

**Welcome to INFO216:  
Knowledge Graphs  
Spring 2022**

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# Session 5: Open KGs

- Themes:
  - Linked Open Data (LOD)
  - the LOD cloud
  - *Open Knowledge Graphs:*
    - Wikidata, DBpedia, GDELT project, EventKG  
GeoNames, WordNet, BabelNet
    - perhaps ConceptNet, DUL (DOLCE UltraLite)...
    - *...some of them have their own vocabularies*
  - Enterprise Knowledge Graphs (EKGs) (→ S06)
  - Ontologies and vocabularies (→ S08 and S09)



# Readings

- Resources in the portal, including:
  - Wikidata
  - DBpedia
  - the GDELT project
  - EventKG
  - GeoNames
  - WordNet
  - BabelNet
  - and perhaps others

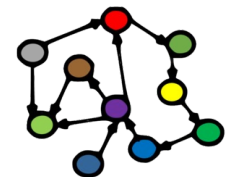


**THE KNOWLEDGE GRAPH  
COOKBOOK**  
RECIPES THAT WORK

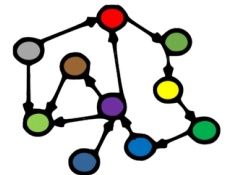


**ANDREAS BLUMAUER  
AND HELMUT NACY**

1st edition, 2020



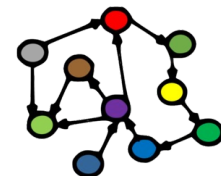
# Linked Open Data (LOD)





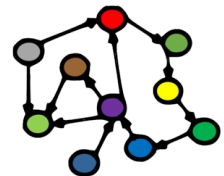
## Places to start (→S02)

- Open and semantic:
  - open semantic data sets: <http://lod-cloud.net>
  - vocabularies: <https://lov.linkeddata.es/dataset/lov/>
- Open data in general:
  - internationally: <http://datahub.io> or <http://ckan.org>
  - Norge: <http://data.norge.no>
  - EU: <https://open-data.europa.eu>
  - UK: <http://data.gov.uk>
  - USA: <http://data.gov>



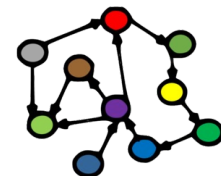
# Linked Open Data (LOD → S4)

- 3-4 *basic principles* (Berners-Lee 2006):
  - 1 URIs (*Uniform Resource Identifier*)
    - *identify resources* <http://dbpedia.org/resource/Bergen>
  - 2 URIs *answer to HTTP requests* (*dereferencing*)
    - for example *SPARQL queries*, *Turtle files*, ...
  - 3 Returns *information about the resource* on standard format,
    - e.g., *RDF-XML*, *Turtle*, *N3*, *JSON-LD*  
(*JSON*, *XML*, *CSV*, *TSV*, *HTML*)
  - 4 The information contains *URI-s that identify related resources*



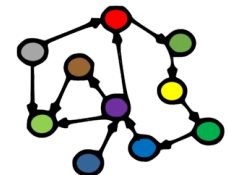
# Best Practices for Data Provisioning

- Recommended directly by W3C
  - or emerged within the LOD community:
    1. *Provide dereferencable URIs*
    2. *Set RDF links pointing at other data sources*
    3. *Use terms from widely deployed vocabularies*
    4. *Make proprietary vocabulary terms dereferencable*
    5. *Map proprietary vocabulary terms to other vocabularies*
    6. *Provide provenance metadata (e.g., PROV)*
    7. *Provide licensing metadata (e.g., CC)*
    8. *Provide dataset-level metadata (e.g., VANN, VS)*
    9. *Refer to additional access methods (e.g., SPARQL)*

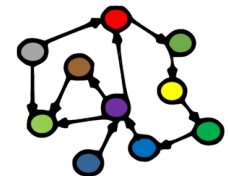
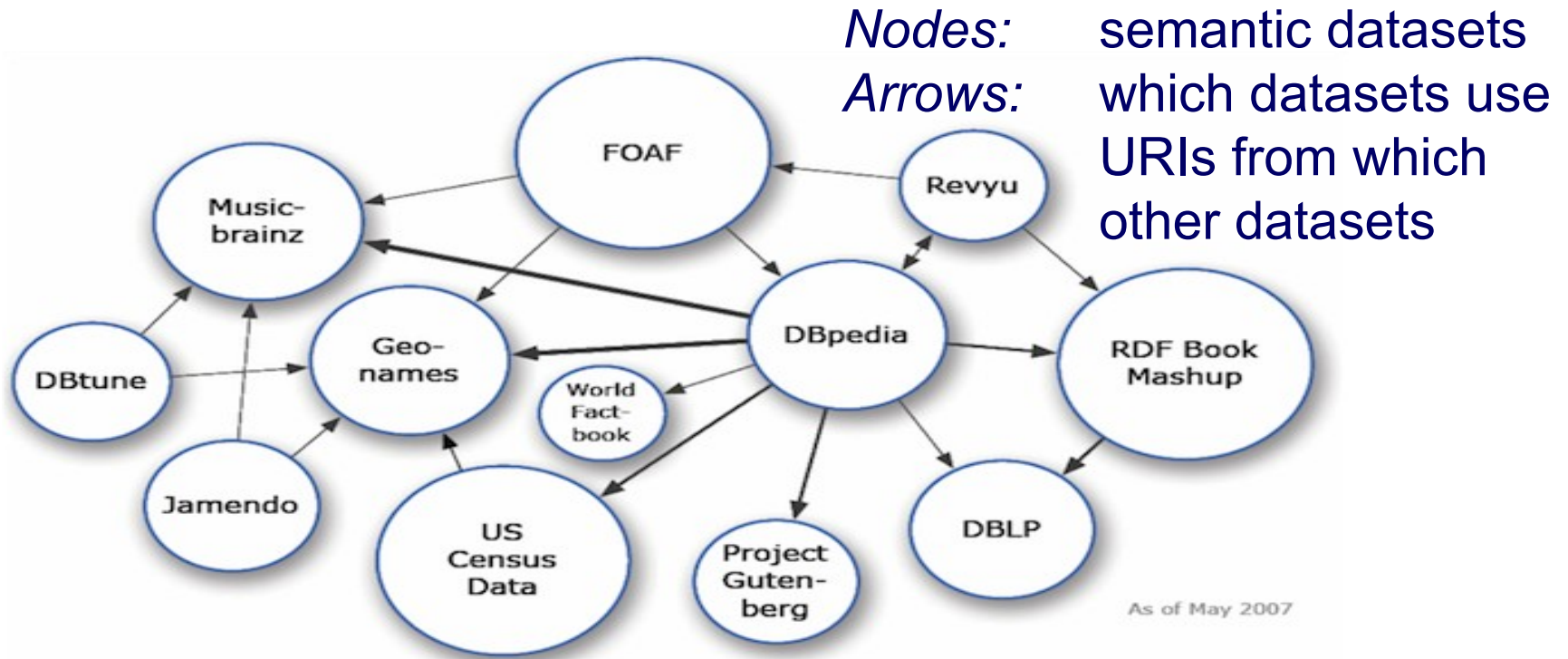


# The LOD cloud

- <http://www.lod-cloud.net/>
  - started in 2007
    - exponential-like growth for a few years
    - still growing, but more slowly now
  - statistics at [www.lod-cloud.net/state](http://www.lod-cloud.net/state)
    - ca 1250 data sources (May 2020)
  - based on data from DataHub (+ some crawling)
    - datahub.io or ckan.org
    - an open data portal
    - not necessarily semantic
  - ...also based on LOD crawling



