Karlsruhe Institute of Technology

AIFB

KOIOS: Intuitive Access, Analysis, and Visualization of Structured Environmental Information

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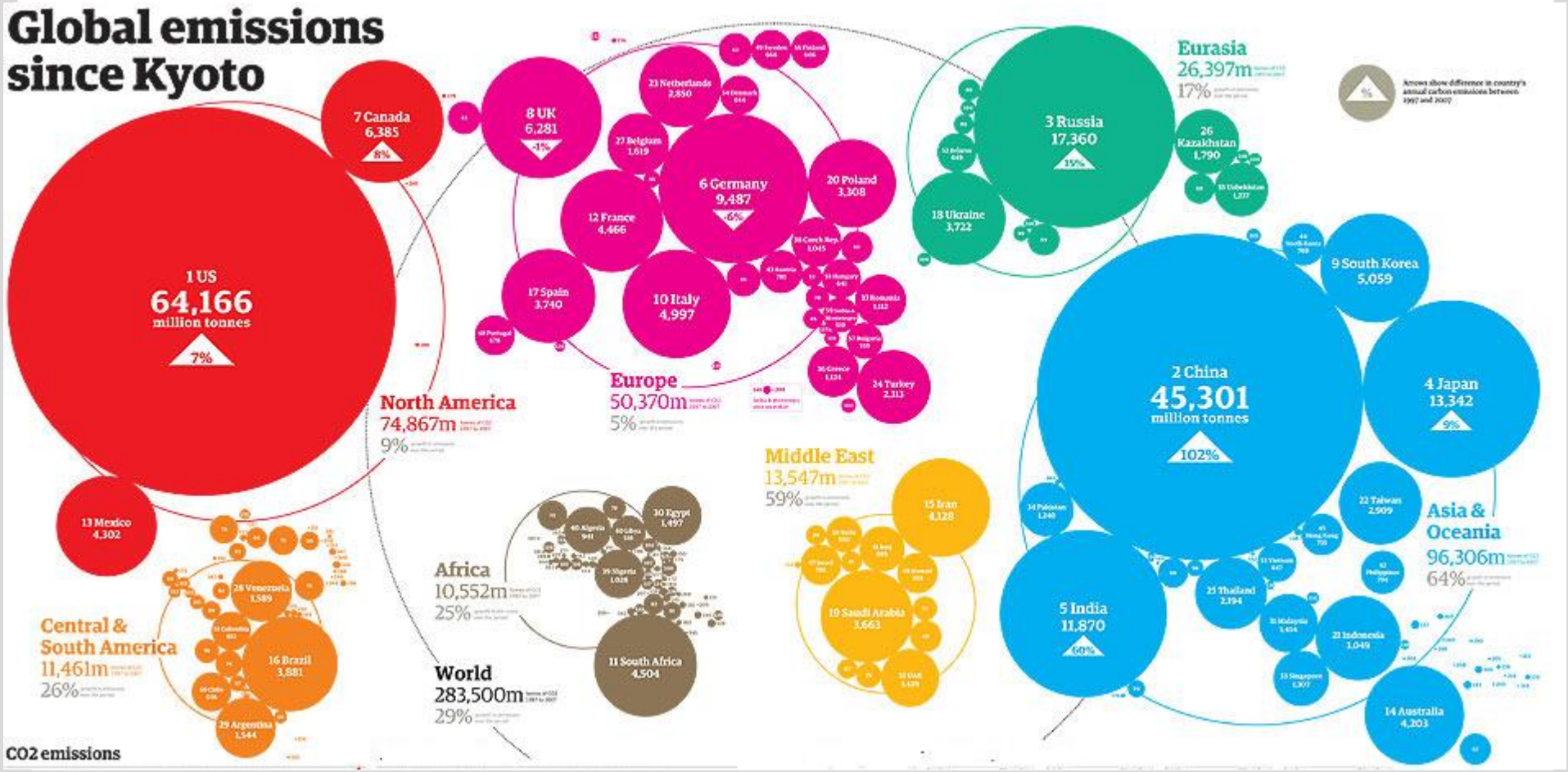
Institute of Applied Informatics and Formal Description Methods (AIFB)

