Rough Calculus and Numerical Analysis
A Mathematical Foundation

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Abstract

Rough set theory and college calculus are two disjoint pieces of mathematics on discrete and continuous worlds. Somehow Pawlak observed their commonality and create a subject called Rough Calculus. Numerical analysis and scientific modeling are another such a pair, in fact, a better pair: A real line can be visualized as a generalized meterstick. Markings for centimeters are labelled by integers, markings for millimeters are labelled by one decimal place …… are labelled by n decimal places. Such sequence of labellings supports the granulation topology $\mathscr{G}$ (recall the concepts of granular computing and mathematics) that contains the old friend, the usual topology $\mathscr{U}$, as a subtopology. Such observations allow us to build a mathematical model for Approximate Arithmetic, which has been missing for centuries. An extended abstract, that needs some updating, has been announced in the Encyclopedia of Complexity and System Science in March, 2023.

Tsau Young (T. Y.) Lin received his Ph.D. from Yale University, and is a professor of Computer Science at San Jose State University and a fellow in Berkeley Initiative in Soft Computing (BISC), University of California. He has served as the President of International Granular Computing Society, the Founding Chair of Special Interest Group of Granular Computing in BISC, the Founding President of International Rough Set Society, and the Chapter Chair of IEEE-Computer Society in Silicon Valley. He shares the Editor-in-Chief position with Tony Xiaohua Hu for the International Journal of Granular Computing, Rough Sets and Intelligent Systems. He has served as Editor-in-Chief, Associate Editor, Member of Advisory/Editorial Board in several reputable international journals, such as Theoretical Computer Sciences (Chinese), Knowledge Discovery in Databases, Knowledge and Information Systems, Data Mining and Bioinformatics, and Machine Automation and Soft Computing. He has served as a (Co-)Chair and Program Committee Member of many conferences and workshops in the areas of data mining, computer security, rough sets, granular computing, etc. He also serves in Advisory Boards and as a Panelist on some government agencies. He has a wide spectrum of interests that includes approximate retrieval and reasoning, data, text and web mining, data security, data warehouses and novel computing methodologies (e.g. granular, rough, Petri nets [He solved the Peterson conjecture negatively; Proc. of the Fourth Annual Symposium of Parallel Processing, 1990], and soft computing). He received the best contribution awards from ICDM 2001 and International Rough Set Society (2005), and the Pioneer Award from GrC 2008. His current activities center around granular computing, and its applications to web technology. In fact, he is responsible for coining the term granular computing (GrC). In GrC, he introduced a category based GrC

model. Depending on the choices of categories, he has developed 8 models and various theories and applications. The applications range from automata to webpages. In the category of Turing machines, if we treat finite automata as granules (7th GrC Model), then any patterns (low complexity Turing machines) can be approximated probabilistically by finite automata. These approximations have been used to identify authorships of articles, books or programs; the last one leads to intrusion detection systems. In the category of binary pretopological spaces (pretopology is derived from a binary relation), the Discretionary Access Models and the uncertainty principle in quantum mechanics have been modeled by the 3rd GrC Model. In the category of sets there are six models. The 2nd GrC Model includes an "ancient" geometric structure, called simplicial complexes (of combinatorial topology). It is somewhat a surprise, he found that the concepts hidden in a set of webpages can be represented by such a simplicial complex. By regarding such a simplicial complex as a geometric knowledge base that carries the hidden semantics of webpages, webpages can be clustered semantically and hence search semantically. He is also interested in many other areas, such as the foundation of data mining and fast computing of association rules.