

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

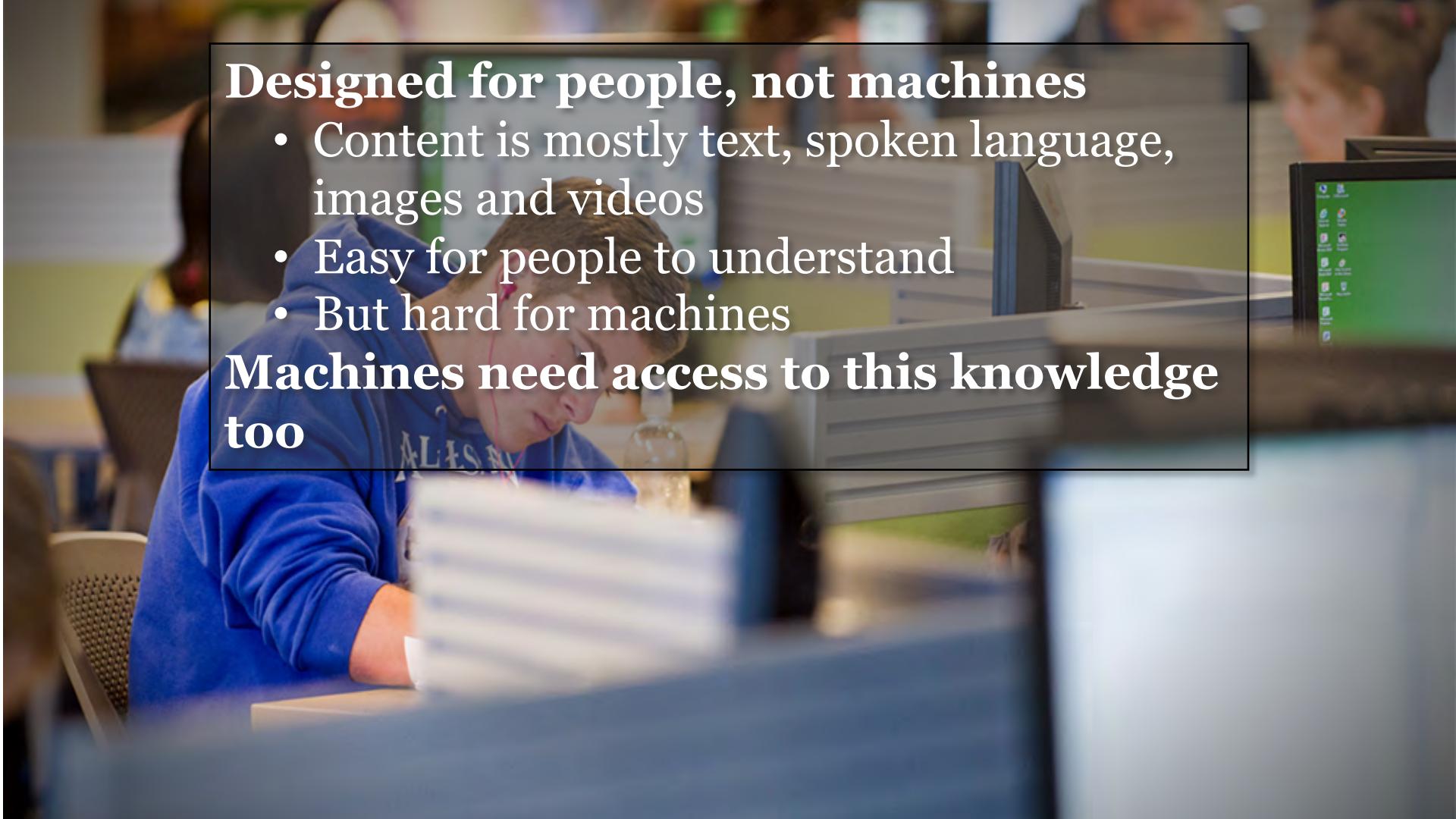


But it has limitations



Designed for people, not machines



A photograph of a person wearing a blue hoodie with "ALLEN" printed on it, sitting at a table and looking down at a document. In the background, there are other people and a computer monitor displaying a green screen with icons.

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



Vannevar Bush envisioned a hypertext/IR system in 1945

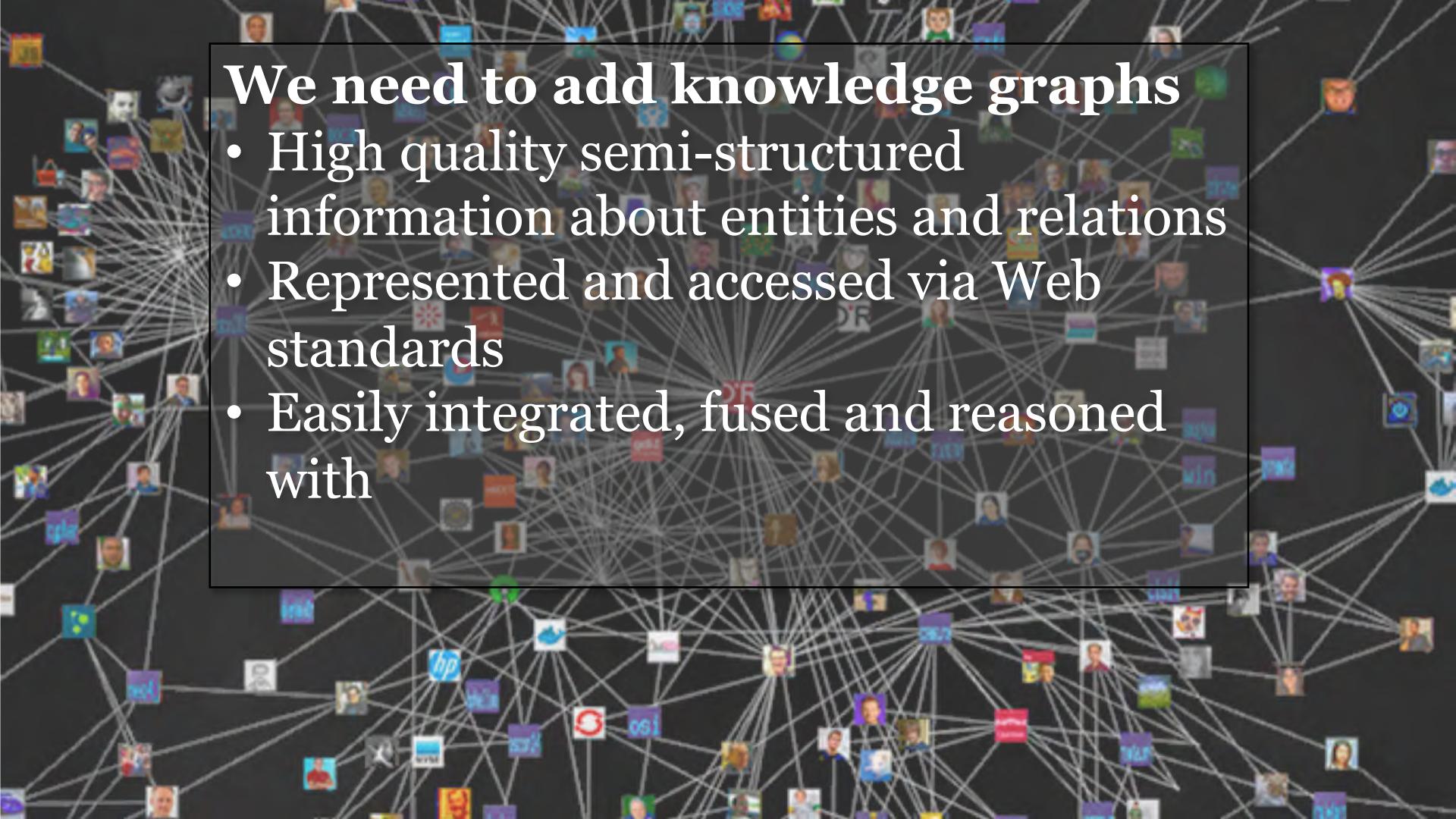
Access is primarily via information retrieval

- 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 system in 1945



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

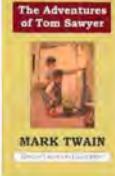
when was tom sawyer written

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

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?