Large amount of environmental data

- Environmental issues stir public interests
- Growing amount of data
  - Public access through EU directive 2003/4/EC
  - PortalU (Germany) http://www.portalu.de/
  - EDP (UK) http://www.edp.nerc.ac.uk
  - Envirofacts (USA) http://www.epa.gov/enviro/index.html
- Linking data in international context
  - Local government databases of environmental part of LOD cloud
  - Linked environment data for the life sciences

Opportunity: mass **dissemination** and consumption of environmental data

- Increase transparency, awareness, responsibility, protection



Opportunity: mass dissemination and **consumption** of environmental data

- Complex results
  - CO emission values around Karlsruhe area in Germany
- Analytics
  - CO emission values around Karlsruhe area in Germany
    - **Sorted by year**
    - **Bar chart**
  - Emission values of US and Germany
    - **Compare average**
    - **Timeline** visualization

Challenges: **intuitive access and visualization** of structured environmental data and analytics

- The percentage of people who actively find environmental information is significantly lower than those who have those with frequent access to it!

- Complex structured queries
  - Knowledge of the underlying data / query language
- Complex structured data
  - Heterogeneity and distribution of environmental data is overwhelming
- Complex structured results
  - Understanding results and extracting relevant information / analytics are difficult tasks

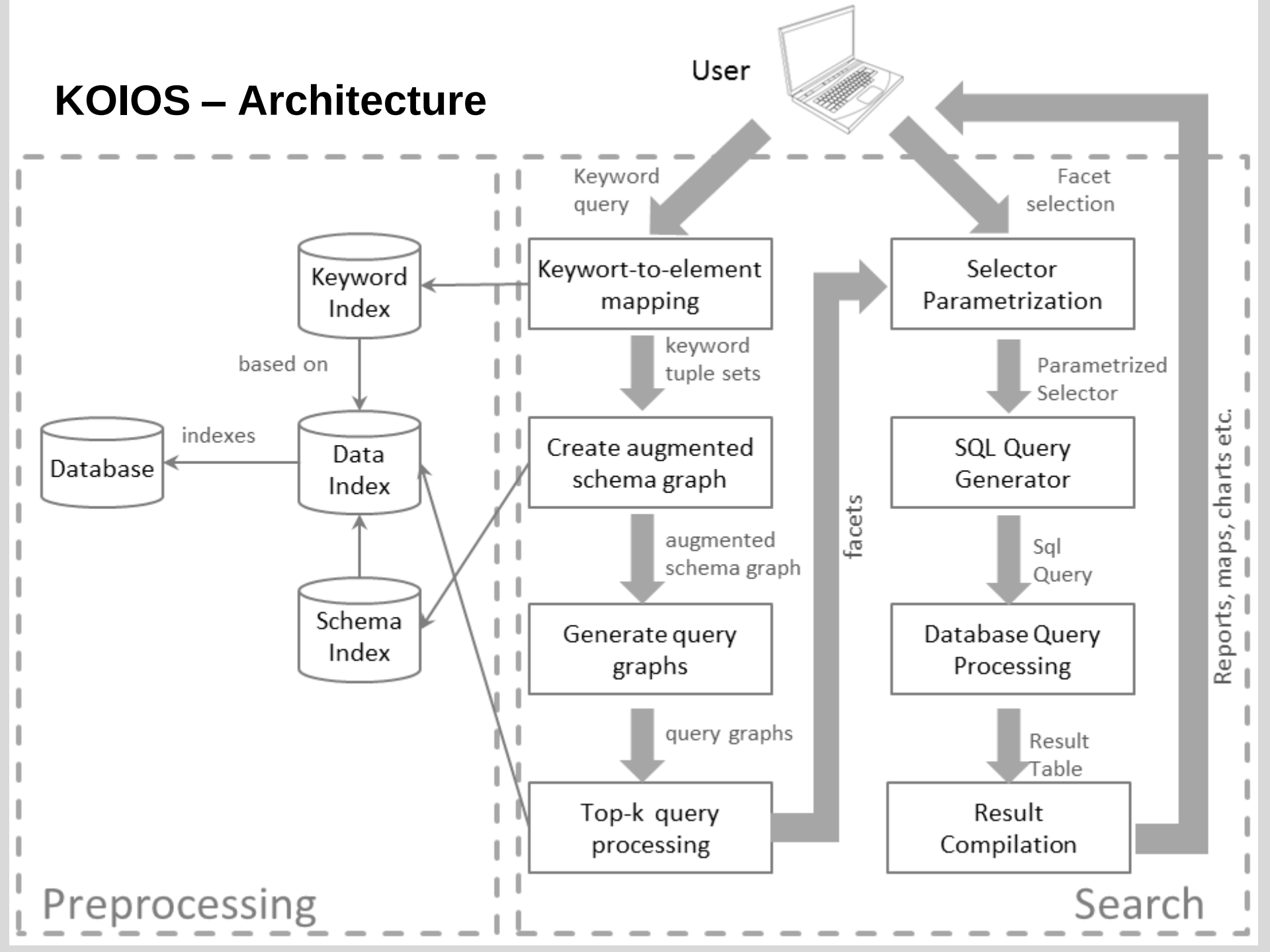
Agenda

- Semantic search system, KOIOS, for **intuitive access, analysis,** and **visualization** of structured environmental information
  - Overview and architecture
  - Structured query generation from keywords
  - Facet-based browsing and refinement
  - Selector initialization for final result and view construction
  - Implementation and deployment
  - Conclusions

KOIOS – Overview

- A semantic search system
  - Exploit semantics in the data for keywords interpretation to hide complexity of query languages and data representation
  - Keyword search for searching structured data
  - Lower access barriers while enabling richness of data to be fully harnessed
- Contribution
  - Transfer research results to commercial EIS
  - Selector mechanism
- Process
  - Input: keywords
  - Facet-based refinement
  - Selector (result and view template) initialization
  - Output: query results embedded in specific views

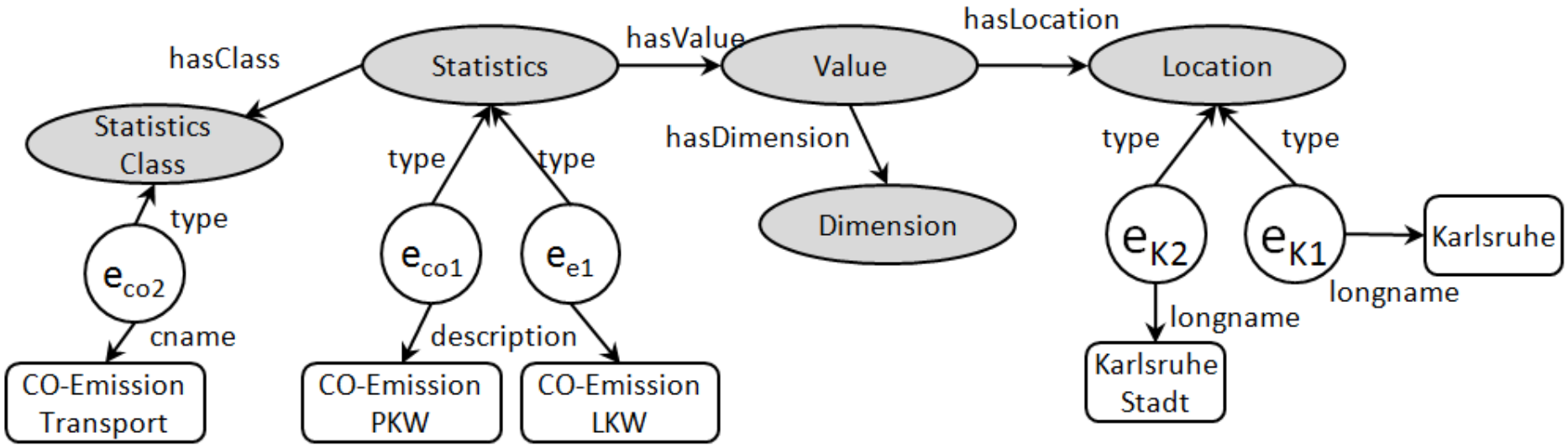
KOIOS – Architecture



Query exploration

- Retrieve data elements for keywords from index
- Constructing **query space** from keyword elements + schema
- Top-k **query exploration**
  - Subgraphs connecting keyword elements:
  - Query interpretations: keyword elements + schema information

