



# INTRODUCTION TO THE SEMANTIC WEB

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# THE BEGINNINGS

“The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation”

[Berners-Lee, Hendler & Lassila, 2001]





# NOT A SEPARATE WEB

Decentralized information space (for people)

Consisting of documents and other Web resources

- Uniquely identified
- Connected to each other via hyperlinks
- Accessed via the Internet
- Created and used by different parties

<http://info.cern.ch/hypertext/WWW/TheProject.ht>

## Technologies

- URIs
- HTML
- HTTP

### World Wide Web

The WorldWideWeb (W3) is a wide-area [hypermedia](#) information retrieval initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this document, including an [executive summary](#) of the project, [Mailing lists](#), [Policy](#), November's [W3 news](#), [Frequently Asked Questions](#).

#### [What's out there?](#)

Pointers to the world's online information, [subjects](#), [W3 servers](#), etc.

#### [Help](#)

on the browser you are using

#### [Software Products](#)

A list of W3 project components and their current state. (e.g. [Line Mode](#), [X11 Viola](#), [NeXTStep](#), [Servers](#), [Tools](#), [Mail robot](#), [Library](#).)

#### [Technical](#)

Details of protocols, formats, program internals etc

#### [Bibliography](#)

Paper documentation on W3 and references.

#### [People](#)

A list of some people involved in the project.

#### [History](#)

A summary of the history of the project.

#### [How can I help?](#)

If you would like to support the web..

#### [Getting code](#)

Getting the code by [anonymous FTP](#), etc.



# BUT AN EXTENSION OF THE CURRENT ONE

A decentralized information space (for computers and people)

## A Web of data

Consisting of information and non-information resources

- Uniquely identified
- Connected to each other via hyperlinks
- Accessed via the Internet
- Created and used by different parties



# INFORMATION WITH WELL-DEFINED MEANING

Machines can process Web information 'intelligently'

One can encode this additional information in a machine-processable way

- Using formal knowledge representation languages and reasoning

Artikel / Diskussion

Lesen / Bearbeiten / Versionsgeschichte

## Paul Schuster (Autor)

**Paul Schuster** (\* 20. Februar 1930 in Hermannstadt/Siebenbürgen; † 5. Mai 2004 in Berlin) war ein deutscher Schriftsteller.

Inhaltsverzeichnis [verbergen]
1. Leben
2. Werke
3. Herausgeberschaft
4. Übersetzungen
5. Literatur
6. Webpräsenz
7. Einzelnachweise

**Leben** [Bearbeiten]

Paul Schuster entstammte der rumänisch-deutschen Minderheit der Siebenbürger Sachsen. Sein Vater war Kleinrentner. Nachdem er am **Dukecentral-Gymnasium** in Hermannstadt das Abitur abgelegt hatte, ging Schuster 1949 nach Bukarest. Dort war er als Lehrer tätig, später gehörte er den Redaktionen der Tageszeitung „Neue Welt“ und der Literaturzeitschrift „Neue Literatur“ an. Er war verheiratet mit der rumänischen Schriftstellerin Ana Novac. Seit Mitte der Fünfzigerjahre veröffentlichte er eigene Prosawerke in deutscher Sprache, sein bekanntestes Werk ist der zwiebändige Roman *Fünf Lär Zucka*, der als Panorama der Geschichte der Siebenbürger Sachsen angelegt war und 1963 in Rumänien unvollendet. 1969 wurde der Roman als erstes Werk eines deutschen Schriftstellers aus Rumänien im Westen auf der Frankfurter Buchmesse vorgestellt. Die Arbeit am dritten Band wurde erst nach dem Umzug nach Berlin 1972 möglich.<sup>[1]</sup>

Am 15. November 1968 wurde Schuster in der konstituierenden Sitzung des Rats der **Werkstätten deutscher Nationalität der Sozialistischen Republik Rumänien** als Stellvertreter des Vorsitzenden Edoard Eisenburger gewählt. Zu weiteren Stellvertretern wurden Alton Bietelshofer, Richard Winter und Peter Lamoth gewählt.<sup>[2]</sup> Während seiner enge Kontakte zum rumänischen Staatschef Nicolae Ceaușescu, förderte aber auch unter anderem Autoren der späteren Aktionsgruppe Basal, mit denen er sich jedoch in der Fa

This article is about a person  
This article is about a writer  
People and writers have characteristic properties e.g.,

- they are born somewhere
- they publish books
- books have topics, chapters, a price etc.



