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An online public access catalogue (OPAC) for university library end users using TRS: project and prototype

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AN ONLINE PUBLIC ACCESS CATALOGUE (OPAC) FOR UNIVERSITY LIBRARY END-USERS USING TRS: PROJECT AND PROTOTYPE

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ABSTRACT

This paper reports the initial results of the design and development of an OPAC prototype which has been developed to interact with the software tool of the Italian National Project of library automation which operates in the NATURAL and ADABAS environment. The OPAC prototype has been designed to operate for end-users of an university complex library system.
The design and development project of the OPAC prototype has been organised into three main steps: identification of end-user's categories and analysis and design of end-user's requirements; design of functional specifications of an OPAC for university library end-users; design and development of the OPAC prototype.
The paper presents the state of advancement of the prototype using the three steps of the project as guidelines of the presentation.

1. INTRODUCTION

The four Universities of the Region of Veneto (the University of Padua, the two Universities of Venice, and the University of Verona) have launched a project to design a prototype of a third-generation OPAC (Online Public Access Catalogue) for the retrieval of information from the bibliographic database of the universities.

The libraries database is managed by one of the software tools which have been designed and developed for the Italian National Project of library automation: the SBN project (SBN stands for "Servizio Bibliotecario Nazionale") [ICCU, 1985; ICCU, 1987].

The software tool which is in use at the University of Padua has been developed in NATURAL and the database is managed by the DBMS ADABAS [Guerra & Segre, 1987].

A general study has been conducted at the University of Padua to analyse its complex library system of more than one hundred libraries with one million and a half books and twelve thousands serials [Agosti & Favotto, 1987]. Following this general study a specific study has been started for the design of OPAC prototype [Agosti et al, 1989].

The OPAC design project started in spring 1989 and the OPAC prototype is expected to fully operate by the end of 1990.

The project has been organised into three main steps:

1) identification of end-user's categories and analysis and design of end-user's requirements [Moressa, 1989];

2) design of functional specifications of an OPAC for university library end-users;

3) design and development of the OPAC prototype.

The paper presents the state of advancement of the design and prototype. Initial results of the use of TRS as an open tool allowing the creation of the OPAC database are also presented.

2. MOTIVATIONS

The main target of our library automation project is the creation and management of an integrated and unique catalogue which contains the bibliographic descriptions of the documents of the complete library system. The SBN procedures which are implemented by this software tool have to be carried out by the librarian: cataloguing, acquisitions, serials control, and subject indexing. This means that this software tool has been designed to interact with a professional user: the librarian.

In an university environment it is not possible to imagine all the different types of end-users to interact with the librarian, or to continue to use the traditional card catalogues. For this reason in early 1989 it has been evaluated that it was necessary to develop a prototype of an online catalogue for the end-users of the university libraries. In mid-1989 the project for the design and development of an experimental prototype OPAC has been launched.

It is important to bear in mind that this project intends to design, develop and evaluate only a prototype, because the role the University of Padua intends to play is not a role of professional developer of software, but the role of the organisation which has the end-users ready to use advanced library automation and information retrieval facilities and the technical and scientific experience to be in the position of really develop and test a prototype of an OPAC.

3. A THIRD-GENERATION OPAC

Since we have decided to develop in our project a third-generation OPAC, it seems necessary to recall here what are the main characteristics and features of an OPAC, and specifically what are the searching capabilities of third-generation OPAC (following the Hildreth classification of OPAC generations [Hildreth, 1982]). The presentation of main characteristics and

searching capabilities of such an online catalogue is also going to be used as a reference scheme for the presentation of the characteristics of our prototype.

The aim of a third-generation online public access catalogue is that of making easily and directly available to the end-user of a library (or library system) the information on the documents which are present in the library and which could be useful to satisfy the end-user's information needs. This means that this OPAC tool must have the capabilities to be able to implement two different roles:

1) retrieve, through a matching function which works on one or more than one of the document attributes, data on documents which are described in the library catalogue database; the document attributes which can usually used for this type of retrieval are: document author/s, title (or title words), and year of publication;

2) retrieve information on documents which are semantically related and pertinent to a specific topic of interest for the end-user; these capabilities are usually identified are OPAC subject searching capabilities.

