CS 7810 - Knowledge Representation and Reasoning (for the Semantic Web)

01 - Introduction

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Acknowledgements

- A good number of slides in this presentation are adapted from:
  - Sebastian Rudolph, “Overview and XML”, slides for Foundations of Semantic Web Technologies course, Dresden, April 9, 2014.
  - Pascal Hitzler, “Slides 1 – 01/03/2012”, slides for Knowledge Representation for the Semantic Web course, Winter quarter 2012.

About me and the course

DaSe Lab

- About the course, visit: http://dase.cs.wright.edu/courses/cs-7810-knowledge-representation-and-reasoning-fall-2016

- About me, see: http://dase.cs.wright.edu/people/adila-krisnadhi

About you …

- Who are you?
- Which year?
- Which specialization area, if any?
- Why are you taking this class?

The (World Wide) Web

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- Pervasive: various aspects of life are web-ized.
  - Social contacts (social networks, blogs, …)
  - Economics (buying, selling, advertising, …)
  - Authorities, administration (government)
  - Education (e-learning, Web as information system, …)
  - Work life (information gathering and sharing)
  - Recreation (games, role play, creativity, …)
- Immensely successful (Why?)
- Generate huge amount of data
- Syntax-standards for transferring structured data
- Machine-processable, human-readable **documents**.

- **But**: content/knowledge and meaning/semantics of transferred data are not accessible by machine.

Problems with the Web (1)

- Huge amount of information, too little structure.
- Emphasis on human consumption.
  - Standard syntax for presenting information to human.

Prof. Dr. Pascal Hitzler

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Problems of the Web (1)

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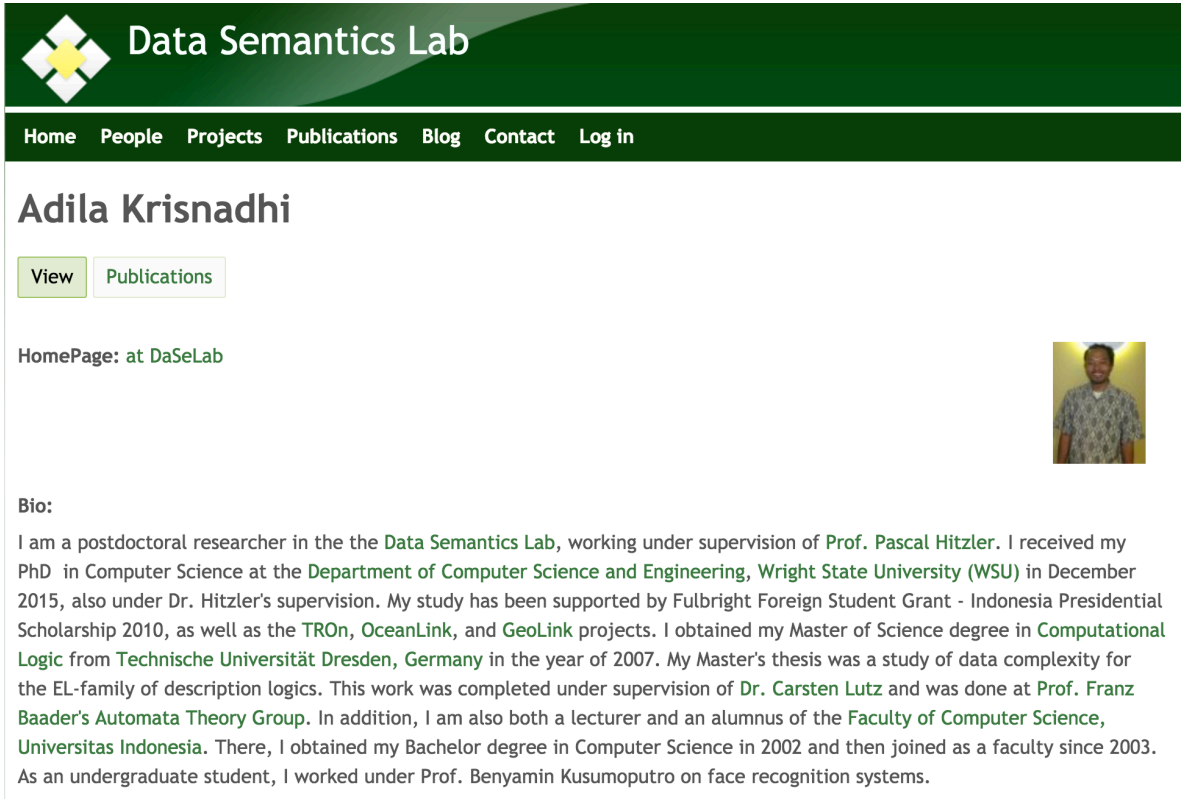

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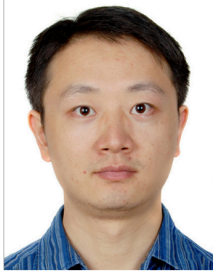

漆桂林

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论文 "Conflict-based revision operators in possibilistic logic" 被AAAI'12录取 (full paper).

论文 "A new operator for ABox revision in DL-Lite" 被AAAI'12 录取 (short paper).

论文 "Large scale temporal RDFS reasoning using MapReduce " 被AAAI'12 录取 (short paper).

