INFO4188: Semantic Web and Applications

Introduction

**Semantic Web
Link Open Data**

Ontologies Heavyweight ontology

Lightweight ontology DB, MDA, UML, Rules, DLs

Knowledge Acquisition
Knowledge Representation
Knowledge engeneering **Expert systems**
Ontologies Learning
Ontologies Integration
Domain ontologies IRI, URI, URL **Decision Support Systems**

RDF, RDFS, OWL, Turtle
Rules, SWRL, RIF **Cryptography**

Protege Hermit SPARQL
METHONTOLOGY

Jena API **DBPedia** **O4TBSS** NeOn
GraphDB Google Search
OWL API Virtuoso **Yago** **Sourcepedia** Music Brain

Source2onto Pellet **BFO**

BioPortal

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Dr. Azanzi Jiomekong

- Teacher and researcher at University of Yaounde I

- Teaching at University of Yaounde I :
  - Algorithmic and data structures
  - Object Oriented Modeling and Object Oriented Programming
  - Advanced Programming Techniques
  - Development of Mobile Applications
  - Semantic Web and applications

- Teaching Université Virtuelle du Sénégal :
  - Knowledge Engineering

- Teaching at Université Nazi Boni :
  - Web of Data

Dr. Azanzi Jiomekong

- Research objective : Semantic-aware software engineering

- Research topics
  - Empirical Software Engineering
  - Semantic Web Technologies
  - Knowledge Engineering
  - Knowledge Graph

- Research projects :
  - **TSOTSA :** A system for Nutrient Prediction and Food Recommendation using Graph Machine Learning techniques
  - **Mendi :** A system for traffic urban trafic description using Graph Machine Learning Techniques
  - **HISFactory :** A system based on MDE and KG for the generation of Health Information Software

Internet

- ARPANET :
  - Advanced Research Projects Agency Network
  - One of the goals was to establish reliable communication between computers
  - 29 October 1969 : ARPANET started among four Universities - University of Santa Barbara, University of California, Stanford Research Institute and Utah University
  - Universities are connected
  - Researchers involved : J. C. R. Licklider, Robert Taylor, Larry Roberts

- From Internet to Web 2.0 :
  - December 1969 : connecting 4 Universities
  - June 1970 : more universities connected
  - March 1972 : more universities connected
  - July 1977 : more universities connected

Internet

- First Generation :
  - Internet
  - Computer Centered Processing

- Algorithm to get the information :
  1. Open terminal
  2. Connect to remote computer
     You should know its address
  3. Retrieve file system data from remote computer
  4. Download the file from remote to local computer
  5. Read the file on local computer

Internet

- **Problems :**
    - Information access requires expert knowledge
      Not for ordinary users
    - Information access is expensive
    - Information retreival is very expensive

- **Solution :**
    - Idea : Document exchange and editing system based on Hypertext
      where the document are connected with each other and you can
      access a document by clicking on a link that connect you to another
      document
        - $\longrightarrow$ A network of connected document
        - $\longrightarrow$ No need to be an expert to use it
    - World Wide Web (WWW)
    - Born at the European Nuclear Research Center in 1990
    - Invented by Tim Berners-lee and Robert Cailliau

Web

- Second generation :
  - The Web
  - Document Centered Processing

- Algorithm to get the information :
  1. Open browser (Netscape communicator)
  2. Load document
  3. Click on the next hyperlink
  4. etc.

- Advantages :
  - No expert knowledge required
  - Simple information access
  - Information retreival via search engines

Web

The Web an old idea ?

- ENCYCLOPEDIE OU DICTIONNAIRE RAISONNÉ DES SCIENCES, DES ARTS ET DES MÉTIERS :
  - Denis Diderot (1713-1784) and Jean Baptiste le Rond d'Alembert (1717-1783)
  - Le diverse et artificiose machine del capitano agostino ramelli (Agostino Ramelli - 1588)

- MEMEX :
  - First Hypertext-System
  - Invented in 1945 by Vannevar Bush

$\longrightarrow$ Usability probllem

Web

- Why was the Web such a big success ?
  - Lynx browser (1993) : Information access with keyboard
  - NCSA Mosaic (1994) : Information access with mouse
  - IPad Safari (2010) : Information access using finger

- There seem to be no limits of growth

- From Web 1.0 to Web 2.0 :
  - Information consumption
  - Information production
  - Interactive participation

Web

Web 2.0

- Web Content and Roles changing
- Business revolution in the computer industry caused by the move to the Internet as platform, and an attempt to understand the rules for success on that new platform - Tim O'Reilly, 2003

Consequences :

- The Web is now big, vast, huge, hogglingly big
- The Web is getting bigger every minute !
- Internet of Things :
  - All the things will connect with social networks
  - "The next logical step in the technological revolution connecting people anytime, anywhere is to connect inanimate objects. This is the vision underlying the Internet of Things : anytime, anywhere, by anyone and anything

Web

Question : How can we find something on the Web ?

- If the information that we're seeking is in foreign languages (for instance, Chinese) ?