# COMPUTERS AND PEOPLE WORK IN COOPERATION

Artificial intelligence: “the science and engineering of making intelligent machines”

[John Mc Carthy, <http://www-formal.stanford.edu/jmc/whatisai/whatisai.html>]

## Areas of AI

- Knowledge representation
- Inference
- Logics
- Search
- Planning and scheduling
- Pattern recognition
- Learning
- Natural language processing
- Computer vision
- Robotics
- ....



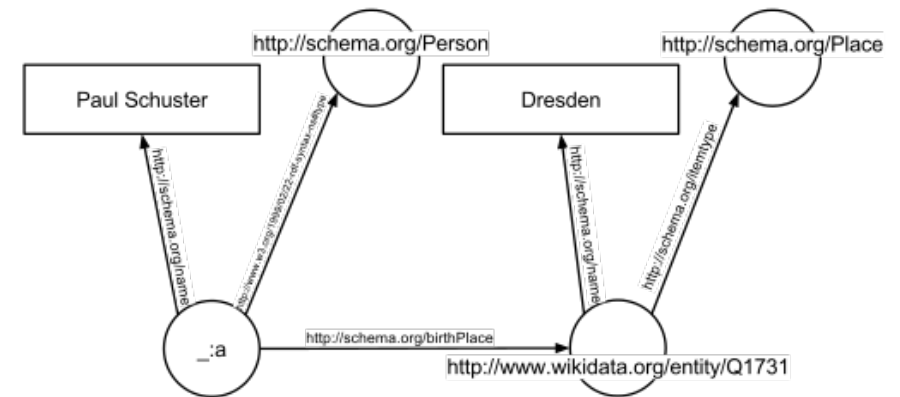


# MEANING ON THE WEB

- Add metadata to Web resources
- Different types of links
- Encode additional information about metadata entities and links in ontologies
- No global information schemas
- Incomplete and inconsistent

```
<div vocab="http://schema.org/" typeof="Person">
  <span property="name">Paul Schuster</span> was born in
  <span property="birthPlace" typeof="Place" href="http://www.wikidata.org/entity/Q1731">
    <span property="name">Dresden</span>.
  </span>
</div>
```

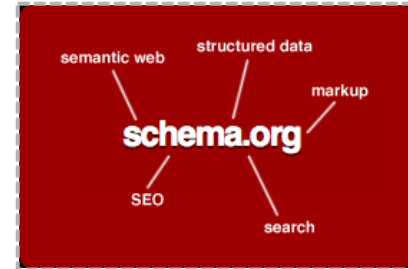
```
_:a <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://schema.org/Person> .
_:a <http://schema.org/name> "Paul Schuster" .
_:a <http://schema.org/birthPlace> <http://www.wikidata.org/entity/Q1731> .
<http://www.wikidata.org/entity/Q1731> <http://schema.org/itemtype> <http://schema.org/Place> .
<http://www.wikidata.org/entity/Q1731> <http://schema.org/name> "Dresden" .
```



[Examples from Wikipedia]



# YOU DON'T HAVE TO BUILD YOUR OWN ONTOLOGY



## Person

**Thing** > **Person**

A person (alive, dead, undead, or fictional).

Usage: Over 1,000,000 domains

[more...]

Property	Expected Type	Description
<b>Properties from Person</b>		
<a href="#">additionalName</a>	Text	An additional name for a Person, can be used for a middle name.
<a href="#">address</a>	PostalAddress	Physical address of the item.
<a href="#">affiliation</a>	Organization	An organization that this person is affiliated with. For example, a school/university, a club, or a team.
<a href="#">alumniOf</a>	EducationalOrganization	An educational organizations that the person is an alumni of. Inverse property: <a href="#">alumni</a> .
<a href="#">award</a>	Text	An award won by or for this item. Supersedes <a href="#">awards</a> .
<a href="#">birthDate</a>	Date	Date of birth.
<a href="#">birthPlace</a>	Place	The place where the person was born.
<a href="#">brand</a>	Organization or Brand	The brand(s) associated with a product or service, or the brand(s) maintained by an organization or business person.
<a href="#">children</a>	Person	A child of the person.
<a href="#">colleague</a>	Person	A colleague of the person. Supersedes <a href="#">colleagues</a> .
<a href="#">contactPoint</a>	ContactPoint	A contact point for a person or organization. Supersedes <a href="#">contactPoints</a> .
<a href="#">deathDate</a>	Date	Date of death.
<a href="#">deathPlace</a>	Place	The place where the person died.
<a href="#">duns</a>	Text	The Dun & Bradstreet DUNS number for identifying an organization or business person.
<a href="#">email</a>	Text	Email address.
<a href="#">familyName</a>	Text	Family name. In the U.S. the last name of a Person. This can be used along with <a href="#">givenName</a> instead of the