被邀请为语义Web最权威杂志Journal of Web Semantics的Editorial Board成员

个人简介

漆桂林，东南大学教授，博士生导师。漆桂林是中国计算机协会会员，ACM professional member。现任中国中文信息学会语言与知识计算专业委员会副主任和CCF中文信息技术专委会委员。是澳大利亚Griffith大学访问教授（2011年11月-2012年2月和2013年6月-2013年7月）和法国图卢兹第一大学访问教授（2013年1月-2013年2月）。1998年毕业于宜春学院数学专业，2002年获得江西师范大学数学与信息系硕士学位，2006年获得英国贝尔法斯特女皇大学计算机博士学位。2006年8月至2009年8月在德国Karlsruhe大学AIFB研究所做博士后研究。

漆桂林教授长期从事人工智能、语义Web和知识工程方面的科学研究及教学工作。截至目前,已经发表高质量学术论文100篇多篇,特别是在国际人工智能著名会议IJCAI、AAAI、KR、UAI以及国际语义Web著名会议ISWC、ESWC发表多篇会议文章，在国际著名杂志Information Science和Fuzzy Sets and Systems等发表多篇杂志文章。其中，一篇文章在亚洲语义Web会议上获得最佳论文提名奖。获得欧盟第七框架Marie Curie Actions — International Research Staff Exchange Scheme (IRSES)资助（漆桂林为其中一个workpackage的负责人）。获得多项国家自然科学基金资助，其中两项为项目负责人。2014年获得百度主题研究项目资助。作为主要参与人参加了863大数据“类人类智能”方向的课题。

Problems of the Web (1)

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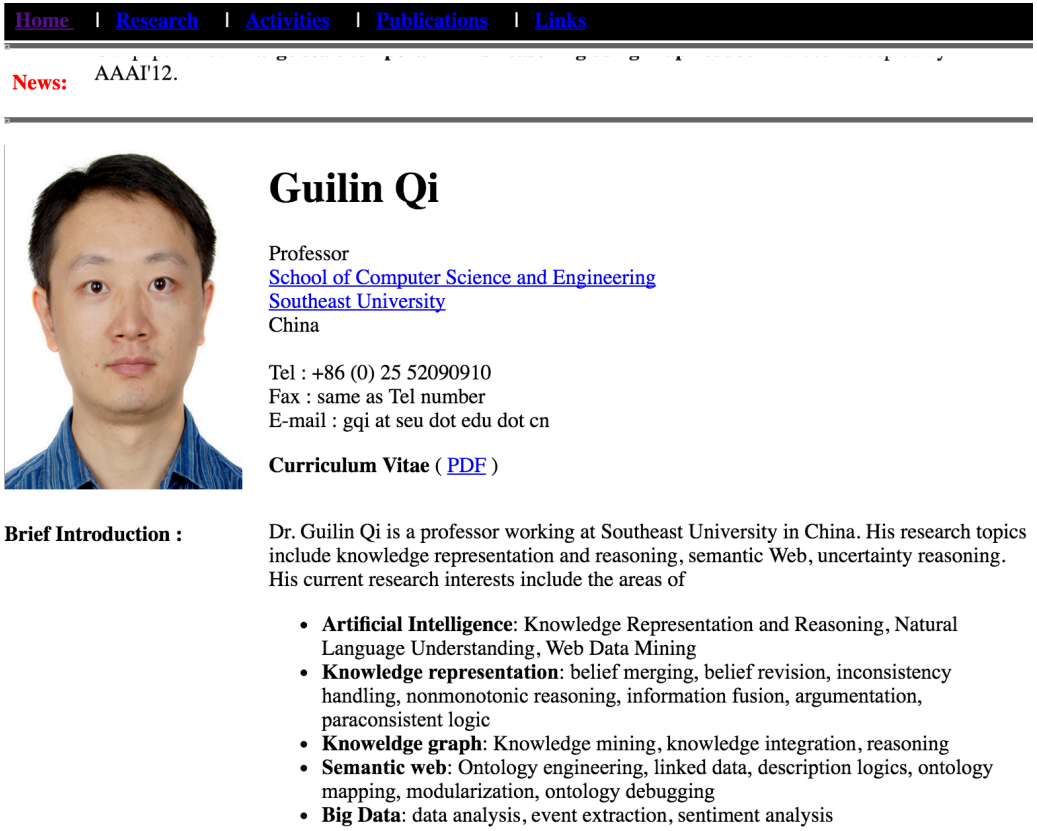

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News: AAAI'12.

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Curriculum Vitae (PDF)

Brief Introduction :

Dr. Guilin Qi is a professor working at Southeast University in China. His research topics include knowledge representation and reasoning, semantic Web, uncertainty reasoning. His current research interests include the areas of

- **Artificial Intelligence**: Knowledge Representation and Reasoning, Natural Language Understanding, Web Data Mining
- **Knowledge representation**: belief merging, belief revision, inconsistency handling, nonmonotonic reasoning, information fusion, argumentation, paraconsistent logic
- **Knoweldge graph**: Knowledge mining, knowledge integration, reasoning
- **Semantic web**: Ontology engineering, linked data, description logics, ontology mapping, modularization, ontology debugging
- **Big Data**: data analysis, event extraction, sentiment analysis

Problems of the Web (2)

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- Localizing information is challenging.
- Today's search engines are good, but mostly keyword-based.
  - Example: try google for "kohl" images; how many kinds of kohl will you find?

- Desiderata: search for content → semantic search

Problems with the Web (3)

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- Heterogeneous
  - content
  - structure (e.g., where a particular piece of information can be found on webpages)
  - character encoding (e.g., ASCII vs. Unicode).
- Desiderata: intelligent information integration

Problems with the Web (4)

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- Deriving new (implicit) information from given pieces of information is possible for human.
  - The current Web can only operate on syntax.

- Desiderata: automated deduction.
  - Formal logics are required.

So what is this “Syntax vs Semantics” about?

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- Syntax:
  - Greek: σύνταξη → composition, sentential structure
  - denotes the (normative) structure of data
  - characterizes what makes data “well-formed”
- Semantics:
  - Greek: σημαντικός → significant, belonging to the sign
  - denotes the meaning of data
  - characterizes conclusions that can be drawn from data.

- Example:
  - 7+) = (syntactically incorrect
  - 7+3 = 11 syntactically correct, semantically incorrect
  - 7+3 = 10 syntactically and semantically correct

Problems of the Web (Solutions?)

