Breast Cancer Knowledge On Line Portal: an Intelligent Decision Support System Perspective

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Abstract

Information provision over the Internet offers little by way of "intelligently" assisting users in retrieving personally relevant information. Web portals are envisaged as tools for matching users information needs in order to enhance their ability for decision-making. This paper looks at portals as a new type of intelligent decision support systems, which incorporate problem domain knowledge in order to improve efficiency in information provision. The main focus of the paper is in suggesting how certain characteristics of an intelligent decision support system can be implemented in a portal, which seeks to deliver personalised information to support efficient healthcare decision-making.

Keywords

Portal, decision support systems, health care, information retrieval, metadata

INTRODUCTION

The Breast Cancer Knowledge Online (BCKOnline) project addresses the challenge of meeting the diverse information needs of women with breast cancer and their families through the provision of timely, relevant information to support decision-making via a portal (Fisher et al 2002). Previous research highlights significant problems users have with information searches particularly when related to searching the Internet for health information. The key problems include the quantity of information with users often feeling swamped, the quality and authority of the information presented, the level to which the information is sufficiently specific for the individual and the extent to which it meets the individual's needs.

The role that has been envisaged for the BCKO portal is one of an online resource serving multiple purposes to support informed decision making, provide authoritative, relevant health care and related information to users, manage the quantity of information presented and provide information about the quality and provenance of the information accessed using metadata. This paper builds on research presented at an earlier ACIS conference and reports on current progress.

Information provision for decision support over the Internet offers little by way of "intelligently" assisting a user in retrieving personally relevant information. Web portals are envisaged as tools for matching users information needs in order to enhance their ability for decision-making. Current literature on web-based decision support and expert systems identifies a shift from considering them as purely analytical tools to a more comprehensive environment for supporting efficient information provision and processing based on good understanding of the problem context. Such intelligent decision support systems incorporate problem domain knowledge to improve their information provision capabilities. Web portals connect people with information and applications they need for performing tasks. Unlike a conventional website, a portal should support both push (subscription) and pull (search) functions in assisting users to gain access to essential situated information. In this sense portals can play the role of a new type of intelligent decision support system, which incorporates problem domain knowledge in order to provide differentiated information access.

Information provision is frequently facilitated using metadata description of the information resources as a mechanism for describing context, content, structural and management information about the resource (Asprey and Middleton, 2003). Such metadata is partly already available in the context of Internet resource description

due to Internet initiatives such as the Dublin Core Metadata Initiative (DCMI, 1995-2003) and the Dublin Core-based Australian Standard AGLS metadata schema (AGLS, 1998). However, we argue that metadata can also provide a mechanism to incorporate "user-centric" resource description, which can be utilised to better meet information needs of the users. Such description requires expert knowledge within the domain and a good understanding of the context the resources will be used in. Intelligent decision support systems were expected to act as mediators between the user-decision maker, the database and a model-base aiming to meet the user's information needs. The intelligence of such a system depends on how well it "knows" what those expectations are and on the quality of the information it has access to. In the BCKOnline portal such information can be drawn from the metadata schema.

The paper aims to assess the role of BCKOnline portal as an intelligent decision support tool. Further it aims to review the functionality of such a portal as compared to conventional decision support and expert systems.

PREVIOUS RESEARCH

The project discussed in this paper has a number of phases.

