Semantic Web
Ontologien

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Unterlagen zur Lehrveranstaltung
Interoperabilität und Geodateninfrastrukturen

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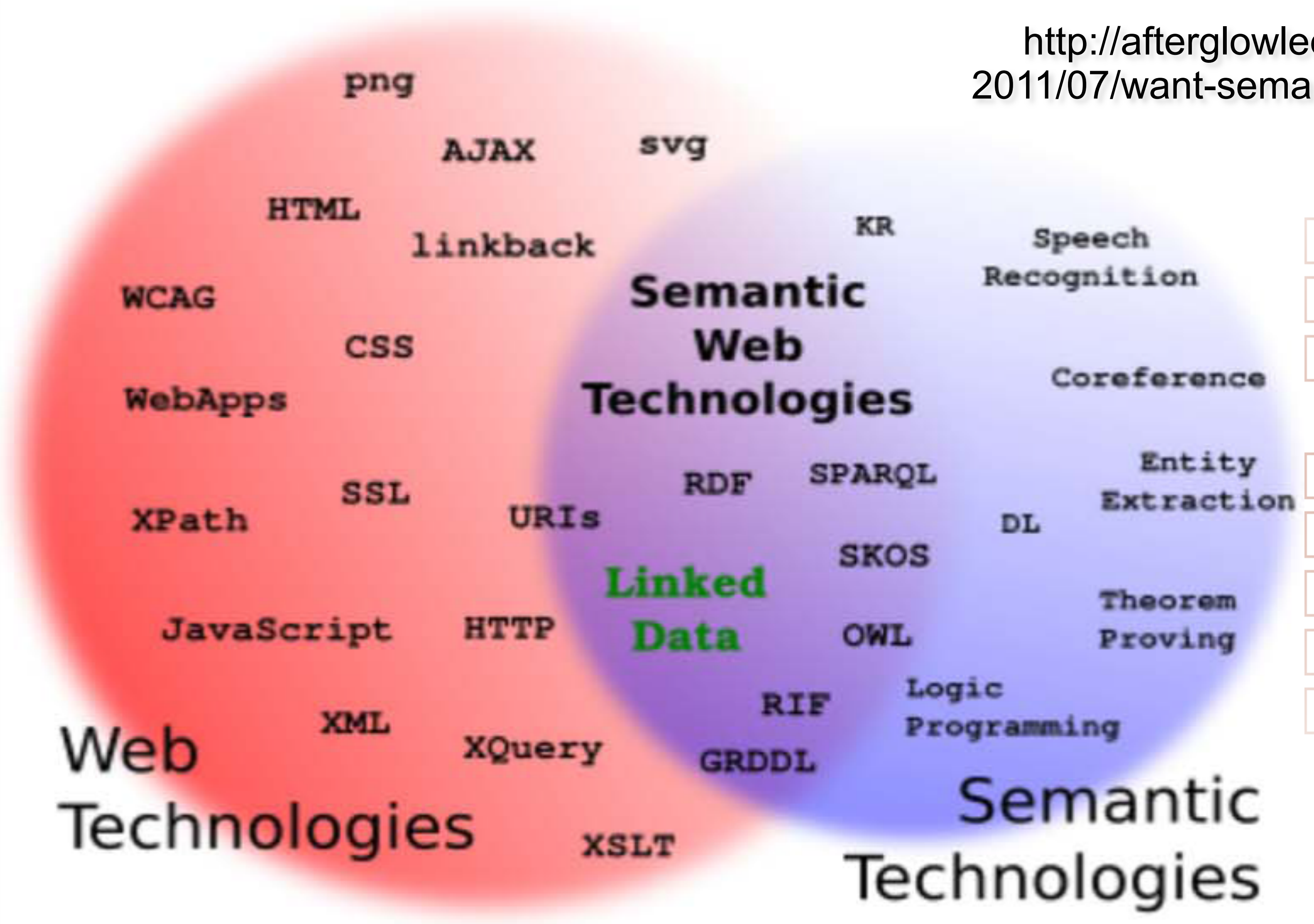


http://afterglowlee.blogspot.com/2011/07/want-semantic-web-linked-data-job.html

Quellen

Pellegrini, T., A.Blumauer (Hrsg): Semantic Web. Wege zur vernetzten Wissensgesellschaft. Springer-Verlag 2006.

Rob Lemmens: Semantic Interoperability of Distributed Geo-Services. NCG Netherlands Geodetic Commission, Delft 2006, https://www.semanticscholar.org/paper/Semantic-interoperability-of-distributed-Lemmens/71f0e7112284141c042d76e1e6a9ee173cc81b8d

Semantic Web https://de.wikipedia.org/wiki/Semantic_Web

Semantic Web Company http://www.semantic-web.at/

Know Center der TU Graz http://know-center.tugraz.at/

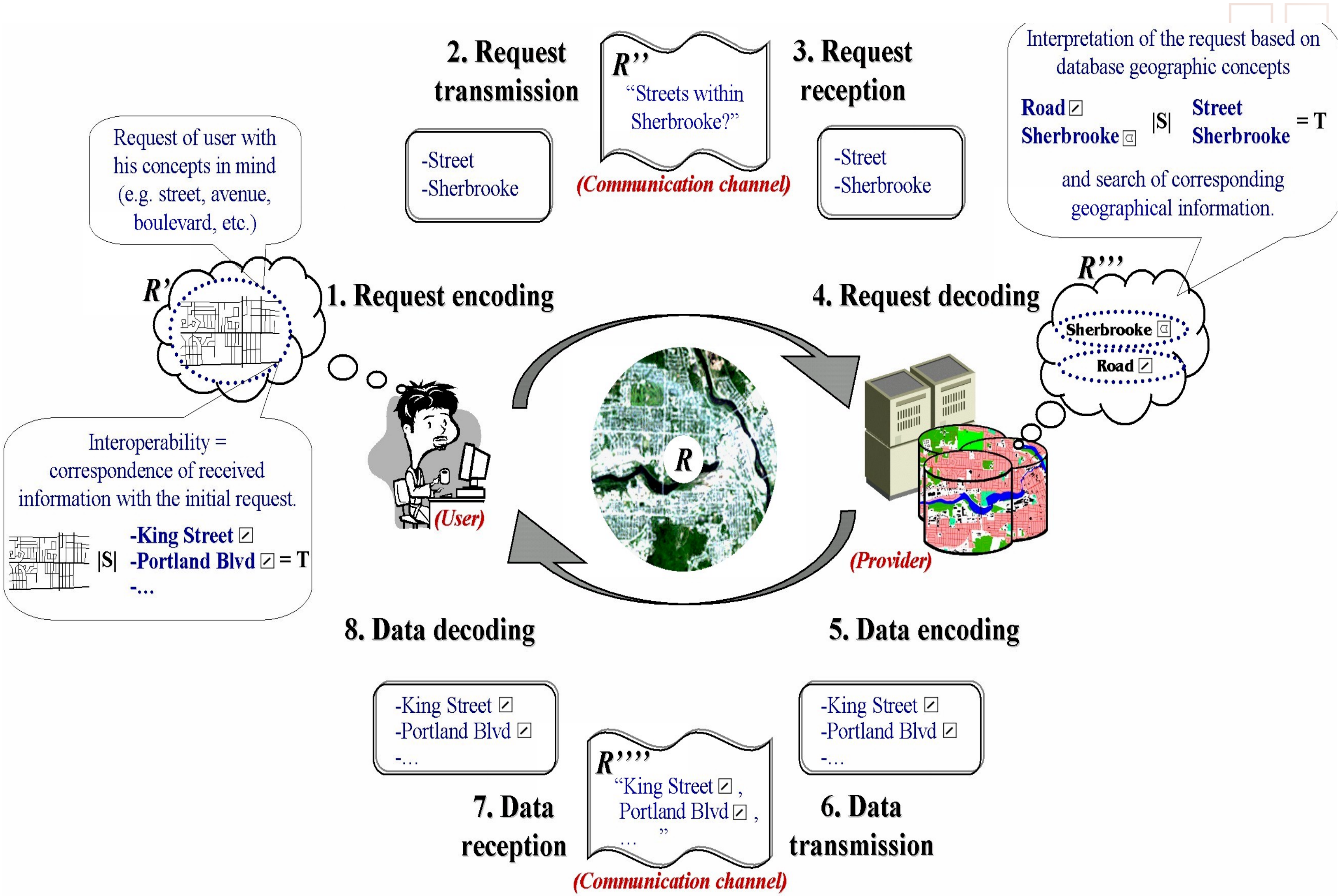
http://www.w3.org/

Information Abstraction Stack (R.Lemmens)

Abstraktionsstufe	*Kennzeichen, Objekte, Methoden*
Reale Welt	. . .
Kognitive Welt	Intuitives und Gedanken
Welt der Konzepte	Text, Bilder, UoD, informelle Ontologien
Symbolisierte Welt	Konzeptionelle Modelle, formelle Ont.
Implementierungswelt	Softwareklassen, Datenströme, …