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- Ad hoc:
  - Employs methods (e.g., NLP techniques, machine learning) to evaluate existing unstructured information on the Web
- A priori:
  - Put structure on the pieces of information prior to publishing on the Web such that later automated deployment and processing are enabled.
- Semantic Web (usually) belongs to the latter.

Basic ingredients for the Semantic Web

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- Open standards for describing information on the Web
  - Make some knowledge representation languages as standard.
- Methods to obtain further information from such descriptions
  - Reasoning algorithms.

Reasoning

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- Logical deduction (automated reasoning)
  - Columbus is a state capital.
  - Every state capital is a city.
  - **Then**: Columbus is a city.
- We use logic
  - Predicate logic (for most of the time).
  - The logic determines which conclusions are valid.
  - Algorithms to derive conclusions are needed.

Semantic Web: Basic Idea

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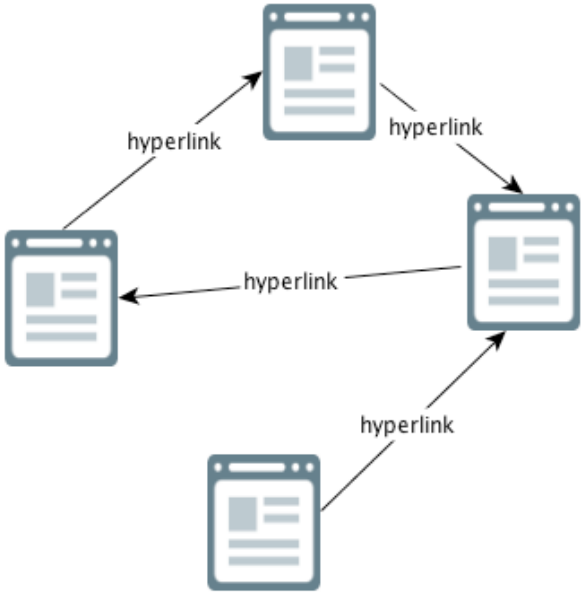
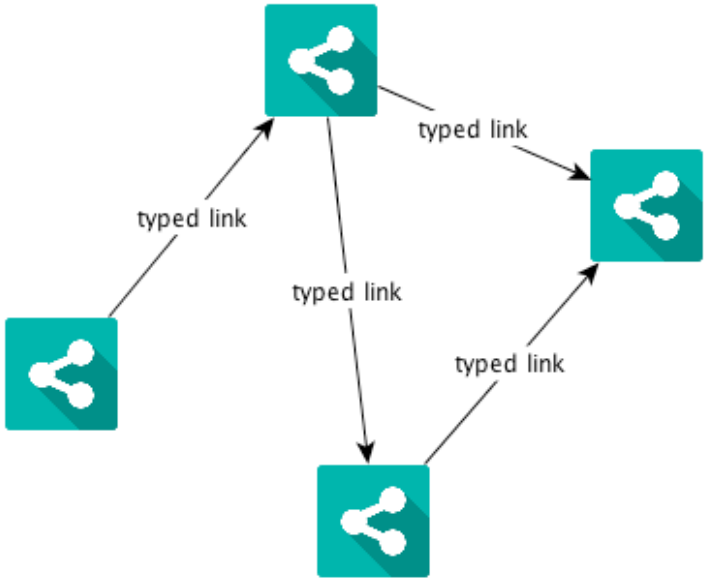
The Web (of Documents)



The Web (of Data)



Semantic Web = Web of Data + formalized vocabulary
Formalized vocabulary = ontology = collection of terms (used for links and classes) whose semantics are formally defined.

Semantic Web: Basic Idea

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- Try visualize (at least partially) the Web (of Documents) starting from https://en.wikipedia.org/wiki/Dayton,_Ohio
- Try visualize the Web of Data starting from http://dbpedia.org/resource/United_States
  - Which term would you consider as 'data'?
  - Which term would you NOT consider as 'data'?

Ontology & Ontology Languages

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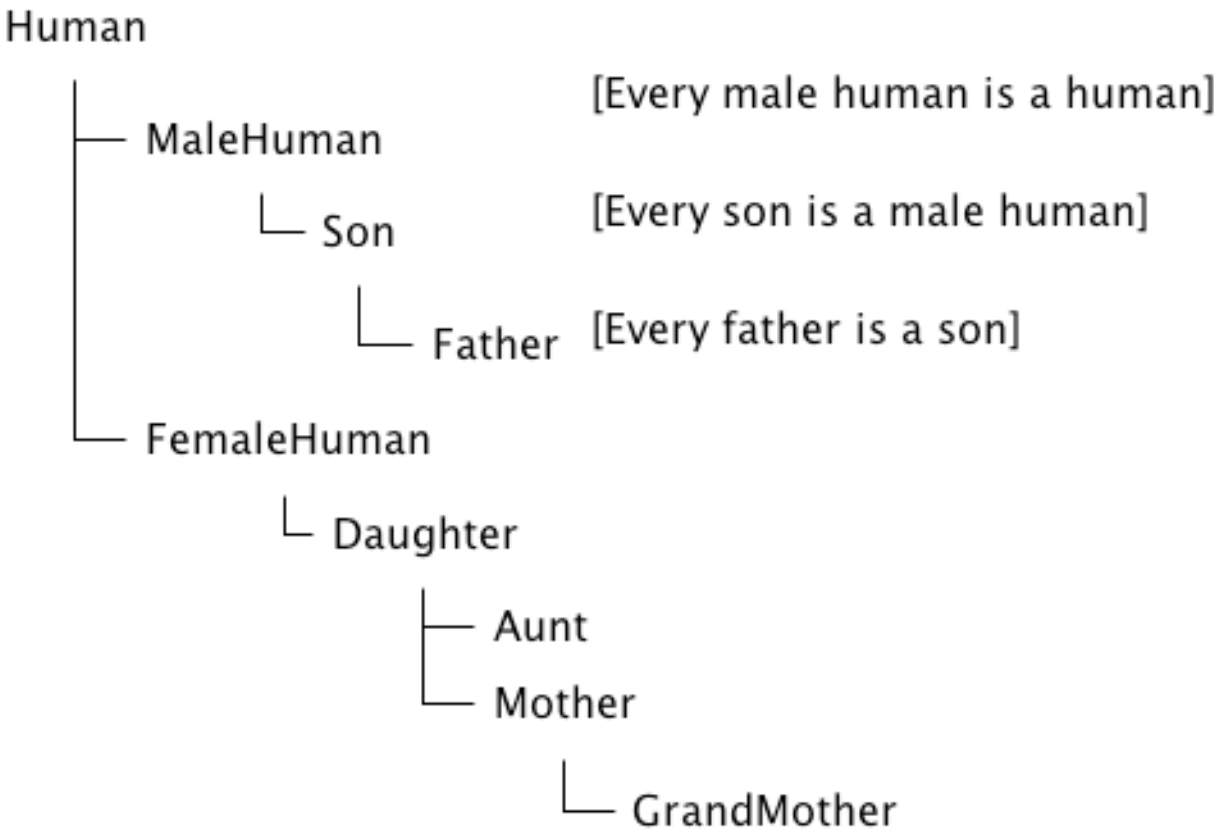
- Vocabulary term: term acting as metadata.
  - For links between data, and class names for typing of instance data
- Ontology: specification containing formal definition of vocabulary terms
  - E.g., “every country is a populated place”
- To specify an ontology, we need an ontology language.
  - Meaning/semantics via logic and automated reasoning
  - Scalability is a challenge: the more expressive an ontology language is, the less scalable it will typically be.

