International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 24 Issue 3 – FEBRUARY 2017 (SPECIAL ISSUE).

SURVEY OF RECENT RESEARCH IN GRANULAR COMPUTING

V.Suresh Kumar [#1],Dr.J.Dhillipan[*2] and D.B.Shanmugam [*3]

[#1]*M.Phil, Research Scholar, Dr.M.G.R.Chockalingam Arts College, Arni.*

[*2] *Asst.Prof.,(S.G) & Head, MCA Department, SRM University, Ramapuram Campus, Chennai*

[*3]*Associate Professor, Department of MCA, Sri Balaji Chockalingam Engineering College , Arni*

***Abstract*— Granular computing, as an emerging research field, provides a conceptual framework for studying many issues in data mining and new multidisciplinary study and has received much attention in recent years. This paper examines some of those issues, including data and knowledge representation and processing. It is demonstrated that one of the fundamental tasks of data mining is searching for the right level of granularity in data and knowledge representation. An important aspect in granular computing is to view granular computing as human-centric intelligent systems. Human-centered information processing was initiated with the introduction of fuzzy sets. Such insights have led to the development of the granular computing paradigm. From machine-centered to human-centered approaches is considered one of the trends in GrC research.**

A conceptual framework is presented by extracting shared commonalities from many fields. The framework stresses multiple views and multiple levels of understanding in each view. It is argued that granular computing is more about a philosophical way of thinking and a practical methodology of problem solving. By effectively using levels of granularity, granular computing provides a systematic, natural way to analyze, understand, represent, and solve real world problems. With granular computing, one aims at structured thinking at the philosophical level, and structured problem solving at the practical level.

***Index Terms*—Granular Computing, survey, granularity, knowledge reprentation.**

I. INTRODUCTION

The basic ingredients of granular computing are granules such as subsets, classes, objects, clusters, and elements of a universe. These granules are composed of finer granules that are drawn together by distinguishability, similarity and functionality. Based on complexity, abstraction level and size, granules can be measured in different levels. The problem domain, i.e., the universe, exists at the highest and coarsest granule. Granules at the lowest level are composed of elements of the particular model that is used.

Granulation is one of the key issues in granular computing for problem solving. The original meaning of granulation from dictionaries is the act or process of forming something into granules. It is a process of making a larger object into smaller ones. Zadeh adopted this idea to decompose a universe to granules and pointed out. Granulation involves a decomposition of whole into parts. Conversely, organization involves an integration of parts into whole. Based on this definition, there will be two operations in granular computing, i.e., granulation and organization. Granulation involves two directions in problem solving: construction and decomposition. The construction involves the process of forming a larger and higher level granule with smaller and lower level sub-granules. The decomposition involves the process of dividing a larger granule into smaller and lower level granules.

The former is a bottom-up process and the latter a top-down process. The reason for a more general and broad view of granulation is that construction and decomposition are tightly related. When one chooses a particular granulation in an application, the benefits and efficiency of one direction is correlated to its opposite direction. If we consider a decomposition operation without the consideration of construction we may end up with a very efficient decomposition operation and a very inefficient construction.

In order to conduct granulation, it is crucial to understand relationships amongst granules. We may classify granular relationships into two groups: interrelationship and intrarelationship.

Decomposition divides a larger granule into smaller granules from which a larger granule can still be formed with construction. Construction groups smaller granules that share similarity, in distinguish ability, and functionality to a larger granule. The relationship involved in the former granulation is considered as interrelationship, the latter intrarelationship. In other words, interrelationship is the basis of grouping small objects together while intrarelationship is the foundation of dividing a granule into smaller ones. Refinement and coarsening are additional types of relationships.

A granule o1 is defined as a refinement of another granule o2, or equivalently, o2 is a coarsening of o1, if every sub-granule or object of o1 is contained in some sub-granules of o2. Partitions and coverings are two simple and commonly used granulations of a universe. A partition of a universe is a collection of its non-empty and pairwise disjoint subsets whose union is the universe. It forms a covering if it is not disjoint. The subsets are called covering granules in a covering, and partition granules in a partition.

Recent Developments in Granular Computing Representative and influential research in granular computing are briefly summarized:

II. Philosophic and Fundamental Views of Granular Computing

Defining granular computing is one of the important research tasks for this community. Instead of simply defining what is granular computing research, Yao views the scope of granular computing from three perspectives, namely, the philosophical perspective, methodological perspective and computational perspective. It is argued that with each perspective focusing on different aspects of granular structures, the three perspectives working together will provide a more general and complementary view of granular computing. The philosophical perspective concerns structured thinking. The methodological perspective concerns structured problem solving.

