Linked Open Data and Its Potential for CREDO

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CREDO Week 2018

Knowledge Representation

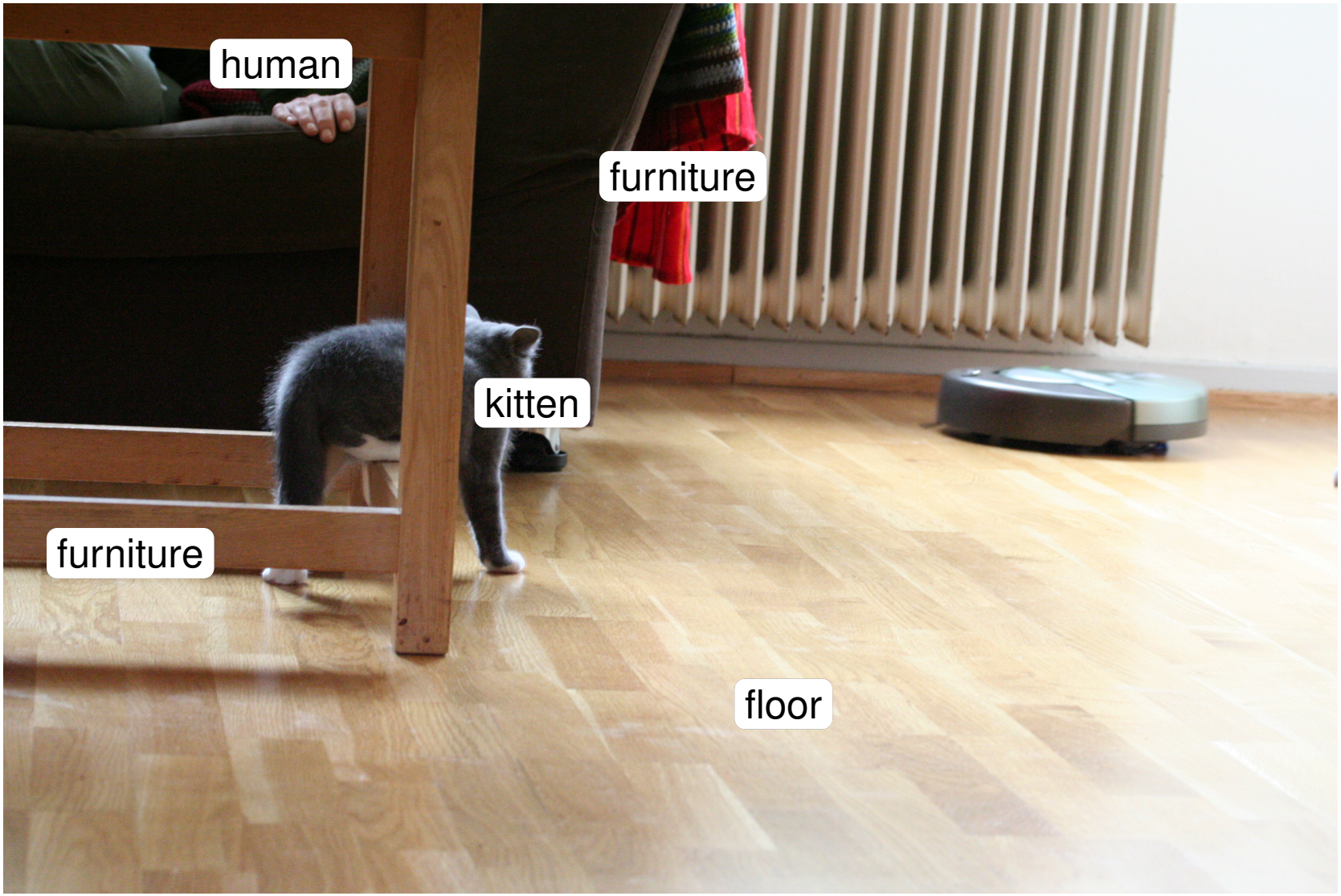
Knowledge Representation

Knowledge representation (KR) studies how knowledge is captured, represented, and reasoned with in computer systems in order to solve complex tasks.

