HELP TO SPECIFY USER NEEDS IN GEOGRAPHIC INFORMATION ON THE WEB

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Résumé

Avec le nombre croissant des sites Web géographiques, les utilisateur novices ou experts ont de nouveaux besoins par rapport à leur usage de l'information géographique sur le réseau Internet. Ils ne peuvent pas toujours exprimer leurs besoins. Cet article propose de résoudre ce problème. Ceci consiste à ajouter plus d'interactivité aux sites Web géographiques en introduisant de nouveaux moyens de communication entre les internautes et leur machine : la langue naturelle et les échantillons de cartes. Nous proposons une aide aux utilisateurs pour spécifier leurs besoins en information géographique sur le Web. D'abord, une revue sur les moyens actuels d'accès à l'information géographique est réalisée, ainsi qu'une analyse des problèmes récurrents. Notre contribution est alors définie : combiner la langue naturelle et les échantillons. Enfin, nous présentons l'architecture générale de notre système en nous focalisant sur l'utilisation des échantillons dans le cadre d'un dialogue homme-machine en langue naturelle.

Abstract

With the increasing number of geographic Web sites, users novices or experts have new requirements with regard to their usage of geographic information on the internet network. They can not always express these requirements. This article seeks to solve this problem. This consists in adding more interactivity to geographic Web sites by introducing new means of communications between Net surfers and their machine: natural language and map samples. We propose an help to users to specify their needs for geographical information on the Web. At first, a review of the current means of access to the geographic information is realized as well as an analysis of encountered problems. Our contribution is then defined : to combine natural language and samples. We present the general architecture of our system focus on the use of samples in the human-computer dialogue in natural language.

Introduction

Internet is a wonderful tool of communication, exceeding the abstract and physical barriers like languages and distances. Everyone, with internet connection, can surf on the Web and access to enormous amounts of information. Besides the information delivering, other services are available like mailer, direct communication, data transfer, process execution.

Geographic information is today more and more conveyed on Internet and there are new perspectives of offering Web services in this domain to all potential users. The advantages are multiple: the delivering and the transfer of data offer earnings at time. It is possible to show data in real time with animations and «3D» maps on for example the natural risks or the phenomena of pollution, meteorological, road traffic, etc. Multimedia with sound, video, hypertext links, images, offers more interactivity and dynamism to maps. With these technologies, the geographical information exists and is accessible, but does it answer to the users' needs? Making geographical information accessible to the common user is still problematic. Existing tools are mainly for GIS experts and particular efforts are needed to fulfil all users' profiles.

In our work, we focus on users' requirements. We want to establish a link between the novice users on Web and stored or calculable information on a distant machine facilitating the expression of the users' need for geographical information. These needs can be for example to look for the monuments of a city by localizing them with a chosen symbol or to ask a map representing only roads and certain buildings along a river. Concretely, it is necessary to rely two reasoning processes : that of the human and that of the machine. Users want data adapted to their need. It is not to the user to adapt to the machine, but rather to the system to understand the user. To realize the link between the man and the machine, we propose new means of communication, the natural language and the samples of geographic data. By interaction with the

user, the system must also be able to «understand» its demand and to propose a help to specify its requirement. Our method allows to realize more or less complex processing of geographical information without the user possesses thorough knowledge in the field of the geographic information.

We present in the Section 1 the current geographic Web sites and the works on spatial query languages. In the Section 2, we expose our choices concerning the means of expression offered to the user to specify its requirements. Finally, we explain in Section 3 the general architecture and the mechanism of our system to combine natural language and geographical samples for users specification.

1. Access to geographical information

Access to geographical information is not for novice users. To study how Net technologies are used to deliver geographical information, we analyze the current Web sites. We also present the research on spatial query languages which contribute to users' specifying their need regarding GDB and GIS. These researches can be exploited by exporting them on the Web. But they have limitations as well as the geographical Web sites.