The end-user which uses the OPAC for its role 1 capabilities knows the documents is looking for, his aim is to check if the documents are present in the library catalogue database, and to be in position to ask to have the documents available. The role 1 capabilities are determistic in nature and much work has been done, also in the database management area to implement this type of capabilities. The aspect that can require more attention, and still innovative work, in the development of an OPAC is the design and implementation of the interface, that must work for untrained and inexperienced end-users.

The role 2 capabilities are very difficult to design and implement, because they are not deterministic in nature and, for this reason, they are dissimilar from the other characteristics and capabilities of the main procedures of a library automation system, which are deterministic in nature. This difference is similar to the distinction has been made clear by Blair in [Blair, 1984] between the management of data in database management and document in information retrieval [Salton & McGill, 1983; Van Rijsbergen, 1979]. Because of these capabilities the design of a third-generation OPAC has commonalties with the design of an advanced information retrieval system and not only with a traditional Boolean information retrieval system [Lancaster, 1979]. In fact, as it has been underlined by Hildreth in [Hildreth, 1989], when comparing Boolean commercial information retrieval systems and retrieval systems to be used in a library environment, it is important to note these main differences:

- an OPAC has to be used directly by untrained and inexperienced end-users (the online searches are usually made by an experienced intermediary);

- records in the library catalogue database lack of abstracts, the subject indexing is sparse (because it is made by different trained librarians in different areas libraries, especially in an university environment) and the controlled vocabularies are often not representative of current terminology (e.g., the update of the LCSH - Library of Congress Subject Headings or subject headings of the DDC - Dewey Decimal Classification is a very long procedure); and

- the library catalogue database includes data on a wide variety of disciplines and subject areas.

The two approaches to subject searching that have been implemented in the second-generation OPACs are (from [Hildreth, 1989], p.11):

a. *querying* - the query search requirements are: search aim/criteria are known and can be expressed with relative precision and completeness; this type of access is implemented by:
   i. phrase matching: text strings or controlled vocabulary;
   ii. keyword matching: discrete words, with Boolean or proximity formulations

b. *browsing* - the browse search requirements are: search aim/criteria are not specific, are not known, and/or cannot be expressed in appropriate query/indexing language; this type of access is implemented by:
   i. pre-sequenced, linear, inflexible: typically, lists of index terms, headings, descriptors or brief titles;
   ii. non-linear, multi-directional, flexible: "navigation", "chain", "bridge", "relational", "serendipitous" browsing.

The main limitations of second-generations OPACs have been the separation between these two types of accesses, and the obscurity of the usage of these two approaches that is done by the software system. The third-generation OPACs have to overcome these problems making explicit to the end-user the accesses procedures and implementing the interaction of the different access approaches.

In the design of the third-generation OPAC prototype for the universities of the Region of Veneto, we have kept in mind the state of the art of the OPAC research and we are proposing an operational solution in the framework of the library automation tool adopted.

4. THE OPAC PROJECT OF THE UNIVERSITIES OF THE REGION OF VENETO

4.1 End-user Requirements Analysis and Interviews

As it has been previously recalled, the OPAC project has been organised into three main steps; the first to be addressed has been the step devoted to the identification of end-user's categories and analysis and design of end-user's requirements [Moressa, 1989].

With the purpose of identifying the different end-user's categories of the university library system, it has been conducted an initial analysis, which has schematically distinguished these end-users' categories: students, PhD students, researchers, and professors. After the completion of this first target, it has been decided to conduct the analysis and design of the end-user's requirements using the interview technique. A sample representative of the identified end-user's categories has been designed, and the corresponding interviews have been conducted.

In the construction of the sample, the end-user discipline of interest has been taken in specific account because it was necessary to know about possible different end-user's search attitudes depending on the subject of study: humanities, law, science or engineering. It has been decided to add to the sample some librarians of Faculty libraries, because this type of librarian often supports the students in their document searches, thus it was necessary to record also their experience of students information search attitudes.

The results of this work have been fully reported in [Moressa, 1989]. We report here those results which have directly influenced the project guidelines design.

The results have shown that to identify the end-users' search attitudes it is important to know:
- the state of development and settlement of the subject of study;
- if the end-user is engaged in applied or theoretical research;
- if the subject of study is of interdisciplinary nature or not;
- the necessity to use documents of one or more countries (e.g., for some ancient historical studies the references are almost all in one language and of one country, for computing science studies the documents are of very different countries);
- the speed of document obsolescence.

