

## Chapter 9

# Rough Set on Two Universal Sets Based on Multigranulation

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### ABSTRACT

*The fundamental concept of crisp set has been extended in many directions in the recent past. The notion of rough set by Pawlak is noteworthy among them. The rough set philosophy is based on the concept that there is some information associated with each object of the universe. There is a need to classify objects of the universe based on the indiscernibility relation among them. In the view of granular computing, rough set model is researched by single granulation. It has been extended to multigranular rough set model in which the set approximations are defined by using multiple equivalence relations on the universe simultaneously. However, in many real life scenarios, an information system establishes the relation with different universes. This gave the extension of multigranulation rough set on single universal set to multigranulation rough set on two universal sets. This chapter defines multigranulation rough set for two universal sets  $U$  and  $V$ . In addition, the algebraic properties, measures of uncertainty and topological characterization that are interesting in the theory of multigranular rough sets are studied. This helps in describing and solving real life problems more accurately.*

### INTRODUCTION

Information technology revolution in the recent past has brought radical change in the way data are collected or generated for ease of decision making. The huge data collected has no relevance unless it provides certain meaningful information pertaining to the interest of an organization. Therefore, the real challenge lies in converting huge data into

knowledge. This leads to classification and clustering. The earliest to handle classification is classical set. In addition, knowledge associated with classical set is very limited and it fails to process ill-posed objects. But, the objects associated in the information system contains uncertainties and are imprecise in nature. Therefore, the rudimentary concept of classical sets has been extended in many directions as far as modeling of real life situations

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is concerned. The earliest is the notion of Fuzzy set by L. A. Zadeh (1965) that captures impreciseness in information. On the other hand rough sets of Z. Pawlak (1982, 1991) capture indiscernibility among objects to model imperfect knowledge. The basic philosophy is that human knowledge about a universe depends upon their capability to classify its objects. So, classification of a universe and indiscernibility relations defined on it are known to be interchangeable notions. The basic idea of rough set is based upon the approximation of sets by pair of sets known as lower approximation and upper approximation. Here, the lower and upper approximation operators are based on equivalence relations. However, the requirement of equivalence relations is a restrictive one and failure in many real life situations. In order to achieve this, rough set is generalized to binary relations (Yao, 1998; Kondo, 2006; Pawlak & Skowron, 2007a), fuzzy proximity relations (Tripathy & Acharjya (2008, 2010)), intuitionistic fuzzy proximity relations (Tripathy, 2006; Tripathy & Acharjya (2009, 2011)), Boolean algebras (Liu, 2005; Pawlak & Skowron, 2007b), fuzzy lattices (Liu, 2008), completely distributive lattices (Chen et al., 2006) and neighborhood systems (Lin, 1989). Development of these techniques and tools is studied under different domains like knowledge discovery in database, computational intelligence, knowledge representation, granular computing etc. (Saleem Durai et al., 2012; Acharjya et al. (2011, 2012); Tripathy et al., 2011).

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). Such processing need is now commonly available in vast quantities into a humanly manageable abstract knowledge. On the contrary, 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.

In principles of programming, a granule can be a program module. In general, information granules are collections of entities that usually arranged together due to their similarity, functional or physical adjacency etc. On contrary, information granulation involves partitioning a class of objects into granules, with a granule being a bunch of objects which are drawn together by 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, whereas a composite granule consists of group of its interconnected and interacting granules. 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. In addition, granules can be differentiated by a minimum set of properties such as internal, external, emergent, and contextual.

The internal properties of a granule generally deal with its organizational structures, its relationships and the interaction among the elements whereas the external properties of a granule reveal its interaction with other granules. The emergent properties of a granule may be viewed as one type of external property. But, 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. All the above said types of properties together

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