FRACAS: A Computerized Aid for Reasoning in Tax

Varghese S. Jacob
The Ohio State University, Columbus, OH, USA

Joanne H. Turner
University of Michigan Law School, Ann Arbor, MI, USA

Abstract Problem solving in the tax domain requires two kinds of knowledge: of the law itself and of how the law has been applied in the past. The need for the second factor arises as a result of the ambiguity of natural language. The problem solver requires information on how the courts have adjudicated specific cases in the past. This information would then provide the basis for reasoning about the current case. In this paper we address the issue of developing a system which will retrieve relevant historical cases. The cases are stored using a frame representation scheme and the users can retrieve cases by specifying either attributes alone or attributes and values associated with them. Currently the system has been implemented in Pascal on a Cray. The case base contains 250 cases relating to Section 183 of the tax code.

Introduction

Problem solving in the tax domain requires knowledge on two levels. On one level the problem solver must have knowledge of the law itself. That is, the problem solver must know (or be able to find out) what types of income are taxable, which expenses are deductible, and so on. For example, Section 162 of the Internal Revenue Code specifies that 'There shall be allowed as a deduction all the ordinary and necessary expenses paid or incurred during the taxable year in carrying on any trade or business'. However, because of the ambiguity of the natural language in which tax laws are written, knowledge of the legal terms alone is not enough. In addition to knowing that expenses incurred in a trade or business are deductible, the problem solver must know (or be able to find out) what makes a particular endeavor a 'trade or business'.

The judicial system operates under the doctrine of *stare decisis*, meaning 'let the decision stand'. Under this policy, courts generally abide by or adhere to previously decided cases. As a result, the current interpretation of ambiguous

phrases such as 'ordinary and necessary' is, to a large degree, governed by their interpretation in the past. Therefore, legal problem solving also requires knowledge about cases which have previously been adjudicated (called 'precedents'). Knowledge of either statutory language or precedents alone is not sufficient.

A major feature of problem solving within the legal domain is the linking of this knowledge to the case at hand. Previous attempts at linkage have generalized information from the precedents and the statutory law to form rules, rather than utilizing case knowledge directly.[1] For example, Hellawell's (1980) CORPTAX system used IF-THEN deductive logic to determine whether a stock redemption qualified for favorable tax treatment under the 'substantially disproportionate' provisions of Section 302(b)(2), considering the related attribution rules of Section 318(a). However, CORPTAX essentially

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[1] An exception is the TAXMAN II project (McCarty and Sridharan, 1981, 1989), which uses a prototype-and-deformation model to analyze components of income.

replicated the statutory provisions of Section 302(b), without addressing semantic and definitional issues. A second stream of research is exemplified by Robison (1983), who applied probit analysis and stepwise regression to discern five factors which influence the judgment of whether an activity constitutes a business or a hobby. While Robison's goal was not a rule-based system *per se*, the factors he isolated could easily form the basis for rules. A third category is the 'expert' system, which attempts to replicate human expertise in narrow problem domains. We do not discuss the various expert systems in tax as extensive reviews on the topic can be found in Michaelson and Messier (1987), Brown and Streit (1988) and Brown (1988a).[2]

Although a rule-based approach is valuable, it has limitations for some users. First, one can generalize only if a sufficient number of cases have been decided in the same manner. This necessarily limits the issues for which a rule-based system can be generated to those that have been widely litigated. Second, laws change over time, and rules that were valid in the past may not be appropriate in the future. As a result, rules must be continuously reviewed and updated where necessary. Third, a rule-based system typically does not include enough or sufficiently detailed rules to incorporate all the factors which may influence the outcome, such as the court in which a specific case was decided or the particular judge who rendered the decision. This may be deliberate, in order to simplify the rule structure, or a necessary result of the fact that sufficient cases have not been decided which incorporate a particular factor to be able to articulate a rule. Finally, as noted by Fikes and Kehler (1985), rules are inadequate to define terms. This problem seems particularly acute in domains such as tax, where disputes over the definition of such terms as 'trade or business' comprise the great majority of cases litigated and disputes over the form of a rule itself are relatively rare.

In this paper we propose an alternative approach to the representation of legal knowledge and its retrieval. The approach assumes that the user is going to utilize historical cases as the basis for reasoning about the current case. The system, therefore, functions as a decision support system to provide the user with the appropriate information. Discussion on the case approach to problem solving can be found in Riesbeck and Schank (1989).

The paper is structured as follows. In the next section we discuss a frame-based system[3] for storing knowledge in the tax domain, and a method for retrieving the information based on similarities between the current case and those in the case base. The Appendices contain sample interactions with such a system, which we call FRACAS (FRAme-based Case Analysis System), which has been implemented on a prototype basis. The final section presents conclusions and possible future research directions in the area.

Development of FRACAS

The development of FRACAS (a FRAme-based Case Analysis System) was founded on the concept that a court case is a collection of attributes. Examples of these attributes include the fact that each case has a name and citation, was decided on a particular date, by a particular judge (or judges). Attributes also encompass the facts of the case, including characteristics of the parties involved such as age, education, occupation and income. Finally, the reasoning indicated by the judge to determine the outcome forms additional attributes.

There may be several cases which have similar attributes, but never would there be two cases in which all the attributes were

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[2] Application of artificial intelligence techniques in tax can be found in Brown [1988b]. A comprehensive annotated bibliography on expert systems in accounting can be found in Brown [1989].

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[3] The system described here does not model or capture expertise or the thought processes of a human expert. Rather, it focuses on what Holsapple and Whinston (1987) call 'descriptive knowledge', that is, knowledge about the past, present and/or anticipated states of the world. In this respect, it differs from such previously developed systems as Taxadvisor (Michaelsen, 1984) and ExperTAX (Shpilberg *et al.*, 1986). For this reason, we consider the system a decision aid which supports tax reasoning, rather than an expert system. However, the development and application of expertise to problem solving in law requires abilities such as this system supports.
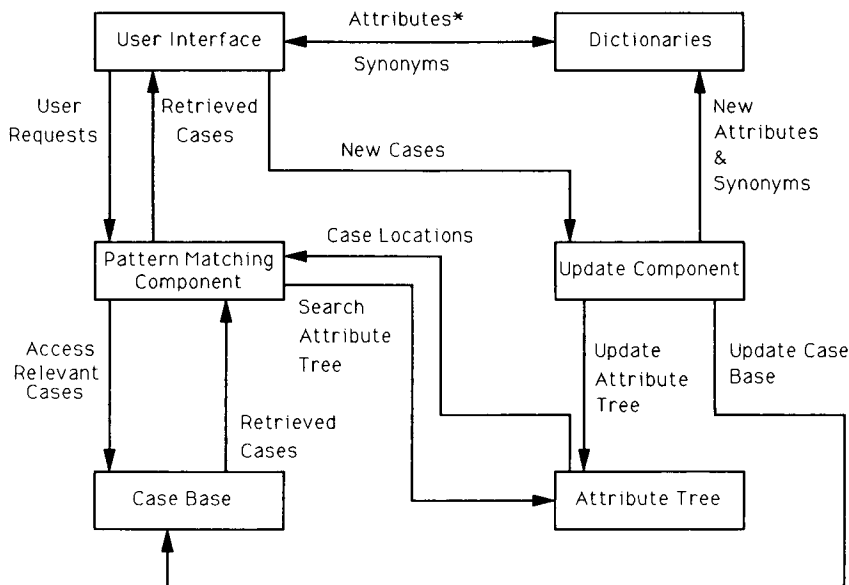
Figure 1 Structure of FRACAS. *Currently holds listing of the attributes on which the user can search.

identical.[4] (Indeed, if that were so, the second case would not have been adjudicated at all.) Given this assumption, the goal of FRACAS is to assess the similarity of the current case under adjudication to those in the case base. In this section we discuss the structure of the case base and the search process used to locate and retrieve the relevant cases.

