mQA: Question Answering in Mobile devices

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Abstract. In this paper, we present a novel proposal for Question Answering through mobile devices. Thus, an architecture for a mobile Question Answering system based on WAP technologies is deployed. The architecture propose moves the issue of Question Answering to the context of mobility. This paradigm ensures that QA is seen as an activity that provides entertainment and excitement pleasure. This characteristic gives to QA an added value. Furthermore, the method for answering definition questions is very precise. It could answer almost 90% of the questions; moreover, it never replies wrong or unsupported answers. Considering that the mobile-phone has had a boom in the last years and that a lot of people already have mobile telephones (approximately 3.5 billions), we propose an architecture for a new mobile system that makes QA something natural and effective for work in all fields of development. This obeys to that the new mobile technology can help us to achieve our perspectives of growth. This system provides to user with a permanent communication in anytime, anywhere and any device (PDA's, cell-phone, NDS, etc.).

Keywords: Mobile devices, Question Answering, WAP, GPRS.

1 Introduction

Each generation of mobile communications has been based on a dominant technology, which has significantly improved spectrum capacity. Until the advent of IMT-2000, cellular networks had been developed under a number of proprietary, regional and national standards, creating a fragmented market.

- First Generation was characterized for Advanced Mobile Phone System (AMPS). It is an analog system based on FDMA (Frequency Division Multiple Access) technology. However, there were also a number of other proprietary systems, rarely sold outside the home country.
- Second Generation, it includes five types of cellular systems mainly:

  - Global System for Mobile Communications (GSM) was the first commercially operated digital cellular system.
  - GSM uses TDMA (Time Division Multiple Access) technology.
  - TDMA IS-136 is the digital enhancement of the analog AMPS technology. It was called D-AMPS when it was fist introduced in late 1991 and its main objective was to protect the substantial investment that service providers had bmade in AMPS technology.
  - CDMA IS-95 increases capacity by using the entire radio band with each using a unique code (CDMA or Code Division Multiple Access)
  - Personal Digital Cellular (PDC) is the second largest digital mobile standard although it is exclusively used in Japan where it was introduced in 1994.
  - Personal Handyphone System (PHS) is a digital system used in Japan,
- Third Generation, better known as 3G or 3rd Generation, is a family of standards for wireless communications defined by the International Telecommunication Union, which includes GSM EDGE, UMTS, and CDMA2000 as well as DECT and WiMAX. Services include wide-area wireless voice telephone, video calls, and wireless data, all in a mobile environment. Thus, 3G networks enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency.

Currently, mobile devices are part of our everyday environment and consequently part of our daily landscape [5]. The current mobile trends in several application areas have demonstrated that training and learning no longer needs to be classroom. Current trends suggest that the following three areas are likely to lead the mobile movement: m-application, e-application and u-application. There are estimated to be 2.5 billion mobile phones in the world today. This means that this is more than four times the number of personal computers (PCs), and today's most sophisticated phones have the processing power of a mid-1990s PC. Even, in a special way, many companies, organizations, people and educators are already using iPhone, iPod, NDS, etc., in their tasks and curriculas with great results. They are integrating audio and video content including speeches, interviews, artwork, music, and photos to bring lessons to life. Many current developments, just as ours [5, 3, 6], incorporate multimedia applications.

In the late 1980's, a researcher at Xerox PARC named Mark Weiser [4], coined the term "Ubiquitous Computing". It refers to the process of seamlessly integrating computers into the physical world. Ubiquitous computing includes computer technology found in microprocessors, mobile phones, digital cameras and other devices. All of which add new and exciting dimensions to applications.

As pragmatic uses grow for cellphones, mobile technology is also expanding into creative territory. New public space art projects are using cellphones and other mobile devices to explore new ways of communicating while giving everyday people the chance to share some insights about real world locations.

While your cellphone now allows you to play games, check your e-mail, send text messages, take pictures, and oh, yeah, make phone calls, it can perhaps serve a more enriching purpose. Thus, we think that widespread internet access and collaboration technologies are allowing businesses of all sizes to mobilise their workforce. Such innovations provide additional flexibility without the need to invest in expensive and complex on-premise infrastructure requirements. Furthermore, it makes "eminent sense" to fully utilise the web commuting options provided by mobile technology.