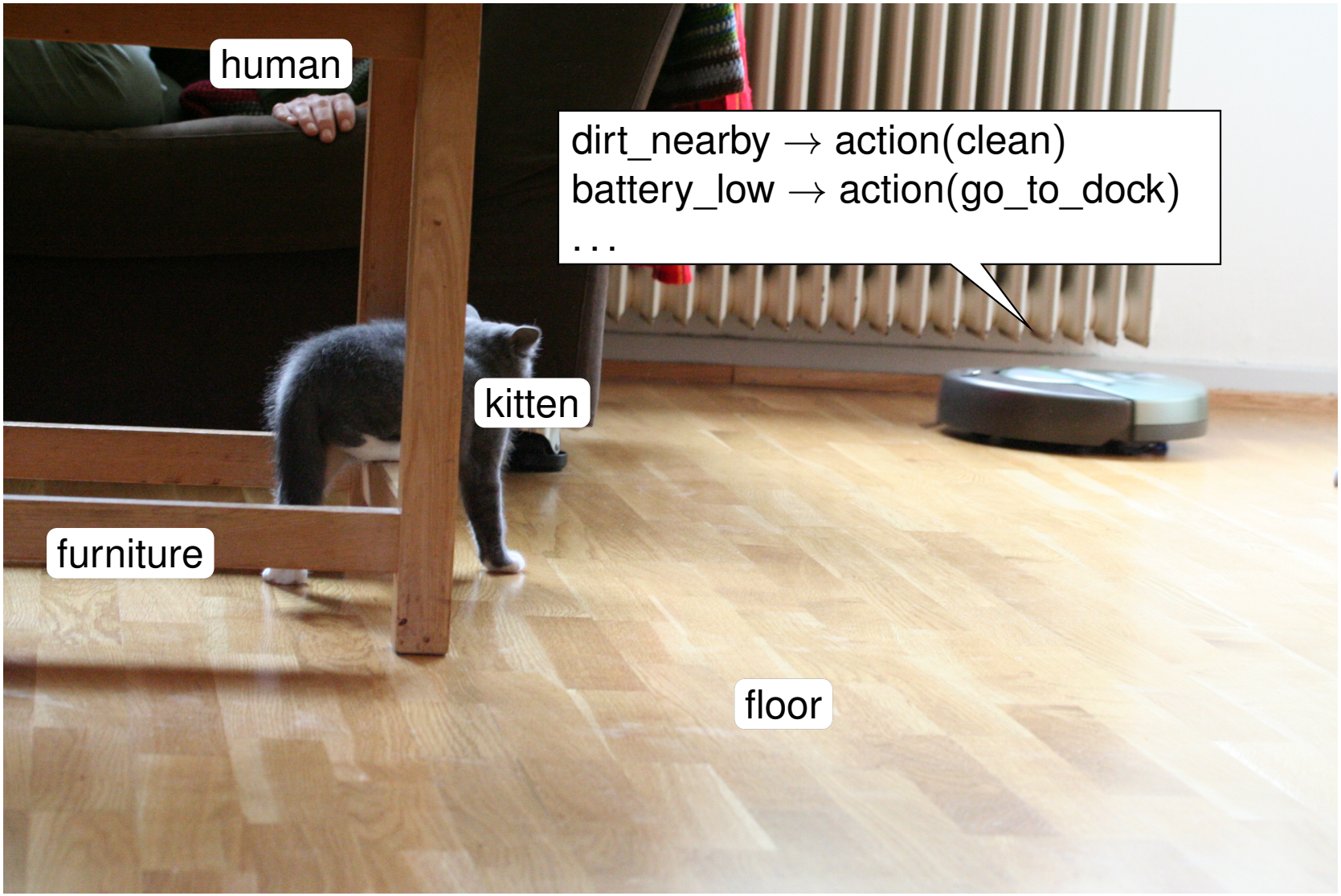
Artificial Agent

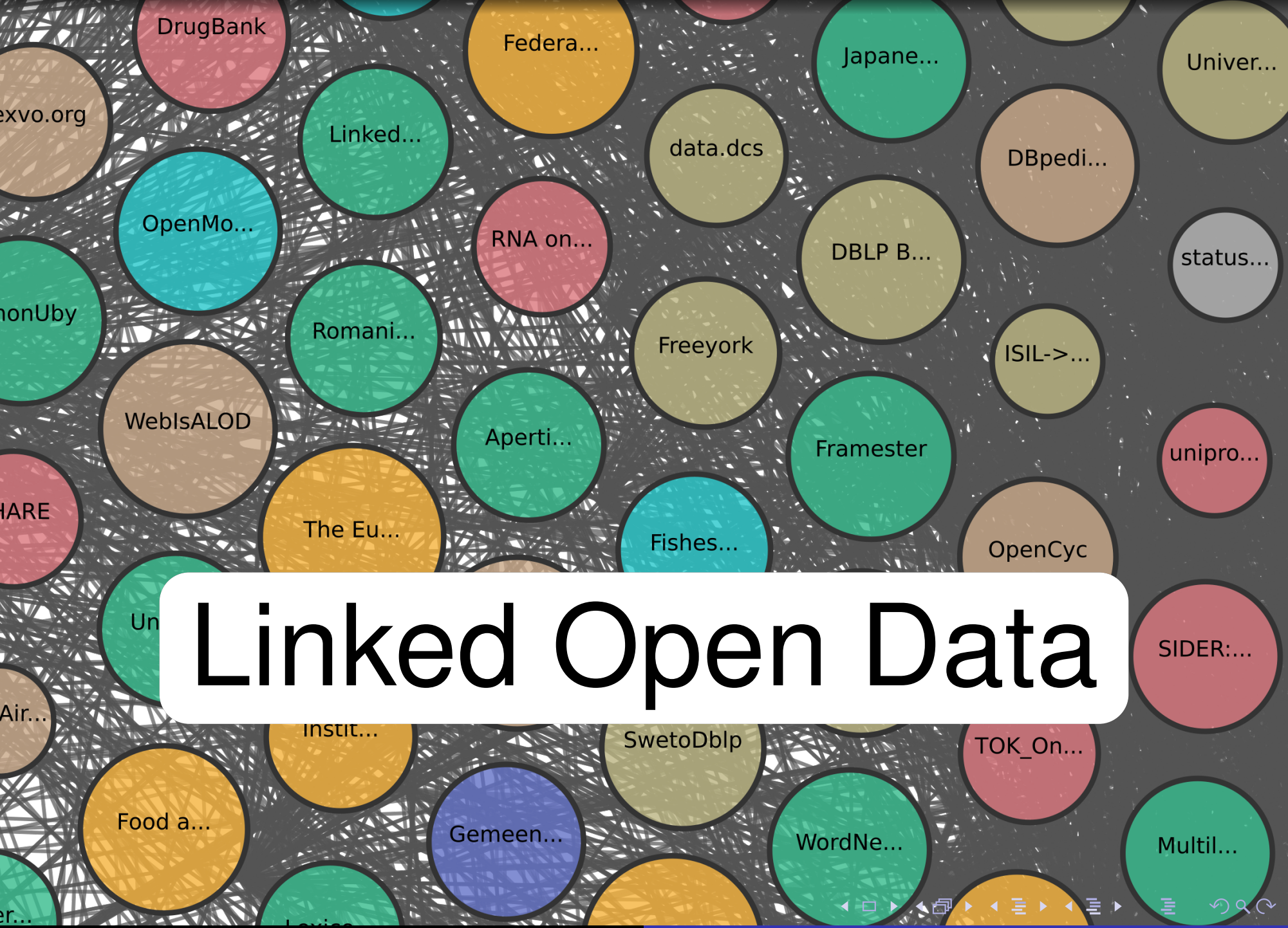
Artificial Agent in Environment

Artificial Agent in Environment



Artificial Agent in Environment





Linked Open Data

Can We Make Web Machine Understandable?

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TEACHING

- Computational Logic
- Knowledge Representation and Reasoning (a.k.a. Representation, Knowledge, Reasoning)

What Can We Read Out?

What useful information can we read in this page?

```
Martin Homola is an assistant professor.
Martin Homola has e-mail homola@fmph.uniba.sk.
Martin Homola teaches Computational Logic.
```

What Can We Read Out?

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```

All simple property assertions of the form:

```
subject predicate object .
```

RDF: Resource Description Framework

The SW language of triples:

```
@prefix rdf: http://www.w3.org/1999/02/22-rdf-syntax-ns# .
@prefix dai: http://dai.fmph.uniba.sk/RDF# .

dai:homola  rdf:type dai:AssistantProfessor .
dai:homola  dai:name "Martin Homola" .
dai:homola  dai:email "homola@fmph.uniba.sk" .

dai:complog rdf:type dai:Course .
dai:complog dai:title "Computational Logic" .
dai:complog dai:instructor dai:homola .
```

RDF: Resource Description Framework (cont.)

Abbreviated syntax:

```
@prefix rdf: http://www.w3.org/1999/02/22-rdf-syntax-ns# .
@prefix dai: http://dai.fmph.uniba.sk/RDF# .