Solution :

- Semantics
- Give the meaning to things on the Web

Semantic Web
Outline

- Tim Bernee Lee "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"

- The meaning of knowledge is made explicit

- Use a formal (structured) and standardized representation of knowledge

- Extends information sources with a semantically structured representation

- Use ontologies to include semantic in data sources

Semantic Web

Outline

Allow us to :

- Automatically process information before returning it to users

- Describe and integrate heterogeneous data sources

- Automatically deduce implicit data or non-obvious data

- Data integration

Ontologies

- Studer et al. : "A formal, explicit specification of a shared conceptualization"

- Conceptualization :
  ○ abstract model of a domain
  ○ machine readable
  ○ all the elements are explicitly defined and accepted by the members of a group

- Facilitate information exchange between machines and between a human and a machine

- Build using knowledge from :
  ○ Domain experts
  ○ Knowledge sources : text, databases, source code, existing ontologies,

Course general objectives

This course aims to provide students with theoretic and practical knowledge in Semantic Web and their applications.

Course specific objectives

After taking the course, students should :

- Know the Web of Data

- Know the Semantic Web

- Ontologies engineering :
  - Ontologies development methods
  - Ontologies development methodologies
  - Ontologies development tools

- Knowledge Graphs

Pre-requisite

- Basic knowledge in algorithm

- Basic knowledge in programming

- Good knowledge on Web applications development

Profile : Master students in Computer Science

Progress

- Course in English and French

- Presentations and discussion with students

- Hands on sessions by students

- Duration = 24h :
  - Course ? ?h
  - Practice : ? ?h

Course content

- Overview

- Facts representation

- Basic knowledge representation

- Knowledge storing

- SPARQL

- Ontologies

Course content

- OWL

- Rules

- Ontologies engineering

- Knowledge Graph engineering

Hands on sessions

- Hands on 0 : Installation and configuration of tools

- Hands on 1 : knowledge acquisition
  - Manually
  - (Semi-)automatically

- Hands on 2 : Knowledge modeling
  - Software engineering techniques
  - Logic techniques

- Hands on 3 : knowledge representation
  - XML
  - RDF
  - RDFS, OWL
  - Inference mechanism

Hands on

- Hands on 4 : Ontology construction
  - Manual construction with Protégé
  - (Semi-)automatic construction

- Hands on 5 : Knowledge accessing :
  - SPARQL
  - GraphQL
  - Inference mechanism

- Hands on 5 : knowledge graph programming

Exam

- Continuos assessment
  - Knowledge acquisition = 10%
  - Knowledge representation = 10%

- Practice :
  - Construction of the ontology/knowledge graph = 10%
  - Knowledge storage and querying = 10%
  - Knowledge embedding = 10%

- Final exam (50%)

Job opportunities

- Work in a large company as a knowledge engineer :
  - Local company
  - Company Abroad

- Start a company

- Work in FreeLance

- Teach

- Research

Job opportunities
Job references

- Glassdor

- PayScale

Some opportunities

- CodeJam

- Google Summer of code
  - https://summerofcode.withgoogle.com/

- Facebook Online Hackathon Series

- #BuildforSDG Challenge

References

Books

- Le Web Sémantique - Comment lier les données et les schémas sur le Web ?
  par Fabien Gandon, Catherine Faron-Zucker, Olivier Corby, 2 mai 2012.

- Foundations of Semantic Web Technologies by Pascal Hitzler, CRC Press, 2009.

- Logic for Computer Scientists by Schöning, 2008.

- Linked Data : Evolving the Web into a Global Data Space by Tom Heath and
  Christian Bizer, February 2011.

- Ontological Engineering : with examples from the areas of Knowledge
  Management, e-Commerce and the Semantic Web by Asunción Gómez-Pérez,
  Mariano Fernandez-Lopez and Oscar Corcho, October 2010.

- Ontology Learning for the Semantic Web by Alexander Maedche, December
  2012.

References

Web ressources

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  https://www.w3.org/TR/2014/REC-rdf11-mt-20140225/,
  https://www.w3.org/TR/2014/REC-rdf-syntax-grammar-20140225/
- **RDF :** https://www.w3.org/TR/rdf-primer/,
  https://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/,
- **Turtle :** https://www.w3.org/TR/2014/REC-turtle-20140225/
- **RDFS :** https://www.w3.org/TR/2014/REC-rdf-schema-20140225/
- **SPARQL :** https://www.w3.org/TR/rdf-sparql-query/
- **OWL :** https://www.w3.org/OWL/
- MOOC-FUN Web Sémantique et Web de Données : https://www.fun-mooc.fr/courses/course-v1:inria+41002+self-paced/about
- etc.
- https://www.w3.org/TR/rdf-schema/
- https://www.w3.org/TR/turtle/
- https://www.w3.org/TR/rdf11-concepts/

Credit

Some resources (slides and figures) from Harald Sack :

- Semantic Web Technologies
- Knowledge Engineering with Semantic Web Technologies
- Linked Data Engineering (Semantic Web)
- Information service engineering

Contact

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