Figure 1 depicts the structure of FRACAS. The system has been implemented on a Cray Y-MP supercomputer, and the search procedure is written in Pascal.[5] Although implementation on a supercomputer may be viewed as overkill for a prototype with 250 cases, clearly such a

machine would be necessary for a complete implementation which took into account the whole tax code. Additionally, we believe that for a system to be truly successful in the tax domain it would need multiple-reasoning schemes. At a minimum it should also include case-based, analogical and rule-based reasoning. A combination of the size of the knowledge base and the reasoning schemes would require a fast machine for real-time access. The current research, as a first step, seeks to illustrate the feasibility of utilizing a supercomputer for one aspect of the problem. An alternative approach would be to utilize a network of co-operating processors, where each processor in the network can be viewed as an expert in a specific area of the code. A discussion on the networked approach as it relates to auditing can be found in Jacob and Bailey (1991).

The current system has four components: a user interface, a pattern-matching (search) component, an update component and the case base. Each of these components is described below.

The Case Base

Tax cases form the knowledge base for FRACAS and these cases are subclassified by the particu-

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[4] An appeal of an earlier case would share many characteristics with the lower court case. However, attributes such as citation, date and judge(s) would obviously differ. Most importantly, the reasoning advanced by the appeals court for its decision may differ (sometimes radically) from that of the lower court.

[5] At the time the project was initiated, the host computer was a Cray X-MP, which supported a limited range of programming languages. Pascal was chosen because it was supported by the Cray, and because programming assistance in Pascal was readily available.

lar tax provision at issue. For convenience, and following common practice, cases are subclassified by the particular Code section at issue. Thus, cases involving the deductibility of medical expenses under Code Section 213 form one subclass while those relating to the taxation of dividend income from mutual funds form another subclass under Code Section 852. Tax cases can be further classified by the particular court in which the case is adjudicated. For example, all tax cases decided in the US District Courts form one subclass while all decided by the US Tax Court form another.

Given the class/attribute nature of the problem domain, the case base is organized in frames. A *frame* is a knowledge-representation technique typically used to represent an object or a class of objects. Several expert systems shells have been developed using frames (see Waterman, 1986, for a list of these shells). Frames can be organized into taxonomies based on classes. Within each class, one can describe subclasses or specializations of the more generic classes. For example, within the class of all tax court cases, those involving the deduction for interest expense form a subclass. These cases have properties common to all tax cases, such as the fact that one party in the case is the Commissioner of Internal Revenue or the US Government. In addition, they have properties which distinguish them from other types of tax cases. These properties revolve around the factual matters presented in the case and the reasoning used by the court to reach a decision.

Currently, our system contains cases involving Section 183, which limits the deductibility of expenses of activities not engaged in for profit.[6] In particular, our system contains cases on the issue of whether an activity constitutes a 'trade or business' (in which losses are deductible) or simply a hobby (in which losses are not deductible).[7] An activity which shows

a profit in three of five consecutive years (two of seven consecutive years if the activity deals with horses) is presumed to be a business, a presumption which can be overcome by the IRS.[8] On the other hand, an activity which shows losses in more than two of five consecutive years (five of seven consecutive years if the activity deals with horses) is presumed to be a hobby, a presumption which can be overcome by the taxpayer.

In addition to these 'safe harbor' rules, the Regulations accompanying Section 183 detail several factors which may be considered in determining whether an activity is engaged in for profit, such as whether it is conducted in a 'businesslike manner', the expertise of the taxpayer and the time and effort expended by the taxpayer. In all, nine factors are discussed. These appear in judges' opinions and are facets or subslots describing the court's opinion.

Section 183 was chosen as a basis for development of the prototype for several reasons. First, it is an area of frequent litigation between the IRS and taxpayers. Thus, the development of a system to aid tax researchers in this area would be of immediate usefulness in practice. Second, it is so frequently litigated primarily because

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[6] Section 183 falls under Subtitle A (Income Taxes) of Title 26 of the US Code, Chapter 1 (Normal Taxes and Surtaxes), Subchapter B (Computation of Taxable Income), Part VI (Itemized Deductions for Individuals and Corporations).

[7] Under Section 469(1), enacted in 1986, any trade or business in which the taxpayer does not 'materially participate' is classified as a 'passive activity'. The deductibility of losses incurred in passive activities is severely restricted. However, Section 469 may

have little impact on the level of litigation under Section 183, for two reasons. First, before Section 469(1) may be applied it must be determined that the activity in question is a trade or business. That determination is made under Section 183. Thus the status of taxpayer's activity as either a trade or business or a hobby is a threshold issue which must be addressed before Section 469 comes into play. Second, in many cases litigated under Section 183, the taxpayer would meet the 'material participation' standard. Temp. Reg. 1.469-5T outlines seven test which may be used to measure material participation. Under the second of those tests, a taxpayer materially participates in an activity if 'his participation constitutes substantially all of the participation in the activity of all individuals (including nonowners) for the tax year'. That is, in Section 183 cases it typically is the taxpayer's motive for engaging in the activity, not the taxpayer's level of participation, which is the crucial issue.

[8] Prior to 1987, the presumption of a business required a showing of profits in only two of five consecutive years. Cases decided under pre-1987 law are included in the case base because of their obvious applicability in other respects to current problems. A user searching for cases specifically decided under pre-1987 law may so specify by restricting the search by year decided.

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the language of Section 183 is ripe for interpretation. (For example, what is a 'businesslike manner'?) Thus, it would illustrate the abilities of the prototype system to link previously decided cases to ambiguities in statutory language.

The cases are organized in a hierarchy with generic cases at the top of the hierarchy. This allows lower-level cases to *inherit* properties of the class, such as default values, from the higher-level frames. For example, all cases stored in FRACAS within the class of tax cases decided in US District Courts have the property that a jury trial is available. Specific cases within the class indicate whether or not a jury was used.

Lower-level cases can have specialized properties as well. For example, most court opinions are written by a single judge. However, on occasion, an opinion is designated 'per curiam', indicating no individual judge is responsible for the decision. If a particular case is decided *per curiam*, its case frame so indicates.

Attributes of each case are incorporated within the frame in *slots*. Since attributes can have properties of their own, one can also specify the properties of slots within subslots, called *facets*. Because of the particular code section chosen as the basis for the prototype, some slots in FRACAS incorporate features associated with decisions under Section 183 itself, such as the taxpayer's wealth and background. Other slots in FRACAS store the citation of the case and the name of the judge rendering the opinion. Although every court case contains this information, the facets describing these slots are based on the information in a specific case.

Illustrative Example

Consider the case of *Rex B. Foster* (32 TCM 42 (1973)). This case will be used to demonstrate the robust ability of a frame-based system to store knowledge about a tax case in easily retrievable fashion.[9] Briefly, Dr Foster and his wife, Betty, raised Shetland ponies on their farm outside Waterloo, Iowa. Though they lost money every year from 1955 through 1970, they were able to convince the Tax Court that their operation was engaged in for profit, and thus the expenses of which were deductible without limit. Thus, they were able to overcome the presumption that a horse-breeding operation which fails to show a profit in two of seven consecutive years is not a business.