1.1. Web sites proposing geographical information

Designers of geographical Web site must choose between an industrial or a "home" solution. Industrial solution uses a extension Web – GIS products. This allows to create, update and manage sites easily. Examples of Web GIS extensions are : ArcIMS of ESRI, MapX of MapInfo, MapGuide of Autodesk, GeoMedia of Intergraph. In a "home" solution, designers must create themselves extensions between geographical data and process and the Web. These works are to be found mainly in research laboratories like GeoTools (e.g. www.ccg.leeds.ac.uk/geotools/).

The presentation of geographical data on the Web is done via maps or plans. Metadata are used in sites for experts who do not seek for elaborate geographical information. Four types of maps are proposed : maps to read, maps to click, maps to create and animations. Maps to read are passive or slightly interactive maps (e.g. www.meteo.fr). Maps to click have links displayed or zones to click to reach to new related to the location on the map (e.g. www.cammap.com). Maps to create propose varied functionalities to user to manipulate or to create its maps (e.g. www.makeyourmap.com, atlas.gc.ca). Two kinds of animations exist : temporal animation to visualize a dynamic phenomena in time (e.g. www-itg.lbl.gov) and spatial animation to visualize in 3D with flying over an area (www.solarviews.com).

Map is associated to a set of tools :

- For visualization : zoom, pan, direction arrows, printing, pass to previous or next map.
- For elementary cartography : choice of legend (color and symbol) and selection of topics (roads, rivers, woods).
- For querying : to query information related to objects on the map, spatial query of SQL (Standard Query Language) type (for example : "city > 1000" for the cities higher than 1000 inhabitants).
- For processing : calculation of itinerary (www.geoweb.pt), manufacture of map online (www.makeyourmap.com) or choice of projection and colors (life.csu.edu.au/cgi-bin/gis/Map).

1.2. Spatial query languages

A classical query on a geographic database is built on the types figuring in the data scheme and logical operators. Logical operators are not intuitive. Efforts to build spatial query languages aim at allowing queries built on spatial objects and on specific spatial operators. Some efforts also add intuitive means of communication like text, icons or drawings. A classification of these languages is proposed hereafter:

- A language of SQL type is a spatial extension of a query language for database. [EGENHOFER 94] defines the Spatial SQL language and GRL (Graphical Representation Language) by adding unary and binary operators manipulating spatial relations (disjoint, meet, overlap, etc.).
- A textual language allows to query a database by selecting a type of operators and by writing parameters with words of vocabulary of the current language, e.g. PICQUERY [JOSEPH, CARDENAS 88].
- Visual languages allow to draw a query on a visual interface. These languages are divided in two family : basic visual languages and sketches.

CIGALES [MAINGUENAUD 95] and LVIS [BONHOMME et al. 99] are basic visual languages, i.e. visual editors of spatial queries. They offer a graphical interface with spatial operators (the inclusion, the intersection, the bordering, the path, the Euclidean distance), basic objects or metaphors (line and area) and icons as metaphors of objects of the real world (city, wood, road, etc.).

Sketches are scripts that users build to define their query. The difference with basic visual language is that spatial operators do not exist. The user draws its query and the system interprets the drawing and finds itself spatial operators. Works on sketches are Sketch! [MEYER 92], Spatial-Query-by-Sketch [EGENHOFER 96] and VISCO [HAARSLEV, WESSEL 97].

- Hybrid languages are spatial query languages which combine both the previous languages. [LEE, CHIN 95] proposes an hybrid language with icons. PEGASE [PROULX et al. 95] is an hybrid language combining text and graphic, using an graphical interface, on which user can choose values in preset fields. The Geographical Anteserver [SZMURLO et al. 98] is an visual/natural hybrid language on a GIS. In addition to the use of geographical object (line, point, area), labels are defined to specify spatial constraints on or between these objects with nominal groups.

1.3. Remaining problems

Lots of problems remain in the process of users interacting with geographical information on the Web. Web sites so far propose very few GIS functionalities. The difficulty in adapting functions reserved to experts for novice users seems to be the reason for it.