# The LOD cloud (2007-05)

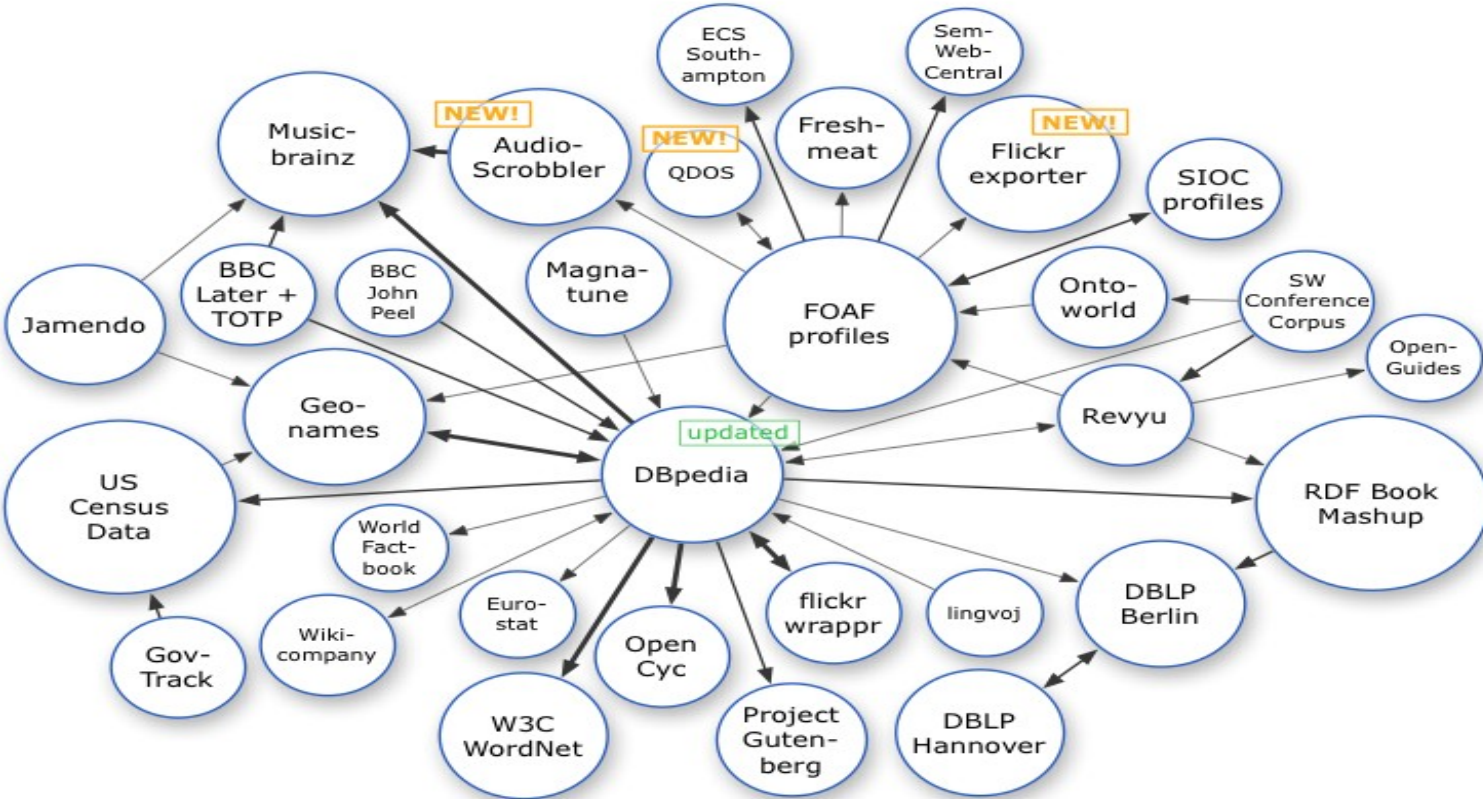






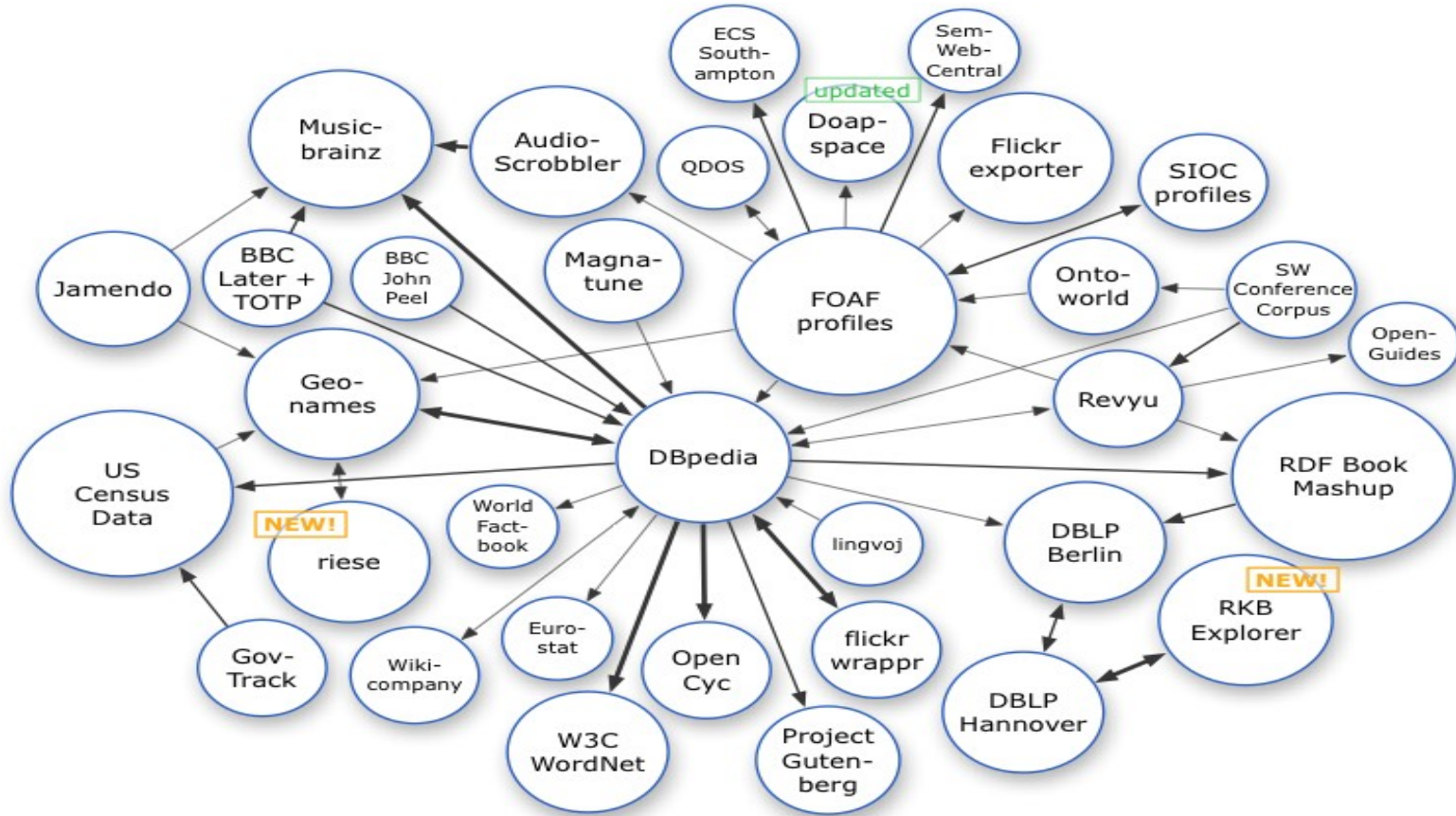


# The LOD cloud (2008-02)





# The LOD cloud (2008-03)













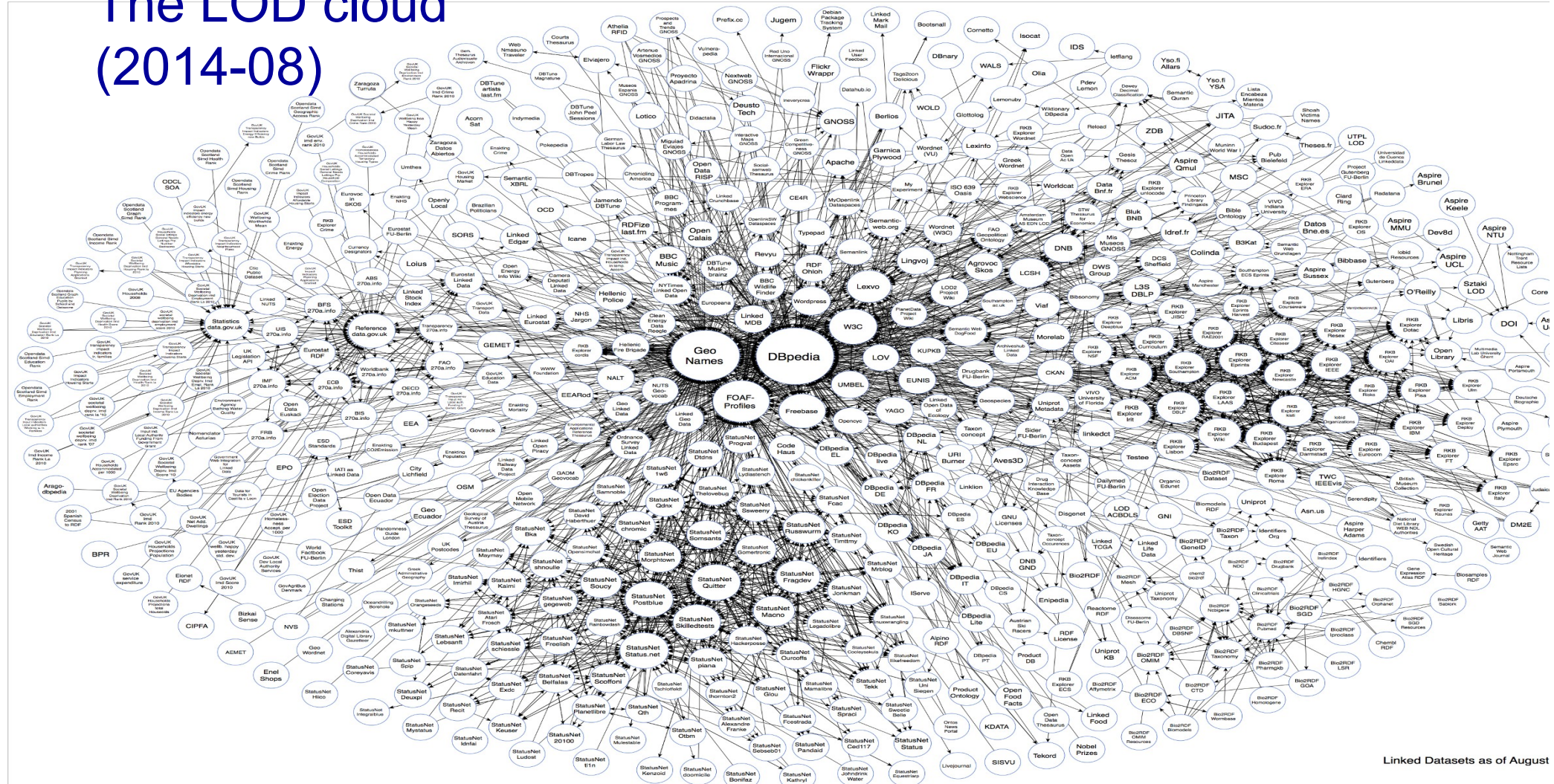








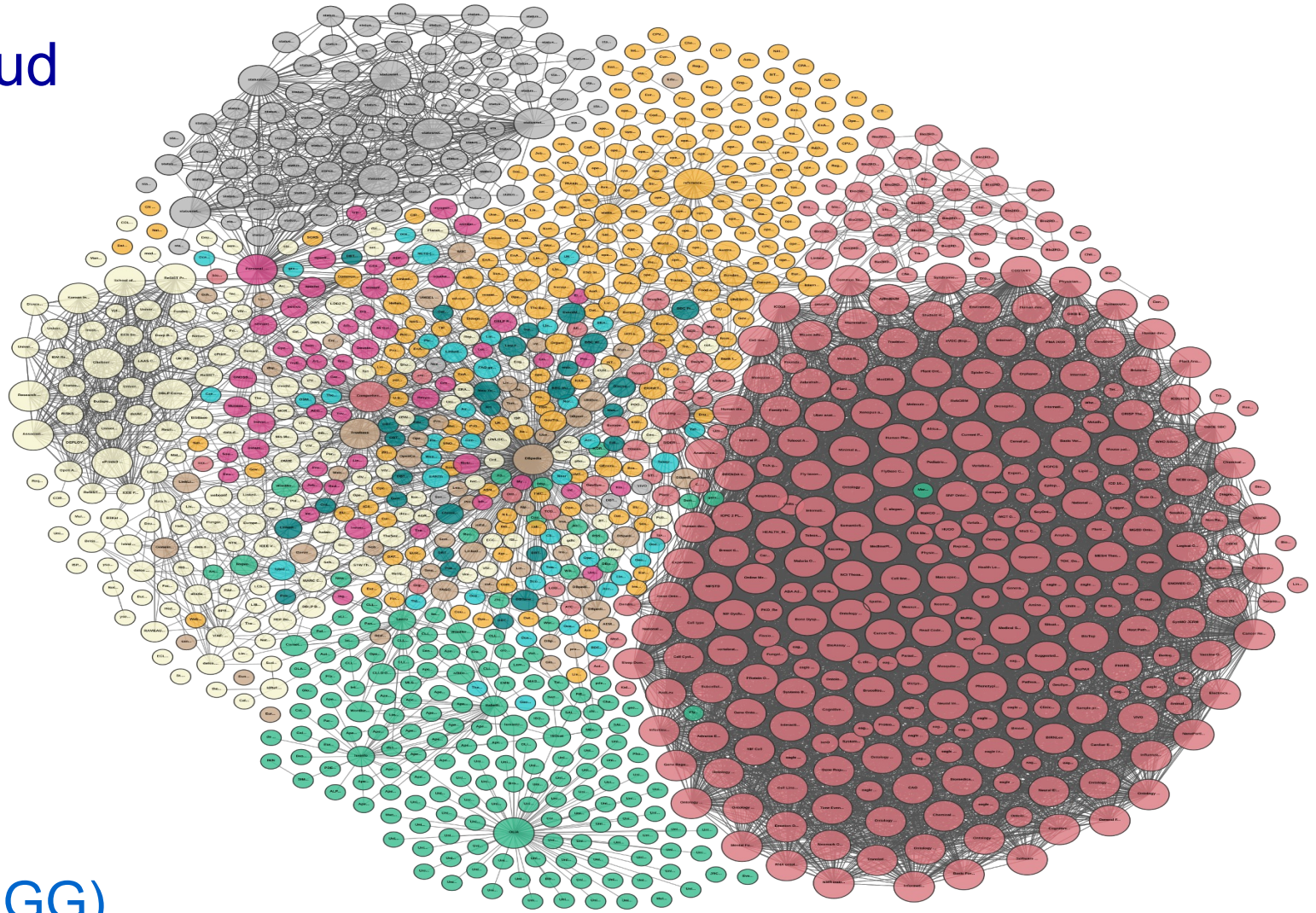
# The LOD cloud (2014-08)



Linked Datasets as of August



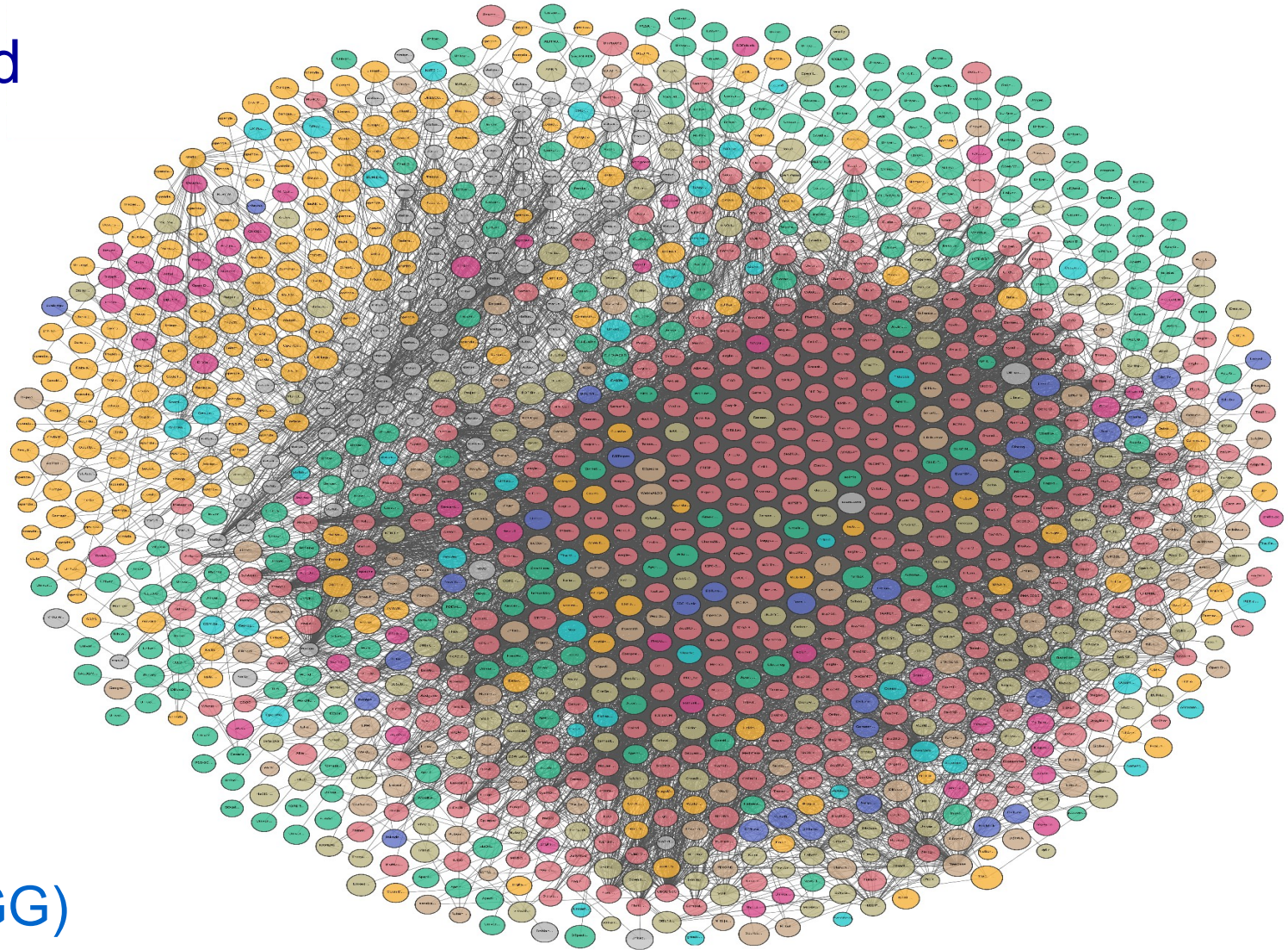