On-demand Geoprocessing: Ein Beispiel

Quelle: ISO Ontology-Working Group



Semantische Interoperabilität

GEO INFORMATION

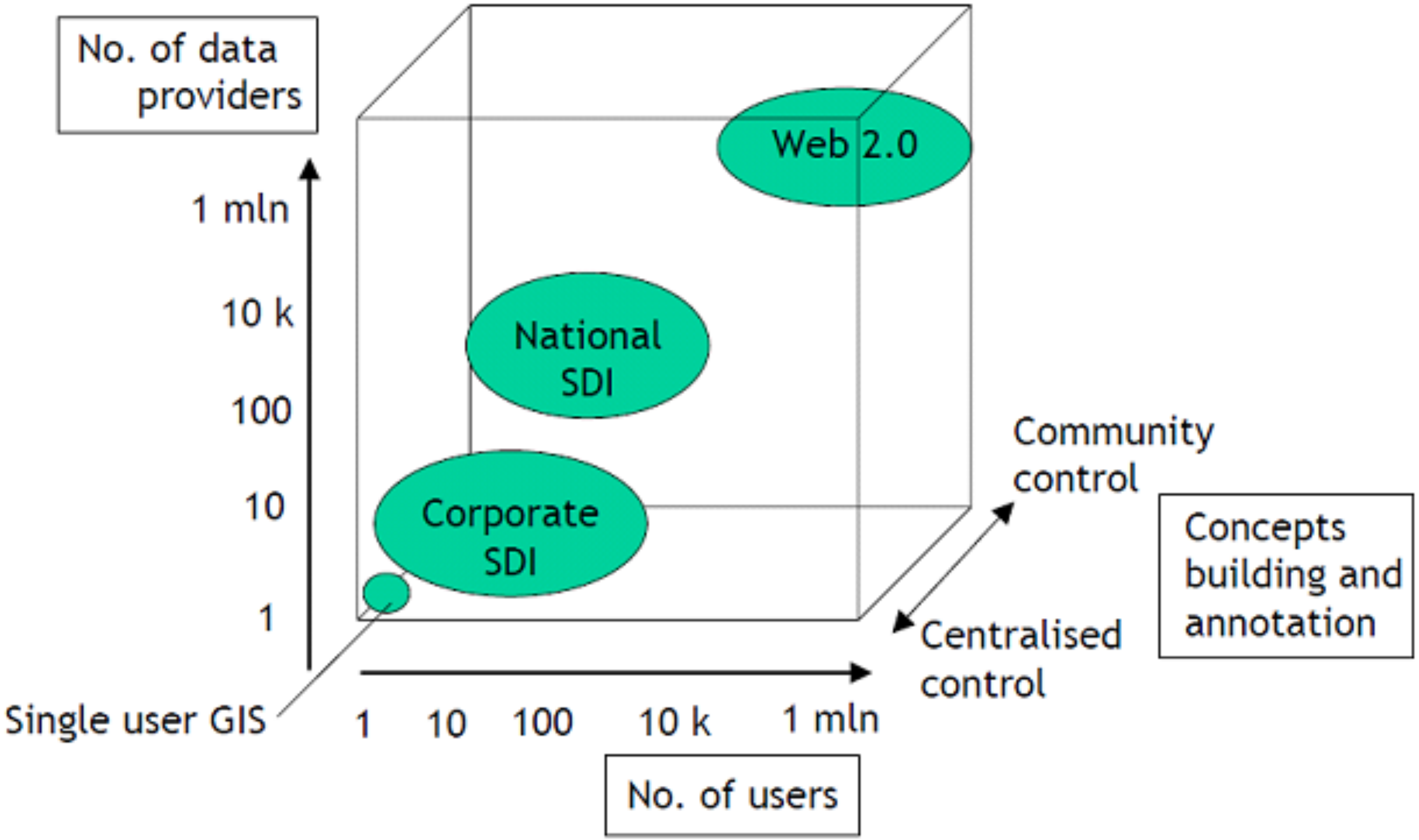
Semantische Interoperabilität:

Kombination von Ontologien,
deren Beziehungen sowie
Methoden für Ontologie-basierte Beschreibung
von Informationsquellen (Daten, Services)
+ dazugehörige Tools

Wird für Web 2.0 / Web 3.0 immer wichtiger:

Dynamik stärker
Instanzen wichtiger als Konzepte
Abbildungen zwischen Ontologien nicht immer a priori
Regeln nicht mehr strikt

IOP und Web 2.0 (nach Rob Lemmens)



Semantische Modellierung

Stufen der Interoperabilität:
- Syntaktische IOP
- Strukturelle IOP
- Semantische IOP

Ziele der Semantischen IOP:
- Konzeptuelles Modell eines UoD (Universe of Discourse) durch Formalisierung der Semantik (Ontologie)
- Abbildungen zwischen Ontologien
- Wissens-Infrastruktur
- Geht ein Stück in Richtung AI (Artificial Intelligence)

Semantische Modellierung

Spielarten:

- Informell ← → formell: basiert auf natürlicher Sprache oder ist Logikbasiert
- Von Menschen lesbar ← → von Maschinen lesbar
  Kombination: XML, darauf aufbauend OWL Web Ontology Language
- Ist tief strukturiert (z.B. Naturstand, insb.Gebäude) ← → ist seicht (z.B. Bibliotheks-IS)

Semantic Web (Web 3.0)

Beispiel Google:

Google Knowledge Graph https://support.google.com/knowledgepanel/answer/9787176?hl=de_AT

Google Search: Suchergebnisse werden über Knowledge Graph teilweise mit semantischen Informationen angereichert; diese werden dabei wie Google-Now-Ergebnisse als Karten angezeigt

Google Now: Erweiterung von Google Search, sagt Suchanfragen mit Hilfe des Google Prediction API voraus und zeigt diese an (ähnlich Siri, Alexa) https://www.heise.de/tipps-tricks/Was-ist-Google-Now-Alles-was-Sie-wissen-muessen-4078179.html#google_now

„Sie erhalten Karten mit hilfreichen Informationen für Ihren Tagesablauf – und das sogar, bevor Sie danach suchen“

Google Prediction API: Machine learning and pattern matching to analyze your data and make predictions: https://cloud.google.com/vertex-ai/docs/start/ai-platform-users?hl=de#prediction

Blog: https://ahrefs.com/blog/

Google Prediction, Use Case Purchase Prediction

Imagine a site that sells beer, wine, and cheese, and you want to predict whether a visitor will be interested in wine, given their purchase history.

In this situation, we might create training data with three features:
1. The number of times the customer has bought fancy dessert cheese.
2. A value of 1 if the customer has ever bought wine, and 0 if not.
3. The number of times the customer has bought beer.

A sample of training data for this problem might be encoded as follows:
- "wine",5,1,1
- "no-wine",0,0,10

The first instance (row) would then encode an example where a customer who likes wine has done the following:
- Bought fancy dessert cheese 5 times.
- Bought wine at least once in the past (value of 1).
- Bought beer once.

Google Prediction

„Google Prediction provides pattern-matching and machine learning capabilities.
After it learns from your training data, Prediction can predict a numeric value or choose a category that describes a new piece of data.

With these capabilities, you can create applications to perform tasks such as predicting what movies or products a user might like,
categorizing emails as spam or non-spam,
assessing whether posted comments have positive or negative sentiment,
or guessing how much a user might spend on a given day.“

Finden Sie geo-relevante Szenarien, wo (in Zukunft) der Context aufgrund vorangegangener Suchvorgänge eingeschätzt werden kann!

GEO INFORMATION

A-O-I Modell (nach Pellegrini-Blumauer)

Unterschiedliche Perspektiven, oft nur lose gekoppelt:

- Anwender-Perspektive: Zusammenführen fragmentierter, disperser Informationsbestände, bessere (intelligentere) Benutzeroberflächen, effiziente Suche, Merkfähigkeit
- Organisations-Perspektive: Ansprechpartner, Vernetzung von Wissensträgern, Knowledge Management
- Infrastruktur-Perspektive: Verteilung, Integration, Metadaten, Mapping inkompatibler Ontologien

Ontologie

Grundpfeiler,

erlaubt gemeinsames Nützen von Semantik

Beispiele:

beim Autofahren,

beim Bestellen im Restaurant,

In der Stadtplanung mittels GIS,

…

Definition: Ontologie = explizite Spezifikation einer abstrakten, vereinfachten Sicht auf Objekte, Konzepte und deren Beziehungen, die in einem UoD vorkommen, das auf einen bestimmten Zweck ausgerichtet ist.

(Gruber, 1993, Proceedings of Int'l Workshop on Formal Ontology, Padua)

Ontologie: Bedingungen, Unterschiede

Folgende Bedingungen müssen in einer solchen Sammlung von Objekten und Konzepten erfüllt sein:

- eindeutige Definition
- erschöpfend (nicht explizit Definiertes darf nicht verwendet werden)
- Sammlung hat Struktur mit Beziehungen

Unterschiede hinsichtlich

- Formalisierungsgrad informell, semi-informell, semi-formell, streng formell
- Ausmaß der Erklärbarkeit
- Komplexität der Struktur
- UoD (z.B. „Landbedeckung", „EVU-Versorgungsbereich")
- Sprache (natürlich – maschinenlesbar)
- Maß an Ausdruckskraft (OWL-lite, OWL DL, OWL-full)
- Darstellung (natürliche Sprache oder UML)

Ontologie: Historisches

Geht auf Anfänge in der AI Artificial Intelligence zurück

Historisch (etwa 1970-1980) zwei grundsätzliche Zugänge:

- Logik-basierte Zugänge (z.B. Regelbasierte Systeme)
- Kognitionsbasierte Zugänge (z.B. Semantisches Netz, Frames)

Danach Annäherung

Beschreibungslogik (DL Description Logics) vereint beides

ISO 19150 *Ontology* covers ontologies as far as spatial data are concerned.