Moreover, sites are not flexible. Users can not take initiative in dialogue, they are constrained to follow the preset plan of the site.

The Net surfers can only visualize information by using processing and calculations pre-coded. They have not the means to personalize their query and to express specific needs.

Spatial query languages offer more freedom to express needs for geographical information. But they are limited. It is possible to carry out only simple queries. The graphical interface and the spatial operators are not always intuitive.

2. Our choices for a geographical human-computer interface

Our priority is to facilitate users' access to geographical information. We focus on designing a Web geographical human-computer interface (GHCI) which provides a user-friendly language to access to geographical information, possibly to express spatial queries built on existing spatial query languages (see figure 1).

2.1 Our general approach

To establish a connection between a user and a server of geographical data and applications, we design a human-computer interface directed towards geographical information. Its role is to understand the user's need to propose in return information answering this need within the limits of what the system can do.

Human and machine have not a common language. An interface is needed to establish a link between the logic of the man and the logic of the machine. Our interface relies on the natural language for the expression of the needs in textual form and the visual samples to help the user to specify its needs. The natural language and the drawing are the modes of communication the most used by the human beings. The use of the natural language is complex. Moreover, it is difficult to describe geographical objects. In order to circumvent these problems, the sample seems the ideal complement of natural language. Samples are another technique of dialogue. The articulation of these two languages must be carefully defined.

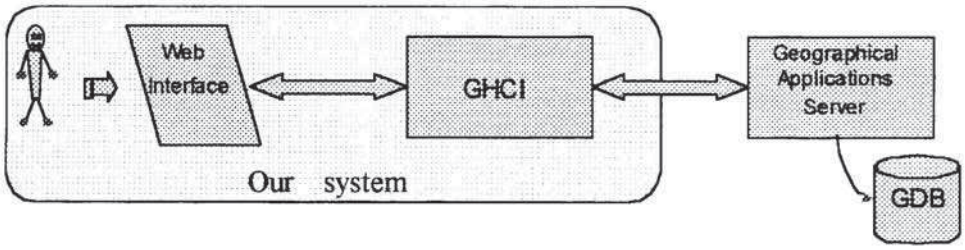

figure 1 : basic architecture of our system

2.2. Using the natural language

Our system should allow the user to express itself with full sentences and not only with a set of predefined words as in textual spatial query approaches (Spatial SQL, PICQUERY, PEGASE, The Geographical Anteserver).

Natural language has been studied in the research areas of human-computer dialogue and natural language processing. [LEHUEN 97] and [SABAH et al. 97] propose states of the art in the field of the human-computer dialogue. This work has also applications on the Web. For example, the system HALPIN [ROUILLARD 00] proposes a dialogue in natural language between a user and a machine to reach a documentation database.

The contributions of natural language in human-computer dialogue are multiple :

- If it is not yet possible to carry out true discussion between a human and a computer on any subject, a reachable objective is to create a dialogue finalized in a field specialized like geographical information.
- By using techniques of human-computer dialogue in natural language, we want to obtain a dialogue more real than a simple set of questions-answers, where the user follows the plan of the machine.
- At any moment in the dialogue, the initiative can come from the user. The system then should interpret the initiative to understand the reason of its reaction.

2.3. Using samples

In our work, a sample is a raw extract of a geographical database of relatively small size. For the user, the sample is only an image extracted of a map. We can have basic sample or treated samples that are basic samples to which geographical processing were applied. The system associates a sample with the description of properties of it.

2.3.1 Why

How would it be possible to describe in natural language an extract of geographical data to propose to the user? It would be difficult to the user to represent it and to the system to express it. If the system proposes a sample and asks : « do you like that? «, the user can easily understand the question and associate the term «that» with the sample. An answer in natural language then can be made.

It is easier for the system to show samples than to generate sentences dynamically. The user can analyze the graphic properties of the samples and say if these properties approach or not its need.