# The LOD cloud (2017-02)



# The “Gigantic Global Graph” (GGG)



# The LOD cloud (2018-07)



# The “Gigantic Global Graph” (GGG)



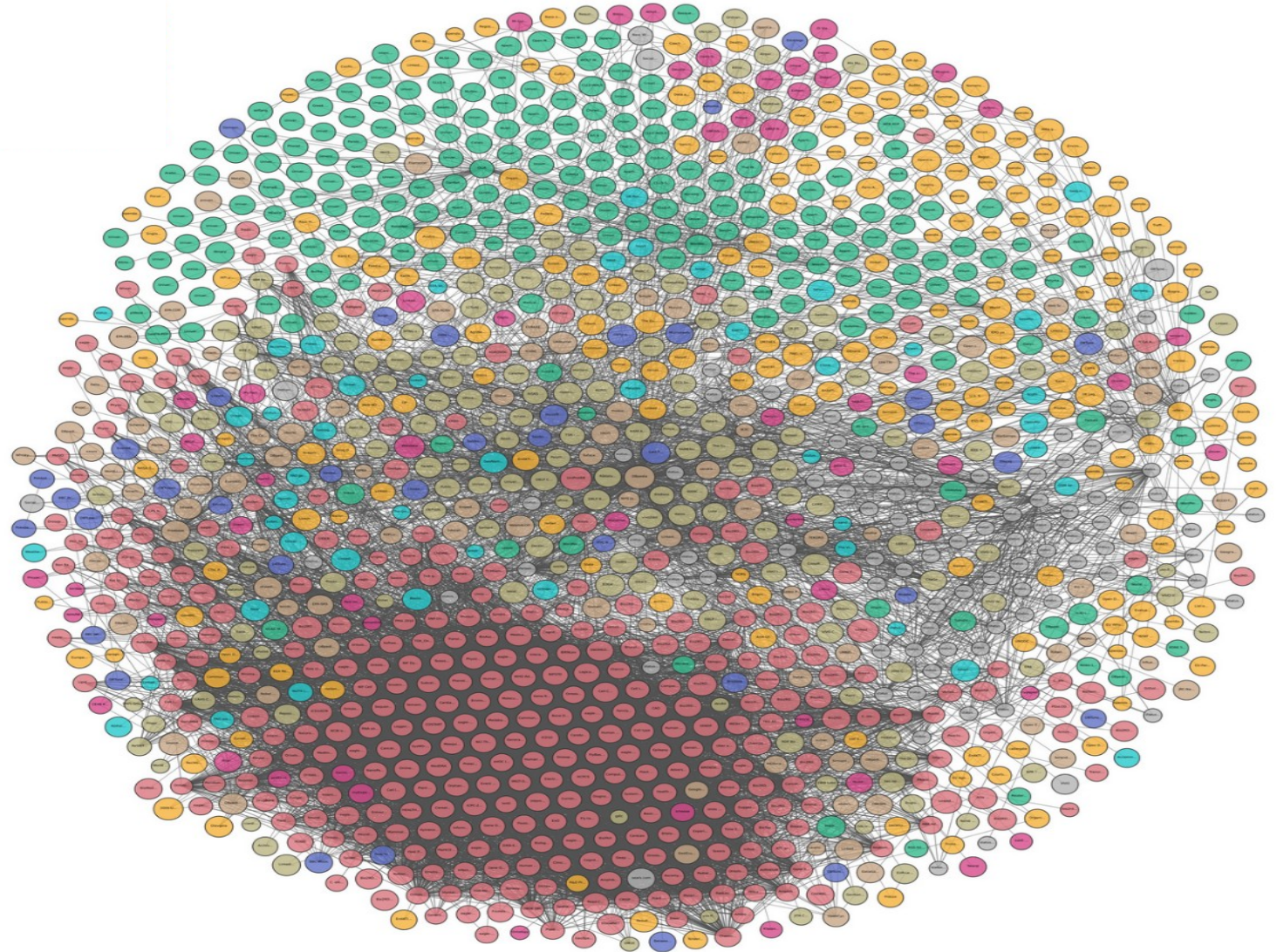
## Legend

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

## Domains:

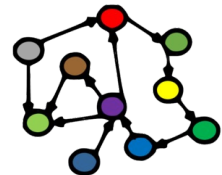
- general
- geography
- government
- life sciences
- linguistics
- media
- publications
- social networking
- user generated