The end-user's requirements that have come out from interviews have been the following:
- the end-user's expectations of system interaction are similar to present day on-line databases query languages typical of second-generation OPAC document attributes and subject searching;
- the use of a unique controlled vocabulary for subject indexing seems to be very difficult, because of the past usage of specific indexing language at library level;
- the interest in searching the universities library database seems more interesting for interdisciplinary and applied study subjects;
- all the end-users expect to have precise data on the presence and availability of documents in the library system.

4.2 Project Guidelines

These have been the two main technological project guidelines [Agosti et al, 1989]:

- the OPAC tool has to be integrated in the general SBN project and software tool; it is possible to foresee from the present OPAC design and implementation experience the necessity of a re-design of the SBN database to integrate in only one database the most of the data that are necessary for cataloguing and searching; this re-design would permit to add other useful data for information retrieval purposes, as, for example, document indexes and abstracts;

- the possibility to use the OPAC tool from any terminal of the computing network of the universities.

These have been the guidelines for the design and implementation of the architecture of the OPAC database and software tool [Agosti et al, 1989]:

- the end-user has to interact with only one software interface to use different information sources, then the OPAC tool needs to be integrated with other tools which are in use for: searches from on-line databases and local CD-ROM; e-mail; word processing and management of local information and images databases; and videotex;
- the software tool needs to be modular, so it will permit to add more easily in the future new capabilities;
- the design of the database and of the software tool needs to support different subject indexing procedures;
- the end-user needs to have an user-friendly interface;
- it is necessary to support the end-user with the possibility of printing search results using standard ways of producing bibliographies or list of references; and with the possibilities of retaining his/her search strategies;
- mechanisms of keeping useful data of search sessions have to be included for subsequent evaluation.

5. DESIGN OF THE OPAC DATABASE

5.1 Introduction

This section presents the architecture and characteristics of the OPAC database which has been designed to implement the project guidelines introduced in the previous section; it is important to bear in mind that one important target of the OPAC database design has been to avoid data duplication logically integrating SBN and OPAC databases.

The OPAC software tool has been developed in NATURAL; it interacts with the TRS for the OPAC database generation and for the implementation of the Boolean queries.

The OPAC prototype implements two different ways of end-user interaction: the first way is for inexperienced end-users that

have never used the tool or that are going to use the system from time to time; the second way of interaction has been designed for the end-users that use regularly the system or that are experienced in on-line databases queries.

In the first way of interaction the end-user is guided in his/her query formulation and searching by a sequence of self-explaining menus with fill-in masks; in the second way the user can directly use the Boolean operators for query formulation and searching; in both ways of interaction the end-users can have the availability of the innovative retrieval aids and help facilities of the OPAC prototype.

In section 5.2 the data that is present in the SBN database and that is useful for the OPAC capabilities is shown. Section 5.3 presents the OPAC database.

5.2 The Architecture of the SBN Database

The main characteristic of the SBN database is to contain data for administrative and cataloguing purposes. Because of that, in the SBN software all query accesses have been implemented to permit pre-defined accesses only, also if an access is through textual document attributes (pre-coordinate access). This means that it is not possible to make accesses to textual attributes through single words or expressions of single words combined by Boolean operators (post-coordinate access). The SBN database contains information on documents of many disciplines because the universities of the Region of Veneto have twelve faculties.
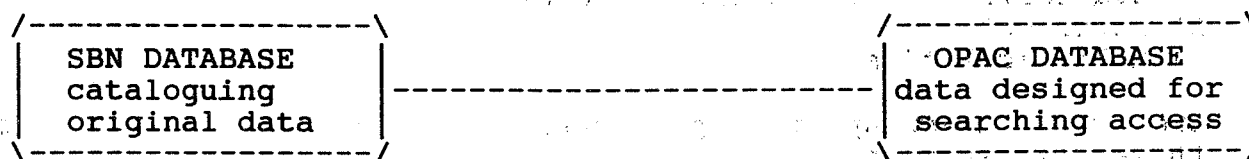
The data of the SBN logical schema which can be useful for the construction of the OPAC database are: title bibliographic description; "nature" of the title; terms of the controlled vocabulary developed by the National Library of Florence, these terms are directly related to the document title; classification subject heading directly related to the title; document author's name; document language; document country publication; date type and date of publication; type of publication.