dai:homola   rdf:type dai:AssistantProfessor ;
             dai:name "Martin Homola" ;
             dai:email "homola@fmph.uniba.sk" .

dai:complog  rdf:type dai:Course ;
             dai:title "Computational Logic" ;
             dai:instructor dai:homola .
```

Ontologies

But where is the semantics in the Semantic Web?

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It is in ontologies.

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- Everyone can create properties and classes
  . . . with defined meaning
- Everyone can read the definitions and understand the data
- Everyone can reuse already defined properties and classes

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SW ontology languages: RDF Schema & OWL

RDF Schema

```
@prefix rdf: http://www.w3.org/1999/02/22-rdf-syntax-ns# .
@prefix rdfs: http://www.w3.org/2000/01/rdf-schema# .
@prefix dai: http://dai.fmph.uniba.sk/RDF# .
@prefix schema: http://schema.org/.

dai:Professor           rdf:type rdfs:Class ;

dai:AssistantProfessor  rdf:type rdfs:Class ;
                        rdfs:subclassOf dai:Professor .

dai:Course              rdf:type rdfs:Class;

dai:name                rdf:type rdf:Property ;
                        rdfs:domain dai:Professor ;
                        rdfs:range rdfs:Literal .

dai:instructor          rdf:type rdf:Property ;
                        rdfs:domain dai:Course ;
                        rdfs:range dai:Professor .
```

