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DIALOG and Mead Join the Relevance Ranks

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TARGET & FREESTYLE: DIALOG and Mead join the relevance ranks

Abstract:
DIALOG Information Services Inc's TARGET and Mead Data Central Inc's FREESTYLE are new non-boolean, natural language data base search techniques. A maximum record number set is retrieved, and the records are displayed in order of importance. A comparative test of these systems reveals that the ratio of relevant records retrieved was 56% with TARGET and 61% with Boolean searching on DIALOG and 53% in FREESTYLE and 64% in Boolean searching on Mead's NEXIS. Despite the lower accuracy of natural language searching in this test, such techniques may be preferable in certain search circumstance.

Full Text:
Everyone undoubtedly has seen announcements of the new, non-Boolean, natural language search techniques from West, DIALOG, and Mead Data Central. Some of you may already be experimenting with or using Westlaw's WIN, DIALOG's TARGET, or Mead's FREESTYLE. All are based on the assumption that our standard command-driven online systems coupled with Boolean logic searching are not only difficult to learn, but may sometimes miss relevant documents. This assumption is based not only on searchers' experiences, but on years of controlled tests in the information retrieval laboratories.

There is no doubt that this new way to search old systems is gaining a lot of attention. Westlaw Is Natural (WIN) was introduced in the fall of 1992 and on its first anniversary won the ONLINE Product of the Year award at ONLINE/CD-ROM '93. It continues to garner favorable reviews and is now the search method that Westlaw trainers teach first to new searchers. DIALOG's TARGET and Mead's FREESTYLE were announced at ONLINE/CD-ROM '93 to great fanfare, and became publicly available in late 1993 and early 1994.

Searchers are definitely interested. It was standing-room only at ONLINE/CD-ROM '93s session on natural language systems. Teresa Pritchard-Schoch's article, "Natural Language Comes of Age"[1], won the IAC Best Article award for 1993.

THE NATURAL ALTERNATIVE

Although each product works somewhat differently, all three offer an alternative to searching with command interfaces and Boolean/proximity operators. (Proximity operators such as specifying within a paragraph or within a specified number of words are an extension of the Boolean AND.) They offer (somewhat) natural language input, with no need for commands or logical operators. This input method is coupled with so-called "associative," "probabilistic" or "statistical" retrieval techniques that provide relevance ranking of search results.

Unlike exact-match Boolean logic systems, where all concepts or terms linked with AND or a proximity operator must be present, relevance retrieval techniques are partial-match systems. They retrieve all documents that contain any words used to represent a concept (as if all words were ORd together). These documents are then run against a mathematical algorithm that weights and ranks the documents.

Statistical methods compare, for example, how many times the search words appear in each record with how many times they appear in the database as a whole. Documents that contain many of the search words are given higher weights. If those terms appear relatively less frequently in the database as a whole, the documents that contain them are weighted even more heavily. Relative lengths of each document are taken into account as well. The documents are then sorted by the assigned weights to display first those documents that best match the query. Pritchard-Schoch provides a clear explanation of the history and methods of these techniques, which have been tested for decades. They have been available on smaller online or CD-ROM systems and in software for in-house databases for several years[2].

The most important question for experienced searchers is what will relevance search systems retrieve compared to the tried-and-true Boolean search engines? Should experienced searchers use the new methods? Will your search results be better with one technique or the other? Which method should we teach our end-users? Do all of the new systems achieve the same results?

WESTLAW IS NATURAL

Since WIN has been around the longest of these three, it is setting the standard for the other relevance retrieval search systems[3]. WIN goes beyond just statistical relevance ranking by offering a powerful combination of natural language input, automatic word-stemming, automatic recognition of legal phrases, and a thesaurus.

We did not study WIN for this article, because others are doing so and because Westlaw's subject domain is limited to law. Legal searchers should carefully compare WIN with Mead's new FREESTYLE in the LEXIS service, since both include many of the same legal reference sources.

We chose to look more closely at the relevance retrieval systems on DIALOG and Mead's NEXIS as they might be used for searching full-text newspapers. Full-text searching of newspapers poses unique challenges since the topics and lengths of documents vary so widely, and thus is an apt test of relevance retrieval techniques.

TARGET

DIALOG officially announced TARGET in October 1993 and made it available for all users in December 1993. Although it was under development off and on for several years, it wasn't until WIN's success that DIALOG decided to get TARGET ready for release. The DIALOG development staff looked at many different relevance methods and tested a variety of algorithms before programming what we see now.

