ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Study of Granular Computing and Its Impact on Human Life

Sushma Gupta*, Rakesh Patel, Chanda Patel
Kirodimal Institute of Technology, Raigarh(C.G.),India

Abstracts

Granular computing, as an emerging research field, provides a conceptual framework for studying many issues in data mining. 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.

Keywords: Granular Computing.

Introduction

Granular computing (GrC) : GRC is an emerging computing paradigm of information processing. It concerns the processing of complex information entities called information granules, which arise in the process of data abstraction and derivation of knowledge from information or data. Generally speaking, information granules are collections of entities that usually originate at the numeric level and are arranged together due to their similarity, functional or physical adjacency etc.

An umbrella term to cover any theories, methodologies, techniques and tools that make use of granules in problem solving .Granular computing process of performing computational and operation on granules.

The concept of granular computing have been studied under various names in many different fields, such as quantization, divide and conquer, structured programming, interval analysis, rough set theory, cluster analysis, machine learning, data analysis and data mining, databases, and many others .More specifically, granular computing is a multi-disciplinary study with the objectives to investigate and model a way of thinking, a family of granule-oriented problem solving methods, and a paradigm of information processing. It is a study of a general theory of problem solving based on different levels of granularity and detail.

Example of granular computing

- ✓ For travelling one needs to know about the weather conditions like cloudy or rainy etc. Instead of exact temperature.

- ✓ While establishing a course view of the world-map, we deal with high level information like countries and oceans. When more details are required, we move down to region, states, seas etc.

Overview of granular computing

The basic ideas and principles of granular computing are not entirely new and have indeed been investigated in many disciplines of social and natural sciences. It is unfortunate that they are examined in relatively isolated and independent ways, expressed in much domain dependent and scattered in many places. The study of granular computing therefore aims at arriving at a new powerful philosophical view and a general problem-solving theory. They are referred to as structured thinking and structured problem-solving.

Broadly, granular computing can be studied based on the notions of representation and process. The representation concerns granules and their organizations in terms of levels, networks, and hierarchies. One focuses on common features and universally applicable principles for the understanding, description, organization, and formulation of various problems across many different disciplines. The process deals with (computational) methods that manipulate granules and granular structures. Based on this simplified view, we list some fields and specific research areas where the ideas of granular computing have been investigated.

• **Computational intelligence**: The explicit study of granular computing starts within the computational intelligence community. In 1979, Zadeh first introduced the notion of information granulation and suggested that fuzzy set theory may find potential applications in this respect. To some extent, rough set theory makes more people realize the importance of the notion of granulation.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

The above studies may be broadly characterized as a set-theoretic study of granular computing. Each granule is defined and represented as a (fuzzy) set, and the granular structure is a family of (fuzzy) sets.Additional studies of granular computing, within the context of computational intelligence and proceedings of International Conference on Rough Sets, Fuzzy Sets, Data Mining, and Granular Computing and IEEE International Conference on Granular Computing.

• **Artificial intelligence** : The ideas of granular computing have been investigated in artificial intelligence through the notions of granularity and abstraction. In fact, the notion of granules plays an important role in knowledge representation, searching, and reasoning. A few examples are given to illustrate the main ideas. The theory indeed captures some of the essential features of granular computing. That is, we represent the world under various grain sizes, and abstract only those things that serve our present interests. The ability to conceptualize the world at different granularities and to switch among these granularities is fundamental to our intelligence and flexibility.

• **The theory of hierarchy**: The hierarchy theory focuses on the understanding and representation of complex systems using multiple level structures. One can conceptualize a complex system by discriminating entities, relations, processes and levels as the basic ingredients of a hierarchical structure. A hierarchy links the parts or components into a whole, and hence provides a multi-level and multi- resolution description of a system .

The hierarchy theory reflects, to some degree, the philosophy of reductionism, where the understanding of a whole is decomposed into the understanding of its smaller parts. Hierarchical analysis is one of the successful methods used in the investigation and understanding of complex systems. For example, social hierarchy is a well studied concept in many branches of social science.