Semantics: Take Two

RDF is a logic with model-theoretic semantics

This enables to characterize:

- Consistency of vocabularies and data-sets
- Logical consequence
- Entailment and derivation
- Query answering

☺ Enables algorithmization

☺ Polynomial complexity

SPARQL Query Language

Query language designed to retrieve and manipulate store triple data

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dai: <http://dai.fmph.uniba.sk/RDF#>

SELECT ?name
       ?email

WHERE {
       ?person rdf:type dai:Professor ;
               dai:name ?name ;
               dai:email ?email .
       ?course dai:instructor ?person .
}

GROUP BY ?person
HAVING (count(?course) > 3)
```

Link Open Data

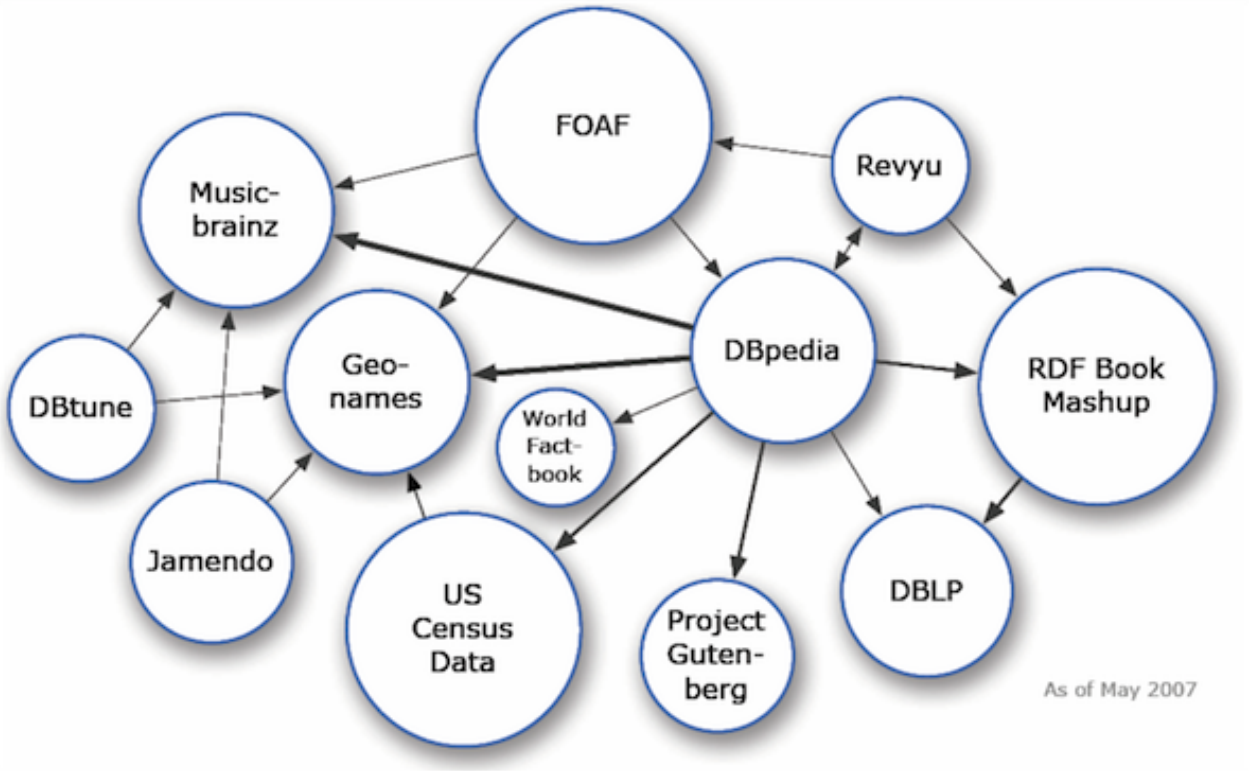
Early 2000s:

- SW brought a number of useful technologies: RDF/S, OWL, SPARQL, RIF/SWRL, WSDL, SSWAP, ...
- Implemented RDF triple stores and tools
- Few early vocabularies appear

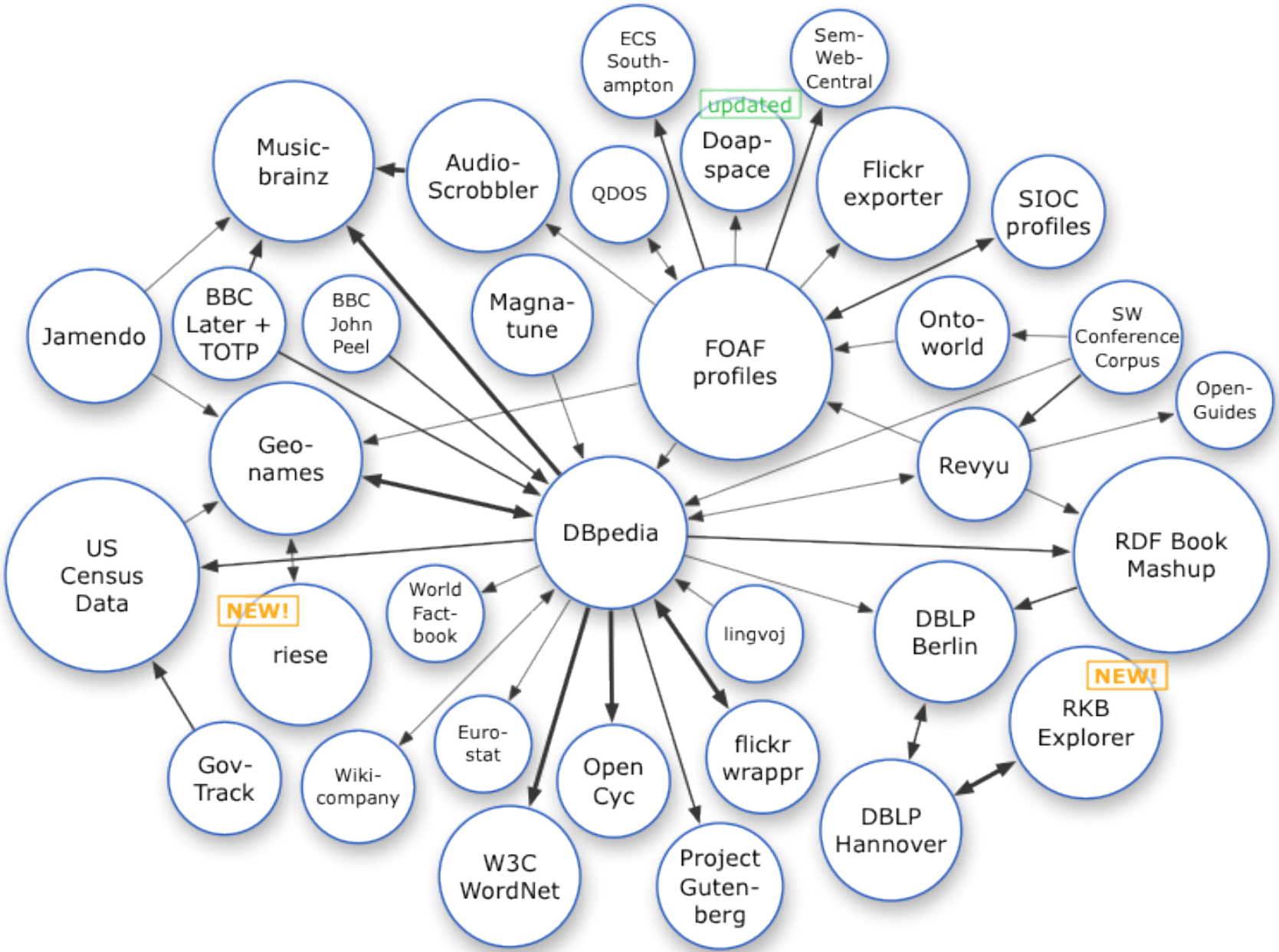
Late 2000s Linked Open Data:

- Why not actually start using it?

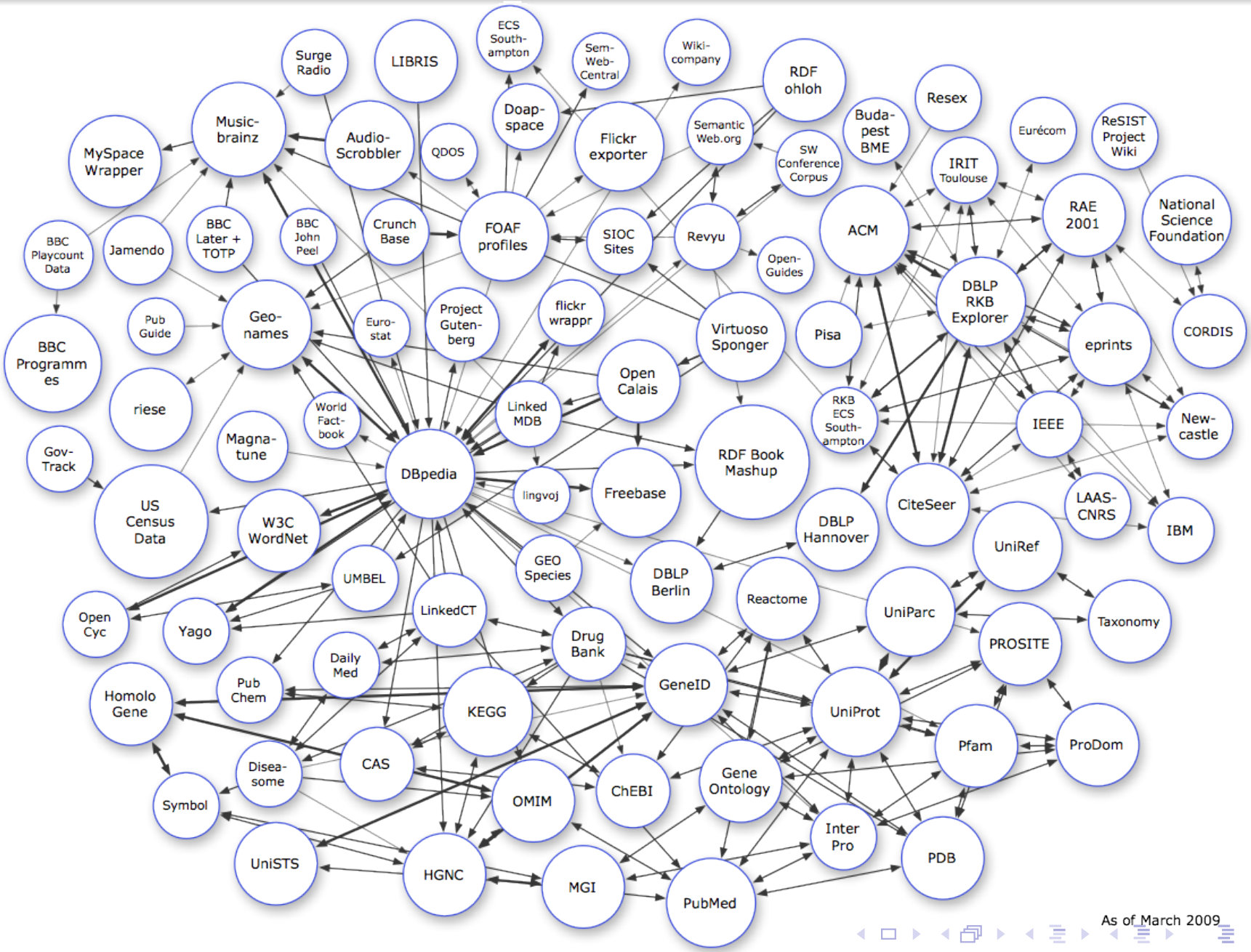
LOD Cloud


FOAF
Music-
brainz
Revyu
DBpedia
Geo-
names
DBtune
World
Fact-
book
RDF Book
Mashup
Jamendo
US
Census
Data
Project
Guten-
berg
DBLP
As of May 2007

LOD Cloud

