Sculpting the State Space

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Abstract This talk will provide some new and novel application-independent perspectives on why improved performance usually occurs as one goes from crisp, to type-1 and to interval type-2 fuzzy systems, by introducing three kinds of partitions: 1) *Uncertainty partitions* that let us distinguish type-1 fuzzy sets from crisp sets, and interval type-2 fuzzy sets from type-1 fuzzy sets; 2) *First-and second-order rule partitions* that are direct results of uncertainty partitions, and are associated with the number of rules that fire in different regions of the state space, and, the changes in their mathematical formulae within those regions; 3)*Novelty partitions* that can only occur in an interval type-2 fuzzy system that uses type-reduction. Rule and novelty partitions sculpt the state space into hyper-rectangles within each of which resides a different nonlinear function. It is the greater sculpting of the state space by a type-1 fuzzy system that lets it outperform a crisp system, and the even greater sculpting of the state space by an interval type-2 fuzzy system that lets it outperform a type-1 fuzzy system. The latter can occur even when type-1 and interval type-2 fuzzy systems are described by the same number of parameters.

Jerry M. Mendel received the Ph.D. degree in electrical engineering from the Polytechnic Institute of Brooklyn, Brooklyn, NY. Currently he is Professor of Electrical Engineering at the University of Southern California in Los Angeles, where he has been since 1974. He has published over 570 technical papers and is author and/or co-author of 13 books, including *Uncertain Rule-based Fuzzy Systems: Introduction and New Directions, 2nd ed.* (Springer 2017), *Perceptual Computing: Aiding People in Making Subjective Judgments* (Wiley & IEEE Press, 2010), and *Introduction to Type-2 Fuzzy Logic Control: Theory and Application* (Wiley & IEEE Press, 2014). He is a Life Fellow of the IEEE, a Distinguished Member of the IEEE Control Systems Society, and a Fellow of the International Fuzzy Systems Association. He was President of the IEEE Control Systems Society in 1986, a member of the Administrative Committee of the IEEE Computational Intelligence Society for nine years, and Chairman of its Fuzzy Systems Technical Committee and the Computing With Words Task Force of that TC. Among his awards are the 1983 Best Transactions Paper Award of the IEEE Geoscience and Remote Sensing Society, the 1992 Signal Processing Society Paper Award, the 2002 and 2014 *Transactions on Fuzzy Systems* Outstanding Paper Awards, a 1984 IEEE Centennial Medal, an IEEE Third Millenium Medal, a Fuzzy Systems Pioneer Award (2008) from the IEEE Computational Intelligence Society for "fundamental theoretical contributions and seminal results in fuzzy systems"; and, 2015 USC Viterbi School of Engineering Senior Research Award. His present research interests include: type-2 fuzzy logic systems and computing with words.