Conceptually, ISO 19150 consists of six parts:

1. ISO 19150-1 *Ontology – Part 1: Framework*
2. ISO 19150-2 *Ontology – Part 2: Rules for developing ontologies in the Web Ontology Language (OWL)*
3. ISO 19150-3 *Ontology – Part 3: Semantic operators*
4. ISO 19150-4 *Ontology – Part 4: Service ontology*
5. ISO 19150-5 *Ontology – Part 5: Domain ontology registry*
6. ISO 19150-6 *Ontology – Part 6: Service ontology registry*

Source: Wolfgang Kresse, David Danko, Kian Fadaie: „Standardization“

Handbook of Geographic Information, Springer 2022, 2nd edition, p.383-492
ISBN 978-3-030-53125-6 (eBook)

Ontologie: Darstellungsvarianten

- Konzept-Hierarchien (Klassen, unäre Prädikate)

Geographic Feature
- **Building**
- **...**
- **Country**
  - **CountryWithCoast**
  - **LandLockedCountry**
- **Sea**
- **...**

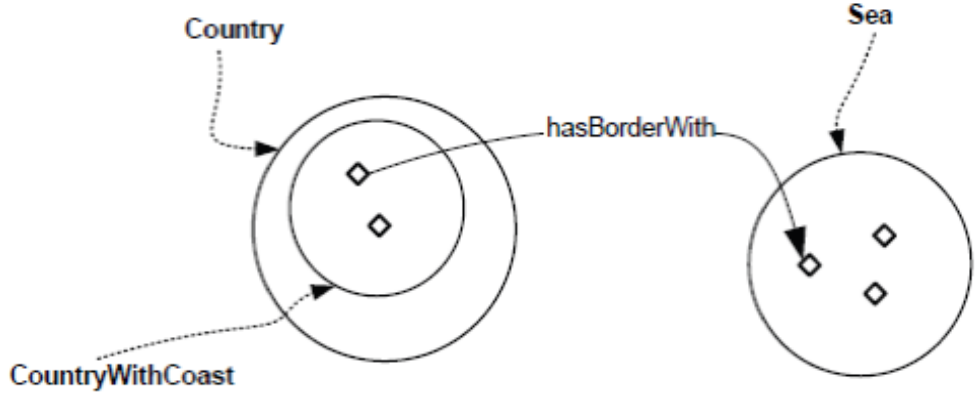
- Rollen (Beziehungen, binäre Prädikate)

(Country) HasBorderWith (Country)
or
(Country) HasBorderWith (Sea)

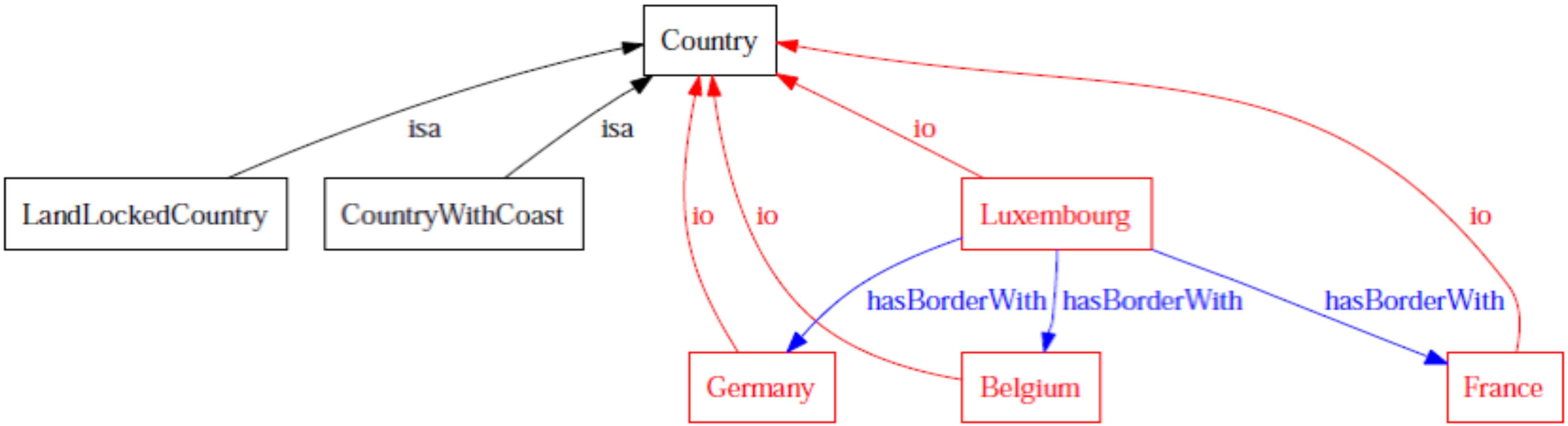
- Beschreibungen (Description Logics)

$$CountryWithCoast \equiv Country \sqcap \exists hasBorderWith.Sea$$

Diagramme: Klassen: Kreise
Instanzen: Diamonds
Eigenschaften: Pfeile



Schwarz: Klassen, Bez. „is-a“
Rot: Instanzen, Bez. „instance-of“
Blau: Bez. zwischen Instanzen



Ontologie: Beschreibungslogik

Description Logics DL baut auf Prädikatenlogik auf:
Konzepte (unäre Prädikate) u. Rollen (binäre Relationen)

Ein Konzept (z.B. „Bauwerk“) wird durch seine individuellen Realisierungen (Instanzen; z.B. „Eiffelturm“, „Taj Mahal“, …) beschrieben (**Extension** eines Konzepts;

Ein anderes extensionelles Beispiel: Konzept „Jahreszeit“ und Realisierungen „Frühling“, „Sommer“, „Herbst“, „Winter“

Gegensatz **Intension** z.B. „ein Tag ist ein Zeitraum von 24 Stunden“

Eine Rolle (z.B. „hat Baustoff“) besteht aus einem Paar individueller Realisierungen bzw. Instanzen; z.B. („Eiffelturm“, „Stahl“)

Ontologie: Beschreibungslogik - Beispiele

Subclass (Beziehung „Ist-ein“)
„Ein Gebäude ist ein Bauwerk“

$$Building \sqsubseteq Construction$$

„Ein Gebäude, das mindestens 3 Stockwerke hat und wo man über-nachten kann“

$$Building \sqcap (\geq 3\ hasFloor) \sqcap \exists hasFunction.Accommodation$$

„Ein Land, das am Meer liegt“

$$Country \sqcap \exists hasBorderWith.Sea$$

„Ein Binnenland“

$$Country \sqcap \forall hasBorderWith.(\neg Sea)$$

Ontologie: Aufbau einer Wissensbasis

In einer Wissensbasis (Knowledge Base) werden aus grundlegenden Fakten und Axiomen (extensionelles und intensionelles Wissen) neue Erkenntnisse geschaffen und gespeichert.

Beispiel: aus

GB ist ein Land
GB hat eine Küste
Land mit Küste hat eine Seegrenze

folgt

GB hat eine Seegrenze

RDF
Resource Description Framework

Sprache, die auf Tripeln (Prädikat, Subjekt, Objekt) aufbaut

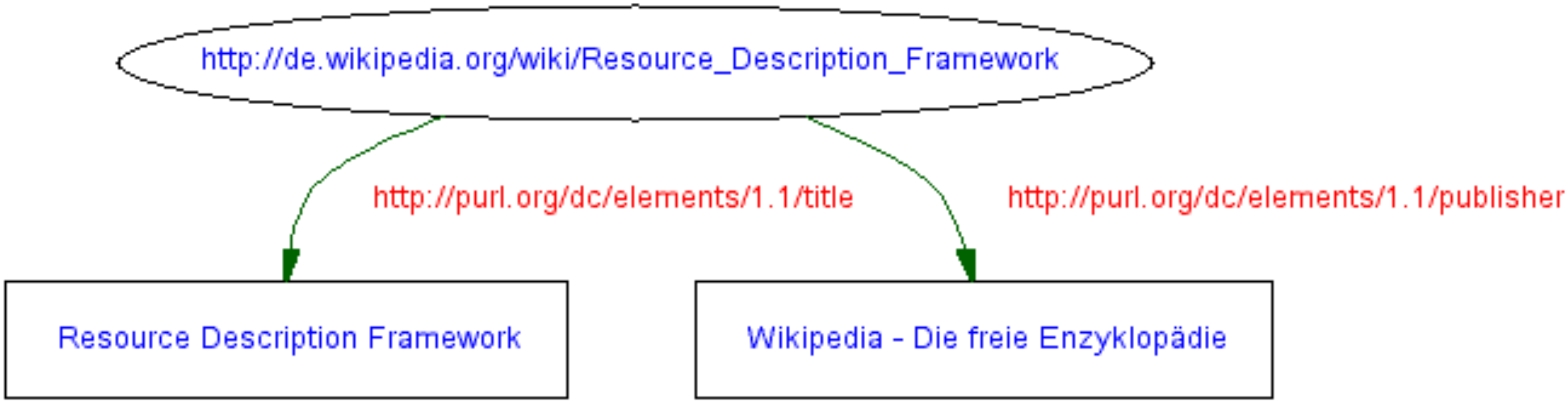
(„Punkt“, „SubClassOf“, „Geometrie-Objekt“)
(„Linie“, „SubClassOf“, „Geometrie-Objekt“)
(„Polygon“, „SubClassOf“, „Geometrie-Objekt“)

RDFS RDF-Schema
(analog zu XML – XML Schema)

Verwandtschaft zu XML ausgenützt, indem XML zur Übertragung von RDF-Graphen verwendet wird

Siehe z.B. auch https://de.wikipedia.org/wiki/Semantic_Web

RDF
Resource Description Framework



Dieser RDF-Graph sagt aus, dass die Ressource – in diesem Fall der vorliegende Artikel – einen Titel namens „Resource Description Framework“ hat, sowie einen Publisher Wikipedia

Anm.: PURL = persistent URL: Link-Resolver leitet zum aktuellen URL weiter
http://upload.wikimedia.org/wikipedia/de/9/98/Servlet_164433.png
PURL wird von OCLC (Online Computer Library Center) verwaltet

GEO INFORMATION

SPARQL = **S**PARQL **P**rotocol **a**nd **R**DF **Q**uery **L**anguage
(rekursives Acronym)

Das folgende Beispiel findet die Namen aller afrikanischen Hauptstädte und das Land in dem sich jedes befindet.

```
PREFIX abc: <http://example.com/exampleOntology#>
SELECT ?capital ?country
WHERE {
        ?x abc:cityname ?capital;
            abc:isCapitalOf ?y.
        ?y abc:countryname ?country;
            abc:isInContinent abc:Africa. }
```

Quelle:
http://de.wikipedia.org/wiki/SPARQL

Variable werden mit vorangestelltem „?“ oder „$“ gekennzeichnet. Dabei werden alle Variablenbelegungen für „?capital“ und „?country“ zurückgegeben, die auf die Muster dieser vier RDF-Tripel passen.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CHARACTER SETS
HTML Character Sets
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Introduction to RDF

„RDF is a framework for describing Web resources, such as the title, author, modification date, content, and copyright information of a Web page“

RDF Rules

RDF Example

RDF Main Elements

RDF Container Elements

RDF Collections

RDF Schema (RDFS)

RDF Dublin Core Metadata Initiative (DCMI)

RDF / OWL

RDF Reference

http://www.w3schools.com/

RDF und OWL

RDF stands for Resource Description Framework
RDF is a framework for describing resources on the web
RDF is designed to be read and understood by computers
RDF is not designed for being displayed to people
RDF is written in XML
RDF is a W3C Recommendation
RDF is a part of the W3C's Semantic Web Activity.
W3C's "Semantic Web Vision" is a future where:

- Web information has exact meaning
- Web information can be understood and processed by computers
- Computers can integrate information from the web

http://www.w3schools.com/

RDF und OWL

What is Ontology?