*A “lumpy cloud”*



# Challenges

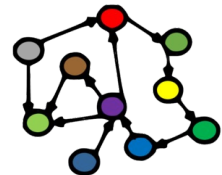
- Semantic technologies / Web of Data / LOD has enormous potential
  - Enterprise Knowledge Graphs are maturing
    - Google, Amazon, BBC, Reuters...
    - industry: biodata, publishing, music/media...
    - government: clean energy, libraries...
    - *“lumps” in the LOD cloud form domain-specific and more tightly-knit subnetworks around EKGs*
  - ...but Open Knowledge Graphs are not used to their fullest
    - *maintenance*: individuals versus organisations
    - *abstraction*: general versus domain data
    - *trust*: open versus closed networks



# Open Knowledge Graphs

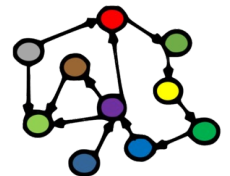
# Wikidata (→ S01)

- *A free and open knowledge base that can be read and edited by both humans and machines*
  - a Wikimedia project, crowdsourced, multi-lingual
  - *a Wikipedia for structured, secondary data*
  - from managing Wikipedias *cross-language links*
  - to *central storage of structured data* for
    - Wikimedia sister projects (Wikipedia etc.)
    - many other projects, sites and services
  - verifiability, link to sources, perspectives
  - free license (CC0), standard formats, interlinked
- Wikidata entities:
  - > 92M items (things)



# Wikidata access

- Available through
  - the Wikimedia API
  - HTTP: <http://www.wikidata.org/entity/Q42>
  - RDF: <http://www.wikidata.org/entity/Q42.ttl>
  - SPARQL endpoint: <http://query.wikidata.org>
    - Wikidata Query Service (WDQS)
      - for download (JSON, RDF, XML)
- Also as Linked Data Fragments:
  - <https://query.wikidata.org/bigdata/ldf>
- DBpedia also offers Wikidata compatible dumps





**label** — **Douglas Adams** (Q42) — **unique identifier**

**description** — English writer and humorist  
Douglas Noël Adams | Douglas Noel Adams — **aliases**  
▶ In more languages

**Statements**

**property** — **educated at** — **value**

**rank** — **St John's College** — **qualifiers**

end time	1974
academic major	English literature
academic degree	Bachelor of Arts
start time	1971

**statement group** — **opened references**

▼ 2 references

stated in	Encyclopædia Britannica Online
reference URL	http://www.nndb.com/people/731/000023662/
original language of work	English
retrieved	7 December 2013
publisher	NNDB
title	Douglas Adams (English)

+ add reference

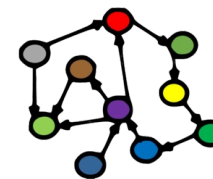
**collapsed reference**

▲ Brentwood School

end time	1970
start time	1959

▶ 0 references

+ add (statement)

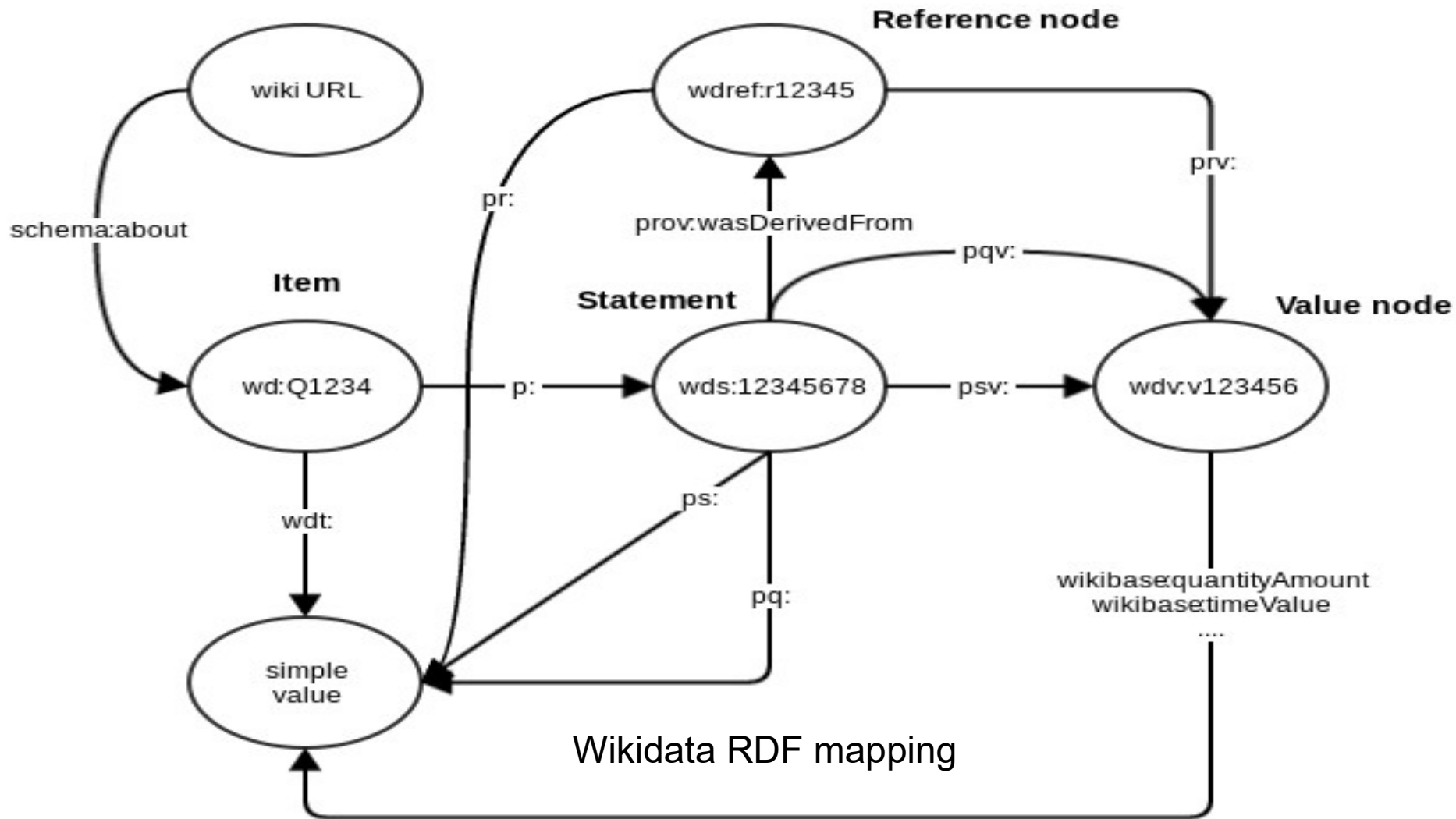


# Wikidata item structure

- Items:
  - item identifier ( $Qnn$ )
  - fingerprint:
    - multilingual label, description, aliases
  - statements, each:
    - claim: a property-value pair
    - qualifiers: additional property-value pairs *about the claim*
  - references (one or more property-value pairs)
  - rank
- Site links
- *Similar structure for properties!*

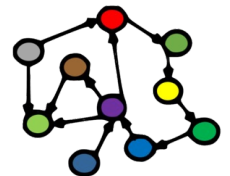






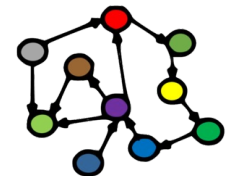
```
PREFIX wikibase: <http://wikiba.se/ontology#>
PREFIX wd: <http://www.wikidata.org/entity/>
PREFIX wdt: <http://www.wikidata.org/prop/direct/>
#defaultView:BubbleChart
```

```
SELECT ?cLabel ?p WHERE {
  ?c wdt:P31 wd:Q6256 .
  ?c wdt:P30 wd:Q46 .
  ?c wdt:P1082 ?p .
  SERVICE wikibase:label {
    bd:serviceParam wikibase:language "en" .
  }
}
```



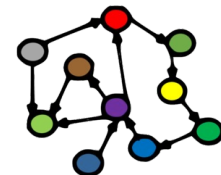
# Wikidata Query Service (WDQS)

- SPARQL wrapper for Wikidata (<http://query.wikidata.org>)
  - based on Blazegraph, OpenRDF/RDF4J
  - built-in prefixes
  - generate query URIs
  - various entity/ontology explorers, e.g.,
    - SQID (<https://tools.wmflabs.org/sqid/#/>)
  - GraphBuilder
  - built-in visualisations
  - built-in SERVICEs ([wikibase:label](#))
- Also:
  - Linked Data Fragments  
(<https://query.wikidata.org/bigdata/ldf>)



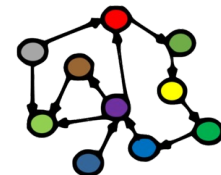
# WDQS visualisations

- Use a comment: `#defaultView:viewName`
- Supported viewNames:
  - **Table** - default view, displays the results as a table
  - **Map** - displays coordinate points if present
  - **ImageGrid** - displays result images as a grid
  - **BubbleChart** - displays numbers as bubble chart
  - **TreeMap** - displays hierarchical tree map for numbers
  - **Timeline** - displays timeline for results having dates
  - **Dimensions** - displays rows as lines between points
  - **Graph** - displays result as a connected graph
- (More limited) server-side alternative to Sgvizler



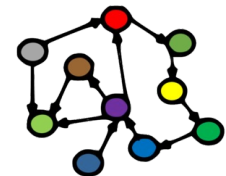
# DBpedia

- Extracting structured information from Wikipedia
  - a crowd-sourced community effort
  - making this information available on the Web of Data
- Central source of individual URIs:
  - <http://dbpedia.org/resource/<Res>>
- Available as:
  - RDF files, SPARQL endpoint (<http://dbpedia.org/sparql>)
  - HTML pages (<http://dbpedia.org/page/<Res>>)
  - faceted RDF browsing, powered by Virtuoso OpenLink
  - live SPARQL endpoint (<http://live.dbpedia.org/sparql>)
  - entity resolver service (<http://demo.dbpedia-spotlight.org/>)
  - lexicalizations dataset (maps names to DBpedia URIs)



# DBpedia: old extraction

- Since January 2007:
  - first only in English
  - the 15 largest languages (since 3.7)
  - around 125 languages (since 3.8)
  - Wikipedia's *infoboxes* are central, but also
    - page links, inter-language links, redirects, disambiguation pages, categories
  - ...also full-text extraction and some NL parsing
  - triple version + quad version with *provenance*