Taxonomy

- Often (not always!), the core of an ontology is a taxonomy -- classes of things arranged in a subclass hierarchy.



Partonomy

- Taxonomy is often confused with partonomy – classes of things arranged in a hierarchy of "part-of" relationships.

Taxonomy vs Partonomy

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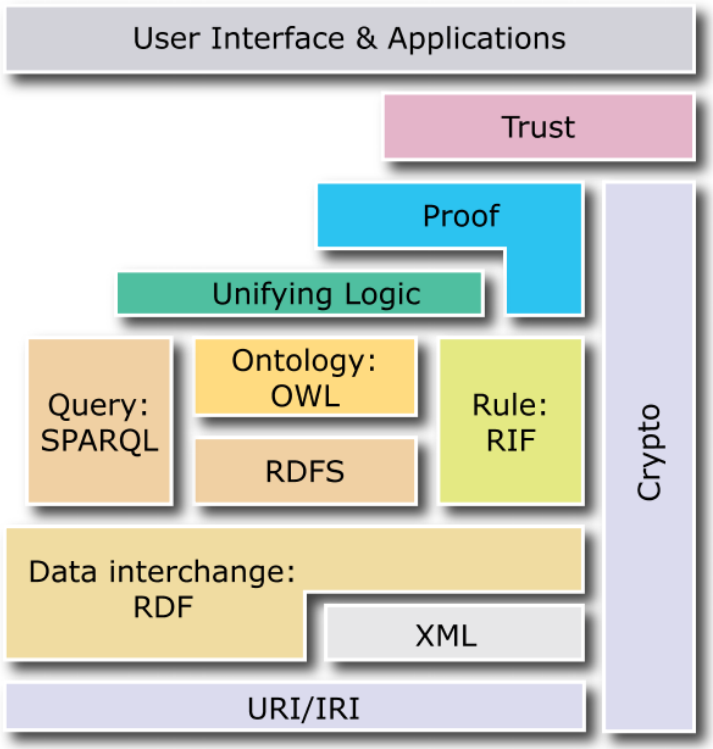
- Taxonomy: *every* A *is a* B
  - Every father is a man
  - Every horse is a mammal
  - Every university is an organization
  - Every arm is a limb

- Partonomy: A *is a part of* B
  - Arm is a part of body
  - Ohio is a part of USA
  - Engine is a part of car
  - Daselab is a part of Wright State University

Semantic Web Standards



https://www.w3.org/2007/03/layerCake.png

1994 First public presentation of the Semantic Web
1998 Start of standardization of data model (RDF) and a first ontology language (RDFS)
2000 Start of large US & Europe research projects on ontologies (DAML & Ontoknowledge)
2001 Tim Berners-Lee, et al landmark paper.
2002 Start of standardization of new ontology language (OWL)
2004 RDF and OWL standards finalized (RDFS is part of RDF standards)
2008 SPARQL standard finalized
2009 OWL 2 standard finalized
2010 Rule Interchange Format (RIF) standard finalized
2012 OWL 2 standard updated to 2nd edition
2013 SPARQL 1.1 standard finalized, RIF standard updated to 2nd edition
2014 RDF 1.1 standard finalized