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

Tim

Apple Pie by Grandma Ople x

allrecipes.com/recipe/12682/apple-pie-by-grandma-ople/ 18 20

BROWSE Find a recipe Ingredient Search Create a profile

Home > Recipes > Desserts > Pies > Fruit Pies

Apple Pie by Grandma Ople

5 stars | 6969 reviews

Recipe by: MUMASMAMA

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

Grandma Ople's Apple Pie

5 stars 1930

Many commercial recipe sites on Web

Related

Recipes Videos Categories Articles

Blueberry Pie 5 stars 1K

All-Day Apple Butter 5 stars 883

Apple Pie by Grandma Ople

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

"This was my grandmother's apple pie. I have never had one quite like it. It will always be my favorite and has won me several first place ribbons at local fairs. I hope it becomes one of your favorites as well!"

26

Related

Recipes Videos Categories Articles

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

Conversational Bots

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

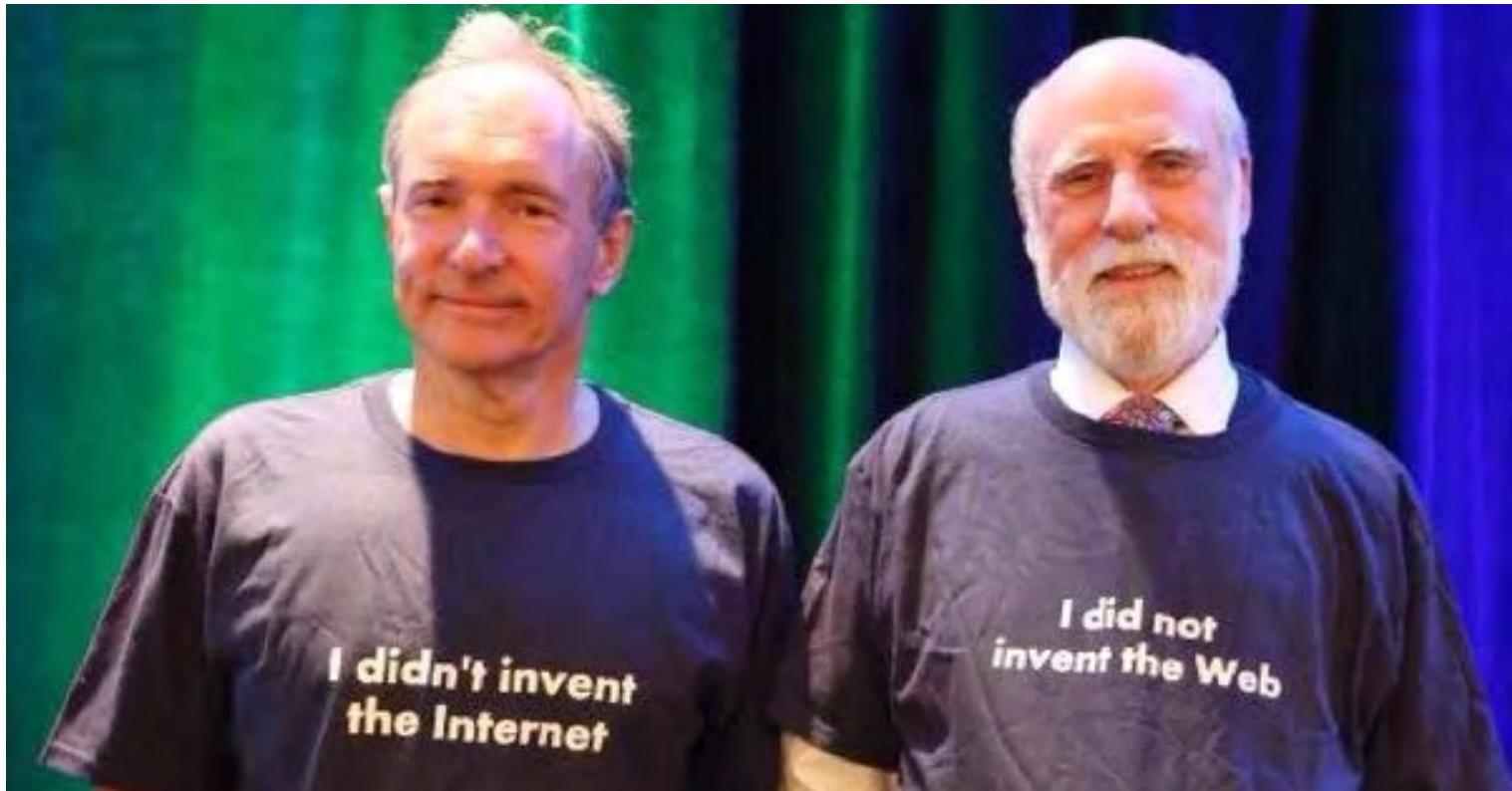


Where does the knowledge come from?

- 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?

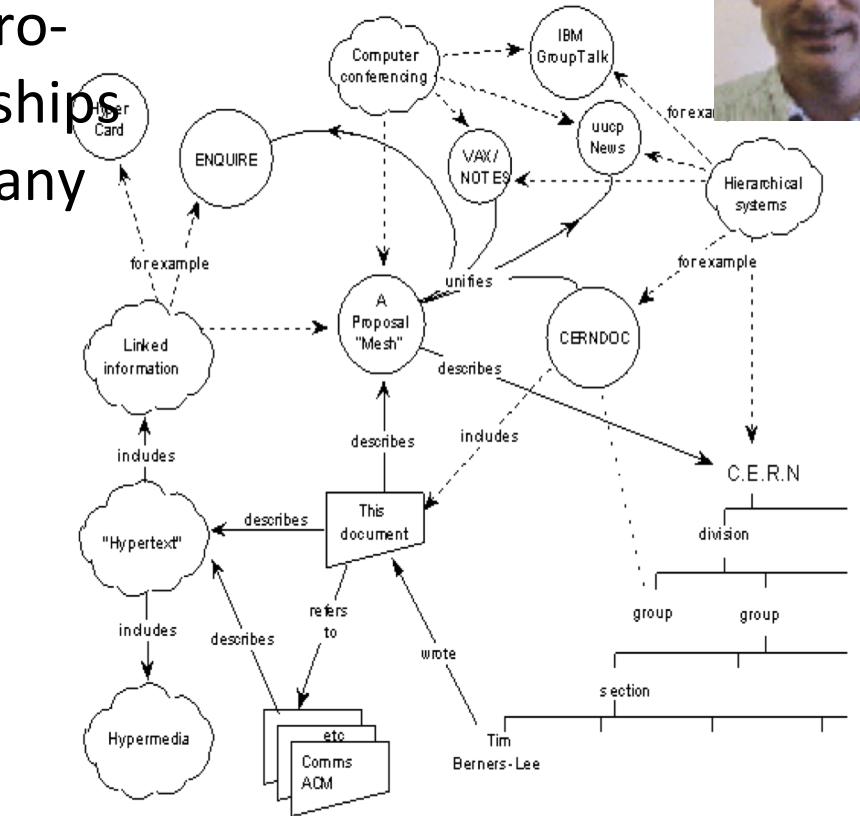


Semantic Web Origin

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)
- ...



