Web-Mapping Application to Retrieve Spatial Data by means of Spatial Ontologies

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Abstract. Many types of information are geographically referenced and interactive maps provide a natural user interface to such data. However, the process of access and recover spatial data presents several problems related to heterogeneity and interoperability of the geo-information. In this paper, a Tourism Onto-Guide-Web Application (TOGWA) is presented, which is a *web-mapping* system focused on retrieving and representing geo-information on the internet by means of spatial ontologies. Moreover, a Multi-Agent System is proposed in order to deal with the process of obtain the tourism geo-information, which aids in the information-integration task for the several nodes (geographic sites) that are involved in this application. The agent system provides a mechanism to communicate different distributed and heterogeneous Geographical Information Systems and retrieve the data by means of GML description. Also, this paper proposes an interoperability approach based on spatial ontologies matching. The matching is performed by the Multi-Agent System in every node considered in the application. The retrieval mechanism is based on encoding the information in a GML description to link the spatial data with the ontologies that have been proposed. TOGWA is a web-mapping system that is composed by two tiers: Client tier and Spatial Data Server tier, it offers an efficient and user-friendly interface to the clients.

1 Introduction

Nowadays, the use of maps has increased considerably for local, networked and mobile information systems that share or communicate geographically referenced information. This has become possible recently due to the relative widespread availability of digital map data and developments in Geographical Information System (GIS) technology. The application range is wide and includes: local government planning, environmental monitoring, market analysis, navigation and public access to information [1].

Interaction with a digital map is typically based on a cycle of elicitation of user input via menu and dialog boxes, the selection of map areas or features, and the return of information, which may in turn induce a modification to the map content. The maps themselves are often close replicas of traditional paper map cartography.

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This approach is usually found in many commercial GISs and is now being adopted in mapping applications on the Internet.

Developments in human computer interaction with regard to information retrieval and data visualization raise the question of whether or not the conventional approach can be improved. Certainly, there is a motivation to investigate new methods, since the current map interface, particularly on the Internet, often suffers from poor legibility of symbols and text, unnecessary user actions and inadequate adaptation to user interests [1].

Nowadays, the spatial databases are very useful and powerful tools to handle, display, and process the geographical information. These databases usually integrate GISs, which are designed to store and process spatial data. In order to solve some ambiguities in the spatial data processing and interpretation, the geo-information should have good quality, from the input to the representation. The "adequate" representation of spatial data is crucial for improving the decision making process in different environments [2].

In this paper, spatial ontologies based on the spatial semantics are generated, these ontologies can be used to represent geographical objects by means of concepts ("not words"). Such spatial data conceptualization aims to compress the data and to facilitate the knowledge discovery into spatial databases (SDB).

Up-to-date GISs do not extensively explore the spatial data semantics. In that sense, the development of a solid spatial semantics theory is a great challenge in the new trends of the Geocomputation field. For this, the spatial analysis can use alternative methods to represent spatial data. This data representation, together with the semantic rules - both based on data semantics - can be stored in a knowledge-base to generate new concepts that form the spatial ontologies. These concepts are defined by the properties and the behavior of geographical objects, and explored by human experience. In general, we seek to correctly represent geographical objects for their subsequent processing [2, 3], as to retrieve spatial data from different SDBs and to represent them in the TOGWA, for instance.

In our proposal, the first step to generate the spatial ontologies is to obtain the *spatial semantics* of the geographical objects. By obtaining this definition, we can generate spatial ontologies and rely on centralized ontology databases, which are stored in relational database systems. The emergence of Extensible Markup Language (XML) and Geographic Markup Language (GML) allows the ontology metadata to be embedded in the encoded web document, facilitating *semantic matching* by retrieval spatial concepts.

We propose a *Multi-Agent System* (MAS) to perform the communication between the different spatial databases. Although the encoding agents may still refer to centralized ontology databases during the encoding process, the spatial databases can also be encoded in GML because of its openness. Like many systems, we propose a Spatial User Interface Agent (SUIA) in TOGWA to make use of ontologies to validate user inputs and to capture the requests for retrieving spatial data by means of "concepts". In addition, the SUIA works in a web browser providing an easy-use web user interface for online geo-information retrieval. SUAI is characterized by the following features:

- Handle spatial data.

- Retrieve spatial data by means of concepts, considering the spatial subject domain.
- Perform spatial queries according to the generated spatial ontologies.
- Generate new geo-information making spatial analysis.

In this application, the spatial data are associated with different concepts, provided by the spatial ontologies. Moreover, an agent is considered to make several processes, which are divided into different tasks. The tasks that we are considering are the following: representation of geographical phenomena, capability of communicating with the spatial data (different SDB), access to the spatial ontologies, and retrieval of the GML definition according to the user query.

The rest of the paper is organized as follows: In Section 2 we describe the Multi-Agent System proposed to perform a number of tasks in the application, and the spatial ontology that retrieve the spatial data. In Section 3 we present the architecture of the TOGWA web-mapping application. The implementation of the prototype is shown in Section 4. Section 5 shows the preliminary results obtained by TOGWA. Our conclusions are sketched out in Section 6.

2 Multi-agent system and spatial ontology

TOGWA is composed by two basis components to retrieve spatial data. These components are the following:

- A Multi-Agent System (MAS) to perform tasks related to communicate different spatial databases by means of GML definition and to encode the spatial data for retrieving in the SUAI.
- Spatial ontologies to solve *ambiguities* that are presented in the spatial data through concepts ("not words").

2.1 The multi-agent system

According to [4], an agent is a system that tries to fulfill a set of goals in a complex, dynamic environment. It can sense the environment through its sensors and act upon it using its actuators. In this work, we propose a Multi-Agent System (MAS) that provides some services to facilitate the geo-information retrieval mechanism within a tourism system, which is called TOGWA.

There are two main functions of the agent in the TOGWA. One is to provide the user with an intelligent service that communicates different spatial databases and encodes the spatial data for retrieving. The other is to check the GML definition and to link the ontology for knowing whether the concepts fulfill the search criteria.

Several types of agents have been proposed, they are organized in four layers depending on its functionality. The agents are shown in Fig. 1.

- *Data Layer.* It is composed by the agents that provide data access services. These services can be, among others: retrieval, storage, adjustment to the communication format.
- *Management Layer.* The agents of this layer handle and coordinate other agents into MAS. Also, they provide the capabilities of communication to other agents.
- *Application Layer.* In this layer the agents perform the tasks of the specific application, such as visualization and functions to the spatial data. Moreover, these agents manage the ontologies (*Trip Package* and *Map*) that provide the needed data to the interface in order to give its own services.
- *Presentation Layer.* Here, the agents provide a user graphic interface to allow the users to obtain the TOGWA services.

