# A Conversational System to Assist the User when Accessing Web Sources in the Medical Domain

*Marta Gatius, Tsetsegkhand Namsrai*

Software Department
Technical University of Catalonia
Barcelona, Spain
*e-mail: {gatius,tsena}@lsi.upc.edu*

*Abstract*— **The aim of our research is to develop a framework of personal conversational assistants, adapted to different types of tasks and users. In particular, we have focused on how a conversational assistant can help the users in several situations related to the medical domain, and thus can help people take care of their health. In this paper we describe how the cultural assistant could help the user in four situations: finding a new specialist, finding the closest pharmacy, consulting a specific drug prescription and making an appointment to see the doctor. Our proposal is based on the integration of language, dialogue and ontologies to assist the user when accessing different types of web sources: informational and transactional services, dictionaries, maps. We have focused in a set of selected scenarios were a conversational assistant can be useful and the conceptual and linguistic resources needed are limited.**

*Keywords-conversational web assistant systems; ontologies; medical domain.*

## I. INTRODUCTION

The improvement of language technologies has made possible the development of conversational assistants that help users when accessing the web. The main advantage of language modes of interaction (text and speech) is that they are friendly and easy to use. Natural language modes support different types of web interaction: menus (the system asks the user to choose between a set of options), form filling (the system asks for a very specific information) and commands (the user can express an order, e. g. to perform a transaction). For this reason, the use of language is specially appropriate for devices not allowing easy internet browsing as well as for users who are not used to access the web.

The use of language also facilitates the development of intelligent web systems because language supports phenomena not supported by other modes, such as references to previous entities and descriptions of complex concepts. Besides, speech and text can be integrated with other modes of communication.

However, the use of language also present several disadvantages compared to other modes of communication. On one hand, the usability of conversational assistants (henceforth, CA) is limited because they present more mistakes and misunderstandings than interfaces using other modes of communication. As a result, tasks efficiency and user satisfaction in CA presents problems to be studied. On the other hand, CA are expensive to develop and difficult to reuse.

In order to solve these problems, most commercial CA restrict the communication to dialogues in which the system asks the user the specific information needed by the application. Those systems can be efficient and easy to use for simple applications: mistakes and misunderstandings are limited because the linguistic and dialogue resources used are adapted to the application. Besides, the cost of the development of the CA is reduced because the language and dialogue resources needed are limited. Those CAs are, however, difficult to reuse.

Limiting language and dialogue resources to the application has proven appropriate for application that require simple data from the user. Efficient and friendly CA for applications that need more complex information involves advanced conceptual, linguistic and dialogues resources.

Information retrieval systems are examples of applications requiring limited language and dialogue resources are. Dialogues needed by those systems are usually simple, as those in the web retrieval system for mobiles described in [1]. Systems performing complex tasks, such as the Medication Adviser (described in [2]) usually require more complex language interfaces, supporting mixed-initiative dialogues and incorporating domain knowledge. The development of those complex language systems still presents several challenges and it is an active research area.

An approach followed in intelligent systems using language to assist the user in complex tasks (or domains) is based on the use of conceptual ontologies. Ontologies facilitate reasoning about the application domain and can also be used to improve communication in different forms: to infer default information, to provide descriptions of domain concepts, to enrich lexical resources, etc.

The use of ontologies also favors the integration and reusability of the different type of knowledge involved in complex language systems: conceptual, linguistic and dialogue. In order to achieve efficient and friendly communication, complex CA are usually developed for a

specific type of application and their adaptation to a different type of application is not easy. The main problem is that the adaptation of the CA to a new application implies the modification of conceptual, linguistic and dialogue knowledge, usually represented in heterogeneous sources. Ontologies representing the application domain can be shared by the system knowledge bases, thus facilitating their integration as well as their adaptation to new applications.

The integration of advanced techniques on language processing and generation, dialogue and knowledge representation is a complex problem that presents several challenges to be solved. There are different approaches to this problem and most research works on the area are focused on a specific aspect of the problem. Examples of relevant systems integrating language, dialogue and ontologies to assist the user in different tasks are the multimodal SmartWeb system [3], the Active platform [4] and several works done in the framework of the TALK project [5].

Smartweb is a multimodal multilingual dialogue system that provides access to a selection of web-based information services (for example, those giving data related to a specific event, such as world football coup). Smartweb is focused on the integration of several communication modes and languages of communication and semantic web techniques.

Active platform is an intelligent system to assist the user in several daily tasks. It is focused on the integration of language, ontologies and advance techniques on artificial intelligence, such as active recognition techniques.

Several prototypes of multilingual dialogue systems using ontologies have also been developed for different applications in the framework of the TALK project. Most of these works are focused on the use of advanced dialogues strategies.