TARGET works on all DIALOG databases, but it is best suited for full-text databases or those with lengthy abstracts. These are the databases that rely on free-text searching and often retrieve excessive false drops with conventional searching. Since relevance retrieval compares how many times words occur in a document in relation to the length of each document, entire documents about a topic can be differentiated from those with only a single paragraph or a mention in passing of the desired subject. The most relevant documents should be placed at the top of the set for display first in relevance-ranked retrieval.

TARGET FOR SUBJECT

SEARCHING

TARGET works best for text searching. Just as with DIALOG's Boolean system, TARGET defaults to the basic index. Those of you who are regular DIALOG searchers are aware of this distinction in its indexes. Unlike NEXIS and many other online systems, DIALOG maintains separate indexes for subject and non-subject searching. The "basic index" typically includes only words from titles, words from abstracts, words from full text, and words or phrases from descriptors or identifiers - fields which are all considered to represent the subjects of documents. The basic index is searched by default if a searcher doesn't specify any particular field.

To search for an author, journal name, corporate source, or other non-subject field in Boolean DIALOG, the searcher must explicitly name that field. (e.g., SELECT AU=ASIMOV, Isaac or SELECT JN=Library Journal). This separation helps avoid false drops in the regular Boolean system, because you will not, for example, retrieve articles authored by Mr. Carpenter when searching for the subject carpenter.

TARGET provides two ways of searching these non-subject fields:

1) By putting the prefix search in single quotes (e.g., target |au=asimov, isaac') 2) An author set created in a Boolean search can be added to a TARGET search (e.g., s au=asimov, isaac; target *s1 |life science' biology zoology).

HOW TO SEARCH WITH TARGET

Target can be used in a single database or in multiple databases. Searchers can use a predefined OneSearch grouping or BEGIN in whichever databases they desire. Databases are searched with the CURRENT option by default (current calendar year plus one year) in databases that support the CURRENT feature, but searches can be modified to include other date ranges. If the database does not support CURRENT, TARGET will search the entire database.

After beginning in a database or database group, a searcher inputs the word TARGET to get into the TARGET menu search mode. TARGET menu mode provides helps, prompts, and some menu choices to guide the novice user through the search process. Figure 1 shows the beginning of a TARGET menu mode search session.

Alternatively, experienced searchers can use the word TARGET as a command, if they follow it with search terms. Inputting: target radiation experiment? military will search for the three terms using the relevance retrieval engine, but without bringing up any of the TARGET system prompts or menus. It will not allow special TARGET display features, unless TARGET menu mode is turned on for that search session with the SET TARGET command.

NOT NATURAL LANGUAGE

Even in the novice TARGET mode, TARGET does not claim to support natural language. It does replace the need for Boolean or proximity connectors, but only the actual words or phrases to be searched should be entered. This differs from Westlaw's WIN, since WIN allows a user to enter a natural language statement directly. WIN's natural language interface supports a search statement such as what is the government's obligation to warn military personnel about their exposure to radiation? The system then strips out common phrases (e.g., "what is the"), identifies legal phrases matched from a phrase thesaurus, and eliminates stopwords.

TARGET requires formalized input of major terms, phrases, and synonyms and does little automatic processing. A TARGET statement might look like this: government? obligation warn? (|military personnel' soldier? sailor?) expos? *radiation. Just as with DIALOG Boolean searching, understanding the required syntax is necessary.

The question mark indicates truncation, just as it does in the regular DIALOG system. Unlike full Boolean, however, TARGET does not support single or specified character truncation. The single ? retrieves any number of characters after the input stem; DIALOGs ? ?, ??, ???, etc. (used to specify maximum number of characters following a stem) are not supported in TARGET, because TARGET is intended to be easier to use than the Boolean system.

Unlimited truncation of course works best for relatively long character strings such as government. TARGET help screens use the search examples of dog cat food and recommends truncating dog as dog? to retrieve dog or dogs. Most experienced searchers would hesitate to input a three-character stem such as dog? with unlimited truncation, for fear of retrieving such words as dogfish, doggerel, dogma, dogwood, etc. TARGET does no automatic stemming, so even singulars/plurals must be indicated by the user. In the dog example it is safer to explicitly search for dog dogs.