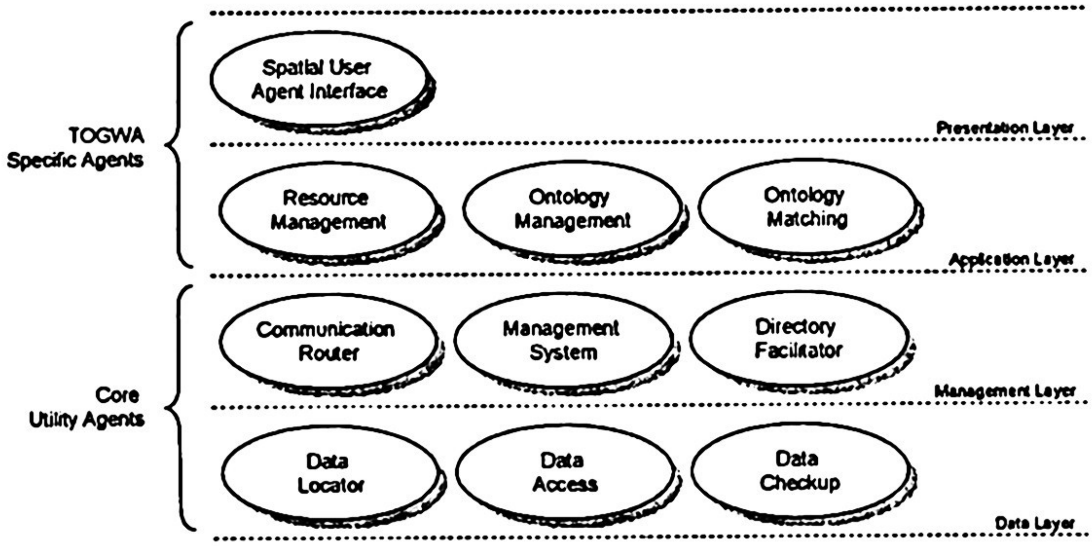

Fig. 1. Classification of the agents used in TOGWA

In Fig. 1 we grouped the layers into two clusters: Core Utility Agents and TOGWA Specific Agents. Core Utility is a set of agents that can be used not only in TOGWA but also in any other application. Its tasks are the following:

- *Data Locator.* It finds the data that better fulfills the description given by its clients. The agent provides, as a result, the address of the agent which can provide the access to the data.
- *Data Access.* It provides the mechanisms to access to the data and metadata of a particular source. The queries and results are given in XML.
- *Communication Router.* This agent provides the capabilities to MAS for communicating with other one, through any suitable way (Internet, others MAS, Virtual Private Networks, etc.).
- *System Management.* This agent handles the process within a MAS. It starts the compute of all other agents in the same MAS.
- *Directory Facilitator.* It maintains a list of all the known agents by MAS as well as the services that each agent provides to the layers.

- *Spatial Facilitator.* This agent retrieves the spatial data from the SDB. According to the client's request. The agent sends the geographical objects to make-up a map in the adequate format (GML description).

The TOGWA Specific Agents is a set of agents that work to accomplish specific TOGWA goals so that they can not be used in other applications. The agents that belong to this cluster are the following:

- *Resource Management.* This agent deals with all the resource assignment tasks, as searching a hotel and flight and finding trip packages, for instance.
- *Ontology management.* This agent keeps the information about the Map Geo-Ontology and uses it to translate the user's request into structured queries, which will be computed into the Ontology Administration Query Module. These queries allow other agents assigning resources to users and finding out geographical objects to provide maps to the clients.
- *Ontology matching.* This agent acts when there are confusions about the concepts in the client's ontology and the MAS ontology. Then the agent attempts to find the closest concept in MAS ontology, according to the concept given by the client.
- *Spatial User Interface Agent.* This agent translates data given by the MAS into a rendered map that the user can understand. The agent is the user interface of the MAS, but it does not belong to it.

The elements that compose the TOGWA-MAS are shown in Fig. 2. We can see that MAS consists of seven agents and an ontology repository.

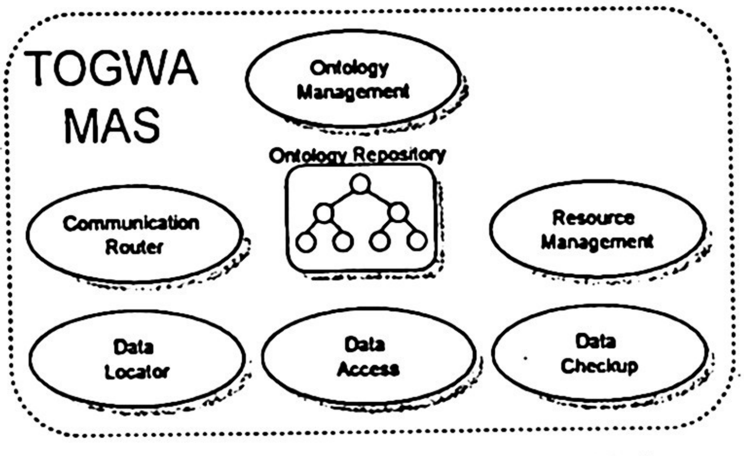

Fig. 2. Features that compose the TOGWA-MAS

In Fig. 3 the interaction model between two TOGWA-MAS is shown. Moreover, Fig. 3 shows the steps to accomplish the TOGWA process, which is outlined as follows.

1. The Client (Spatial User Interface Agent) makes a request to TOGWA (for example, a user in Spain desires to get a road map of the zone of Cancun in Mexico).
2. The MAS in Spain asks to its Directory Facilitator for the MAS that has such information.

3. The Directory Facilitator searches in its database the requested information, and responds to the MAS that the MAS of Mexico has the map.
4. The MAS in Spain asks the MAS in Mexico for the road map of the zone of Cancun.
5. The MAS in Mexico computes the request and determines if it has such information.
6. If it does, then the request passes to the Spatial Facilitator.
7. It makes a spatial query to the SDB for retrieving the geographical objects requested.
8. The Spatial Facilitator returns to the MAS in Mexico the geographical objects needed to make-up the requested map.
9. The MAS in Mexico translates this information using the ontology to a format that the MAS in Spain will understand.
10. Hence, it sends the information to the MAS in Spain.
11. Finally, the MAS in Spain sends the result to the client, and it displays the road map of Cancun to the user with a brief attributive description.