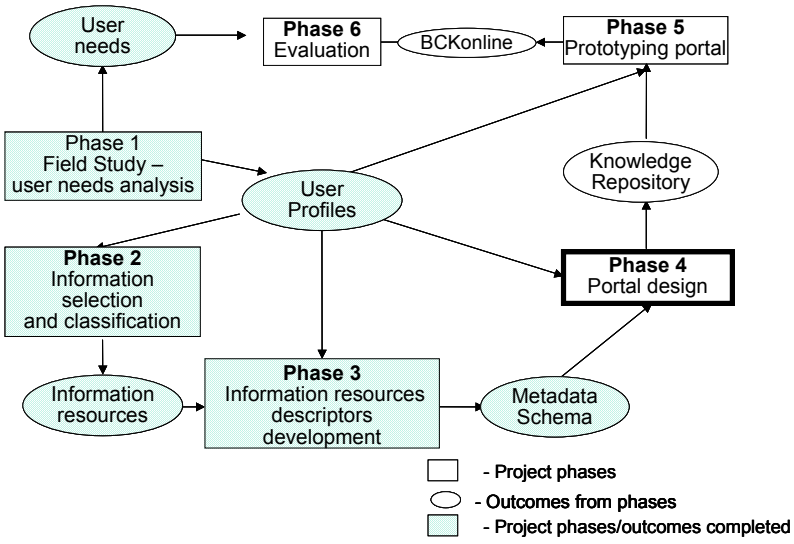

Figure 1 Breast Cancer Online Project Phases

Figure 1 illustrates the stages of the project that have been completed and previously reported on (Fisher et al 2002; Williamson, and Manaszewicz, 2003). Focus groups have been held with women with breast cancer and their information needs identified. Phases 2 and 3 are currently being completed and will be reported later. The use of metadata as a way of classifying information for better information retrieval has been explored. The AGLS metadata schema has been adopted as a starting point and extended with specific elements for describing information items to be stored in the BCKOnline repository. However, a detailed discussion of the metadata approach to the resource discovery and provision is outside the scope of this paper.

This paper focuses on the Portal Design stage (Phase 4). Although the BCKOnline portal provides a gateway to information and services in the health and medical areas, for the purpose of this paper the portal is treated in a generic way.

INFORMATION PORTALS

An information portal is not a new concept (White 2000). There are numerous portals acting as 'gateways' to information and services as well as a taxonomy of the various types of portals based on their functionality (Firestone, 2003). The taxonomy, as described by Firestone (2003), comprises four major types of portals:

a) Enterprise information portals (EIP) – connecting people with information by organizing large collections of content on the basis of subjects or themes;

b) Collaborative portals – enabling teams of users to establish virtual communities;

c) Expertise portals – linking people based on their skills and expertise and

d) Knowledge portals- doing everything the first three types do and something "more" (Firestone, 2003).

The first type, EIP, is the most appropriate type for the purpose of this project. An enterprise information portal can also be defined as "… a single gateway connected by a server that connects people with information. It allows you to get access to services, software applications and a variety of information" (Harvard Computing Group, 2002). Shilakes and Tylman (1998, p. 1) define information portals as applications that unlock internally and externally stored information, and provide users with a single gateway to personalized information to make informed decisions. In this sense EIP can be seen as a decision support tool, which can take an active role in helping the users define and meet their information needs. To achieve this goal a portal requires a special interface and built-in knowledge about the problem domain in order to guide the users intelligently through the process of locating and delivering quality information sources. A sceptic would say that the term 'portal' no longer provides any definite meaning given the number of software products that are now touted as having some type of portal functionality. Using the generic term 'portal' could mean little more than a Lotus Notes database, with a web interface. However, there is a role for portals as intelligent decision support systems that has not been fully explored yet.

The emphasis in this paper is on a portal as a *decision support* facility and a new type of an *expert system* that is capable of providing comprehensive support to meet the diverse and changing needs of individual users and to '*add-value*' by enabling users to judge the quality and reliability of the information provided. Such a portal will not make decisions for the users but will provide them with the kind of information they need to make informed decisions for themselves.

For example, the BCKOnline portal aims to support individual needs for quality information and also meet users' differential needs. The users are expected to refer to the BCKOnline portal when they are seeking information to help resolve problems or inform decision-making for themselves and/or their family and friends in relation to breast cancer. Note that the intelligence in the BCKOnline portal is related to the translation of the user needs analysis into user sensitive resource description and interface design, NOT in the system functionality itself.

DECISION SUPPORT SYSTEMS AND EXPERT SYSTEMS

Decision support systems (DSS) over time have become increasingly sophisticated, making use of models from a variety of disciplines ranging from artificial intelligence, operations research, and management science. Systems that use artificial intelligence techniques are often referred to as expert systems (ES) or knowledge-based systems (Dhar and Stein, 1997, p.2). This section reviews decision support and expert systems concepts in relation to the potential of an information portal to play these roles.