Semantic Technologies in the US

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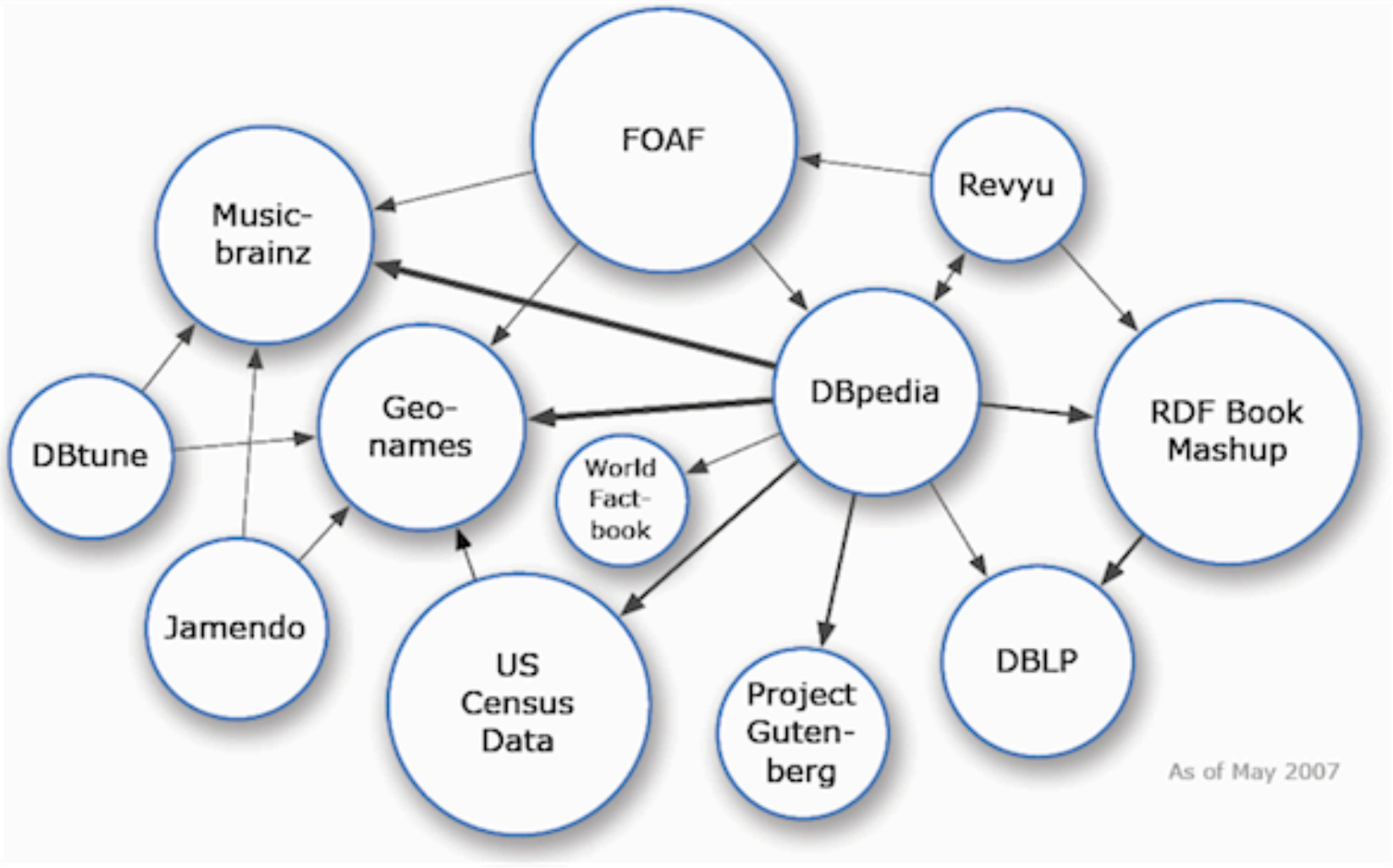
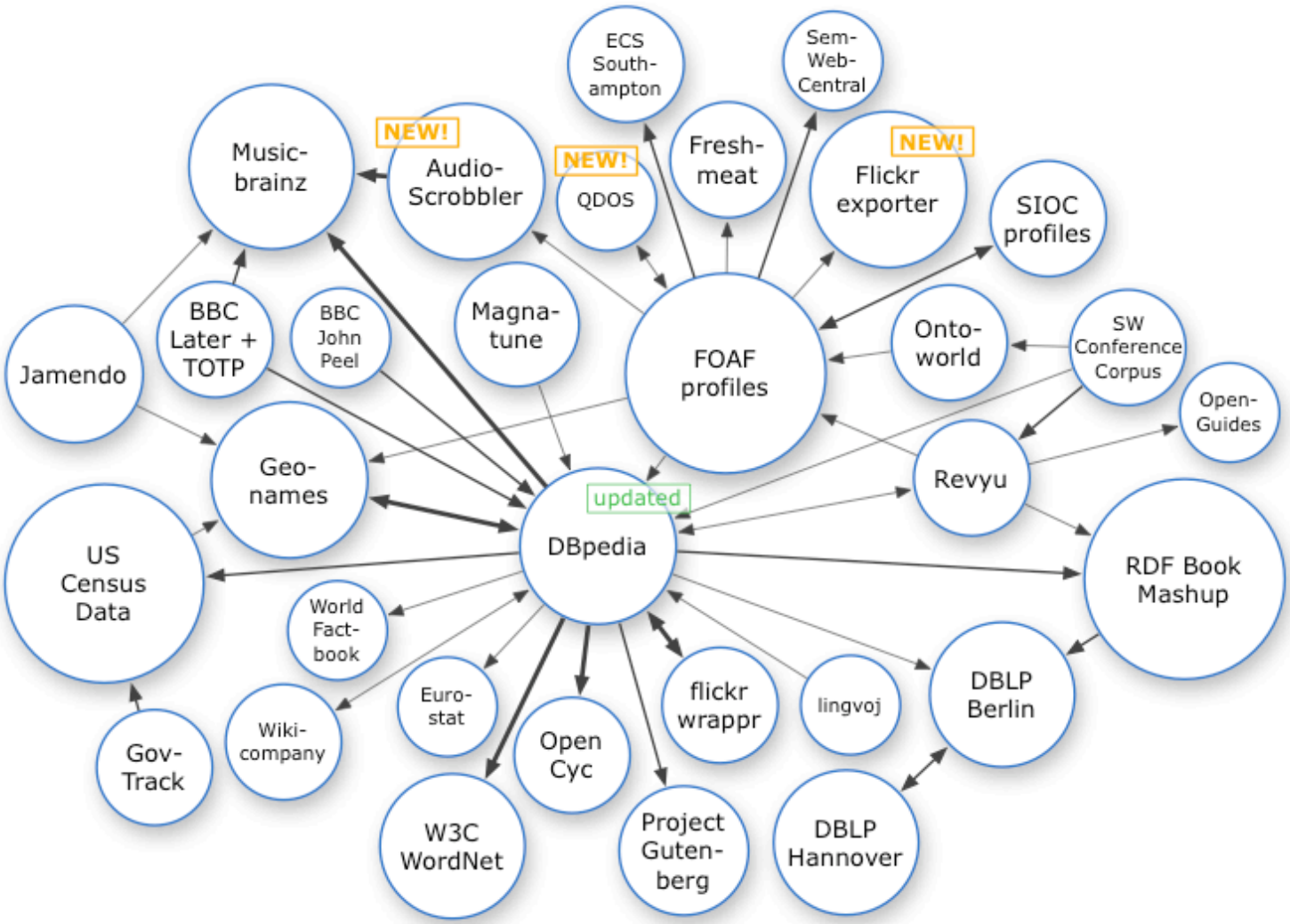
- (Government) research funding via:
  - NIH, NSF, DoD, DoE, AFRL, IARPA, DARPA
- Industrial take-ups:
  - Annual Semantic Technology Conference (since 2015 called Smart Data conference) hosted by Dataversity
  - Investment by major enterprises (Oracle, IBM, HP, Google, Accenture, Siemens, Bosch, GE)
  - Major government contractors (BBN, Lockheed, …)
  - Venture capital (e.g., Vulcan)
  - Structured data on the Web (BBC, nytimes, data.gov, …)