<http://www.w3.org/History/1989/proposal.html>

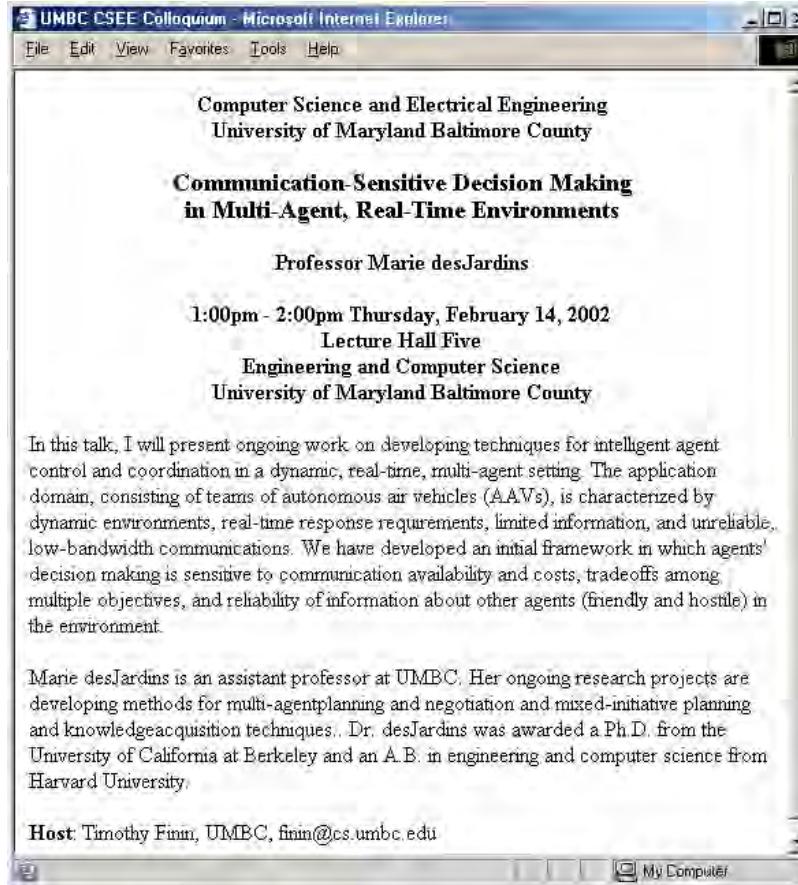
W3C's Semantic Web Goals

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."

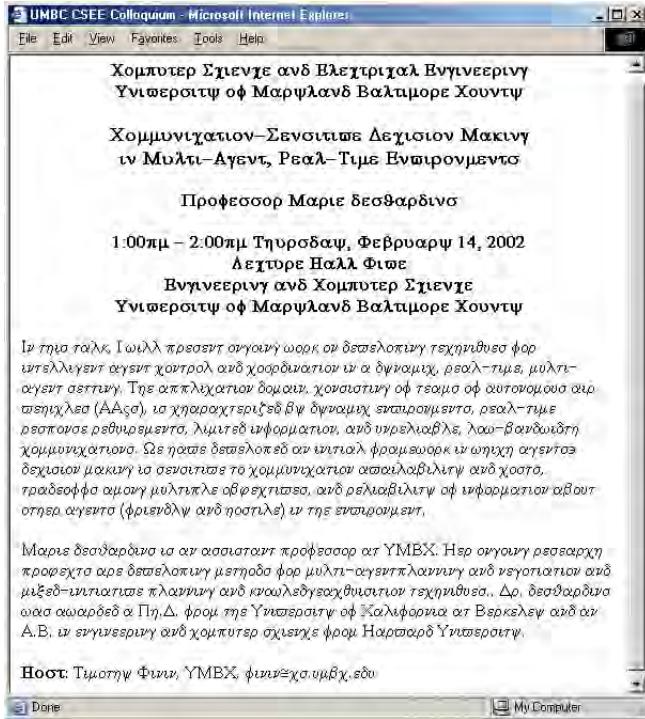
-- Berners-Lee, Hendler and Lassila, The Semantic Web, Scientific American, 2001

Why is this hard?



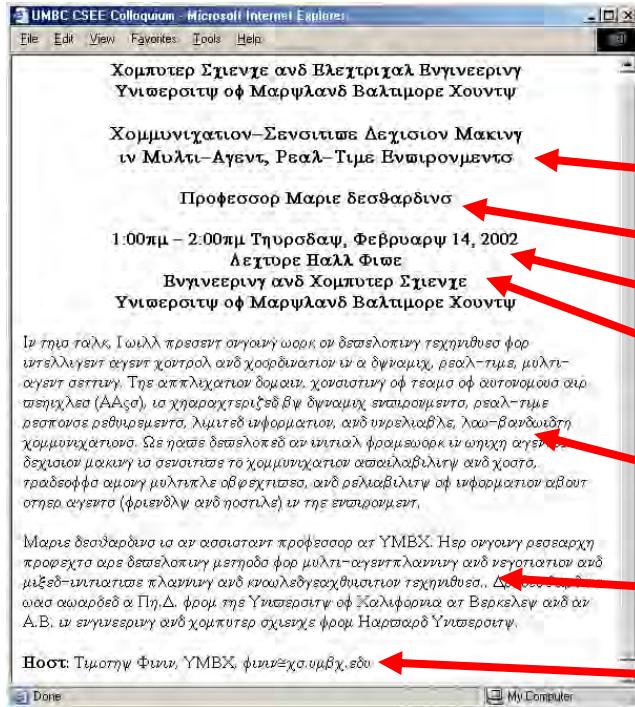
after Frank van Harmelen
and Jim Hendler