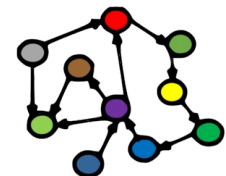
# DBpedia: raw and mapped extraction

- Wikipedia's *infoboxes* are central
  - raw transformation from *infoboxes* to triples:
    - language-specific property names
    - infobox templates may be badly defined and used
    - inconsistent properties
    - no literal types, units
  - manual mapping (by scripts) from *infoboxes* to triples:
    - generates standardised properties  
→ the DBpedia *ontology*
    - fixes many infobox problems
    - increasingly specific
    - wiki for creating mappings: [mappings.dbpedia.org](https://mappings.dbpedia.org)



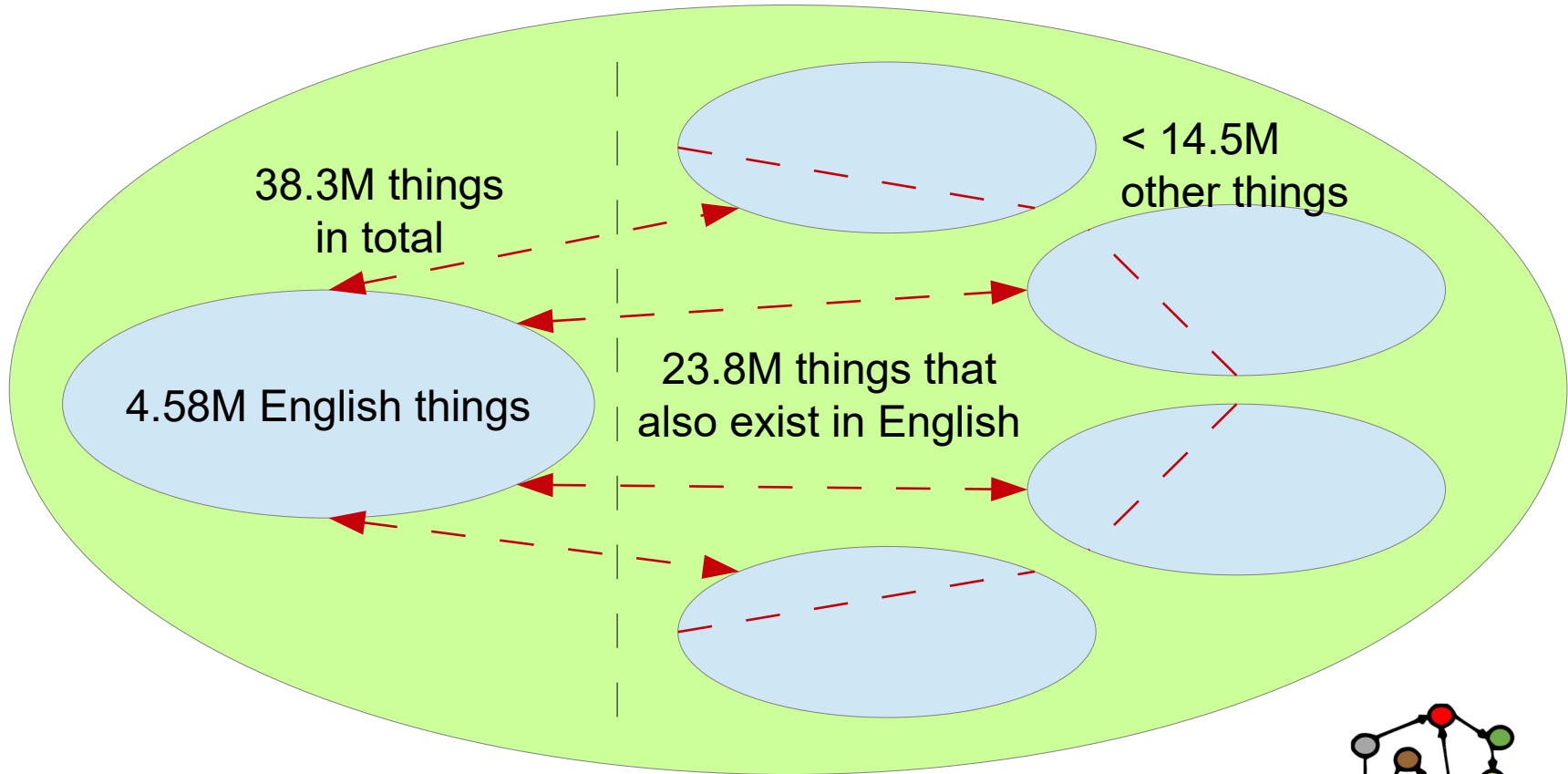
# DBpedia: ontology and identities

- URIs derived from Wikipedia, e.g.:
  - <http://en.wikipedia.org/wiki/Bergen> →
  - <http://dbpedia.org/resource/Bergen>
  - **English, canonical, dereferencable URIs**
- localised/national:
  - <http://no.dbpedia.org/resource/Bergen>
  - **not always dereferencable URIs**

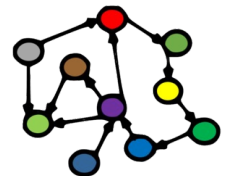




# Canonical and localised resources



*(Example numbers from 2015-10.)*



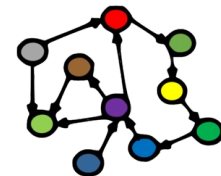
# DBpedia: some name spaces

- <http://dbpedia.org/> – language-independent base, URIs
- <http://nn.dbpedia.org/> – language-specific base, URIs
  - approx. 125 languages, not all dereferencable
- <http://dbpedia.org/resource/> – resources (individuals)
- <http://dbpedia.org/property/> – *raw* infobox properties
- <http://dbpedia.org/ontology/> – *mapped* infobox properties and types
- <http://dbpedia.org/reference/> – external references
- [foaf:homepage](http://foaf.org/homepage) – external identifier reference
- [owl:sameAs](http://owl.w3.org/ontology/sameAs) – interlinking, e.g, across languages
- [rdf:type](http://rdf.w3.org/type) – three classification schemes



# DBpedia: new extraction

- Since 2020:
  - monthly extraction in four groups
  - generic
    - generic parsers, language-specific RDF properties
  - mappings
    - editable ontology mappings: [mappings.dbpedia.org](https://mappings.dbpedia.org)
  - text
    - abstract and article full-text extraction
  - Wikidata
    - mapped and cleaned Wikidata data  
*using the DBpedia Ontology*

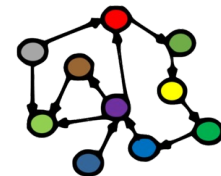


# DBpedia ontology

- DBpedia Ontology:
  - 685 classes, 2795 properties
  - max depth: 5
- Available as download, SPARQL endpoint, Linked Data interface...

Instances per class

Class	Instances
Resource (overall)	4,233,000
Place	735,000
Person	1,450,000
Work	411,000
Species	251,000
Organisation	241,000



# DBpedia: resource statistics (old extraction)

- Contents:
  - 4.6M resources in the English DBpedia
    - 4.22M in a consistent ontology
    - 1.445M persons, 735k places, 411k works, 241k organisations, 251k species, 6k diseases...
    - also 1.7M SKOS concepts and other stuff
  - 38.3M resources in national DBpedia versions
    - around 125 languages
    - 23.8M resources are localised versions of resources that also exist in the English DBpedia
  - *may* describe more than 19M unique resources (things)

# DBpedia: triple statistics (old extraction)

- The full (international) data set:
  - 9.5G triples (*perhaps 6-7% of the LOD cloud*)
    - 1.3G from the English DBpedia
    - 5.0G from other DBpedias
    - the rest from Commons **and Wikidata**
  - 38M labels and abstracts (2015 here and below)
  - > 120M categorisation links
    - 67M links to Wikipedia categories
  - 24.6M links to images
  - 27.6M links to external web pages
  - 45M other external links: GeoNames, Freebase, Wikidata, Flickr wrappr, YAGO, UMBEL...



# DBpedia: concept schemes (old extraction)

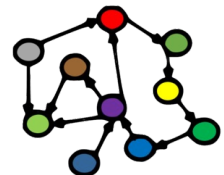
- Wikipedia categories:
  - *81M links*
  - SKOS vocabulary and DCMI terms
- YAGO classification:
  - *41M links*
  - Yet Another Great Ontology
  - derived from Wikipedia using WordNet (also from GeoNames)
- WordNet synsets
- *...also 50M other links (30M to web pages)*





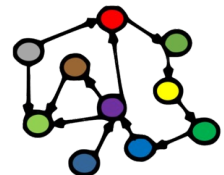
# DBpedia: advantages

- Covers many domains
  - like Wikipedia, exploits *the long tail*
- Real community agreement
- Automatically evolves (as Wikipedia changes)
- Is truly multilingual
- Includes Wikidata
  - in a better managed ontology(?)



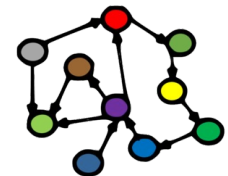
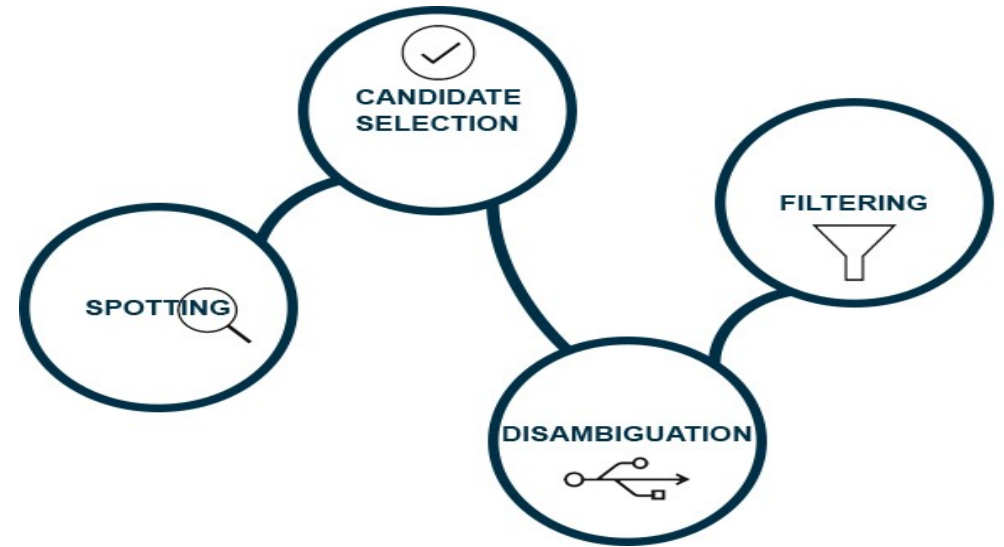
# DBpedia Spotlight