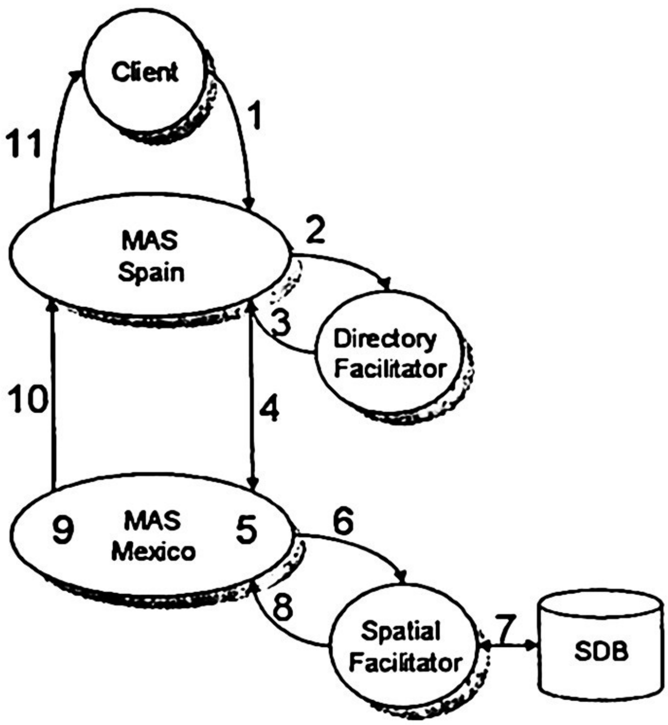

Fig. 3. Interaction model between two existing TOGWA-MAS

2.2 The spatial ontologies

The most widely accepted common conceptualization of the geographical data is based on the description of geographical objects and fields [5, 6]. These objects are not necessarily related to a specific geographic phenomenon, because human-built features are typically modeled as objects [7, 8]. The spatial semantics definition is described in [2] and aim to correctly represent spatial data in an alternative and universal way to generate spatial ontologies.

For this purpose, we will consider a spatial ontology as an explicit, shared and structured specification of conceptualization, that is, a description of properties and relationships that can exist between the geographical objects to form concepts.

Moreover, ontologies can be considered as "languages", which use a specific vocabulary to describe entities, classes, properties and functions related to a certain view of the geographical world [9, 10].

In that sense, our approach is designed to solve the ambiguities that can exist when we deal with single characteristics of the geographical objects. This can be achieved because the spatial ontology is defined by concepts (not by words) according to the geographical objects.

The spatial ontologies can be classified in levels according to their dependence on a specific task or point of view. These levels are generated for a specific spatial ontology (*top-ontology*) and it can be particularized to define a particular ontology (*down-ontology*). There are also different levels of information detail: *Low-level* ontologies correspond to very detailed information and *high-level* ontologies correspond to more general information.

In this situation, the generation of more detailed ontologies should be based on the *high-level* ontologies, so that each new ontology level can incorporate the new knowledge presented in the higher level. These new ontologies are more detailed, because they refine general descriptions of the level from which they have been generated [11].

The levels of ontologies can be used to guide processes for the extraction of more general detailed information. The use of multiple ontologies allows the extraction of information in different stages of classification.

The use of explicit spatial ontologies contributes to better correct spatial representation, because every geographical object description is based on an implicit ontology. By using that, it is possible to avoid explicit *conflicts* and *confusions* between the ontological concepts and the implementation [12].

On the other hand, spatial ontologies play an essential role in the conceptualization of spatial databases, allowing the establishment of correspondences and interrelations among the different domains of geographical objects and relations.

For instance, the ontology "Limit" can be represented in different concepts for diverse spatial databases. "Limit" in some cases represents: "coast boundary", separation between the "ground" and the "sea", "contour of value zero", "boundary" among two regions (states, countries, etc.), and so on (Fig. 4).

Using this approach, we can generate specific spatial ontologies after defining the top-ontology to particularize the conceptualization in other specific ontologies (down-ontology).

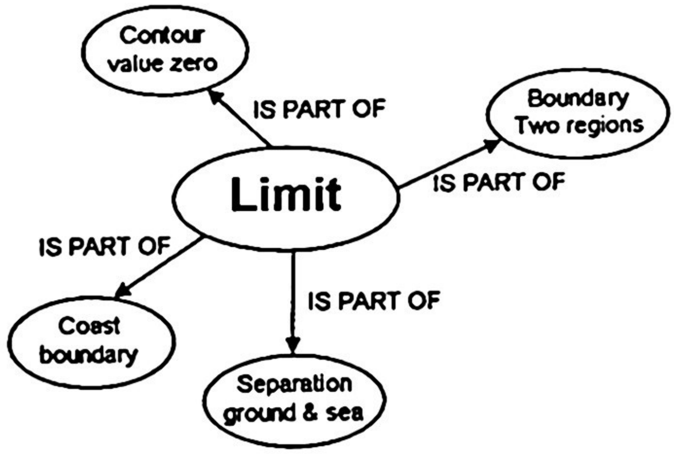

Fig. 4. Ontology "Limit" that is composed by different concepts related to "limit" for subsequent spatial representation

According to our approach, it is obligatory to count with a spatial subject domain. It is defined as a set of "names" that describe the primitives of spatial representation. Thus, we can start with *a priori* knowledge of the geographical objects that appear, e.g. in the map legend. For example, "blue" lines are united under the concept (name) "river" and "black" lines are united under the concept "fracture", etc. In reverse, the different concepts are united under the same description of the spatial representation that is "line" [2]. The interaction between the subject domain and the taxonomy is used to locate concepts into the spatial subject domain that correspond to a case of study, and to compute these concepts in order to generate spatial ontologies [2, 4]. Fig. 5 shows the definition of spatial subject domain.

