# Introduction to the semantic web
or
tripping with triples. . .

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# About me

Before we start - some words about myself...

- I'm Pascal Mainini
- I'm also known as gurke
- Open minded, critical hacker
- Started with computers almost 20 years ago, working professionally since nearly 10 years
- Currently network and security specialist
- *I don't like beeing photographed or recorded otherwise, thanks!*

# About this speech

This speech will

- Give an idea of what the semantic web is about
- Give an overview of underlying technologies
- Serve as a starting point for further explorations of the semantic web

# About this speech

This speech will **NOT**

- Provide an exact mathematical background (I'm too lame for that...)
- Give an in-depth tutorial of the technologies used (URIs, XML, RDF...)
- Allow you to start working with semweb-technologies without investing any further work

# About this speech



The slides and additional material can (soon) be found at:

http://impressionet.ch/semwebspeech2

# Prerequisites

To understand the examples in this speech, you will need a basic understanding of

- URIs
- XML and XML namespaces
- a bit of XML DTDs and schema

**If you have questions, just ask them right away during the speak!**

# Problems of the current web

The web as we know of it today has some problems...

- A gigantic bunch of information, a large diversity of formats
- This information is stored in a form understandable for humans (which is great!)
- It's not that easy for a machine to understand...
- Thus, information is hard to find and reuse

# Solution approaches

To solve these problems, two possible ways exist:

- Either, improve the usage of what's already there
  - By improving techniques, especially artificial intelligence
  - This is hard to accomplish and the results so far aren't satisfying
- Or by providing the information in a way better understandable by machines
  - This requires standardised formats
  - These must be formally correct, simple and easily extensible

# The semantic web

This is where the idea of the semantic web comes in.

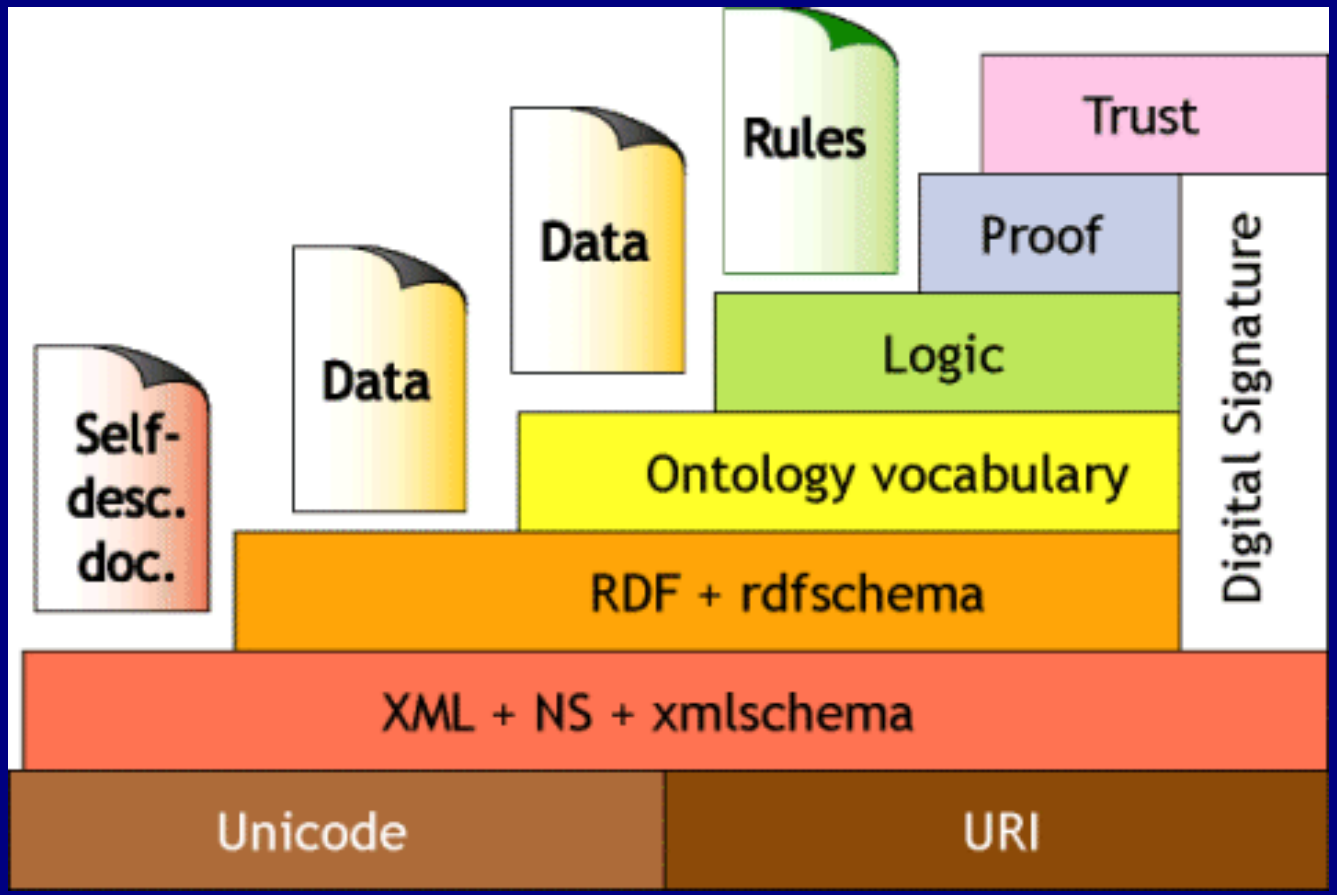
A full set of standards to accomplish this has been created by the W3C.