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

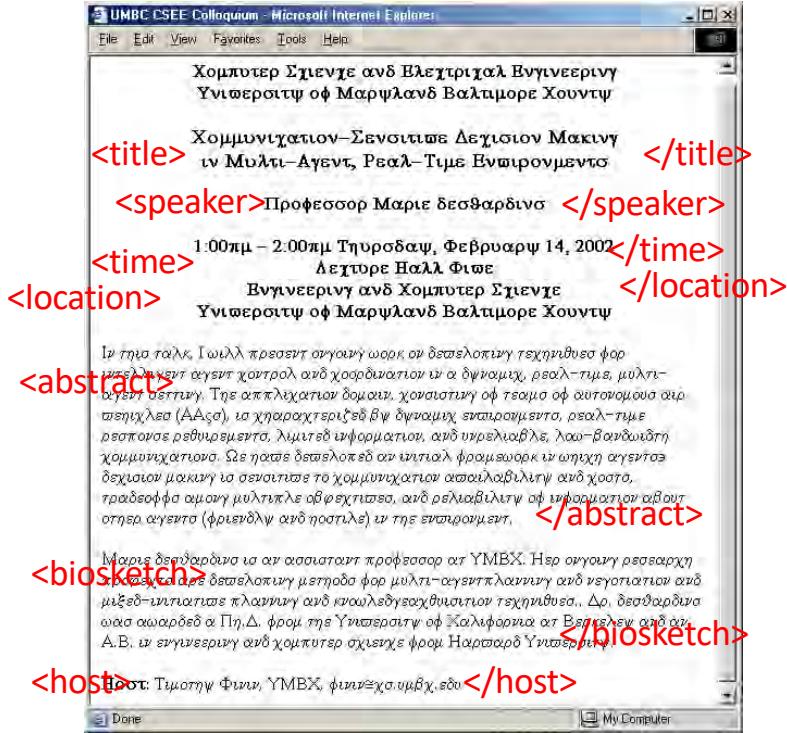
location

abstract

biosketch

host

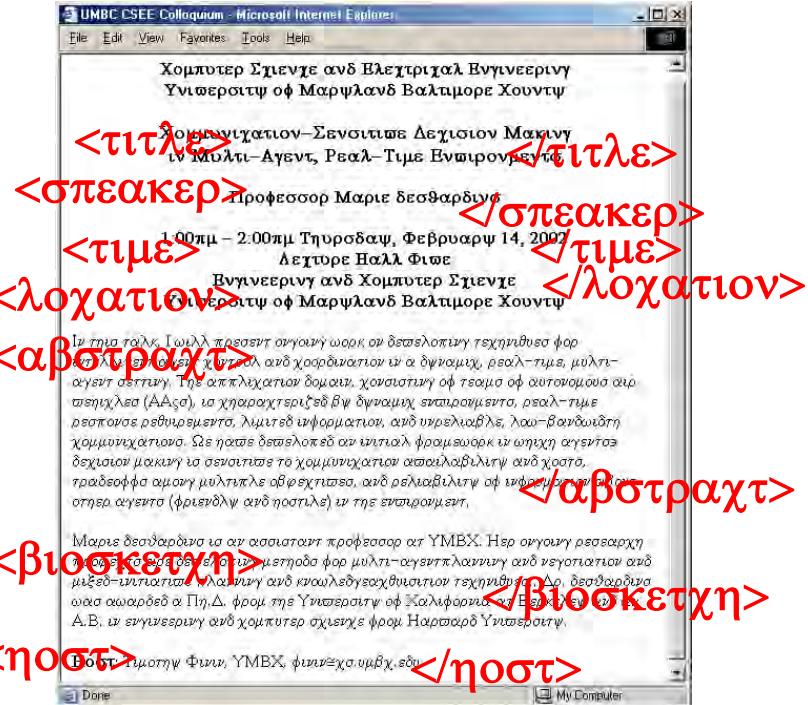
XML to the rescue?



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:element name="since" type="xs:date"/>
            <xs:element name="qualification" type="xs:string"/>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
      <xs:attribute name="isbn" type="xs:string"/>
    </xs:complexType>
    <xs:element name="book">
  </xs:schema>
```

XML Schemas provide a simple mechanism to define shared vocabularies.

The diagram illustrates the relationship between an XML Schema file and two XML documents. A green arrow points from the schema to the first document, and another green arrow points from the schema to the second document. The first document shows how elements from the schema are mapped to specific fields in the XML. The second document shows the resulting well-formed XML document.

Below is the XML Schema code:

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:element name="book">
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        <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:element name="since" type="xs:date"/>
            <xs:element name="qualification" type="xs:string"/>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
      <xs:attribute name="isbn" type="xs:string"/>
    </xs:complexType>
    <xs:element name="book">
  </xs:schema>
```

The first XML document (left) contains the following XML:

```
<book>
  <title>Χομποτερ Σημήσεις ανδ Ελεγχτήσατ Βγυνερινή Υνιαρετίνη αφ Μαρφλανδ Βαλτιμορε Χουντ</title>
  <author>Πρόφεσορ Μαρίε Λεθερδίνση</author>
  <character><name>Πρόφεσορ Μαρίε Λεθερδίνση</name><friend-of>Οικογένεια Τζέριαση, Φεβρουάριος 14, 2002</friend-of></character>
  <since>2002-02-14T00:00:00Z</since>
  <qualification>Λεπτόρες Πατέρ Φωτε</qualification>
  <isbn>978-0-393-32224-2</isbn>
</book>
```

The second XML document (right) contains the following XML:

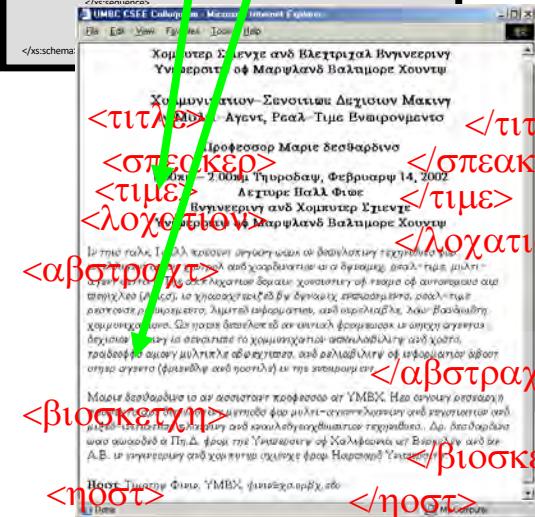
```
<book>
  <title>Χομποτερ Σημήσεις ανδ Ελεγχτήσατ Βγυνερινή Υνιαρετίνη αφ Μαρφλανδ Βαλτιμορε Χουντ</title>
  <author>Πρόφεσορ Μαρίε Λεθερδίνση</author>
  <character><name>Πρόφεσορ Μαρίε Λεθερδίνση</name><friend-of>Οικογένεια Τζέριαση, Φεβρουάριος 14, 2002</friend-of></character>
  <since>2002-02-14T00:00:00Z</since>
  <qualification>Λεπτόρες Πατέρ Φωτε</qualification>
  <isbn>978-0-393-32224-2</isbn>
</book>
```