The computational perspective concerns structured information processing. Granular computing also focuses on the application of its theory to knowledge-intensive systems. The representation and processes of a system are two things to consider. Representation of a system describes the granules and granular structures within the application domain.

III. HUMAN-CENTERED AND FUZZY INFORMATION PROCESSING

Human-centered information processing was initiated with fuzzy sets. The insights have led to the development of the granular computing paradigm (Bargiela & Pedrycz, 2008; Zadeh, 1997). Shifting from machine-centered approaches to human-centered approaches is a trend in granular computing research. Granular computing adopts a structured combination of algorithmic and non-algorithmic information processing that mimics human, intelligent synthesis of knowledge from information.

By integrating various different agents in which each pursues its own agenda, exploits its environment, develops its own problem solving strategy and establishes required communication strategies, one may form a more effective human-centered information system. In fact, each agent may encounter a diversity of problem-solving approaches and realize their processing at the level of information granules that is the most suitable from their local points of view. To this level, the hybrid model raises a fundamental issue of forming effective interaction linkages between the agents so that they fully broadcast their findings and benefit from interacting with others.

IV. ROUGH-GRANULAR COMPUTING

Rough set theory plays an important role in granular computing. Recent work studies the formation of granules with different criteria from a rough computing point of view (Skowron & Stepaniuk, 2007). When searching for optimal solutions satisfying some constraints, one of the challenges is that these constraints are often vague and imprecise. In addition, specifications of concepts and dependencies involved in the constraints are often incomplete. Granules are built in computations aimed at solving such optimization tasks.

General optimization criterion based on the minimal length principle was used. In searching for (sub-)optimal solutions, it is necessary to construct many compound granules using some specific operations such as generalization, specification or fusion. These criteria can be based on the minimal length principle, can express acceptable risk degrees of granules, or can use some utility functions.

V. MINIMAL LENGTH PRINCIPLE

The minimum description length (MDL) principle is a powerful method of inductive inference, the basis of statistical modeling, pattern recognition, and machine learning. It holds that the best explanation, given a limited set of observed data, is the one that permits the greatest compression of the data. MDL methods are particularly well-suited for dealing with model selection, prediction, and estimation problems in situations where the models under consideration can be arbitrarily complex, and overfitting the data is a serious concern.

VI. WHY GRANULAR COMPUTING?

There are many reasons for the study of granular computing. The previous discussion provides some motivations. They stem mainly from the use of levels of granularity. The following list summarizes and reiterates some of the points:

1) Truthful representation of the real world. Many natural, social, and artificial systems are organized into levels. Granular computing provides true and natural representations of such systems. Through the multiple level representation, one can obtain a full understanding of a system.

2) Consistent with human thinking and problem solving. Human problem solving is based crucially on levels of granularity and change between granularities. Granular computing therefore extracts the common elements from human problem solving. The implementation of the principles of granular computing would lead to more effective information processing systems.

3) Simplification of problems. A multiple level representation shows the orderness, the control, and the organization of a complex system or a complex problem. Different levels focus on different granularities characterized by different grain sizes. By omitting unnecessary, irrelevant details and focusing on the right level of abstraction, we are able to simplify a complex system, or a complex problem.

4) Economic and low cost solutions. By considering the same problem at different levels of granularity, we ignore some details. This in turn may lead benefit is that such solutions can normally be obtained economically at a fraction of the cost.

A. Granule:

A granule may be interpreted as one of the numerous small particles forming a larger unit. By considering a small group as a granule, we can draw results from the theory of small groups. We need to consider at least three basic properties of granules:

– internal properties reflecting the interaction of elements inside a granule;

– external properties revealing its interaction with other

granules;
– contextual properties showing the relative existence of a granule in a particular environment.
A granule is treated both as a collection of individual elements characterized by its internal properties and as a whole characterized by its external properties. The existence of a granule is only meaningful in a certain context. Elements of a granule can be granules, and a granule can also be an element of another granule.

B. *Granular structures:*

Granular structures provide structured descriptions of a system or a problem under consideration. By combining ideas fromsystems thinking, complex systems theory, and theories and techniques of hierarchies, we can identify at least three levels of structure on a web of granules:
– internal structure of a granule;
– collective structure of a family of granules;
– hierarchical structure of a web of granules.
A collective structure of family of granules may be interpreted as a level or a granulated view in an overall hierarchical structure. Itself may be an inter-connected network of granules. For the same system or the same problem, many interpretations and descriptions may co-exist. Granular structures need to be modeled as multiple hierarchies and multiple levels in each hierarchy.