Our case-based knowledge retrieval system for tax cases begins with a frame containing identifying information about the case itself. The case information frame has several facets associated with it, such as its citation, the years at issue and in whose favor the case was decided (Figure 2).

The linkage properties of frame-based systems become apparent immediately. The *Foster* case shares many properties with other cases heard in US Tax Court, such as:

JURY TRIAL?   Not available
APPEALABLE-TO: US Court of Appeals

The *Foster* case is automatically linked with other Tax Court cases appealable to the Eighth Circuit, and with cases already heard in the Eighth Circuit. If there are other properties which are common to other cases, those links are also established when the case is stored.

Next, the system stores information about the Fosters themselves. For example, the Fosters are individual taxpayers filing a joint return, and thus the *Foster* case frame inherits important default properties from the class of INDIVIDUALS, such as calendar tax years and a cash accounting method. These properties can, of course, be overridden by the facts of the case itself, but there is no mention to the contrary in the *Foster* case.

The case contains a lengthy accounting of the receipts and expenses of the Fosters' pony breeding between 1955 and 1970. Many aspects of their finances may be of interest to others: the size of their losses, both in absolute dollars

[9] For purposes of this prototype, cases were coded into frames by one of the researchers. A standard template was established based on a preliminary reading of a sample of cases. Frames and slots were added to and deleted from this template to accommodate specific cases. The *Foster* case was chosen as an illustration because it was particularly thorough in its discussion of the facts of the case and of the elements of the court's reasoning. Not all cases included in the case base are as complete in their discussion.

SLOT: <u>CASE INFORMATION</u>

      TAXPAYER-NAME   Rex B. Foster
                                Betty C. Foster
      CITATION
        CCH   32 TCM 42
        PH   TC Memo 1973-13
        US   None
        PROCEDURE   (No US citation is
                               available for Tax Court Memo
                               decisions)
        COURT   U.S. Tax Court
          DECISION-TYPE   Memorandum
          JURY TRIAL?   No
          APPEALABLE-TO   U.S. Court of Appeals
            CIRCUIT   Eighth
          JUDGE   Irwin
        DATE-OF-DECISION   1/23/1973
        YEARS-AT-ISSUE   1964, 1965, 1966, 1967
        DECISION-FOR   Taxpayer
        BUSINESS-CLAIMED   Raising animals
          ANIMAL-TYPE   Shetland ponies

SLOT: <u>TAXPAYER</u>

      TAXPAYER-TYPE   Individual
        RETURN-TYPE   Joint
        TAX-YEAR   Calendar
        ACCOUNTING METHOD   Cash
      RESIDENCE
        YEARS-AT-ISSUE   Waterloo, IA
        TIME-OF-TRIAL   Delray Beach, FL
      OCCUPATION   Professional
        PROFESSION   Dental surgeon
      EMPLOYER   Foster and Foster partnership
      AGE   68
      RELATED-EXPERTISE   Qualified judge of Shetland ponies
      RELATED-EDUCATION   Special course in schooling Shetland
                               ponied

SLOT: <u>BUSINESS INCOME</u>

      YEAR1   1955
       GROSS RECEIPTS   0
        NET INCOME (LOSS)   (1,974.64)
      YEAR2   1956
       GROSS RECEIPTS   800
        NET INCOME (LOSS)   (4404.14)
                 .   .
                 .   .
                 .   .
      YEAR10   1964
       GROSS RECEIPTS   4,614.21
       OPERATING EXPENSES
       HAY AND FUEL   1,232.07
       LABOR   2,644.55
       SHOEING   1,036.50
       INSURANCE   468.58
                  .   .
                 .   .
                 .   .
      DEPRECIATION   6,741.31
      NET INCOME (LOSS)   (16,273.47)
      IF-NEEDED   (Procedure for computing number of
                               years of profits/losses)

Figure 2 Frame representation of a sample case.

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SLOT:   OTHER INCOME

        YEAR1                       1955
          AMOUNT                    13,725.00

                    .                         .
                    .                         .
                    .                         .

        YEAR10                      1964
          AMOUNT                    29,771.27
          IF-NEEDED                 (Procedure for computing size of
                                    losses relative to other income)


SLOT:   JUDGE'S OPINION

        BUSINESS-LIKE MANNER?
          EVIDENCE CITED            Adequate facilities
                                    Participation in horse shows
                                    Advertising in trade journals

        EXPERTISE?                  Yes
          EVIDENCE-CITED            Occasional help of part-time
                                      trainer
                                    Shipped ponies to another trainer

        TIME AND EFFORT?            Yes
          EVIDENCE-CITED            Physical work
                                    Hours spent by wife
        EXPECTATION OF APPRECIATION?  Selectively bred herd
        FINANCIAL STATUS?           Income from dental practice "ample"
                                      but not "very wealthy"
        OTHER FACTORS CITED         Decline in market for "color"
                                      ponies
                                    Growing demand for "show" ponies
                                    Other breeders left business
                                    Health of taxpayer
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Figure 2 Continued.

and in relation to the income from Dr Foster's dental practice; the pattern of losses; the relative and absolute amounts of depreciation and cash expenses; even the particular expenses claimed. The researcher may thus inquire as to the existence of cases under Section 183 in which a particular pattern of income or losses, or income or losses of a particular size, occurred.

Searches of this kind are simply not possible in pure text-based retrieval systems and are difficult to accommodate in rule-based ones. Consider a tax accountant or attorney whose client's horse-breeding operation has failed to show a profit in two of seven consecutive years, and thus does not qualify for the presumption of a trade or business. Such a taxpayer has a particularly heavy burden of proof, because in order to win, the taxpayer must overcome the presumption that the activity is *not* a trade or business. Locating previously decided cases in which the taxpayer succeeded in overcoming the presumption would obviously be helpful.

However, such a search is impossible to conduct on LEXIS or other pure-text-based retrieval systems because there is no consistent way used in previous cases to describe such a pattern of losses. Consider these examples from four horse-breeding cases selected at random: 'sustained series of losses', 'absence of profits during the taxable years in question', 'petitioner's horse-breeding operation incurred losses for each of the years in question', 'a loss in each and every year'[10]

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[10] As a second example, consider a tax accountant or attorney whose client, a physician, is concerned about the effect his occupation may have on the chances of winning a dispute with the IRS over expenses on his horse farm. A LEXIS search using the key words 'Sec. 183 and horse w/5 breeding and physician' retrieved a total of eight cases. However, in one of those cases, the taxpayer's occupation was not physician; rather, the taxpayer had reduced his involvement in horse breeding on his *physician's*

Rule-based systems do not necessarily fare much better. A rule-based system involving Section 183 may generate the rule that situations in which the taxpayer showed profits in only one year are likely to be decided against the taxpayer, but would not be able to pinpoint specific cases which are the exception to the rule. Similarly, a rule-based system which indicated specific income levels at which the taxpayer either prevailed or lost would be likely to be rejected as overly specific. Indeed, the number of exception rules which would have to be specified in any rule-based system in the tax domain would be large. (An approach to combat this problem is that taken in the TAXMAN II system (McCarty and Sridharan, 1980, 1981).) Yet, locating these precedents is key to the taxpayer's ultimate success.

