The BROWSE System: An Introduction

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Abstract

We describe a system which exhibits novel information-access capabilities. The BROWSE system is an online library catalogue developed at Carnegie-Mellon. Its novelty lies in the browsing capability provided by its simple interface to a richly connected network of information. The BROWSE system is built on top of the ZOG system, a man-machine communication system built at CMU. BROWSE enables computer-naive library users to personally access the database without assistance. The system allows both a browsing and parameterized approach to searching. In addition, we describe the system that automatically generates the BROWSE system and the problems it poses in both computer and information science.

1. Introduction

The Carnegie-Mellon BROWSE System is a novel approach to interfacing computer-naive users to large databases. It is designed to allow public access to on-line library catalogues. Based on the ZOG system (Robertson et al, 1977), the BROWSE system allows the user to *intelligently browse* through a database without being cognizant of system structure and idiosyncracies.

Traditional modes of database interfaces have been highly stylized and idiosyncratic. They have required potential users to be trained or skilled personnel to be supplied as intermediaries (e.g., information system specialist). Such is the case with current on-line library catalogues, e.g., Ballots (1975), OCLC (1973). As a result, public access to databases such as library catalogues has been stifled.

Within the last few years, work in Artificial Intelligence (AI) on Natural Language Understanding (NLU) has been applied to the database interface problem (Mylopolous et al, 1975; Waltz, 1975; Sacerdoti, 1977; Hayes-Roth et al, 1978). It is hoped that allowing a more natural man-machine communication medium will facilitate access by system-naive users. Though natural language admits a wider variety of search specifications, they are still parameter based. That is, a set of parameters which entries must match (e.g., author, title, date, etc.) are the essence of the communication.

While it is true that NLU will allow wider access to databases, it does not imply that the accessing of information will be satisfactory. Searches for information will only be partially successful. Experiments have shown that physical searches of library catalogues are successful only 33% of the time that the searcher *thought* they were successful (Bates, 1977). This inability to correctly locate relevant material is due to the searcher's unfamiliarity with the organizational structure of the database (catalogue). They do not know how data is classified (structured) in a particular system, hence what parameters to specify. Differences in the user's view of the database structure and the logical structure presented by the information system are important factors in measuring the effectivness of database interfaces.

In addition to interface problems, library information systems are expensive. The requirement of simultaneous access to large databases has resulted in information systems being designed and implemented on large, multiple terminal, expensive time-sharing systems. The cost of such systems prohibits their portability and limits their use. Though there is a trend to reducing costs by using mini-computers, little progress has been made.

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2. BROWSE System Goals

The BROWSE system was designed to solve the aforementioned problems. Its goals include

1. providing a simple man-machine interface that takes little training (less than one minute) to master.

2. presenting the system in such a way that the systems logical structure is easily and quickly assimilated.

3. providing a browsing style approach to database searching.

4. providing an inexpensive system.

In the following we describe the design of the BROWSE System, its current state (phase I) and its support software.

3. BROWSE System Approach

The BROWSE system was designed to use the ZOG system developed at Carnegie-Mellon by Robertson et al (1977). ZOG has its roots in the University of Vermont's PROMIS system (Schaltz, 1971). To understand how the BROWSE system works requires an understanding of ZOG. A brief description follows.

3.1. The ZOG System and Philosophy

ZOG is a rapid response, large network, menu-selection system used for man-machine communication. A ZOG user sits in front of a terminal on which a frame is displayed. The frame consists of some text, and a set of options. At the discretion of the user an option is selected and almost "instantaniously" a new frame is displayed. The process then starts again.

ZOG was designed using a philosophy developed at the PROMIS Laboratory of the University of Vermont. ZOG's basic features are:

1. Rapid Response: When a user selects an option that leads to another frame, the next frame should appear fast enough so that the user does not feel that he is waiting for the system. A user must feel free to explore surrounding frames without being concerned with the time it takes to display each frame. The current implementation of ZOG, using specialized hardware, can display a new frame in 1/10 of a second.

2. Simple Selecting: The act of selection should be a simple unitary gesture. At the present time there are two forms of selection available. These are 1) single character input from the keyboard, and 2) a touch screen.

3. Large Network: The network should be large enough to provide most of the information needed by the user.

4. Frame Simplicity: The frame display should be kept simple. The user should be able to quickly assimilate the information contained in the frame. The idea of frame simplicity has lead to the development of frames that contain a small amount of text and up to 5 or 6 options. This is not necessarily true of frames developed for the BROWSE system, where the simplicity comes from the very structured nature of the information. Although a large amount of information may be displayed on a single frame, the information desired by the user can still be assimilated quickly.

