Semantic Interpretation of Search Queries for Personalization

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ABSTRACT

This demo paper describes the semantic query interpretation model adopted in the OnToMap Participatory GIS and presents its benefits to information retrieval and personalized information presentation.

CCS CONCEPTS

•**Information systems** → **Geographic information systems**; *Ontologies;* **Search interfaces;** *Personalization;*

KEYWORDS

Information search, User modeling, Ontologies

1 INTRODUCTION

Geographical information search is a challenging application domain for user modeling and personalization research, because it combines the complexity of understanding the user's information needs with the difficulty of presenting possibly large amounts of heterogeneous data.

Most Web-GIS and location-based social networks base information retrieval on category-based and/or textual search. The former approach can be problematic because it exposes people to the system's domain conceptualization, and to possibly complex types of information that they might not be familiar with. Differently, textual search has the potential to alleviate the problem, but most applications adopt a keyword-based data-retrieval approach, which does not support the recognition of the concepts the user is referring to. Consequently, they can return irrelevant data (e.g., items having a term of the query in their addresses), or they might miss information items that belong to the concepts the user is interested in, but do not match the terminology (s)he uses. For instance, query "municipal educational services in Torino" likely implies searching for schools, kindergartens, and other types of services related to education. However, by inputing the query to the OpenStreetMap server [8], the user receives an empty result set. In the case of the Google search engine, the result is limited to a list of references to the municipal web page of educational services, which has the appropriate keywords in its name.

Some GIS projects employ semantic knowledge representation techniques to integrate heterogeneous data [4], or to enhance geographical information retrieval. For instance, [7] and [3] defined ontologies for improving information search, respectively, in a task-oriented domain, and in OpenStreetMap.

The OnToMap Participatory GIS [9], described in this paper, builds on such experiences and extends the use of ontologies to information presentation and to the navigation of complex information spaces. The following sections shortly present our model and outline opportunities for personalization research.

2 ONTOMAP FEATURES

The OnToMap Participatory GIS (https://ontomap.ontomap.eu) supports both the consultation of spatial data and the creation of public and private interactive maps, which reflect individual information needs and can be enriched with crowdsourced content (information items and geo-localized comments) to help project design and group collaboration; see [9].

2.1 Semantic Query Interpretation

Regarding query interpretation, we investigated the benefits of integrating a semantic knowledge representation layer, based on a domain ontology that describes the types of information provided by the application, with encyclopedic and linguistic knowledge about the ontology concepts, aimed at flexibly identifying references to concepts in free-text queries. The ontological representation of geographical information allows data abstraction, categorization and multi-faceted retrieval. The system ontology defines semantic relations among concepts, allowing to treat heterogeneous information as Linked Data; see [10]. Moreover, each concept is enriched with linguistic and encyclopedic knowledge that describes its meaning and synonyms, specifying a rich terminology that can be used to refer to it. For instance, concept "childcare services" is defined as follows: "educational center aimed at children" and it is also enriched with a set of synonyms; i.e., infant, child, center, structure.

As described in [1], OnToMap interprets a search in three steps:

(1) Recognition of geographical constraints and identification of the bounding box for data retrieval.
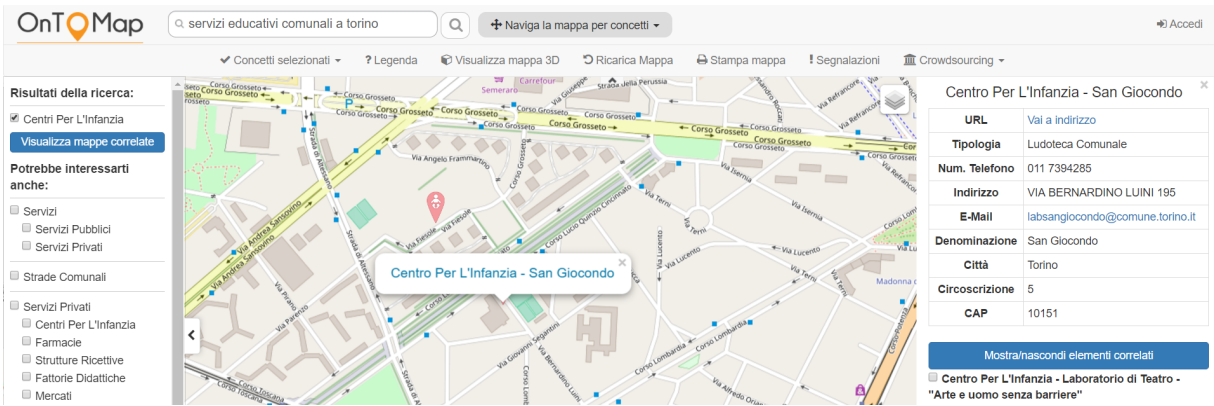(2) Semantic concept identification: the words occurring in the query are matched to the descriptions associated to

Figure 1: Search results for "servizi educativi comunali (municipal educational services) in Torino".

the ontology concepts through synonym recognition and word sense disambiguation.[1]

(3) Filtering of results to take the qualifiers specified in the query into account. This is done by projecting the retrieved data on the items having in their own description attributes that coincide, or are semantically similar to those qualifiers, taking synonyms into account.

For instance, query "municipal educational services in Torino" is matched to a set of ontology concepts related to services and schools because they include the "education" term, or its synonyms, in their description; e.g., kindergartens.

2.2 Presentation of Search Results

OnToMap visualizes the results of a search query on an interactive map that can be used to retrieve detailed information about geographical items. Figure 1 shows the results of query "municipal education services in Torino". The user has narrowed the search on childcare services ("centri per l'infanzia") and zoomed the map on a specific area of the town.

The Linked Data Representation supports structured information presentation. For instance, given the search results visualized in the map, the user can inspect individual items by clicking on their icons; e.g., see the sticky note and the table in the right portion of Figure 1. Moreover, when focusing on an item, the user can explore the geographically and semantically related information items; e.g., see the bottom-right portion of the page, below button "Mostra/nascondi elementi correlati" (show/hide related items).

Finally, the semantic relations defined in the ontology enable the user to browse the information space by exploring a concept graph that displays the concepts defined in the ontology and the relations existing between them. The nodes of this graph, which we cannot show because of space constraints, can be selected to visualize the corresponding results in the map; see [2].

3 TOWARDS PERSONALIZATION

The features described so far represent an important basis for learning individual user models in geographical information search.

By collecting data about the interaction with the application, On-ToMap will infer several types of information about the user; e.g., the concepts that (s)he references in her/his search queries (and the relative frequencies of concepts in the queries), the concepts associated to the data items (s)he inputs or annotates in her/his maps (not described in this paper), and information about the individual geographical objects that the user inspects, as in Figure 1. This data will make it possible to develop long-term and short-term interest models that, in turn, can be employed to help users explore the most interesting parts of the information space. In this direction, we are developing a dynamic model for learning concept clusters that reflect the co-occurrence of concepts in search queries; see [6]. This index is the basis for the development of dynamic thematic maps [5] specifying personalized data layers to quickly visualize relevant information. Two types of thematic maps can be envisaged: general ones, reflecting typical aggregations of interests in the user population (e.g., concepts clusters forming a tourist layer or a family one) and personal ones, reflecting the individual user's frequent searches.

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[1]Based on the BabelFy multilingual Entity Linking and Word Sense Disambiguation service (http://babelfy.org).