Synonyms can be, but don't have to be, grouped with parentheses by the searcher (but without placing a Boolean OR between them). In the earlier example, |military personnel,' soldier, and sailor are all synonyms. Grouping synonyms cuts down the weighting for each individual term.

TARGET does not have a thesaurus, so the burden of identifying and inputting synonyms is completely on the user, just as it is in DIALOG's Boolean system. Creating a thesaurus that would serve all of the databases on a supermarket system such as DIALOG would be a daunting task. Westlaw has an easier time of it, building a thesaurus of legal terms and phrases. FREESTYLE has a general synonym-type thesaurus. To make natural language search techniques truly useful for novices, databases and systems will have to spend the time and effort to develop and maintain complete multitopic thesauri.

TARGET searchers can indicate bound phrases with quotation marks (e.g., |military personnel'). The phrases will then be searched as adjacent, bound phrases only, rather than as separately weighted search terms. No phrases are automatically identified, again the searcher must explicitly mark all phrases for the system. The relevance algorithm does, however, weight individual search words more heavily if they occur within several words of another search word.

The asterisk (used in this example in front of *radiation) can be used by the TARGET searcher to indicate a term that must be present in a search. Records that do not have this term will not be retrieved, just as if a Boolean AND were used. Individual terms can be marked as mandatory, or a concept can be marked as mandatory by putting the asterisk outside the parentheses. For example, if the military personnel concept is considered mandatory, the searcher would input * (|military personnel' soldier? sailor) to indicate any one of these terms must be present in retrieved records.

TARGET MODIFICATIONS

AND DISPLAY

Search statements in the TARGET menu mode can be modified by choosing the Modify option (but only after a search is run and after the first three items are displayed). Modifications can be made to add or delete terms, to change the designation of a term as a required term, or to change the dates being searched. TARGET statements build a set which can then be used in a Boolean search.

TARGET examines all of the records that contain any of the input words and calculates likely relevance of each. The formula goes beyond just counting word frequency by comparing how many of the search terms appear in each record with how many times each word appears in the database as a whole. Uncommon words that appear frequently in a document are given more weight. Unequal document lengths are taken into account as well as are proximity of search words.

The resulting document ranking is used as the basis for order of display. Unlike Boolean's reverse chronological display or a user-specified sorting order such as alphabetically by author, relevance ranking displays first documents that are most likely to answer the user's query. This is good output for browsing until an information need is satisfied, and for those questions where the user doesn't need a comprehensive search. "Relevance" is always ultimately subjective of course, so there is no guarantee that the fiftieth item displayed will be of less interest in a particular case than the fortieth, or even the first, item.

TARGET displays up to 50 items. Most searches retrieve at least the full 50 items because with multiple words or concepts in a search, documents with even only one of the words will be retrieved. It may be more intuitive to end-users that inputting a fuller description (more terms) of their information needs will retrieve more documents.

The default brief display format includes title, publication, and date. Customizing the display in any way desired can be done as a modify function after a search is run. In addition to specifying the fields desired in a custom display, TARGET can attach to each record in the display term, frequency counts for each term in the search statement and an overall statistical relevance percentage that is used by the system to determine the order of display.

FREESTYLE

Mead's FREESTYLE is available for both the LEXIS legal service and NEXIS news service. FREESTYLE's performance in LEXIS is best compared to WIN, since LEXIS and Westlaw share many of the same legal databases and compete head-to-head in the legal research market. We chose instead to examine FREESTYLE only in NEXIS, specifically in full-text newspapers.

FREESTYLE works on all NEXIS files, either selected individually, selected as NEXIS pre-specified group files, or mixed together in ad hoe groupings by the searcher. After selecting a filename, searchers enter the command .FR to get to FREESTYLE mode. To return to Boolean mode, enter .BOOL.

PLAIN ENGLISH

FREESTYLE is closer to plain English than is TARGET, because it will automatically strip stopwords from an input query. Singulars and plurals are automatically searched (but other word form variations such as past tense and gerunds are not). As with the full NEXIS system, common abbreviations, British/American spelling, and equivalencies (e.g., 4 and four) are also automatic.

As with WIN, a FREESTYLE search could be directly entered as what is the government's obligation to warn military personnel of exposure to radiation? or using a shorter, more formalized statement as in TARGET. If entered in the former way, "what, is, the, to, of" and "to" will all be discarded as stop (noise) words. (In plain English searches we tested, effect, services, and information were not discarded as stopwords.) Government's will be searched as government, governments, or government's. The other words will be searched as singulars or plurals, but obligation will not be truncated to oblige, warn to warning, exposure to expose or exposed, etc.