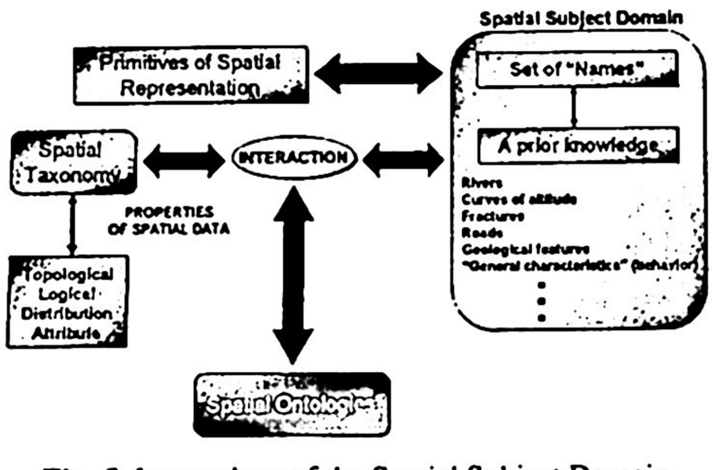

Fig. 5. Interactions of the Spatial Subject Domain

To define the spatial subject domain, it is necessary to elaborate a description of the spatial thematic to be analyzed, considering the main features that compose this theme, such as the data model and the resolution levels of the spatial data.

All characteristics that are considered in the description of the spatial subject domain should represent relationships between themselves too. Spatial subject domain has to recognize the different *semantic levels* of *a priori* knowledge that is stored in this domain.

The use of ontologies in spatial databases enables knowledge sharing and information integration. The proposed approach provides dynamic and flexible information exchange and allows partial integration of spatial data when completeness is impossible.

This can help the next generation of spatial databases to solve *semantic ambiguities* in the available geo-information, because the context of the spatial data can change according to the case of study [11].

The query functionality to retrieve spatial data by means of spatial ontologies is the following: 1) the user makes a request by means of TOGWA; 2) the information is searched in any TOGWA-MAS; 3) when the data are located; it is encoded into the GML definition; 4) this definition is sent to the Ontology Administration Query Module to compute the request for obtaining the spatial and attributive data by means of concepts, which form the ontology; 5) inside TOGWA, *a priori* knowledge that is stored in the spatial subject domain interacts with the spatial taxonomy, considering in this case, the "arcs" as primitive of representation. Fig. 6 shows the mechanism to obtain the spatial ontology by means of the Ontology Administration Query Module.

In addition, Fig. 6 shows the query mechanism to describe the concept "Roads" into the *Map Geo-Ontology*. In this case, the ontology is composed by several "sub-concepts", which are ordered in a hierarchical way. Moreover, we see in Fig. 6 different levels of the concepts, starting with a top-level (Roads) and finishing with down-levels (One rail, two rails, etc.). When the ontologies present more levels of concepts, it is possible to particularize these in sub-concepts, while the level is less (down-level), the concept is more particular. The ontologies that have been proposed by TOGWA are described in Section 4.

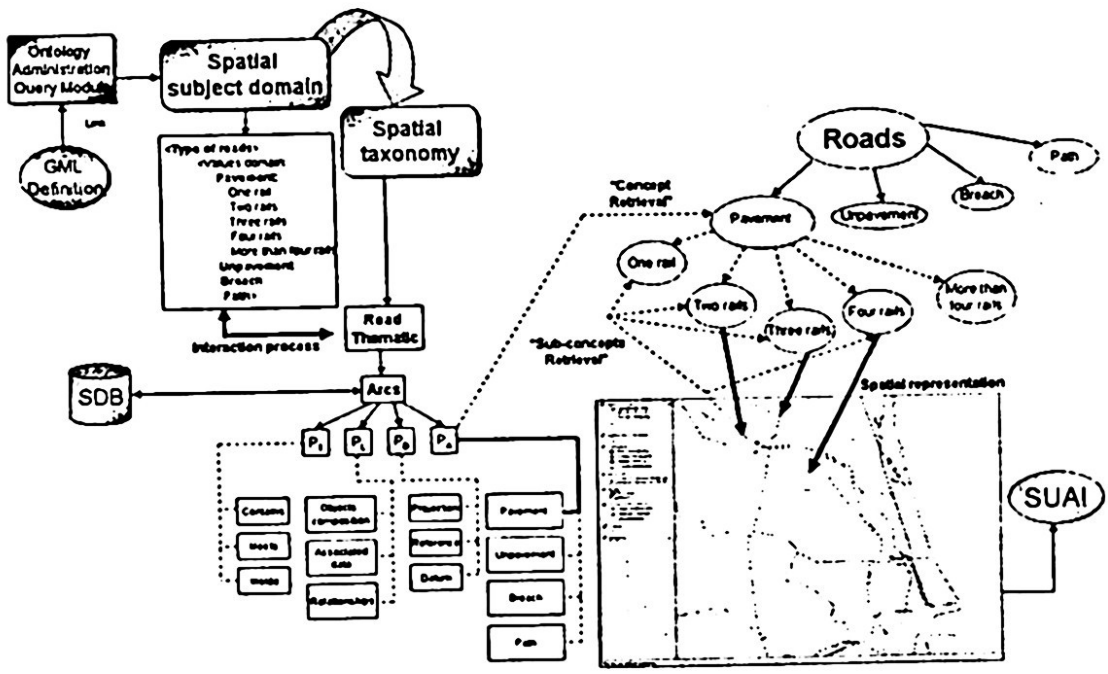

Fig. 6. Interactive process to retrieve geographical objects by means of spatial ontologies

3 Architecture of TOGWA

The Tourism Onto-Guide-Web Application (TOGWA) is a web-mapping system that is composed by two tiers: Client tier and Spatial Data Server tier. These tiers contain the following components: Spatial User Agent Interface (SUAI), Ontology Administration Query Module (OAQM), Spatial Data Server (SDS), Agent Administration Module (AAM) and Spatial Database (SDB) [13].

This application presents client-server architecture. TOGWA is considered a distributed system because it is able to retrieve spatial data from different GIS sites by means of GML definition. Fig. 7 depicts the general architecture of the Web-Mapping system.

