An Intelligent Front-end for Government Websites

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Abstract: The HANDS question-answering and direction application, consisting of Answer Tree and Address Guesser modules is described in relation to the EDEN project from which it is derived. The use of an Open Source (OSS) model for application development and service delivery is considered in the context of European policy. The interaction of HANDS with Public Bodies' (PBs) existing business process is described. We then consider the evaluation of the factors that affect acceptance by PBs, including those that go beyond technical effectiveness. We describe the underlying language processing engine used by HANDS and discuss the advantages of using Natural Language Processing (NLP) over keyword-based question-answering techniques in terms of increasing the potential for take-up from all citizens, not just the most literate or IT skilled.

1 Introduction

This paper describes the current beta of Helping Answers Decision Service (HANDS) which is an online communication service offered by Public Bodies (PBs) to their users/citizens, based on advanced Natural Language Processing (NLP) techniques. The end users access HANDS through the Public Body's web site, and type their questions on the keyboard using everyday language (without needing to use any keywords or Boolean operators).

The HANDS project aims at validating the results obtained from the IST EDEN project [2] [14] in the European market. In HANDS two natural language based tools developed by Italian partners under EDEN are being further developed as a single Open Source application and deployed in three public authorities and one utility company in Italy, Germany and the UK. The project is in collaboration with four public bodies and a technology developer, Stylo srl of Italy. HANDS is co-funded through the European Commission eTen Programme and will last for 18 months. Some of the content of this paper is derived from internal project documents.

As well as explaining the applications, this paper describes the implications and viability of providing the application through an open source model. It also discusses the evaluation techniques used to measure impact and success of the technologies.

2 Objectives

The aim of the market validation process is to investigate the administrative and economic viability of the proposed service, identifying the conditions for the future deployment of the HANDS service on a European scale.

The objectives of this paper are to review the business opportunities and risks arising from the open source (OSS) distribution model chosen and to give an overview of the

technology, summarise the process of adapting evaluation techniques for an eTen market validation project.

The in-depth cost/benefits analysis of the service implementation will be particularly focused on the PB's internal users, with specific regard to the service management perspectives, since the assessment of the viability of the HANDS service considerably depends on its strengths and weaknesses relative to other solutions, in the areas of ongoing support and development, integration with existing systems, maintenance of content and linguistic resources and user training and acceptance.

3 Methodology

3.1 Market Testing

The HANDS applications will be released as open source. The validation process therefore includes consideration of the impact of a model that denies itself revenue from the sale of software, while creating opportunities for alternative sources of revenue and for community involvement in developing the code. A major issue in the management of FLOSS applications is gaining assurance that there will be ongoing development and support once the initial funding has ceased: the evaluation process takes this into account.

In the current context, possible business models that the evaluation process will explore include:

- Offering an integrated modular system, allowing access to web sites and knowledge repositories through a Q/A interaction;
- Offering consultancy services, exploiting the growing amount of data extracted from the system during interaction;
- Offering the system as a hosted service, thus making monitoring, adaptation to users' needs and performance improvement easier.

The HANDS service is intended to be brought onto the European market as a domain independent online communication service, open to use in different contexts. To this end, each Pilot Site will test and validate the HANDS service in two different application domains, marking a significant step forward from the original EDEN R&D project, where the developed tools were validated in a unique application domain, Urban Planning.

The market evaluation process includes identification of managers and discussion of their preferences for sourcing and implementing an application such as HANDS.

3.2 Usability Evaluation

The acceptability of the pilot service is evaluated from the perspectives of the partners, citizen/customers in the target populations, officers and other stakeholders. The evaluation tests the assumption that the pilot enhances the appeal of online enquiry channels and in particular whether the benefits, if realised, are likely to increase take-up of the service among people who are current internet users and target service users. From internal users' and service management perspectives, the viability of the HANDS service will depend on its strengths and weaknesses relative to other solutions in the areas of integration, maintenance of content and linguistic resources, and user training and acceptance.

HANDS is an exercise in implementing the EDEN results, therefore it was logical in drawing up the evaluation framework to start by building on that project's experience. Developments since the original EDEN project – which started in 2001 – were reviewed and their implications for the evaluation of the HANDS tools considered, in the context of a broader e-government policy framework. Additionally, the greater business focus of the HANDS project was taken into account by carrying out a comparison with industry-standard management objectives.

The EDEN indicators were reviewed and adapted. Thus it should be possible to achieve some measure of assurance that the performance of the HANDS tools is comparable to their EDEN equivalents, while at the same time having an assurance that the chosen indicators are relevant and practicable.

The PBs contributed information on performance indicators for existing services and suggestions for preferred additional indicators were reviewed and used as the basis for organisational and management-oriented criteria.