In the first version of FREESTYLE (February 15-May 30, 1994), these variations need to be explicitly input by the searcher (oblige obliged obligation) because truncation, other than automatic plurals, is not supported by FREESTYLE. The NEXIS symbols for user-specified truncation (! and *) did not work in the version of the software we tested.

FREESTYLE THESAURUS

Unlike TARGET, FREESTYLE does have an accompanying thesaurus where searchers can look for synonyms or variant word forms to add to their search. The thesaurus is not invoked automatically; searchers must select the thesaurus option from a Search Options screen and specify which of their search terms they want to check for synonyms [4]. Figure 2 (see page 34) shows a sample FREESTYLE thesaurus screen.

FREESTYLE does not invoke the thesaurus automatically, according to Mead, because of the variety of word meanings in the English language. Searches would retrieve too many false drops from homographs (e.g., strike, plant, etc.), or from variant endings that change the meaning of the stem word (e.g., injury, injurious). A Mead spokesperson said, "Until we can parse for parts of speech, we will not invoke the thesaurus automatically, and that's a long way off."

Searchers may specify bound phrases by putting them in quotation marks (e.g., "military personnel"). These phrases will then be treated as adjacent words and counted together in the relevance ranking algorithm. Unlike TARGET, some terms not explicitly bound by the searcher will be recognized as phrases by FREESTYLE. Mead has a dictionary of over 300,000 phrases that are checked each time a search is entered. These include general phrases (e.g., red carpet); legal phrases (e.g., personal injury); pharmaceutical phrases (e.g., names of specific drugs); and medical phrases (e.g., names of diseases).

SEARCH OPTIONS/RESULTS

After inputting a search statement but before FREESTYLE runs the search, a Search Options screen is displayed. Search Options include viewing the thesaurus, editing the search statement, or running the search as is.

Edit choices include adding or deleting search terms or phrases, designating terms as mandatory, or adding restrictions such as date, byline, etc. (If date restrictions are not selected, FREESTYLE defaults to searching the full file. Date edits allow users to specify a specific date or date range.) If more than one edit is desired the process can take a while. The Search Options screen must be entered for each modification and each must be done individually. Command stacking provides a shortcut through the restrictions and allows users to enter more than one option at a time.

Like the asterisk (*) in TARGET, designating a term as mandatory means that the term must be present in any documents retrieved and ranked by FREESTYLE. It adds more precision to the search by combining a Boolean-like search technique with relevance ranking. However, in FREESTYLE the mandatory designation must be made after an initial search statement is entered, and the desired term must be retyped after the mandatory option is selected.

Since NEXIS has one large inverted index, rather than a subject-related basic index and non-subject field additional indexes like DIALOG, authors (bylines) and publication years will be searched if they are entered as part of the initial search statement. Searching for isaac asimov as a byline in FREESTYLE can be done just by entering his name, but documents that include mentions of Isaac Asimov in the text or as a subject will be retrieved in addition to articles written by him. To gain more precision by searching for him only as a byline, use the Restrictions choice on the Search Options screen, followed by selecting byline. This can only be done if you have already entered a basic search query, however. You cannot select an author alone.

When the search is run, a Search Results screen is displayed. The screen reports any stopwords that were input in the search statement and any phrases found in the phrase dictionary. It summarizes which terms were designated mandatory and any

restrictions applied.

FREESTYLE DISPLAY

After a FREESTYLE search is run and the system calculates relevance, up to 25 documents will be displayed in ranked order. (This number can be changed at the Search Options screen to anywhere between one and 1,000.) All NEXIS display options are supported, including CITE, KWIC, and FULL. SuperKWIC is a new display format that displays only the portion of each document that is most heavily weighted and therefore most likely to most relevant. FREESTYLE records can be sorted in reverse chronological order for current event searching.

WHERE AND WHY

While DIALOG has included information about the occurrences of words and relevance ranking score as a display option with each record, Mead has chosen to make this diagnostic information part of two separate commands. The WHERE and WHY commands are unique to Mead.

WHERE shows which documents contain each of the search terms, and WHY shows the level of importance assigned to each term by the system. If you have changed the display to more than 25 documents, WHERE will only display information about the first 25 documents retrieved in any FREESTYLE search. This will be changed in the new release expected in June 1994.