- A tool and web API for lifting text:
  - automatically annotating mentions of DBpedia resources in text
  - linking unstructured information sources to the LOD cloud through DBpedia
  - available as:
    - online demo <https://demo.dbpedia-spotlight.org/>
    - web API: [api.dbpedia-spotlight.org/en](https://api.dbpedia-spotlight.org/en)  
<https://api.dbpedia-spotlight.org/en/candidates?text=...>
    - download:
      - open source code
      - Docker



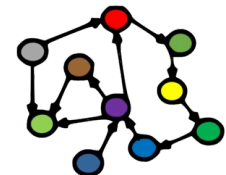
# DBpedia Spotlight

- **Spotting:** identify potential *mentions* (substrings) of *named entities* in texts
- **Candidate selection:** find DBpedia *resources* that may match the *surface form* of a mention
- **Disambiguation:** select the more likely candidate resource for each surface form
- **Filtering:** adjust to user-specific requirements (e.g., confidence)
- **Limitation:** only DBpedia entries
  - focus on named entities
  - fewer *concepts, events, relations, times...*



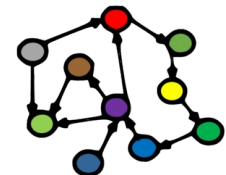
# Text lifting tasks

- DBpedia Spotlight covers *entity extraction*:
  - entity recognition (detection)
  - entity disambiguation (name resolution)
  - linking
- Does not focus on:
  - word-sense disambiguation (WSD)
  - topic extraction
  - text classification
  - relation extraction
  - sentiment analysis, attitudes, negation



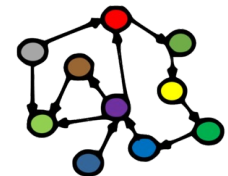
# DBpedia ↔ Wikidata

- Similarities:
  - both publish **RDF data** about **entities/resources**
  - both offer **standard URIs** and define **ontologies**
  - both are extensively **linked** to other semantic datasets
- Differences:
  - **source**: DBpedia is derived; Wikidata is crowdsourced
  - **direction**: DBpedia extracts data from Wikipedia;  
Wikidata provides data to Wikipedia
  - **structure**: DBpedia adds structure to Wikipedia data;  
Wikidata is natively structured
  - **maturity**: DBpedia is older; Wikidata is recent
- Recently: DBpedia also extracts data from Wikidata



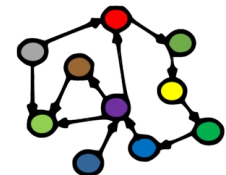
# DBpedia and Wikidata ↔ Freebase

- *A terminated free and open knowledge base that could be read and edited by both humans and machines*
  - from 2007
  - similar to DBpedia, but crowdsourced
  - acquired by Google in 2010
  - closed in 2014
    - data dumps still available
- Central information source for
  - Google's knowledge graph
  - Wikidata



# The GDELT project

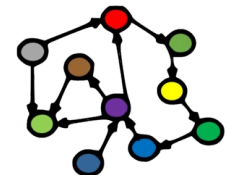
- Global Database of Events, Language, and Tone (GDELT)
  - free open platform
  - monitors the world's broadcast, print, and web news
  - focus on crises, but much broader in practice
  - globally in over 100 languages
  - identifies people, locations, organizations, themes, sources, emotions, counts, quotes, images, events
  - *“can we map happiness and conflict, provide insight to vulnerable populations and even potentially forecast global conflict in ways that allow us as a society to come together to deescalate tensions, counter extremism, and break down cultural barriers?”*





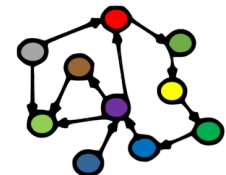
# The GDELT project

- Archives back to 1979 (expanding back to 1800)
- Increasingly integrating social media
- Translations from 65 languages into English
- Supported by Google
  - runs in the Google Cloud
- Almost a knowledge graph, but
  - not native RDF
  - not fully linked
  - no ontology



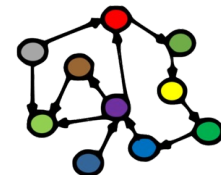
# The GDELT project: data streams

- Downloadable CSV files (every 15 minutes)
  - <http://data.gdeltproject.org/gdeltv2/lastupdate.txt>
  - *Events* (...export.CSV, ~400k)
    - low-level actor - event type – actor triples
  - *Mentions* (...mentions.CSV, ~600k)
    - where in and which source is each event mentioned?
  - *Global Knowledge Graph* (...gkg.CSV, ~50M)
    - which people, locations, organizations, themes, sources, emotions, counts, quotes, images, events are mentioned where and in which source?
  - Also available as Google BigQuery tables
- Lots of other datasets and streams, raw and analysed, native language or translated to English



# The GDELT project: data streams

- Other data streams:
  - *Visual GKG*
    - codifying the world's news images in real time
    - random sampling, Google's Vision API
  - *Global Entity Graph*
    - experimental, random sampling of news articles
    - deep learning, Google's Natural Language API
    - provides Wikidata links for entities
  - *Global Relationship Graph*
    - experimental, related to the global entity graph
    - extracts verbs and the words in their context
    - groups new articles with similar verbs-in-context



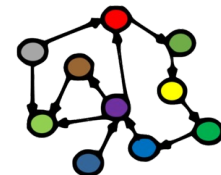
# The GDELT project: Events 2.0

- For each event:
  - global event id and datetime
  - actor 1 and 2:
    - name (person, organisation, location, ethnicity, religion, type) and CAMEO code
  - event:
    - CAMEO code and importance of event type
    - numbers of mentions and sources, tone
  - geography
- Codebooks
  - [http://data.gdeltproject.org/documentation/GDELT-Event\\_Codebook-V2.0.pdf](http://data.gdeltproject.org/documentation/GDELT-Event_Codebook-V2.0.pdf)
  - <http://data.gdeltproject.org/documentation/CAMEO.Manual.1.1b3.pdf>



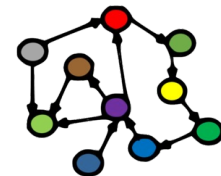
# The GDELT project: Mentions 2.0

- For each event
  - global event id and datetime
  - mention type and datetime
  - source name and identifier (e.g., a URL)
  - sentence number
  - actor 1 and 2 mentions (character indices)
  - confidence
  - source length and tone
- Codebook
  - [http://data.gdeltproject.org/documentation/GDELT-Event\\_Codebook-V2.0.pdf](http://data.gdeltproject.org/documentation/GDELT-Event_Codebook-V2.0.pdf)



# The GDELT project: GKG 2.0

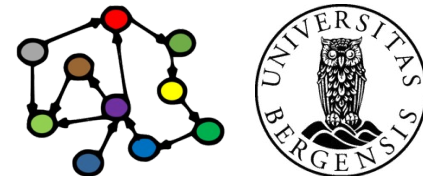
- For each document:
  - record id and datetime
  - source and document identifier (e.g., a URL)
  - keywords/themes (taxonomies of 50k keywords)
  - person and organisation names and types
  - locations, their types, names, geo-coordinates
  - counts, their types and counted objects
  - average tone, positive/negative score, polarity
  - ...and lots of other stuff
- Codebook
  - [http://data.gdeltproject.org/documentation/GDELT-Global\\_Knowledge\\_Graph\\_Codebook-V2.1.pdf](http://data.gdeltproject.org/documentation/GDELT-Global_Knowledge_Graph_Codebook-V2.1.pdf)



# EventKG



- The LOD cloud is *entity* centric
  - people, organisation, places, works...
- For many purposes *events* are more important
  - a type of entity, but less focussed on
  - ...and harder to extract/describe
- EventKG is a *Multilingual Event-Centric Temporal Knowledge Graph*
- Extracted from:
  - Wikidata, DBpedia and YAGO
  - Wikipedia Current Events Portal (WCEP)
  - Wikipedia event lists in 15 languages

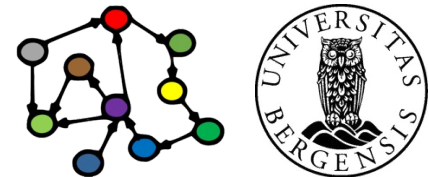




# EventKG



- EventKG 3.0:
  - > 1.3 million events
    - 56.25% from the existing KGs
  - > 676 million triples
  - > 4.5 million temporal relations
- Example uses:
  - “interactive spatio-temporal biographies”
  - “cross-lingual event timelines”
  - “semantic event-centric queries and their verbalisations in three languages”
  - “event-centric user interaction traces”



# Example

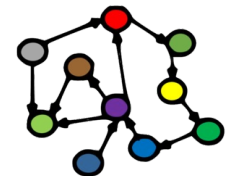
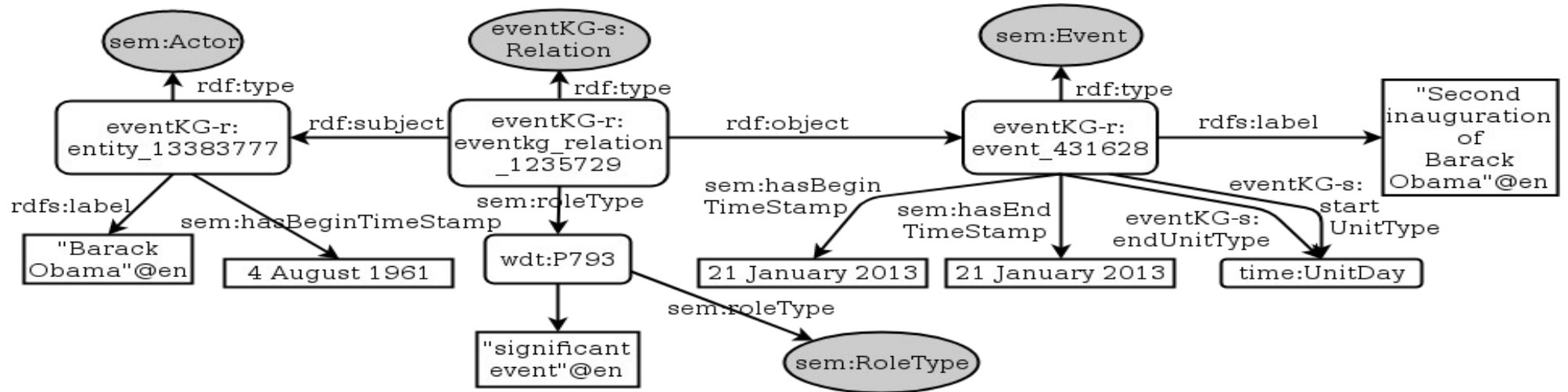
- The Brexit referendum
  - <http://www.wikidata.org/entity/Q21812812>
- Local EventKG
  - <https://imdb.uib.no/bg-eventkg>
- PREFIX owl: <<http://www.w3.org/2002/07/owl#>>  
SELECT \* WHERE {  
 GRAPH ?g  
 { ?s ?p <<http://www.wikidata.org/entity/Q21812812>> . }  
}
- DESCRIBE  
 <[http://eventKG.l3s.uni-hannover.de/resource/event\\_61609](http://eventKG.l3s.uni-hannover.de/resource/event_61609)>
  - Total results: 2930, displaying...
  - ~ 2800 are link relations  
<http://eventkg.l3s.uni-hannover.de/>

