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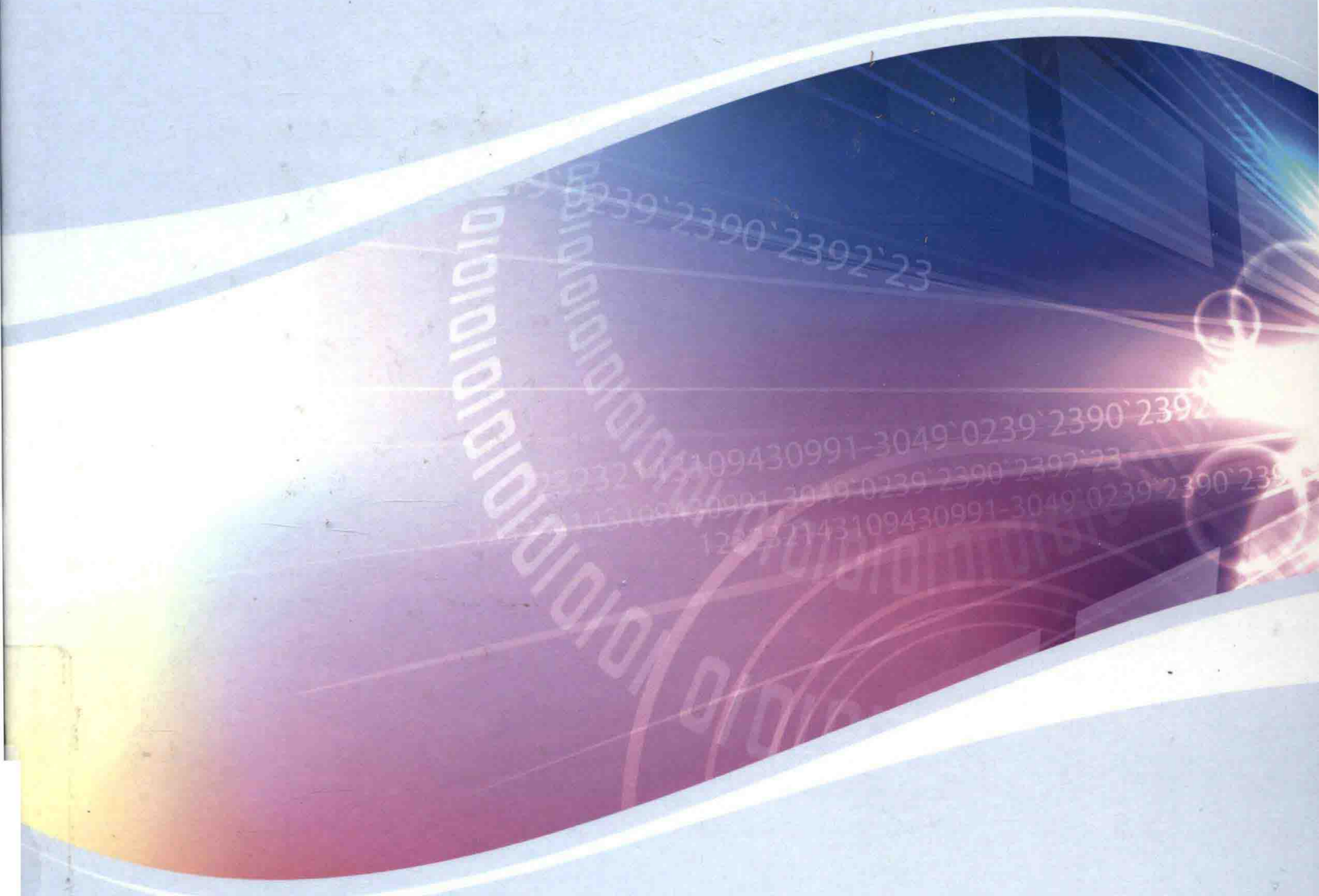

Mehdi Khosrow-Pour

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Systems and Software Development, Modeling, and Analysis:

New Perspectives and Methodologies

Mehdi Khosrow-Pour
Information Resources Management Association, USA

A volume in the Advances in Systems Analysis, Software Engineering, and High Performance Computing (ASASEHPC) Book Series

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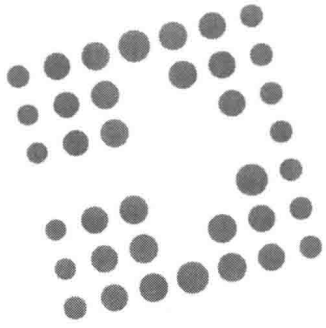

Advances in Systems Analysis, Software Engineering, and High Performance Computing (ASASEHPC) Book Series

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Preface

With the rise of service-oriented architecture and multi-vendor system integration, computer systems and software have become increasingly complex. This increasing complexity calls for a multi-faceted approach to not only the development process but also the modeling and analytical processes, taking into special consideration the functionalities best suited for the evolving needs of the end-user. *Systems and Software Development, Modeling, and Analysis: New Perspectives and Methodologies* discusses the issues, challenges, and standards associated with systems and software development, the dynamic modeling methods required for successful system analysis and design, and the analytics tools used to identify tendencies and standards that must be considered in order to yield a relevant, high-quality end product.