The problem of answering questions has been recognized and partially tacled since the 70's for specific domains. However, with the advent of browsers working with billions of documents in internet, the need has newly emerged, having led to approaches for open-domain QA. Some examples of such approaches are emergent question answering engines such as *answers.com*, *ask.com*, or additional services in traditional nrowsers, such as *Yahoo*.

Recent research in QA has been mainly fostered by the TREC and CLEF conferences. The first one focus on English QA, whereas the second evaluates QA systems for most European languages except English. To do, both evaluation conferences have considered only a very restriced version of the general QA problem. They basically contemplate simple questions which assume a definite answer typified by a named entity or noun phrase, such as factoid questions (for instance, "How old is Cher?" or "Where is the Taj Mahal?") or definition questions ("Who is Nelson Mandela?" or "What is the quinoa?"), and exclude complex questions such as procedural or epaculative ones.

Our paper is structured as follows: In section 2 we describe the state of the art about QA and similar works. Next, in section 4 we present our mobile architecture to support question answering. Section 5 contains our perspectives about our future work. This work consist in incorporate answering definitions questions. Finally, the conclusions are drawn in section 6.

2 The state of the art

One of the oldest problems of human history is raising questions about several issues and conflicts that torments our existence. Since children this is the mechanism we use to understand and adapt to our environment. The counterpart to ask questions is to answer the questions that we do, an activity that also requires intelligence. This activity has a difficulty level that has tried to delegate to computers, almost since the emergence of these. The issue of question answering for a computer has been recognized and tackled from the decade of the 70s century past for specific domains. In Mexico, have been obtained excellent results in this context, for this reason we propose to bring these same results with mobile technologies.

Recent research has focused on developing systems for question answering to open domain, ie systems that takes as their source of information a collection of texts on a variety of topics, and solve questions whose answers can be obtained from the collection of departure. From question answering systems developed so far, we can identify three main phases:

1. *Analysis of the question.* This first phase will identify the type of response expected from the given question, that is expected to be a question of "when" a kind of response time, or a question "where" will lead us to identify a place. Response rates are most commonly used personal name, name organization, number, date and place.
2. *Recovery of the document.* In the second stage performs a recovery process on the collection of documents using the question, which is to identify documents on the question that probably contain the kind of response expected. The result of this second stage is a reduced set of documents and preferably specific paragraphs.
3. *Extraction of the response.* The last phase uses the set of documents obtained in the previous phase and the expected type of response identified in the first phase, to locate the desired response.

Questions of definition require a more complex process in the third stage, since they must obtain additional information segments and at the same time are not repetitive. To achieve a good "definition" must often resort to various documents [1].

Currently the question answering on mobile devices for open domains is in a development stage. The project QALL-ME, is a project of 36 months, funded by the European Union and will be conducted by a consortium of seven institutions, including four academic and three industrial companies. The aim is to establish a shared infrastructure for developing a QA infrastructure via mobile phone for any tourist or citizen can instantly access to different information regarding the services sector, be it a movie in the cinema, a theater or restaurant of a certain type of food. All this in a multilingual and multimodal mode for mobile devices. The project will experiment with the potential of open domain QA and evaluation in the context of seeking information from mobile devices, a multimodal scenery which includes natural speech as input, and the integration of textual answers, maps, pictures and short videos as output.

The architecture proposed in the QALL-ME project is a distributed architecture in which all modules are implemented as Web services using standard language for defining services. In figure 1 shows the main modules of this architecture. The architecture of the QALL-ME described as follows:

"The central planner is responsible for interpreting multilingual queries. This module receives the query as input, processes the question in the language in which it develops and, according to the parameters of context, directs the search for required information. Extractor to a local response. The extraction of the

