knowledge graph: "things, not strings"

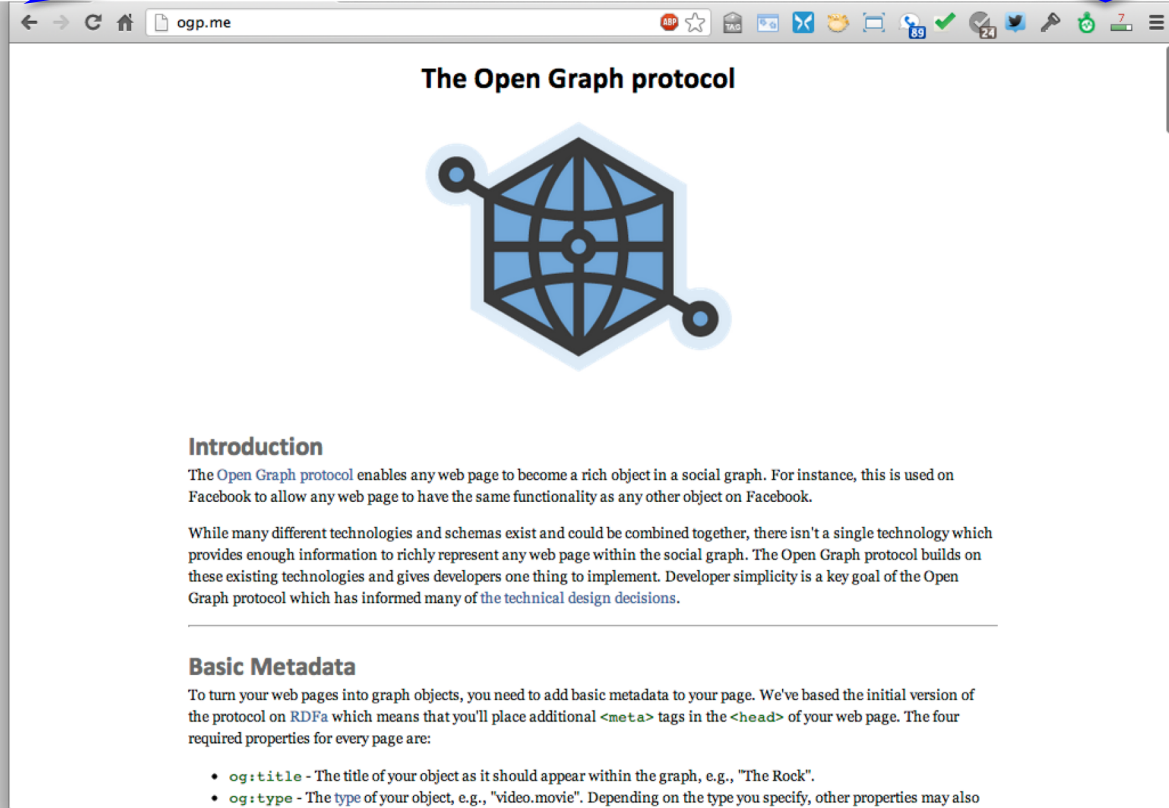
# Who wrote Tom Sawyer?



Annotate your web pages in RDFa


# Facebook Open Graph

=> object in the FB graph

A screenshot of a web browser displaying the 'The Open Graph protocol' page. The browser's address bar shows 'ogp.me'. The page features a large blue hexagonal logo with a globe and nodes. Below the logo, there are sections for 'Introduction' and 'Basic Metadata'. The 'Introduction' section explains that the Open Graph protocol enables any web page to become a rich object in a social graph, used by Facebook. The 'Basic Metadata' section states that to turn web pages into graph objects, basic metadata must be added to the page's head, specifically mentioning RDFa and the <meta> tags. A list of required properties is provided at the bottom.

← → ↻ 🏠 📄 ogp.me

## The Open Graph protocol



### Introduction

The [Open Graph protocol](#) enables any web page to become a rich object in a social graph. For instance, this is used on Facebook to allow any web page to have the same functionality as any other object on Facebook.

While many different technologies and schemas exist and could be combined together, there isn't a single technology which provides enough information to richly represent any web page within the social graph. The Open Graph protocol builds on these existing technologies and gives developers one thing to implement. Developer simplicity is a key goal of the Open Graph protocol which has informed many of [the technical design decisions](#).

---

### Basic Metadata

To turn your web pages into graph objects, you need to add basic metadata to your page. We've based the initial version of the protocol on [RDFa](#) which means that you'll place additional `<meta>` tags in the `<head>` of your web page. The four required properties for every page are:

- `og:title` - The title of your object as it should appear within the graph, e.g., "The Rock".
- `og:type` - The [type](#) of your object, e.g., "video.movie". Depending on the type you specify, other properties may also

speech => text =>  
entities => task

# Apple's SIRI


SIRI engineers  
from AI/SW  
community

www.apple.com/ios/siri/


Store Mac iPod iPhone iPad iTunes Support

iOS

Overview What's New What is iOS

 **Siri.** Beta  
Your wish is its command.

Siri lets you use your voice to send messages, schedule meetings, place phone calls, and more.\* Ask Siri to do things just by talking the way you talk. Siri is so easy to use and does so much, you'll keep finding more and more ways to use it.