Item [Discussion](#) [Read](#) [View history](#)

## Dresden (Q1731)

capital city of the Free State of Saxony in Germany  
Elbflorenz

[edit]

Wikipedia (118 entries) [edit]

- af Dresden
- als Dresden
- am ድሬዚና
- an Dresde
- ar درسدن
- ast Dresde
- ay Dresden
- az Drezden
- bar Dresdn
- be\_x\_old Дрэздэн
- be Горад Дрэздэн
- bg Дрезден
- br Dresden
- bs Dresden
- ca Dresden
- ce Дрезден
- ckb درسدن
- co Dresda

### Statements

locator map image	Saxony DD.svg	[edit]
	0 references	[add]
image	Dresden from Albertbrücke.jpg	[edit]
	1 reference	[add]
instance of	big city	[edit]

- [Main page](#)
- [Community portal](#)
- [Project chat](#)
- [Create a new item](#)
- [Item by title](#)
- [Recent changes](#)
- [Random item](#)
- [Help](#)
- [Donate](#)

#### Print/export

- [Create a book](#)
- [Download as PDF](#)
- [Printable version](#)

#### Tools

- [What links here](#)
- [Related changes](#)
- [Special pages](#)
- [Permanent link](#)
- [Page information](#)
- [Concept URI](#)
- [Cite this page](#)





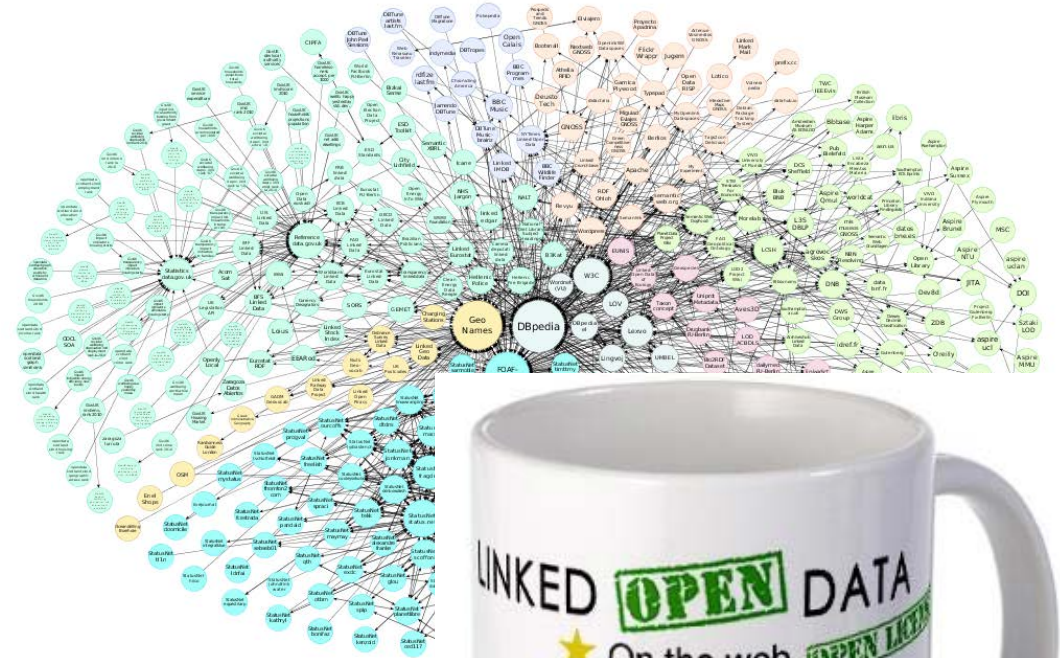
# LINKED DATA MAKES DATA INTEGRATION EASY