Document abstracts and indexes, and any other form of semantic representation of document content are not present in the SBN database.

5.3 The OPAC Database Architecture

The architecture of the OPAC database is oriented to make the OPAC information retrieval capabilities as efficient as possible; for this reason it has been necessary to design the database and the software to work efficiently for words and terms accesses on the textual data of the SBN database which have been previously mentioned. Since the SBN database does not contain the data for word searching in the textual document attributes, it has been necessary to decide in what way to make the necessary data available in the OPAC database.

We have decided to avoid a complete duplication of the SBN files and we have physically designed the OPAC database to logically contains a controlled vocabulary to make efficient accesses to textual attributes using the TRS capabilities.

```
/------------------\                      /------------------\
|  SBN DATABASE     |                      | OPAC DATABASE     |
|  cataloguing      |----------------------|data designed for  |
|  original data    |                      |searching access   |
\------------------/                      \------------------/
```

One important engineering problem to solve has been the updating of the OPAC database which needs to be updated in sequence to the SBN database. We have adopted the solution of accessing the OPAC database for search purposes only, when the query has been formulated and solved, the OPAC prototype accesses the SBN database to have the bibliographic data available for the end-user; in this way the bibliographic data that are displayed to the end-user is always consistent with the most recent SBN database updates.

The most difficult task of the OPAC prototype development has been the construction of the controlled vocabulary to give in the multi-disciplinary and multi-language environment of the university library system the advanced and sophisticated searching capabilities that are reported in section 6.

TRS is used for its capability of generating and managing the OPAC database files which assume a dictionary structure.

The controlled vocabulary is central to the functioning of the prototype and it is generated and maintained through the TRS primitives. The data managed for each word is:
- the word itself;
- the word written with all the letters in the opposite order (e.g., for the word "vocabulary" the sequence of letters which is maintained is "yralubacov");
- word root/s;
- word aspect/s, where by aspect is intended the role the word plays in the dictionary; one aspect used in the vocabulary construction has been: "stopword", that is a word which has not be considered useful in the generation of the OPAC database and which cannot be used in the query formulation (e.g., some words that are often considered as stopwords in English are: about, as, but, for, of, the, with); another aspect which has been used in the construction of the database is the language of the word: at each word is associate its language, with this information it is possible to design the partitions of the complete vocabulary for the different document languages and to manage the multi-languages document collection; and
- word synonym/s.

The end-user interface part of the prototype has been developed using the NATURAL language.

6. THE OPAC PROTOTYPE CAPABILITIES

The prototype capabilities can be grouped in three main classes:

1) **query formulation and searching**, with the presentation of available data on retrieved documents,
2) **retrieval aids**,
3) **help facilities**,

and they are going to be presented in the following using those three main entries.

1) Query formulation and searching

As far as query formulation, the prototype has been designed to provide two ways of user's interaction:

a) query formulation with Boolean operators using the TRS syntax;
b) query formulation with pseudo-natural language.

The query formulation using TRS syntax has been firstly developed in the prototype because it has permitted to develop in a short time a test environment to be used to verify the efficiency and quality of the OPAC database architecture and to collect the first logging data on the prototype use.

The pseudo-natural language query formulation represents an easy approach of interaction with the OPAC system for the inexperienced end-user. In this context the term "pseudo-natural" means that we allow free formulation of the expressions to be searched in the database. This decision has been inspired by the following methodological consideration: we believe that it is possible to implement a more efficient system-user interaction asking the end-user to freely formulate an initial query in pseudo-natural language and providing many aids which are automatically invoked during the retrieval process, than leaving the end-user explaining all his/her information needs at the first step of interaction with the system.

At the present stage of development, the OPAC prototype fully implements the query formulation with Boolean operators; the query formulation with pseudo-natural language is under refinement. Because of that, the available searching capabilities can be still considered of a second-generation OPAC, but they are gathered with some retrieval aid options which are completely new for operating OPACs and which are aligned with the third-generation OPAC philosophy.

The present retrieval process consists of two different steps: the initial search and the next searches. While the initial search asks the end-user to make a "blind" query formulation, the next searches start after the end-user has examined the documents retrieved in response to the previous query.

The initial query formulation reveals three possible ways of searching, depending both on the kind of information which is

needed by the end-user and on the data he/she has got on the documents he/she wants to find:

a) searching through a specific document attribute;
b) searching a set of documents which all have the same value of a precise document attribute;
c) subject searching.