A DSS is an interactive, computer-based information system that utilizes decision rules and models, coupled with a comprehensive database (Turban and Watkins, 1986). A properly designed decision support system is expected to improve the effectiveness of a decision maker by providing a powerful modelling and data analysis tool (Bidgoli, 1990). A typical DSS includes three components: database, model base and dialog management (Bidgoli, 1993).

An ES on the other hand, is a computer program that includes a knowledge base containing an expert's knowledge for a particular problem domain, and a reasoning mechanism for propagating inferences over the knowledge base (Turban and Watkins, 1986). Updating and maintaining the knowledge base and enhancing the capability of the inference engine are central to an ES (Raggad and Gargano, 1999). Knowledge based systems are a broader term to define computerise systems, which capture some expertise in a computable form and make it available to the user needing expert advice about this context specific knowledge. This knowledge can be sourced from individual experts, collective explicit knowledge of the professional group or some other published material.

There are several fundamental differences between these two technologies. Most importantly, the objectives of the two approaches are different. The DSS supports people making decisions, while the ES operates as an advisor. The DSS database contains facts whereas in ES the knowledge base contains, in addition to facts, procedures for problem solving. An ES by definition exhibits reasoning capability, DSS does not. Furthermore, in the DSS environment the user asks the system questions before reaching a decision, whereas in the ES environment the system asks the user questions before reaching a decision (Bidgoli, 1993).

These distinctions between the DSS and ES are of limited use for the purposes of a portal from the decision maker's standpoint. This is a consequence of an inability to provide adequate "intelligence" in the case of a DSS and lack of personalized information in the case of an ES. The user needs help with the analysis to make good decisions (Dhar and Stein, 1997, p.3). Thus, if a portal is to play a role in addressing these needs effectively, it requires an integration of decision support system features and some of expert system functionality. Such

integration has been addressed by introducing the concept of Intelligent Decision Support System (Turban and Watkins, 1986).

An Intelligent Decision Support System (IDSS)

Despite their differences there is a strong sense in the literature that AI-related technologies such as expert systems can improve the quality of today's DSS and vice versa, for instance existing expert systems can be used as independent computerized systems similar to DSS systems, advising users on a specific problem area. The integration of ES and DSS can offer a more balanced system containing expert knowledge and reasoning and explanation capabilities, with greater emphasis on the end-user profiles. DSS/ES integration benefits can be realized along several dimensions: the ES contribution, DSS contribution, and the synergies resulting from the DSS/ES contribution. Turban and Watkins (1986) describe possible theoretical models of integration by adapting an existing DSS system to perform in an ES style. Such adapted systems are considered by many to be *intelligent decision support systems* (IDSS) (Turban and Watkins, 1986; Hollnagel, 1986; Norman, 1986; Bidgoli, 1993) with the focus on the functioning of 'man and machine' together. Despite the complexity of the integration process, recent literature suggests there are promising signs for the integration of DSS and expert systems.

An IDSS is more of a cognitive rather than a technological system. The fundamental difference is that even basic characteristics of intelligence cannot be captured in mechanistic terms (Hollnagel, 1986, Burstein et al, 1994, Linger and Burstein, 1997). Conversely, a cognitive system,

"produces 'intelligent action', that is, its behavior is goal oriented, based on symbol manipulation and uses knowledge of the world (heuristic knowledge) for guidance. Furthermore, a cognitive system is adaptive and able to view a problem in more than one way. A cognitive system operated using knowledge about itself and the environment, in the sense that it is able to plan and modify its actions on the basis of that knowledge. It is thus not only data driven, but also concept driven." (Hollnagel and Woods, 1983)

From this definition, a number of characteristics of cognitive systems may be derived. Of interest to this paper are the minimum defining characteristics required of an IDSS as a cognitive system and an expert/decision support system that can then be implemented in a portal. In this context, a system requires functionality that is currently absent from the traditional model-based decision support systems (DSS); mainly learning, memory and reasoning. Portal-based implementation provides an opportunity to collect and store context-specific knowledge with the aim of building in learning capabilities in the future based on analysing patterns of use of existing and desired content of the facility.