5. Transparency: The user should be able to understand exactly what the system is doing and what he need to do to gain additional information. At no point should

the user feel that he has lost control of the system.

6. Communication Agent: ZOG has been designed to act as a communication agent between a user and another system. As a communication agent ZOG presents commands to the user in a simple format, as well as an explanation of what the command will do. When the use makes a selection, ZOG sends the more complex set of commands to the other system for processing. This facility is used by the BROWSE system for the parameterized search interface.

7. External Definition: Unlike many menu-selection systems, ZOG-NETS are databases which exist independent of and external to the ZOG system. Frames can be defined external to and/or within the ZOG system.

The basic philosophy of ZOG is that a menu-selection system can be an effective communication system if the user can move around in the system quickly and if there is a large network available to meet the user's needs.

A menu-selection system allows the user to have almost complete knowledge of what is occurring in the system whenever he selects an option. It also allows for related information to be located nearby (by placing a link between related frames). Menu-selection systems normally have a disadvantage in the time it takes to move from one frame to another. This is solved by the fast response nature of the ZOG system. Another characteristic of many menu-selection systems is that the same information is provided to all users, regardless of their needs. An expert user is presented with the same information as the naive user. In ZOG, different paths would be provided for each level of user. The naive user would get more information about what he is doing while the expert user would be presented with just the frames needed to perform the task.

3.2. The BROWSE system: Phase I

The BROWSE system provides browsing access to a growing database of books, technical reports, journal articles, etc. contained in the Carnegie-Mellon University Computer Science Department library. All new titles are entered into the database by library staff. Thereafter, classification of the entries is carried out by members of the computer science department.

The current version of the BROWSE System is composed of two distinct systems. The first is the BROWSE-NET running on ZOG supporting both browsing-style and parameterized searches of the catalogue database. The second system is the support software which allows the system designer to enter, alter and store bibliographic entries in a separate database, and to automatically translate the database into a BROWSE-NET. Facilities for designing and altering frame formats are also provided.

3.2.1. What is Browsing?

When browsing through books on a shelf, it is a simple matter to scan books that are conceptually related. This is true because the normal classification system used in a library places related books near each other. A book only exists in one physical location, hence having only one classification. Secondary relations are indicated by multiple classification card catalogues (e.g., subject, author-title). Physical restrictions reduce the effectiveness of these approaches to providing a browsing capability. The existence of only one physical location of a book confines shelf browsing to one area, and the physical separation of alternate classifications in card catalogues hinders browsing. The BROWSE system attempts to provide a richer browsing capability than is found in a typical library and its card catalogue. This is achieved by making an entry (e.g., book, technical report) accessible under more than one classification and classification system, and via author, institution, keywords and any meaningful descriptor, and by easing the movement between them. Using the library shelf metaphor, the BROWSE library has multiple classification systems: Library of Congress, Dewey Decimal, Computing Reviews, Author, subject, institution, keywords, etc. It would be as if copies of an entry could be found on different shelves in the library, each shelf corresponding to a different classification. The uniqueness of the BROWSE system is that the shelves can be viewed as intersecting at any book in which one is interested; therefore, accessing a book allows one to access all related books under all possible classifications.

The BROWSE System enables browsing by allowing the user to move quickly and easily through a classification hierarchy. Moving from one class to another is as simple as selecting an option. At each category frame, the user may select a sub-class or entries classified under the current class. An entry in the BROWSE System can have multiple classifications. When at an entry the user can visit its other classifications. Other classifications by author, institution, journal, keyword, etc. can be added, providing a rich set of cross-reference links through which to browse. As a result, the logical view of the database perceived by the user is an entry sitting on many shelves under different classifications. Accessing via one shelf position of a book gives instant access to the other shelves (via options).

We call this intelligent browsing because each classification frame provides information about the class. As the user browses in an unfamiliar subnet he learns the structure and the semantics of the classification, thus reducing the user and logical view problem. Assimilation of system structure is facilitated by allowing the user to "see" the classification structure which is hidden in other systems. It is the user who decides which frame to visit, the frames to be skipped and the frames to which to return.

3.2.2. The BROWSE-NET

The BROWSE-NET is composed of two sub-nets: a browsing net and a parameterized search net. The browsing net is composed of two types of frames: entries and categories. Each entry, e.g., technical report, is represented by a set of frames that include typical bibliographic information. In addition, information such as the technical report's index, abstract, reviews, and even the technical report itself (depending on storage availability) is represented in the frame set.