The court's decision can also be stored in a way which permits easy access to specific portions. For example, the system stores the judge's conclusions (where indicated) as to whether the activity was carried on in a 'business-like manner' and any facts the judge mentions which guided the determination. A researcher can thus use FRACAS to survey successful arguments for the presence of a 'business-like manner', or any of the other eight factors indicated in the Regulations as indicative of a trade or business.

A concern in any knowledge-representation system is the danger of biasing the search process by attempting to determine in advance which aspects of a case are important. This has been a traditional criticism of pre-storage (as opposed to post-storage) analysis (Chandler, 1974). However, the inherent flexibility of a frame-based system allows the details as well as the general principles of a case to be stored. Also, as the above example demonstrates, the inheritance and default properties of frames actually allow more information about a case

instructions. In three other cases the taxpayer was a physician, but was not involved in horse breeding. LEXIS retrieved the cases because they contained the statutory language of Section 183, which includes the phrase 'horse breeding'. In only four of the eight retrieved cases was the desired combination of factors present. Obviously, the search retrieved only those cases where the taxpayer's occupation was described as 'physician', as opposed to dentist or surgeon or doctor.

to be stored than perhaps the case itself explicitly mentions.

In addition to efficient storage of information, the hierarchical nature of the stored information makes for efficient retrieval of information. For example, if a user were interested in cases dealing with Section 183 under subtitle A, the search would follow the path indicated by the arrows in Figure 3. This eliminates the necessity for searching the entire knowledge base until cases involving Section 183 are found.

To facilitate retrieval, the frames are linked along several additional dimensions. One link
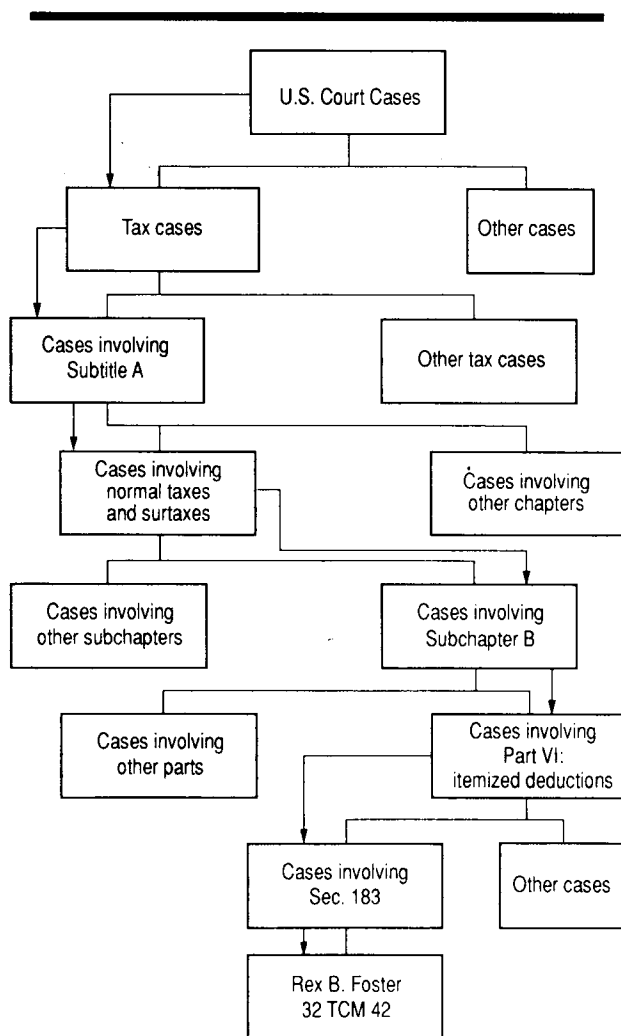
Figure 3 Organization of case frames on an issue basis.

recognizes that users may be interested in retrieving cases with particular attributes. For example, one may be interested only in cases in which the adequacy of the taxpayer's record keeping is discussed. The presence or absence of this attribute differentiates one case from another. Another link recognizes that users may be interested in retrieving cases with a specific attribute–value combination. For example, one may be interested in cases decided by a particular judge. Since all cases are decided by judges, the feature which distinguishes these cases is the judge. Cases having attributes with common value are thus linked, and the links are used to retrieve cases based on the user's needs.

The Pattern-matching Component

This component serves two functions. First, given the attributes which are specified for the current case, it retrieves all those cases which have the specified attributes. Second, given that there would rarely be a perfect match between the current case and any prior case, the component also generates a measure of the similarity betwen each retrieved case and the current case based on the match between attributes.

Users may take one of two possible approaches to accessing the knowledge base. The first is to search for cases with specific attribute–value combinations. FRACAS conducts such a search by following the links embedded within the frames. The end result of such a search is only those cases which have all the specified attribute–value pairs. For example, such a search may produce all Tax Court cases in the case base in which the taxpayer's occupation was attorney but would not produce Tax Court cases involving taxpayers in other occupations. A search which specified many attribute–value pairs would undoubtedly produce relatively fewer cases, but the user could easily query the system with subsets of attribute–value pairs to see those cases which were not complete matches.

The second approach assumes the user is interested in viewing cases with certain attributes, regardless of the value of the attribute. For example, the user may be interested in retrieving all cases which indicated the taxpayer's occupation or discussed the impact of

the taxpayer's occupation on the ultimate result, without restricting the search to a specific occupation.[11] Once the user has specified the attributes of interest, the system uses this as a basis for retrieving cases using an attribute tree, rather than using the cases directly.

The attribute tree contains less information than the case hierarchy, thus manipulating the tree is much easier than manipulating the set of cases itself. The nodes of the attribute tree contain differentiating attributes, that is, attributes which make a set of cases uniquely different from another set of cases. The tree is organized such that each parent has all the common attributes of the children, and siblings differ from each other by at least one additional attribute.[12] Each node is linked to the one (or more) frame(s) which has all the attributes specified at the node. The search for attributes progresses by searching the attribute tree, and then the frames composing the cases.[13]

Since the likelihood of finding an exact match between the user-specified attributes and a specific case is low, particularly as the number of specified attributes increases, the user can specify on a scale of 1 to 10 the importance of

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[11] It is relatively common in cases under Section 183 for the court to discuss the taxpayer's occupation. Courts often cite the taxpayer's occupation as evidence that the activity was not undertaken for the purpose of sheltering income. For example, in *Comm. v. Yancy* (48 TCM 872) the taxpayer worked two full-time jobs (truck driver and steelworker). The court noted, 'Petitioners engaged in their horse-racing and horse-breeding activities in order to make profits so as to enable them to raise their economic standard of living . . . Petitioners did not have other wealth to fall back on.' Courts apparently also believe that certain occupations are so time consuming as to leave the taxpayer little or no time to devote to the 'business'. In *Comm. v. Joint Implant Surgeons, Inc.* (56 TCM 799), following a description of the taxpayer's typical workday, the court observed: 'With such constraints on his time as mentioned in his description, it would appear near impossible for him to take part in any daily activities associated with the farm's operation.' Finally, courts may simply believe that taxpayer in certain occupations are more likely to turn to such 'businesses' as farming and horse breeding, which can generate substantial paper losses, in order to shelter income from other sources.
[12] For example, parent A and children B and C share attributes 1 through 5. Child B also has attribute 6, while child B has attribute 7.
[13] The attribute tree is not imbedded in the frames.

each attribute in the search as well as the level of match required. Cases which do not fall within these user-specified bounds are discarded. The similarity between the retrieved cases and the current case is based on the number of matching attributes. Specifically, the similarity score is the ratio of the sum of the user-assigned values of attributes successfully matched to the total weights indicated by the user, and thus ranges from 0 to 1. In the current framework a case which has more than the number of attributes specified by the user will be assumed to be similar to that of the user.