after Frank van Harmelen and Jim Hendler

But there are many schemas

XML Schema file 1

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xsi="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>
```



Χορηγείται Στάγιος ανδ Ελεγχτή των Βιβλιοθηκών
Υπαίθρια φ Μαργαρέτα Βαλαμούρη Χουντή

Χομιανάτιον - Σενούτσα Διεργία Μακινά
ΩΔΗ - Αγαντ, Ρεάλ - Τιμ Βιωμαρίμαντο

Ιανουάριος Μαρίας Δεσφαρίνης
<title> </title>
<speaker> </speaker>
<time> 09:00 - 2.000€ Τηλεοράση, Φεβρουάριος 14, 2002 </time>
<location> Λαζαρίδη Πατέλ Φωταί
Υπαίθρια στα Χορηγείται Στάγιος
Μαργαρέτα Βαλαμούρη Χουντή </location>

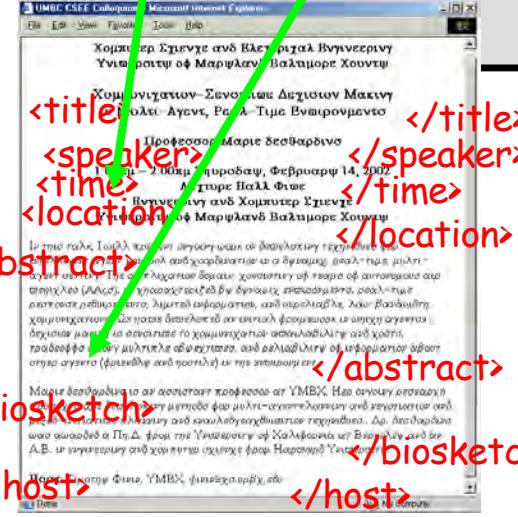
Λιτό τόλμη τα άλλα περισσότερες από διαδικτυακές
εργασίες, με αποχρώσεις στο δημόσιο, απλά - την μετα-
ανάγνωση, την λογοτελή, την γραπτή χρονοτρέψη από την οποία αποτελείται το περιεχόμενό της, σαν απλή
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χρονογράφηση. Οι πράξεις διατάσσονται σε αντικα ημερομηνία και απογραφή
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Μαρία Δεσφαρίνη θα αποστέλεξε προφέσσος από YMBK. Η αριθμού έργων της
παραπομπής της στην επόμενη φάση μετατρέπεται σε έναν πρωτότυπο από
μεταπομπή σε πρωτότυπη σε απλούστερη μορφή, με την οποία αποτελείται η περιοχή. Δηλαδή στην
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Η οποία παραπομπή θα αποτελείται από πρωτότυπη φάση Νομοθεσία Υπαίθριας, από
<abstrakt> </abstrakt>
<biosketch> </biosketch>
<host> </host>

XML Schema file 42

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xsi="http://www.w3.org/2001/XMLSchema">
<xs:element name="host">
<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"/>
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</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```



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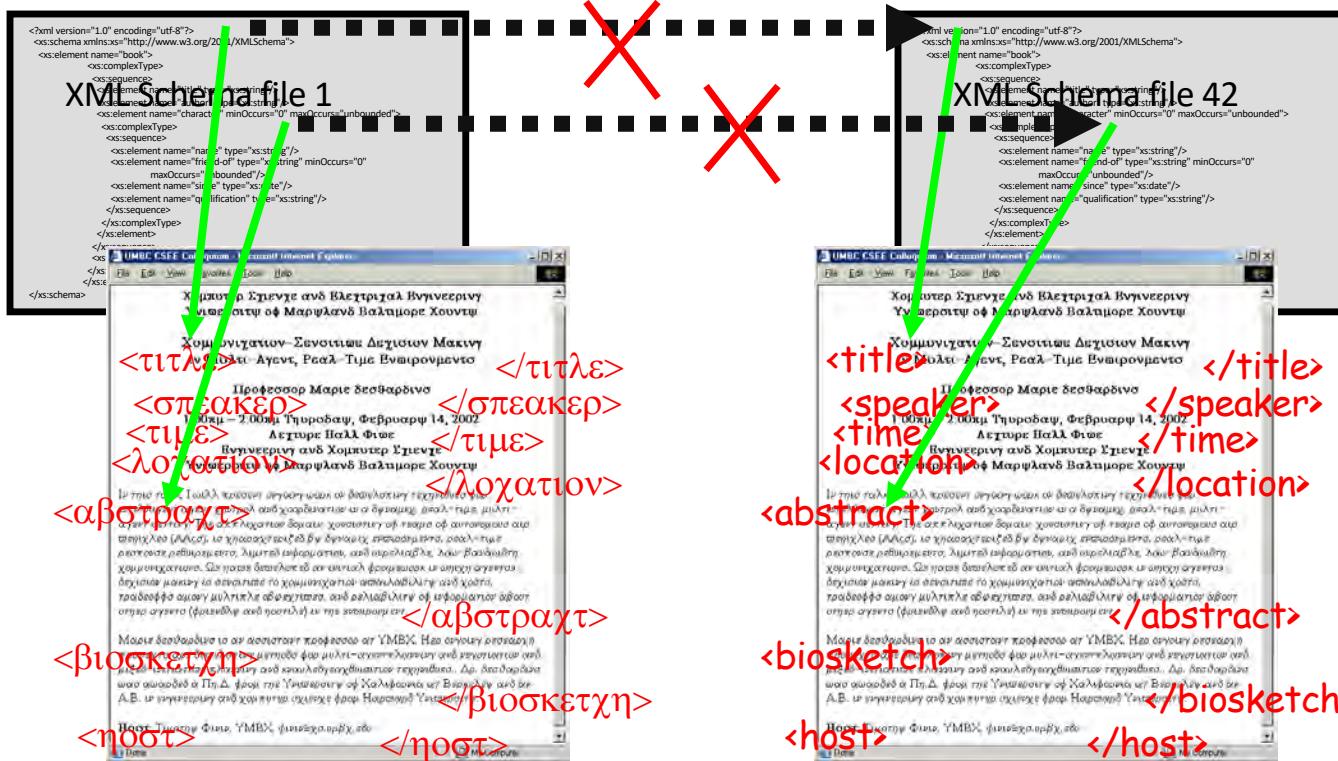
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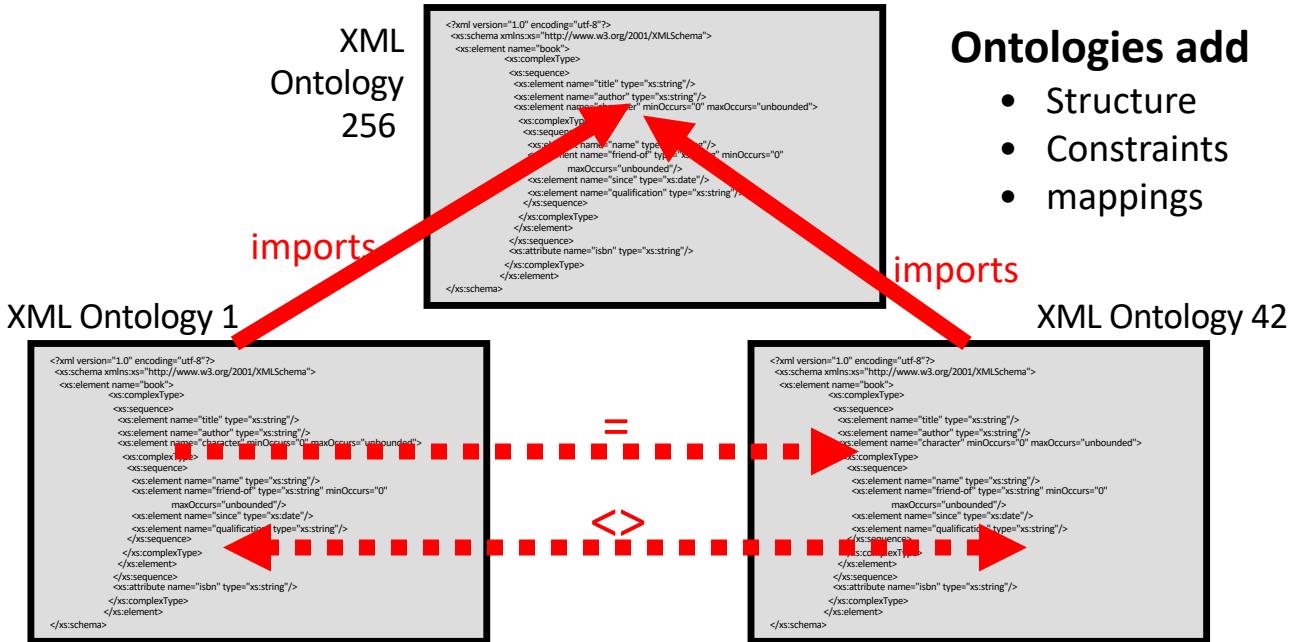
after Frank van Harmelen and Jim Hendler

There's no way to relate schema



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

Ontologies add

- Structure
- Constraints
- mappings

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



2007

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

LOD beginning

The node in the center is DBpedia

