OnToMap - Semantic Community Maps for Knowledge Sharing

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ABSTRACT

We present the information retrieval model adopted in the OnToMap Participatory GIS. The model addresses the limitations of keyword-based and category-based search by semantically interpreting the information needs specified in free-text search queries. The model is based on an ontological representation of linguistic and encyclopaedic knowledge, which makes it possible to exploit terms and synonyms occurring in the definitions of concepts to flexibly match the user's and system's terminologies. This feature enables users to query the application using their own vocabulary.

CCS CONCEPTS

•**Information systems → Geographic information systems;** *Ontologies;* **Search interfaces;** *Presentation of retrieval results;*

KEYWORDS

Participatory GIS, Information search, Ontologies, Linked Data

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1 INTRODUCTION

Web-GIS are increasingly used to support geographical information sharing, but they challenge information retrieval by imposing a fixed terminology for the specification of information the user is interested in. Starting from the GeoSpatial Semantic Web vision [2], we investigate the usefulness of semantics for enhancing not only data management and integration, but also multi-faceted information search and data visualization. Specifically, we propose an ontology-based model that integrates linguistic and encyclopaedic knowledge to enhance information search. This model is applied in the OnToMap Participatory GIS, described in the following.

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2 SEARCH QUERY INTERPRETATION

OnToMap [3] supports the management of interactive geographic maps for information sharing and participatory decision-making. The development of this application started with project "Mappe di Comunità 3.0" (https://ontomap.ontomap.eu), that investigated the possibility of a new representation of community maps, using digital media and a semantic representation of spatial knowledge. OnToMap supports both the consultation of spatial data and the creation of public and private maps, which reflect individual information needs and can be enriched with crowdsourced content to help project design and group collaboration.

The application offers two information search modes, and different granularity levels in the specification of the relevant data.

- The former mode enables the user to enter free-text search queries; see [1]. Starting from the limitations of keyword-based and category-based search, that are offered by most Web GIS and location-based social networks, we investigated the potential of integrating semantic and linguistic knowledge for improving information retrieval. For this purpose, we defined an ontological representation of geographical information that allows the categorization of heterogeneous data, defining semantic relations among concepts, and is enriched with linguistic and encyclopaedic knowledge to define the meaning of concepts and the terms that can be used to refer to them. The ontology has a central role in supporting multi-faceted information retrieval because it offers a bridge between the domain conceptualization adopted by the system and the user's vocabulary: starting from the words occurring in the queries, and applying word sense disambiguation and synonym recognition, the system can identify the relevant concepts and provide the corresponding results, letting the user free to express her/himself in a natural way.

  Search queries are interpreted in three steps:
  1. Recognition of geographical constraints and identification of the bounding box for data retrieval.
  2. Semantic concept identification, by matching a semantically expanded query to the domain ontology in order to identify the referenced concepts. This enables the retrieval of a set of information items belonging to the general topics of the search query; e.g., hospitals.
  3. Filtering of results to take the qualifiers specified in the query into account; e.g., *pediatric* hospitals. This is done by projecting the retrieved data on the items