The work we present in this paper is also about the integration of language, dialogue and ontologies to assist the user in several situations, as the relevant works already described. The main difference of our work and those already mentioned is that we have focused on how to assist the users when accessing different types of web sources in a complex domain: the medical domain. For this purpose, we have studied several common situations in which different types of users may find difficulties when accessing web medical sources. We have focused on those situations where using a CA would be useful and the linguistic and conceptual resources required were limited.

Our proposal is based on a previous work on dialogue systems to guide the user when accessing informational and transactional web services (described in [6]). In [6], a prototype was developed that simulated access to two web services of different type: an informational service on cultural events and a transactional service on large objects collection. The results of the evaluation of the prototype showed the usability of the system was high (most of the users had a good impression of the system: 3,58 over 5), but could be improved. In order to improve the system usability, we have studied the use of domain ontologies for fostering the collaborative ability of the system ([7]). In particular, the use of ontologies was studied in two critical situations that can take place when assisting the user to find information: no results are found and too many results were found (and thus, it is difficult to present them in a clear form). In the first situation, domain ontologies can facilitate the reformulation of the user's query, while in the second situation, the ontology can be used to organize (or summarize) the results.

In this paper, we describe our study on how [6] could be adapted and extended to assist the user in several common scenarios related to the medical domain. The scenarios described are the following: finding a new specialist, finding the closest open pharmacy, consulting a specific drug prescription and stating an appointment to see the doctor. In these scenarios, the user needs to access web sources of different type: informational and transactional services, dictionaries, maps, etc.

In order to study the main challenges when assisting the user in several scenarios in the medical domain, we have implemented a prototype that provides textual access in Spanish to the several web sources selected for each scenario.

The next section gives an overview of the conversational assistant we developed, including a description of the scenarios considered and the prototype implemented. Then, last section draws some conclusions and future work.

## II. OVERVIEW OF THE SYSTEM

This section describes several of the scenarios we have considered for a web assistant in the medical domain as well as the prototype we designed to study how to approach main challenges those scenarios present.

### A. Studied Scenarios

We have studied a selected set of those scenarios, where several users can have some problems when accessing web medical sources and a CA using limited linguistic, dialogue and conceptual knowledge sources could be useful. Those cases of study were used to study how to approach main challenges when assisting the user to access web sources related to the medical domain.

The scenarios described are the following: the user wants to visit a new specialist, find an open pharmacy, consulting a medical prescription and making a reservation for an appointment to a primary health care center. Our main goal when describing these scenarios was presenting the advantages of using a conversational assistant. For this reason, the situations are simplified, in real situations much more choices could be presented to the users.

#### 1) Searching for a Specialist

We have considered the case of a user that pays for a private medical insurance having an informative web page, containing all clinic and hospitals which are covered by this insurance. Most of these pages are filled with drop down menus as that on Figure 1.
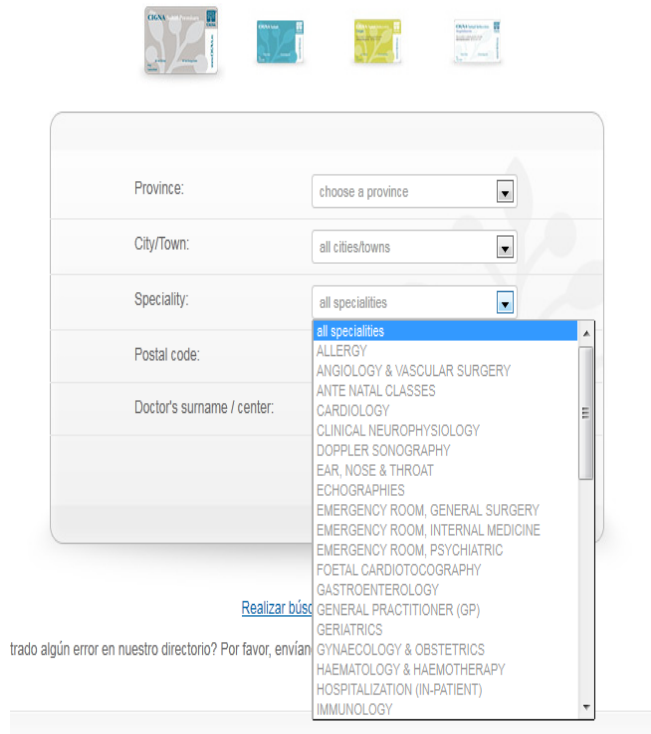
Figure 1. Searching for a Specialist in a web insurance page

TABLE I.        EXAMPLE OF DIALOGUE  WHEN SEARCHING FOR A SPECIALIST

S1:  Hello. This is the automatic health service information system. How can I help you?