The Update Component

The update component automatically updates the search tree as new cases are added to the knowledge base. Once the attributes of the new case are specified by the user, the system automatically determines its position in the search tree and establishes links between the new case and other related cases in the knowledge base. The update component also updates the dictionary. Appendix 2 contains a part of a sample interaction between the user and the update component.

The User Interface

As the appendices illustrate, the user interface is set up in menu fashion. The first screen displays the user instructions and the main menu from which the user may choose several actions: view a dictionary, conduct an attribute-based search, conduct a search for attribute-value pairs, update the knowledge base or exit the program.

The system includes two dictionaries. One lists all the attributes which differentiate the cases themselves, while the other lists those attributes on which an attribute–value search may be conducted. Examples of differentiating attributes include whether the taxpayer maintained 'acceptable' records, whether the taxpayer devoted much time to the activity and whether persons other than the taxpayer testified on the taxpayer's behalf in court. The primary purpose of the dictionaries is to acquaint the user with the attributes present in the knowledge base. Future expansion of the dictionary would involve specifying synonyms, so that the user is not constrained to the specific

terminology used in the knowledge base. Examples of attributes on which an attribute-value search may be conducted include taxpayer's name, citation, name of the judge rendering the decision and specific years at issue.

Choosing the attribute search option allows the user to retrieve cases with particular attributes. The user has the option of ranking the importance of the attributes on a scale of 1 to 10, with 10 being the most important. If the user chooses not to enter any weights, the system automatically assigns equal weights to the specified attributes.

Once the user has entered the attributes, the system offers the user the option to perform a search for specific values among retrieved cases. If this option is chosen, the user is requested to enter desired values for the attributes. Finally, the user is asked to specify maximum and minimum percentages of attributes specified to be retrieved. The higher the maximum value specified, the more restrictive the search will be and the lower the minimum value, the more inclusive the search.

The system displays the cases retrieved, with the highest degrees of matching displayed first. Since cases could have more attributes than those specified by the user, the user is first shown the differentiating attributes in the case(s) matched. Next, an excerpt from the first case is displayed (see Appendix 1). If a value search was specified, the excerpt indicates any positive results of the value search. At this point, the user is shown a menu from which he or she may choose to see the frame of the case excerpted, go on to the next case having the attributes specified, go on to the next set of cases which have a different set of attributes or return to the main menu.

The third option on the main menu is the value search. If this option is chosen, the user is asked to specify attribute–value pairs. As before, the system displays frames of cases which match the specifications, as well as the particular combinations matched. The user may view frames of the matched cases, continue accessing cases or return to the main menu.

Finally, the option for updating the knowledge base allows the user to enter attribute–value pairs for new cases. If the system does not recognize an attribute, the user may view the dictionary to select an

existing description for the attribute or add the new description to the dictionary. Before the entry is finalized the system displays the information entered and gives the user the opportunity to make changes.

Sample Interaction with FRACAS

Appendix I shows a sample interaction between the user and the system. The user in this session is interested in finding previous cases with six attributes, and identifies the most important characteristics of these previous cases to be that the taxpayer in question (1) experienced extraordinary problems, (2) had a large amount of outside (nonfarm) income and (3) used the knowledge gained from consultation with others to improve business operations. The user identifies of somewhat lesser importance the fact that the taxpayer in question experienced relatively small business losses. Finally, the user indicates an interest in previous cases involving animal breeding in which the judge determined that the taxpayer had acted in a business-like manner.

The system returns with a score which indicates how close the attributes in the case are to those specified in the search.[14] There is no penalty if the retrieved case possesses more attributes than were specified. Since the attribute tree is stored in arrays, the index in an attribute search denotes the location at which the set of attributes begins. An index is also used to denote the location of a particular case in the case base. (The index was primarily set up for debugging purposes.)

The system also returns with a list of differentiating attributes. That is, the retrieved cases possess these attributes in addition to those requested in the search. The first case recalled possesses all the requested attributes. Note that in determining that the Engdahls had experienced extraordinary problems, the judge cited four factors: a change in the market for saddlebred horses, illness among their horses, the deaths of two horses and the fact that the

---

[14] The matching score is calculated as the sum of the assigned values of all achieved matches divided by the total weight possible if all matches were achieved. If all possible matches are achieved, the matching score equals 1.

trainer hired by the Engdahls failed to devote his best efforts to the task. The judge indicated that the Engdahls had used the knowledge learned to improve their operations, but gave no specifics. On the other hand, the judge cited four separate facts in determining that the Engdhals had acted in a business-like manner: although they did not maintain a separate bank account for their horse operations, they did keep a separate ledger for their horse-related expenses and checked monthly variations in their expenses. They also advertised and exhibited their horses.

Based on the Engdahl case, the user now has concrete examples of situations which constitute 'extraordinary problems' in the language of the Regulations. A horse breeder who has experienced one or more of these factors can argue that they too have had extraordinary problems and that the fact that they have suffered persistent losses should not prevent their activities from being considered a trade or business. A taxpayer in some activity other than horse breeding or who experienced some other problem can use these examples to argue by analogy. Similarly, the Engdahl case gives four concrete examples of what constitutes a 'business-like manner', which may be used to support an argument for classifying an activity as a trade or business.

Conclusions

This paper discusses a decision-support system which may be used to retrieve historical court cases relevant to a particular current legal problem. As compared to traditional uses for a decision-support system, practitioners in legal-related domains are more typically interested in retrieving historical cases than in modelling issues. We have developed a system which allows the user to access relevant cases easily based on a comparison of desired attributes or values of the attributes.

To develop a complete decision-support system for legal reasoning will obviously require considerable effort. One of the most labor-intensive parts of such a developmental effort is obviously the coding of cases into frames. In the absence of standardization, decisions about the type and number of slots for a particular case must be made (as in this

prototype) by the system developer, working in conjuction with experts in the area. We note the many parallels between this effort and the methods used in developing and maintaining the West Digest system.[15] Further research is also required to enhance the developed system to take into account such features as the generation of rules (where appropriate) and other modes of reasoning.