The sample remains in the language of geographical in-

formation by its cartographic representation. The users being accustomed to visualize maps, it does not give any problem of adaptation. The dialogue in natural language allows the user to express its reaction.

With the treated samples, the user will not require to know the geographical processing, e.g. to know that to obtain a sample A, it was necessary to apply 3 processing with the values W, X, Y.

When the user chooses a sample, the system uses knowledge associated with this one to understand and approach the user need without having to analyze the graphic properties.

The use of samples facilitates the processing of geographical information. Most of time, such processing (e.g. generalization) cause considerable times of calculation for the system. The samples will lead to a solution close enough to the user's need to run the adequate processing at one moment t.

2.3.2 Strategies to use samples

The strategy of the system to interpret the user's reactions and to propose new samples mainly relies on the properties associated with samples. These properties hold knowledge about geographical data and geographical processes. Actually, some samples are associated with a treatment and other samples with data properties. Various strategies can then be deployed :

• Strategy 1 : to search for coherent values of properties : The user selects a set of samples. According to the chosen samples, a space of constraints on the values of the properties is defined. The system builds hypotheses on this space and tries to restrict it by proposing new samples.

• Strategy 2 : queries on the constraints : The user selects a sample and qualifies it in natural language. It can use for example the terms larger, squarer, red. These terms will be put back into their context to determine the exact meaning of them. If the system is unable to find a solution sample, it can run an application on a close sample with adequate constraints.

• Strategy 3 : queries for processing : The user is familiar with geoprocessing. It can ask for a smoothing of a sample. Smoothing is associated with a geographical processing. The sample corresponding, if it is present, is turned over to the user. Otherwise our application is run with this sample.

3. General architecture of the GHCI

The general architecture of our GHCI, supporting the above proposed dialogue, is detailed with the various modules and their functionalities. A scenario to understand the general mechanism of our GHCI then is developed.

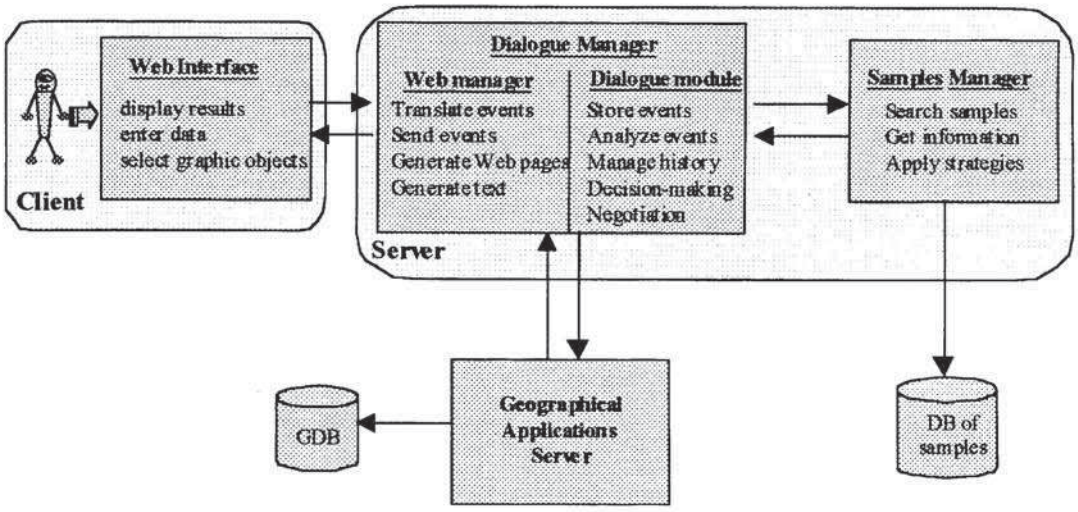

figure 2 : general architecture of our GHCI

3.1. The modules and their functionalities

The architecture of our GHCI (see figure 2) is composed of three modules: the Web interface, the dialogue manager, the samples manager.