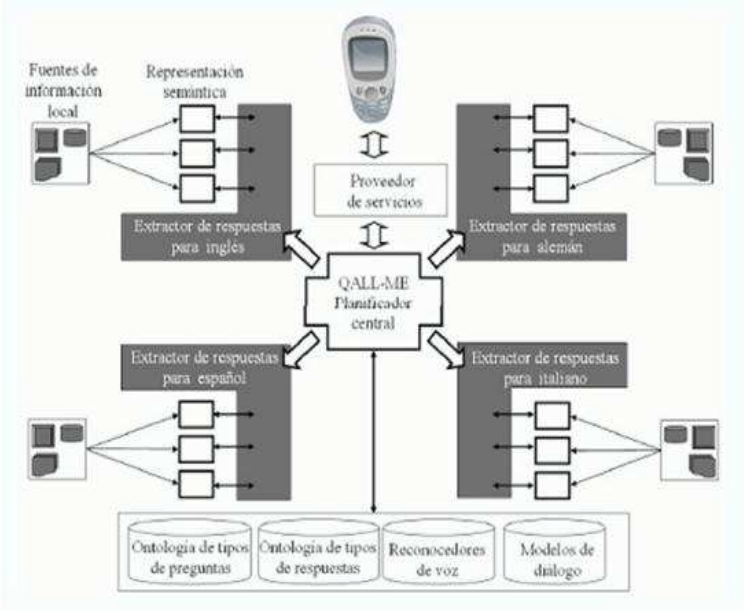

Fig. 1. Main QALL-ME Architecture [8]

response is made on different semantic representations of the information depends on the type of the original source data from which we get the answer (if the source is plain text, the semantic representation is an annotated XML document if the source is a website, the semantic representation is a database built by a wrapper). Finally, the responses are returned to the central planners to determine the best way to represent the requested information" [8].

3 Movile Question Answering for Definitions Questions

The method for answering definition questions uses Wikipedia [10] as target document collection. It takes advantage of two known facts: [10] Wikipedia organizes information by topics, that is, each document concerns one single subject and, [11] the first paragraph of each document tend to contain a short description of the topic at hand. This way, it simply retrieves the document(s) describing the target term of the question and then returns some part of its initial paragraph as answer.

Figure 2 shows the general process for answering definition questions. It consists of three main modules: target term extraction, document retrieval and answer extraction.

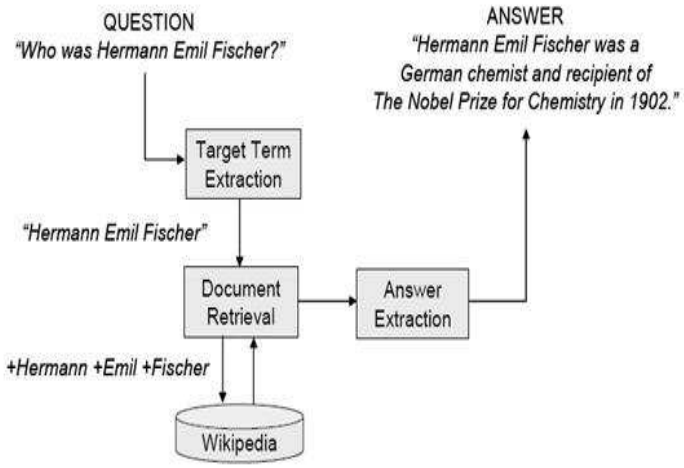

Fig. 2. Process for answer definition questions [7]

3.1 Finding Relevant Documents

In order to search in Wikipedia for the most relevant document to the given question, it is necessary to firstly recognize the target term. For this purpose the method uses a set of manually constructed regular expressions such as: "What—Which—Who—How"+"any form of verb to be"+<TARGET>+"?", "What is a <TARGET> used for?", "What is the purpose of <TARGET>?", "What does <TARGET> do?", etc. Then, the extracted target term is compared against all document names and the document having the greatest similarity is recovered and delivered to the answer extraction module. It is important to mention that, in order to favor the retrieval recall, we decided using the document names instead of the document titles since they also indicate their subject but normally they are more general (i.e., titles tend to be a subset of document names). In particular, the system uses the Lucene [11] information retrieval system for both indexing and searching.

3.2 Extracting the Target Definition

As we previously mentioned, most Wikipedia's documents tend to contain a brief description of its topic in the first paragraph. Based on this fact, this method for answer extraction is defined as follows:

– Consider the first sentence of the retrieved document as the target definition (the answer).

– Eliminate all text between parenthesis (the goal is to eliminate comments and less important information).
– If the constructed answer is shorter than a given specified threshold2, then aggregate as many sentences of the first paragraph as necessary to obtain an answer of the desire size.

For instance, the answer for the question "Who was Hermann Emil Fischer?" (refer to Figure 2) was extracted from the first paragraph of the document "Hermann_Emil_Fischer": "Hermann Emil Fischer (October 9, 1852 - July 15, 1919) was a German chemist and recipient of the Nobel Prize for Chemistry in 1902. Emil Fischer was born in Euskirchen, near Cologne, the son of a businessman. After graduating he wished to study natural sciences, but his father compelled him to work in the family business until determining that his son was unsuitable".