C. *Granulation:*

Granulation involves the construction of the basic components of granular computing, namely, granules, granulated views, web of granules, and hierarchies. Issues involved are:
– granulation criteria;
– granulation algorithms/methods;
– representation/description of granules and granular structures;
– qualitative/quantitative characterization of granule and granular structures.

D. *Computing with granules:*

Computationally, granular computing can solve a problem by systematically exploring the granular structures. This involves two-way communications upwards and downwards in a hierarchy and moving within a hierarchy. Some of the issues are:
– mappings connecting granules and levels;
– granularity conversion;
– operators of computing;
– property preservation or invariant properties.

VII. BIG DATA: CHALLENGES AND RELEVANCE OF GRANULAR MINING

Various aspects of our day-to-day activities have been influenced and regularized with the presence of big data. It has not only revolutionized individuals but also affected the science, and planning and policies of the government. Although, accomplishment in this domain is in the initial stage, several technical challenges are posed that need to be addressed to fully realize the potential of big data. Generally, achieving the usefulness of big data is followed by multiple levels of operational steps, such as acquisition, information extraction and cleaning, data integration, modelling and analysis, and interpretation and deployment. Fuzzy sets, rough sets, neural networks, interval analysis and their synergistic integrations in granular computing framework have been found to be successful in most of these tasks. Research challenges around big data arise from various aspects and issues, such as their heterogeneity, inconsistency and incompleteness, timeliness, privacy, visualization and collaboration.
One may note that managing uncertainty in decision-making and prediction is very crucial for mining any kind of data, no matter small or big. While fuzzy logic (FL) is well known for modeling uncertainty arising from vague, ill-defined or overlapping concepts/ regions, RS models uncertainty due to granularity (or limited discernibility) in the domain of discourse. Their effectiveness, both individually and in combination, has been established worldwide for mining audio, video, image and text patterns, as present in the Big data generated by different sectors. FS and RS can be further coupled, if required, with (probabilistic) uncertainty arising from randomness in occurrence of events in order to result in a much stronger framework for handling real life ambiguous applications. In case of Big-data the problem becomes more acute because of the manifold characteristics of some of the Vs, like high varieties, dynamism, streaming, time varying, variability and incompleteness. This possibly demands the judicious integration of the three aforesaid theories for efficient handling.

VIII. CONCLUSION

We elaborate on several issues of the granular computing by attempting to answer its fundamental questions. Specific and concrete theories, methodologies, and tools of granular computing are discussed by many authors. For this reason, we concentrate on a high-level conceptual investigation.
Granular computing, in our view, attempts to extract the commonalities from existing fields to establish a set of generally applicable principles, to synthesize their results into an integrated whole, and to connect fragmentary studies in a unified framework. Granular computing at philosophical level concerns structured thinking, and at the application level concerns structured problem solving. While structured thinking provides guidelines and leads naturally to structured problem solving, structured problem solving implements the philosophy of structured thinking.The presented personal views and ideas may be immature, and perhaps controversial. They are meant to stimulate more researchers to look further into granular computing.

REFERENCES

[1] E. E. S. (Eds.), Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. John Wiley and Sons, N. Y., 2015.
[2] T. Y. Lin, Granular computing: Practices, theories, and future directions. in: R. A. Meyers (Eds.), Encyclopedia of Complexity and Systems Science, Springer, Heidelberg, 2009, pp. 4339-4355.
[3] W. Pedrycz (Eds.), A. Skowron, and V. Kreinovich, Handbook of Granular Computing. John Wiley and Sons, London, 2008.
[4] S. K. Pal and A. Skowron, (Eds.), Rough-Fuzzy Hybridization: A New Trend in Decision Making. Springer-Verlag, Singapore, 1999.

[5] S. K. Pal, L. Polkowski, and A. Skowron, (Eds)., Rough-neural Computing: Techniques for Computing with Words. Springer-Verlag, Berlin, 2004.

[6] S. K. Pal and S. K. Meher, "Natural computing: A problem solving paradigm with granular information processing," Applied Soft Computing, vol. 13, pp. 3944–3955, 2013.

[7] J. T. Yao, A. V. Vasilakos, and W. Pedrycz, "Granular computing: Perspectives and challenges," IEEE Trans. Cybernetics, vol. 43, pp. 1977–1989, 2013.