WHERE and WHY have been favorably received, especially by experienced searchers [5]. WHERE helps searchers determine which documents to browse according to their own idiosyncratic view of relevance. WHY helps an experienced searcher determine if a new strategy should be used, if a Boolean search might get better results, or even if they are in the wrong database.

COMPARING TARGET

AND FREESTYLE

The main purpose of this article is to compare DIA-LOG Boolean searching with DIALOG TARGET and NEXIS Boolean with NEXIS FREESTYLE. We did not set out to compare TARGET and FREESTYLE head-to-head, although some comparison is obvious. Most of the differences in the approaches taken by the two systems reflect their differing basic philosophies.

TARGET puts the searcher more in control and does very little automatically. FREESTYLE, on the other hand, does some things automatically and attempts to lead the searcher by the hand a bit more. This is consistent with the different focuses of these systems - experienced searchers for DIALOG and novice end-users for NEXIS. Figure 5 summarizes the main features of TARGET and of FREESTYLE and shows where they differ.

COMPARING RELEVANCE

AND BOOLEAN

An in-depth comparison of these Boolean search engines with relevance search techniques requires testing real questions and searches. This should be done over time by many searchers - we have just scratched the surface.

We gathered questions from reference librarians in four libraries and selected six questions to test. Each question was translated into four search queries:

1) TARGET 2) DIALOG Boolean 3) FREESTYLE 4) NEXIS Boolean

We did all of the searches in the same newspapers, in an ad hoc grouping of the Los Angeles Times, Boston Globe, and Washington Post papers for 1993-1994.

Search results were downloaded and judged for relevance on a four-point scale, from not at all relevant (1) to very relevant (4). We compared the order in which documents were displayed, as well as the total number of documents retrieved, the number of relevant documents retrieved, and unique documents retrieved by each search method.

Figure 3 (on page 36) is a list of questions searched and the corresponding search statements in both DIALOG and NEXIS. The questions represent three levels of search complexity:

1) single-concept searches 2) two-concept searches 3) three- or more concept searches

Known item searches (such as retrieving a known article from a specified journal issue) were not tested, since both systems recommend Boolean techniques for these.

TEST SEARCH RESULTS

Figures 4 and 6 show how many items were retrieved by each search method for each question, and how many relevant documents were retrieved. The maximum display was set to 50 in both TARGET and FREESTYLE. Presumably many more documents that contained at least one of the search terms are in the databases, but the displayed items should be the 50 most relevant items. As

expected, because of the restricting properties of adding concepts in a Boolean search, simple Boolean searches (one or two concepts) usually retrieved more items than relevance searching, but more complex searches (three or more concepts) retrieved fewer.

On DIALOG, an average precision ratio (relevant retrieved/all retrieved) of 56% was achieved by TARGET, compared to 61% by Boolean. NEXIS results were similar, with 53% for FREESTYLE and 64% by Boolean (Figures 4 and 6). (For the precision calculations, documents judged definitely relevant (a rating of 4) and probably relevant (a rating of 3) were both counted as relevant.)

The better overall precision with Boolean should be contrasted with the greater number of total documents retrieved and, at times, greater number of relevant documents, obtained by relevance searching.

DISPLAY ORDER

Since relevance searching presumably ranks items in decreasing order of relevance, display order and degrees of relevance were examined as well. Figures 7 and 8 present a relevance judgment map of each search question.

As you can see, the display order of TARGET and FREESTYLE generally puts more relevant items first, but not always. The pattern is inconsistent and difficult to anticipate. Searchers should not assume that because they have viewed some non-relevant items, that the next items will also be false drops.

In the electromagnetic fields question, for example, many highly relevant documents were displayed after three obvious false drops on the British Rock Group EMF. Several false drops were scattered among highly relevant and probably relevant documents in discrimination against homosexuals in the workplace and other topics.

UNIQUE RETRIEVALS

Finally, we examined unique retrievals for each search method. In most questions, both Boolean methods and relevance methods retrieved unique documents. In fact, in only one question on DIALOG and none on NEXIS, were all the documents retrieved in the Boolean search also retrieved in the relevance search. In two questions on DIALOG and one on NEXIS, all of the items retrieved in the relevance search were retrieved by the Boolean. The other questions had documents that were uniquely retrieved by relevance searching or Boolean searching. Uniquely retrieved documents, both false drops and relevant items, were examined in more detail.

