A COMPARISON OF BAYESIAN AND FUZZY METHODS IN THE CLASSIFICATION OF HUMAN ATTITUDES TOWARDS COMPUTERS.

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Abstract: We present in this paper the contrast between two treatments of an example of the application of a general methodology for classifying and optimizing information arising from uncertainties that may occur during human-computer interaction (HCI). It is argued that application of fuzzy logic is superior to reliance on Bayesian methods. In this paper we look at two methods, repertory grids and fuzzy transitional relations, and outline their merits.

1 INTRODUCTION

An overall approach to uncertainty about user classification in human computer interaction is described in [1]. In this particular case, we present results from a structured interview aimed at probing users' perceptions of themselves and others performing a range of tasks which may or may not be accomplished using a computer system. The motivation for these interviews was to clarify the correspondance between Arabic speaking users' self perceptions and those of English speaking users, as described in [2]. We describe briefly a method to elicit the self perceptions of users in the next section then we proceed to the mathematical formalization of the fuzzy transitional relations. We end our paper by evaluting the two methods using a concrete example and expressing some concluding remarks.

2 ELICITATION OF USERS' SELF PERCEPTIONS

Users' self perceptions and their perceived relationship to users with less experience, including themselves at an earlier stage, were probed by drawing up a list of "elements" to be judged by means of the "repertory grid" technique. Easterby-Smith (1980), [3], provides an overview of the main varieties of the technique. Triads from the set of elements

$$\text{elements} = \{e1, e2, e3, \ldots, e10\}$$

were used to elicit "constructs" or descriptors.

General labels are provided as follows

e1: myself using the computer
e2: myself at a laboratory task not involving computers
e3: myself using a typewriter
e4: myself writing a letter using pen and paper
e5: someone I know who is familiar with computers
e6: myself working on an academic paper
e7: my mother using a computer
e8: my father using a computer
e9: a non-American overseas student using a computer
e10: an American student using a computer.

Although general labels can be given, users were asked to contextualize and particularize the general characterization, as is usual for repertory grid interviews, see [2 and 3].

For the purpose of contrasting our methodology with alternatives, discussion can be confined to the data from one Arabic speaker. Interpretations of the results from the point of view of Arabic software design is discussed in Kallala and Bellin [2]. From the procedure, the following descriptors were obtained:

d1 individual working
d2 strategic knowledge
d3 correction easy
d4 clarifying
d5 no idea
d6 in harmony
d7 American standard
d8 no idea
d9 absorbing

3 THE CONCEPTUALISATION OF FUZZY TRANSITIONAL RELATIONS

The methodology is well described and amply discussed in [2 and 4]. However, given a set of elements and a set of descriptors, we have the following set of relations:

De: elements x descriptors,

from which we derive the transitional relations

(i) element ---> descriptor ---> element

and (ii) descriptor ---> element ---> descriptor.

There are several definitions for --->, for further details see Kallala [4]. Here we consider only the Lukasiewicz operator, min(1,1-a+b), where a and b in [0,1].

In Figure 1, an example of such a classification, using the Lukasiewicz operator is depicted. Figure 1 shows both the classification of element-to-element compositions and also descriptor-to-descriptor compositions cut at half-upper. The properties of the element-to-element relations for this user were reflexivity, antisymmetry, transitivity, preorder and order.

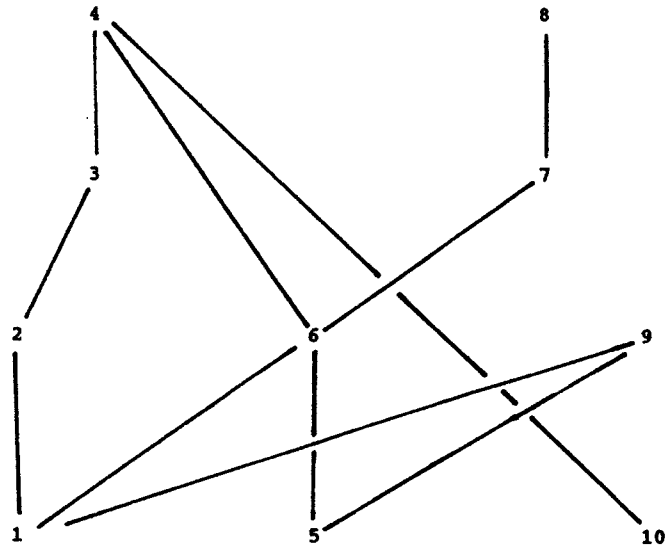
4 REPERTORY GRID VS FUZZY TRANSITIONAL RELATIONS

What was important for the semantics of human-machine interaction in this case was the way in which elements representing normal activities like "myself writing a letter using pen and paper" were very distant from computer-related activities. There was no such separation for English speakers at the same level of computer experience, or for experienced users who spoke Arabic but made less use of the text handling facilities. It was concluded that there was very low task compatiblity between text handling on the particular system in the trial and other ways of handling text.

The most usual way of treating these kinds of results is to regard what we term descriptors as "constructs" in a theory laden sense (see Bannister and Fransella, [5]). An attempt is often made to find contrasts in order to approximate the assumptions behind use of the correlation coefficient.

