classifications were presented as color-coded images and as two- and three-dimensional displays of cluster center data in feature space. Fuzzy cluster analysis proved to be a clinically useful dimension reduction technique that resulted in improved diagnostic specificity of medical magnetic resonance images.

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A Fuzzy Logic Programming Environment for Real-Time Control

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Expert systems based on fuzzy logic inferencing have been shown to be effective in controlling complex processes. The experiences of human operators are naturally captured as linguistic fuzzy control rules. This paper describes a programming environment being developed to facilitate the implementation of fuzzy control systems that allows a user to easily describe a set of fuzzy rules, graphically edit the fuzzy variable definitions, and verify the rules through simulation.

In an actual control system, the rules will reside in and be processed by a special-purpose chip for fuzzy logic inferencing. An object-oriented approach to the programming environment naturally models this hardware architecture. Each set of rules is associated with a chip object simulated in software. The content of the chip object is changed as the rules are modified. When the simulation results are satisfactory, the content of the simulated chip can be copied directly into the hardware chip for real-time applications. A complex controller that involves multiple domains of expertise can be developed by first focusing on component chip objects and then interconnecting the components. The ability to translate linguistic rules into practical implementations is a unique and useful feature of this environment.

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Reliability of Existing Framed Structures Using Fuzzy Sets

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A rational approach through the applications of classical probability and statistical theory has greatly enhanced the assessment of structural safety. Although the studies conducted in this area are comprehensive and well developed, classical set theory still fails to provide adequate representation of some parameters; for instance, workmanship and deteriorated condition are observed by engineers and reported qualitatively. In the area of structural system reliability, studies have been concerned primarily with the load space, material properties, and dimensions, which are objective (quantitative) information. Recent research has demonstrated that imprecise (subjective or qualitative) information can have significant adverse effect on structural safety. Studies in medicine, economics, and engineering have also shown that fuzzy set theory may indeed by a useful tool for the

expression of professional judgment. In this study, the reliability of an existing framed structure is evaluated, first based on objective information using a classical approach and then updated with subjective information using fuzzy sets. The contribution of additional imprecise data to the overall safety of the structure is also discussed.

The Problem of Linguistic Approximation in Clinical Decision Making

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This paper deals with the problem of linguistic approximation in a computerized system for the diagnostic analysis of the electrocardiogram (ECG). The ECG is automatically analyzed to extract useful numerical parameters. Their linguistic description is provided by the system to the decision program, which uses both the linguistic description of the signal under examination and a fuzzy rule-based knowledge base to create a group of decision sets. Each decision set is formed by three fuzzy intervals defined over the same decision space, which represent the suitability or acceptability of three alternative decisions.

The linguistic approximation of each interval is suggested as user-friendly output to solve the decision problem. The problem is to find the appropriate linguistic label for a given fuzzy interval. Some methods already presented in the literature are briefly reviewed and their drawbacks are pointed out. Then a suitable term-set derived from the medical literature is proposed.

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On Fuzzy Probabilities and Interactive Fuzzy Variables

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Fuzzy probabilities are fuzzy sets that satisfy the axioms of probability theory. In particular, if p_i denote the fuzzy probabilities of several mutually exclusive and exhaustive events, $\Sigma p_i = 1$, and $0 \leqslant p_i \leqslant 1$, $i = 1, 2, \cdots, n$. Because of these constraints, a function of the p_i's, such as the fuzzy expected value, is a function involving interactive fuzzy variables; i.e., the value of p_i affects the range of values that can be taken by p_j, $j \neq i$. A procedure to evaluate functions of fuzzy probabilities is described. The procedure is based on the vertex method for processing fuzzy information. It is shown that interactivity constrains the admissible domain in variable space and affects only the number and locations of the vertices defining the domain. Aside from that, the vertex method is applicable without modification to problems involving fuzzy probabilities. The procedure is illustrated using numerical examples.

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