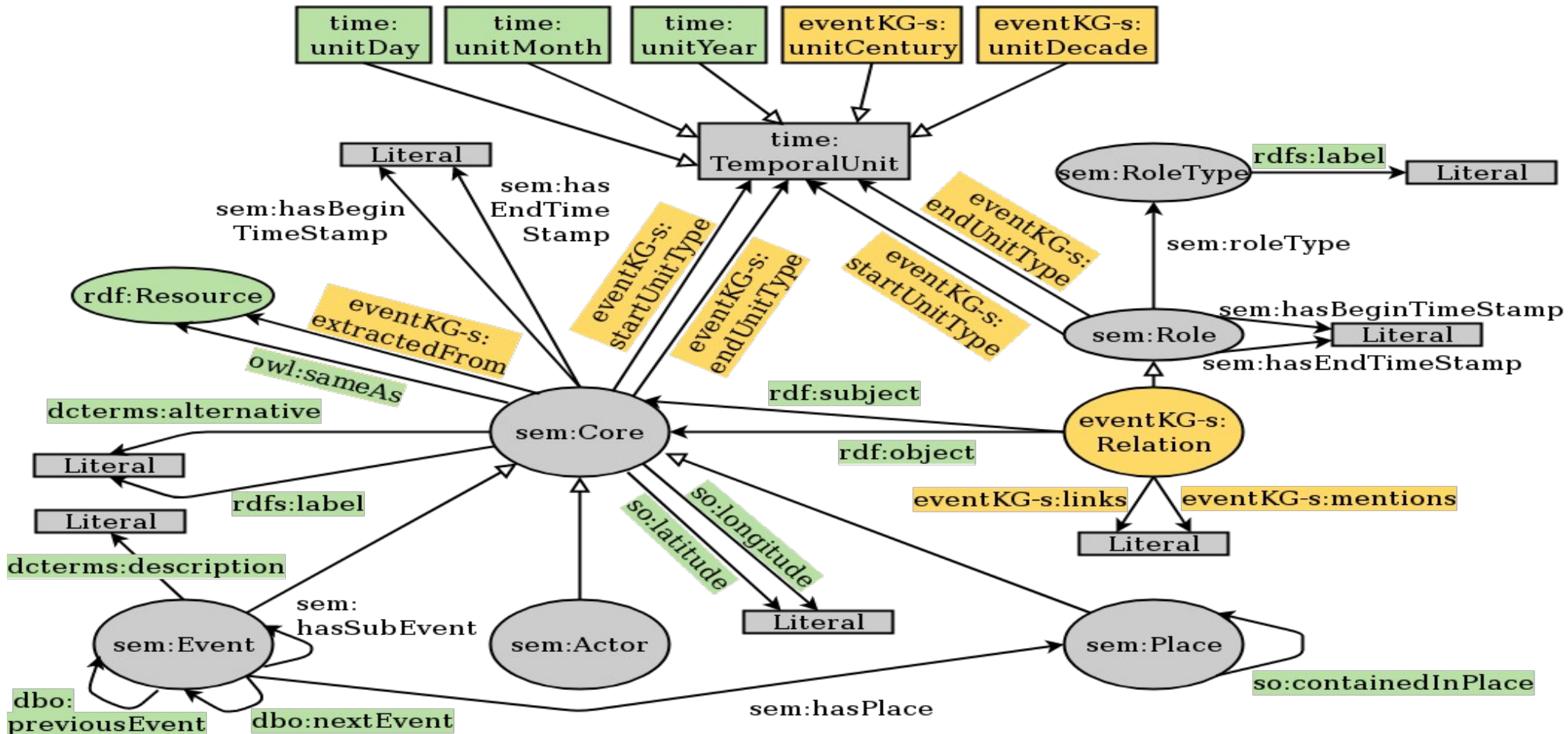
# Example

- The Brexit referendum
  - <http://www.wikidata.org/entity/Q21812812>
- PREFIX eventKG-r: <<http://eventkg.l3s.uni-hannover.de/resource/>>  
DESCRIBE eventKG-r:eventkg\_relation\_1705321
- eventKG-r:eventkg\_relation\_1705321
  - rdf:type eventKG-s:Relation;
  - sem:roleType wdp:P92 ; # “main regulatory text”
  - rdf:subject eventKG-r:event\_61609 ;
  - rdf:object eventKG-r:entity\_8402669 .
- eventKG-r:entity\_8402669
  - ... ;
  - owl:sameAs dbr:European\_Union\_Referendum\_Act\_2015 ;
  - ....

# A visual relation

- Relation from Barack Obama's second inauguration





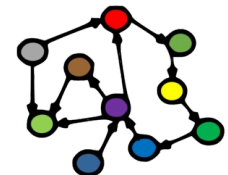
SEM = Simple Event Model (S08-09)

<http://eventkg.l3s.uni-hannover.de/>



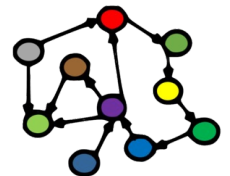
# EventKG ↔ GDELT

- EventKG
  - native RDF, historic / static (but updated)
  - linked resources (DBpedia, Wikidata, YAGO)
  - ontology (DBpedia ontology, Wikidata, YAGO)
  - limited to existing KGs + Wikipedia
  - quality-controlled by crowdsourcing
- GDELT
  - real time, 15 minute updates, does its own lifting
  - thousands of live sources: text, audio, video
  - sentiment, topic, keyword and other analyses
  - metadata from codebooks
  - much noise, imprecisions, errors



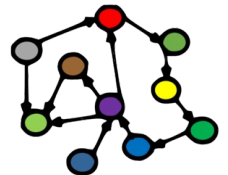
# GeoNames

- *Adding geospatial semantic information to the web*
  - a geographical database: <http://www.geonames.org>
  - collected from a large number of sources
  - > 25M geographical names (*toponyms*, Norway 68k),  
> 11M unique features, ~ 4.8M populated places,  
~ 13M alternate names
- Offers *dereferencable URIs* for *toponyms / place names*
  - “303 redirection” for *Concept-Document distinction*
  - i.e., an entity and the information about it are different resources
    - <http://sws.geonames.org/3161732/>
    - <http://sws.geonames.org/3161732/about.rdf>



# GeoNames

- Available as:
  - map-based HTML pages (POW – “Plain Old Web”)
  - web APIs (REST, XML, RDF)
  - SPARQL endpoints
  - dereferencable URIs
  - downloadable (TSV)
  - Gazetteer lists
- Also as Linked Data Fragments:
  - <http://data.linkeddatafragments.org/geonames>

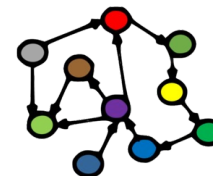


# GeoNames ontology

- Vocabulary in OWL:
  - @prefix gn: <<http://geonames.org/ontology#>> .
  - gn:Feature class
  - 9 top-level feature codes:
    - **A** country, state, region, ...; **H** stream, lake, ...;
    - L** parks, area, ...; **P** city, village, ...; **R** road, railroad;
    - S** spot, building, farm; **T** mountain, hill, rock, ...;
    - U** undersea; **V** forest, heath, ...
  - 645 detailed feature codes (in a hierarchy)
  - gn:name, gn:alternateName, gn:locationMap, gn:countryCode, gn:featureClass, gn:featureCode, gn:nearbyFeatures, gn:parentADM1, gn:parentADM2, gn:parentCountry, gn:population, gn:wikipediaArticle
  - also uses properties from *geo*, *foaf*, *dcterms*, *cc*, *rdfs*...