Concepts, entities, and properties are accessible on the Web just as traditional Web documents

**Linked Data:** Set of technologies and principles to publish and access data on the Web

<http://lod-cloud.net/>

[http://www.ted.com/talks/tim\\_berners\\_lee\\_on\\_the\\_next\\_web.html](http://www.ted.com/talks/tim_berners_lee_on_the_next_web.html)





# SEMANTIC WEB STACK

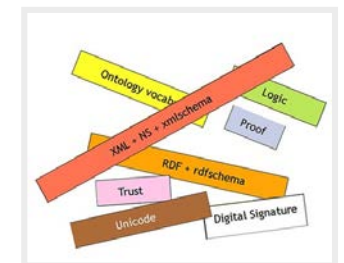
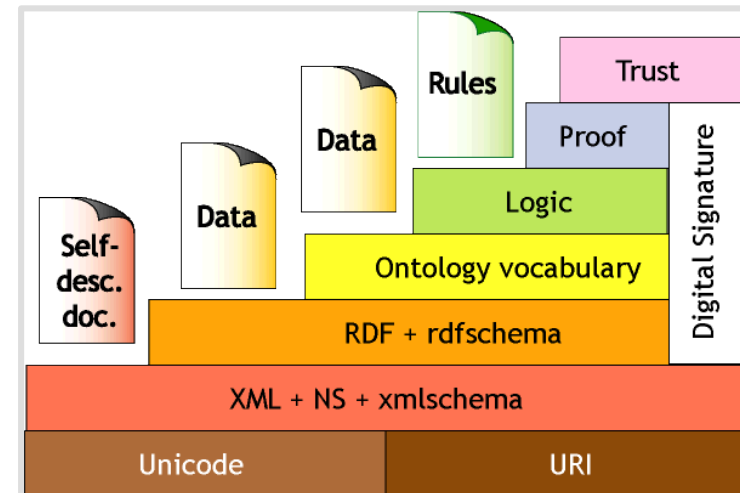
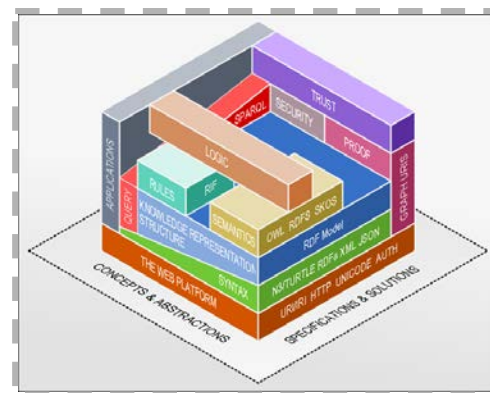
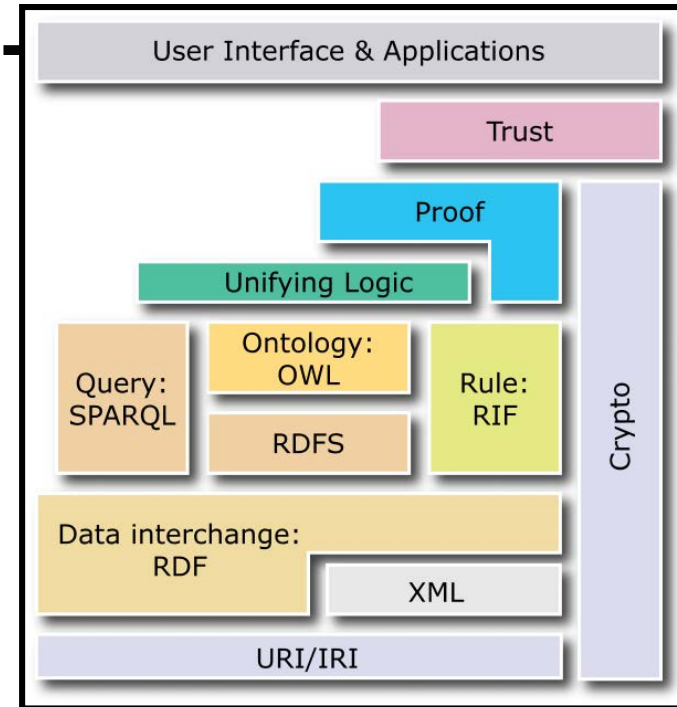
Standardized family of languages

- Compatible with the Web architecture
- With a formal semantics

Linked data is part of the stack

## Tools

- Editors
- Data stores
- Reasoners
- Machine learning
- NLP
- Data interlinking
- ...