IDSS Functionality for Portal

This section discusses a minimum functionality that a portal should have to make it an IDSS. We have identified intelligent information retrieval, a knowledge repository and memory, an explanation facility, information classification and prioritising; adaptivity and personalisation as major characteristics essential for a portal as an IDSS. A portal with these features is capable of providing users with personalized information to make informed decisions, as per the general definition of a portal presented earlier in this paper.

Knowledge repository and memory

An information portal plays the role of a gateway to relevant information for users. To satisfy this role it has to have some knowledge of its purpose, the context it is built to serve, and its audience of users. As such a portal may not contain information resources within its physical infrastructure, but has to have a knowledge base, which contains the context model, user model and some mechanism of matching between the two. This knowledge repository can initially be created based on problem domain knowledge representation. However, due to the dynamic nature of knowledge this repository needs to be constantly updated and maintained. Such maintenance is an essential feature of a true intelligent DSS. It converts a knowledge repository into a dynamic memory system (Linger and Burstein, 1997).

Intelligent information retrieval

The goal of information retrieval (IR) is to retrieve only the documents relevant to a user's information needs. A better way to understand the characteristics of information retrieval is by studying it in relation to data retrieval. Information retrieval is quite often mistaken for data retrieval. Although the boundary between data retrieval and information retrieval is often quite vague, nevertheless different ranges of complexity are associated with each mode of retrieval (Rijsbergen, 1979).

In data retrieval (DR) one normally looks for an exact match, checking to see whether an item is or is not present in the file. In information retrieval, this may sometimes be of interest but more generally one wants to

find those items which partially match the request and then select from those a few of the best matching ones. As a result in DR the query is generally a complete specification of what is wanted, in IR it is invariably incomplete. The extent of the match in IR is assumed to indicate the likelihood of the relevance of that item (Rijsbergen, 1979). One simple consequence of this difference is that DR is more sensitive to error in that, an error in matching will not retrieve the wanted item which implies a total failure of the system. In IR, small errors in matching generally do not significantly affect system performance.

Consequently a good IR model is one which gives each document a relevance estimation as close as possible to the user's own relevance judgment (Nie and Lepage, 1998). This idea of *relevance* is what is at the centre of information retrieval. The purpose of a retrieval strategy is to retrieve all the relevant documents and at the same time retrieving as few of the non-relevant as possible. When the characterisation of a document is determined, it should be such that when the document it represents is relevant to a query, it will enable the document to be retrieved in response to that query (Rijsbergen, 1979).

Furthermore, the cognitive relevance for information retrieval is not just based on the relationship between a document and the topic of a query but rather it is a 'document-query' relationship within a certain context and as such establishes *situation dependent relevance* (Nie and Lepage, 1998). A cognitive IR model can be contrasted with a computational model as shown in Figure 2.

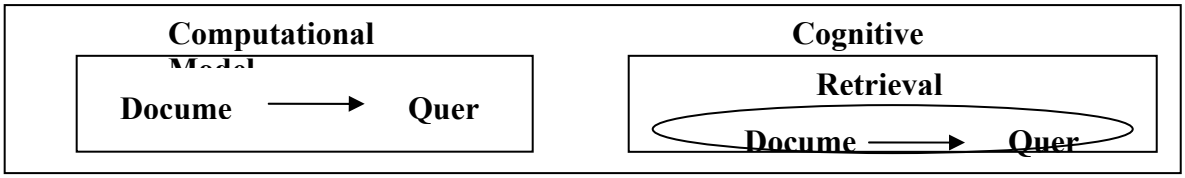

Figure 2 A view of computational models and cognitive models (Nie and Lepage, 1998, p.18)

In principle, although situation dependent retrieval seems simple and logical, it is very difficult to implement. Quite often it relies on classification-based technology that has evolved as part of knowledge representation research and can be based on semantic networks (Gregor, 1991).

