INF3580 – Semantic Technologies – Spring 2010

Lecture 1: Introduction

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26. januar 2010

Department of Informatics

University of Oslo

Petroleumsdagen 2010

– Vil du være med og skape energifremtiden?

Torsdag 4. februar 2010 kl. 08:45-15:30

Helga Engs hus, Blindern

`http://www.matnat.uio.no/konferanser/petroleumsdag2010/`

Viktig anvendelsesområde for semantiske teknologier!

Frist for påmelding: 1. februar!

Today's Plan

1. Practicalities
2. Software
3. Introduction to Semantic Technologies

Outline

When, Where, and Who

When and Where

- Lectures Tuesdays 14:15–16:00 in Store aud.
- No lecture 30. March and 6. April (Easter break)
- Homepage:
  `http://www.uio.no/studier/emner/matnat/ifi/INF3580/`

Lecturers

Martin Giese
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Audun Stolpe
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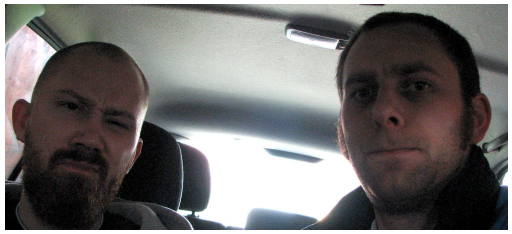
Exercises

Exercises

- Practical exercises every week
- Terminal room VB 203, Tuesday 12:15–14:00, Friday 10:15–12:00
- Exercises available on website well in advance. Come prepared!
- Consider bringing your laptop!

Teachers



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Martin G. Skjæveland
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Mandatory Assignments, Exam

Assignments

- Two mandatory assignments
- Corrected by teachers
- Pass/Fail
- Must have passed all assignments in order to attend exam
- Assignment 1: published week 8, collected week 10
- Assignment 2: published week 16, collected week 18

Exam

- Three hours written Exam 10. June
- Grades A–F
- "Trekkfrist" 27. May

Reading

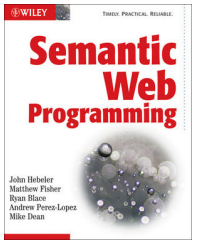
- For practical aspects: (main text)

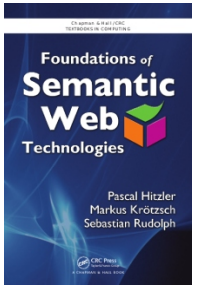
  Semantic Web Programming.
  Hebeler, Fisher, Blace, Perez-Lopez.
  Wiley 2009

- For theoretical aspects: (auxiliary)

  Foundations of Semantic Web Technologies.
  Hitzler, Krötzsch, Rudolph.
  CRC Press 2009

- Can buy both in Akademika
- Slides available on course homepage





Outline

Software

- Programming-oriented course
- With non-trivial theoretical components
- Various off-the-shelf software required to work on exercises
- Installation help in weekly exercises and exercise sessions.
- Most software already installed on ifi machines.

Software: Java

In principle, any programming language can be used for semantic web programming, but...

- Will explain Sem. Web programming using Java libraries
- The textbook concentrates on Java
- Exercises are built around Java

So: get JDK6 from

`http://java.sun.com/`

Software: Eclipse

In principle, you can use any environment to develop Java programs, but...

- The Eclipse IDE is free, open source software
- It is particularly suited for Java development
- We will use the Eclipse IDE for demonstrations
- We will be able to help you with Eclipse problems

So: get the Eclipse IDE from

`http://www.eclipse.org/`

Software: Jena

There are various Java libraries for Sem. Web programming out there, but...

- The textbook uses Jena
- It is one of the most used and mature Java libraries for Sem. Web
- It is powerful enough for our purposes

So: get Jena 2.6.2 from

`http://www.eclipse.org/`

Alternatives:

- Sesame, `http://www.openrdf.org/`
- OWL API, `http://owlapi.sourceforge.net/`
- Redland RDF Libraries (C), `http://librdf.org/`
- etc., Google for "RDF library"...

Software: Pellet

There are several reasoning systems around, but...