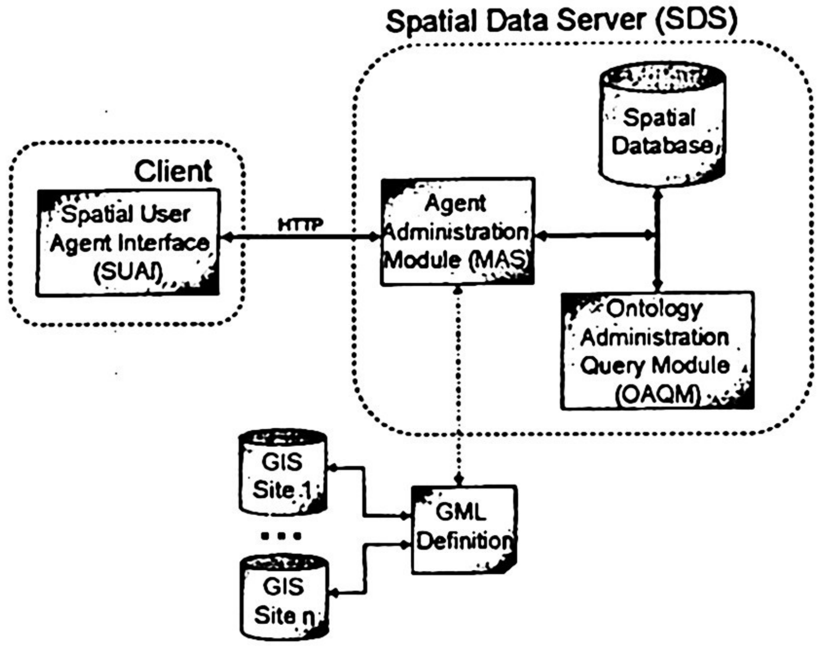

Fig. 7. Architecture of the Tourism Onto-Guide-Web Application

The general process to retrieve spatial and attributive data is the following:

Spatial User Agent Interface (SUAI) receives requests from a user. It assists the client to search, query and manipulate the map in an efficient and user-friendly way. SUAI attempts to understand the subject domain (geographical context of the user), and sends a message to the Spatial Data Server (SDS) to ask more geo-information or to modify the map to change the content and resolution detail. SUAI should keep a concise profile for each user to record his search of interest. The Agent Administration Module (AAM) receives requests from the SUAI and broadcasts the requests of the users to the Ontology Administration Query Module (OAQM) in order to search the concept into the ontologies and to retrieve the geo-information from the Spatial Database (SDB). If the geo-information associated to the concept could not be found in the SDB, the OAQM will send a notification to the AAM to perform a query in different GIS sites linked to TOGWA. This process is made up by means of the GML definition, when the geo-information is found; it is encoded in the GML description and transferred to the AAM to retrieve the spatial data according to the spatial ontology. Finally, the spatial data is sent to the SUAI.

4 Implementation of the prototype

TOGWA prototype has been implemented in Java to keep the distribution and multiplatform execution [14]. TOGWA consists of seven nodes to retrieve spatial and attributive data. The nodes that are considered to this application are the following: Mexico, Spain, Costa Rican, Italy, England, Cuba and Chile. The SUAI is implemented as a Java Applet and runs on the client side to interact with a web user. The AAM has been implemented as a Java servlet using Tomcat 5.0.12. The visualization on the client side is based on *Shapefiles*, which is proposed by Esri, Inc [15].

There are several components in the prototype, a web page, an invisible applet, a servlet and an ontology parser. The data workflow is depicted in Fig. 8.

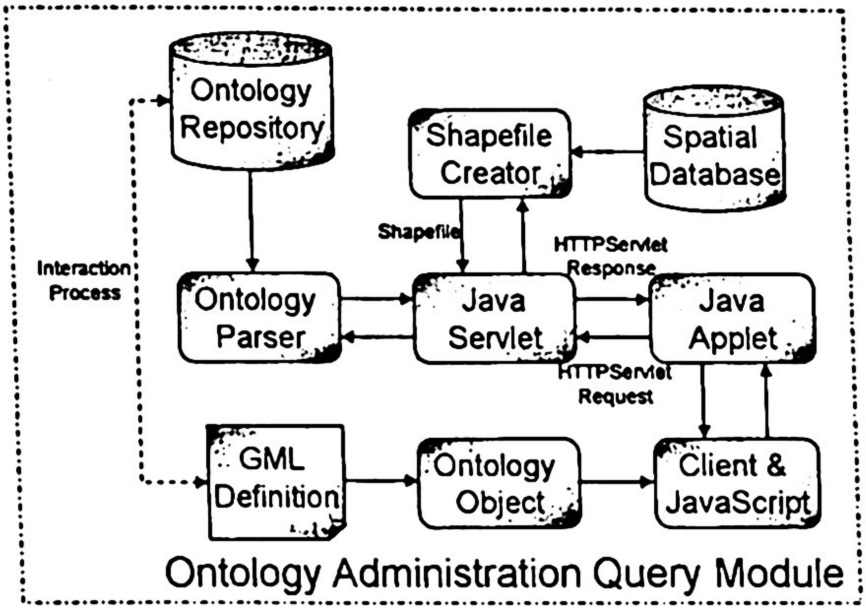

Fig. 8. Data workflow to obtain the spatial data according to the spatial ontology

When a user accesses the web page, the JavaScript embedded in the web page will call a Java applet to send an http request to the Java servlet, which will invoke the ontology parser to create an ontology object from the ontology repository. If the information is not found in the Ontology Repository, the OAQM sends a GML definition to locate the data in any node. When the information is found, it is received by the OAQM for being computed. Later, the OAQM sends the object as a serialized Java object to the applet.

The ontology object contains the entire ontology. The applet uses the ontology object to verify if the user has performed a valid search. If valid, the applet will submit the search to the servlet, which in turn invokes the shapefile generator to obtain a shapefile for the client to refresh the web page and to retrieve the spatial data.

In this context, a spatial ontology is a part of knowledge, concerning a particular spatial subject domain; it describes a spatial taxonomy of concepts for that subject domain, which define the *spatial semantic interpretation* of the knowledge. Spatial ontologies in TOGWA define the *spatial semantic relationships* of the geographical objects. The ontology repository is organized in a tree structure.

We propose two ontologies to obtain the spatial data by means of concepts, in this case the *Map Geo-Ontology* and *Trip Package Ontology*.

These ontologies provide the concepts related to the information retrieval to the user. The retrieval process is performed by constraints, which are defined by the client.

Map Geo-Ontology is focused on retrieving particular maps of the user interest. This spatial ontology can generate four types of maps: Roads, Weather, Urban and Sightseeing. The spatial ontology is generated by the interaction process of the spatial taxonomy and the spatial subject domain.

Trip Package Ontology is proposed to acquire attributive data related to the interest places to visit for the users. A user can obtain relevant information according to his interest and the matching concepts in the definition. The data can be found in any node considered into the application.

