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Guest Editorial

Special Issue on Granular Knowledge Discovery

Granular Computing becomes increasingly popular in modeling of intelligent systems. Granulation of information is inherent in human thinking and reasoning processes. Granular Computing provides an information processing framework where interactive computation and operations are performed on information granules, and is based on the realization that precision is sometimes expensive and/or not much meaningful in modeling and controlling complex systems. When a problem involves incomplete, uncertain, and vague information, it can be difficult or infeasible to differentiate distinct elements. Therefore, one can find it convenient to consider granules for such problem's handling. Moreover, this may lead to more efficient approximate reasoning supporting the decision processes.

This special issue aims at presenting the state of the art in foundations and applications of Granular Computing. As important trends in applications, we consider the Knowledge Discovery in Databases and the Decision Support Systems. In both these areas, data and knowledge granulation lead to more robust models and processes, more meaningful interaction with domain experts and more efficient cooperation between different layers of complex systems. In particular, granulation on different layers can result in generation of relevant (e.g., for classification) structured objects and patterns over such objects. Thus, it is important to conduct research on how to discover granules from data and how to utilize them to represent high-level concepts in decision support mechanisms. From this perspective, we proposed to entitle this issue as the special issue on Granular Knowledge Discovery.

The issue consists of seven papers. Paper submissions were gathered on invitation basis. An open call for special issue contributions was announced as well. Submissions were carefully peer-reviewed by independent experts, with two evaluation reports per manuscript. Revised versions of pre-accepted papers were reexamined to assure that all recommended changes and extensions were introduced.

The first paper, by Hiroshi Sakai, Mao Wu, Naoto Yamaguchi and Michinori Nakata, is titled "Granules for Association Rules and Decision Support in the getRNIA System". The authors work with granules gathering objects supporting components of association rules derived from non-deterministic information systems, which can reflect data sources with missing values, set values or interval values. While taking a form of easy-to-handle blocks for classical data sets, granules of objects supporting association rules become more complex if incompleteness, inexactness and uncertainty are involved. Nevertheless, the authors show that association rules can be learnt using computations on granules even for such non-standard, non-deterministic data. The appropriately designed Granular Computing framework is implemented within the getRNIA decision support system developed by the authors.

The second paper, by Witold Pedrycz, is titled "Granular Fuzzy Rule-Based Architectures: Pursuing Analysis and Design in the Framework of Granular Computing". The author studies granular rule-based models whose rules assume a format "if G(...) then G(...)", where G(...) denotes granular generalizations of numeric conditions and conclusions. Generalizations can be expressed, e.g., in terms of interval-valued, type-2 or probabilistic fuzzy sets. The author discusses and motivates several classes of fuzzy models depending on available information granules. The design of granular architectures exploits principles of justifiable granularity and optimal allocation of information granularity. Performance indexes of rules are thoroughly studied as well. Like in the case of the first paper, this research utilizes granular models to deal with complex real-world data sets.

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The third paper, by Cong Li, Junzo Watada, Shuang Fu and Huiming Zhang, is titled "A Granularity Approach to Compound Real Option in Multi-stage Capital Investment Project". The authors propose an approach to real option analysis, which is a relatively new way to evaluate corporate investment decisions made in stages. Capital investment is often a gradual project, which can be indeed divided into multiple stages that can effectively reduce the risks. However, this makes the outcomes of the whole process more difficult to predict, as decision-makers need to deal with incomplete information and uncertainty. To handle such challenges, the authors utilize fuzzy numbers. Moreover, to process groups of multi-stage investments as compound options, the authors organize fuzzy numbers into granules. With this respect, information granulation leads toward significant extension of the model.

The fourth paper, by Łukasz Sosnowski, is titled "Framework of Compound Object Comparators". The author discusses foundations and implementation of comparators, which are basic units to compare compound inputs with repositories of reference objects. Comparisons are modeled with fuzzy relations combined with exception rules. Objects are described by attributes specified according to application's domain ontology. Input objects are processed as granules gathering information about their components, as well as similarity degrees corresponding to particular reference (sub-)objects. More compound objects are processed via networks of comparators, which reflect their hierarchical nature. The author illustrates efficiency of the overall proposed framework using practical case studies related to optical characters recognition and semantic parsing of bibliography items.

The fifth paper, by Noriyuki Kushiro, is titled "Can Residents Manage Energy in a Home by Knowing Their Own Life Events?". The author develops an algorithm for intelligent home energy management. It can adapt to residents' lifestyle basing on an activity recognition life event sensor, which measures electric power consumption and detects a usage of electronic devices by utilizing high frequency current waveforms as their unique signatures. In order to evaluate the proposed framework, a long-term data collection system was implemented and installed in two occupied houses for a year. The system acquired knowledge at different levels of granularity adjusted for designing the sensor and the algorithm. The appropriately modeled hierarchy of information granules lets the system establish a bridge between basic numerical signals and compound concepts reflecting residents' life patterns.

The sixth paper, by Karol Kreński, Adam Krasuski, Marcin Szczuka and Stanisław Łazowy is titled "Granular Knowledge Discovery Framework for Fire and Rescue Reporting System". The authors extend a previously-developed platform for fire and rescue Incident Data Reporting System (IDRS) using semantic background of the analyzed phenomena. The authors outline how to build and tune practically meaningful models of processes by means of granules, by approximating their states and instances. They also discuss how the incorporation of granular paradigm in knowledge discovery from IDRS data may enrich the final outcomes of data preparation and transformation. The proposed approach is illustrated by several case studies related to existing IDRS. The complexity of available data sources that can be utilized to make the developed methodology more useful is studied as well.

The seventh paper, by Yasufumi Takama and Masaki Okumura, is titled "Interactive Visualization System for Monitoring Support Targeting Multiple BBS Threads". The authors show how to support the process of monitoring bulletin board system (BBS) threads, which are a popular source of text stream information on various topics. The authors utilize keyword-based visualization with different levels of granularity for tracking candidates reflecting various topics and detailed keywords giving an insight into tracked topics. The constructed system provides views for displaying topics of multiple threads and a focused thread at the same time. Experiments are conducted with test participants by simulating standard job conditions where users can follow threads only during breaks. Like in the sixth paper, this research confirms that granulation can improve knowledge representation quality.

In summary, we hope that this special issue shows a variety of ways of embedding data, information and knowledge granulation into Knowledge Discovery and Decision Support. It is worth emphasizing that the selected papers represent both foundations of granular decision systems and applications in a number of real-world projects related to, e.g., monitoring, control, prediction and identification.

We would like to express our appreciation to all authors for their important contributions and to all reviewers for their insightful evaluations. We are also very grateful to Editors-in-Chief of Intelligent Decision Technologies journal for their hard work to make this special issue possible to happen.

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