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William Friedman
University of Central Arkansas

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Decision Table Enhancements

William H. Friedman, University of Central Arkansas, friedmanw@acm.org

Abstract

This paper presents logical, pedagogical and practical principles for the enhancement, systematic construction, and radical simplification of decision tables. Suggested departures from current practice will be obvious to those familiar with current treatments. The way is pointed to extending the analysis in future work to an axiomatic treatment and the inclusion of additional logical properties such as certainty factors and payoffs.

Purposes of Decision Tables and the Suggested Enhancements

- To present an organization's policy in a more understandable, non-verbal format. The table may be simplified for *users* by eliminating overlapping and irrelevant situations.
- To facilitate the coding of conditional statements in a program more accurately. Decision tables are especially suited for representing case-structures, e.g., COBOL's EVALUATE verb.
- To analyze the actions that are needed for all possible condition-values of the relevant conditions. Use of the techniques presented here helps ensure that no possible set of condition-values escapes consideration, thereby protecting the organization from not taking the corresponding appropriate actions.

Construction

Although the construction of decision tables is familiar to most IS professionals, the construction techniques employed here and the formal properties of these tables have to be articulated in order to assess the nature of the enhancements to be proposed later as well as to develop an axiomatic treatment in other studies. A traditional decision table presents a set of conditions and actions that are performed when the conditions take on certain values. A decision table rule indicates that an action is to be performed provided a certain set of condition-values obtains and the action value has a value of T. The action-values appear in the lower section of the same rule-column (just below the governing combination of condition-values).

The first technique suggested here is to specify the condition names, the number of values they can take within parentheses, and the actual values within brackets. Next, enter all possible permutations of condition values in a systematic way following the information next to the condition-name. First, one calculates the number of condition-value columns by multiplying the various numbers of values for each condition. In the table below, there are two values in the each of the two conditions; hence, there are four columns for condition-values. Each such column constitutes a rule for action. The actual condition-values for each condition row are obtained as follows: first, by alternating and repeating single values (T-F-T-F) in the lowest row of conditions (COND-2 in the table below); second, alternating and repeating pairs of values (TT-FF-TT-FF) in the row above that, and, if there were a higher row, quadruples (TTTT-FFFF-TTTT-FFFF), and so forth.

	RULES			
	1	2	3	4
COND-1 (2) [T,F]	T	T	F	F
COND-2 (2) [T,F]	T	F	T	F
ACT-1	T	X	F	T
ACT-2	F	X	U	T

Note the contents of the four bolded outline quadrants, sometimes called stubs. These will be referred to numerically, clockwise from the upper left, but will be discussed in the order: Q1, Q2, Q4, Q3. The columns are equivalent to IF-THEN rules.

Quadrant 1: lists the conditions. A number in parentheses indicates how many values each condition will have in the table; finally, all the condition-values to be used are shown in brackets. Planning just this quadrant often sharpens thinking for the entire decision making process. In this example, the condition-values are T and F, but not always--they could, in case of a SIZE condition be given in the presently proposed notation as (3) [S, M, L], for Small, Medium, Large. When it is later discovered that the values of a condition do not have any influence on whether a certain action is performed, one can place a dash in the relevant cells.

Quadrant 2: gives the condition-values for each condition row.

Quadrant 4: simply lists the relevant actions. An enhancement is possible here by listing the actions in the sequence in which they will be performed—if that is important. Decision tables have been criticized for lacking that capability (Rademacher et al. 1982). Sequence could be represented most simply by the action listing order or else by a numeral attached to the action name. If the sequence of actions were to vary from column to column, one could numerically subscript the action values within each column to reflect this.

Quadrant 3: Symbols in each cell indicate whether the associated row action is to be done, given the condition-values of the column. T = the action should be done; F= the action is definitely not done. X = impossible (i.e., the combination of condition-values in the quadrant 2 part of the column could never occur simultaneously)—i.e., the rule never applies. If there is even one X in the Q3 part of a column, all the other entries there must logically be X's as well. This use of X's can only occur in Q3. U = undetermined so far, i.e., there is at the time of table construction no definitive guidance as to whether the action--on that row-- should be executed or not. Only T, F, X, and U can appear in the third quadrant (of an unenhanced table). No cell should be left empty, even for readability, since it opens the possibility of unnoticed careless omissions. Further notational enhancements could indicate degrees of certainty of execution or even payoffs, e.g., 20% or $20.

In practice, one would regard total uncertainty over an action cell as a temporary situation and should seek to determine the actual value of U before giving the table to anyone for use. Also one probably should not present a user with a version of a table showing X's, since he/she would never encounter that (impossible) state of affairs indicated by those X's.