It is about the exact description of things and their relationships.
For the web, ontology is about the exact description of web information and relationships between web information.

What is OWL?

OWL stands for Web Ontology Language
$\boxed{\text{OWL is built on top of RDF}}$
OWL is for processing information on the web
OWL was designed to be interpreted by computers
OWL was not designed for being read by people
OWL is written in XML
OWL has three sublanguages
OWL is a W3C standard

http://www.w3schools.com/

RDF und OWL

Why OWL?

OWL is a part of the "Semantic Web Vision" - a future where:

Web information has exact meaning

Web information can be processed by computers

Computers can integrate information from the web

OWL was Designed for Processing Information

OWL was designed to provide a common way to process the content of web information (instead of displaying it).

OWL was designed to be read by computer applications (instead of humans).

OWL is Different from RDF

OWL and RDF are much of the same thing, but OWL is a stronger language with greater machine interpretability than RDF.

OWL comes with a larger vocabulary and stronger syntax than RDF.

http://www.w3schools.com/

RDF und OWL

OWL Sublanguages

- OWL Lite
- OWL DL (includes OWL Lite)
- OWL Full (includes OWL DL)

OWL is Written in XML

By using XML, OWL information can easily be exchanged between different types of computers using different types of operating system and application languages.

OWL is a Web Standard

OWL became a W3C (World Wide Web Consortium) Recommendation in February 2004.

A W3C Recommendation is understood by the industry and the web community as a web standard. A W3C Recommendation is a stable specification developed by a W3C Working Group and reviewed by the W3C Membership.

http://www.w3schools.com/

OWL Web Ontology Language

owl:AllDifferent
owl:allValuesFrom
owl:AnnotationProperty
owl:backwardCompatibleWith
owl:cardinality
owl:Class
owl:complementOf
owl:DataRange
owl:DatatypeProperty
owl:DeprecatedClass
owl:DeprecatedProperty
owl:differentFrom
owl:disjointWith
owl:distinctMembers
owl:equivalentClass
owl:equivalentProperty
owl:FunctionalProperty
owl:hasValue
owl:imports
owl:incompatibleWith

Sprachelemente
in OWL DL
u.OWL Full

Anmerkung:
OWL Lite ohne:
owl:one of,
owl:unionOf,
owl:complementOf,
owl:hasValue, owl:disjointWith,
owl:DataRange

owl:intersectionOf
owl:InverseFunctionalProperty
owl:inverseOf
owl:maxCardinality
owl:minCardinality
owl:Nothing
owl:ObjectProperty
owl:oneOf
owl:onProperty
owl:Ontology
owl:OntologyProperty
owl:priorVersion
owl:Restriction
owl:sameAs
owl:someValuesFrom
owl:SymmetricProperty
owl:Thing
owl:TransitiveProperty
owl:unionOf
owl:versionInfo

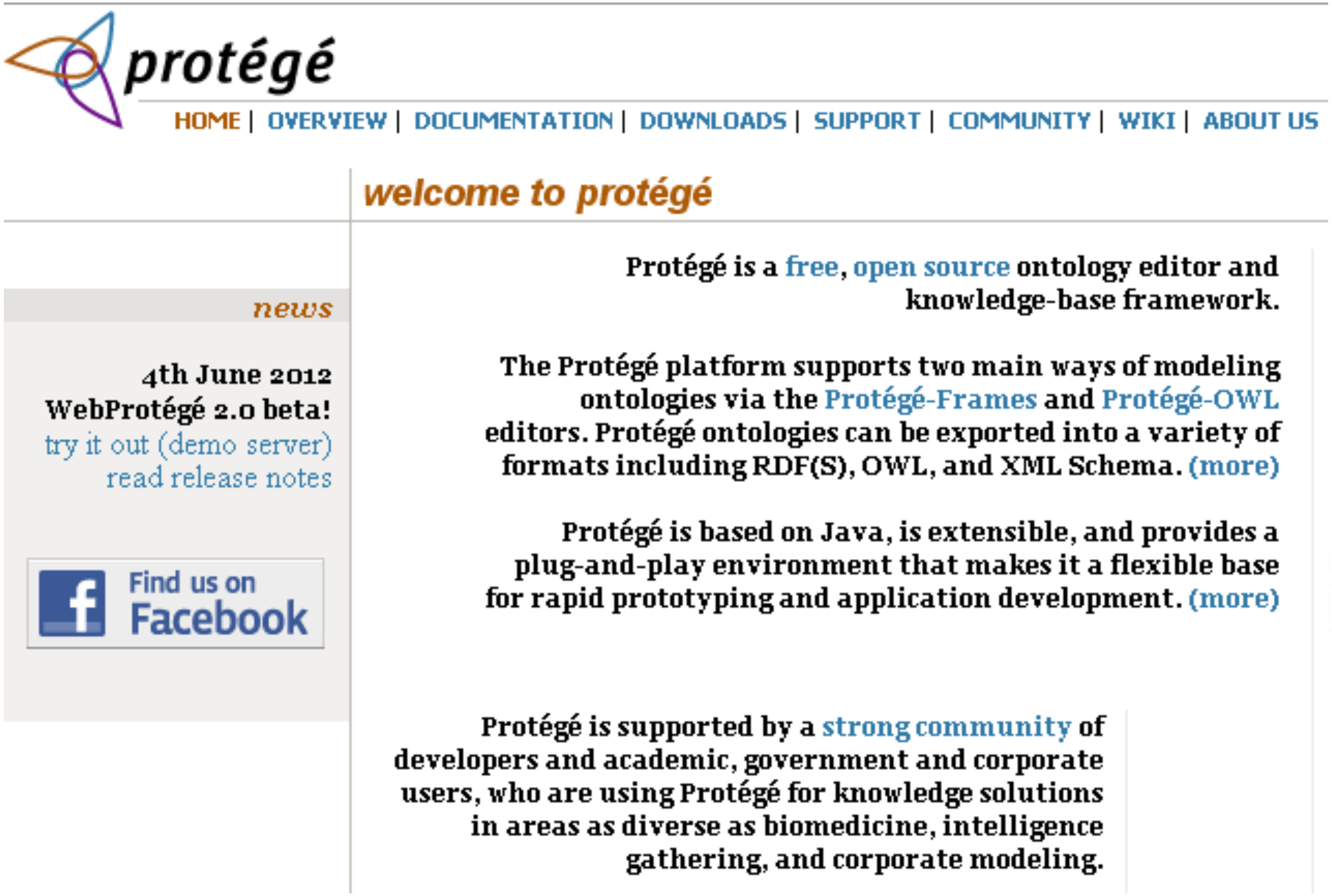
OWL Beispiel

```
<owl:Class rdf:ID="LandLockedCountry">
  <owl:equivalentClass>
    <owl:Class>
      <owl:intersectionOf rdf:parseType="Collection">
        <owl:Class rdf:ID="Country"/>
        <owl:Restriction>
          <owl:onProperty>
            <owl:ObjectProperty rdf:ID="hasBorderWith"/>
          </owl:onProperty>
          <owl:allValuesFrom>
            <owl:Class>
              <owl:complementOf rdf:resource="#Sea"/>
            </owl:Class>
          </owl:allValuesFrom>
        </owl:Restriction>
      </owl:intersectionOf>
    </owl:Class>
  </owl:equivalentClass>
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2002/07/owl#Thing"/>
</owl:Class>
```