State of Linked Data (2007)



Linking Open Data cloud diagrams, by Max Schmachtenberg, Christian Bizer, Anja Jentzsch and Richard Cyganiak. http://lod-cloud.net/

State of Linked Data (2008)



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State of Linked Data (2009)

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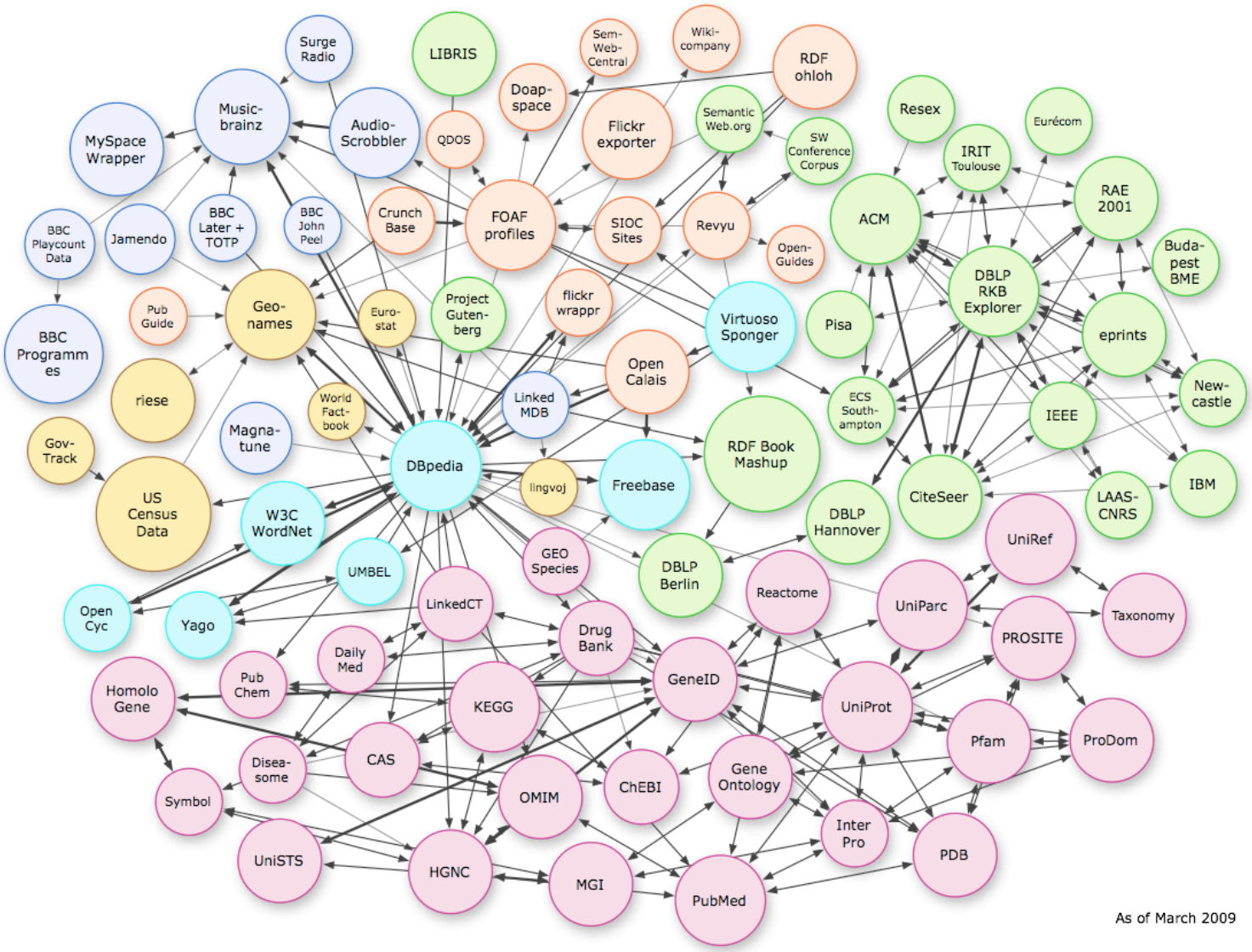

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State of Linked Data (2010)