A screenshot of a web browser window displaying the DBpedia page for the University of Maryland, Baltimore County. The title bar reads "About: University of Maryland, Baltimore County". The page header includes the DBpedia logo and links for "Browse using", "Formats", "Faceted Browser", and "Sparql Endpoint". The main content area features a large blue header "About: University of Maryland, Baltimore County". Below it, a text block states: "An Entity of Type : National Space Grant College and Fellowship Program, from Named Graph : http://dbpedia.org, within Data Space : dbpedia.org". A detailed description 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.". At the bottom, a table shows the "dbo:abstract" property with its value being the same descriptive text.

Property	Value
dbo:abstract	<ul style="list-style-type: none">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,

http://dbpedia.org/page/University_of_Maryland,_Baltimore_County

Semantic Web => Linked Open Data

Use Semantic Web Technology
to publish shared data &
knowledge



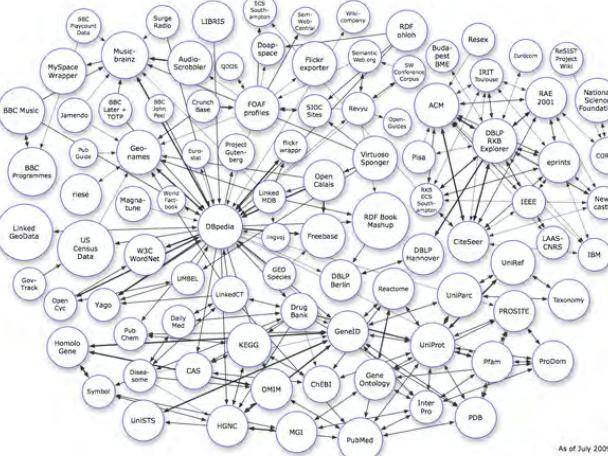
2008

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

LOD growing

Semantic Web => Linked Open Data

Use Semantic Web Technology to publish shared data & knowledge



2009

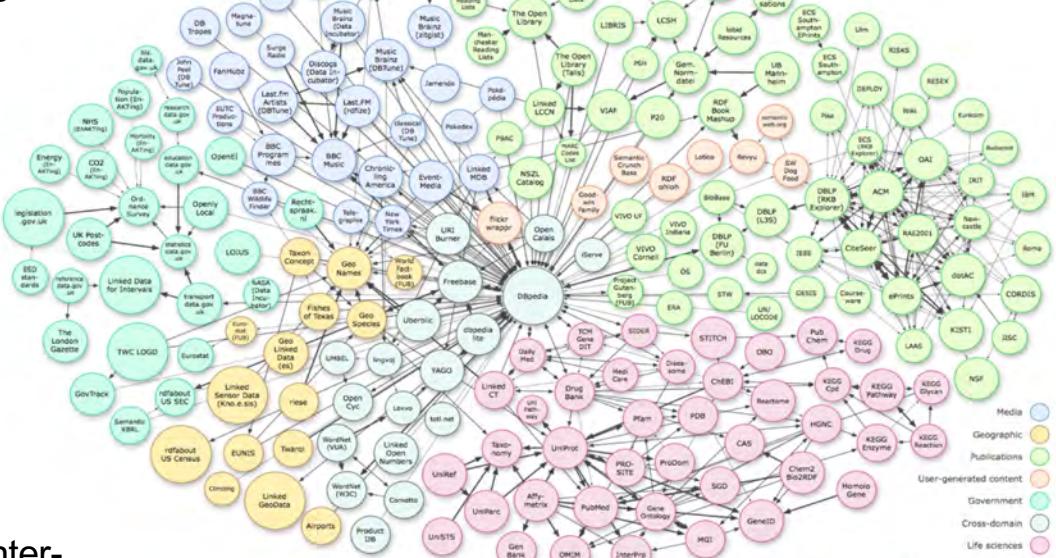
Data is inter-linked to support integration and fusion of knowledge

... 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

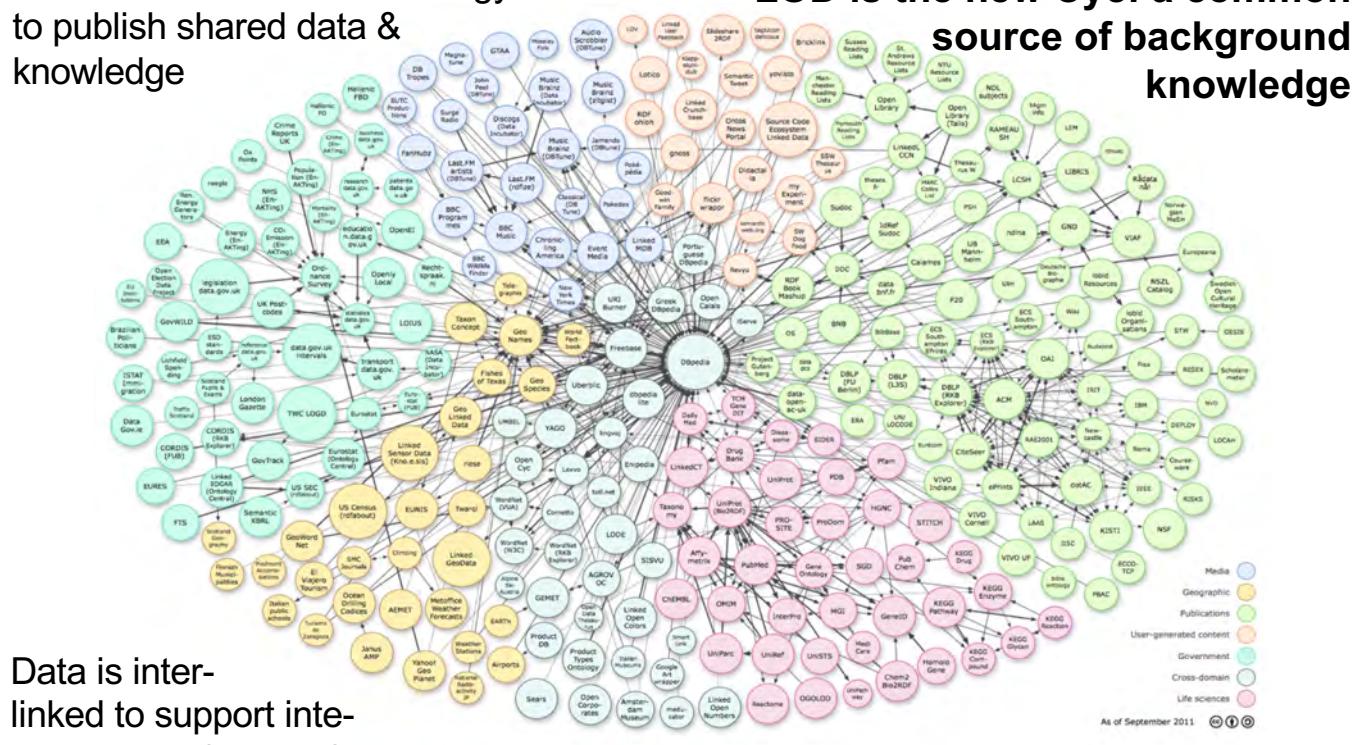
2010

...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](#)

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://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](#) to develop useful vocabularies
 - Data.gov has many datasets in RDF

Wikipedia data
in RDF

DBpedia

The screenshot shows a web browser window displaying the DBpedia page for Alan Turing. The page lists various properties and their values, such as almaMater, awards, birth date, birth name, birth place, doctoral advisor, field of study, individualized PND number, and known for. A blue callout box highlights the triple dbpedia:Alan_Turing dbpedia-owl:doctoralAdvisor dbpedia:Alonzo_Church . Below this, another blue callout box highlights the triple dbpedia:Alonzo_Church dbpedia-owl:doctoralStudent dbpedia:Robin_Gandy . The browser interface includes a toolbar at the top and a status bar at the bottom.

dbpedia.org/page/Alan_Turing

dbpedia-owl:almaMater

- dbpedia:King's_College,_Cambridge
- dbpedia:Princeton_University

dbpedia-owl:award

- dbpedia:Royal_Society
- dbpedia:Order_of_the_British_Empire
- dbpedia:Fellow_of_the_Royal_Society
- dbpedia:Officer_of_the_Order_of_the_British_Empire

dbpedia-owl:birthDate

- 1912-06-23 (xsd:date)
- 1912-06-23 (xsd:date)

dbpedia-owl:birthName

- Alan Mathison Turing

dbpedia-owl:birthPlace

- dbpedia:Paddington
- dbpedia:Maida_Vale

dbpedia-owl:doctoralAdvisor

dbpedia:Alonzo_Church .