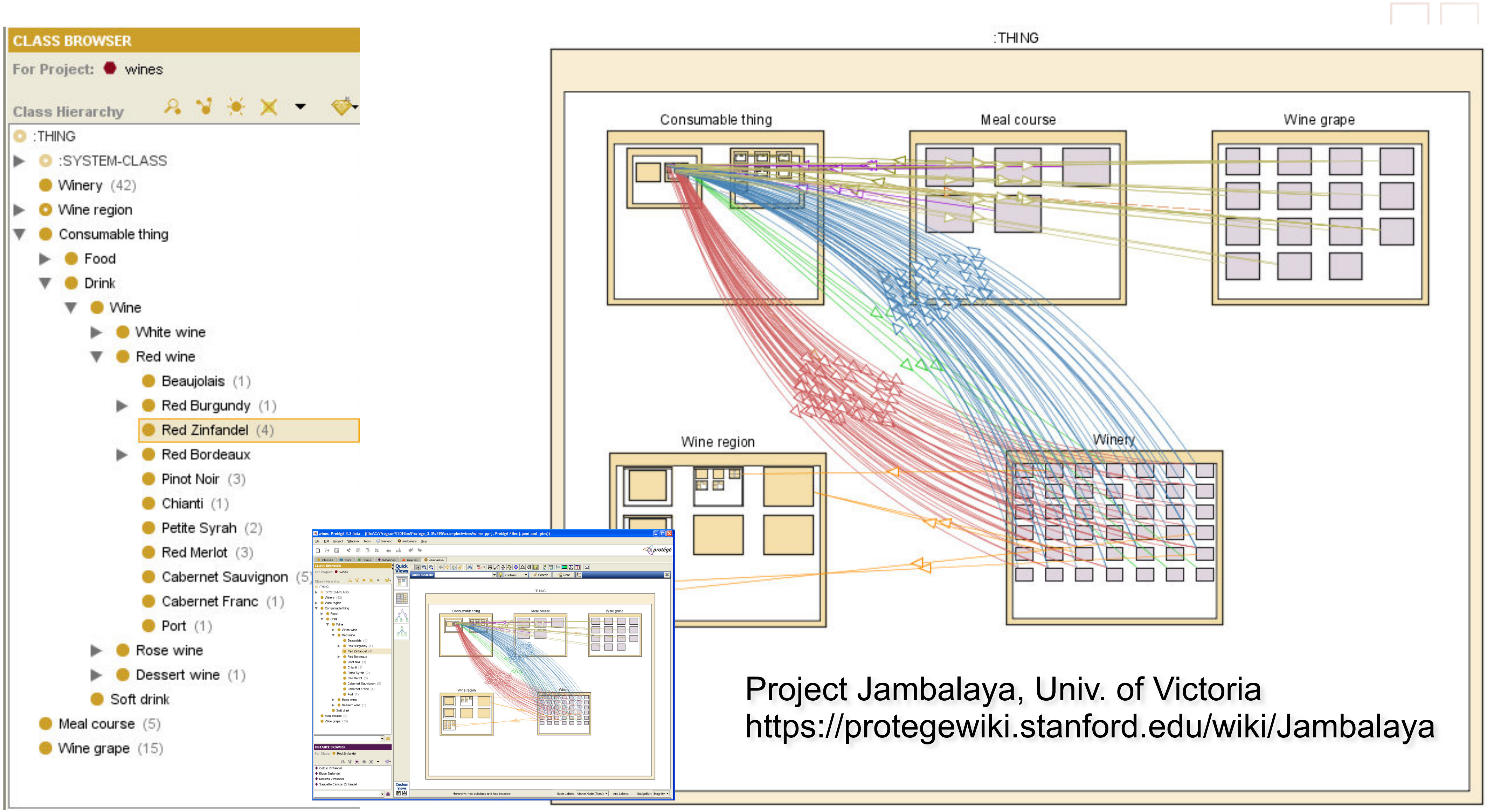
Vorgangsweise beim Design

1. Lege Ziel der Ontologie fest
2. Lege fest, wie sie verwendet werden soll. Was sind die typischen Abfragen?
3. Skizze mit den wichtigsten Konzepten und Relationen
4. Liste aller Konzepte im Detail
5. Finalisiere die Ontologie-Struktur mit einem OWL-Editor (z.B. Protegé; siehe nächste Seite)
6. Instanziiere mit individuellen Realisierungen

Ontologie-Editor: protegé

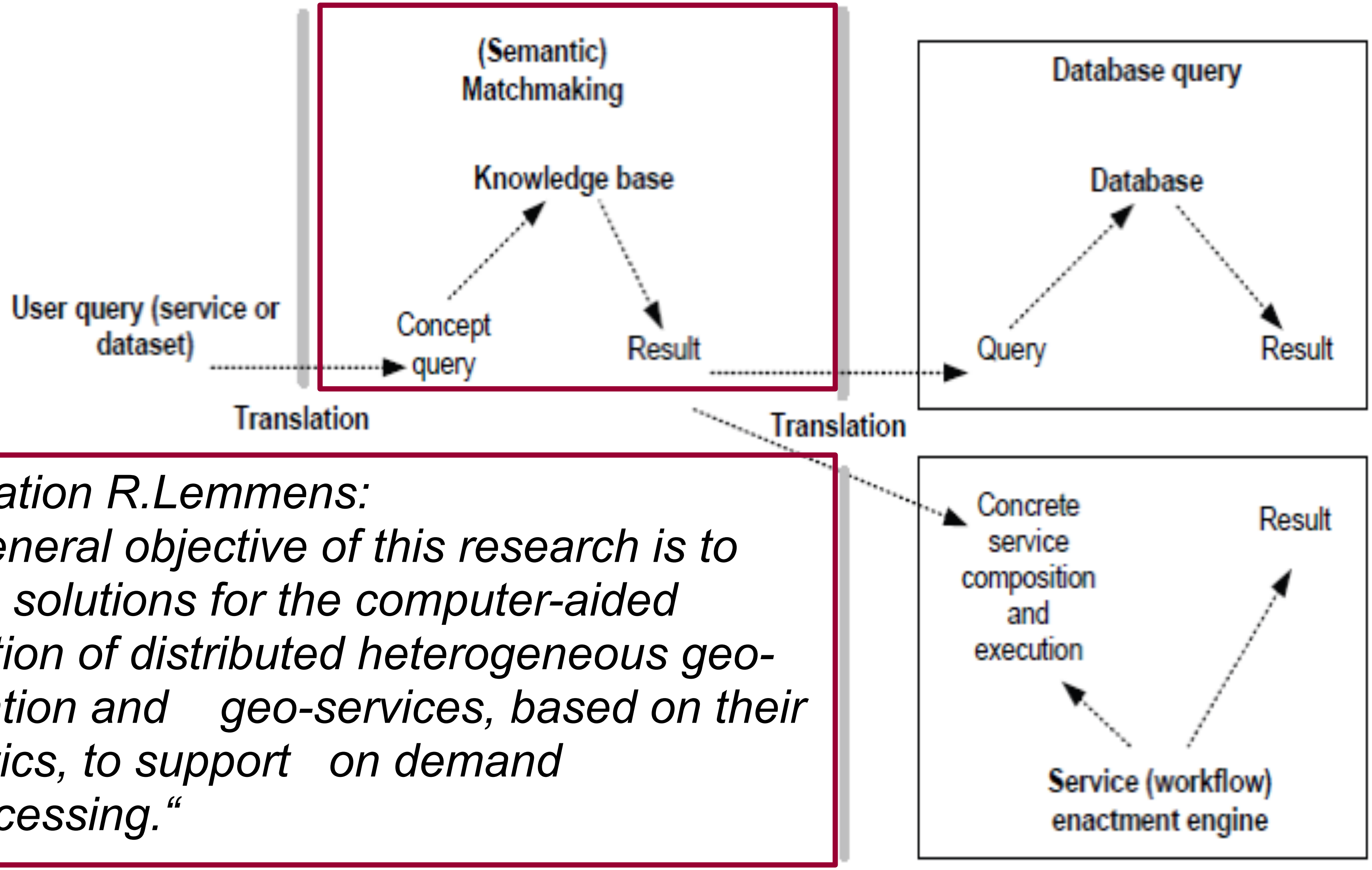


https://protege.stanford.edu/



Project Jambalaya, Univ. of Victoria
https://protegewiki.stanford.edu/wiki/Jambalaya

Wissensbasis, Datenbank, Services



Dissertation R.Lemmens:
„The general objective of this research is to provide solutions for the computer-aided integration of distributed heterogeneous geo-information and geo-services, based on their semantics, to support on demand geoprocessing."

NoSQL-Datenbanken

The acronym NoSQL („Not Only“ SQL) was coined in 1998.
Both technologies can coexist and each has ist place.
The NoSQL movement has been in the news in the past few years as many of the Web 2.0 leaders have adopted a NoSQL technology.

Companies like Facebook, Twitter, Digg, Amazon, LinkedIn and Google all use NoSQL in one way or another.
NoSQL emerged from a need:

- Data volume (Exabytes!),
- Interconnections (e.g. Social Networks),
- Data complexity

„Scaling out“ instead of „scaling up“!

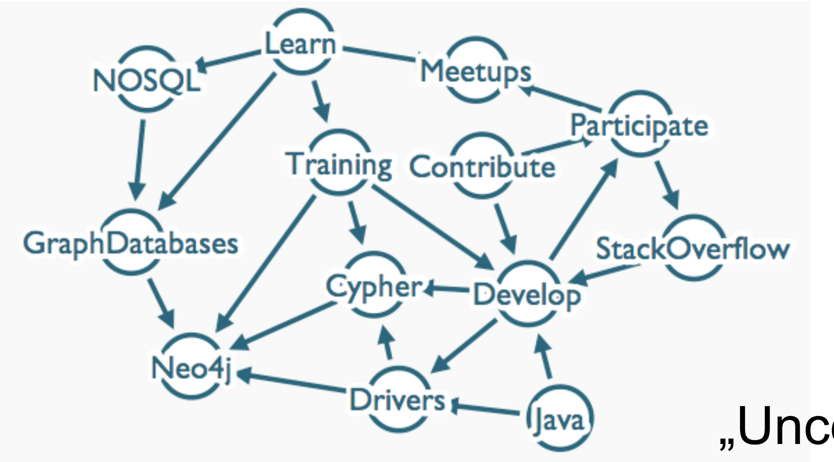
Ein Beispiel von vielen:
https://www.ibm.com/de-de/topics/nosql-databases

NoSQL-Datenbanken

4 categories:

Key-values stores (e.g. Dynamo / Amazon or Cassandra / Facebook)
Column family stores (e.g. BigTable / Google)
Document stores (Couch DB, Mongo DB, both OpenSource)
Graph databases (Neo4J, Open Source)

Querying NoSQL:
Restful
or Query APIs
or SPARQL



„Uncover hidden relationships"
https://neo4j.com

NoSQL-Datenbanken

ACID
Atomic: All operations in a transaction succeed or each operation is rolled back

Consistent: On transaction completion, the DB is structurally sound

Isolated: Transactions do not contend with one another; access to state is moderated by the DB so that transactions appear to run sequentially.

Durable: The results of applying a trans-action are permanent, even in the presence of failures.

vs. BASE:
Basic Availability: The store appears to work most of the time.

Soft-state: Stores don't have to be write-consistent, nor do different replicas have to be mutually consistent all the time.