Appendix 1: A Sample Interaction with FRACAS

```
WELCOME TO FRACAS.  THROUGH THIS PROGRAM THE USER MAY ACCESS A
DATABASE OF TAX CASES.  THE INFORMATION CONTAINED IN THESE CASES
HAS BEEN REDUCED TO A SERIES OF ATTRIBUTES AND VALUES - EXAMPLE:
JUDGE/SMITH.    THE   CASES   HAVE   BEEN   ORGANIZED   BY   PRIMARY
DIFFERENTIATING ATTRIBUTES.  CASES CAN BE RETRIEVED BY MATCHING A
SERIES OF ATTRIBUTES TO THE DATABASE.  WHEN USING THIS PRIMARY
ATTRIBUTE SEARCH, THE USER MAY ALSO SPECIFY THE VALUES HE IS
INTERESTED IN FOR UP TO 10 ATTRIBUTES.  FOR EXAMPLE, A USER MAY
WISH TO SEARCH THE DATABASE BASES ON THE EXISTENCE OF THREE
ATTRIBUTED - INCOME, PROPERTY, AND BACKGROUND.  AT THE SAME TIME
THE USER MAY NEED TO RECOGNIZE WHICH OF THE MANY CASES WITH THE
ABOVE ATTRIBUTES HAS THE VALUE SMITH FOR THE ATTRIBUTE JUDGE AND
THE VALUE OF $30,000 FOR INCOME.  THE ABOVE IS THE PREFERREd
SEARCH.
      THE DATABASE MAY ALSO BE SEARCHED SOLELY ON ATTRIBUTE/VALUE
COMBINATIONS BY CHOOSING VALUE SEARCH FROM THE MAIN MENU.  FOR
EXAMPLE, ALL CASES WITH JUDGE/SMITH TYPE/HORSEBREEDING.
                    ENTER FOR MORE
      TWO DICTIONARIES OF TERMS ARE PROVIDED FOR USE WITH THIS
PROGRAM.  THE FIRST CONTAINS PRIMARY DIFFERENTIATING ATTRIBUTES TO
BE USED IN THE ATTRIBUTE SEARCH.  THE SECOND CONTAINS A LISTING OF
ATTRIBUTES WHOSE VALUES MAY BE OF INTEREST EITHER AS THE SECONDARY
STEP TO THE ATTRIBUTE MUST BE ENTERED EXACTLY AS THEY APPEAR IN THE
DICTIONARIES.
      HERE ARE SOME MORE HELPFUL HINTS:
            1.    WHEN SPECIFYING A DATE USE TWO DIGITS AND SLASHES
                    EXAMPLES:  78, 06/78, 06/15/78
            2.    DO NOT USE $ SIGNS IN AMOUNTS.  EXAMPLE:  9,999.99

NOW, YOU MAY
      1.    LOOK AT A DICTIONARY
      2.    SEARCH BASED ON ATTRIBUTES
      3.    SEARCH BASED ON VALUES
      4.    UPDATE THE DATABASE
      5.    QUIT
ENTER NUMBER
1
WHICH DICTIONARY DO YOU NEED?
      1.    PRIMARY ATTRIBUTES
      2.    VALUE SEARCH ATTRIBUTES
ENTER NUMBER
1
ACCEPTABLE RECORDS
ACT COST-CONSCIOUS WAY
ACTING
BACKGROUND
BREEDING
BUSINESS-LIKE MANNER
CASE INFO
CPA OR ATTORNEY IN COURT
DEVOTE MUCH TIME TO FARM
DISCONTINUE POOR METHODS
EMPLOY COMPETENT LABOR              **************************
EMPLOY TENANT FARMER               * Examples of attributes*
EXPAND FARMING OPERATION           * stored in FRACAS       *
EXPECT PROP APPRECIATE             **************************
EXPECT OF APPRECIATION
EXPERTISE
EXTRAORDINARY PROBLEMS
FARM HAVE FORMAL BUS NAME
FARM IN BUS-LIKE MANNER
```