Technologies used base (not exclusively) on **XML** and **URI**s as discussed before.

On top of these follow **RDF**, **rdfschema** and **OWL**.

This is called the *semantic web layer cake*, let's have look at it...

# The layer cake




[w3.org]

This talk focuses on layers 3 and 4

# Syntax? Semantic?!?!?

While talking a lot about semantics and syntax...
...what's this all about?

*Syntax*
Syntax means defining rules about the structure of data, i.e. the structure of words in phrases or how well formed XML looks like.

*Semantic*
Semantic in general defines the meanings of terms, sentences or XML- constructs.

For example, the word "*wine*" has different meanings while beeing syntactically the same. It can represent a beverage or also a famous piece of software.

# History

Important points in the history of the semantic web:

- Some initial work during 1997-1998
- In 1999
  - February: First recommendation, RDF model and syntax
  - March: rdfschema proposal
- February 2004: A suite of RDF and OWL recommendations, rdfschema recommendation
- Most widely used since for RSS-feeds (but not known for that. . . )
- My first contact with it: 2003

# Basic concepts

*"Everything should be representable, so one needs a common model with great generality"*

*"Two basic elements:*
*Assertions*
*Quotations (statements about assertions)"*

`[http://www.w3.org/DesignIssues/Semantic.html]`

# RDF model

This leads to a very simplistic model, to RDF:

- Information is represented as a *triple*, as a statement
- Every triple consists of three elements:
  - **Subject**
  - **Predicate**
  - **Object**
- Subjects and predicates are given as URIs
- Objects can either be other URIs or literal data
- RDF data is represented by directed graphs

# Example. . .

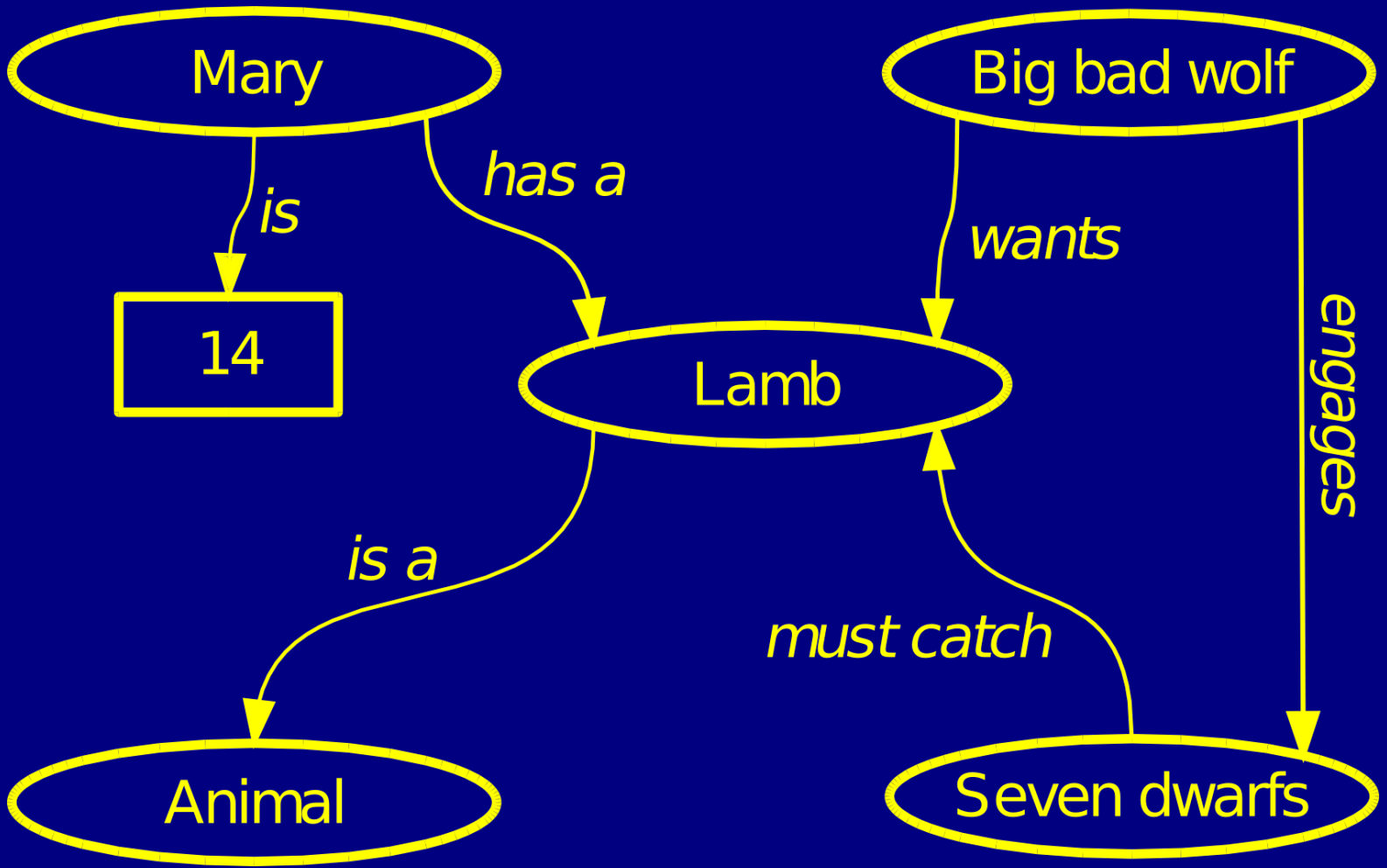
Based on that knowledge, we can build a first example.