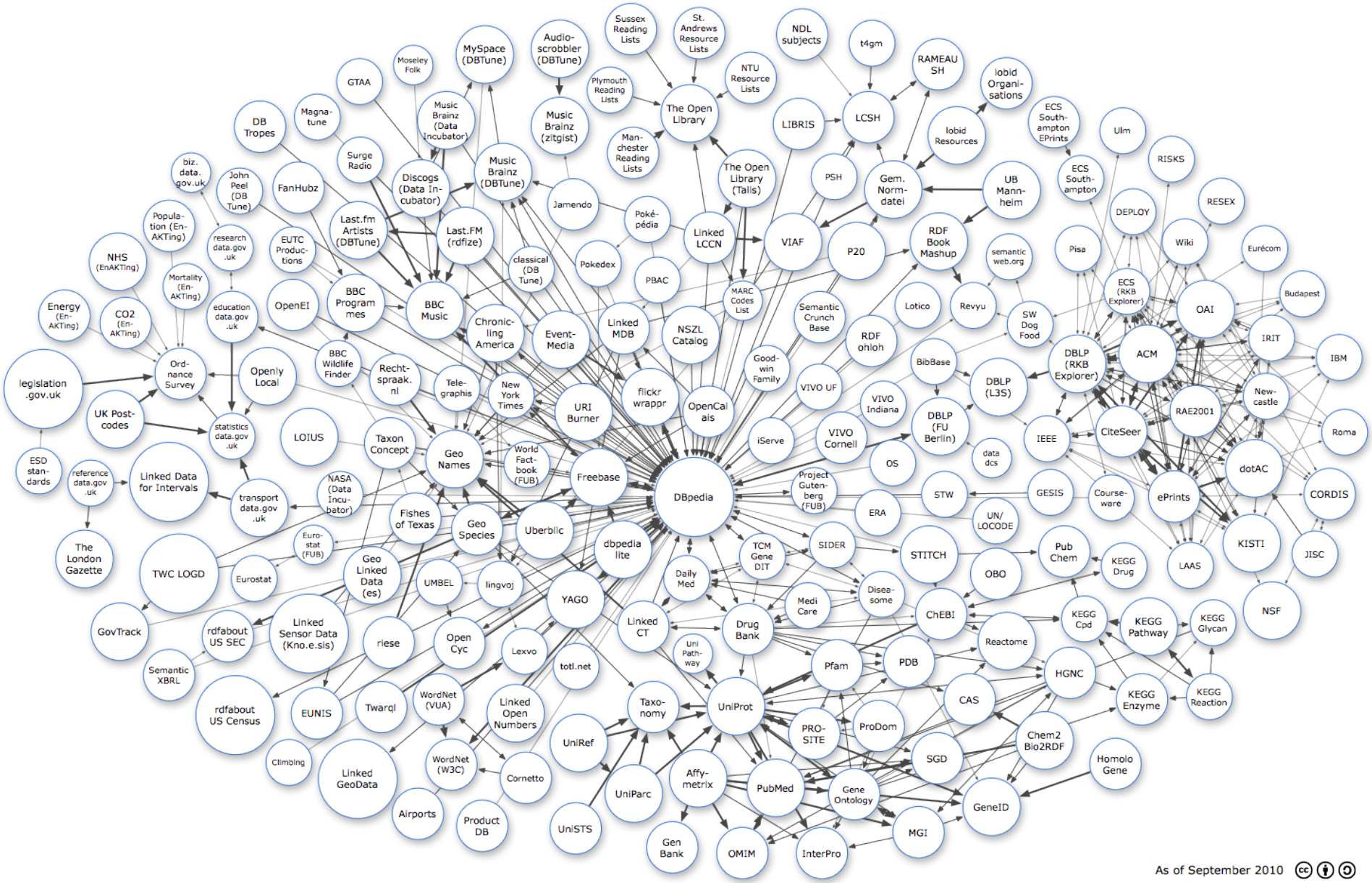

ECS South-ampton
Sem-Web-Central
updated
Doap-space
Music-brainz
Audio-Scrobbler
QDOS
Flickr exporter
SIOC profiles
Jamendo
BBC Later + TOTP
BBC John Peel
Magna-tune
FOAF profiles
Onto-world
SW Conference Corpus
Open-Guides
Geo-names
Revyu
US Census Data
DBpedia
RDF Book Mashup
NEW!
riese
World Fact-book
lingvoj
DBLP Berlin
NEW!
RKB Explorer
Euro-stat
flickr wrappr
Gov-Track
Wiki-company
Open Cyc
DBLP Hannover
W3C WordNet
Project Guten-berg

LOD Cloud



As of March 2009

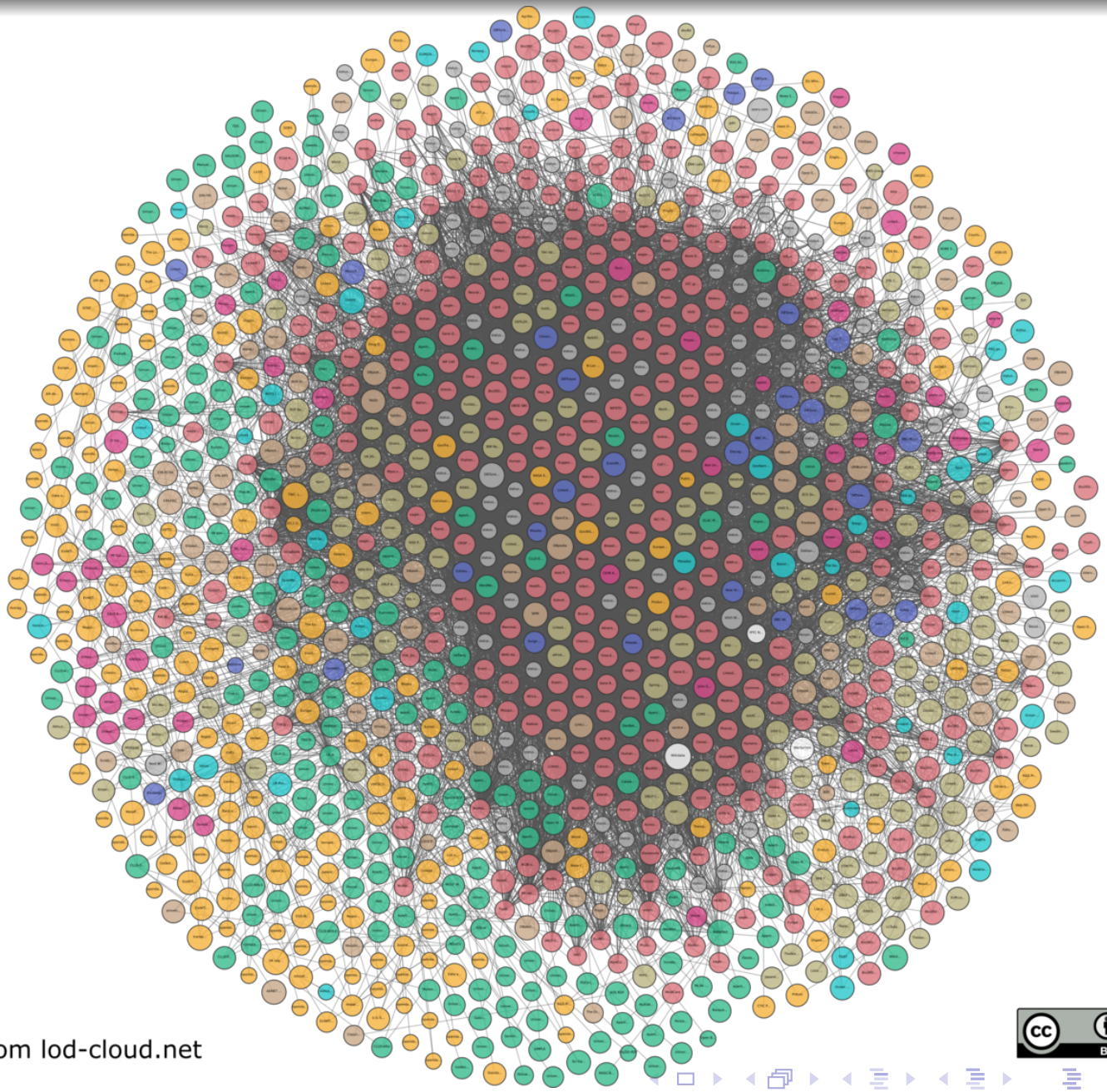
LOD Cloud



As of September 2010

LOD Cloud

- Cross Domain
- Geography
- Government
- Life Sciences
- Linguistics
- Media
- Publications
- Social Networking
- User Generated



The Linked Open Data Cloud from lod-cloud.net

Example: DBPedia

Free open RDF database extracted from Wikipedia.

Accessible via human readable browser, RDF files and SPARQL interface.

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Free open RDF database extracted from Wikipedia.

Accessible via human readable browser, RDF files and SPARQL interface.

DBpedia contains 9.5b triples about 6m entities:

- 1.5m people
- 810k places
- 275k organizations
- 410k works
- 301k species

What Can We Find in DBPedia