 U1: Hi. I need to find a doctor.

S2:  Which specialist do you need? You can say the common name.

U2: Ear doctor please.

S3:  Would you like to search in a big hospital or would you prefer to search in smaller equipments?

U3: A big hospital.

S4:  There are otolaryngology departments in Teknon, Dexeus and Hospital Clinic. Which one would you prefer?

U4: Teknon.

S5:  Dr. Ear is visiting at Teknon Tuesdays from 4 to 6 in the afternoon. Is it OK?

U5: Yes.

S6:  Would you like me to find an itinerary there?

U6: Yes please.

S7:  Would you prefer going  by car or by public transportation

U7: By public transportation, from Pl. Catalunya.

S8:  Take FGC L7 from Pl.Catalunya and get out at Sarria.

U8. Thank you.

S9: Thank you for calling.

In insurance web pages, specialists are usually associated with the formal names of the specialization, which can present a difficulty for people without medical knowledge. In order to solve this problem the CA would allow the user to provide a common name for doctor specialization, for example *nose doctor*, *heart doctor*. To implement this functionality, we have parsed the Physician Specialist Glossary on the WebMD site ([8]) and build a knowledge source in the XML format.

An example of dialogue in this scenario supported by our system is given in Dialogue 1.

In order to improve the collaborative ability of the CA, the information on the specialists presented to the user would include information on how to go to the specific address or equipment where the she/he works. In particular, the system could guide the user about how to reach an address in three different ways: by public transportation (itinerary is retrieved by accessing Barcelona city web page on public transportation,[9]), by car and  walking (using the information provided by Google Maps).

*2)   Searching for practical drug information*

Practical information about a particular drug is usually available, either on the prescription information sheet or online. However, this information is not easy to read for all patients. The paper sheet that comes inside the drug box can be lost or printed in small fonts that can result difficult to read for elderly people. There are already online resources giving information on medical prescription of most drugs, but computer skills are needed to access them. A CA could be useful for answering most common questions included in drugs prescriptions, and the linguistic and conceptual resources required by the CA for this task are limited.

Prescriptions in many countries follow the same official structure. This structure favors answering most common questions related to drug prescriptions. In many countries there are online databases prescriptions of the drugs allowed in the country and those prescriptions  follow the official structure. Those databases are usually accessible in the country language (for example, the Spanish database related to Spanish drugs, [10], accessible in Spanish language).

The sections in the drugs prescriptions in Spain are the following:

1.  What is DrugName?
2.  Before using DrugName
3.  How should you take DrugName?
   3.1 What happens if you  miss a dose? .
   3.2 What happens if you overdose?
4. What I should avoid while taking DrugName?
5. Conservation of the DrugName

The typical drug prescription is structured in sections that are associated with most common questions. For this reason, most users questions can be just matched to those in the

prescription and information answering it can be easily extracted. For example, a typical question the user can ask the system would be: *"I missed a dose of tardyferon. What should I do now?".* Since there is a subsection associated with the question "*What happens if you miss a dose?* ", the system will just have to extract and present the fragment of text associated with this question.

*3) Searching for an Open Pharmacy in the Neighbourhood*

Finding an open pharmacy in the neighborhood is a quite common situation. Barcelona city hall's web page provides lot of relevant information about public health care ([11]), including all city pharmacies (together with their address, business hours and telephone numbers). In order to help the user in such scenario our system would just ask him the time and the place, parse the information about the pharmacies in the web page and present specific details of the pharmacies close to the user's location, indicating those that are open at that time. The system would use information about the addresses in the same zone (also available in the city hall's web page).

*4) Stating a Date to Visit your Doctor*

We have also considered a CA could be useful not only to help the user to find web information but also to perform other tasks, such as that of using a transactional web service to help the user when stating a date to see a doctor.



Figure 2. Making an appointment to see your doctor

In this scenario, the system will assist the user to give the data the service needs. The main challenge in this scenario, as in may other using transactional services, is that mistakes could have negative consequences. For this reason, clarification and confirmation dialogues are needed.

In particular, we have adapted our system to assist the user when using the web site of the public health care provider in Catalonia ("CatSalut" ), that allows the user to make a reservation for an appointment to a primary health care centre (CAP) by introducing the user's personal health care card number, as shown on Figure 2. Once the user has introduced this number, then a calendar showing possible dates is shown. Finally, when a correct date has been selected a drop down menu displaying time for the selected day is shown.

The CA would facilitate the reservation of a date and time by allowing the user to introduce NL sentences expressing time, what can result friendlier for several users For example, the user can introduce *"Please program for me a visit to my doctor on Monday or Wednesday, but I am free only after 18:00."* and the system will parse the sentence and will automatically select the day and the time within the user specified choices.