Eventual consistency: Stores exhibit consistency at some later point (e.g. lazily at read time).

www.neo4j.org/

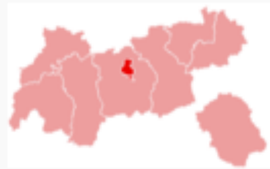
DBPedia

Extracts various kinds of structured info from Wikipedia and combines this into a huge, cross-domain knowledge base

DBpedia uses RDF and SPARQL

```
{{Infobox Town AT |
  name = Innsbruck |
  image_coa = InnsbruckWappen.png |
  image_map = Karte-tirol-I.png |
  state = [[Tyrol]] |
  regbzk = [[Statutory city]] |
  population = 117,342 |
  population_as_of = 2006 |
  pop_dens = 1,119 |
  area = 104.91 |
  elevation = 574 |
  lat_deg = 47 |
  lat_min = 16 |
  lat_hem = N |
  lon_deg = 11 |
  lon_min = 23 |
  lon_hem = E |
  postal_code = 6010-6080 |
  area_code = 0512 |
  licence = I |
  mayor = Hilde Zach |
  website = [http://innsbruck.at] |
}}
```

Innsbruck



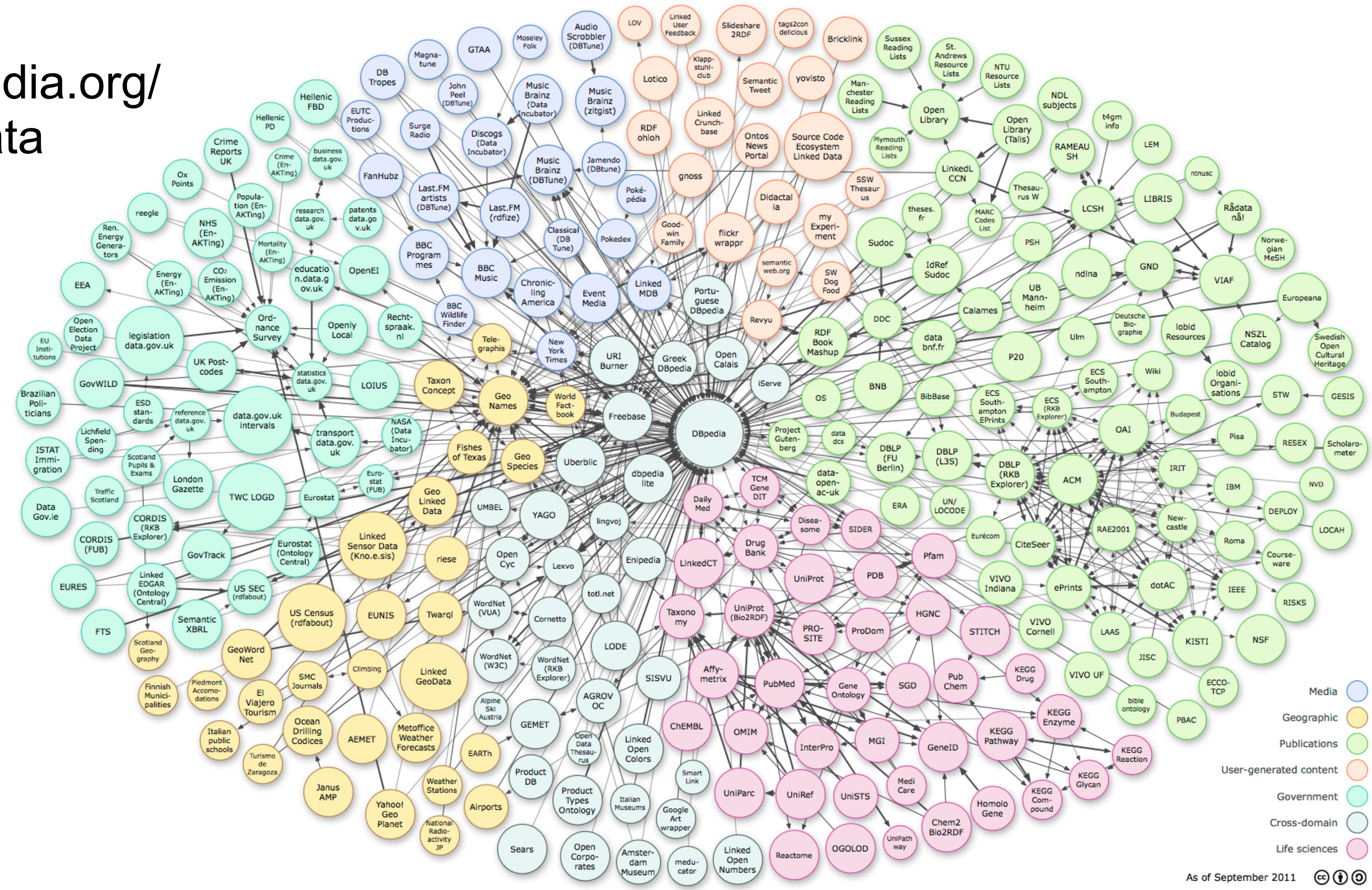
Country	Austria
State	Tyrol
Administrative region	Statutory city
Population	117,342 (2006)
Area	104.91 km²
Population density	1,119 /km²
Elevation	574 m
Coordinates	47°16' N 11°23' E
Postal code	6010-6080
Area code	0512
Licence plate code	I
Mayor	Hilde Zach
Website	www.innsbruck.at

Global and Unified Access to Knowledge Graphs
http://wiki.dbpedia.org/Datasets

Method of exposing, sharing, and connecting data via URIs

http://en.wikipedia.org/wiki/Linked_Data

Data:
DBPedia
GeoNames
SensorPedia
Social Networks (FOAF friends of other friends)
etc.



Vom WWW zum GGG

Giant Global Graph' (GGG) was notably used the first time 2007 by the inventor of the World Wide Web, Tim Berners-Lee.

It may be described as the content and links of the WWW transitioning to **content and links plus relationships plus descriptions**.

It merges social networks with Semantic Web technology so it goes beyond having a friends list. The social graph is based on who you are connected to based on things such as interests, location and work. The internet links computers, the WWW links documents, and the GGG expresses relationships among people or documents in a way that lends itself to reuse of that data. (Wikipedia)

Linked Data Principles

1. According to Tim Berners-Lee, 2007:

- Use URIs to denote things,
- so that these things can be referred to and looked up by people and user agents
- Provide useful information about the thing when its URI, using RDF*, SPARQL
- Include links to other related things (by their URIs) when publishing data on the Web

2. According to Tim Berners-Lee, 2009:
- All kinds of conceptual things, they have names now that start with HTTP
- I get important information back in a standard format
- for somebody else, it might be useful data about that thing, about that event
- that information has got relationships. And when it has relationships, whenever it expresses a relationship then the other thing that it's related to is given one of those names that starts with HTTP.

http://en.wikipedia.org/wiki/Linked_Data

Erweiterungen notwendig wegen einiger wichtiger Charakteristika, die GI von anderen IT-Domänen abheben: (nach Lemmens; Details auf folgenden Folien)

1. GI should exhibit spatial relationships between features.

2. GI is multi-dimensional. The integrated spatio-temporal and thematic aspects of geo-information contribute to its importance in a wide variety of application domains.

3. GI is characterised by multiple-representations.

4. Geo-services often depend on tightly-coupled geodata.

GI is meant to exhibit spatial relationships between features:

These relationships are used for spatial analysis in GIS by computations on topology and metrics of geometries.

Currently, ontology languages such as OWL do not contain specific constructs that model spatial relationships.

As a workaround, common practice is to specify roles with a spatial connotation, such as 'Touch', 'Overlap' and 'North'.

Another alternative is to outsource the spatial analysis to conventional computational solutions.

Semantische Modellierung im GIS-Umfeld

Multi-dimensional:
Beim / Am / Im Schloßberg

Quellen: Wikimedia commons, Kultur-server.graz.at

Zeitbezogene Beispiele:
„Stau Glacisstraße“ wochentags / sonntags / vormittags / nachts
„Freizeitaktivitäten Planai“ Sommer / Winter
...

GI is characterised by multiple representations:

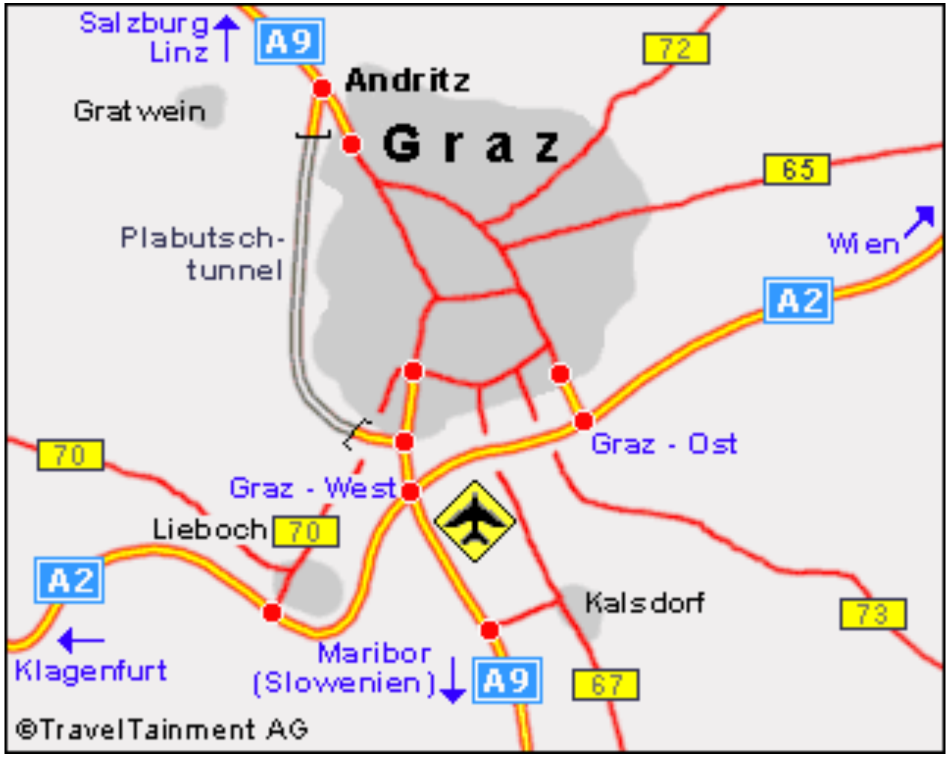
Typical for GI (and geo-services) is that it is very common for a geographic phenomenon to take many different feature representations in multiple or even a single geodata set.