# FROM THE SEMANTIC WEB TO SEMANTIC TECHNOLOGIES



“The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries”

[W3C]

# EXAMPLE: KNOWLEDGE GRAPH GRAPH MAKING SEARCH MORE INTELLIGENT



The screenshot shows a Google search for "taj mahal". The search results include several links to Wikipedia, a travel website, and the official Taj Mahal website. A knowledge panel on the right provides details about the Taj Mahal, including its location, height, opening date, address, architectural style, phone number, and architect. A "See results about" popup is visible, showing results for "Taj Mahal Musician" and "Trump Taj Mahal Casino Resort".

**Taj Mahal**  
The Taj Mahal is a white marble mausoleum located in Agra, India. It was built by Mughal emperor Shah Jahan in memory of his third wife, Mumtaz Mahal.

**Taj Mahal (musician)**  
Henry Saint Clair Fredericks (born May 17, 1942), who uses the stage name **Taj Mahal**, is an American Grammy Award winning blues musician. He incorporates ...

**Atlantic City New Jersey Casino Hotels | Trump Taj Mahal, Atlantic...**  
For five star Atlantic City Casino hotels, Trump **Taj Mahal** Casino Hotel offers restaurants, nightlife and a casino floor you can't resist. Explore our Atlantic City ...

**Taj Mahal**  
www.tajmahal.gov.in/  
★★★★★ 262 Google reviews - Write a review  
Symbol of Day of Judgement ,SH 62 282001 Agra, Uttar Pradesh, India  
0562 222 6431

**Taj Mahal - Welcome to tajblues.com HOME**  
www.tajblues.com/  
Official site includes news, tour schedule, discography, audio/video and pictures.

**The Taj Mahal India**  
www.islamicity.com/culture/taj/default.htm  
**Taj Mahal** is regarded as one of the eight wonders of the world, and some Western historians have noted that its architectural beauty has never been surpassed.

**Images for taj mahal** - Report images

**Taj Mahal**  
www.tajmahal.org.uk/  
**Taj Mahal** at Agra, India is one of the wonders of the world. Find information related to **Taj Mahal** travel and tourism in this article.

**Explore the Taj Mahal Virtual Tour - "5 STARS ...**  
www.taj-mahal.net/  
\* WOW!...Thrilling...Exotic...Ravishing! \* says The SundayTimes, London - 360\*

**Taj Mahal**  
The Taj Mahal is a white marble mausoleum located in Agra, India. It was built by Mughal emperor Shah Jahan in memory of his third wife, Mumtaz Mahal. Wikipedia

**Height:** 561 feet (171 m)  
**Opened:** 1648  
**Address:** Symbol of Day of Judgement ,SH 62 282001, Agra, Uttar Pradesh, India  
**Architectural style:** Mughal architecture  
**Phone:** 0562 222 6431  
**Architect:** Ustad Ahmad Lahauri

**See results about**

**Taj Mahal Musician**  
Henry Saint Clair Fredericks, who uses the stage name **Taj Mahal**, is an American Grammy Award winning blues

**Trump Taj Mahal Casino Resort**  
The Trump Taj Mahal is a casino located at 1000 Boardwalk in Atlantic City, New Jersey, United States, in

# EXAMPLE: BBC & MEDIA CONTENT PUBLISHING AND INTEGRATION




BBC Text Help Search Explore the BBC

## WILDLIFE FINDER

WATCH THE MOST AMAZING ANIMALS IN THE WORLD

LATEST WILDLIFE



23 November 2009  
... as hermit crabs, lobsters  
... (deca = ten, pod = foot).

### Mosquitoes

Mosquitoes are a family of insects encompassing over 3,000 species, most of which live in warm and humid regions, although they can be found in all parts of the world. Some species feed on nectar, however, the females of some species feed on blood to develop eggs.

#### COLLECTIONS

Collections offer a new perspective on the vast catalogue of clips showcasing presenter favourites, aspects of wildlife film-making, and gathering content together in illuminating ways.