4 Description of Application

4.1 The open source development environment

> "The need for greater interoperability, better security and cost-efficiency is attracting a growing interest among EU public administrations on the use of open source software (OSS). Indeed, OSS has several characteristics that fit particularly well the needs of public sector administrations. It allows organisations to share software and know-how and re-use it to build solutions adapted to their needs."
> *IDABC Open Source Software Observatory*[i]

Organisational acceptability is a critical factor for HANDS's success as a business application: the choice of underlying technology is only one factor that management will take into account. Perhaps more important is giving organisations and the decision makers confidence that HANDS will add value to their processes at an acceptable risk. As many EC-funded projects are now open source, HANDS will provide a useful exploration of OSS's potential for supporting a viable business model for the delivery of services based on an OSS platform

Pooling Open Source Software (POSS) [12] issued in June 2002 identified the requirements of a successful OSS projects. There is more to OSS than just the legal aspect: a successful OSS application exists within a community of users and developers to allow continuing improvement of the application to reflect real requirements. POSS identifies that the community in turn requires support from tools to support a common code repository and at the least the tracking of bugs, issues and feature requests.

At a high level then there is an awareness of the need to provide a framework to better support the dissemination of applications that are funded by the EC (see also [6] [7]). However, no effective resources are yet available for EC-funded projects leaving the application effectively on its own once development and marketing funding expires, a situation that would be no different if the code was proprietary.

By releasing HANDS as an open source software (OSS) application, the sale of software licences is no longer a viable source of revenue. In compensation alternative resources are will be investigated; although work has been done on the motivations of OSS developers (eg [4]), little is know about motivations of organisations participating in smaller OSS projects such as this.

4.2 Processes

This section describes HANDS from the perspective of the user. As an application with real world usefulness, it is not enough to demonstrate that the NLP engine is effective when properly trained, as described in the section 4.3 below. The application must provide tools to measure its performance and assist an organisation to track key indicators. This issue is considered, after an overview of the application as seen by the end-user.

The two tools that comprise HANDS, **Answer Tree** and **Address Guesser,** entail the processing of citizens' enquiries by computational linguistics technology or NLP. The NLP technology applied in HANDS (and EDEN) is summarised in section 4.4 below and described in detail elsewhere[3]

HANDS envisages that citizens with a question, comment or complaint can choose to go online and send a private message to the administration (via Address Guesser), perhaps first checking to see whether their concern is already addressed by a FAQ (Frequently Asked Question) in Answer Tree.

As the name suggests, the Answer Tree (AT) allows a topic tree to be browsed to find an answer. The AT can also be searched, and can respond to questions in natural language without the user needing to know how to use keywords effectively, or use Boolean operators to combine them. When contacting a Public Body (PB), many citizens neither know nor care about the administrative structures. In that case Address Guesser automatically identifies the most likely correct office, based on a comparison between the content of the message, and that of a compiled set of previous emails answered by each office.

The HANDS operator within the PB can provide feedback to continually improve the operation of HANDS by identifying misdirected Address Guesser emails and identifying candidate FAQs to be added to the Answer Tree system.

The HANDS service provides an integrated front end for all queries and it is intended to be capable of being extended to cover further domains over a period of time.

In the second phase of the project, the two HANDS applications described above will be integrated so that the user is seamlessly passed from the Answer Tree to the Address Guesser if they ask a question that cannot be answered from the existing FAQs.

We plan to establish the extent to which there is a demand for the application to provide information to support management of HANDS-supported services, in the form of indicators such as the percentage of unanswered (or mis-answered) AT questions week-by-week or the proportion of questions routed by AG that had to be allocated to another office. Our hypothesis is that trust in the application will depend on the continual improvement in the quality of the answers provided.

4.3 NLP and information retrieval

Before the technology used by HANDS is described, this section places NLP into a broader information retrieval (IR) context.

The TREC conferences[ii] have streams that deal with question answering [13] . NLP can be seen in this context as an alternative to indexing keywords as a tool for information retrieval. Keyword-based searches, such as is used by Google, Yahoo! and MSN have the advantage of being fully automatable and (relatively) language independent. However, a basic keyword based search cannot take context or meaning into account, so a search phrase such as ‘find me a thatcher in Lincoln’ is more likely to return links to national leaders than someone who can repair roofs in East Anglia, England. It can be seen that keyword-based searches work best when searching for products, companies and slogans while e-government services would be a natural domain for NLP.

Most modern search engines and text indexing tools have some adjustments for surface lexical variations but ultimately they are not designed to deal with synonyms. Instead, the user of the search engine has to understand how to use related keywords to narrow down the range of results; this approach works well for a minority of the population: the people who use the internet every day, and for whom information retrieval has become second nature.