The success of the implementation of a true context-based retrieval system depends on the quality of the cognitive model and ability to explicitly match the user's context with the captured model in the context of the document. Some of this context-related information can be incorporated into the document metadata. For example, the AGLS metadata schema includes an element called *Audience*, which defines who this information may be relevant to. Many portal search engines combine full text search with metadata search. So if information about the context is expressed as part of a document's metadata it can help to increase search efficiency and retrieval as well as reduce search time (Asprey and Middleton, 2003). Context-related metadata information can also be useful when displaying to the user a summary of search results rather than the entire document.

Adaptivity and personalisation

An adaptive system is continually attempting to configure itself so as to match the input data. It is a flexible yet rigid system. That is, although it is always adapting to mirror the arriving data, it does so by means of pre-coded existing knowledge and within existing configurations. A special consequence of adaptivity is multiviability (Hollnagel, 1986). It means that a system can reach its goal in more ways than one, and it implies that the choice of a particular way is based on knowledge of the characteristics and requirements of the current situation, rather than being random. "The ability to choose an appropriate way to the goal means that the system is "intelligent" (Hollnagel, 1986) agreeing with the general notion that intelligence characterizes the means rather than the end. A fundamental and essential aspect of adaptive systems behaviour is learning (Norman, 1986). Raggad and Gargano (1999) defined learning as the ability of the ES to improve system recommendations based on experience. They also provide a model for ES learning that incorporates three components: a learner, an evaluator, and a testing case store as illustrated in Figure 3.

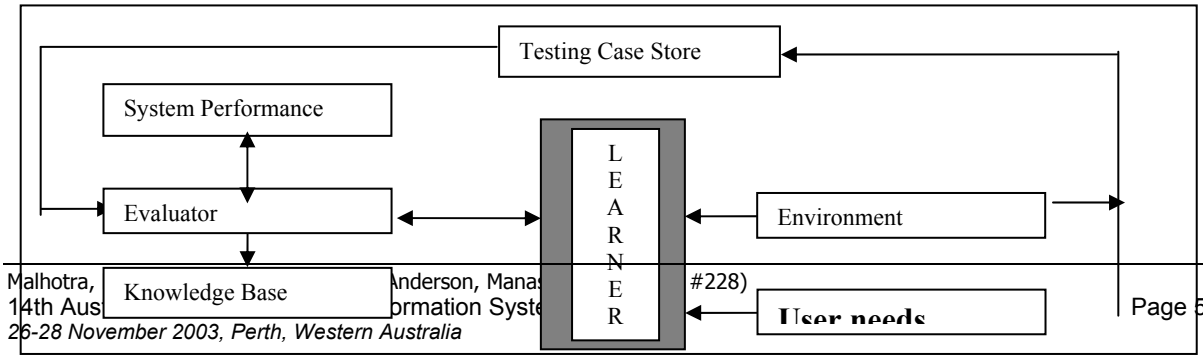

Figure 3 Expert System Learning Model (Raggad and Gargano, 1999)

The main functionality outlined in their model is that information is fed to the learner, which is then evaluated by the evaluator by comparing it with a number of random cases taken from the testing case store. If the performance of the ES is high then the new knowledge is added to the knowledge base.

Personalisation has the ability to provide differentiated information access to users and is one of the major features, which distinguish them from conventional websites. In this sense, the model presented in Figure 3 can be applied to describe the operational behaviour of a portal. A Testing Case Store is equivalent to pre-defined user profiles, which are used by a portal interface to identify relevant information from the knowledge base. Existing "intelligent" portals "learn" about the information needs of individual users by analyzing patterns of previous information seeking behaviour. Thus commercial services such as amazon.com can provide individual users with information about new publications that might be relevant to them on the basis of their previous information seeking and purchasing behaviour.

Information classification and prioritising

Users can become overloaded and distracted when many events occur in a short time period. This can happen when they need to either continually change focus to deal with new arriving information or focus upon what might turn out to be not critically relevant aspects of the situation (Norman, 1986). This is where an IDSS can play a major role. The goal of an IDSS should be to classify and prioritize the information and advise the user on various aspects of the quality of the information.