**Life**  
The wildlife of Life  
In autumn 2009, a major new series brought us life as we've never seen it before. Filmed in HD, the series illustrated the extraordinary lengths to which animals and plants go in order to survive.

David Attenborough's favourite moments  
David Attenborough's favourite moments from the last 30 years represent not only memorable personal experiences, but also the

#### EDITOR'S CHOICE

This week's highlights from Natural World.


Sunflower star 2 videos

Giant cuttlefish 2 videos

BBC Home News Sport Weather iPlayer TV Radio More... Search

## LION (PANTHERA LEO)

Wildlife Finder > Animals > Lion



### SCIENTIFIC CLASSIFICATION

Kingdom: Animal (animalia)  
↳ Phylum: Chordate (Chordata)  
↳ Class: Mammal (Mammalia)  
↳ Order: Carnivora  
↳ Family: Felidae  
↳ Genus: Panthera  
↳ Species: **Lion (leo)**

### OTHER PANTHERA

- Jaguar (onca)
- Leopard (pardus)
- Tiger (tigris)

### WAYS OF LIFE

- Acoustic communication
- Carnivorous
- Chemical communication
- Co-operative breeding
- Helpless young
- Kleptoparasitic
- Learning
- Maternal care

# EXAMPLE: OPEN GRAPH INTEROPERABLE CONTENT REPRESENTATION



<http://ogp.me/>

Represent Web content in a social graph  
in an interoperable way

Used by Facebook ('stories'), Google  
(snippets), IMDb etc.

Facebook: actors, apps, objects with  
metadata to create stories

- Example: Elena has finished reading 'The Economist', an object of type Newspaper
- Types with attributes, extensions allowed
- Pre-defined and custom actions on objects