Relevance search methods often retrieved false drops that contained only one or two, but not all of the search terms. In the question on the effect of PCBs on fish, for example, many articles that mentioned only PCBs and many others only about fishing were retrieved by both TARGET and FREESTYLE. (Unfortunately, sometimes these were displayed before relevant items that included both terms.) This could have been avoided by designating both terms as mandatory, much as a Boolean AND (or a proximity operator) would do. The only advantage to using TARGET or FREESTYLE in that case would be to rank the PCB and fish articles in order by how often in each document the terms occur.

Boolean methods, on the other hand, retrieved full articles that only contained words in passing, such as mentioning job discrimination as one type of discrimination faced by gays. False drops also sometimes resulted from figurative speech or one-time misspellings. (Relevance searching might retrieve these as well, but would put them at the end of a display, sometimes beyond the fifty documents displayed.) For example, one Boolean false drop in the EMF question contained one misspelling "Emfrem Zimbalest" in the text. Another described the situation in Bosnia as "two electromagnetic fields in conflict."

Unique relevant documents also were retrieved by Boolean searching when the search words used by the searcher did not occur frequently, but alternative terms did. For example, one highly relevant EMF document included that term only once, so it fell out of the TARGET and FREESTYLE searches, but was retrieved in the larger Boolean set. Throughout the body of the article, terms such as "high voltage power lines" were used instead. Others referred more often to "cellular phones" or "cellular antennas." A system thesaurus can sometimes help with this problem.

Finally, every searcher approaches search strategies differently. We chose to link DIALOG Boolean concepts with the "within the same paragraph" operator (S) instead of the Boolean AND or the proximity operator NEAR (N). We used the w/50 connector (within 50 words) in NEXIS Boolean. Some of the relevant documents uniquely retrieved by TARGET and FREESTYLE contained words further apart than this. Although a Boolean AND would have retrieved these, there would have been so many additional false drops that the value would be obscured. TARGET and FREESTYLE were clearly better for those searches where (S) or w/50 were not enough, but AND would be too much.

WHEN DOES RELEVANCE

WORK BEST?

What does all of this tell us about the important question of when should you use TARGET or FREESTYLE and when should you use Boolean searching? Unfortunately, there are no absolute answers, but some general advice is emerging. Based on our tests, recommendations from DIALOG, Mead, and West, and comments from other searchers, we can make some recommendations.

Use relevance searching:

* Only when you are doing primarily a subject search.

* Especially when you are searching full-text databases or databases with lengthy abstracts.

* When you want just a few, highly relevant items on a subject.

* When you will be satisfied with no more than the system maximum number of items, even if there are more than that in the database.

* When concepts are of unequal weight and some peripherally relevant items may not contain all of the concepts.

* When you want to browse through a subject to be brought up-to-date on a topic.

* When a Boolean search is too broad and retrieves too many items.

* When search terms are common words that retrieve too much in a Boolean search.

* When a Boolean search is too precisely specified and retrieves too few items.

* If you don't know the database or the information you are searching well.

* You are training novice users who don't want to have to memorize commands and learning operators.

WHEN DOES BOOLEAN

WORK BEST?

Continue to use Boolean and proximity operators when:

* You are looking for a known item or known citation.

* You want everything by a particular author.

* Non-subject fields are an important part of your search.

* Your search has concepts that are of equal weight and you want everything on the topic.

* You are an experienced Boolean searcher and it works for you.

Both methods are powerful search techniques. Boolean has the advantage of over twenty years of testing in the real world of searching. Relevance searching is the newcomer in commercial applications, with many enhancements yet to come. Perhaps in another twenty years, with comprehensive thesauri; natural language input, including parsing for parts of speech; and further testing of the best statistical weighting algorithms in large multitopic full-text databases, relevance retrieval will be all we need. For now it is another weapon in the good searcher's arsenal.

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[2] Tenopir, Carol. "The New Generation of Online Search Software." Library Journal 117 (October 1, 1993): pp. 67-68.

[3] WIN is not the first commercially available online system to go beyond Boolean. That honor probably belongs to Congressional Quarterly's Washington Alert, which has used the Personal Librarian search engine since 1989.

[4] The FREESTYLE thesaurus is a synonym list thesaurus such as Roget's, not the kind of thesaurus defined in the ANSI (American National Standards Institute) or ISO (International Standards Organization) standards for use with indexing. It lists only synonyms and word form variants, and does not specify term hierarchies, such as broader terms, narrower terms, etc.

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