If we use a broader meaning for hierarchies, instead of the restricted mathematical notion defined by a partial ordering, it is possible to combine the theory of hierarchy and the systems thinking, as well as taking advantages of both. For example, although a complex system may be modeled as a web of entities, one can still investigate in different levels of details. It may also be useful to examine a web of sub-webs, where each sub-web can be viewed as a granule.

• **Divide and conquer**: The strategy of divide and conquer can be used to effectively solve many types of problems. It is also related to the philosophy of reductionism in the sense that a large problem is decomposed into a family of smaller problems, and the solution of the large problem is obtained by combining the solutions of smaller problems. Two example applications of the divide and conquer strategy are structured programming.
The top-down structured programming is an effective technique to deal with the complex problem of programming. The principles and characteristics of the top-down design and stepwise refinement, More specifically, the following issues are considered: (a) design in levels; (b) initial language independence; (c) Postponement of details to lower levels; (d) formalization of each level; (e) verification of each level; and (f) successive refinements.

• **The theory of small groups**: Small group research is a field in psychology. Its basic issues and methods are very relevant to granular computing, if we view a small group as a granule. A general theory of small groups as complex systems. Groups are studied as adaptive, dynamic systems determined by three factors: (a) interaction among group members; (b) interaction between different groups; and (c) the embedding contexts of groups. Obviously, we need to study similar types of factors in granular computing.
Many ideas from the small group research, as well as its research methodologies, can be readily applied to the study of granular computing. In the development of the general theory of small groups, Arrow, MaGrath and Berdahl established five propositions addressing the following fundamental issues:
The nature of groups;

- Causal dynamics in groups;
- Group purposes or functions;
- Group composition and structure;
- Modes of group life.

The basic ingredients and issues of granular computing are summarized below, the previously discussed theories and topics*:*
• **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 structure of a granule;
- ✓ Collective structure of a family of granules;
- ✓ Hierarchical structure of a web of granules.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

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.

• **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.

• **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.

Additional discussions and descriptions of a general framework of granular computing can be found in some recent papers. The potential of granular computing can perhaps be derived from the previously described new understanding and perception. This probably will bring more changes than any concrete model.

Granular computing as a basis for data mining

A review of some existing studies points at the needs for a new framework of data mining based on granular computing.

Examples of granular computing based studies on data mining

Data mining aims at discovering knowledge embedded in data. Rules are one of the most commonly used knowledge representation methods. Different types of rules can be studied based on their characteristics. There are many studies on granular computing for data mining .We can examine some existing methods from several perspectives. For clarity, we restrict the discussion to rule mining.

• **Rule representation/interpretation**: A key notion of fuzzy set theory is linguistic variables. A fuzzy granule can be defined in terms of generalized constraints. Fuzzy granules may be represented by words of a natural language. A rule summarizes a connection between two granules. Consequently, we have a human friendly, natural interpretation of rules.

As a concrete example of granular computing, rough set theory has been applied to data mining. In this context, rules are expressed in terms of definable granules. Properties of rules can be interpreted and studied based on granules involved in the rules.

• **Rule mining**: Granular computing techniques can be applied to rule mining. In order to mine more general or meaningful rules, one may group attribute values into granules, or a hierarchy of granules by considering the semantic relationships between attribute values.

Rule mining based on granular computing and proposed a machine-oriented modeling framework. A given attribute value is represented by the set of objects having the value, which in turn is coded as a bit string. The mining process is then carried out through operations on bit strings.

• **Combination with other methods**: Granular computing can be combined with other methods to produce new or more effective mining methods. In the context of computational intelligence, evolutionary computing, and granular computing (in particular, fuzzy and rough sets) can augment each other. Many researchers have attempted to combine granular computing and other theories for data mining.

Granular computing for human

For human-oriented studies of granular computing, we focus on a particular way of human problem solving that uses multiple levels of granularity. We attempt to identify, extract and formalize such a class of principles, strategies, heuristics and methods. The main objective is to understand and unlock the underlying working principle of granular thinking, and to develop new theories and methods for human problem solving. On the evidence and results from human-oriented studies, the machine-oriented studies focus on the application of granular computing in the design and implementation of human-inspired machines and systems.