3.3 Evaluation Results of our method

This section presents the experimental results about the participation [7] at the monolingual Spanish QA track at CLEF 2007. This evaluation exercise considers two basic types of questions, definition and factoid. However, this year there were also included some groups of related questions. From the given set of 200 test question, our QA system treated 34 as definition questions and 166 as factoid. Table 3.3 details our general accuracy results.

Table 1. System's general evaluation

	Right	Wrong	Inexact	Unsupported	Accuracy
Definition	30	-	4	-	88.23%
Factoid	39	118	3	6	23.49%
TOTAL	69	118	7	6	34.50%

It is very interesting to notice that our method for answering definition questions is very precise. It could answer almost 90% of the questions; moreover, it never replies wrong or unsupported answers. This result evidenced that Wikipedia has some inherent structure, and that our method could effectively take advantage of it. [7]

4 Proposed Architecture

New technologies such as Wireless Application Protocol (WAP), General Packet Radio Service (GPRS) and 3G (3rd generation) further increase communication technologies and access to information. Wireless Application Protocol (commonly referred as WAP) is an open international standard for application layer network communications in a wireless communication environment. Its main use is to enable access to the Mobile Web from a mobile phone or PDA. The recent advances in mobile technology and wireless basic requirements of the applications of WAP has helped improve trade and mobile services. This protocol is a secure specification allowing users to access services and information instantly through wireless mobile devices. WAP is composed of the following form: uses Wireless Markup Language (WML), which includes the Handheld Device Markup Language (HDML). WML can also trace its roots to eXtensible Markup Language (XML). The best known markup language is Hypertext Markup Language (HTML). Unlike HTML, WML is considered a Meta language. WAP also allows the use of standard Internet protocols such as UDP, IP and XML. Although WAP supports HTML and XML, the WML language (an XML application) is specifically devised for small screens and one-hand navigation without a keyboard.

WAP also supports WML Script. It is similar to JavaScript, but makes minimal demands on memory and CPU power because it does not contain many of the unnecessary functions found in other scripting languages. The WAP programming model is similar to the Web programming model with matching extensions, but it accommodates the characteristics of the wireless environment. Figure 3 illustrates this model.

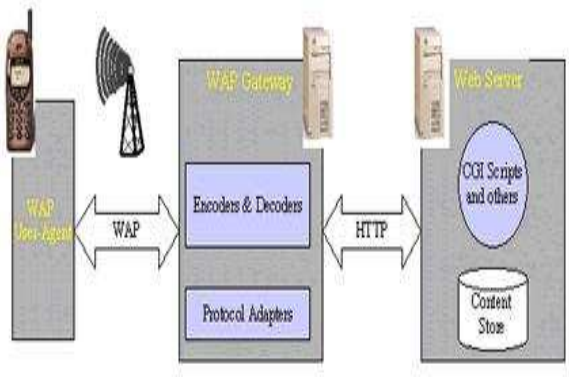

Fig. 3. Rga WAP Programming Model [9]

As you can see, the WAP programming model is based heavily on the Web programming model. But how does the WAP gateway work with HTML? In some cases, the data services or content located on the Web server is HTML-based. Some WAP gateways could be made to convert HTML pages into a format that can be displayed on wireless devices. But because HTML wasn't really designed for small screens, the WAP protocol defines its own markup language, the Wireless Markup Language (WML), which adheres to the XML standard and is designed to enable powerful applications within the constraints of handheld devices. In most cases, the actual application or other content located on the Web server will be native WAP created with WML or generated dynamically using Java servlets or JSP.

In HTML, there are no functions to check the validity of user input or to generate messages and dialog boxes locally. To overcome this limitation, JavaScript was developed. Similarly, to overcome the same restrictions in WML, a new scripting language known as WMLScript has been developed. I'll cover more on WML and WMLScript in later sections. However, General packet radio service (GPRS) is a packet oriented mobile data service available to users of the 2G cellular communication systems, global system for mobile communications (GSM) and provides data rates of 56-114 kbit/s.