```
@prefix rdf: http://www.w3.org/1999/02/22-rdf-syntax-ns# .
@prefix dbr: http://dbpedia.org/resource/ .
@prefix dbo: http://dbpedia.org/ontology/ .

dbr:Marie_Curie rdf:type dbo:Scientist ;
                dbo:field dbr:Chemistry ;
                dbo:field dbr:Physics ;
```

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@prefix dbr: http://dbpedia.org/resource/ .
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dbr:Marie_Curie rdf:type dbo:Scientist ;
                dbo:field dbr:Chemistry ;
                dbo:field dbr:Physics ;
                dbo:birthPlace dbr:Warsaw ;
                dbo:birthDate "1867-11-07" ;
```

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                dbo:field dbr:Physics ;
                dbo:birthPlace dbr:Warsaw ;
                dbo:birthDate "1867-11-07" ;
                dbo:birthName "Maria Salomea Skłodowska" ;
                dbo:deathDate "1934-07-04" ;
                dbo:deathPlace dbr:Sancellemoz ;
                dbo:deathPlace dbr:Passy,_Haute-Savoie ;
```

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@prefix dbr: http://dbpedia.org/resource/ .
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                dbo:birthDate "1867-11-07" ;
                dbo:birthName "Maria Salomea Skłodowska" ;
                dbo:deathDate "1934-07-04" ;
                dbo:deathPlace dbr:Sancellemoz ;
                dbo:deathPlace dbr:Passy,_Haute-Savoie ;
                dbo:deathCause dbr:Aplastic_anemia ;
```

What Can We Find in DBPedia

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                dbo:deathCause dbr:Aplastic_anemia ;
                dbo:doctoralAdvisor dbr:Gabriel_Lippmann ;
```

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                dbo:birthName "Maria Salomea Skłodowska" ;
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                dbo:deathPlace dbr:Passy,_Haute-Savoie ;
                dbo:deathCause dbr:Aplastic_anemia ;
                dbo:doctoralAdvisor dbr:Gabriel_Lippmann ;
                dbo:doctoralStudent dbr:Marguerite_Perey ;
                dbo:doctoralStudent dbr:Óscar_Moreno ;
                ...
```

(see live)

Scientific Data in LOD

How can science benefit from LOD?

Scientific Data in LOD

How can science benefit from LOD?

- Scientific datasets are already published in LOD
- Specific scientific domain ontologies

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Especially in :

- Medicine
- Biology
- Linguistics

(see example)

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(see example)

Our next target:

- Information security
- CREDO (?)

Gamification

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Gamification has been successfully applied in:

- User engagement
- Organizational productivity
- Learning
- Crowdsourcing
- Employee recruitment
- Ease of use
- Physical exercise
- Traffic violations
- Voter apathy

Gamification for engagement/learning

Problem: Students fail to engage in activities which are not compulsory

Gamification for engagement/learning

Problem: Students fail to engage in activities which are not compulsory

Thank You for Your Attention!

Questions?