After applying the correlation coefficient as a measure of descriptor-to-descriptor relations, there is reliance on principal components analysis to interpret either element-to-element or descriptor-to-descriptor relations. Figure 2 shows output from programs by Slater (see further in Easterby-Smith [3]). In Figure 2, there is a two-factor solution for the descriptors which suggests only two underlying constructs, whereas Figure 1 (b) would suggest a more complex dimensionality. There is also an intuitive justification for allowing that the users' elicited descriptors are more than a mere reflection of two underlying constructs.

As to the element-to-element relations, the location of the elements in the component space allows for an interpretation in line with that of the Haase diagrams. In both cases, the distance between the fourth element and others is the main



1a. element-to element compositions.

(u1): {1}, {2}, {3, 4, 6, 7}, {5, 8}, 9

1b. descriptor-to-descriptor compostions).

Fig. 1. Two Hasse Diagrams of one User obtained using the Lukasiewicz operator cut at Half-Upper.

PLOT
COMPONENT 1 VERSUS COMPONENT 2

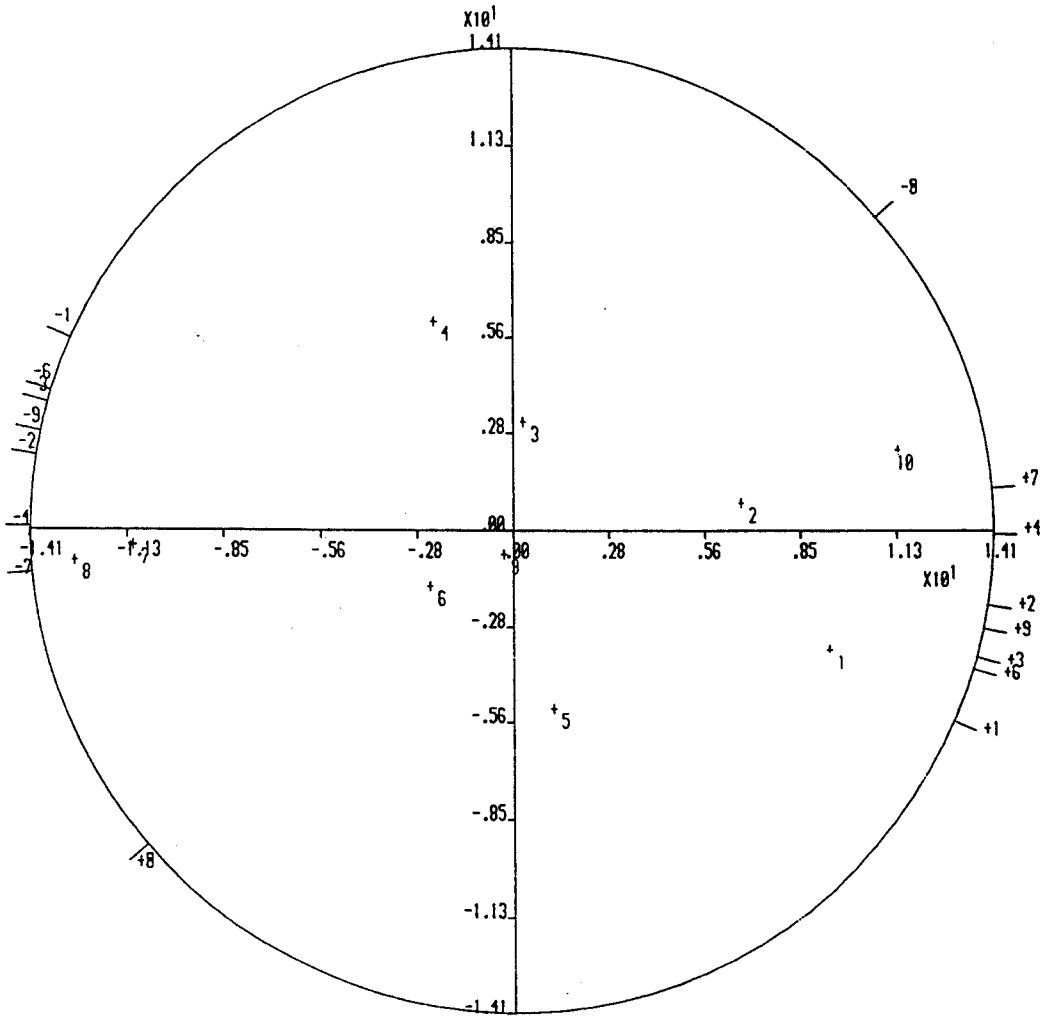


Fig. 2. A Repertory Grid of Data obtained from one User.

structural feature. However, since the fourth element is not far from the centre of the figure, that means that the proportion of variance accounted for is too low for laying weight on the interpretation.

5 CONCLUDING REMARKS

The analysis applying fuzzy logic shows why uncertainty remains after the analysis on Bayesian lines. Correlation is a measure for symmetric relations where linearity assumptions hold. The element-to-element relations do not include symmetry in the list given above. Furthermore there is no assurance about linearity assumptions. Hence, there is no reason to expect a principal components solutions that would allow interpretation with any certainty. We maintain that applying fuzzy logic allows for a more straightforward interview procedure, a more straightforward treatment of the results as descriptors rather than constructs having some linear scale properties, and much more uncertainty reduction in interpreting the results.

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