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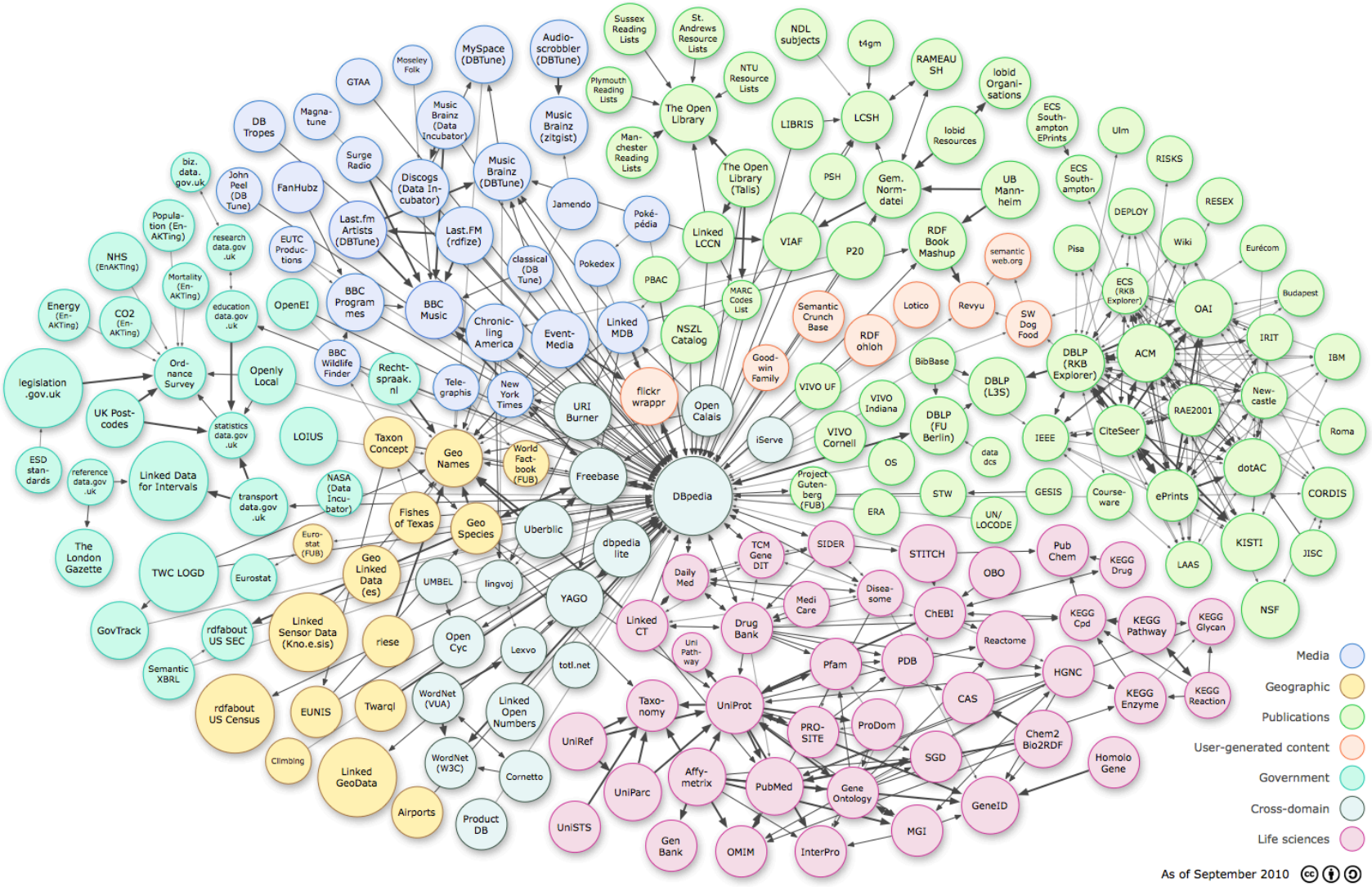

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State of Linked Data (2011)

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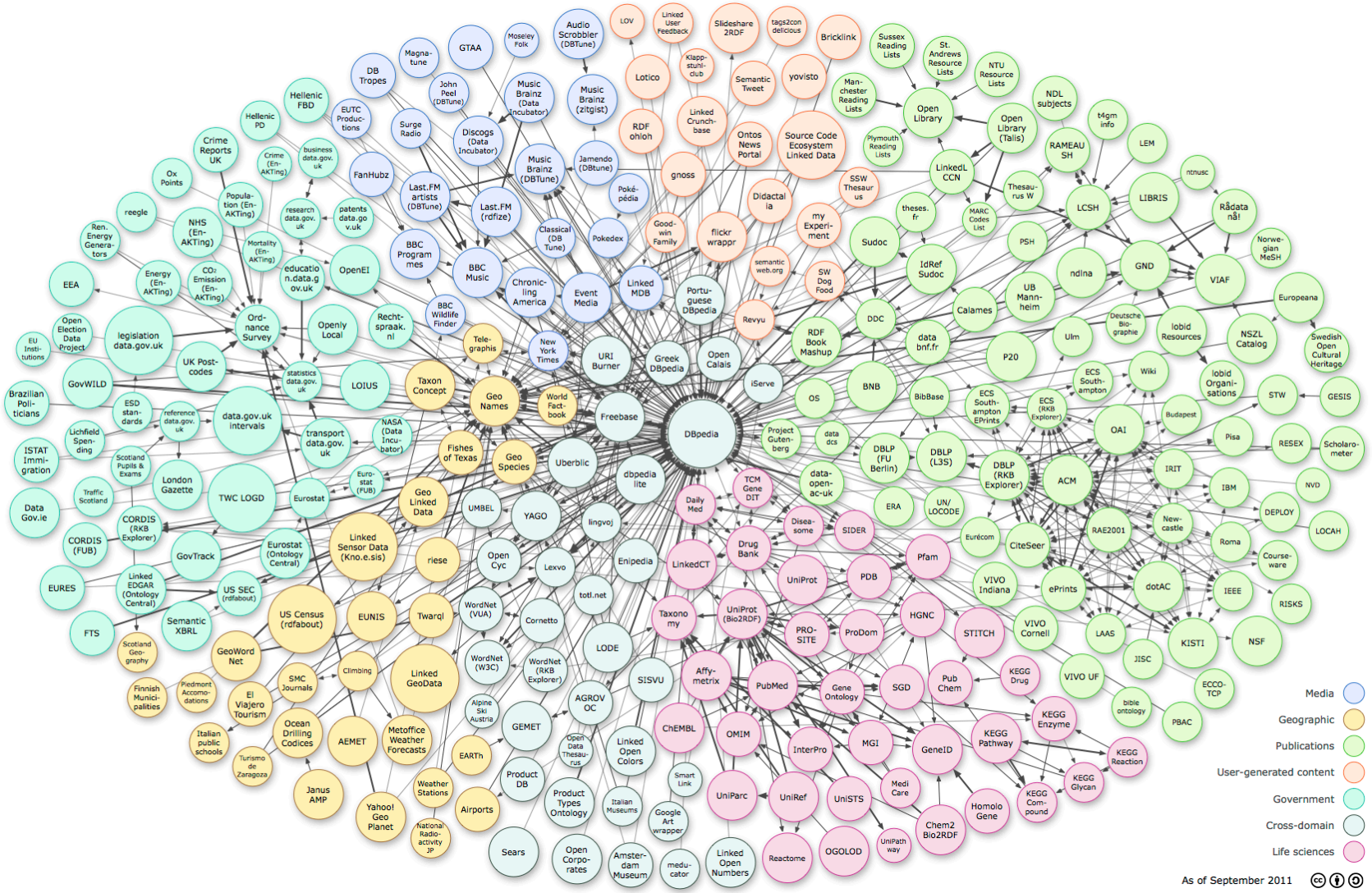