B. The Prototype

In order to study the main challenges the described scenarios present, we have developed a prototype using limited linguistic and dialogue resources. The prototype only supports text-based communication in Spanish. The prototype consists of three modules: the input/output module, the Dialogue Manager and the Task Manager. The system also includes a conceptual knowledge base (CK) that represents the application domain knowledge involved in communication. The CK is shared among all the system modules. These modules are described next

The input/output module processes user interventions and presents system messages. In the current implementation, this module consists of a Chabot that uses pattern matching templates for parsing the input request. Those patterns are stored in a XML file. The input is matched against those patterns and, if the match is found, the right command is forwarded to the Dialogue Manager.

The Dialogue Manager determines the content of the system intervention. It controls the information the Task Manager needs from the user to access the web and also how the information obtained from the web has to be presented to the user. In current implementation, this module is quite simple.
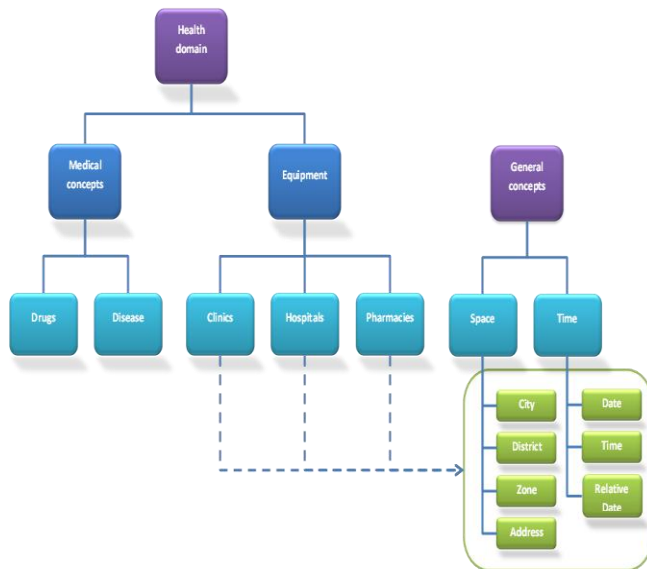
Figure 3. The Domain Conceptual Knowledge

The Task Manager controls the web access. Once the content of the user intervention has been passed to the Task Manager, it chooses which web site to automatically interact with. For accessing the web sources automatically, we have chosen HtmlUnit ([12]) because it is an open source Java library that creates HTTP calls which imitate the browser functionality. To extract the information from these web sources we developed a template based algorithm. This algorithm uses most common tags in simple html pages (such as those defining tables and lists) to extract the information.

One of the main challenges of our work consists of the representing the information obtained from the several web sources involved in a conversation with the user in an efficient form. For this reason, the CK, where information from several web sources is integrated plays a central role in our system. The CK involved in the specific studied scenarios (described above) has been represented in an ontology, shown on Figure 3.

As mentioned in the introduction, the use of ontologies can also be used to improve the collaborative abilities of our system when presenting the results of a web search in two different situations: when there were no results and when there were too many results. These two situations are critical in several of the scenarios we have considered, in particular, when searching a new specialist and when finding a specific equipment.

When assisting the user to search for specific information, in case the CA finds no results, concepts in the query can be substituted by their upper classes (to relax query constraints). For example, the system can replace a specific address in a query by the more general concept zone. In case too many objects satisfying the user's goal are found, the resulting set can be classified considering domain knowledge, as done in Dialogue 1 when the system propose the user to search for specialist in big hospitals (equipments are classified considering their size).

## III. CONCLUSION AND FUTURE WORK

In this paper, we have described an intelligent CA to guide the user when accessing several types of web sources in the medical domain. We have studied several scenarios where the user needs access to web medical resources of different type: glossaries, informational and transactional services. We have also considered scenarios where the combination of several web resources is needed.

We have implemented a prototype of the conversational assistant in form of a Chabot guiding the user in Spanish in the scenarios described: searching information (an specialist, an open pharmacy, a drug prescription), as well as performing a transaction (stating a date to see the doctor in a primary health care centre). In several of these scenarios, the system could, additionally, guide the user to go to a specific address (or equipment) presenting three alternative ways: using public transportation, a car or walking. The prototype incorporates an algorithm we implemented that extracts the information needed from the set of predefined web pages.

Future work will include extending the system to deal with new scenarios, even complex scenarios implying the integration of information obtained from several web sites using automatic web service composition solutions. We are also planning to extent the linguistic and dialogue system resources to support more complex communication phenomena in several languages. Additionally, we want to study how to adapt the system to different types of users.

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