The nature of e-government services is such that (1) many of the users (citizens) are not skilled users of information retrieval techniques and (2) even if they were, they are unlikely to know the exact terms that a particular PB would use to refer to the service they wish to know more about. By ‘understanding’ a sentence or sentence-fragment, an NLP-based IR engine is more likely to be able to identify the information that is actually being sought, even if when there are no directly matching words.

Achieving high participation (however defined: see Macintosh[8] for a fuller discussion) is often a central goal of e-government; this requires tools that support the large minority of citizens whose functional literacy is not high: 48% of the US population has low literacy according to Jakob Neilsen [9] . Although it may be that European figures are a little better, it can be seen that an e-government tool that does not require high skill levels with the written language will be at an advantage. For many users, being able to ask questions in their own language is likely to be a factor increasing take-up of e-government services.

There are other European projects that make use of semantic technologies. For example, QUALEG [5] [11] assign meanings to ambiguous search terms by combining manually created ontologies with contexts automatically created by agents used for data integration.. A combination of two autonomous agents are used: language-independent knowledge extraction, and an opinion analyser which "uses techniques from IR and NLP to improve content understanding" ([5] section 5). It is interesting to note that the knowledge-extraction agent delivered the higher precision and recall scores, emphasising the challenge faced by all NLP-based tools.

It must be recognised that NLP applications come at a cost: considerable and skilled upfront effort is required to (1) create a grammar for the language and (2) input and structure a vocabulary for the search domain(s). These are real issued that have to be taken into account when evaluating the viability of the service in a live situation.

4.4 Underlying technology

This section gives a brief overview of the technology involved, focussing on the underlying Linguistic Engine (LE).

As illustrated in Figure 1, HANDS can be visualised as consisting of three layers, supported by authentication and administration sub-systems.

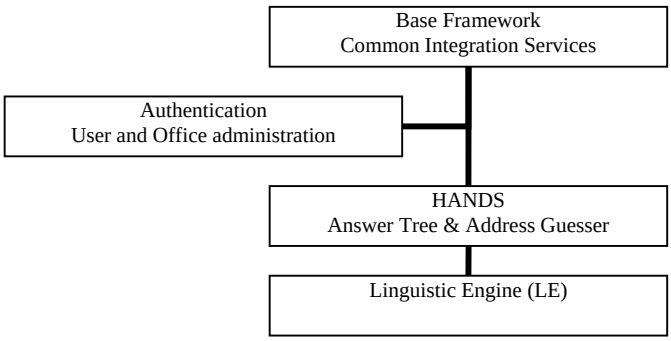

Figure 1: HANDS Service Architecture

The LE is the module for performing a linguistic analysis of user input. The system is composed of four main modules:

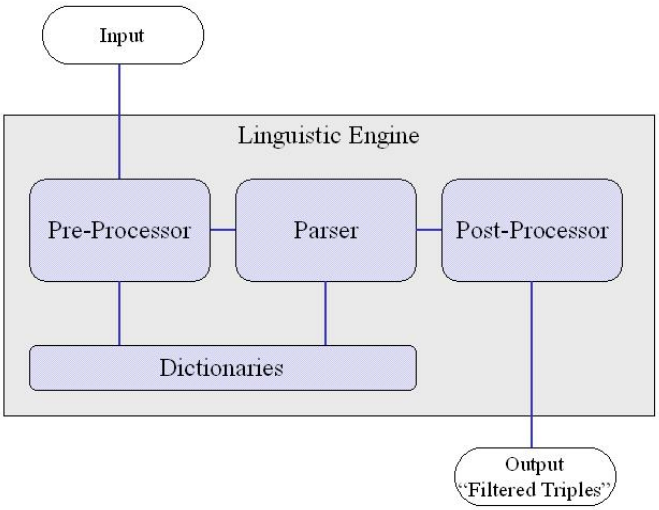

Figure 2 Information flow in the HANDS Linguistic Engine

1. The dictionary, containing lexical data (morpho-syntactic information about words);
2. The pre-processor, which processes user's input by tagging linguistic entities (such as dates, proper names, numerical expressions) and converting special characters (such as quotes, line feeds, language-specific characters) to a standard format;
3. The parser, which analyses the pre-processed text by applying lexical information and grammatical rules, and returns lists of syntactic constituents (such as noun or verbal groups, or complex clauses);
4. The post-processor, which processes the parsing results according to criteria defined by the user, and prints/sends out results in the form of triples (e.g., Question-type – verb – subject) which are the used by the higher level tools: Answer Tree and Address Guesser.