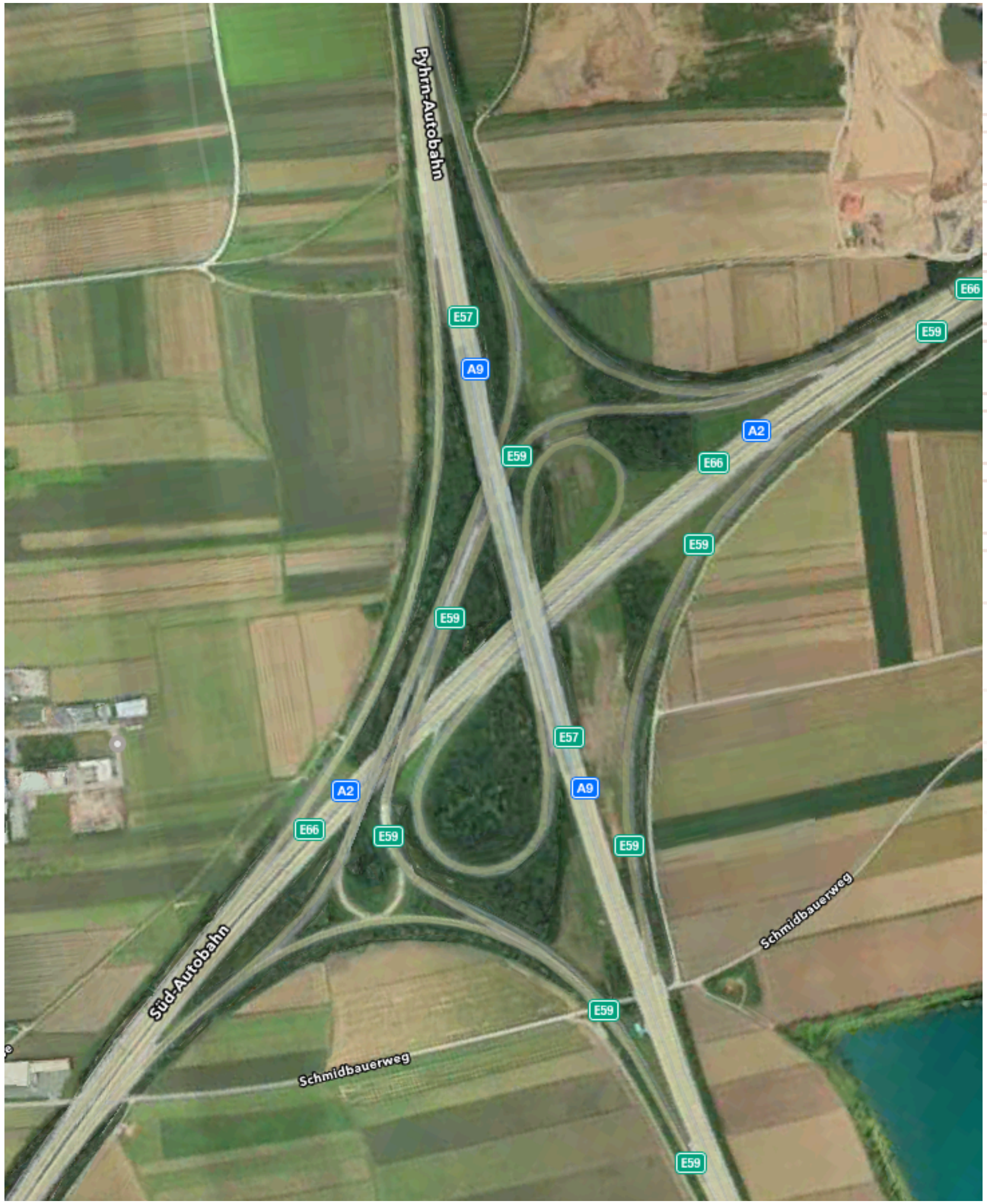
Representations may differ in terms of spatial, temporal and thematic attributes. Such attributes may vary also along different levels of generalisation and aggregation.

Reasoning about geo-services has to take into account these aspects, specifically with respect to the meaning of its input and output parameters.

Multiple Representations:

Graz-West Übersicht / Detail





Geo-services often depend on tightly-coupled geodata:

Tight coupling:

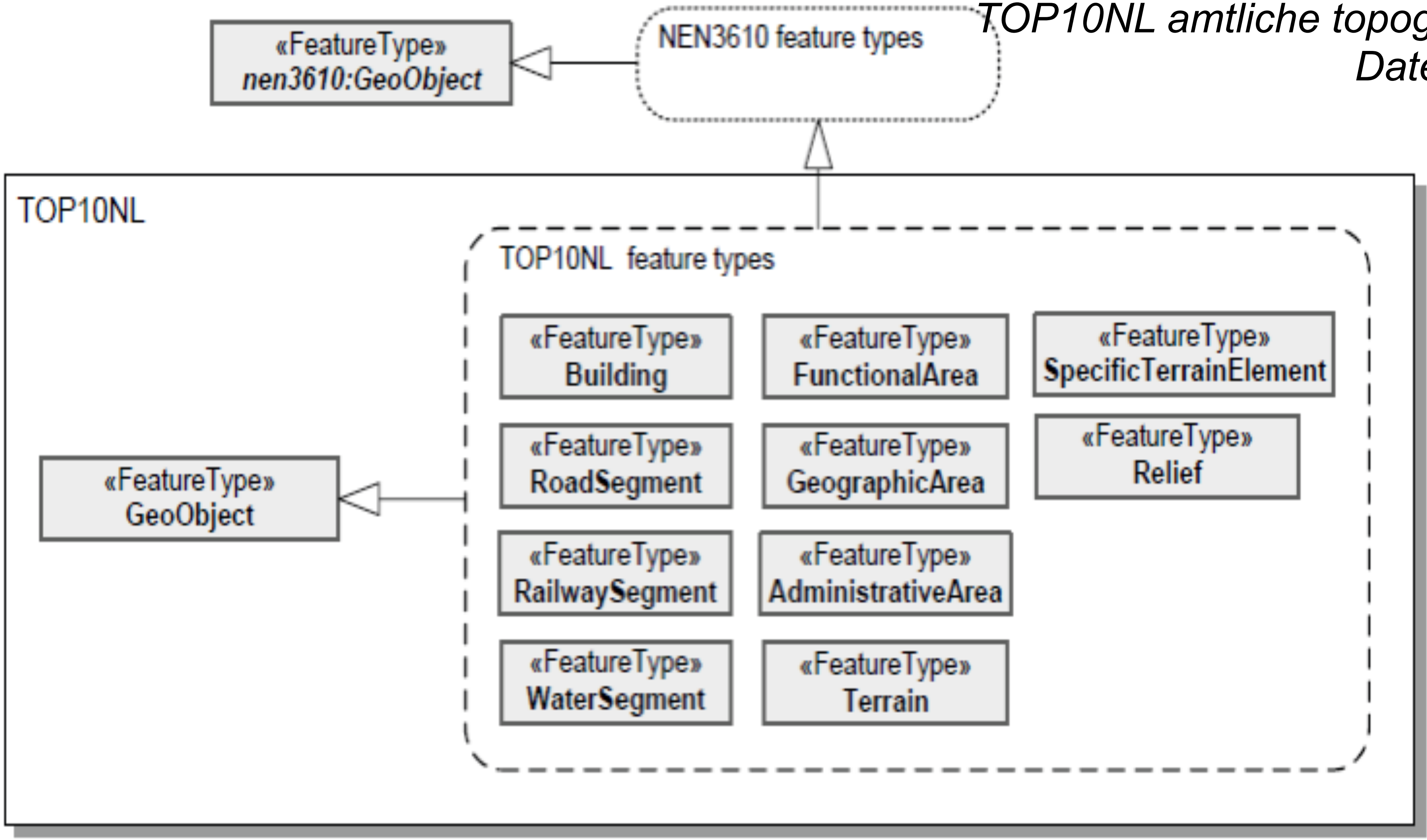
- Jedes Element hängt von „vielen" anderen Elementen ab („viele" ist umgebungsabhängig zu interpretieren)
- Elementeigenschaften nur im Zusammenhang verständlich
- Änderung eines Elements nicht unabh. von Umgebung

Beispiele:

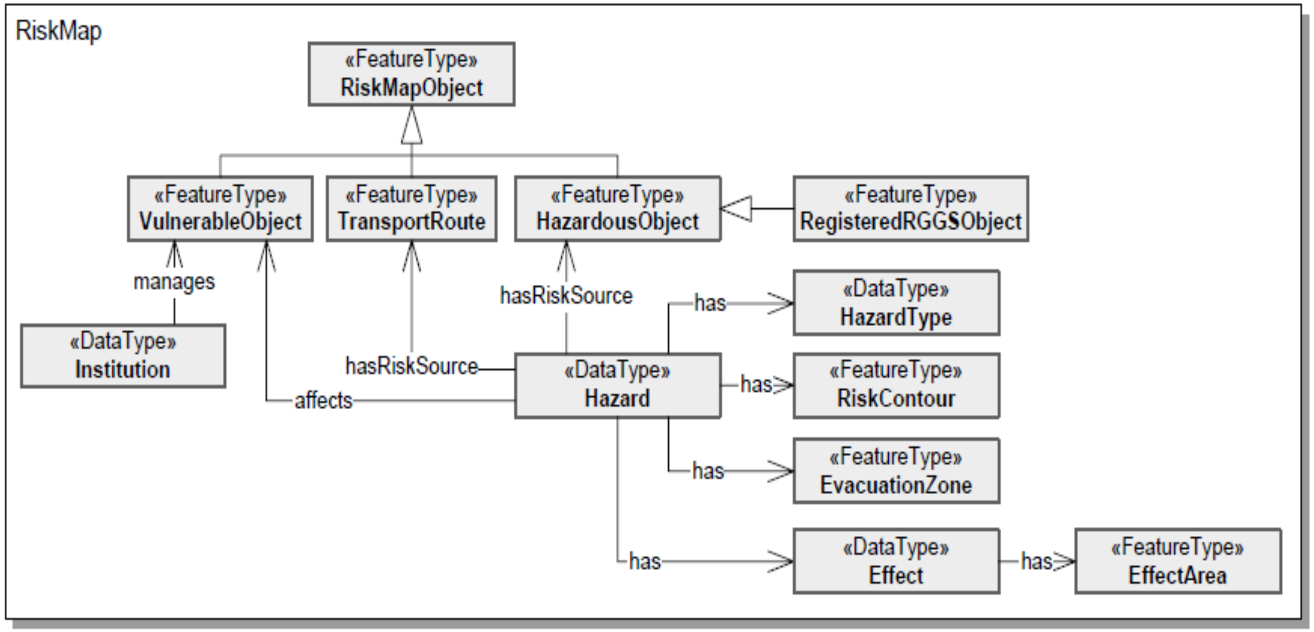
- Katasterdaten
- Daten, in denen Topologie eine große Rolle spielt
- DLM des BEV mit Straßenachsen (eng mit einem möglichen Service einer Routenplanung verbunden)