dbpedia-owl:doctoralAdvisor

- dbpedia:Wilmslow
- dbpedia:Alonzo_Church
- dbpedia:Robin_Gandy

dbpedia-owl:doctoralStudent

- dbpedia:Computer_science
- dbpedia:Mathematics
- dbpedia:Cryptanalysis

dbpedia-owl:field

- 118802976

dbpedia-owl:individualisedPnd

- dbpedia:Turing_machine
- dbpedia:Cryptanalysis_of_the_Enigma
- dbpedia:Automatic_Computing_Engine
- dbpedia:Turing_test

dbpedia-owl:knownFor

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 homepage. At the top left is the SMW logo. The top right features a navigation bar with links for 'Create account' and 'Log in'. Below the header, there's a main content area with a paragraph about SMW being a free, open-source extension to MediaWiki. To the left is a sidebar with navigation links like 'Main page', 'Introduction', and 'User manual'. The main content is divided into several sections: 'More about Semantic MediaWiki' (with links to introduction, FAQ, talks, and testimonials), 'Installation' (with a large orange 'Download' button), 'User community' (with links to support, a community wiki, and SMWCon), 'The SMW project' (with links to project details), and 'Usage' (with links to user manual, SMW reference, and reporting bugs). A 'Wiki of the Month - January 2013' box highlights the 'triple A wiki'.

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

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

• 10 January 2013: Survey: What do you think about SMW?

Freebase

Acquired by
Google in 2010

www.freebase.com/view/en/alan_turing

Freebase Find topics... Data Schema Apps Docs finin Settings Sign Out

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 (/tjoʊərn/ 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

Place of birth: Maida Vale, United Kingdom

Alan Turing Quotes

“ Mathematical reasoning may be regarded... ”

“ No, I'm not interested in developing a powerful brain... ”

These people have edited this topic:



Edit this topic

Last edited Dec 12, 2012 See all topic history »

Related Topics

-  Edward Thomas Hall
-  Alan Turing
-  William Kingdon Clifford
-  Ada Lovelace

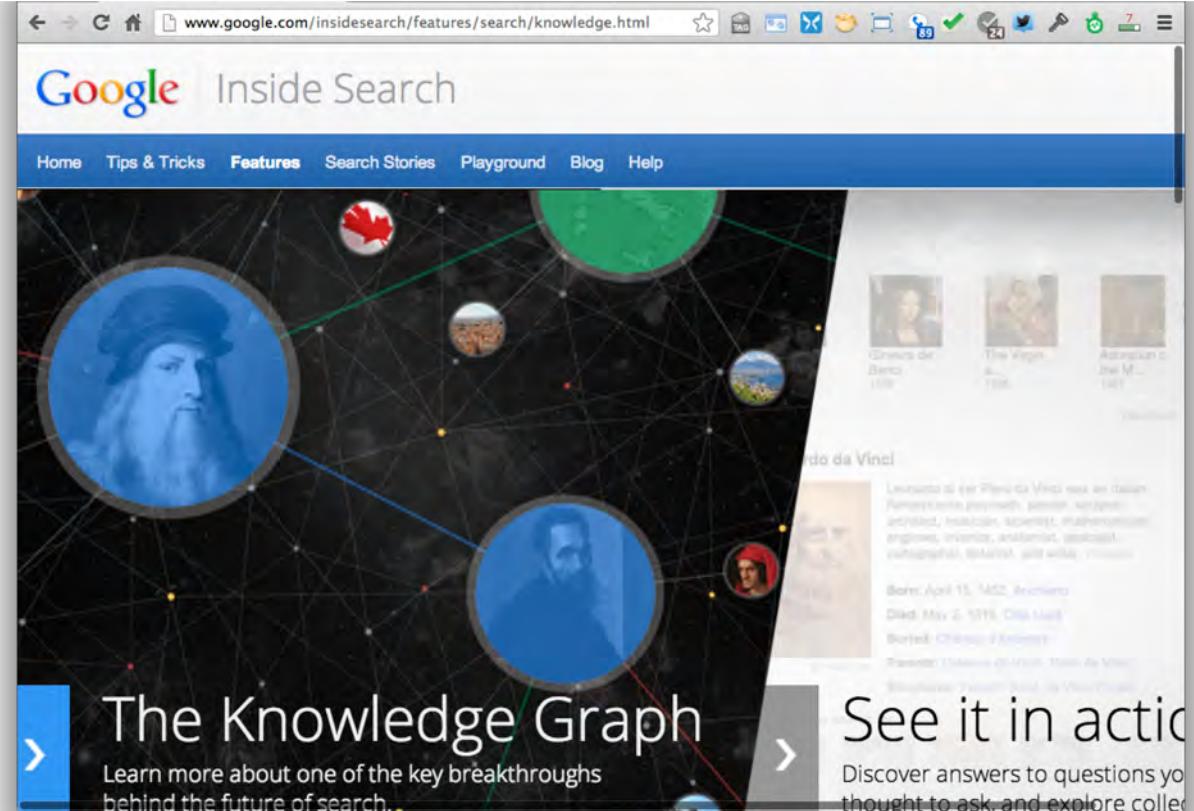
Alan Turing elsewhere on the web

★ Official Website

w: Wikipedia

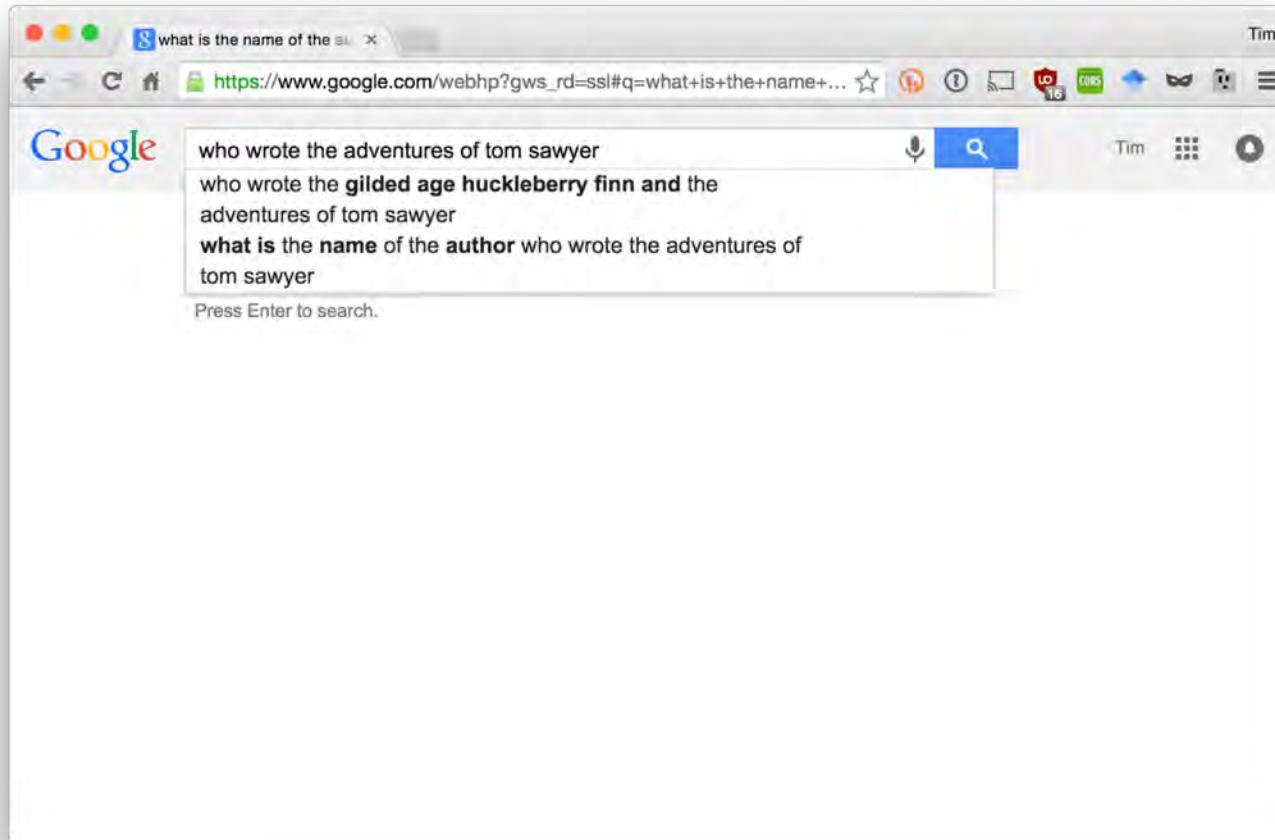
“An entity graph of people, places and things, built by a community that loves open data”

Google Knowledge Graph



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

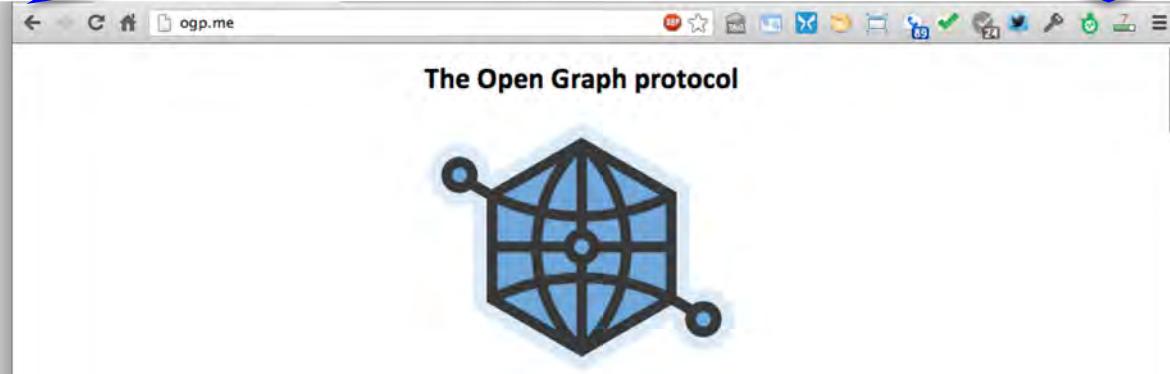
Who wrote Tom Sawyer?



Annotate your web
pages in RDFa

=> object in the FB
graph

Facebook Open Graph



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