Given the following natural language assumptions:

*"Mary has a lamb."*
*"Mary is 14."*
*"Big bad wolf wants this lamb."*
*"Big bad wolf engages the seven dwarfs."*
*"The seven dwarfs must steal the lamb."*
. . . and of course. . .
*"the lamb is an animal!"*

Represented as a graph, this would look like. . .

# Example - graph



# Serialisation

Expressing triples as graphs is nice and comprehensible - for humans. But again - not very well parseable. Usually triples are handled in some serialized form. Multiple serialisation forms exist.

- **Notation 3 (N3)** - first form, quite complex
- **N-Triples** - subset of N3, possible recommendation
- **Turtle** - extension of N3
- **XML**

Turtle and XML are the most used forms. Turtle is quite practical when writing triples by hand, XML of course in automated exchange.

# Example - turtle serialisation 1

```
➥ <http://example.org/Mary> <http://example.org/has>
<http://example.org/Lamb> .
➥ <http://example.org/Mary> <http://example.org/is> ‘‘14’’ .
➥ <http://example.org/BigBadWolf> <http://example.org/wants>
<http://example.org/Lamb> .
➥ <http://example.org/BigBadWolf> <http://example.org/engages>
<http://example.org/SevenDwarfs> .
➥ <http://example.org/SevenDwarfs>
<http://example.org/muststeal> <http://example.org/Lamb> .
➥ <http://example.org/Lamb> <http://example.org/isa>
<http://example.org/Animal> .
```

*Note: lines are split up due to space. Each line starts with* ➥

# Example - turtle serialisation 2

Of course this isn't very handy, so here is a more cleaned up version:

```
@prefix ex:  <http://example.org> .
ex:Mary ex:has ex:Lamb ;
ex:is ‘‘14’’ .
ex:BigBadWolf ex:wants ex:Lamb ;
ex:engages ex:SevenDwarfs .
ex:SevenDwarfs ex:muststeal ex:Lamb .
ex:Lamb ex:isa ex:Animal
```

*Note: Turtle provides also other shortcuts not shown here*

# Example - XML serialisation

I will now show you this example serialised as XML.
Unfortunately, I didn't have the time to fully remake it, so i took the one from the previous speech - but there are only a few things missing and it will be enough to demonstrate how it looks like...

# RDF - additional features

RDF provides additional features for added expressiveness

- Typed literals: literals are identified by an URI, often used for XMLSchema-datatypes
- Localisation of literals (language specific literals)
- Empty nodes for complex relationships
- Containers, lists, collections

*I won't cover these in this talk, please refer to additional literature.*

# rdfschema - simple ontologies

rdfschema can be used to describe simple **ontologies**.