The interaction and communication process has been described in previous section (Multi-Agent System). The retrieval of concepts among ontologies is performed considering the *relationships* of them by means of MAS. Fig. 9 and Fig. 10 show the ontologies that we propose to retrieve spatial data by means of concepts.

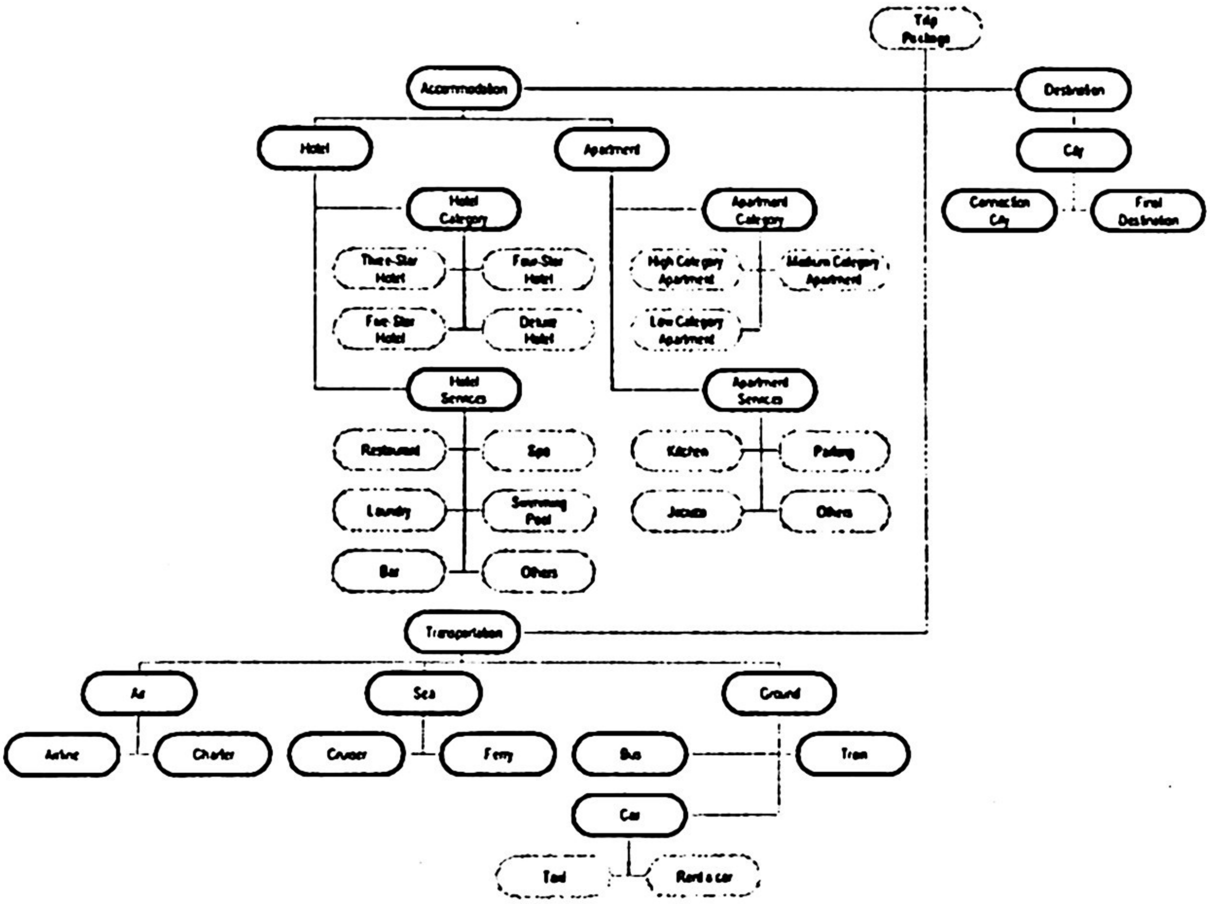

Fig. 9. Trip Package ontology

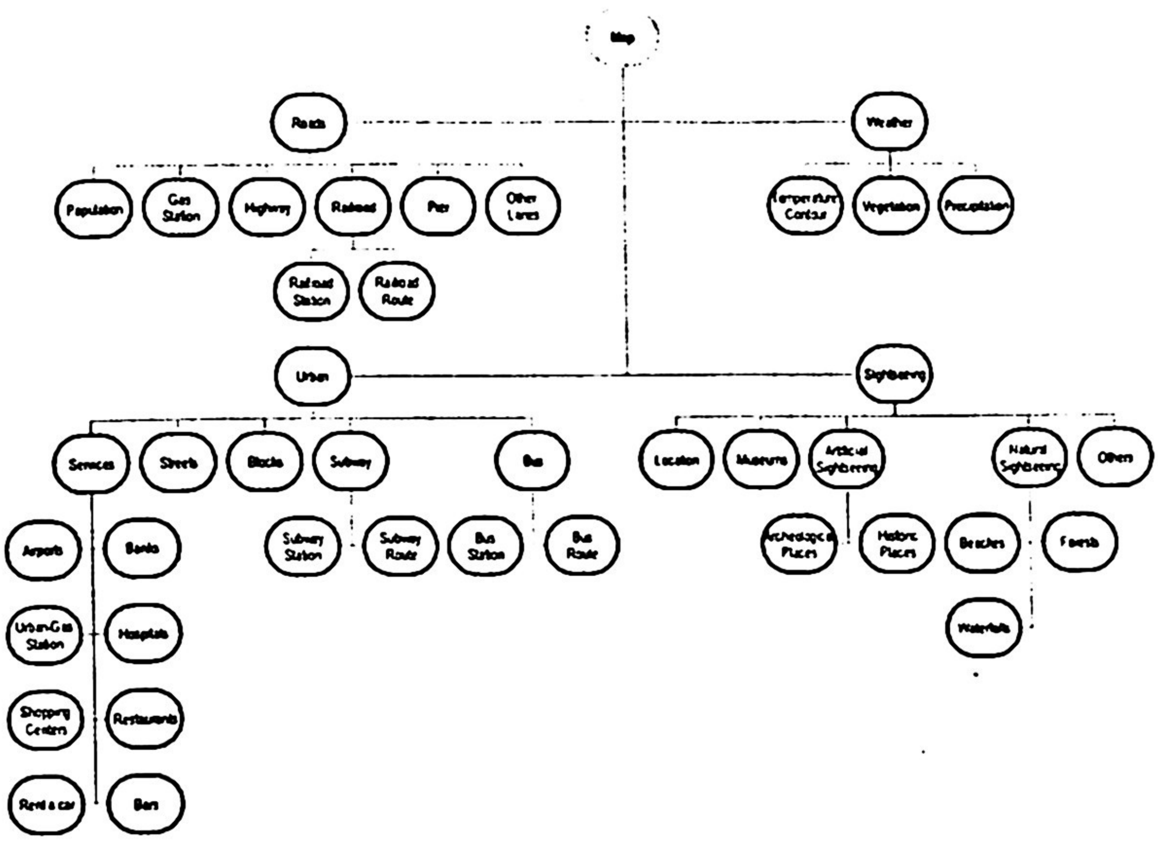

Fig. 10. Map spatial ontology

On the other hand, a GML definition is used to obtain the spatial data from different distributed GIS according to the request of the user. MAS sends this definition to find the specification related to the request. If the data has been found, the GML definition encodes the information, which is sent to the Ontology Repository for matching this information encoded into the GML definition with the ontology structures. Inside the Ontology Administration Query Module, the information is parsed for relating it with the concepts, which integrate the ontologies. We use the *relationships* between concepts that belong to the ontology to communicate the *Map* and *Trip Package Ontologies*. The use of relationships of concepts provides detailed information (spatial and attributive), because we can obtain concepts in certain directions as breath and depth first search.

If the information is valid, it is necessary to generate the *shapefile* by means of the Shapefile Creator in order to send it to the Spatial User Agent Interface. A brief description of the GML definition is shown in Table 1.

5 Preliminary results by TOGWA

By using TOGWA, we have developed roads, city, weather and sightseeing maps. These maps are generated by means of concepts that belong to the *ontologies* (*Trip Package* and *Map*). The data have been retrieved by the GML definition according to the user request. *SUAI* contains an efficient and user-friendly interface, which is composed by some spatial tools. Some results are shown in this section.

Fig. 11 depicts the *map of roads* for Toluca City, Mexico. This map consists of different thematics as Populations, Roads, Urban Areas and Internal Administrative Divisions. The roads presented in this map are classified by its properties: four rails, two rails, tracks and urbanized routes. The goal of this map is to guide the users for knowing their interest places in low level of detail (1:200,000).