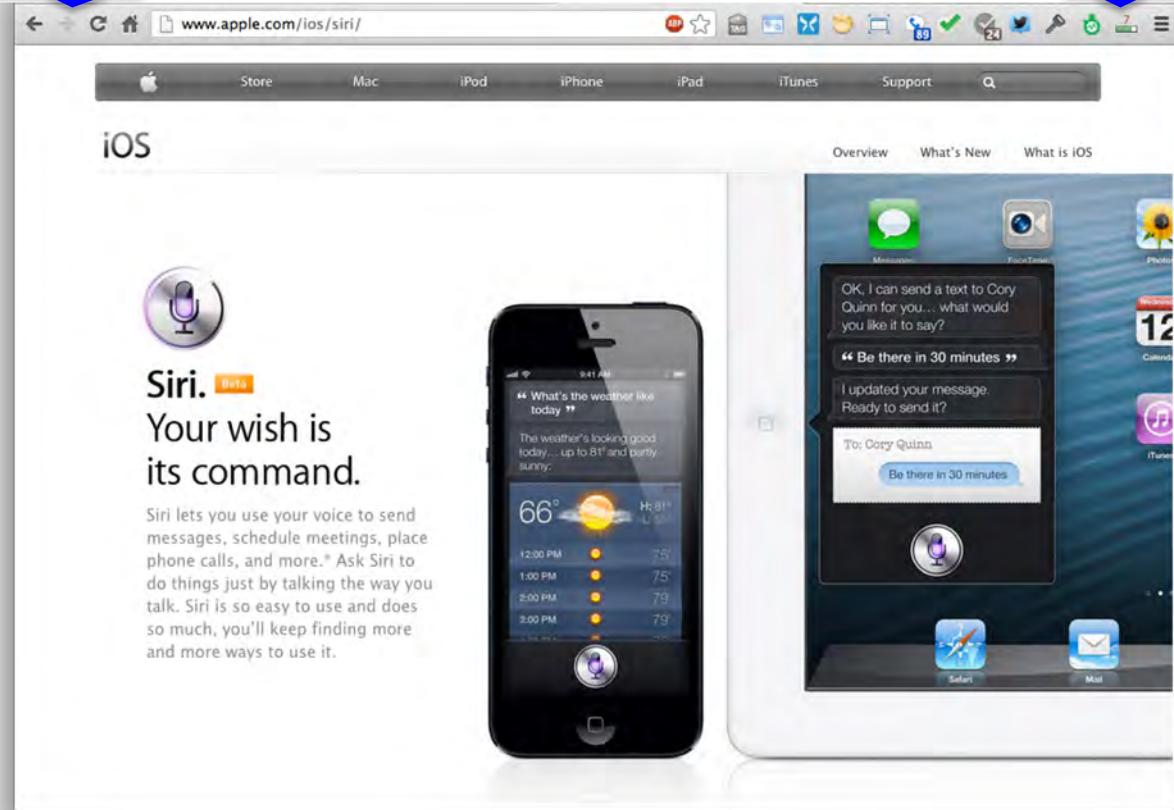
To turn your web pages into graph objects, you need to add basic metadata to your page. We've based the initial version of the protocol on RDFa which means that you'll place additional `<meta>` tags in the `<head>` of your web page. The four required properties for every page are:

- `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



SIRI needs lots of semantic data about entities in the world

IBM's Watson

The screenshot shows the homepage of the IBM Watson website at www-03.ibm.com/innovation/us/watson/. The page features a large title "IBM Watson: Ushering in a new era of computing" with a globe graphic. Below the title are navigation tabs: Watson, Putting Watson to work, Science behind Watson, Getting ready for Watson (which is highlighted), and News/events. To the left, there's a sidebar with a "Watson goes to work" PDF download link. The main content area includes sections on "Putting Watson to work" and "Take the next step". On the right, there are links to contact IBM about Watson via email or phone, and sections for following IBM Watson on social media and recent news.

IBM Watson: Ushering in a new era of computing

Watson goes to work (1.55MB)

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

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

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 understandable statements

The screenshot shows the schema.org Person page. At the top, there's a navigation bar with links for Home, Schemas, and Documentation. Below the navigation, the title "schema.org" is displayed. The main content area has a red header with the text "Thing > Person". A sub-header below it says "A person (alive, dead, undead, or fictional)".

The page lists properties for both "Properties from Thing" and "Properties from Person".

Property	Expected Type	Description
additionalType	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.
alternateName	Text	An alias for the item.
description	Text	A short description of the item.
image	URL	URL of an image of the item.
name	Text	The name of the item.
sameAs	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.
url	URL	URL of the item.
Properties from Person		
additionalName	Text	An additional name for a Person, can be used for a middle name.
address	PostalAddress	Physical address of the item.
affiliation	Organization	An organization that this person is affiliated with. For example, a school/university, a club, or a team.
alumniOf	EducationalOrganization	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