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State of Linked Data (2014)

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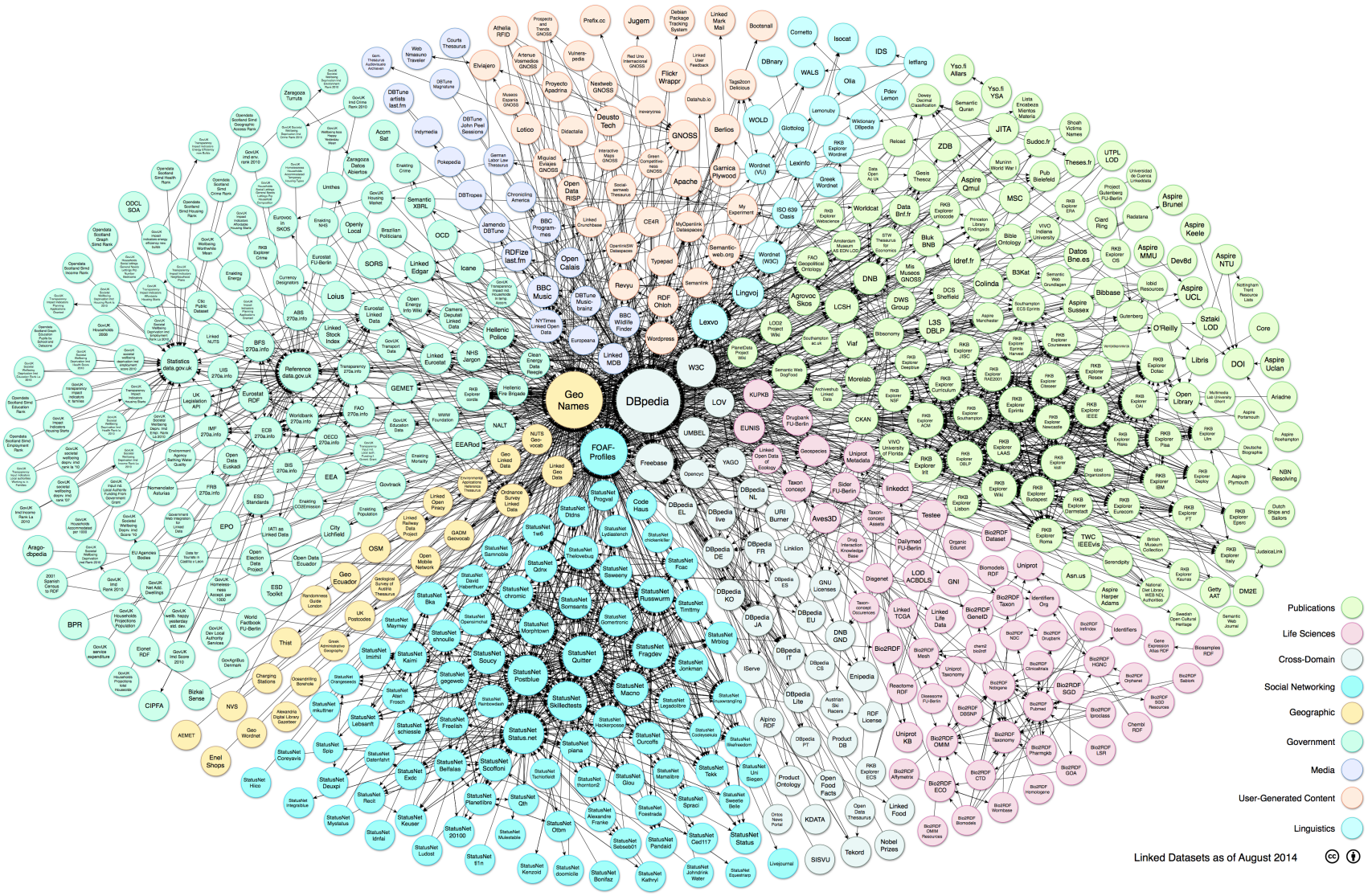

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Planned Course Content

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- RDF, RDFS
  - Syntax
  - Semantics
  - Reasoning
- SPARQL
  - Syntax
  - Semantics
  - Reasoning
- OWL, OWL fragments
  - Syntax
  - Semantics
  - Reasoning
- Ontology Engineering with Ontology Design Patterns
- Linked Data Publishing with ODPs

Course Content Discussion

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- How much do you know about XML?
- How much do you know about predicate logic?

- Next topic: RDF