- The textbook uses Pellet
- It is open source software
- It has a direct interface to Jena
- It is one of the more mature and comprehensive reasoners
- It is powerful enough for our purposes

So: get Pellet 2.0.1 from

`http://clarkparsia.com/pellet/`

Alternatives:

- FaCT++, `http://owl.man.ac.uk/factplusplus/`
- RacerPro, `http://www.racer-systems.com/`
- etc., `http://en.wikipedia.org/wiki/Semantic_reasoner`

Software: Protégé

There are several ontology editors available, but...

- The textbook uses Protégé
- It is open source software
- It is the most widely used ontology editor
- Probably the best non-commercial one

So: get Protégé 4.0.2 from

`http://protege.stanford.edu/`

Alternatives:

- see `http://en.wikipedia.org/wiki/Ontology_editor`

Outline

The Vision of a Semantic Web

A vision

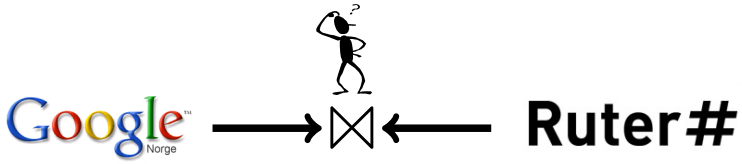
I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web—the content, links, and transactions between people and computers. A 'Semantic Web', which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy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

Tim Berners-Lee

Quoted from: *Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web*. Tim Berners-Lee with Mark Fischetti. Harper San Francisco, 1999.

Let's go to the cinema!

- Kringsjå studentby, 20:00...
- "Let's go to see *Avatar* now!"
- Need to find out which cinema plays the movie tonight, e.g. on `http://www.google.no/movies`
- Need to find out where those cinemas are
- Need to find out which of those cinemas we can reach on time using public transport, e.g. on `http://www.trafikanten.no/`
- Web user needs to combine information from different sites
- Essentially a database join!



The Solution?

- Wait for Google to produce a Cinema+Public Transport mashup?

Ruter#

- But what about
  - Real estate + public transport?
  - Plane schedules and pricing + weather information?
  - Car rental + tourism?
  - Public information + private information (preferences, calendar, location, etc.)
- Can hardly wait for a separate mashup for each useful combination!

A Web of Data!

Imagine...

- All those websites publish their information in a machine-readable format.
- The data published by different sources is *linked*
- Enough domain knowledge is available to machines to make use of the information
- User-agents can find and combine published information in appropriate ways to answer the user's information needs.

But How?

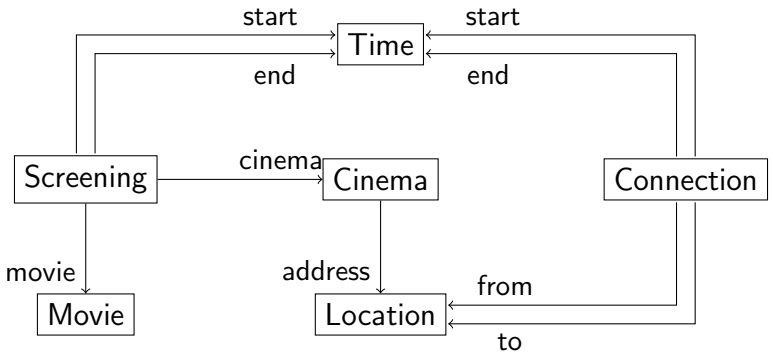
- This sounds like a nice idea, but how can it work?
- There has been a lot of hype around the Semantic Web!
- Visions instantly transformed to promises (and $$$)
- Most of this simply does not work (yet?)
- But then, a lot does!
- Current *partial* solutions build on traditions of
  - Modelling
  - Calculating with Knowledge
  - Information Exchange

Building Models

- A *model* is a simplified representation of certain aspects of the real world.
- Made for
  - understanding
  - structuring
  - predicting
  - communicating
- Can be
  - Taxonomies (e.g. species, genus, family, etc. in biology)
  - Domain models, e.g. in UML
  - Numerical Models (Newtonian mechanics, Quantum mechanics)

A Cinema Transport Model

An example of a UML domain model:



- What is the vocabulary?
- How is it connected?

A Query

What is it we want?

- Screening(s), movie(s, AVATAR)
- cinema(s, k), address(k, l)
- Connection(c), from(c, KRINGSJÅ), to(c, l)
- start(c, cStart), *before*(20:00, cStart)
- end(c, cEnd), start(s, sStart), *before*(cEnd, sStart)

Find s, k, l, c, cStart, cEnd, sStart satisfying this and we have the answer!