A number of web-specific studies highlight various aspects of human behaviour focusing specifically on web-based information seeking (Ford, et al., 2002). The study of users' interaction with web search engines is an important and emerging research area with implications for the development of more effective web-based human-computer interaction models, search engines and interfaces (Spink, et al., 2000). Ranking is particularly important in web-based information seeking insofar as web searchers on average, display only the first ten retrieved items (Ford, et al., 2002) where a page is a group of ten results. Ranked systems are best used for higher recall than precision (Jones, 1999). The advantage of relevance ranking is that although it does not guarantee complete recall, it brings more relevant documents to the top of the list. The larger and more heterogeneous 'the collection' of documents the more difficult it may be to achieve sufficiently high precision to ensure that relevant retrieved items will be presented within a number of pages acceptable to many searchers. Thus arguably search techniques like Boolean searching which lack ranking capability are at a disadvantage in the context of web searching on portals. Jansen and Pooch (2001) in reviewing these studies argue:

".....the vast majority of web searchers use approximately two terms in a query, have two queries per session, do not use complex query syntax, and typically view no more than 10 documents from the results list. Use of Boolean operators in web queries is almost non-existent, ranging from 2% to 8%." (Jansen and Pooch, 2001)

Classification and prioritising information is used in portals as a part of a mechanism for differentiated information provision. The amount and form of the information to be presented to the user can also be controlled through this mechanism and initial dialog with the users at the time they define their profiles.

Explanation facility

In principle an intelligent system needs to be capable of explaining to users both the knowledge they contain and the reasoning processes they go through. Since the advent of advice-giving intelligent computer systems, explanation facilities have been one of their important and valued features (Gregor and Benbasat, 1999). Explanations, by virtue of making the performance of a system transparent to its users, are influential for user acceptance of intelligent systems and for improving users' trust in the advice provided. The reasons for including explanations in intelligent systems are that they have been clearly shown when suitably designed, to improve performance, learning and result in more positive user perceptions of a system (Gregor and Benbasat, 1999). For example, the developers of a hospital patient system advocate "Intelligent Assistant" to be delivered via the Internet found that an explanation facility was necessary to give patients information about their health conditions (Miksch, et al., 1997).

In a portal context users may be interested to know, why the information provided is regarded as relevant and valid. Some form of explanation is therefore necessary. It can come in a form of ratings or references, based on assessments from the previous users of the information. This facility can also be implemented as part of the quality assessment procedures captured in a sub-set of the metadata elements.

IDSS APPROACH FOR BCKO

The BCKOnline portal aims to optimise efficiency in providing users with relevant information. This is achieved by implementing a metadata repository and user-centric information resources description. The BCKOnline portal as an interactive web-based personalised information system exhibits some basic features of an IDSS as described above. This section analyses to what extent the BCKOnline portal supports the functionality of an IDSS.

Metadata Repository of User Centric Resource Descriptions

To be user sensitive, the portal needs to know the women's differentiated breast cancer information needs, and it needs rich contextual information about breast cancer information resources. Most online search engines rely on free-text searching – they examine and index the content of online documents, looking for word patterns and associations.

Given the highly contingent needs of women with breast cancer, and their concerns with the quality and reliability of the information they are seeking, the BCKOnline team has developed complex user profiles based on extensive analysis of the diverse characteristics and differentiated information needs of members of the breast cancer community. These profiles have been used to develop a set of descriptors; a metadata schema, which will enable breast cancer information resources to be catalogued in an online database with reference to the information needs of their target audiences. Usually online catalogues or metadata repositories contain descriptions of information resources that are "resource-centric" – they describe the resource in terms of *Attributes: Author, Publisher, Title, Subjectt.* Search engines are given access to contextual information about the resource, but not the user. The BCKOnline contains a metadata repository, which is a catalogue of resources that describes resources in this conventional way, but will also include "user-centric" resource descriptors. For example, the metadata stored in this catalogue includes information about target audience, how to access the resource if it is available offline, restrictions associated with its use, and information about quality and reliability. By referring to the descriptions of information resources in its metadata repository, the portal will "know" that a particular resource is highly relevant to women in an early stage of breast cancer, is written in plain English, and includes information about the most common treatments. It will also "know" which resources include useful information about the availability of treatment and support services for rural women, and which contain stories and anecdotes sharing breast cancer experiences. The quality of the resource is described in relation to the credentials of the writer, the type of organization responsible for the web site, the currency and evidence base of the information, and whether the information provided represents a consensus of medical opinion or is controversial. The "intelligence" available to the portal in its metadata repository will enable it to match the users' queries with resources most relevant to that user and provide them with useful contextual information to help them assess their value and interpret them. Creation of such a metadata repository is impossible without deep understanding of the problem domain and has to involve domain experts. Effectively, it becomes a knowledge base in the context of IDSS.