An ontology is a *network* of informations with logical relations. One can also think of it as "knowledge in a jar", an ontology usually covers one or more areas of knowledge.

As opposed to this, a **taxonomy** is *hierarchically organised*. Example: In biology, the classification of a human as a mammal (with multiple levels inbetween of course), is a taxonomy.

# rdfschema - simple ontologies

rdfschema provides basic mechanisms for structuring RDF data.

Often, the functions given by rdfschema will be sufficient for simple ontologies.

Dublin core is a well known rdfschema ontology.

# Features of rdfschema

The most important constructs given by rdfschema are:

- `rdfs:Class`, `rdfs:subClassOf`
- `rdfs:Property`, `rdfs:subPropertyOf`, `rdfs:range`, `rdfs:domain`
- `rdfs:type`
- `rdfs:Container` (used for lists, sequences etc.)

# rdfschema - examples

Let's look at some examples (based on the tale of the lamb and the wolf. . . ):

```
ex:Person rdfs:subClassOf <http://genome.org/human>

ex:Mary rdfs:type ex:Person

ex:is rdfs:subPropertyOf
<http://older.net/ageproperty>

ex:is rdfs:range ex:Person
```

Of course, these are only a few and very simple examples - I hope you get the idea!

# OWL - introduction

**OWL** is the **W**eb **O**ntology **L**anguage

Yes, that would be **WOL** and not **OWL**! but...

- It's clear how to pronounce OWL...
- This acronym is great for making logos...
- OWLs are associated with wisdom...
- This makes up a great backstory...

`[http://lists.w3.org/Archives/Public/www-webont-wg/2001Dec/0169.html]`

A theory is also, that this comes from Winnie the Pooh, where the owl wasn't able to write her name correctly...;-)

# OWL - variants

There are three different variants of OWL:

**OWL Full**

- Contains **OWL DL** and **OWL Lite**
- Very expressive
- Not decideable (that causes headaches to reasoners. . . )
- Not fully supported by software

**OWL DL**

- Contains **OWL Lite**
- Decideable
- Nearly fully software supported

**OWL Lite**

- Decideable
- Fully software supported
- Less expressive

# OWL Lite - constructs

OWL Lite provides constructs for

- (In-)Equality
- Property characteristics
- Property restrictions
- Cardinality restrictions
- Header informations
- Class intersections
- Versioning
- Annotation
- Datatypes

And of course, rdfschema can also be combined with OWL. . . !

# OWL Lite - constructs

Some example of OWL Lite constructs:

- `owl:equivalentClass`, `owl:equivalentProperty`
- `owl:ObjectProperty`, `owl:DatatypeProperty`
- `owl:minCardinality`, `owl:maxCardinality`
- `owl:intersectionOf`
- `owl:versionInfo`
- `owl:AnnotationProperty`, `owl:OntologyProperty`

# OWL DL/Full - constructs

Additionally, OWL DL and OWL Full introduce the following constructs:

- oneOf
- dataRange
- disjointWith
- equivalentClass
- unionOf, complementOf
- maxCardinality, cardinality
- hasValue

# Full example

Let's have a look at a simple example which shows what has been discussed until now.

This example has been taken from wikipedia.

# What can be done now?

We've learned a lot about technologies so far - but how can this be used?

There are a lot of APIs out there for various languages, which help working with semantical information and ontologies. Examples include Jena (JAVA) and LibRDF (multiple languages).

Also, there is a multitude of triplestores. Triplestores are the databases for RDF-data, they store - as the name implies - triples.

*Check out my links for more information. . . !*

# Querying

RDF data can also be queried. Recently, **SPARQL** has been defined as an official standard.

Giving a broad introducion into SPARQL doesn't fit into the timeframe of this speech. I recommend you further reading on the web. . .

# Infering and Reasoning

Besides of that, also infering and reasoning are interesting and important applications of RDF.

You can understand those as making automatic assumptions about triples. As a (very simple) example, look at this:

*When we know that all human beeings are born...*
*...and we know that Pascal Mainini is a human beeing...*
*...we can automatically infer that Pascal Mainini has been born!*

Reasoning and infering go into artificial intelligence. I won't go any further here too - but it's a very interesting field and you can - again find a lot of information and tools on the web!

# Conclusion

We are reaching the end of this speech...
I hope that:

- This was interesting to you...!
- I was able to give you a good overview over this broad topic...!
- You will be able to start your own explorations - if you like to...!

# Questions

Are there any...

...Questions?!?

# Thanks a lot for your interest!

Check out

`http://impressionet.ch/semwebspeech2`

by the end of next week to find all the information!