Chapter 3.15
Granular Computing in Object-Oriented Software Development Process

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ABSTRACT

Granular computing as a methodology of problem solving has been extensively applied in a variety of fields for a long history, but the special research interest in granular computing has only been developed in past decades. So far most granular computing researchers address the mathematical foundation and/or the computation model of granular computing. However, granular computing is not only a computing model for computer-centered problem solving, but also a thinking model for human-centered problem solving. Fortunately, some authors have presented the structures of such kind models and investigated various perspectives of granular computing from different application points of views. In this paper we present the principles, models, components, strategies, and applications of granular computing. Our focus will be on the applications of granular computing in various aspects and phases of the object-oriented software development process, including user requirement specification and analysis, software system analysis and design, algorithm design, structured programming, software testing, and system deployment design. Our objective is to reveal the importance and usefulness of granular computing as a human-centered problem solving strategy in object-oriented software development process.

1. INTRODUCTION

The basic principles of granular computing involve granularity, granulation and computations with granules and relationships among them. The idea has been studied extensively in various research communities and application domains for a long time in a variety of ways, either implicitly or explicitly (Bargiela & Pedrycz 2002). However, as a general computing paradigm of problem solving, granular computing has only been investigated for decades, but has received much attention in computing intelligence society in recent years. The

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following is a brief history of modern granular computing development:

- Zadeh (1979) first introduced the notion of information granulation in 1979 and suggested that fuzzy set theory may find potential applications in this respect, which pioneers the explicit study of granular computing. With the concept of his information granulation, Zadeh further presented granular mathematics (Zadeh, 1997).
- Pawlak (1982) proposed the rough set theory to deal with inexact information by using rough sets to approximate a crisp set in 1982, and investigated the granularity of knowledge from the point of view of rough set theory (Pawlak, 1998).
- Hobbes (1985) presented a theory of granularity as the base of knowledge representation, abstraction, heuristic search, and reasoning in 1985. In his theory the problem world is represented as various grains and only interesting ones are abstracted to learn concepts.
- Giunchigalia and Walsh (1992) presented a theory of abstraction to improve the conceptualization of granularities in 1992, where the conceptualization of the world can be performed at different granularities and switched between granularities.
- Lin (1997B) suggested the term "granular computing" to label this growing research field in 1997. Lin also proposed a theoretical model of granular computing with neighbor system based on binary relations (Lin, 1979; Lin, 1997A).
- Yao, Y. (2005) investigated the trinity model of granular computing from three perspectives: philosophy, methodology, and computation, and discussed a hierarchical architecture of granular computing.
- In the past decade, different granular computing models have been conducted in various aspects and applied in various application domains, including machine learning, data mining, bioinformatics, e-Business, network security, high-performance computing and wireless mobile computing, etc. The essence of these models has been addressed by researchers to build efficient computational algorithms for handling huge amounts of data, information and knowledge. The objectives of these computation models are computer-centered and mainly concern the efficiency, effectiveness, and robustness of using granules such as classes, clusters, subsets, groups and intervals in problem solving. In recent years, some researchers have investigated the granular computing paradigm from perspectives of philosophy, cognitive science, and human thinking (Yao, Y., 2004; Yao, Y., 2005) as well as the general strategies of interactions between granules (Yao, J., 2006) and operations on granule coverings (Wu & Yang, 2005). Yao, J. (2007) summarizes and reviews the development of granular computing in the past ten years.

So far most granular computing researcher address the mathematical foundation and/or the computation model of granular computing, while neglect the research of its importance and usefulness in our human beings daily problem solving. Granular computing is not only a computing model for computer-centered problem solving, but also a thinking model for human-centered problem solving. Actually the basic concept of granular computing has been extensively applied in many problem solving disciplines with different formats either consciously or unconsciously by human beings. Recently, some authors have presented the structures of such kind models and investigated various perspectives of granular computing from different application points of views. For instance, Yao, Y. (2003) scrutinizes the structured writing with granular computing strategies and demonstrates that by consciously using granular computing