The portal interface is another "user sensitive" component of the portal. It will enable users to create their own user profile and define their information needs in terms of variables such as disease stage, age, life-style, information preferences, and specific information queries. To help them to do this, the portal will present them with a range of "mix and match" options based on the diverse characteristics and information-needs patterns of the breast cancer community that are built in to the portal. The portal matches individual user profiles with relevant resources, using the context rich, user-centric resource descriptions in its metadata repository. Information about resource quality and availability (for offline resources or those not freely available online) will also be provided. The portal will combine metadata-driven searches with free-text searching within the metadata repository to deliver precise outcomes for its users.

Intelligent characteristics in BCKOnline portal

Knowledge repository and memory

The BCKOnline portal knowledge repository consists of a metadata catalogue. Selection and description of the information resources to populate this repository requires the involvement of domain experts and is based on their subjective knowledge. Some of this knowledge is based on publicly approved policies and procedures, for example information related to the status of a medical publication, or government schema for service provision. However, when selecting reflections of the disease experience and personal stories of other patients, expert judgment is needed to relate the content to the types of users this information may be relevant to. The quality of this information is also assessed subjectively. In this sense, the BCKOnline portal captures expert knowledge and can be suggested as a new type of expert system. It is essential that this repository is regularly reviewed and

updated to reflect the state of the art information about research and treatment of breast cancer. Maintenance of this repository will be facilitated by people involved in the Brest Cancer Action Group.

Intelligent information retrieval

With the aim of building the portal as an IDSS, it becomes imperative to adopt a cognitive rather than a computational information retrieval model, which maps with the portal's objective of providing differentiated access to resources. We use user profiles as the means of building 'situation dependent relevance' within the portal. The user's first interaction with the system involves selecting values for a predefined profile, which she belongs to. Her selection will be based on what she perceives as the best match of her circumstances, eg age group, the stage of the disease, family status and information style preference (eg scientific, plain, brief or detailed). The system will match this input with the metadata description of the resources in order to establish the relevance. Hence, for the purposes of the BCKOnline portal an operational definition of 'user profiles' relates not so much to the more traditional way of storing personal information of users in repositories, as to generating a dynamic description of a particular user to facilitate the metadata driven search. This results in providing the user with value-added expertly assessed information from the pre-selected portal repository.

Adaptivity and personalisation

The personalisation of BCKOnline portal is achieved through use of user-centric resource descriptors and profiling. The BCKOnline portal is not adaptive by itself. Adaptivity will be implemented primarily through knowledge repository maintenance based on expert input and evaluation of portal usage. It is envisaged that certain statistical information will be collected about the level of usage and needs for certain resources. Other learning mechanisms to ensure continuous growth of the system may be considered in the future. If implemented using suitable technology (eg Autonomy Knowledge Server was considered) such information can be collected automatically. Systematic analysis of data will trigger further improvement of the content of the portal's knowledge base to suit user needs. However, these mechanisms have not yet been explored within the current scope of the project.

Information classification and prioritising

The literature argues that before the results of a query are displayed to the user it is important to address the quality of the results. Information retrieval based on a meta-data search is guaranteed to bring back quality relevant information, which matches the needs of a certain user category. Quality rating and classification of results will also be employed to achieve this aim within the BCKOnline portal.