Access to entries is provided by a classification hierarchy. Each class is represented by a frame containing the class's name, a definition of the category, and its sub-classes. A class may be represented by multiple frames depending on the number of sub-classes it has. Since the frames are embedded in a network, the classification does not have to be strictly hierarchical. Also each entry can be inserted in multiple classes. The BROWSE system currently has one classification, the Computing Surveys classification(1976). The second phase will include additional classification hierarchies (e.g., a hierarchy composed by computer scientists and the library of congress classification) allowing a variety of logical views for browsing.

3.2.3. A Sample Session

The first frame (Figure 1a) that is displayed welcomes the user to the BROWSE system. In the upper right hand corner of the frame is the internal name of the frame (in this case ZOG1). The name is composed of a subnet name (ZOG) and a number within that subnet (1). At the bottom of the frame are a set of standard options (help, back, next,...,find). These options (called global pads) will appear in every frame. They provide system functions that are useful throughout the entire network. The first frame consists of two options. The options allow the user to continue receiving instruction on how to use the BROWSE system or to move directly to the top of the classification hierarchy. To select an option the user types the first letter of the option (a "C" to select the first option and a "T" to select the second option). If a touch screen is available, the user would just touch the option. The information following the option text (between the square brackets) is the next frame that would be displayed if the user selects that option. This information is not present on the actual display that is presented to the user.

The naive user would continue by selecting the "C" option for more instruction. An experienced user would select the "T" option, thus displaying the top of the classification hierarchy (Figure 1b). There are five options (1,2,3,4 and N) to this frame. At the present time only 2 options lead anywhere (1 and N). Whenever an option does not lead anywhere a dash (-) is placed after the first couple of characters. Only the Computing Reviews classification and a new entries list are available.

By selecting option 1, the user moves on to the top of the Computing Reviews classification hierarchy (Figure 1c). The frames forming the classification hierarchy each contain a title (0.: Computing Reviews), a definition section, a list of subcategories, an entry list option (E), an alternate supra-category option (B) and a parameterized search option (S). If there are more subcategories then a more selection option (M) is included. Finally, if a primary supra-category is designated then a option (P) pointing directly to that category is provided. The entry list option leads off to a list of entries that have been classified directly under the current category. In this case there are no such entries. The alternate supra-category option leads to a frame providing all the categories that are considered to be above the current category. Finally the parameterized search option would cause the system to begin a parameterized search and would proceed to a subnet that allows the user to specify the parameters.

The goal in this sample session is to find information on problem solving. This would probably fall under the area of artificial intelligence which possibly falls under the area of applications. So by selecting the option for applications the user is given a list of sub-categories for applications (Figure 1d). Note that artificial intelligence is not one of the sub-categories listed however the definition seems to indicated that the user has moved in the right direction. So by selecting the more selections option (M) the user discovers that artificial intelligence is indeed one of the sub-categories of applications (Figure 2a).

Now by selecting option 2 the user moves on to the frame describing artificial intelligence (Figure 2b) and discovers that problem solving is one of the sub-categories. Note that for this frame an entry list exists as well as a primary supra-category (option P), pointing back to the applications category. By selecting option 4 the goal category has been reached (Figure 2c). There are no sub-categories to problem solving however there is an entry list. The entry list (Figure 2d) is displayed by selecting the "E" option. This provides a list of entries that have been classified under the category problem solving. Along with the list of entries, the entry list frame also contains a pointer back to the category frame that lead to the entry list (option R) and options to move back and forth through the entry list (option M and P (not shown)).

The user, being interested in chess, selects option 2. This leads to reference to a chapter of a book written by Hans Berliner (Figure 3a). This frame gives the basic information about the entry (title, author, author's address, which book its from, etc.). The frame has four options that provide additional information. Option 1 leads to a frame that provides acronyms and keywords for the entry (Figure 3b). Option 2 provides a small amount of information on the book (Figure 3c). The abstract of the article (if available) could be viewed by selecting option 3. The other categories under which this entry is classified can be viewed by selecting option 4 (Figure 3d). This entry is classified under three categories. The user arrived at this point by coming through problem solving, but has discovered that he was really interested in the theory of heuristic methods. By selecting option 3 the user can move to that category and then view the entries classified under that category.

