Transcript of, and comments on, the appended, somewhat illegible, document

June 1975

Precision and Reasonableness in Linguistic Communication: A Fuzzy Model

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Shallow and Exact Reasoning

During recent years Zadeh has proposed a model for the approximate reasoning with vague data that is so characteristic of human thought processes and yet which is so readily discarded to be replaced by artificially, precise formalism in the logical analysis of the semantics of language. Rather than regard human processes as “approximating” to some more refined exact logical process that may be carried out more perfectly, with proper mathematical precision, only by the application of formal rules, for example in a digital computer, Zadeh has suggested that the essence and power of human reasoning is in its capability to grasp inexact concepts directly, and that attempts to model, or emulate it, by formal systems of increasing precision will lead to decreasing the validity and relevance. The appearance of precision artificially induced by the formalisms themselves can lead to the acceptance of chains of reasoning they have no justification in terms of the original data, and which would be rejected as valid arguments in their original imprecise form, but which utilise the fine, but non-existent, distinctions postulated by the formalism to sustain a logical chain that could not persist if the vagueness of the original reasoning is correctly taken into account. Most practical reasoning is essentially ‘shallow’ in nature and does not rely upon long chains of inference unsupported by intermediate data - it requires, rather then merely allows, redundancy of data, and paths of reasoning – it accepts minor contradictions and contains their effects so that universal inference may not be derived from their presence.

The insight that Zadeh’s arguments given into the nature of human thought processes and, in particular, to their support or replication in the computer, are of major importance to a wide range of theoretical and applied disciplines – they are particularly relevant to the relationship between ‘science’ and ‘engineering’, between the formalism and the actuality of system development. The arguments have become particularly associated with ‘fuzzy sets theory’, and this does indeed provide a mathematical foundation for the explication of approximate reasoning. However, it is important to note that Zadeh’s analysis of human reasoning processes and his exposition of fuzzy theory are not one and the same — indeed they are quite distinct developments that must be separated, at least conceptually, if a full appreciation is to be had of either. As analogies one conceive that fuzzy sets are to approximate reasoning what Lebesgue integration is to probability theory; what matrix algebra is to linear system theory; or what lattice theory is to a propositional calculus. Even such analogies are dangerous, because our level of understanding of approximate reasoning is currently such that a better (that is, worse!) analogy might be Hull’s arithmetic modelling of sound behavioural arguments, or Lewin’s vector-theoretic analogies to social processes, both meaningful in some sense, but misleading in others, both aiding the development of essentially sound arguments, but by unsound means.

The role of fuzzy sets theory in the analysis and understanding of fuzzy reasoning, highlights some of the major problems of work in this area. A purely linguistic approach to the presentation of the arguments and the models rapidly becomes in ensnarled in problems of self-referent terminology and levels of discourse. To use the human processes of approximate communication to present approximate reasoning about the meta-linguistics and linguistics of approximate reasoning is neither easy to do nor to follow. Operational definitions in terms of the numerical procedures of a fuzzy logic, enable a clear distinction to be made between these various levels. By expressing the lower levels in a mathematical symbolism with clearly defined rules of inference, arguments may be conducted about intermediate levels with a minimum of terminological and conceptual interference. In this sense, the best analogy may be that fuzzy sets are to approximate reasoning what a flight simulator is to an aircraft, a realistic and well defined environment that faithfully replicates the essential features of the real world. This is a different, but not incompatible, viewpoint from that which would take fuzzy sets theory as a foundation for approximate reasoning. I believe it is a particularly useful shift of emphasis to make in assimilating. Zadeh's recent work on approximate reasoning.

These notes are concerned with some problems in the meta-linguistics of approximate reasoning, and use Zadeh's fuzzy logic model to illustrate the arguments. I am particularly concerned with the effects of terminology on the attitude of potential users of, and contributors to, the development of models of approximate reasoning. A term such as 'fuzzy reasoning' is itself an example of the problems, and the power and subtlety of linguistic communication. To the 'outsider', it may well denote vague reasoning that can, and should, be tightened up, an abrogation of professional responsibilities in science and engineering to express oneself in a precise and universal language. To the 'insider', it may well be accepted as conventional terminological elision, 'a formal and precise calculus of reasoning with informally expressed and imprecise fuzzy data' contracted to 'fuzzy reasoning'. Clearly no one can object to the purity of objectives, the rigor, or scientific pedantry of the full form – some data is essentially vague, and yet still has content of which we may make use. The elision is a natural one in language that we eliminate superfluous verbiage, superfluous that is to our target audience who are expected to be able to regenerate it as we would – hence thence the 'insider/outsider' distinction. This process, so apply illustrated by this example, seems to play a major role in the semantics of natural language and approximate reasoning and will be further discussed in these notes.

The persuasive arguments of the previous paragraph are, however, by no means the whole story in explicating the ;insider' of use of a term such as "fuzzy reasoning". Apart from its obvious second meaning in expressing a wry comment on the developmental nature of any newish area of research, it also has the self referent connotations at a more technical level that are the source of so many problems in comprehending the human use of language. The data may be precise, all lower levels of reasoning from the data may be exact, and yet, at some intermediate level, the person may switch to a shallow mode that selectively destroys much of the precision of inference of the lower stages, e.g. our use of linear system theory in control engineering has precisely this pattern. The study of fuzzy reasoning is concerned with those processes of inference that we use at any level of approximate reasoning, and does admit right from the start that we are unlikely to determine a precise form or model of these processes – the problem with what there is left to say, that is meaningful, significant, and communicative is as real and as difficult as it appears!

Comment Nov-2025: I am making this unpublished note from 50 years ago available because it expresses my initial reactions to Zadeh's (1973) modelling linguistic hedges through fuzzy sets, and the motivation of many of my later contributions to the debate. My contributions to the fuzzy sets literature, and the stance I have taken, have been analysed by others, such as Thomas (1995, pp 29-36), who also discusses Zadeh's (1978) adoption of my term 'possibilistic' for uncertain systems which are neither deterministic nor probabilistic (Gaines, 1975a,b,c, Gaines & Kohout, 1975). Hopefully, this note adds a significant data point for such studies.

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