Ontology-based Geographic Data Access in a Peer Data Management System

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Outline

- OBDA and PDMS
  - The SPEED System
- The easeGO Approach
- The easeGO Tool
- Experiments
- Conclusions and Future Work
Ontology-based Data Access (OBDA)

OBDA is the problem of accessing one or more data sources by means of a conceptual representation expressed in terms of an ontology.

- Goal: to facilitate access to data by separating the user from the data sources using an ontology.
- This ontology provides a user-oriented view of the data and makes it accessible via queries formulated only in the ontology language without any knowledge of the data source schema.
OBDA Principles

i. **Data sources** usually exist independently of the ontologies which describe them

ii. Ontologies and data sources may be represented using **different models**

iii. The ontology is the **unique access point**

iv. Queries submitted on the ontology must be answered using a **set of existing mappings (correspondences)** between the ontology elements and the data source schema
We apply the principles of an ODBA in the light of a Peer Data Management System.

- Using **geographic databases** as data sources
- Geospatial data are represented by using the **vector model** (points, lines or polygons)
Peer Data Management Systems - PDMS

- Considered the result of blending the benefits of P2P networks with the richer semantics of databases.

- They can be used for data exchanging, query answering and information sharing.

![Diagram](https://via.placeholder.com/150)
The **SPEED** system adopts an ontology-based approach to assist relevant issues in data management:

- Uses **ontologies** to represent data source schemas.
- When a peer asks to enter the system, its schema is automatically exported to a **peer ontology**.
- A set of **correspondences** (mappings) between the generated peer ontology components and the original database schema is also generated.
A query reformulation module has been developed [Souza et al. 2011]. It has taken into account only conventional data.

The GeoMap tool was developed for automatically building a geospatial peer ontology [Almeida et al. 2011].
Our goal

- To support query formulation in the context of the SPEED system mediated by a peer ontology and using geospatial visual elements
  - Which abstract the underlying query language syntax

- Our approach has been named **easeGO - Easy Geographical Ontological access**

  - It has been implemented in the light of the SPEED system, although its approach can be applied to any OBDA environment which deals with geographic databases
easeGO Approach

i. An **interface**, which allows working both with the peer ontology and a cartographic representation of the data.

ii. A **query manager**, which reformulates the formulated query into queries which may be executed by the DBMS.
The easeGO Interface: User Perspective

- Users can be novices or experts, but our main purpose is to design an **easy-to-use interface** for the less experienced users.

- The interface should be capable of providing **geospatial data exploration** as well as make use of the peer ontology concepts to facilitate **query formulation**.

- To this end, we apply the principles of **Visual Query Systems – VQS**:
  - Use of icons and visual metaphors, instead of text.
  - The availability of interactive mechanisms to support query formulation.
The easeGO Query Manager: Reformulating Queries

- Given a user query $Q$, a *target geographic database* schema (GeoDB), and a *set of correspondences*, our goal is to find a reformulated query of $Q$ expressed in terms of the concepts of the GeoDB schema in such a way that it may be executed by the DBMS.

- The reformulated query is executed in the DBMS and the query results are returned to the query manager.

- The query manager considers the user preferences and sets the resulting data to be presented.
The easeGO Approach
The easeGO Tool

- Implemented in JAVA, using the OWLPrefuse and GeoTools
- It uses geographic databases coded in Oracle and PostGIS
- Main functional requirements:
  - Peer Ontology Navigation
  - Form-based query formulation
  - Exploration of Geospatial Objects
  - Spatial Query Formulation
  - Query Results Presentation
  - Hints and help messages
The easeGO Tool
The easeGO Tool
The easeGO Tool
We have invited some users to evaluate our tool:

- The tool is very friendly, presenting a good layout, with a reduced learning time.
- The peer ontology and the map really abstract the underlying geographic database.
- Its layout could be improved to allow better understanding of the visual elements, especially the spatial operators.
Conclusions

The **easeGO** is an attempt to put in an easy-to-use way the task of accessing geospatial data using an ontology as a middle layer together with visual elements.

- The tool provides an intuitive and transparent setting where the user is able to work with a peer ontology or with a cartographic view of the geospatial data.
- A query formulated in the interface is reformulated by the query manager using a set of existing correspondences between the peer ontology and the database schema.
Experiments accomplished with real users showed that the **easeGO** tool has some advantages:

- it does not require that users have previous knowledge about the underlying database schema or query language
- it gives the user a closer view of spatial reality where he is able to work with
- it supports a predefined set of spatial operators that improves query capability
- it allows users to pose queries by a visual, form or ontological paradigm
Future Work

➢ Our approach will be *integrated with the query reformulation* module of the SPEED system

✓ The tool will be extended to provide query reformulation between two neighbor peers, taking into account the semantic correspondences between them

➢ The easeGO approach can be applied to any *OBDA environment* which deals with geographic databases and ontologies representing their schemas
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