Use Cases

TOP10NL amtliche topograph. Daten NL

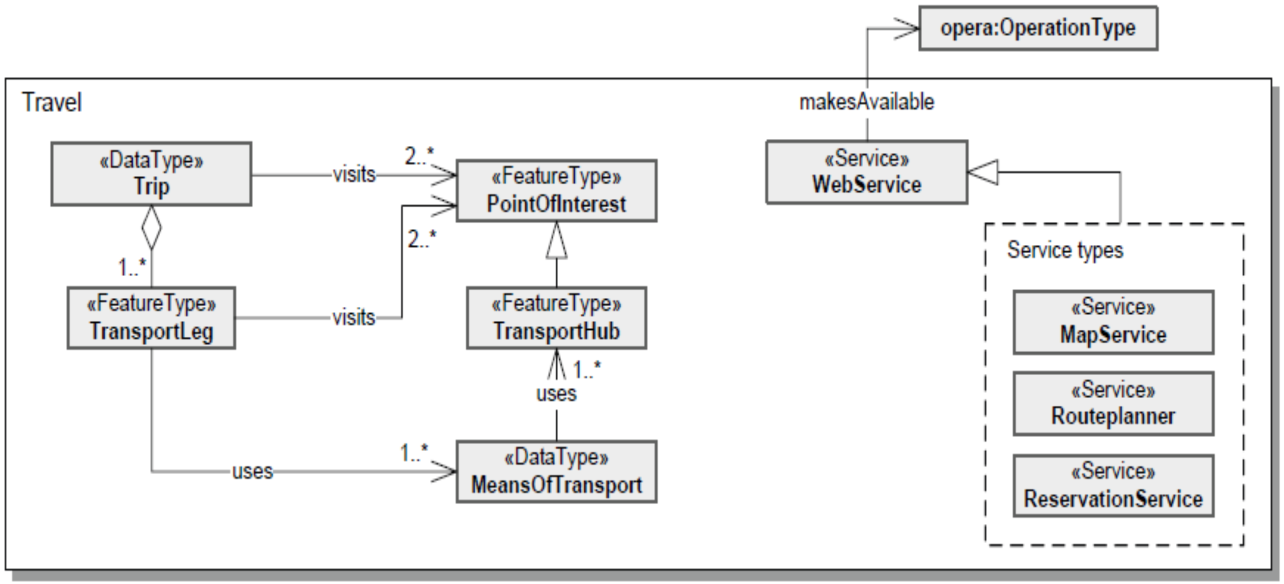


Use Cases

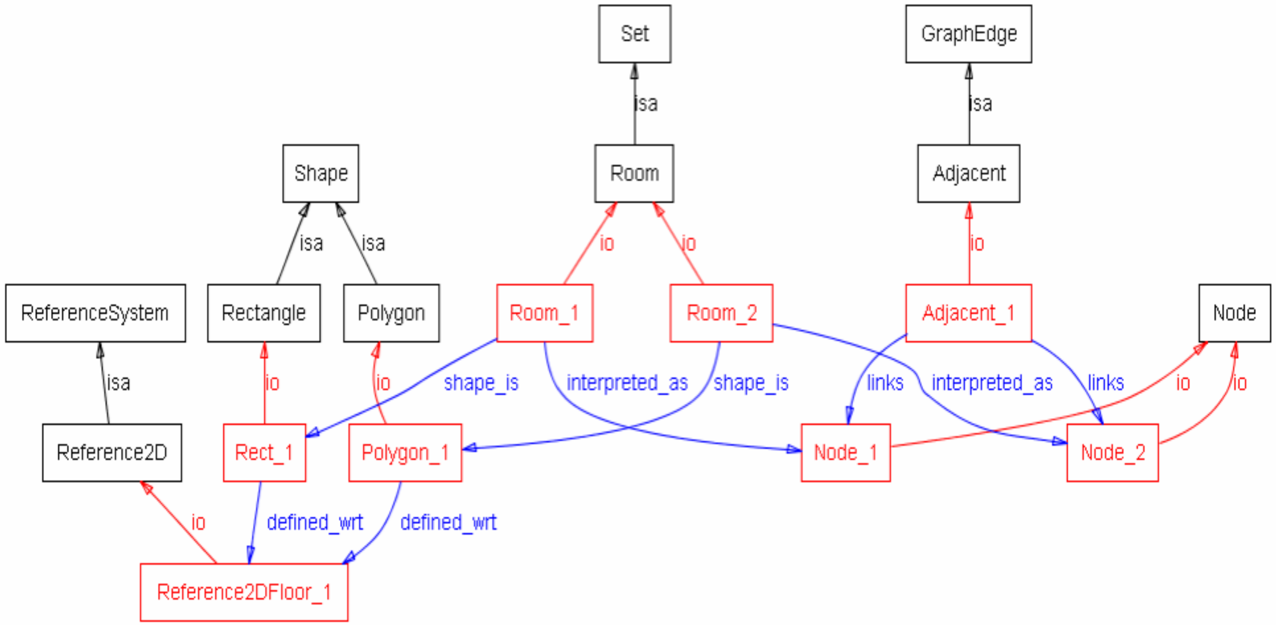


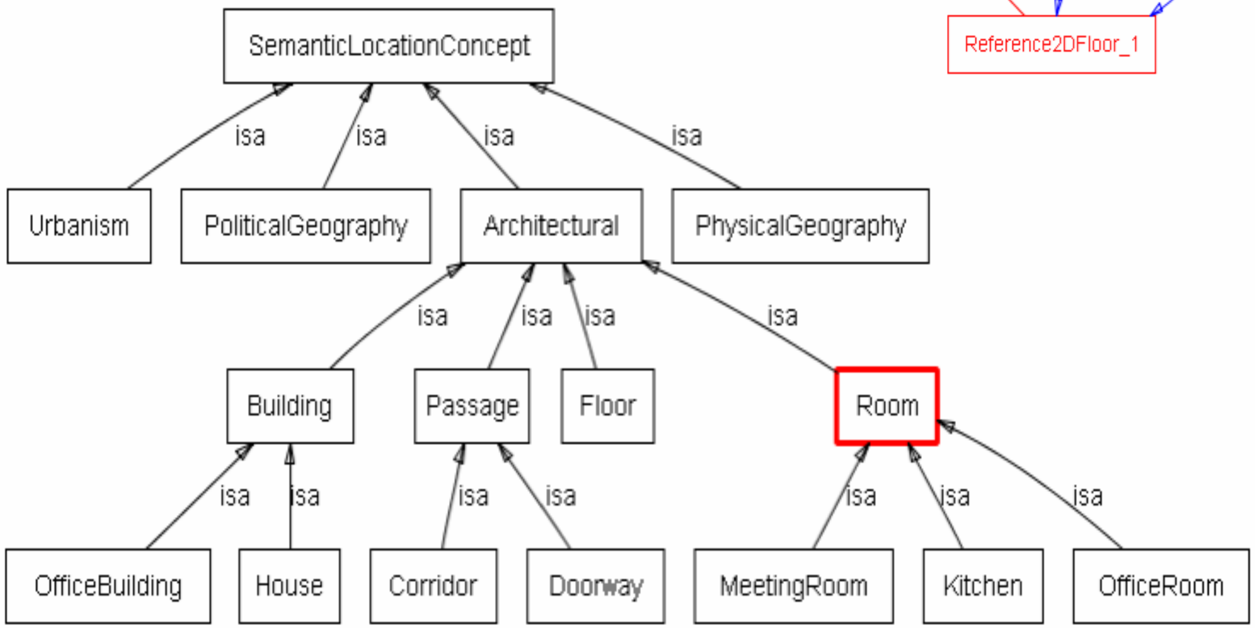
RiskMap

Travel



Use Cases





Quelle:
T.Flury, G.Privat, F. Ramparany:
WL-based location ontology for
context-aware services
France Telecom, R&D Division

Beziehungen zw. Use Cases

Einfach: Äquivalenzen

$$riskmap{:}Hotel \equiv nen3610{:}Hotel$$

$$riskmap{:}Nuclear \equiv top10nl{:}NuclearReactor$$

Kompliziert:
Road
In Riskmap
Unterklassen von
Road

in TOP10NL sind
es unter-
schiedliche
Attributwerte

$$riskmap{:}Highway \equiv \exists\ symbol{:}hasThematicAttributeType.top10nl{:}Highway$$

$$riskmap{:}ProvincialRoad \equiv$$
$$\exists\ symbol{:}hasThematicAttributeType.top10nl{:}RegionalRoad$$

$$M\_Top10\text{-}Riskmap\text{-}MainRoad \sqsubseteq riskmap{:}NationalRoad$$

$$M\_Top10\text{-}Riskmap\text{-}MainRoad \equiv$$
$$\exists\ symbol{:}hasThematicAttributeType.top10nl{:}MainRoad$$

Schlussfolgerungen (R.Lemmens)

- Shift from bi-lateral to multi-lateral contracting
- However, contracts are often only loosely defined at the semantic level by referring informally to the concepts used -> Semantic heterogeneity, need for self-descriptiveness
- Interoperability at all levels (syntactic, structural, semantic)!
- Making services semantically interoperable is an important prerequisite for info sharing in today's networked society
- This can be approached by formalising contracts and by making them machine accessible

Schlussfolgerungen (R.Lemmens)

What are the key problems in making geo-services interoperable and what solutions are currently available?

- Heterogeneity
- Informality of Contracts
- Incomplete Realisation of Contracts
- Incomplete Description of Contracts
- Incompleteness and incompatibility of semantic models