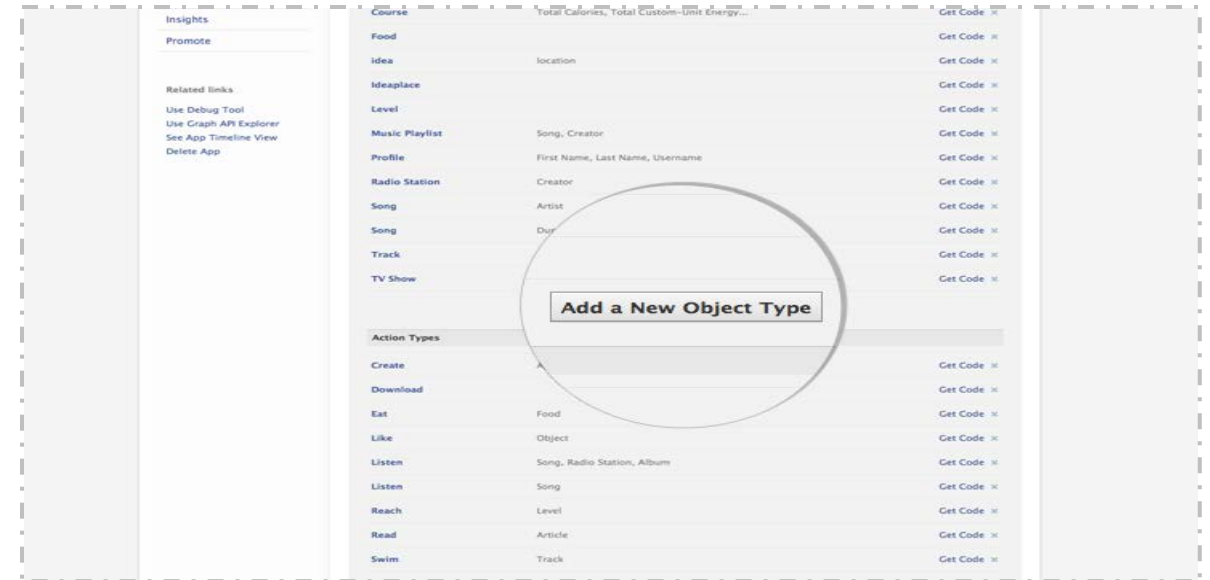
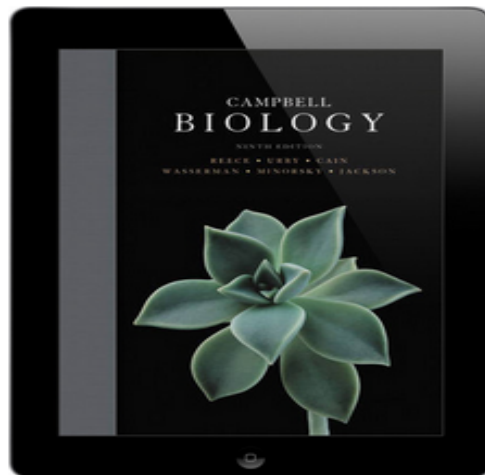
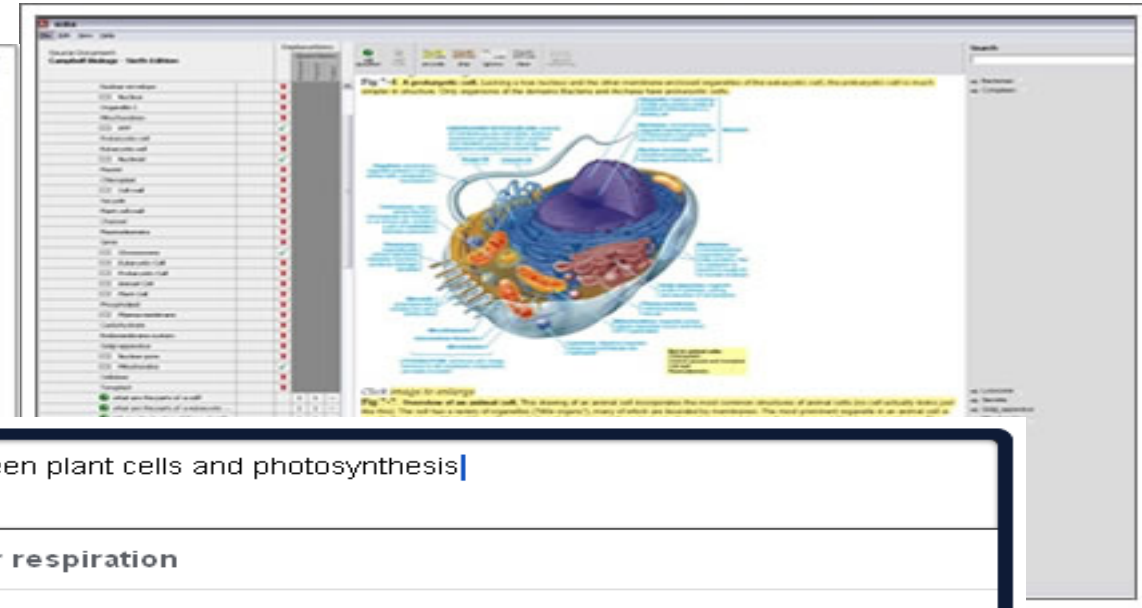
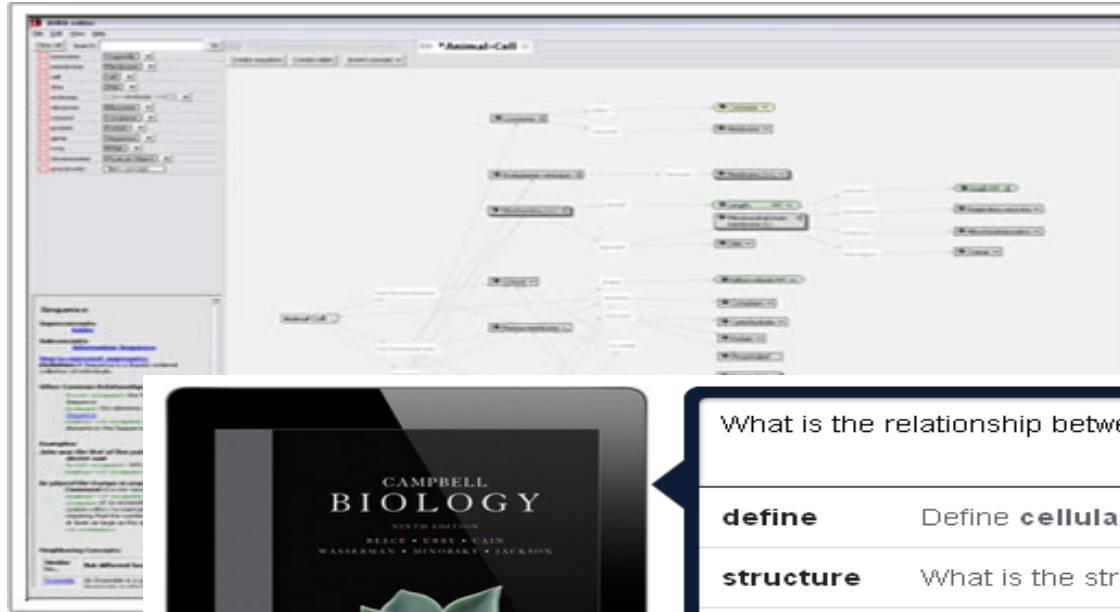


