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Application of fuzzy decision making to the smoking problem*

by

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Abstract: People often fall into a state of waver. A smoker knows "in the head" that smoking harms his health, but fells a desire to smoke in order to compose himself "at heart". In case of an "observation" (say: illness), a waver gradually sets on – whether to smoke or not. This process can be described as having two states of nature ("in the head" and "at heart"), one of which is hidden, and only gradually comes to the surface, which leads to an apparent conflict. In this paper, we propose a model for this situation and the respective decision making and a way to solve the resulting problem, using the precepts of the fuzzy set theory.

Keywords: decision making, waver, fuzzy transition, smoking

1. Introduction

We often fall into a state of waver. An instance is provided by the smoking persons, who know "in the head" that smoking is harmful for the health, but, at the same time, they feel, "at heart", a desire to smoke in order to compose themselves. If such a person is struck by illness, which can be associated with smoking, then an "observation" enters the image, leading to a true waver as to whether to quit smoking or not. This situation can be described for the modeling purposes by the process, in which we have two states of nature ("in the head" and "at heart"). One of them remains hidden, and then, gradually comes up to the surface, due to an observation. This results in a situation of conflict of the two states of nature. The change, and its characterization, can be well represented by a transition matrix, containing respective probabilities. We should, of course, keep in mind that at the beginning one of the states of nature is hidden, i.e. as if nonexistent. In the present paper we model the state of waver in terms of a fuzzy event, using the transition matrix, turned into the

*See the note to the preceding paper by Yoshiki Uemura. This second short paper, whose very abbreviated version is provided here, takes up a very similar subject, and, in fact, gives an additional explanation to the preceding one, so that it can be treated as a complement to this preceding paper.

fuzzy transition matrix. Furthermore, we shall propose a fuzzy decision making rule, following the precepts of the theory of maximum expected utility, using the probability of a fuzzy event, under the premise that the decision maker will establish the distribution of the prior probabilities, with reference to the multi-attribute utility function and to the importance of the two states of nature. The state of waver is assumed here to result from the process of passing from silence to confusion about some question, this process having been the subject of the preceding paper, contained in this issue of the journal.

2. Some explanation

The waver that we aim to analyse, arises in the process of passing from the situation of "cold head and warm heart", running in parallel, to the situation of "dry mind and cool head", the respective passage having been considered before. The state of waver is illustrated schematically in Fig. 1. The transi-

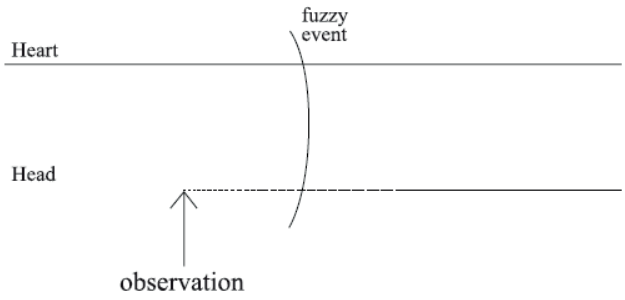

Figure 1. A schematic illustration for the state of waver

tion mentioned takes place under the influence of an observation. The fact of occurrence of an observation introduces an additional condition, which can be interpreted as a constraint, so that only one state of nature results, as shown schematically in Fig. 2.

3. Fuzzy transition matrix

Similarly as in the preceding paper, we deal with the transition of states - the process leading from silence to confusion - as given by the following formula, based on the respective transition matrix:

$$(S_{1t}, S_{2t}) = \begin{bmatrix} 1 & 0 \\ 0 & M \end{bmatrix} \begin{pmatrix} S_{1\,t-1} \\ S_{2\,t-1} \end{pmatrix}$$

The magnitude M, which appears in this formula, is a fuzzy number, which takes the form as shown in Fig. 3. On the other hand, if we attempt to model the

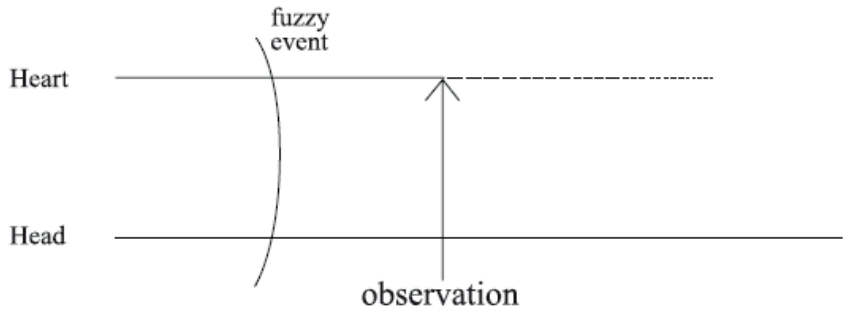

Figure 2. Passage to one state of nature under the influence of an observation

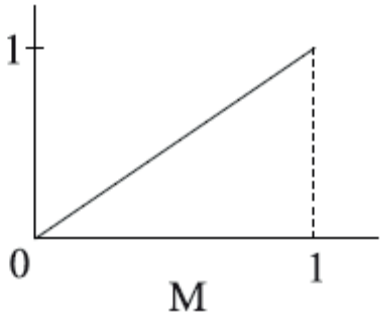

Figure 3. The fuzzy number M in the transition matrix from silence to confusion

transition from waver to the constrained state, we should refer to the following formula:

$$(S_{1t}, S_{2t}) = \begin{bmatrix} M & 0 \\ 0 & 1 \end{bmatrix} \begin{pmatrix} S_{1\,t-1} \\ S_{2\,t-1} \end{pmatrix}$$

In this case, the fuzzy number M, appearing in this formula, takes the form as shown in Fig. 4. On this basis, we can construct the model for the transition process, similar to the one, presented in the preceding paper, namely

$$(S_{2t}, S_{1t}) = \begin{bmatrix} M_{11}M_{12} \\ M_{21}M_{22} \end{bmatrix} \begin{pmatrix} S_{1\,t-1} \\ S_{2\,t-1} \end{pmatrix}$$

4. The decision rule and the conclusions

We apply the decision rule exactly as given in the preceding paper, based on the assumptions here specified and the fact that the decision maker would assign

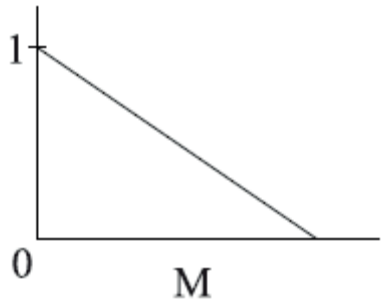

Figure 4. The fuzzy number M in the transition matrix from waver to the constrained state

importance to the respective states of nature. On the basis of the formulae provided, with the appropriate definitions of the fuzzy numbers for the concrete case, the optimum decision can be taken, meaning, in this case, simply the choice between two options (or, in fact, a choice at all). While all the comments from the preceding paper apply here, as well, if we come back to the initial illustrative question, namely that of deciding on smoking or not, we can propose that the laxer the membership function of the fuzzy numbers, forming the transition matrix, the longer the process of falling into the waver. Generally, the process, associated with the state of waver is in a way an inverse of the previously considered transition from silence to confusion. In any case, though, the same decision making rule applies.