GPRS upgrades GSM data services providing:

- Multimedia messaging service (MMS)
- Short message service (SMS)
- Push to talk over cellular (PoC/PTT)
- Instant messaging and presence-wireless village
- Internet applications for smart devices through wireless application protocol (WAP)
- Point-to-point (P2P) service: inter-networking with the Internet (IP)

Some mobile phone operators offer flat rate access to the Internet, while others charge based on data transferred, usually rounded up to 100 kilobytes. During the heyday of GPRS in the developed countries, around 2005, typical prices varied from EUR €0.24 per megabyte to over €20 per megabyte. In developing countries, prices vary widely, and change. Some operators gave free access while they decided pricing, for example in Togocel.tg in Togo, West Africa, others were over-priced, such as Tigo of Ghana at one US dollar per megabyte or Indonesia at $3 per megabyte. AirTel of India charges $0.025 per megabyte, and Telstra of Australia charges $22.53 per megabyte. As of 2008, data access in Canada is still prohibitively expensive. For example, Fido charges $0.05 per kilobyte, or roughly $50 per megabyte. In Venezuela, Digitel charges about $20 per 100 Mb or $25 for unlimited access. In Mexico charges $.04 per Kb. or roughly $40 per megabyte.

This WAP and GPRS infrastructure gives us the appropriate stage to propose the following architecture for QA on mobile devices.

Fig. 4. Main mQA Architecture

In Figure 4 shows the proposed architecture for the definition question answering (DQA), the module will be implemented question answering as Web services using standard languages. It takes a natural language query from a mobile device, this question is sent to the web service which returns a specific answer from a collection of information sources.

The proposed architecture consists of the following modules:

- Mobile Question Answering (mQA): is the interface of the mobile device to the user, which is responsible for communicating via GPRS to the web service DQA.
- Web Service Definition Question Answering (DQA): is the web service to meet all the demands of mQA and from the site, to send all questions to LabTL QA engine to be answered
- "LabTL QA engine: is responsible for seeking the answer to the definition question."
- " Repository of information Wikipedia Spanish-English: Spanish repository in which if the translation to English exists, this will be indicated to the user.

In a broader way, the user on your mobile device generates a question of definition in mQA, the system provides mobile communication system to DQA by GPRS connection (for economy and accessibility by users in case of Mxico 4 cents per KB) , in the DQA service the questions are sent to the LabTL QA system and this searches for the answer in its collection of information (Wikipedia), the answer is validated and this is returned to the user by previously established connection to the mobile device, so you use it according to your needs This architecture pretends to demonstrate the solutions efficiency in question answering by their integration into specific scenarios by mobile devices.

5 Perspectives and Future work

People throughout the world are increasingly relying on cell phones and mobile devices to keep them plugged in. Obviously, search will play an ever increasing role in the evolution of mobile. When will mobile search surpass desktop search? We have been expecting better search capabilities from mobile devices for some time, and know that Asia is far ahead of North America in this respect at the current time. Today, experts discuss their views about the evolution of search in North America. And, what we are sure, is that we must continue working on this line. For this purpose, the next phase of development is the implementation of the Mobile Question Answering System for spanish and English. Furthermore, we seek the application of such search in some opportunity niches such as education.

To sum up the results expected from our architecture presented in this article are:

- Architecture presented here, unlike other proposals based on short text messages [2] is cheaper, such as was presented in section 4.
- Our proposal gives a better performance because the communication via WAP is much more reliable than that based on SMS. This is mainly due to SMS-based systems have a 80 percent certainty. While the WAP protocol provides a 100 percent reliability.
- Our proposal makes use of only a servlet on the server side and a simple midlet on the side of mobile device.
- Furthermore, our proposal will benefit from the availability of Spanish WIKIPEDIA.
- Finally, our proposal is based on Java Micro Edition, thus it will be independent of Operating Systems (OS).

6 Conclusions

A consortium of companies are pushing for products and services to be based on open, global standards, protocols and interfaces and are not locked to proprietary technologies. The architecture framework and service enablers will be independent of Operating Systems (OS). There will be support for interoperability of applications and platforms, seamless geographic and intergenerational roaming. Mobile archutecture proposed in this paper has the advantage of being adaptable to any system and infrastructure, following the current trend that mobile technologies demand.

We believe the selection of topics covered in encyclopedias like WIKIPEDIA for a language is not universal, but reflects the salience attributed to themes in a particular culture that speaks the language. Our approach also would benefit from the availability of the Spanish WIKIPEDIA and the English WIKIPEDIA.

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