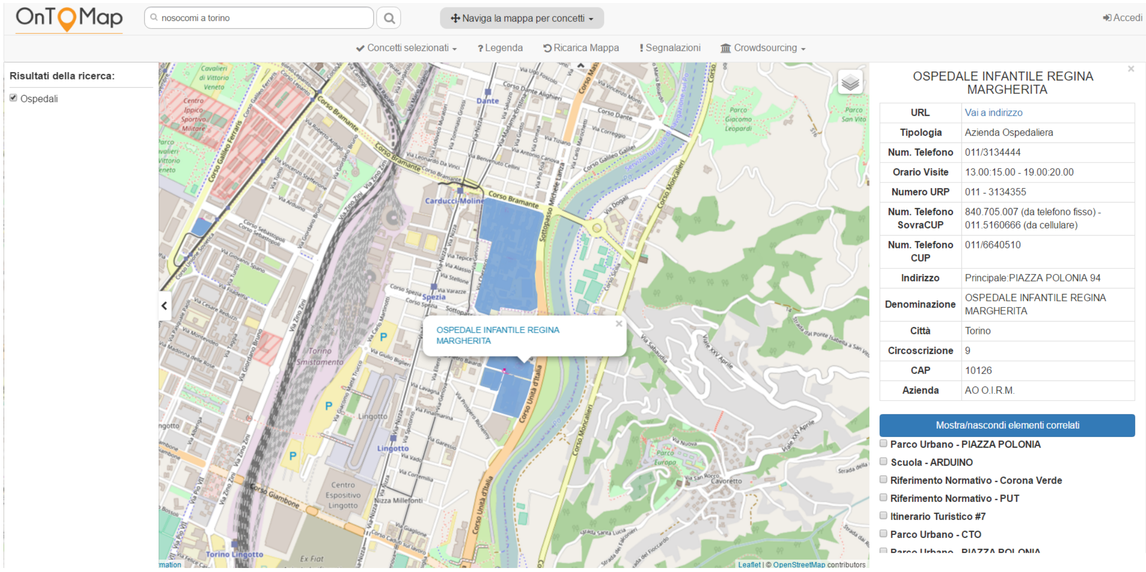

Figure 1: Search results for "nosocomi (hospitals) in Torino" and visualization of the data concerning a specific hospital.

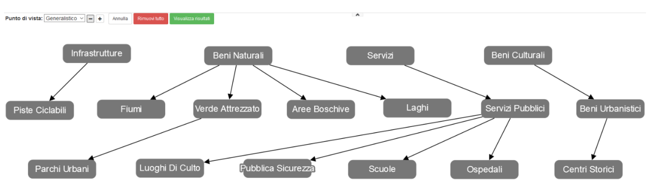

Figure 2: Generalist concept graph.

having in their own description attributes that coincide, or are semantically similar to those qualifiers (considering synonyms for flexibility).

E.g., the query in Figure 1 ("nosocomi a Torino") is aimed at finding the hospitals in Torino, but it is expressed using a different name from the ontology concept ("Ospedali"). The system has recognized the term as a synonym of "ospedale" and visualizes the results in the map. If the query included any qualifiers (e.g., *pediatric* hospitals), the application would filter the instances of "Ospedali" by matching the qualifiers to their descriptions. The result would be a single instance, "Ospedale Infantile Regina Margherita", having recognized that "Infantile" is a synonym of pediatric.

Semantic query expansion is also used to suggest other related concepts, guiding her/him towards types of information that can satisfy her/his needs in a more comprehensive way (not shown in the figure).

- The graph-based information search mode enables the user to explore concepts and relations in a direct way, by browsing a graph that represents a thematic view on the domain conceptualization. For instance, Figure 2 shows a generalist concept graph, which includes data categories relevant to non-expert users and displays subclass relations among concepts. This interaction mode enables the user to explore other possibly interesting concepts, by navigating the semantic relations that link the graph concepts to the rest of the ontology; e.g., the norms regulating the usage of infrastructures ("Infrastrutture") in the city.

The semantic knowledge representation helps the exploration of the information space in several ways, thanks to the structured representation of Linked Data; see [4]. For instance, the user can inspect the details of a geographical object by clicking on its icon; see the sticky note in Figure 1. In that case, a table reporting the main information about the item is displayed in the right portion of the page. Moreover, by clicking on button "Mostra/Nascondi elementi correlati" (*show/hide related items*), the user can visualize other information, related to the item in focus via semantic and geographic relations. For instance, the right portion of Figure 1 provides links to some official documents on land usage relevant for the area of the geographical item ("Riferimento normativo - ..."), to a school ("Arduino") and to a park adjacent to the hospital.

OnToMap was designed to manage participatory processes but it has supported other activities, outperforming other Web-GIS thanks to the semantic interpretation of search queries (w.r.t. keyword-based search) and map management functions. E.g., we collected positive feedback by comparing it with OpenStreetMap (openstreetmap.org) in an experiment in which a group of secondary level students used both applications to organize a sport event.

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