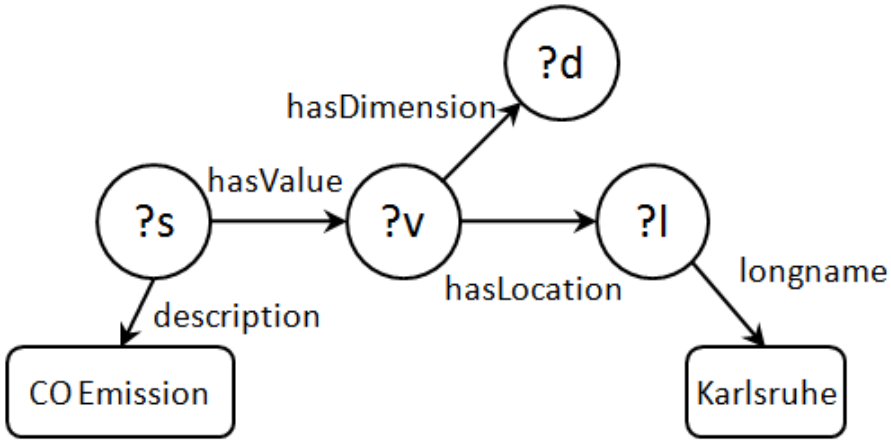
“Karlsruhe Co Emission”



Query translation and processing

- Query interpretations mapped to a query graph
- Query graph written as queries in a particular language (SPARQL, SQL)
- Retrieve answers for automatically chosen top-k queries (alternative: manual selection)

“Karlsruhe Co Emission”



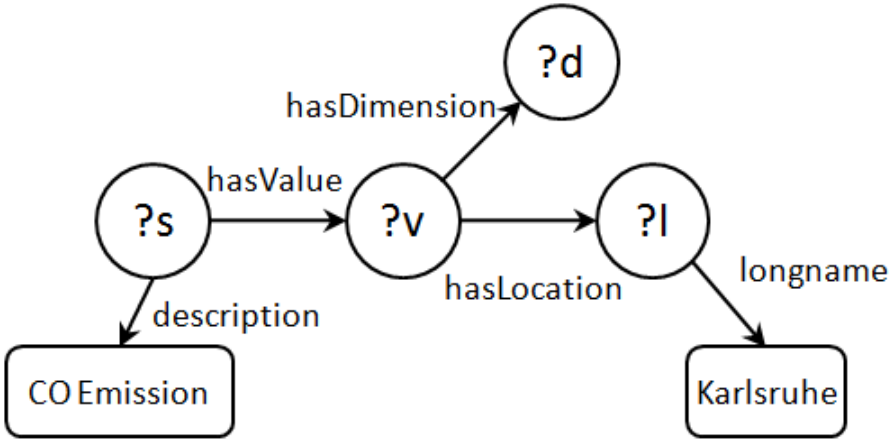
(a) Query Graph

```
Select ?s,?v,?d,?l
WHERE {
  ?s ns:description “CO Emission” .
  ?s ns:hasValue ?v .
  ?v ns:hasDimension ?d .
  ?v ns:hasLocation ?l .
  ?l ns:longname “Karlsruhe”
}
```