• The Web interface is used to display the results in a textual or graphical way. It offers 3 different zones of interaction. The first one is a text input zone. It is always visible and usable by the Net surfer to enter natural languages sentences, so that it can interact constantly with the system. The system displays too these questions in this zone. The second zone is used to display the results with possible interactions through graphic objects, like samples. The last zone proposes a visualization of dialogue evolution between the user and the machine. This evolution is the «common ground». The common ground consists in knowledge resulting from a mutual comprehension between the user and the system [NICOLLE, SAINT-DIZIER DE ALMEIDA 99]. Returns on these agreements are constantly possible for the user.

• The dialogue manager is the core of our system. It links the Web interface to the samples manager and the server of geographical applications. This manager is divided into two modules.

The first module is the Web manager. It recovers the events produced by the user on the Web interface. It forwards them to second module in an exploitable formalism. It has a generator of Web pages to display information coming from the second module to the Web interface.

The second module is the dialogue module. It treats events by various actions. It stores and analyzes the syntax and semantic of data entries in natural

language by the user. It analyzes an history of the interactions. It can start an action like contacting the samples manager or the geographical applications server. It also announces the possible errors. To design this system, the prototype Genedic [LEMEUNIER 00] is used. Genedic manages a dialogue between the man and the machine in natural language and has specific functionalities like the recognition of the intentions of communication of the user.

• The samples manager allows to retrieve samples, and to perform analyses. The knowledge of the various strategies is integrated there.

• The geographical application and data server : we do not want to base our study on a particular GIS or GDBMS software. Knowledge will be necessary to be able to run executions of these applications. A general formalism describing geographical tasks (or generic applications) broken up into treatment sequences to apply to data is in the course of design in a Ph.D. thesis at the IGN COGIT laboratory [BUCHER 01].

3.2 Scenario

To interact with the user, the system mechanism should be cut in several actions, which have precise roles. To understand how we assist the user to specify its needs, we develop a general scenario of use of our GHCI (see figure 3). We use the notation for basic sample and for treated sample i. The goal of our system is to find the appropriate treated sample. This scenario aims at showing relationship between all the modules of our system with a human interaction. It shows the combination between the dialogue in natural language and the samples. The system helps the users to specify their needs, before contacting the geographical applications server. In this scheme, we use the three strategies to use samples (see Section 2.3.2). In fact, these strategies allow to search the samples corresponding to the current action.