---

[15] The West Digest system parses cases based on elements of the reasoning used in deciding the outcome. Cases are then catalogued according to a detailed outline of 'key numbers', which represent a permanent or fixed number given to a specific point of case law. The process of parsing cases is described as follows. 'Every point of law dealt with in the case is carefully noted by the editor, who then writes a headnote for each point ... A case will have as many headnotes as there are points of law in the opinion ... The Key Number is assigned by an attorney editor who is an expert in the field of law governed by the assigned topic' (West, 1988).

```
            FARM-RELATED ASSOCIATIONS
                    ENTER FOR MORE
            FARMING
            FINANCES
            FINANCIAL STATUS
            HAVE A PROFIT PLAN
            HAVE EXPERIENCE
            HIST. OF INCOME & LOSSES
            IMPROVEMENTS
            INCOME
            INVESTMENT
            LEASING
            LEAST ONE YEAR OF INCOME
            LIVE ON OR NEAR THE FARM
            LOSSES IN SIMILAR BUS.
            LOSSES ONLY FIRST 5 YRS
            LOSSES OVER LONG PERIOD
            MEMBERSHIPS
            MUCH NONFARM INCOME
            MUCH NONFARM NET ASSETS
            MUCH PLEASURE FROM FARM
            MUCH TAX SAVINGS
                    ENTER FOR MORE
            NONFARM-RELATED REC.
            OCCASIONAL PROFITS
            OPERATE LIKE PROFIT BUS.
            OTHER POSSIBLE CASES
            OTHERS TESTIFY IN COURT
            PERSONAL PLEASURE
            PERSONALLY TESTIFY
            PROPERTY
            PUBLISHING
            QUIT ANOTHER OCCUPATION
            RACING
            REAL ESTATE
            RENTAL
            REPORT APPROP. EXPENSES
            RESEARCH
            SALES
            SERVICE
            SMALL NET LOSSES
            SOME SUBSTANTIAL INCOME
            SPECULATIVE-TYPE FARM
                    ENTER FOR MORE
            SUCCESS IN SIMILAR BUS.
            SUCCESS OTHER ACTIVITIES
            TAXPAYER
            TERMINATE FARM OPERATIONS
            TIME AND EFFORT
            USE KNOWLEDGE LEARNED




                ENTER FOR MORE

WOULD YOU LIKE TO SEE ANOTHER DICTIONARY
ENTER Y OR N
N


NOW, YOU MAY
        1.    LOOK AT A DICTIONARY
        2.    SEARCH BASED ON ATTRIBUTES
        3.    SEARCH BASED ON VALUES
        4.    UPDATE THE DATABASES
        5.    QUIT
ENTER NUMBER
2
YOU ARE USING AN ATTRIBUTE SEARCH
WOULD YOU LIKE TO RANK THE IMPORTANCE OF THE APPEARANCE OF
ATTRIBUTES
ENTER Y OR N
Y
ENTER PRIMARY ATTRIBUTES, ONE PER LINE:
AND ENTER A RANK FROM 1 TO 10 FOR EACH ATTRIBUTE ON THE NEXT LINE
ENTER '*' WHEN FINISHED
'CASE INFO' AND 'OTHER POSSIBLE CASES' ARE GIVEN ATTRIBUTES
?BREEDING
??        4           ****************************************
?EMPLOY TENANT FARMER    * The user selects six attributes to be *
??        8              * investigated and assigns a level of   *
?EXTRAORDINARY PROBLEMS  * importance to each                    *
??        10             ****************************************
?FARM IN BUS-LIKE MANNER
??        3
```

```
?SMALL NET LOSSES
??        6
?MUCH NONFARM INCOME
??       10
?USE KNOWLEDGE LEARNED
??       10
?*

WOULD YOU LIKE TO DO A VALUE SEARCH:  Y/N
?N

SEARCHING FOR SIMILAR CASES . . .

GIVE MINIMUM PERCENT MATCH YOU WISH TO VIEW.  EX 50
          50
GIVE MAXIMUM PERCENT MATCH YOU WISH TO VIEW.  EX 100
          100
THESE ATTRIBUTES ARE INDEXED AT:   44 WITH A MATCH SCORE OF:  0.882
      CASE INFO
      BREEDING                   ***************************************
      TAXPAYER                   * The retrieved set of cases possess *
      PROPERTY                   * these attributes                   *
      IMPROVEMENTS               ***************************************
      FARM IN BUS-LIKE MANNER
      ACCEPTABLE RECORDS
      DISCONTINUE POOR METHODS
      HAVE EXPERIENCE
      USE KNOWLEDGE LEARNED
      DEVOTE MUCH TIME TO FARM
      LIVE ON OR NEAR THE FARM
      WORK ON THE FARM
      EMPLOY TENANT FARMER
      EXPECT PROP APPRECIATE
      LOSSES OVER LONG PERIOD
      EXTRAORDINARY PROBLEMS
      MUCH NONFARM INCOME
      MUCH TAX SAVINGS
      EXPAND FARMING OPERATION
      CPA OR ATTORNEY IN COURT
      TERMINATE FARM OPERATIONS
      FARM-RELATED ASSOCIATIONS
      OTHER POSSIBLE CASES

ENTER FOR CASES

THE CASE WITH THE ABOVE ATTRIBUTES ARE:

      ***************************************************************
      * THIS CASE'S INDEX IN THE CASE TREE IS:      2430           *
      *                                                            *
      * TAXPAYER:    THEODORE N ENGDAHL                            *
      * TAXPAYER:    ADELINE M ENGDAHL                             *
      * CITATION                                                   *
      * US                              72 TC 659                  *
      ***************************************************************

NOW YOU MAY:
      1.    LOOK AT THE ABOVE CASE
      2.    CONTINUE TO ACCESS CASES
      3.    SKIP TO NEXT GROUP OF ATTRIBUTES
      4.    RETURN TO MAIN MENU
ENTER NUMBER
1

CASE INFO
CASE NAME                       THEODORE N ENGDAHL
CASE NAME                       ADELINE M ENGDAHL
CITATION
US                              72 TC 659US
COURT                           US TAX COURT
DECISION TYPE                   REGULAR
DOCKET NO                       9912-75
DATE OF DECISION                07/11/79
JUDGE                           HALL
YEARS                           71
YEARS                           72
YEARS                           73
DECISION FOR                    TAXPAYER
BUSINESS CLAIMED                BREEDING
BREEDING                        HORSE
TAXPAYER
RESIDENCE                       SANTA CLARA CTY, CA
OCCUPATION                      ORTHODONTIST
              ENTER FOR MORE
*                               THEODORE
EMPLOYER                        SELF
```

```
OCCUPATION                      DIRECTOR
*                               THEODORE
EMPLOYER                        CA. SADDLE HORSE BREEDERS ASSO
HOURS WORKED                    35-55 HRS/WK
PROPERTY
LOCATION                        MORGAN HILL, CA
NO. OF ACRES                    2.5
USED AS RESIDENCE               YES
ACRES USED AS RESIDENCE         .5
EXISTING STRUCTURES             HOUSE
LARGER THAN PREVIOUS            NO
IMPROVEMENTS                    STABLE
DATE OF                         NOT REPORTED
NO. OF STALLS                   7 CONVERTED TO 12
IMPROVEMENTS                    TACK ROOM
DATE OF                         NOT REPORTED
SIZE OF                         7 - 8 TONS OF HAY
              ENTER FOR MORE
IMPROVEMENTS                    FENCE
DATE OF                         NOT REPORTED
WORK DONE BY                    SELF
IMPROVEMENTS                    HOLDING CORAL
DATE OF                         NOT REPORTED
IMPROVEMENTS                    IRRIGATION SYSTEM
DATE OF                         NOT REPORTED
WORK DONE BY                    SELF
IMPROVEMENTS                    PASTURE
DATE OF                         NOT REPORTED
FARM IN BUS-LIKE MANNER         YES
*                               NO SEPARATE ACCOUNT FOR FARM
*                               CHECKED MONTHLY VARIATIONS IN
*                               EXPENSES, ADVERTISED AND EXHIB
*                               HORSES, SEPARATE LEDGER FOR
*                               HORSE OPERATION
ACCEPTABLE RECORDS              YES
*                               SEPARATE LEDGER FOR HORSE OPER
DISCONTINUE POOR METHODS        YES
              ENTER FOR MORE
*                               BOUGHT RANCH TO REDUCE EXPENSE
*                               DISPOSED OF UNSUCCESSFUL HORSE
*                               FIRED TRAINER
HAVE EXPERIENCE                 YES
*                               INFORMAL AND CONTINUOUS CONSUL
USE KNOWLEDGE LEARNED           YES
DEVOTE MUCH TIME TO FARM        YES
LIVE ON OR NEAR THE FARM        YES
WORK ON THE FARM                YES
EMPLOY TENANT FARMER            YES
*                               PROFESSIONAL TRAINER
EXPECT PROP APPRECIATE          YES
LOSSES OVER LONG PERIOD         YES
*                               64-75
EXTRAORDINARY PROBLEMS          YES
*                               CHANGE IN MARKET FOR SADDLE-
*                               BRED HORSES, MEDICAL PROBLEMS
*                               WITH HORSES, 2 HORSES DIED,
*                               TRAINER FAILED TO DEVOTE HIS
              ENTER FOR MORE
*                               BEST EFFORTS
MUCH NONFARM INCOME             YES
MUCH TAX SAVINGS                YES
EXPAND FARMING OPERATION        YES
CPA OR ATTORNEY IN COURT        YES
TERMINATE FARM OPERATIONS       YES
FARM-RELATED ASSOCIATION        YES
*                               CALIFORNIA SADDLE BREEDERS ASSOC
QUIT ANOTHER OCCUPATION         NO
HAVE EXPERIENCE                 NO
SUCCESS IN SIMILAR BUS.         NO
LOSSES IN SIMILAR BUS.          NO
LEAST ONE YEAR OF INCOME        NO
SOME SUBSTANTIAL INCOME         NO
SMALL NET LOSSES                NO
MUCH NONFARM NET ASSETS         NO
MUCH PLEASURE FROM FARM         NO
NONFARM-RELATED REC.            NO
              ENTER FOR MORE
OPERATE LIKE PROFIT BUS.        NOT MENTIONED
FAMILY WORK ON THE FARM         NOT MENTIONED    ****************************
EMPLOY COMPETENT LABOR          NOT MENTIONED    * No conclusions about these *
SPECULATIVE-TYPE FARM           NOT MENTIONED    * factors could be drawn     *
HAVE A PROFIT PLAN              NOT MENTIONED    * from the case              *
REPORT APPROP. EXPENSES         NOT MENTIONED    ****************************
ACT COST-CONSCIOUS WAY          NOT MENTIONED
PERSONALLY TESTIFY              NOT MENTIONED
```

```
OTHERS TESTIFY IN COURT      NOT MENTIONED
FARM HAVE FORMAL BUS NAME     NOT MENTIONED
OTHER POSSIBLE CASES


THESE ATTRIBUTES ARE INDEXED AT:    21 WITH A MATCH SCORE OF: 0.745
        CASE INFO
        BREEDING
        TAXPAYER                    ****************************
        PROPERTY                    * Attributes with the next *
        ACCEPTABLE RECORDS          * highest match             *
        HAVE EXPERIENCE             ****************************
        DEVOTE MUCH TIME TO FARM
        LIVE ON OR NEAR THE FARM
        WORK ON THE FARM
        EMPLOY TENANT FARMER
        EMPLOY COMPETENT LABOR
        LOSSES OVER LONG PERIOD
        EXTRAORDINARY PROBLEMS
        LEAST ONE YEAR OF INCOME
        SMALL NET LOSSES
        MUCH NONFARM INCOME
        MUCH TAX SAVINGS
        MUCH PLEASURE FROM FARM
        REPORT APPROP. EXPENSES
        PERSONALLY TESTIFY
        OTHERS TESTIFY IN COURT
        CPA OR ATTORNEY IN COURT
        FARM-RELATED ASSOCIATIONS
        FARM HAVE FORMAL BUS NAME
        OTHER POSSIBLE CASES

ENTER FOR CASES

THE CASES WITH THE ABOVE ATTRIBUTES ARE:

        ****************************************************************
        * THIS CASE'S INDEX IN THE CASE TREE IS:    973              *
        *                                                            *
        * TAXPAYER:    HUNTER FAULCONER SR                           *
        * TAXPAYER:    MARY T FAULCONER                              *
        * CITATION                                                   *
        * PH               83165 PH MEMO TC                          *
        ****************************************************************

NOW YOU MAY:
        1.    LOOK AT THE ABOVE CASE
        2.    CONTINUE TO ACCESS CASES
        3.    SKIP TO NEXT GROUP OF ATTRIBUTES
        4.    RETURN TO MAIN MENU
ENTER NUMBER
4

NOW, YOU MAY
        1.    LOOK AT ANY ONE OF THE RETURNED CASES
        2.    SEE CASE WITH A MATCH SCORE < YOUR MINIMUM
        3.    RETURN TO 1ST MENU
ENTER NUMBER
3

NOW, YOU MAY
        1.    LOOK AT A DICTIONARY
        2.    SEARCH BASED ON ATTRIBUTES
        3.    SEARCH BASED ON VALUES
        4.    UPDATE THE DATABASE
        5.    QUIT
ENTER NUMBER
3
YOU HAVE CHOSEN TO DO A VALUESEARCH
PRESENTLY, THIS SEARCH WORKS BEST WHEN ONLY A FEW ATTRIBUTE/
VALUE COMBINATIONS ARE LOOKED FOR AT ONE TIME.  THIS IS
BECAUSE ONLY THOSE CASES THAT MATCH ALL ATTRIBUTE/VALUE
COMBINATIONS BEING SEARCH FOR ARE RETURNED.  TWO OR THREE
COMBINATIONS AT ONCE IS RECOMMENDED.  TEN IS THE MAXIMUM

ENTER THE ATTRIBUTES AND THEN THE DESIRED VALUE ON THE LINE
BELOW.  EXAMPLE:   JUDGE
                   SMITH       ****************************************
ENTER '*' WHEN FINISHED         * The user is searching for all cases  *
?JUDGE                          * decided by Judge Nims in which the   *
??NIMS                          * tax year at issue was 1976.  Note    *
?YEARS                          * that the case itself was decided in  *
??76                            * 1986.                                *
?*                              ****************************************
```

```
CASES WHOSE VALUES MATCH THE GIVEN:

        **************************************************************
        * THIS CASE'S INDEX IN THE CASE TREE IS:      4187          *
        *                                                           *
        * TAXPAYER:    KATHLEEN M. JENNY                            *
        * TAXPAYER:    JULIUS R. JENNY                              *
        * CITATION                                                  *
        * PH                       83,001 PH MEMO TC                *
        * JUDGE                    NIMS                             *
        * YEARS                    76                               *
        **************************************************************
```