(b) SPARQL Query

Facets generation

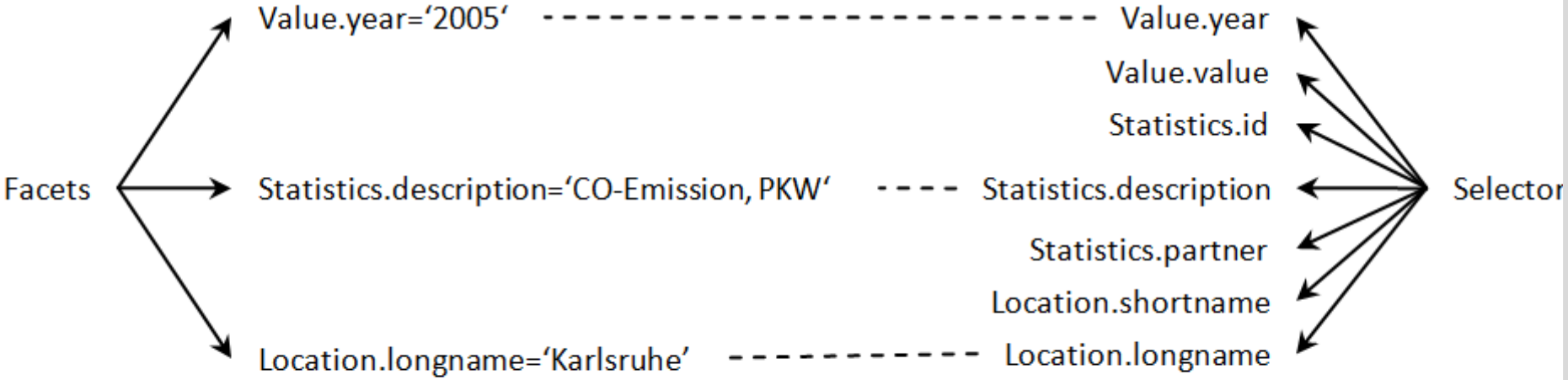
- Derive facets from query results (not from query!) for refinement
  - Attributes serve as **facet categories**
  - Attribute values as **facet values**
- E.g. for ?s
  - Statistics.description: “CO-Emission , PKW”, “CO-Emission , LKW”…
  - Value.year: 2005,2006,…



(a) Query Graph

Selectors

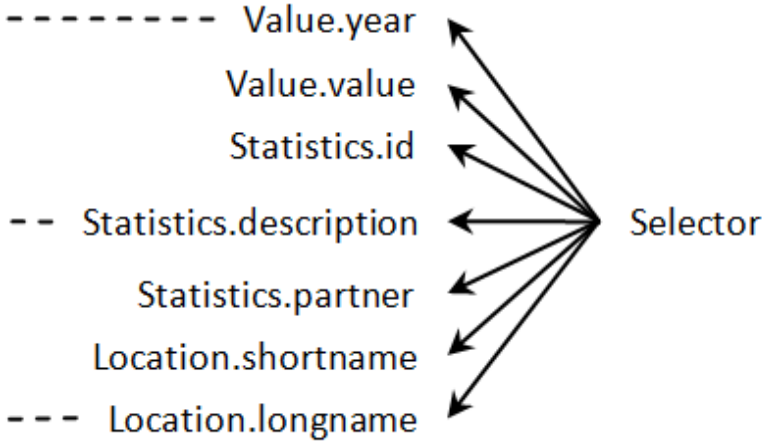
- Selector: parameterized, predefined result and view templates
  - Data parameters: specify scope of information need, initialized to a particular values based on facet categories and values
  - Query parameter: additional data processing for analysis tasks (GROUP-BY, SORT, MIN, MAX, AVERAGE etc.)
  - Presentation parameter: visualization types (data value, data series, data table, map-based, specific diagram type, etc.)



(a) Facet-Selector Mapping

Selector initialization

- Selectors capture templates for information needs and presentation of their results
- Map facets to selectors and initialize them
  - Applicable selectors: cover facet categories
  - Initialize selectors based on facet values
  - Initialized values are captured in the WHERE clause
  - **Non-initialized parameters** are included in the **SELECT** clause




```
Select v.value,s.id,s.partner,l.shortname
FROM Statistics s, Value v, Location l
WHERE v.year='2005'
and s.description='CO-Emission, PKW'
and l.longname='Karlsruhe'
```

Implementation

- Open-source indexes implemented on top of Lucene
  - Keyword lookup
  - Schema retrieval
  - Top-k query graphs processing (graph pattern matching)
- Open-source semantic search modules implemented in Java
  - Query translation
  - Facets generation
  - Selector initialization
- Integration with commercial EIS (Cadenza)
  - Management of selectors
  - Retrieval of final results
  - Result presentation and visualization