All four modules are language-dependent: a localised version is needed for each targeted natural language. The LE is based on an Augmented Phrase Structure Grammar (APSG) [3] . Grammars currently exist for Italian, English, Dutch and German. In EDEN, it proved relatively straightforward to adapt the Dutch grammar for German [2]

5 Developments & Results

The HANDS service is being implemented and validated in three European Public Administrations (PAs) - Bologna, Edinburgh and Saarbrücken - and one Public Utility, Enìa. As a utility, Enìa represents a new market in comparison with the R&D phase of the project, which was limited to the PA's environment. Table 1 contains a full list of test domains for each pilot site.

Table 1 Domains used at HANDS Pilot Sites

Bologna	Youth information service (Informagiovani)
	Transport Information Service (Mobilità)
Edinburgh	Pest Control & Bereavement
	School information service
Enìa	Citizen Information
	School liaison
Saarbrücken	Internal IT support (aimed at the PA's employees only)
	Statistics and elections.

The range of domains provides a series of challenges to the technology, allowing evaluation of its effectiveness in a variety of use-cases, with differing balances of FAQ and individual responses, and testing the ability to deliver information relevant to the sub-domain of enquiry.

HANDS has been installed at the pilot sites and the process of engaging management in the evaluation process has begun. Tools have been developed to measure the information retrieval (IR) performance of the application. As seen in Table 2, validation figures for the two initial sites show satisfactory results for the retrieval of 100 sample questions designed to test the response across the domains, allowing us to proceed to allowing external users access to the site for real-world evaluation.

Table 2 IR validation results

Tool	**AT**			**AG**
Measure	MRR	Mean Recall	MAP	Mean Recall
Target	0.75	0.90	0.50	0.90
Bologna	**0.86**	**0.74**	**0.49**	**0.87**
Enìa	**0.96**	**0.96**	**0.54**	**0.91**

Key: MRR = Mean Reciprocal Rank, MAP = Mean Average Precision

In parallel, to investigate the potential market requirements, the TeleCities conference held in Glasgow in June 2006 was chosen as the location for preliminary evaluation by individuals representing a sample of PBs. A significant level of interest was shown in the application's potential and also have brought out the issues that will have to be addressed during the second phase of the evaluation cycle, including:

- The model for joining the HANDS consortium
- How a business manager can monitor progress in dealing with questions
- Keeping the information up to date, and whether and how the system can learn what information is missing
- How to go about adding support for a new language (eg Dutch, Swedish) to the system

Potential users of the service were seen as English as Second Language users (including asylum seekers) and businesses. These findings will be used to inform planning for the next phase of market testing.

6 Conclusions

The overarching advantages of the HANDS service lie in the opportunity for the Public Bodies to offer a single point of access where end users (who will not necessarily be skilled users of search techniques) can smoothly interact with a system based on Web technologies; and on the possibility for the Public Bodies' officers to have at their disposal a tool supporting advanced facilities to interact with the end-users in a standardised way.

The Customer Relationship Management (CRM) market continues to show the need of advanced search engines that guarantee a high level of interaction between an organisation and its users, in order to decrease customer care costs and guarantee a high quality in support and information services.

NLP is a key technology in the process aiming at improving information retrieval services and Question/Answer engines currently represent the best way to interact with www sites.

Compared with existing portal FAQ and search engines, HANDS provides improved interaction with websites and access to knowledge repositories; and a change in the traditional information retrieval perspective through the adoption of a user-centric approach by not requiring users to understand how to manage the information retrieval process by combining keywords.

If successful, HANDS should support enquirers by providing faster and more accurate targeting of their enquiry when they do not know whom to contact. It should increase the cost-effectiveness of Public Body offices by reducing overall time per response and by providing an overview of 'burning issues' according to localities and target groups. Having direct access to information should stimulate an increase in the number of people accessing information, reducing the workload in responding to routine enquiries.

At an operational level, the main outstanding issue is to identify the requirements to ensure that HANDS can be integrated into routine business processes.

HANDS provides an opportunity for creating a business model for the delivery of services based on an European-funded OSS platform.

Further work will be carried out to understand management and organisational requirements, including managing the different risk profiles of OSS applications.

We will continue to investigate a model for the continued support and development of the application, to allow the project partners to select between a consortium based around a community of committed user/developers, or a consultancy firm that has a revenue model that encourages further development of the code, even though the work will be publicly available.

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[i] *http://ec.europa.eu/idabc/en/document/2627/5894, accessed 27 June 2006*

[ii] The Text REtrieval Conference (TREC - http://trec.nist.gov/) is an on-going series of workshops focusing on a list of different information retrieval (IR) research areas, or tracks. It is co-sponsored by the National Institute of Standards and Technology (NIST) and Advanced Research and Development Activity (ARDA) centre of the U.S. Department of Defense