9:41 AM  
“What’s the weather like today”  
The weather’s looking good today... up to 81° and partly sunny.  
66°  H: 81° L: 59°  
12:00 PM ● 75°  
1:00 PM ● 75°  
2:00 PM ● 79°  
3:00 PM ● 79°

OK, I can send a text to Cory Quinn for you... what would you like it to say?  
“Be there in 30 minutes”  
I updated your message. Ready to send it?  
To: Cory Quinn  
Be there in 30 minutes

SIRI needs lots of semantic data about entities in the world

# IBM's Watson

The screenshot shows the IBM Watson website homepage. At the top, the URL is [www-03.ibm.com/innovation/us/watson/](http://www-03.ibm.com/innovation/us/watson/). The navigation bar includes the IBM logo, links for "Industries & solutions", "Services", "Products", "Support & downloads", and "My IBM", along with a search bar. The main heading is "IBM Watson: Ushering in a new era of computing". Below this, a section titled "What's next for Watson?" invites users to join a discussion and provides a "Learn more" link. A large graphic of a globe with blue and green lines and radiating lines is on the right. A horizontal menu below the graphic includes "Watson", "Putting Watson to work", "Science behind Watson", "Getting ready for Watson", and "News/events". The "Putting Watson to work" section features a video thumbnail titled "Watson goes to work (1.53MB)" and text stating "Cognitive systems like Watson may transform how organizations think, act, and operate in the future. Learning through interactions, they deliver evidence based responses driving better outcomes." To the right, there are contact options: "Contact IBM about Watson", "Email IBM", and "Or call us at: 1-800-966-9875 Priority code: 109HF03W". Below this is a "Follow IBM Watson" section with a YouTube icon. The "Recent news" section lists two items: "IBM hopes its Watson will become doctor's sidekick" and "IBM Exploring Ways to Use, Sell Watson Cloud Services", with a "More Watson news" link. At the bottom, there are two call-to-action boxes: "Putting Watson to work" with the text "Data is growing at extraordinary rates - 800" and "Take the next step" with the text "Is your business ready for Watson? Discover how to prepare your".

**IBM Watson: Ushering in a new era of computing**

**What's next for Watson?**  
We want to hear how YOU would put Watson to work. Join the discussion  
[Learn more](#)

**Watson** | **Putting Watson to work** | **Science behind Watson** | **Getting ready for Watson** | **News/events**

**Watson goes to work** (1.53MB)

Cognitive systems like Watson may transform how organizations think, act, and operate in the future. Learning through interactions, they deliver evidence based responses driving better outcomes.

**Contact IBM about Watson**  
[Email IBM](#)  
Or call us at: 1-800-966-9875  
Priority code: 109HF03W

**Follow IBM Watson**

**Recent news**  
[IBM hopes its Watson will become doctor's sidekick](#)  
[IBM Exploring Ways to Use, Sell Watson Cloud Services](#)  
[More Watson news](#)

**Putting Watson to work**  
Data is growing at extraordinary rates - 800

**Take the next step** Is your business ready for Watson? Discover how to prepare your

IBM used Semantic Web technology and data in Watson, see <http://bit.ly/X44aIE>



A collection of useful ontologies

# Schema.org

Embed in HTML using RDFa to make machine understand-able statements

The screenshot shows a web browser window displaying the Schema.org website. The address bar shows 'schema.org/Person'. The page has a red header with the 'schema.org' logo, a search bar, and navigation links for 'Home', 'Schemas', and 'Documentation'. The main content area is titled 'Thing > Person' and includes a description: 'A person (alive, dead, undead, or fictional)'. Below this is a table listing properties from 'Thing' and 'Person'.

Property	Expected Type	Description
<b>Properties from <a href="#">Thing</a></b>		
<a href="#"><u>additionalType</u></a>	URL	An additional type for the item, typically used for adding more specific types from external vocabularies in microdata syntax. This is a relationship between something and a class that the thing is in. In RDFa syntax, it is better to use the native RDFa syntax - the 'typeof' attribute - for multiple types. Schema.org tools may have only weaker understanding of extra types, in particular those defined externally.
<a href="#"><u>alternateName</u></a>	Text	An alias for the item.
<a href="#"><u>description</u></a>	Text	A short description of the item.
<a href="#"><u>image</u></a>	URL	URL of an image of the item.
<a href="#"><u>name</u></a>	Text	The name of the item.
<a href="#"><u>sameAs</u></a>	URL	URL of a reference Web page that unambiguously indicates the item's identity. E.g. the URL of the item's Wikipedia page, Freebase page, or official website.
<a href="#"><u>url</u></a>	URL	URL of the item.
<b>Properties from <a href="#">Person</a></b>		
<a href="#"><u>additionalName</u></a>	Text	An additional name for a Person, can be used for a middle name.
<a href="#"><u>address</u></a>	<a href="#"><u>PostalAddress</u></a>	Physical address of the item.
<a href="#"><u>affiliation</u></a>	<a href="#"><u>Organization</u></a>	An organization that this person is affiliated with. For example, a school/university, a club, or a team.
<a href="#"><u>alumniOf</u></a>	<a href="#"><u>EducationalOrganization</u></a>	An educational organizations that the person is an alumni of.

# Summary

- Web has made us smarter by sharing information and knowledge as text, audio and images
- Machines should also be able to use the Web to publish & retrieve information & knowledge
- Human forms of knowledge are hard for machines to understand and generate
- The Semantic Web is a collection of languages, ontologies, software tools, services and KBs that are designed to support machines