- Maybe not the easiest way to ask, but it's a start.
- Models are an important part of a Web of Data!
- Need to connect models from different domains.

Calculating

- What is calculation?

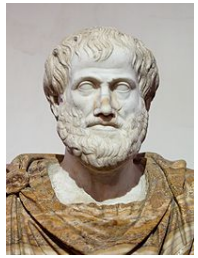
$$\frac{A \text{ owns } x \text{ } B\text{s} \quad A \text{ gets another } y \text{ } B\text{s}}{A \text{ now owns } (x+y) \text{ } B\text{s}}$$

e.g.

$$\frac{\text{Peter owns 2 apples} \quad \text{Peter gets another 3 apples}}{\text{Peter now owns 5 apples}}$$

- Calculation is algorithmic manipulation of numbers...
- ...where the *meaning* of the numbers is not needed
- Can calculate $2 + 3 = 5$ without knowing what is counted
- Abstraction!

Calculating with Knowledge



- Can be traced back to Aristotle (384–322 BC)
- Modus Barbara:

$$\frac{\text{All } A \text{ are } B \quad \text{All } B \text{ are } C}{\text{All } A \text{ are } C}$$

e.g.

$$\frac{\text{All Greeks are men} \quad \text{All men are mortal}}{\text{All Greeks are mortal}}$$

- Algorithmic manipulation of *knowledge*...
- ...where the *meaning* of the words is not needed!
- Also an abstraction!
- The topic of *formal logic*
- a.k.a. INF3170!

Computing with Knowledge About Movies

- Query: find a *fun event* we can reach by public transport
- Knowledge base:
  1. A movie screening is an event
  2. A movie screening is fun if the movie being shown is not a documentary
  3. James Cameron does not direct documentaries
  4. James Cameron directed *Avatar*
  5. There is a screening of *Avatar* at 19:00.

  ...
- Let's deduce...
  6. From 3 and 4: *Avatar* is not a documentary
  7. From 6 and 2: A screening of *Avatar* is fun
  8. From 1, 5, 7: there is a fun event at 19:00

  ...
- Computing with Knowledge is an important part of a Web of Data!

Exchanging Information

- 1974: The Internet: Global network. Unified network addresses. TCP/IP protocol.
- 1990: The WWW: HTTP protocol. HTML markup. URLs.
- 1996: XML: more data-oriented markup.
- All these (and more) are obiously ingredients for a Web of Data!
- Semantic Web standards are being managed by W3C.

Bringing it together

- RDF as common knowledge format:
  - `movie:Avatar movie:director people:jc.`
  - `people:jc people:name "John Cameron".`
- URIs to avoid naming conflicts:
  - `http://heim.ifi.uio.no/martingi/movies#Avatar`
- existing protocols to move data:
  - Use HTTP for queries to a semantic web server
  - Use XML for answers, to encode RDF, etc.
- OWL to express ontologies
  - Somewhat like UML class diagrams but better for Sem. Web
- Reasoners to infer new knowledge
  - Hidden from other tools by standardized interfaces

The AAA slogan

Anyone can say Anything about Anything.

- IMBD: `movie:Avatar movie:director people:jc.`
- Saga Kino: `movie:Avatar movie:shownAt oslokino:Saga.`
- VG: `movie:Avatar vg:terningkast 6.`
- Three statements from three sources about the same object `movie:Avatar`!
- My homepage: `movie:Avatar movie:director mg:myself.`

The "Home" of the Semantic Web

See the W3C pages for the Semantic Web effort:

`http://www.w3.org/2001/sw/`

For standards (RDF, OWL, SPARQL, etc.), see:

`http://www.w3.org/2001/sw/wiki/Main_Page`

Problems with the Semantic Web

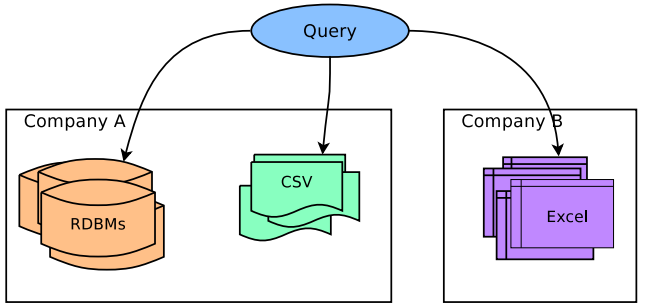
- Relies on ontologies
  - Have to agree on and communicate ontologies
  - Have to agree on the precise meaning of ontologies
- Anyone can say Anything about Anything
  - Good, simple, necessary
  - Difficult to locate relevant information
  - Difficult to trust data sources
  - Have to deal with unreliable, inconsistent data
  - Have to deal with enormous amounts of data
- ...
- Extent of these problems is in stark contrast to the visions that have been stated and the promises that have been made.
- Hype has brought some amount of discredit to the Semantic Web effort.

Semantic technologies

- If Tim Berners-Lee's vision of a Semantic Web is still far away, then what is this course about?
- Let's have a look at what we do have:
  - W3C standards: RDF, SPARQL, OWL, some more
  - Technology like reasoners, ontology editors
  - Interfacing to relational databases, etc.
  - Existing ontologies for applications in medicine, industry, some of them with over 1M concepts
- Possible, and a lot easier, to use Semantic Web technologies for more closed, controlled applications
- We talk about "semantic technologies" since they make sense independent of the Web

Data integration

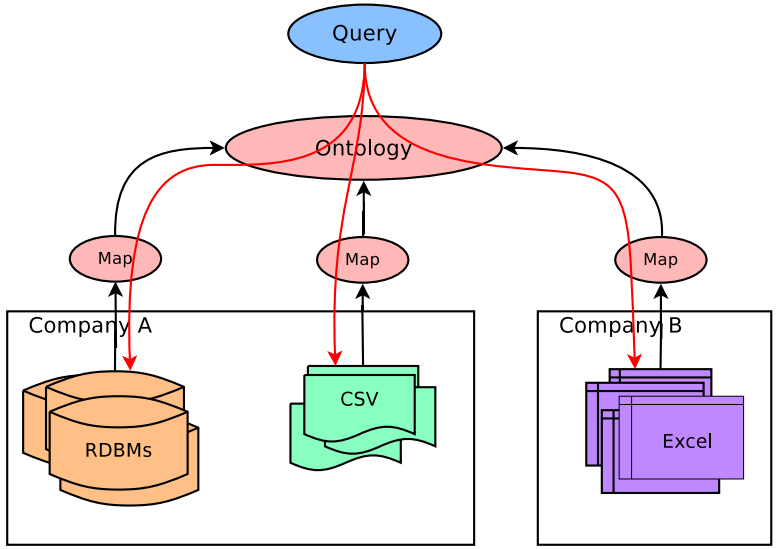
- One of the foremost problems in industry today
  - within one organization
  - between organizations
- Enormous amounts of data gathered over the last decades
  - different formats, different data models
  - specialists needed to find, access, convert data when it is needed
  - large need for automated, unified data access



Ontology-based data access

- Use ontology to define common vocabulary
- Possibly by connecting ontologies for different sources using mediating ontologies
- Create mappings between the common vocabulary and what is in the data sources.
- Access data using queries expressed using the common vocabulary
- Background machinery gives answers as if data had always been stored according to a common data model

Ontology-based data access (cont.)



This course

The aim of this course is to teach you...

- ...enough of the semantics in semantic technologies (logic, reasoning) for you to get an idea of what this is all about, what can and cannot be done.
- ...enough of the technology in semantic technologies (standards, languages, programming interfaces) for you to be able to use them in practice.
- ...enough overview for you to know where to look and what to read when you need a deeper understanding of either side.

If you want to learn more:

- Contact us for possible MSc degree topics

Semantic Technologies at ifi

- Currently 1 professor, 2 post-docs, 3 PhD-students, 6 MSc students directly concerned with semantic technologies in OMS group.
- Semicolon
  - Data exchange between public sector institutions in Norway
  - Publication and interlinking of public data.
  - User partners: Brønnøysundregistrene, Helsedirektoratet, Skattedirektoratet, Statistisk sentralbyrå
- IOHN (Integrated Operations in the High North)
  - Partners include two oil companies, major software vendors like IBM, SAP, Siemens
  - Data exchange and integration for the oil industry
- Great opportunities for both practically and theoretically oriented MSc theses, PhD work,... with strong connections to industry and public sector!