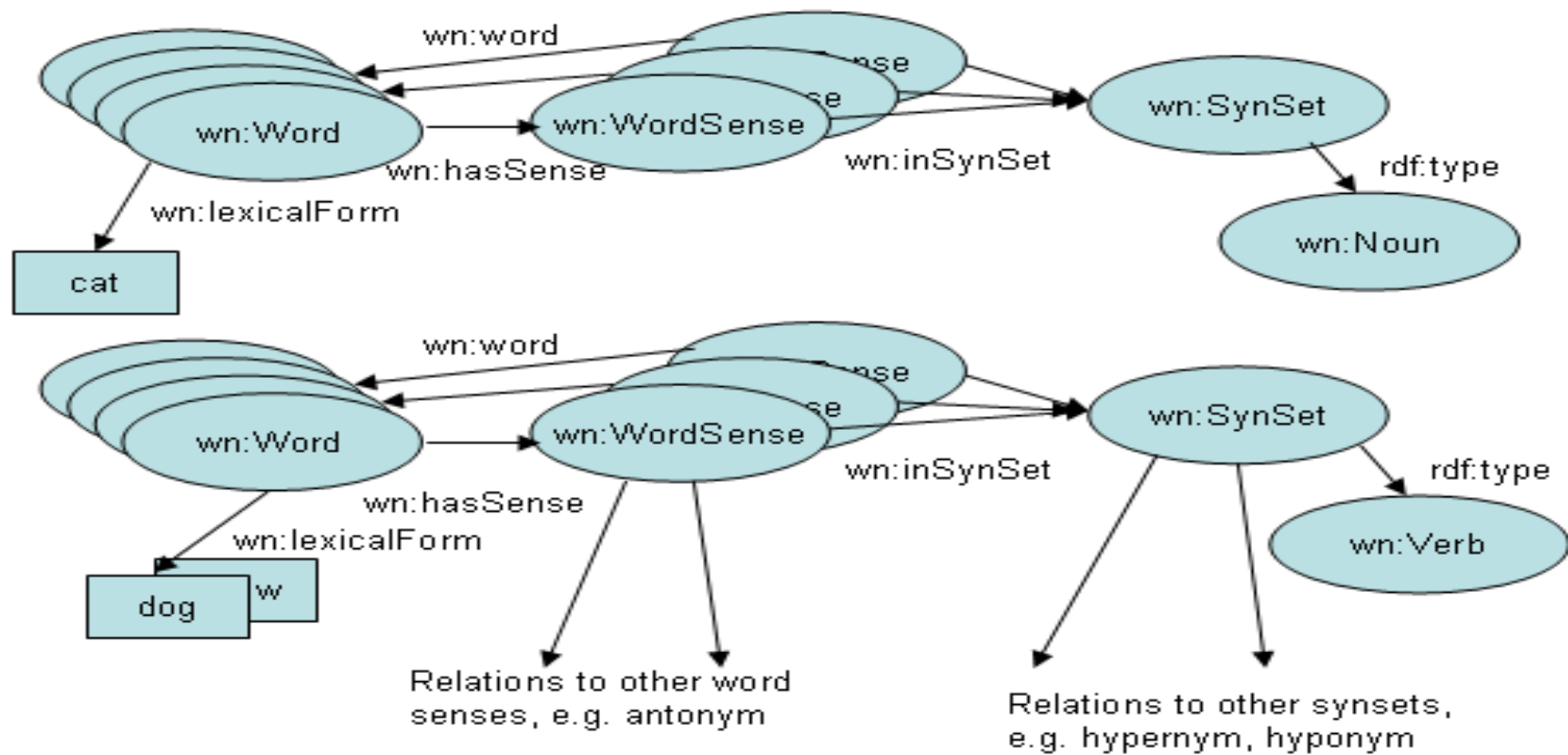
# WordNet

- An electronic open-source dictionary (Miller, 1985-):
- 155k open-class words, 118k synonym sets (*synsets*), 207k Word-Sense pairs
- hand-written definitions, common-use frequencies
- version 3.1 available for download or online:
  - <http://wordnetweb.princeton.edu/perl/webwn>
- APIs in many languages (Java, Python)
- RDFS and OWL versions exist
  - WordNet in RDF:  
<https://www.w3.org/TR/wordnet-rdf/>  
<http://wordnet-rdf.princeton.edu/>
- also versions for other languages





# WordNet: Structure



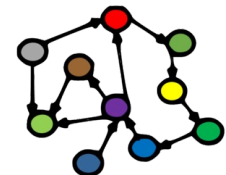
# WordNet: Synset structure

- Different *concept relations* for each *Part of Speech (PoS)*
- Nouns:
  - hyponyms/hypernyms  
*bat-n-1 is-kind-of placental\_mammal-n-1*
  - type / instance  
*Norway-n-1 instance-of Scandinavian\_country-n-1*
  - holonyms/meronyms  
*bat-n-1 has-part wing-n-1*
  - *antonyms*  
*birth-n-1 has-antonym death-n-1*
  - entailment, domains  
*bat-n-2 has-domain baseball-n-1*



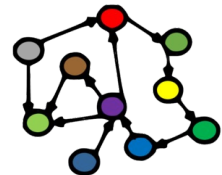
# WordNet: Synset structure

- Verbs:
  - troponyms/hypernym  
*communicate-v-2 has-troponym talk-v-2*  
*talk-v-2 has-troponym whisper-v-1*
    - depending on semantic field:  
*run-v-1 has-troponym jog-v-3*  
*like-v-2 has-troponym love-v-2*
  - verb groups
  - antonyms  
*love-v-1 has-antonym hate-v-1*
  - similarity, sister terms  
*bat-v-1 has-sister swat-v-1*



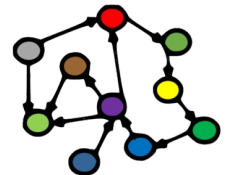
# WordNet: Synset structure

- Adjectives:
  - semantic, similarity, antonyms, indirect antonyms
- Adverbs:
  - similar to adjectives
- Also cross-PoS:
  - island – islander (derived from)
  - talk – speak for (phrasal)...
  - ...and others



# WordNet: Norsk Ordvev

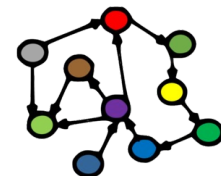
- Developed Kaldera språkteknologi
  - for Nasjonalbiblioteket (The national library)
  - both *bokmål* and *nynorsk*
  - $\approx$  50 000 words, 200 000 synsets each
- Available at
  - <https://www.nb.no/sprakbanken/ressurskatalog/oai-nb-no-sbr-27/>
  - <https://www.nb.no/sprakbanken/ressurskatalog/oai-nb-no-sbr-7/>
  - updated 2013-2014





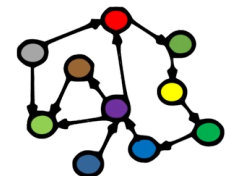
# International language resources

- Global Wordnet Grid (<http://globalwordnet.org/>)
  - building a *Global Multilingual Wordnet*  
<http://compling.hss.ntu.edu.sg/omw/>
- DBpedia Wiktionary as Linked Data Fragments
  - *extracting a DBpedia from Wiktionary*
  - <http://data.linkeddatafragments.org/wiktionary>
- Dbnary (<http://kaiko.getalp.org/about-dbnary/>)
  - *extracting a DBpedia from Wiktionary*
  - automatic extraction of RDF graphs from Wiktionary
- BabelNet (<http://babelnet.org>)
  - multilingual text analysis and translation
  - *not fully open...*



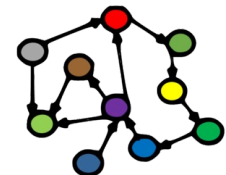
# BabelNet

- A multilingual encyclopedic dictionary and a semantic network of concepts and named entities
  - both lexicographic and encyclopedic coverage
  - 16 million Babel synsets
  - > 800 million word senses
  - > 280 languages
  - integrates data from *WordNet*, *Open Multilingual Wordnet*, *Wiktionary*, *Wikidata*, *Wikipedia*, *Wikiquotes*, *GeoNames* and several others



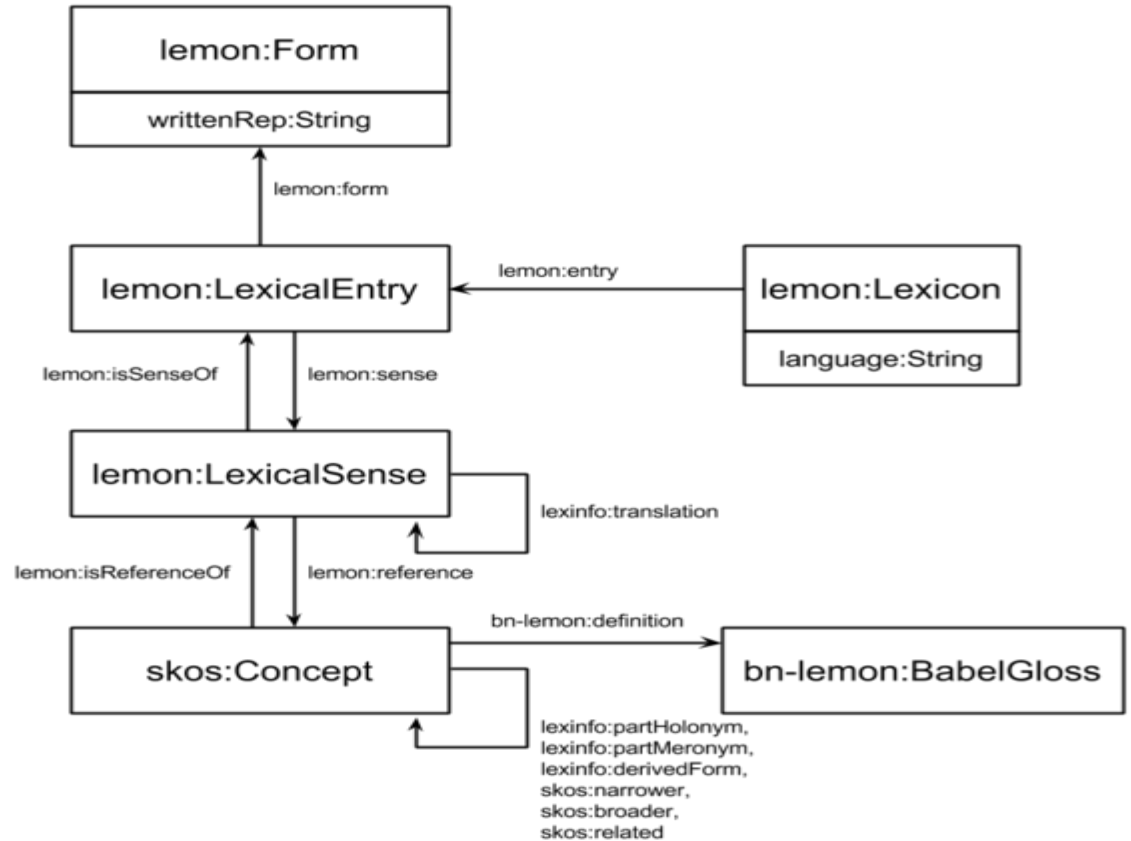
# BabelNet availability

- Available as:
  - web lookup service
  - web translation service
  - web API (JSON) with Java library
  - SPARQL endpoint
  - linked data interface
    - <http://babelnet.org/rdf/page/>
    - the Linguistic LOD (LLOD) cloud
  - Attribution-NonCommercial-ShareAlike 3.0



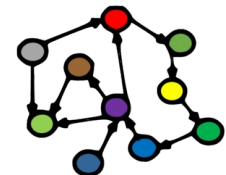
# BabelNet conceptual model

- Making BabelNet part of the LLOD cloud
- Vocabularies:
  - Lemon
  - BabelNet-lemon
  - LexInfo
  - SKOS
  - RDFS
  - DC elements
  - DC terms
- Lemon is the backbone



# YAGO4

- *Yet Another General/Great Ontology:*
  - top-level classes from schema.org and bioschemas.org
  - facts extracted from Wikidata
    - 50M entities, 2B triples/facts
    - places facts and entities in time and space
  - YAGO1-3:
    - based on Wikipedia and WordNet, GeoNames, DBpedia, SUMO...
    - used to categorise DBpedia's resources
    - used in IBM's Watson system
  - downloadable as RDF



**Next week:  
Vocabularies**