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Title: System Modeling and Control: At the Junction with Data Analytics

Biography: Witold Pedrycz (IEEE Fellow, 1998) is Professor and Canada Research Chair (CRC) in Computational Intelligence in the Department of Electrical and Computer Engineering, University of Alberta, Edmonton, Canada. He is also with the Systems Research Institute of the Polish Academy of Sciences, Warsaw, Poland. Dr. Pedrycz is a foreign member of the Polish Academy of Sciences and a Fellow of the Royal Society of Canada. Witold Pedrycz has been a member of numerous program committees of IEEE conferences in the area of fuzzy sets and neurocomputing. He is a recipient of the prestigious Norbert Wiener award from the IEEE Systems, Man, and Cybernetics Society, IEEE Canada Computer Engineering Medal, Cajastur Prize for Soft Computing from the European Centre for Soft Computing, Killam Prize, and a Fuzzy Pioneer Award from the IEEE Computational Intelligence Society.

His main research directions involve Computational Intelligence, fuzzy modeling and Granular Computing, knowledge discovery and data mining, fuzzy control, pattern recognition, knowledge-based neural networks, relational computing, and Software Engineering. He has published numerous papers in this area. He is also an author of 16 research monographs covering various aspects of Computational Intelligence, data mining, and Software Engineering.

Dr. Pedrycz is vigorously involved in editorial activities. He is an Editor-in-Chief of Information Sciences, Editor-in-Chief of WIREs Data Mining and Knowledge Discovery (Wiley), and Int. J. of Granular Computing (Springer). He serves on an Advisory Board of IEEE Transactions on Fuzzy Systems and is a member of a number of editorial boards of other international journals.

Abstract: he apparent challenges encountered in system modeling inherently associate with large volumes of data, data variability, and an evident quest for transparency and interpretability of established constructs and obtained results. Along with the emergence and increasing visibility and importance of data analytics, we start to witness a paradigm shift whose several dominant tendencies become apparent: (i) reliance on data and building structure-free and versatile models spanned over selected representatives of experimental data, (ii) emergence of models at various levels of abstraction, and (iii) building a collection of individual local models and supporting their efficient aggregation.

We advocate that information granules play a pivotal role in the realization of this paradigm shift. We demonstrate that a framework of Granular Computing along with a diversity of its formal settings offers a critically needed conceptual and algorithmic environment. Information granules and information granularity are synonyms of levels of abstraction. A suitable perspective built with the aid of information granules is advantageous in realizing a suitable level of abstraction and becomes instrumental when forming sound, practical problem-oriented tradeoffs among precision of results, their easiness of interpretation, value, and stability (as lucidly articulated in the form of the principle of incompatibility coined by Zadeh). All those aspects emphasize importance of action ability and interestingness of the produced findings either for purpose of control or decision-making. Granular models built on a basis of available numeric models deliver a comprehensive view at the real-world systems. More specifically, granular spaces, viz. spaces of granular parameters of the models and granular input and output spaces play a pivotal role in making the original numeric models more realistic.

The data-oriented models tend to depart from analytical descriptions (in the form of nonlinear mappings) but directly exploit subsets of meaningful/representative data over which such models are developed. A representative class of models with this regard concerns associative memories, which realize both one-directional and bidirectional recall (mapping). We carefully revisit and augment the concept of associative memories by proposing some new design directions. We focus on the essence of structural dependencies in the data and make the corresponding associative

mappings spanned over a related collection of landmarks (representatives OD data). We show that a construction of such landmarks is supported by mechanisms of collaborative fuzzy clustering. In the sequel, structural generalizations of the discussed architectures to multisource and multi-directional memories involving associative mappings among various data spaces are proposed and their design is discussed.