Granular computing integrates human-oriented and machine-oriented studies, relying on the dependency of the latter on the former. Particularly, granular computing involves the following sequence of tasks:

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

1. To understand the underlying principles and mechanisms of human problem solving, with emphasis on multiple levels of granularity,
2. To extract a set of principles of granular computing,
3. To develop formal methodology, theories and models of granular computing,
4. To empower everyone with principles of granular computing,
5. To design human-inspired machines and systems for problem solving.

Granular computing aims at extracting the common discipline-independent principles, strategies and heuristics that have been applied either explicitly or implicitly in human problem There are several benefits from separating human-oriented and machine-oriented studies and from separating granular computing for humans and for machines. First, they identify clearly the scopes and goals of granular computing. Second, they enable us to recognize the importance of granular computing for humans, an aspect that has been overlooked so far. Third, they make us to ask the right questions and to tackle the right problems with respect to different tasks of granular computing. Fourth, they help us to envision different stages of study on granular computing with both long-term and short-term perspectives

Granular computing for machine

Granular computing for machines deals with more specific and concrete theories and methods. Central issues are to represent information and knowledge at multiple levels of granularity, to process it based on such a multilevel granular structure, to reasoning at multiple levels of abstraction, and to explore variable levels of schematic and approximate solutions of problems, from qualitative and symbolic to quantitative and numeric. Depending on particular applications, the high-level principles of granular computing may be implemented differently. The major research effort on granular computing for machines focuses on an information processing perspective. One step in machine problem solving is to choose most suitable and accurate representations of the problem. Furthermore, machines must be able to understand and operate on such representations.

Granular computing for machine needs to implement these human-inspired ideas and notions in machines.

Conclusion

A cross disciplinary enquiry into human understanding and problem-solving leads to the emergence of granular computing. Although each field has its version of the problem-solving process, the basic way of thinking is shared across disciplines. Granular computing may be viewed as a study of such emergent properties from many disciplines. In the chapter, I examine a view of granular computing as a human-inspired paradigm of problem solving and information processing. It covers two types of studies, namely, human-oriented studies and machine- oriented studies, and two goals, namely, granular computing for humans and granular computing for machines. The main stream of research focuses on machine-oriented studies with the goal of granular computing for machines. Human-oriented studies are a prerequisite of machine oriented-studies. As human-inspired structured approaches, granular computing is both for humans and for machines. The application of granular computing for data mining illustrates two points. For one, granular computing is indeed a powerful view that can be used to model many problems. For the other, like many other fields, data mining follows the principles of granular computing.

References

1. Ahl, V. and Allen, T.F.H. *Hierarchy Theory, a Vision, Vocabulary and Epistemology*, Columbia University Press,1996.
2. Allen, T.F. *A Summary of the Principles of Hierarchy Theory*,http://www.isss.org/hierarchy.htm(accessed March 11,2005).
3. Arrow, H., McGrath, J.E. and Berdahl, J.L. *Small Groups as Complex Systems: Formation, Coordination, Development, and Applications*, Sage Publications, Thousand Oaks, California, 2000.
4. Bargiela, A. and PedryczW. *Granular Computing: an Introduction*, Kluwer Academic Publishers, Boston, 2002.
5. Bohm, D. and Peat, F.D. *Science, Order, and Creativity*, Routledge, London, 2000.
6. Lin, T.Y. Granular Computing on binary relations I: Data Mining and Neighborhood Systems, II: Rough Set Representations and Belief Functions, *Rough Sets In Knowledge Discovery*, A. Skowron and L. Polkowski (Eds.), PhysicalVerlag, 107-140, 1998.
7. Lin, T.Y. Data mining: granular computing approach *Methodologies for Knowledge Discovery and Data Mining,Proceedings of PAKDD'99*, LNAI 1574, 24-33, 1999.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

8. Lin, T.Y. Data mining and machine oriented modeling: a granular computing approach, *Journal of Applied Intelligence*,**13**, 113-124, 2000.
9. Gilhooly, K. J. (1989). Human and machine problem solving,toward a comparative cognitive science.In Gilhooly, K. J. (Ed.), *Human and Machine Problem Solving* (pp. 1–13). New York: Plenum Press.
10. Lin, T.Y. *Granular computing*, Announcement of the BISC Special Interest Group on Granular Computing, 1997.