Chapter 1
Multi-Granular Computing through Rough Sets

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ABSTRACT
Granular Computing has emerged as a framework in which information granules are represented and manipulated by intelligent systems. Granular Computing forms a unified conceptual and computing platform. Rough set theory put forth by Pawlak is based upon single equivalence relation taken at a time. Therefore, from a granular computing point of view, it is single granular computing. In 2006, Qiang et al. introduced a multi-granular computing using rough set, which was called optimistic multigranular rough sets after the introduction of another type of multigranular computing using rough sets called pessimistic multigranular rough sets being introduced by them in 2010. Since then, several properties of multigranulations have been studied. In addition, these basic notions on multigranular rough sets have been introduced. Some of these, called the Neighborhood-Based Multigranular Rough Sets (NMGRS) and the Covering-Based Multigranular Rough Sets (CBMGRS), have been added recently. In this chapter, the authors discuss all these topics on multigranular computing and suggest some problems for further study.

INTRODUCTION
Granular computing is an upcoming conceptual and computing pattern of information processing. It has been strongly encouraged by the urgent need for processing practical data in an intelligent manner (Pedrycz, 2007; Pedrycz et al, 2002, Yao et al, 2013). Such processing need is now commonly available in vast quantities into a humanly manageable abstract knowledge. In other words, granular computing offers a platform to transit from the current machine-centric to human-centric approach to gather information and knowledge. Granular computing as opposed to numeric computing is knowledge oriented. Numeric computing is data oriented. The origin of granular computing is in the context of fuzzy sets (Zadeh, 1965). But,
there are many other theories like interval analysis, rough set theory and probabilistic approach, which follow this approach.

Framing a hierarchical model for a given complex problem is the basic task of granular computing. The core components of granular computing include granules, a web of granules and granular structures. In general, a complex system was usually comprised of many interconnected and interactive modules. For such system each module can be considered as a granule and therefore it resulted with group of granules as a representation for the entire complex system. The description about the individual modules can be obtained from the specific granule whereas the web of granules provides us a clear and complete picture about the complex system. We treat granules as a primitive idea of granular computing. From this core idea other ideas could be derived since granules were an abstract notion. In planning, a granule can be a sub-plan.

In programming, a granule can be a program module. Generally speaking, information granules are collections of entities that usually arranged together due to their similarity, functional or physical adjacency, indistinguishability etc., or in other words information granulation involves partitioning a class of objects into granules, with a granule being a bunch of objects which are drawn together by indistinguishability, similarity or functionality.

It encourages an approach to data that recognizes and makes use of the knowledge present in data at various levels. It includes all methods which provide flexibility and adaptability in the resolution at which knowledge or information is extracted and represented. A granule can be either simple or composite. A simple granule either cannot be further decomposed or formed by other granules, where as a composite granule consists of group of its interconnected and interacting granules. A granule is interconnected to other granules by its dual roles. A granule can be considered as an entire one when it is viewed as a part of another granule. A granule is considered to be a group of interconnected and interacting granules when some other granules are viewed as its parts. We need to differentiate granules by a minimum set of properties. It includes

- Internal properties of a granule
- External properties of a granule
- Emergent properties of a granule
- Contextual properties of a granule

The internal properties of a granule generally deal with its organizational structures, its relationships and about the interaction among the elements (Yao, 2008). The external properties of a granule reveal its interaction with other granules (Yao, 2008). The emergent properties of a granule may be viewed as one type of external property (Yao, 2008). In most of the cases, both the internal and external properties of a granule were found to have certain dynamic changes with its related environment. The contextual properties of a granule show its relative existence in a particular environment (Yao, 2008). All the above said types of properties together give us a better understanding towards the notion of granule (Yao, 2008). The knowledge obtained based on granules although approximate but may be good enough for practical uses.

DIFFERENT VIEWS OF GRANULAR COMPUTING

There are several views of granular computing. These are

- Philosophical perspective of granular computing or structured thinking
- Methodological perspective of granular computing or structured problem solving
- Computational perspective of granular computing or structured information processing