Through the user needs analysis it became apparent that women with breast cancer require different types of information to better inform their decision-making. For example, making decisions relating to treatments, care, lifestyle etc requires different types of information. It was recognised that to help in the decision making process these needs had to be addressed by the BCKOnline portal in its role as an IDSS. These types of information were classified into three broad categories:

- Medical - information about treatment and management of the disease, such as various treatment options; clinical trial reports, drug news.
- Supportive - the effect of the disease on the patient and her family, aspects of social and psychological functioning, facilitative information which may include addresses of support groups, government assistance information etc.
- Personal - information based on the reflection of the disease experience including its treatment rigours and incorporation of stories of other patients.

These categories form the basis for addressing users' needs in terms of the type of information resources that will be provided through the BCKOnline portal. For example, a user may want information on one of the cancer treatment drugs, tamoxifen. However, she could want medical style information explaining the purpose of the drug, or may be more interested in personal accounts of side effects (personal), or government subsidies for the drug (supportive). The portal should contain all of these types of information and treat them as different categories in order to satisfy users needs.

Explanation facility

The explanation facility as part of the BCKOnline portal is envisaged as being conducted through quality control of the information resources categorised within the portal's repository. The portal aims to empower the users to make better-informed decisions by capturing and providing expert knowledge about the quality of the selected resources available through the portal. The user will have an opportunity to see the explanation of the quality rating as a part of functionality. The output results will include an option of displaying the *Quality* element and its qualifiers. They include the credentials of the Creator/Publisher/Contributor, eg, lay author(s),

clinician(s), researcher(s), consumer group, commercial body/group, educational institution, government body, medical organisation or cancer organisation; information currency; the review process that the document was subjected to; whether the information is evidence based; its purpose, eg. educational/informative, commercial, reportage of results, discussion forum; and the degree to which the resource represents a consensus view or is controversial in nature.

DISCUSSION AND CONCLUSION

From the presented analysis it is clear that the BCKOnline portal exhibits major features which qualify it it to be treated as an IDSS. Table 1 summarizes the ways IDSS functionality is implemented in the BCKOnline portal.

This paper has examined the extent to which a portal can support more intelligent information provision for decision support. Information provision via the web often relies on searching based on full text. This requires sophisticated skills on the part of the user, which they often do not possess. The consequence is often inadequate results and user dissatisfaction. In the health arena, particularly for women with breast cancer, timely information tailored to individual needs can be critical for informed decision-making.

Table 1. IDSS functionality and how it has been implemented in BCKOnline portal

IDSS functionality	***BCKOnline functionality***	***Ways of implementation***
Knowledge repository and memory	Metadata repository	User-centered content selection and metadata records
Intelligent information retrieval	Interface based on profile selection for providing relevant information on request	Metadata-driven search based on user profiling and user-centred resource description
a) Information classification b) Prioritising	Three types of information resources were identified – medical, supportive and personal; Not currently implemented	User-centered resource description
Explanation facility	Display of *Quality* element and its qualifiers	User-centered resource description and metadata-based retrieval
a) Personalisation b) Adaptivity	Information retrieval based on user selected profiles, which match their current circumstances. Learning from usage patterns. Not currently implemented.	User-centred resource description and profiling Future implementation

In summary, we examined an information portal as a gateway - a single point of access - to information resources. A successful portal must go beyond the need for process improvement, data visibility, and improved decision-making, all through a common platform. For effective information provision a portal as an integrated intelligent system is much more powerful than as a stand alone DSS or an ES system. In this paper we have argued that a portal as an information gateway is an intelligent DSS. As an IDSS, the portal needs to exhibit at a minimum level five core functionalities, including knowledge repository and memory, intelligent information retrieval, information classification and prioritisation, explanation facility, personalisation and adaptivity.

To illustrate this we considered how the BCKOnline portal could play the role of an IDSS. The BCKOnline portal design is based on extensive use of metadata for user-centric resource description and profiling. It implements a metadata-driven search, based on built-in knowledge about the problem domain encoded into a metadata schema in order to guide the users intelligently through the process of locating and delivering quality information.

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