Deployment

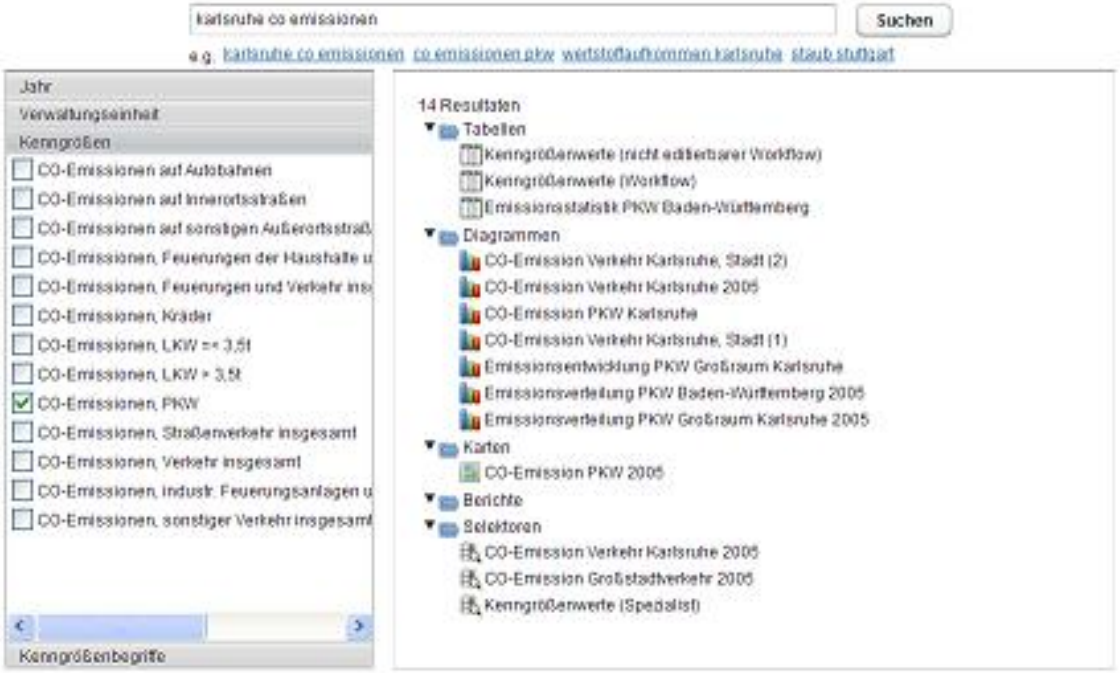
- Hippolytos project (Theseus)
  - Easy access to spatial data warehouse (disy Cadenza) built for domain of environmental administration
- Data about
  - Emission and waste
  - From the Baden-Württemberg
  - Provided by: Umweltinformationssystem (UIS) Baden-Württemberg, Landesamt für Geoinformation und Landentwicklung (LGL) Baden-Württemberg and Statistisches Landesamt Baden-Württemberg

HIPPOLYTOS
Einfacher Zugang zu Umwelt- und Geodaten

Gefördert durch:
Bundesministerium für Wirtschaft und Technologie
aufgrund eines Beschlusses des Deutschen Bundestages

THESEUS
Neue Technologien für das Internet der Dienste

Facets and selectors



Die Daten für die Demonstration stammen vom Umweltinformationssystem (UIS) des Landes Baden-Württemberg, vom Landesamt für Geoinformation und Landentwicklung (LGL) Baden-Württemberg sowie vom Statistischen Landesamt Baden-Württemberg.