3.2.4. Parameterized-Search Net

Browsing is not the only method of accessing information in databases. The BROWSE system provides a parameterized search capability. The system contains a sub-net to guide the user in specifying search parameters. Again, this sub-net was designed so that novices can specify searches with little training. The sub-net is self-contained in that it provides the user with all the information necessary to specify a search. The search is carried out by a sub-job. Results of the search are transmitted to the BROWSE system for display to the user.

Parameterized search has been altered to conform to the browsing philosophy, and thus has produced a more powerful search capability. This was accomplished by making searches context dependent. At any class in the BROWSE-NET, the user may specify the search option, at which point the user is transferred to the parameterized search sub-net. A search so initiated is restricted to the entries covered by the classification at which the user specified the search option. Hence the user can combine browsing and parameterized searching, resulting in more powerful information access. If the user specifies a parameterized search, the same browsing mechanisms are available to peruse the entries that satisfy the search and any *related* entries, where related is defined by the classes in which the entry is a member.

3.3. Support Software

The support software for the BROWSE System consists of the programs: ENTER, MAT, and CATLOG. MAT is used to create and alter standardized frame structure definitions. ENTER and CATLOG are used as data entry systems. ENTER also is responsible for merging the information of an entry with its set of frames structure definitions to produce ZOG frames, and to link the entry to the rest of the BROWSE network.

Before we describe the support software we define a few terms:

Frame	Screenfull of information. Is a node in a ZOG-NET.
Entry	Single conceptual unit such as a book, technical report, journal article, etc. More than one frame is used to represent a single entry.
Element	A single information unit in an entry. e.g., author, title, publisher, etc.
Element Set	A set of elements that comprise an entry.
Classification	The category hierarchy that an entry is classified under and linked to in the BROWSE-NET (e.g. Library of Congress, Dewey Decimal).

3.3.1. Frame Structure Definition

The support software uses a standard frame structure definition (FSD) to guide the creation of frames. Early in the design process we decided to separate the ZOG frame into its content and its form. This allows the user to be able to enter information about an entry without regard to the structure of the frames that will be created. It also allows the structure of the frames to be redefined and a new network generated automatically.

The frame structure definition describes:

1. What information is to be placed in the frame (e.g., title, author, publisher).

2. Where the information is to be placed.

3. What information is necessary to actually create the frame.

4. What options are to appear in the frame.

5. What type of frame does each option lead to.

The FSD consists of a set of rectangular areas called windows. Windows can either be text, option, or quote windows. For text or option windows the FSD specifies which element of the entry is to be used as text filler. For example, the first frame for a chapter of a book (Figure 3a) contains separate windows for title, author, author's address, etc. The text that is placed in a quoted window is given in the FSD.

The FSD also contains a value for each window describing whether or not the frame is to be created, if the window actually contains text. For example, it would not be necessary to create the second frame of a chapter of a book (Figure 3b) unless there were some acronyms and keywords to display, even though there is the title and author available.

The difference between a text and option window is that the option window contains information about what type of frame that the option will lead. Option windows also contain other information associated with an option in the ZOG system.

The MAT program was designed to allow for creation and altering of frame structure definitions. In creating an FSD, MAT allows the user to create any number of windows and position them in the frame. The user also specifies the type of the window, as well as the remainder of the information associated with the window. In altering the frame the user can remove windows, add new windows, move windows as well as change the information associated with the window. MAT uses a two dimensional display format. The user sees the windows as they would appear in a BROWSE-NET frame.

Each entry type (e.g., technical report, book) has a unique set of frames associated with it. This *frame set* is defined by an entry's root frame and the frames accessible through options from the root, excluding other root frames. An entry's frame set implicitly defines an entry's *element set*. The element set defines the information that defines an entry (e.g., title, author, publisher). The element set is compiled by MAT for each entry type, for use by ENTER and CATLOG.

3.3.2. Entry Manipulation

There are two of programs that handle the input and editing of entries. They are CATLOG and ENTER. CATLOG is a simple data entry program. Using an entry's element set (produced by MAT), it queries the user for information on a new entry specified by the user. Editing of the current entry is provided. That information is sent to the BROWSE-NET manager for correction and augmentation. The manager also supplies a list of classifications into which the entry falls. The entry is then passed to the ENTER program for translation into the BROWSE DATABASE.

The ENTER program provides a large set of functions. Included in that set is the ability to create and alter frames, as well as entering entries into the database. Entries that are created by CATLOG can be translated by ENTER and placed into the database. ENTER provides two forms of creation and editing. A user can enter (and alter) information in either a one-dimensional format or in a two dimensional format. In the two dimensional format the user will enter (and alter) the information in the place that the information would appear in a frame. In the one-dimensional format the user enters (and alters) the information in a line by line fashion.