The second-generation OPACs usually develop searching on a specific document attribute. One of the scopes of our prototype, instead, is to investigate new solutions for subject searching in the Italian University libraries. Because of that, in the prototype current version, though it is possible to search on a specific document attribute, the particular design of the OPAC database allows to search using concurrently all the document attributes of the cataloguing description, and the cataloguing description can contain any semantic data.

The end-user can ask the system to find one or more words everywhere in the textual segments of the OPAC database: this particular retrieval behaviour is typical of someone who has a subject in mind on which he/she needs information, but does not know any physical book or publication that may deal with it.

The logical textual segments which have been created for subject searching using concurrently all the document attributes of the cataloguing description are:
- document author's name;
- title;
- the controlled vocabulary developed by the National Library of Florence which is used in subject indexing; in the following it will be used the "subject headings" expression for short to refer to this controlled vocabulary;
- classification subject headings, and
- publisher name.

Document author's name

The document author's name allows free text searching, instead of phrase searching available on second-generation OPACs; the possibility of word searching on the author's name is particularly important for author's corporate names. The cataloguing rules defined in the SBN database consider in a special way the pseudonyms and the acronyms of an author's name: they are linked to the author's name in the authority file but they are not linked with the documents related to the author. The OPAC database put together in the same textual segment all the words which form the original author's name, the pseudonyms and the acronyms, and maintains the Internal Sequence Number (ISN) of the record in the SBN database which contains the full original author's name. The prototype is able to find all the author's works even though the query formulation contains a pseudonym or an acronym.

Title

In the SBN database the titles are related to each other in a hierarchical structure or at a same level (titles which are related), depending on the characteristics of the title. Let us have an example: a monograph can be related at a title of higher level because the monograph title is related to the title of the collection it makes part of; the same monograph can be related to a title which is its version in original language. Among all these titles only the monograph title is linked to the physical book it represents and to the circulation data (data on availability, etc.). The prototype again gathers all the words which form the titles related to the one linked to circulation system, and put them in the same textual segment. In this way the hierarchical order is lost but it is enriched the set of words that could directly bring to the data of availability of the physical book. This operation is justified also by the fact that these hierarchical links, which have some meaning for the library staff, are completely unknown to the end-users of a library.

Subject headings and classification subject headings

Also the subject headings have hierarchical links: one subject heading can be linked to a title and to other subject headings. As for titles, these links on different levels are flatten on same lowest level of the tree of relations. The same operation has been done also for the classification subject headings. These links differ from those of the titles, because they mainly depend on the subject matter of the document and the descriptions on contents in the hierarchy become more and more specific as going down to the lower levels. It can be useful for end-users to see the hierarchy of subject headings or navigate in the classification subject headings tree: this is still possible on the original file of SBN database. In fact, the files created in the OPAC database are complementary to the original ones of the SBN database: while the former improve the possibilities of retrieving a set of relevant documents, the latter assure the navigation throughout links of title, subject headings and classification subject headings.

The library staff of the University of Padua library system is not forced to adopt a sole subject headings system and a sole classification system common which would be unique for all the libraries, but there is the freedom of choosing the system which is semantically closer to the specialised documents of each library. This can be an advantage for the end-user which is searching in a specific library collection, but it becomes a disadvantage when an end-users wants to run a subject searching throughout the collection of one or all universities of Region of Veneto. The solution which has been implemented in the prototype is to use the classification subject heading terms just for their very meaning, but providing the OPAC database architecture for multiple logical segments to distinguish different classification systems.

Publisher name

Also for the publisher names a segment is prepared following the
rules of creation of the the author's name segment. Then it is
possible to conduct a free text searching also on the publisher
name.

The _initial_ _search_ can be constructed specifying in the query
some precise values of document attributes, such as data of
publication, language of publication, or the particular library
in which the end-user wants to look for documents.

The initial query can also be constructed in a completely
different way to make possible to search the database for subject
searching combined with a deterministic query on one or more
specific document attributes. This retrieval behaviour is not
usually used by the end-user in the initial search, because it
supposes that the end-user knows exactly what he/she is looking
for. This possibility becomes very useful for _next_ _searches_: in
fact, the structured attributes of cataloguing data, language and
library, can be used by the end-user as "filters" to reduce the
number of document retrieved by the initial or previous query.