Table 1. Brief GML description related to TOGWA


```
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   xmlns:camb="http://geo.cic.ipn.mx:9090/RDF/VRPexample profile3 schema.rdfs#"
   xmlns:gml="http://geo.cic.ipn.mx:9090/RDF/VRP/Examples/gml.rdfs#"
<!--The camb and gml namespaces replaced for validation purposes Map Ontology Data-->
   <camb:Map>
      <gml:boundedBy>
         <gml:Box gml:srsName="ROAD:4326">
            <gml:coordinates>
               0.0,0.0 100.0,100.0
            </gml:coordinates>
         </gml:Box>
      </gml:boundedBy>
      <camb:modelDate>
         Dic 2003.
      </camb:modelDate>
      <camb:modelMember>
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               I45
            </gml:name>
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               Federal Highway from San Pablito to Cancun.
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            <gml:centerLineOf>
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                              Interstate 35
                           </gml:Name>
                           <gml:description>
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                     </gml:description>
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                     344,552.4,566,763.67,763,234.12, 3,456,655.65, 890,765.31
                  </gml:coordinates>
               </gml:LineString>
                     </camb:Highway>
                  </camb:ModelMember>
         </camb:Roads>
      </camb:modelMember>
   </camb:CityModel> … </rdf:RDF>
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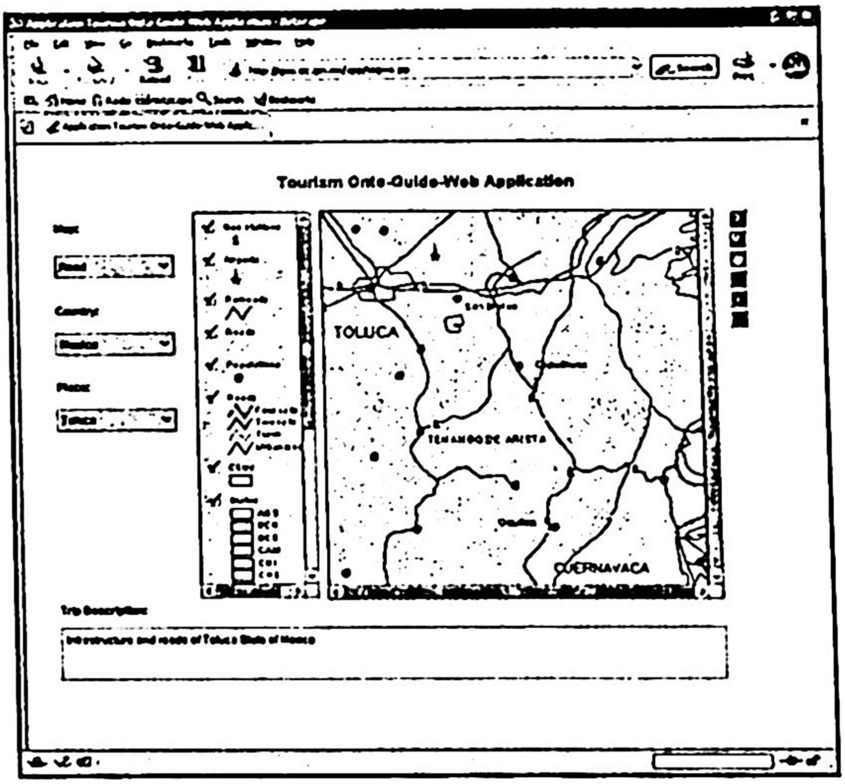

Fig. 11. Map of roads

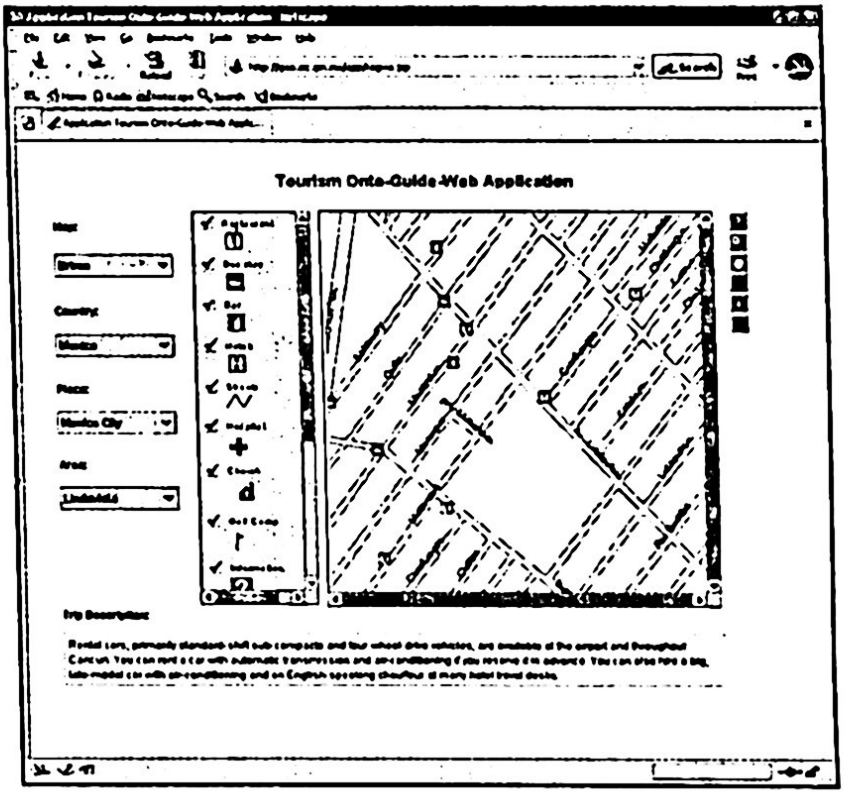

Fig. 12. City Map

City map is composed by streets, avenues and present different interest sites. Fig. 12 shows the city map of Lindavista area in Mexico City, within a scale of 1:5,000. In this map we show the location of different sites as Restaurants, Bus Stations and Hotels in this area. The users can retrieve a *city map* according to their necessities. Also, *Trip Description Box* provides useful information related to the user request.

Fig. 13 shows the *Sightseeing map* of San Pablito in Quintana Roo, Mexico. This map describes general aspects of San Pablito, showing the Information Sites Location, Gas Stations, Camping Zones, Restaurants and Archeological Sites. Moreover, it provides the general structure of the population. Additionally, this map presents the roads that connect with San Pablito (in red color). The map scale depends on the size of the area of interest.

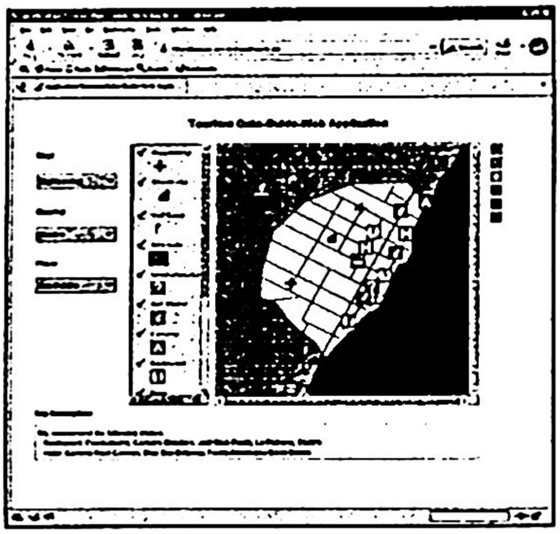

Fig. 13. Sightseeing Map

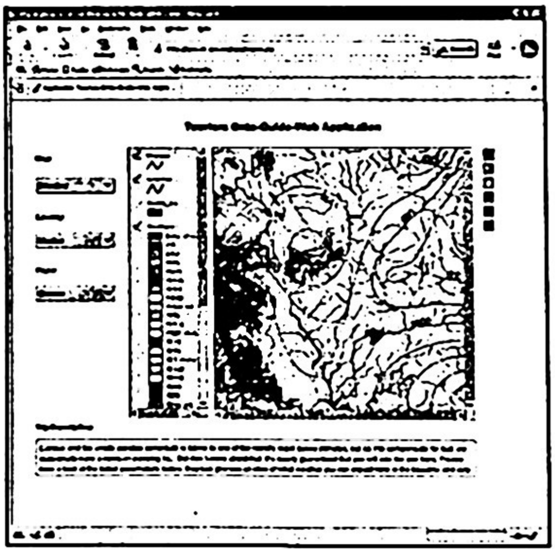

Fig. 14. Weather Map