Unlike CATLOG, ENTER makes it is possible to alter any entries in the database. For each entry an identification code is created using some of the entry's element set. The identification code is used to retrieve the entry from the database.

3.3.3. Entry Database

All entries are stored in the BROWSE DATABASE. Entries entered using CATLOG are translated by ENTER into the database, and entries entered using ENTER are placed directly into the database. The BROWSE DATABASE is randomly accessed by an entry's unique identification code. The database entry representation is independent of the entry's frame set format and the ZOG-frame representation. Hence changes to the frame format do not affect the database.

3.3.4. Network Generation

The basic function provided by ENTER is the creation of ZOG frames from an entry's database description. In providing this function ENTER merges the FSD's of the entry with its database description.

The remainder of the functions provided by ENTER deal with linking an entry into the BROWSE-NET. As stated above, one of the functions the manager of the BROWSE system is to provide the categorization of an entry. Given the categorizations, ENTER will automatically hook the entry into the network. The category frame under which an entry is classified is altered by adding a link (option) to the category. Secondly, a link (option) from the entry to all of its classifications are added to the entry. This allows the browser to transfer from an entry to all of its classifications.

ENTER also provides for the creation of categorizations of authors, keywords, journal, etc. The linking of entries to those categories can be handled the same way as for subject categorizations, except the information needed for determining where to link the entry is already provided in the entry information.

3.3.5. Other Applications

An attempt has been made to generalize the supporting software to allow for other uses. Associated with the support software is a profile file. The profile tailors the support software to a particular application. This file supplies: 1) the file which contains pointers to all the frame structure definitions, 2) the file which gives information about the entry types (i.e. the root FSD, the directory file, the HST file, etc.), 3) files used for protection, and 4) files which give information about searching used by the parameterized search procedure.

It is hoped that the support software can be used in developing other systems for the ZOG system, as well as providing support to other systems. It would be possible to change ENTER to output entries in a different form than the ZOG frame definition.

4. Conclusion

Phase I of the BROWSE system project has been completed. A large network of categories and entries exists allowing the naive user to peruse the computer science department collection at their leisure. The goals of a simple man-machine interface, presenting the database organization to facilitate assimilation, and providing a browsing-style approach to database searching appear to be satisfied. But concrete verification of these goals await the user studies in Phase II (see Fox & Palay, 1979). Though it has been suggested that a browsing-style approach to database searching may not be achievable (Myers, 1970, p. 47), the BROWSE system represents a significant step towards this goal.

5. Acknowledgements

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THE BROWSE-NET ZOG1

THE CARNEGIE-MELLON UNIVERSITY

COMPUTER SCIENCE DEPARTMENT

LIBRARY BROWSING SYSTEM

C. Continue for instruction. (Type C to continue)

T. Top of the BROWSE-NET.

help back next mark return top display comment goto find

FIGURE 1a

Top of the Browse-net. browse5

You are now at the top of the BROWSE-NET. The following are the classifications available for browsing through.

1. Computing Review classification.

2.-CMU Computer Science Dept classification.

3.-Dewey-Mounts classification.

4.-Library of Congress classification.

N. New Entries

help back next mark return top display comment goto find

FIGURE 1b

0.: Computing Review CATEG73

Computing Reviews

1. General Topics and Education [1.]

2. Computing Milieu [2.]

3. Applications. [3.]

4. Software [4.]

M. More Selections

E.-Entry List
B.-Alternate Supra-categories

The Computing Reviews classification is published in Computing Reviews by the Association of Computing Machinery. (Computing Reviews, May 1976).

S. Parameterized Search

help back next mark return top display comment goto find

FIGURE 1c

3.: Applications CATEG109

Computing Reviews

1. Natural Sciences [3.1]

2. Engineering [3.2]

3. Social and Behavioral Sciences [3.3]

4. Humanities [3.4]

M. More Selections

E.-Entry List
B.-Alternate Supra-categories
P. <0.: Computing Review>

This category contains subcategories concerned with the use of computers - where, how, when, and why they are used. It also deals with the relationships between human cognitive and perceptual processes and computing.