If the _initial_ _query_ retrieves one or more books, the prototype
lists the results in two steps:
1. synthetic descriptions of all retrieved titles;
2. extended description of each title in the set.

The end-user can select one or more titles from the synthetic
list (step 1) and obtain the screen display of all pertaining
data (step 2): the complete bibliographic description and the
description of related titles, the subject headings and the
classification subject headings, the names of all the libraries
that own the book or that have just ordered it. At present, the
prototype cannot give the availability information on the
retrieved documents because the SBN system has not yet activated
the library loan procedure.

The prototype gives three different print options for printing
the data on the documents retrieved:
a) synthetic data printing of all retrieved documents;
b) synthetic data printing of some documents chosen by the user;
c) a synthetic data printing of all or some of the retrieved
   documents which is made by using some rules of bibliographies
   construction.

For _next_ _searches_ the prototype offers the possibility to gather
a subsequent query to the results of the previous one: the end-
user can use the Boolean operator AND to connect the two queries
if he/she wants to reduce the number of retrieved documents, or
he/she can use the operator OR if he/she wants to enlarge the set
of retrieved documents. If the result of this new query is an
empty set, the prototype still keeps the last set of retrieved
documents as a ready search context for other queries.

2) Retrieval aids

The retrieval aids are:
- on-line dictionary, and
- retrieval path history,

The on-line dictionary
The on-line dictionary feature has been made available to support the end-user in the formulation of the query and during browsing, because the on-line dictionary is a further possibility of finding exact access points in the vocabulary of words and in the list of pre-defined codes. The on-line dictionary is subdivided in specific on-line dictionaries of words, in fact the end-user can search words in the:
- title,
- document author's name,
- subject headings, and
- classification subject headings.
When the end-user selects a word in one specific dictionary, the word is firstly searched in the selected segment: if it is not found in that dictionary, the OPAC prototype automatically controls if it exists in any other textual segment, if yes, the pertinent dictionary is shown to the end-user.
When the word is entered by the end-user, a stemming algorithm makes an automatic truncation on the sought word and lists the set of words with that stem, each one with the number of occurrences in the titles. If the end-user selects one or more words from the dictionary, the system formulates the equivalent query in correct TRS syntax; the Boolean OR is the default operator which is used between the selected words in the query formulation.

The retrieval path history
The retrieval path history feature gives the information on the end-user's individual interaction history with the library catalogue database. This feature is available in any moment of the interaction: it gives the text of previous queries and the number of corresponding titles retrieved. As for the other features of the prototype, the retrieval path history in under further development and it is also going to give to the end-user the possibility of restarting a new search from a particular set of document retrieved in response to a previous specific query.

3) Help facilities

The prototype has been designed to be user-friendly, because of that, apart from the difficulty of understanding the meaning of Boolean expressions in the query formulation, all the features are easy to use and they are always followed by help messages.

As it has been underlined in section 3 of this paper, the OPACs must be usable directly by untrained and inexperienced users. Thus, help facilities are very important for OPAC systems, because they have to teach end-users how to use the system while they are using it.

Two types of help have been made available in the prototype:
a) specific contextual help;
b) general help on prototype use and features.

Many helps messages have examples of use of the prototype facilities. Also some sort of monitoring on wrong attempts of the end-user has been implemented in the prototype; in fact, after a series of subsequent errors made by the end-user during the interaction with the system, the help facility gives a counsel for an alternative search strategy.

The help messages can always be requested by the end-user. But, on certain conditions, the help messages are automatically displayed by the system; for example, if the end-user makes use of a specific prototype feature for the first time, the system prompts a contextual help message.

7. FURTHER DEVELOPMENTS

The nature of the OPAC prototype is to be in a constant evolution. Up to now the subsequent changes on the database architecture and on the seeking features have been decided on the base of the project guidelines.

The prototype is now ready to be given to a small sample of end-users for collecting first impressions and initial logging data on its use. We will then be able to express an initial evaluation on the rightness of the features provided in the prototype and on the efficiency of the chosen software tools.

In parallel with the design of the prototype evaluation tools, we are designing new features to implement in the next version of the prototype: an automatic selection of alternative retrieval paths when the set of retrieved documents is empty; in the "next searches", it must be possible to ask the system to find other documents similar to those just retrieved; refine the interface for inexperienced end-users.

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