Chart-based visualization

HIPPOLYTOS

Abmelden Hilfe Über Hippolytos

Recherche | Diagramm | Karte | Tabelle | Semantische Suche

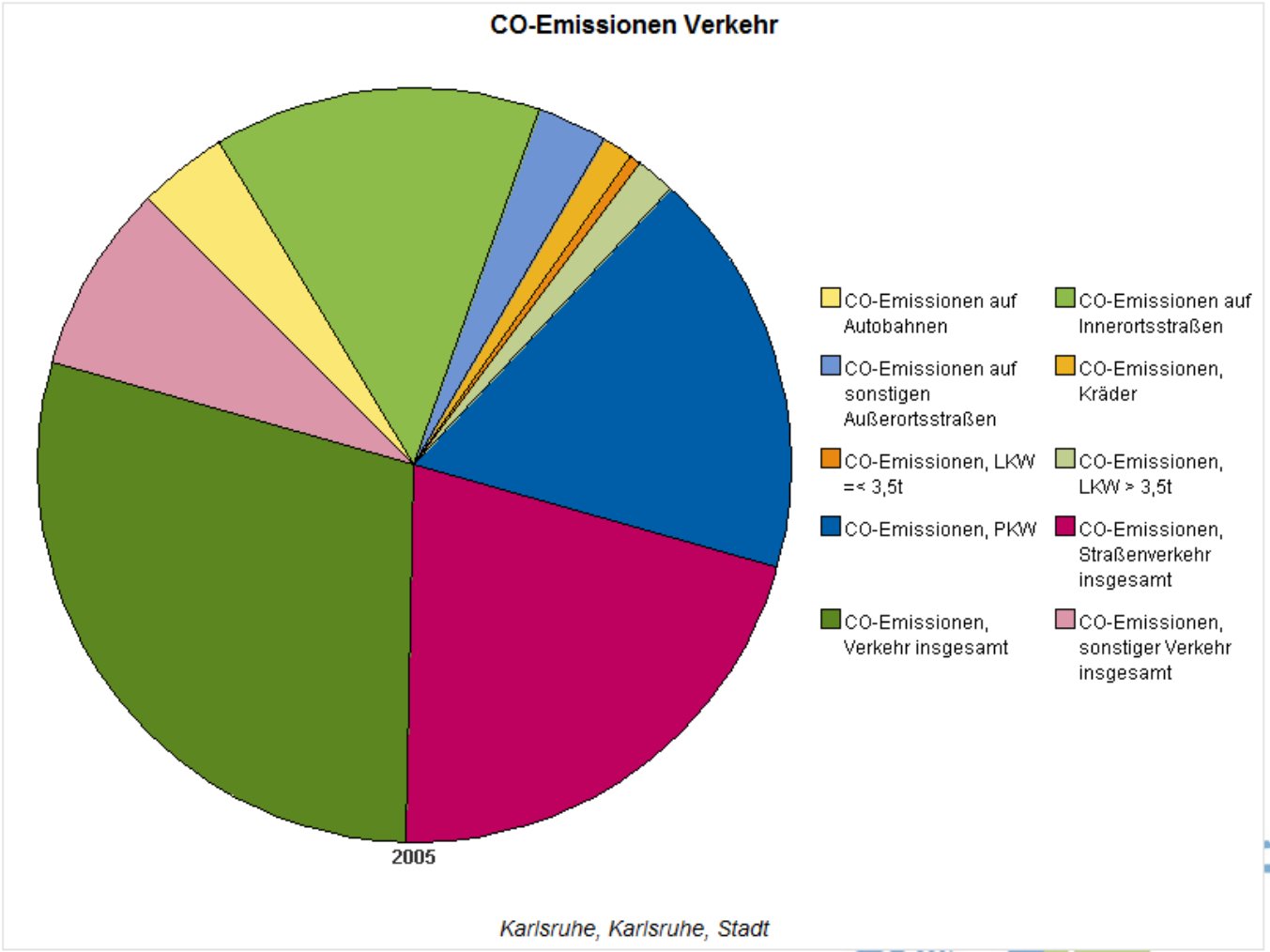
Navigator

Suche:

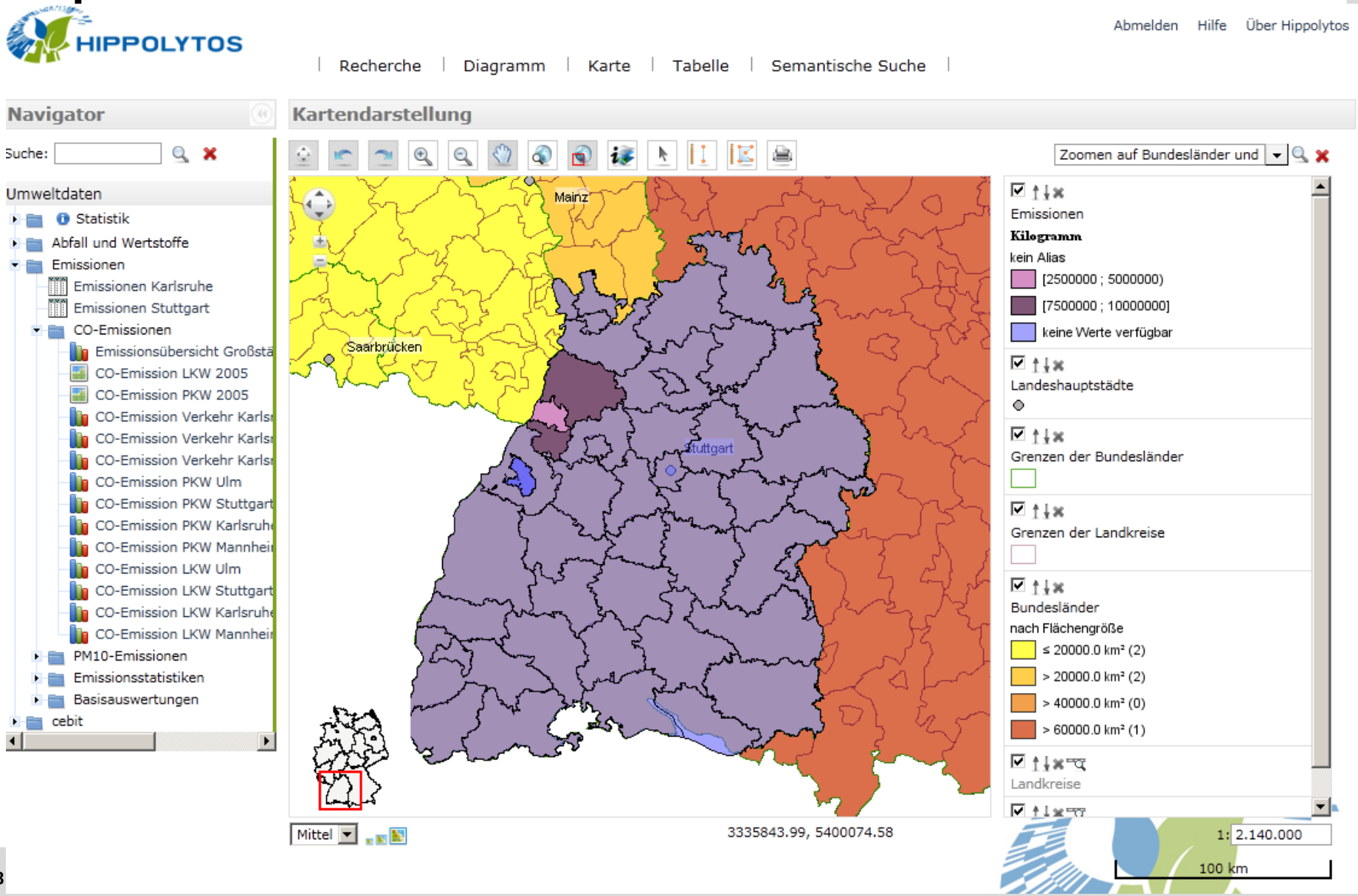
Umweltdaten
- Statistik
- Abfall und Wertstoffe
- Emissionen
  - Emissionen Karlsruhe
  - Emissionen Stuttgart
  - CO-Emissionen
    - Emissionsübersicht Groß
    - CO-Emission LKW 2005
    - CO-Emission PKW 2005
    - CO-Emission Verkehr Kat
    - CO-Emission Verkehr Kat
    - CO-Emission Verkehr Kat
    - CO-Emission PKW Ulm
    - CO-Emission PKW Stuttg
    - CO-Emission PKW Karlsru
    - CO-Emission PKW Mannh
    - CO-Emission LKW Ulm
    - CO-Emission LKW Stuttg
    - CO-Emission LKW Karlsru
    - CO-Emission LKW Mannh
  - PM10-Emissionen
  - Emissionsstatistiken
  - Basisauswertungen
- cebit
  - Emissionen
  - Wertstoffe
  - Emissionen Kartendarstellun
  - Wertstoffstatistik
  - Wertstoffe Diagramm
  - Wertstoffe - Kuchendiagram

Kenngrößenwerte (Spezialist)

Weitere Ansichten...



Map-based visualization



Conclusions

- Replace predefined forms and hard-coded visualization
- Semantic search using lightweight semantics in data and schema to dynamically
  - Translate keywords to queries
  - Generate facets for results
  - Initialize result and presentation templates
- Enables intuitive
  - Access
  - Visualization
  - Analysis of environmental information!

Thanks!

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