Appendix 2: The Update Component of FRACAS

```
NOW, YOU MAY
        1.    LOOK AT A DICTIONARY
        2.    SEARCH BASED ON ATTRIBUTES
        3.    SEARCH BASED ON VALUES
        4.    UPDATE THE DATABASE
        5.    QUIT
ENTER NUMBER
4
YOU HAVE CHOSEN TO UPDATE THE DATABASE.  IT IS ASSUMED THAT
THE NEW CASE IS CURRENTLY IN ATTRIBUTE/VALUE FORM AND THAT
THE SIGNIFICANT DIFFERENTIATING ATTRIBUTES ARE KNOWN

TO ENTER THE CASE, SIMPLY ENTER THE ATTRIBUTE AND THEN ITS
VALUE ON THE LINE BELOW.  IF AN ATTRIBUTE DOES NOT HAVE A
VALUE, ENTER A BLANK LINE.  CASE INFO SHOULD BE THE FIRST
SIGNIFICANT DIFFERENTIATING ATTRIBUTE.  ALL OTHER
SIGNIFICANT DIFFERENTIATING ATTRIBUTES SHOULD BE PRECEDED
BY THE LINES
$
$
AND A "#" SHOULD BE ENTERED TO SIGNIFY THE END OF THE CASE
FOR EXAMPLE:
CASE INFO

JUDGE
SMITH
$
$
BREEDING
HORSES
#

PLEASE BEGIN

?CASE INFO
??
?JUDGE
??SMITH
?$
??$
?BREEDING
??COW
?$
??$
?TAXPAYER
??
?$
??$
?EXTRAORDINARY PROBLEMS
??YES
?EVIDENCE
??TWO STERILE BULLS
?$
??$
?FARM IN BUS-LIKE MANNER
??YES
?$
??$
?MUCH NONFARM INCOME
??YES
?AMOUNT
??
?$
??$
?MUCH PLEASURE FROM FARM
??YES
?$
??$
```

```
?SMALL NET LOSSES
??YES
?AMOUNT
??6000
?$
??$
?USE KNOWLEDGE LEARNED
??
?YES
??YES
?$
??$
?OTHER POSSIBLE CASES
??
?#
??#


        8676  CASE INFO
        8677  JUDGE                        SMITH
        8678  BREEDING                     COW
        8679  TAXPAYER
        8680  EXTRAORDINARY PROBLEMS       YES
        8681  EVIDENCE                     TWO STERILE BULLS
        8682  FARM IN BUS-LIKE MANNER      YES
        8683  MUCH NONFARM INCOME          YES
        8684  AMOUNT
        8685  MUCH PLEASURE FROM FARM      YES
        8686  SMALL NET LOSSES             YES
        8687  AMOUNT                       6000
        8688  USE KNOWLEDGE LEARNED
        8689  YES                          YES
        8690  OTHER POSSIBLE CASES
TO MAKE CORRECTIONS ENTER LINE NUMBER: IF OK ENTER 0
TO START OVER ENTER 1
        8684
ENTER 1 TO CHANGE ATTRIBUTE, 2 TO CHANGE VALUE
?       2
ENTER CORRECT VALUE
?YES
ENTER Y FOR MORE CORRECTIONS AND N TO CONTINUE UPDATE
Y

TO MAKE CORRECTIONS ENTER LINE NUMBER: IF OK ENTER 0
TO START OVER ENTER 1
        8688
ENTER 1 TO CHANGE ATTRIBUTE, 2 TO CHANGE VALUE
?       2
ENTER CORRECT VALUE
?YES
ENTER Y FOR MORE CORRECTIONS AND N TO CONTINUE UPDATE

ENTERING CASE

YOUR CASE HAS BEEN ENTERED AND YOU ARE BEING RETURNED TO THE MAIN
MENU

NOW, YOU MAY
        1.    LOOK AT A DICTIONARY
        2.    SEARCH BASED ON ATTRIBUTES
        3.    SEARCH BASED ON VALUES
        4.    UPDATE THE DATABASE
        5.    QUIT
ENTER NUMBER
5
```

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