Image from

<https://developers.facebook.com/docs/opengraph/creating-custom-stories>



# EXAMPLE: PROJECT HALO



	What is the relationship between plant cells and photosynthesis
<b>define</b>	Define <b>cellular respiration</b>
<b>structure</b>	What is the structure of a <b>chloroplast</b> ?
<b>function</b>	What is the function of a <b>plasma membrane</b> in a <b>eukaryotic cell</b> ?
<b>compare</b>	What are the differences between <b>chloroplasts</b> and <b>mitochondria</b> ?
<b>relate</b>	If the <b>chloroplasts</b> were removed from a <b>plant</b> , what events would be affected?
<b>search</b>	Search book for <b>photosynthesis</b>

Images from <http://www.projecthalo.com> and <http://www.inquireproject.com/>

# EXAMPLE: DATA.GOV USING LINKED DATA TO PUBLISH GOVERNMENT OPEN DATA



Search our catalogs.. SEARCH

- HOME
- DATA
- TOOLS
- COMMUNITY
- METRICS
- DIALOGUE

SEARCH HM Government data

- guardian.co.uk
- News | Sport | Comment | Culture | Business | Money | Life & style | Travel | Environment
- News > Datablog

## DATABLOG

Facts are sacred

- Home
- Blog
- Data
- SPARQL
- Apps
- Ideas
- Forum
- Wiki
- Resources
- About

### Unlocking innovation

Working with UK Public Sector information and data

#### Latest datasets

- 12 July Energy data for the Home Office and MoJ HQ buildings
- 2 July Public servants earning over £150,000 now also covers NDPBs
- 25 June Costs and other data about central government websites

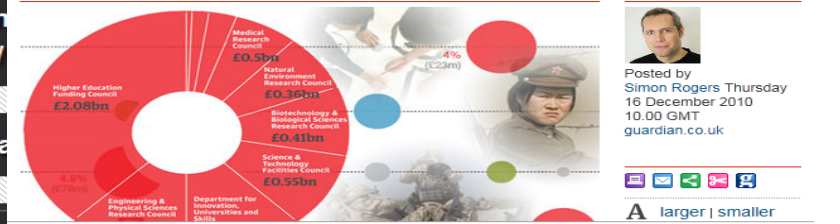
- Subscribe
- Comment
- Log in /
- Local Data

Previous Blog home Next

### Data journalism and visualisation: welcome to our new data site

Today we launch a new gateway to our data journalism and visualisations - find out what's new at [guardian.co.uk/data](http://guardian.co.uk/data)

Tweet 77  
Share 113  
reddit this  
Comments (7)



### What is the Semantic Web?

Combining different data sources has never been easy





# JOIN THE SEMANTIC WEB COMMUNITY



## Mailing lists

- public\_lod
- semanticweb
- Diverse others for special topics (Dbpedia, schema.org etc.)

## Facebook, LinkedIn, Quora

## Conferences

- Academic: ESWC, ISWC, WWW, AAAI etc.
- Applied/industry: Semantics, SmartData etc.

## Workshops

- Knowledge Discovery and Data Mining Meets Linked Open Data @ESWC
- Consuming Linked Data @ISWC
- Detection, Representation, and Exploitation of Events in the Semantic Web @ESWC
- Services and Applications over Linked APIs and Data @ESWC
- Ontology Alignment Evaluation Initiative @ISWC
- Semantic Statistics @ISWC
- Ontology Design Patterns @ISWC
- NLP & Dbpedia @ISWC
- Linked Data for Information Extraction @ISWC
- ...