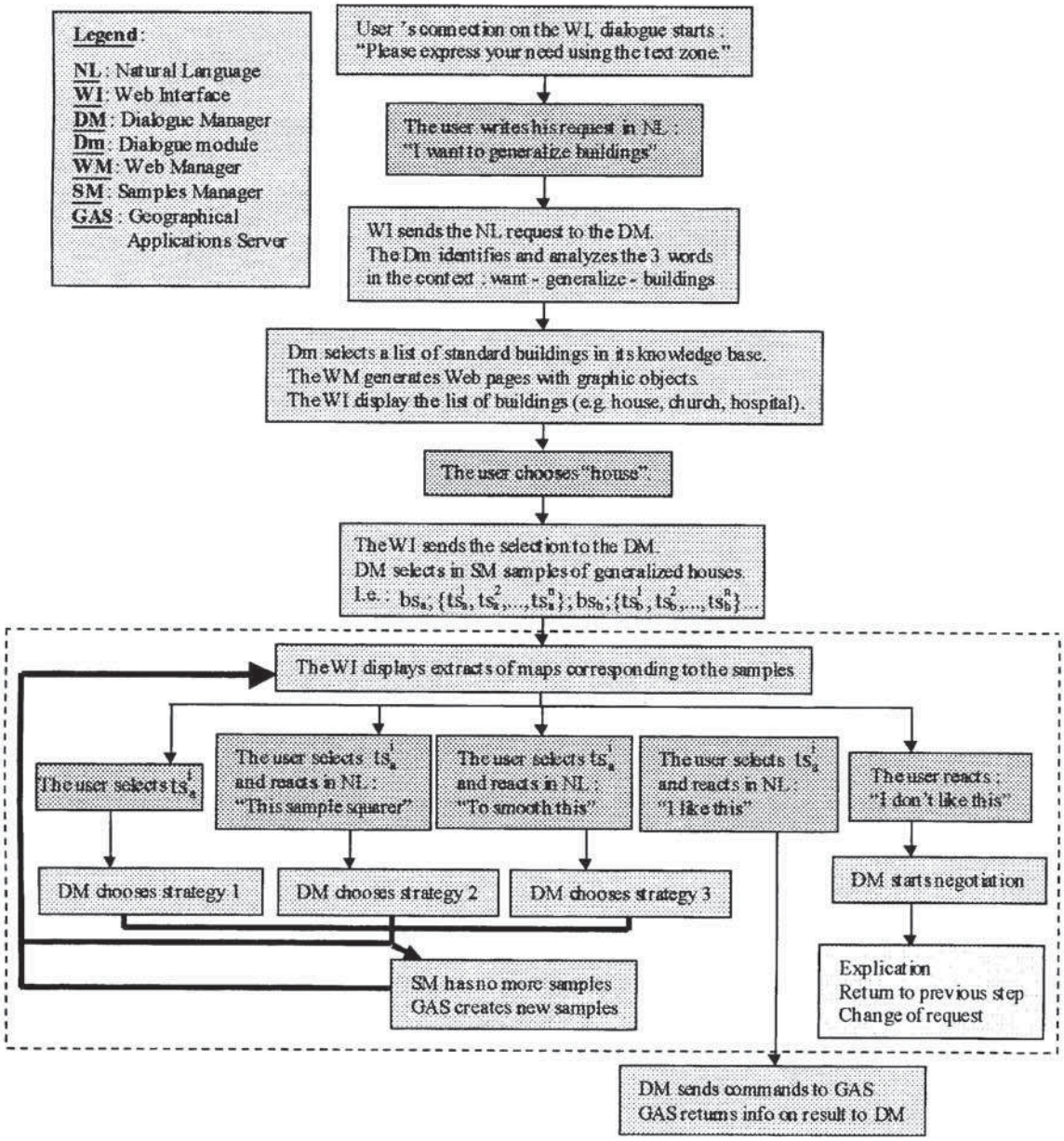

figure 3 : scenario with our GCHI

Conclusion and prospects

To enhance users access to geographic information on the web, we propose a geographic human-computer interface allowing a better communication between users, who have specific needs for geographic information, and the domain of geographic data and geo-processing. The main functionalities of this GHCI are to understand a user's need for geographic information, to find data and derivation processes to produce an answer as close as possible to the expected information, and to display the answer on the Web. The communication between the man and the machine is supported here by the use of samples, and natural language. The use of samples, that are displayed as extracts of processed maps, to dialogue with the user is a promising technique since users are familiar with this type of presentation. It is a new approach in the domain of geographical information.

Work in progress consists in building a prototype of the GHCI. So far, the Web interface has been developed in java. The dialogue manager is under construction. To integrate natural language processing, we adapt the dialogue module Genedic [LEMEUNIER 00] to geographical information. Besides coding the mechanisms of our architecture modules, a crucial effort is eliciting and representing three categories of knowledge : the common French vocabulary of geographical information and of needs expression, e.g. "I want to", metadata about geographic applications and data, and the model used to describe organization and properties of the samples. To narrow this effort, we focused on particular data and processes. These are data describing buildings, roads and urban block, and processes used in generalization tasks.

Further prospects are to connect our work with that of B. Bucher [BUCHER 01] and to the Agent prototype [LAMY et al. 99]; the dialogue manager should interact with a knowledge base about geographic applications, as it interacts with the samples database.

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