S. Parameterized Search

help back next mark return top display comment goto find

FIGURE 1d

FIGURE 1

```
3.: Applications                                        CATEG108

        Computing Reviews
                                    This category contains
1. Management Data Processing [3.5]  subcategories concerned with the
                                    use of computers - where, how,
                                    when, and why they are used. It
2. Artificial Intelligence [3.6]    also deals with the relationships
                                    between human cognitive and
                                    perceptual processes and
3. Information Retrieval [3.7]      computing.

4. Real-Time Systems [3.8]

M. More Selections

   E.-Entry List
   B.-Alternate Supra-categories
   P. <0.: Computing Review>                S. Parameterized Search

help  back  next  mark  return  top  display  comment  goto  find
```

FIGURE 2a

```
|3.6: Artificial Intelligence                                   CATEG78
|
|        Computing Reviews
|                                           This category contains
|1.-Induction and Hypothesis-Formation      subcategories pertaining to
|  [3.61]                                   induction and the formation of
|                                           hypotheses; learning and
|2. Learning and Adaptive Systems [3.62]    adaptive systems; pattern
|                                           recognition; problem solving;
|                                           simulation of natural systems;
|3. Pattern Recognition [3.63]              theory of heuristic methods,
|                                           and general and miscellaneous
|                                           subjects within the broad area
|4. Problem Solving [3.64]                  of artificial intelligence, or
|                                           the machine simulation and
|                                           modeling of human functions,
|M. More Selections                         particularly human
|                                           intelligence.
|   E. Entry List
|   B.-Alternate Supra-categories
|   P. <3.: Applications; >                    S. Parameterized Search
|
|
|help  back  next  mark  return  top  display  comment  goto  find
```

FIGURE 2b

```
3.64: Problem Solving                                   CATEG159

        Computing Reviews
                                    Computer simulation of human
                                    reason as applied to problem
                                    solving.

   E. Entry List
   B.-Alternate Supra-categories
   P. <3.6: Artificial Intelligence>        S. Parameterized Search

help  back  next  mark  return  top  display  comment  goto  find
```

FIGURE 2c

```
|3.64: Problem Solving                                          ENTRY13
|
|1.  A glimpse of truth maintenance; Doyle, Jon; Technical Report;
|
|2.  A representation and some mechanisms for a problem-solving chess
|    program; Berliner, Hans J.; Chapter of Book;
|3.  Advances in computer chess; ; Edited Book;
|
|4.  Creating a chess player; Frey, Peter W.;
|
|5.  Dependency networks as a representation for modelling in general
|    problem solvers; London, Philip E.; Technical Report;
|6.  EG -- A case study in problem solving with king and pawn endings;
|    Perdue, C.; Symposium or Conference Paper;
|7.  Experiences in evaluation with BKG--A program that plays backgammon;
|    Berliner, H.; Symposium or Conference Paper;
|8.  Grandmaster Walter Browne versus Chess 4.6; Douglas, John R.;
|
|
|M. More Entries E                                    R. Root Category
|
|
|
|help  back  next  mark  return  top  display  comment  goto  find
```

FIGURE 2d

FIGURE 2

```
                    Chapter of Book                                    CHAPTER3

A representation and some mechanisms for a problem-solving chess
program

Berliner, Hans J.
Dept. of Computer Science
Carnegie-Mellon University               794.17 A24 v.1 1977
Pittsburgh, PA 15213

  Page number:    7-29                   Berliner H. J. (1977) A

From the book:    Advances in computer chess


    Edited By:    Clarke, M. R. B.

                        1. Acronyms and Keywords.
                        2. Information on Book.
                        3.-Abstract.
                        4. Alternative Subject

help   back   next   mark   return   top   display   comment   goto   find
```

FIGURE 3a

```
|Berliner, Hans J.                                               CHAPTER1
|
|A representation and some mechanisms for a problem-solving chess
|program
|ACRONYM:
|   No acronym for title.
|
|
|KEYWORDS:
|   CAPS-II & chess & problem solving
|
|help   back   next   mark   return   top   display   comment   goto   find
```

FIGURE 3b

```
Berliner, Hans J.                                                  CHAPTER2

A representation and some mechanisms for a problem-solving chess program


From the book:     Advances in computer chess



                   Edinburgh University Press
                   Edinburgh       Scotland
                   1977

                   794.17 A24 v.1 1977


                   Berliner H. J.


help   back   next   mark   return   top   display   comment   goto   find
```

FIGURE 3c

```
|                 Alternate Subject Classifications              CHAPTER94
|
|A representation and some mechanisms for a problem-solving chess
|
|1.   3.62: Learning and Adaptive Systems;
|
|2.   3.64: Problem Solving;
|
|3.   3.66: Theory of Heuristic Methods;
|
|help   back   next   mark   return   top   display   comment   goto   find
```

FIGURE 3d

FIGURE 3