Additional Stubs for Specifying Justifications

Justificatory notes help document the original and/or current reasons (shown in bold letters) behind the policy represented by the table. In the table below, the set of reason-values in a column shows what justifies the whole set of action-values in that column.

Rule 2, for example, can now be read as: If it is raining and it is not chilly, then take an umbrella but not a warm coat, because you want to avoid illness and you want to protect your suit. Note: In the reason-values section, an F means that the justification on the same row is not applicable (to the action) and T means that the justification is applicable.

	RULES			
	1	2	3	4
RAIN (2) [T,F]	T	T	F	F
CHILLY (2) [T,F]	T	F	T	F
TAKE WARM COAT	T	F	T	F
TAKE UMBRELLA	T	T	F	F
AVOID A COLD	T	T	T	F
PROTECT SUIT	T	T	F	F

There is, however, a finer grain method to indicate justifications: by placing in the same cell with the action-value, a reference (pointer) to the relevant justification statement governing the performance or nonperformance of a certain action, given the conditions involved. One can then understand what rationale is behind each action-value for any rule, in other words, the individual contribution of each rationale, rather than the combined, undifferentiated justification for the whole set of actions in a column. Here one would provide a numbered list of justifications outside the table.

	RULES			
	1	2	3	4
COND-1 (2) [T,F]	T	T	F	F
COND-2 (2) [T,F]	T	F	T	F
ACT-1	T: J1	X	T	T: J1,J2
ACT-2	U:J 2	X	T: J2	T: J1

It is conceivable that the same act could be done for different reasons under different conditions, e.g., you may want to wear a coat in a play if the part demands it, hence, not for protection from the weather (see Act-2, Rules 3 and 4). In addition, the same action could be justified by more than one rationale in a certain set of conditions (e.g., Act-1, Rule. 4). Moreover, one could by this enhancement to the decision table, expose the fact that some dictated action is arbitrary or has no known justification (e.g., Act-1, Rule. 3).

Numerical Condition-values

For even greater flexibility, can use single or multiple numerical condition-values (or even ranges like 0 through 3). This permits us to represent degree of fulfilling a condition and to give weight to a combination of condition values in a rule (column). Consider this three-part organizational policy:

1. If and only if the total of condition values is 1 or less, then do Act-1
2. If two values are the same, then do Act-2. (Note: For purposes of this example, it is intentionally not specified what is to be done when the values are different, thus showing the need for U.)
3. In our organization, one never has to deal with a situation where the condition values sum to 4.

	RULES					
	1	**2**	**3**	**4**	**5**	**6**
COND-1 (3) [1,2,3]	1	1	2	2	3	3
COND-2 (2) [1,0]	1	0	1	0	1	0
ACT-1	F	T	F	F	X	F
ACT-2	T	U	U	U	X	U
RATIONALE-1	F	T	F	F	F	F
RATIONALE-2	T	U	U	U	U	U
RATIONALE-3	F	F	F	F	T	F

Note: In this example, one might suspect that the phrase "only if" is intended (but omitted) in Rationale-2. However, if that turned out to be a valid assumption, it would be grounds for converting the U's of Rationale -2 to F's.

Removing Columns and <u>Rows</u>

It is well known that when condition-values are immaterial to certain action sets they can be replaced by dashes, and the columns involved can then be combined into one column. To indicate table-size reduction, the numbers of the original columns can be preserved for historical or back-up purposes and written above the surviving column, as in the table immediately following

	RULES		
	1,2	3	4
COND-1 (2) [T,F]	T	F	F
COND-2 (2) [T,F]	-	T	F
ACT-1	T	U	X
ACT-2	F	U	X

The following maneuvers suppress some information, but will cause no problem in actual practice. Since Rule 3 above has no determinate action, one can eliminate it in a table to make it more comprehensible for the person who will use it. Similarly, Rule 4 never has an application and can also be eliminated. One can also eliminate a condition if all its table values are '-', because the condition makes no difference for any actions in the table. The rule-number heading of "1,2" was only given to show the historical origin of the rule in the prior, larger table—it has some benefits to analysts, but not to users. Again, in practice it can be eliminated without harmful effect. Finally, one can eliminate an action <u>row</u> if the action is never performed, i.e., if its row values are all F. Thus the previous table reduces to a table with a single rule/column with just Condition-1 as true and Act-1 as true.

Future Directions: Axioms and Theorems

Using the above construction guidelines as axioms one could then prove useful theorems, such as: The number of rules that can be consolidated into one rule because of the immateriality of one condition's values must be a multiple of the number of condition-values (given in parentheses) for that condition. Thus, if condition-x has three values, either 3 or 6 or 9, ... columns will ever be consolidated into a single column (that is, if a difference in the values of condition-x in the columns involved do not matter to the action sets of those columns).

References Available on Request