Weather map consists of vegetation areas, temperature and precipitation contours. This map guides to the users to know the characteristics of the weather in a particular place, when the users want to travel according to their criteria of retrieval request. In addition, Fig. 14 depicts attributive information related to the map into the *Trip Description Box.*

6 Conclusions

In the present work, the Tourism Onto-Guide-Web Application (TOGWA) has been proposed. TOGWA is a *web-mapping* system focused on retrieving geo-information by means of spatial ontologies, and on representing it on the Internet. We use the spatial semantics to generate the geo-ontology for representing geographical objects by means of concepts.

TOGWA contains a Multi-Agent System, which performs the following tasks:

- To communicate different spatial databases by means of GML definition.
- To encode the spatial data for retrieval in the SUAI.
- To solve *ambiguities* that can be presented in the spatial data by means of concepts ("not words").

The spatial subject domain definition is oriented towards an interaction with spatial taxonomy to conceptualize the spatial databases. In essence, the spatial subject domain is defined as a set of "names" that describe the primitives of spatial representation. Thus, we can start with *a priori* knowledge of the geographical objects to examine the spatial data, which interact with the spatial taxonomy to generate spatial ontologies.

We attempt to show an alternative approach to represent spatial data on the Internet considering the *relationships* that compose the ontologies to retrieve spatial data according to several search criteria.

In addition, the spatial ontologies catch the semantics of the spatial data to provide relevant information related to the concepts. These ontologies can be used to establish agreements on diverse views of the world and consequently to carry out the "meaning" of the geo-information. In many situations, this geo-information is embedded in the spatial representation of geographical phenomena in the human-mind.

The use of ontologies in spatial databases enables knowledge sharing and information integration. The proposed approach provides dynamic and flexible information exchange and allows partial integration of spatial data when completeness is impossible in the web.

The communication between ontologies is performed by MAS, which seeks the relationships of the concepts to match nodes in the ontologies. This process is iterative and the new generated concepts can be considered in the spatial subject domain.

This approach can aid to solve *semantic ambiguities* between the available geo-information, because the context of the spatial data can change, according to the case of study and the representation state by means of concepts of the spatial data.

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