The book is organized into 11 chapters. A brief description of each of the chapters can be found below:

In chapter 1, "Semantically Integrated Conceptual Modeling Method and Modeling Patterns," Remigijus Gustas and Prima Gustiene discuss the management of evolutionary changes, identification of discontinuities, and separation of concerns in information system development. The chapter presents one of the fundamental problems faced by information system developers today: that most conventional conceptual modeling techniques deal with the collections of loosely linked meta-models, which are defined by the different types of diagrams. In this chapter, the authors present the semantically integrated conceptual modeling method. They posit that the advantage of this method is stability and flexibility of the diagrams to manage the constant changes of system requirements. Through case study examples, the authors show that sequential, underlying, enclosing, overriding, and overlaying interaction loops between actors provide the foundation for the composition of complex scenarios.

Raymon R. Bruce traces the origin of the concept of work in the second chapter of this book, titled "Founding a Field Theory of Work: Re-Organization through Energy Exchange." In five sections, the author provides an answer to the question, what is work?, develops the Greek word family for work into a dynamic model of doing, shows how nature guides work change through energy exchange, examines policymaking as human guidance imitating nature, and presents the author's issue analysis as an invited Organization Development consultant who helps the Sri Lankan government, the University of Moratuwa, and the apparel and textile industry find ways to work together in their extreme makeover of human resource development of their apparel and textile industry. Action training and research, stakeholder management, and wicked problem issue analysis were the organization development methods used to demonstrate this field theory of work re-organization through energy exchange.

In "Context Inference Engine (CiE): Classifying Activity of Context using Minkowski Distance and Standard Deviation-Based Ranks," the third chapter of this book, Umar Mahmud and Muhammad Younus Javed define context awareness and context-aware systems. They propose a Context Inference Engine (CiE) that classifies the current context as one of several known context activities.

Chapter 4, "Simple System Dynamics and Control System Project Models," examines the established Systems Dynamics (SD) methods applied to software projects in order to simplify them. A SIMULINK version of an SD model is used in the chapter, and conclusions are made with respect to the initial main controlling factors, compared to a NASA project. Control system methods are used to evaluate the critical features of the SD models.

Nicholas C. Georgantzas and Evangelos Katsamakas present a System Dynamics (SD) simulation model that replicates self-organizing system uncertainty results and looks at self-organization causally in chapter 5, "Modeling a Simple Self-Organizing System." The authors use SD simulation and model analysis results to show how distributed control leads positive feedback to explosive growth, leaving the system in a stable, negative feedback state. The chapter's SD model analysis helps explain why phenomena of interest emerge in agent-based models, a topic crucial in understanding and designing Complex Adaptive Self-Organizing Systems (CASOS).

In chapter 6, "The Role of Standards in the Development of New Informational Infrastructure," Vladislav V. Fomin and Marja Matinmikko inch towards a better understanding of the notion of informational infrastructure and the role of standards in the development of infrastructures in the new information age. Specifically, the authors consider standardization processes as pertaining to informational infrastructure development. They focus on two particular aspects of standardization: temporal dynamics and social organization. Using Bauman's concept of liquid modernity, they argue that standards often become hybrids of solid and liquid modernities linking together different scales of time, space, and social organization. To better illustrate theoretical concepts, they draw on practical examples from the development of informational standards, infrastructures, and services, particularly from the domain of Cognitive Radio Systems (CRS) with the overall aim of offering scholars of standards and innovation a fresh, non-mainstream perspective on the social and temporal dynamics of standardization and infrastructure development processes.

In chapter 7, José Eduardo Fernandes and Ricardo J. Machado revisit the contributions of Pervasive Information Systems (PIS) researchers to provide a pattern that supports the use of the development framework and profiling approach on software development for PIS. Their chapter, "Development Framework Pattern for Pervasive Information Systems," completes the first series of research contributions for the development of PIS and presents a case study that demonstrates the applicability of these contributions.

Andreas Barth, Andreas Knobloch, Silke Noack, and Frank Schmidt present five case studies to illustrate the current possibilities and limitations of spatial predictions with the use of artificial neural networks in chapter 8, "Neural Network-Based Spatial Modeling of Natural Phenomena and Events." Applications presented by the authors are: (1) the prognosis of soil erosion patterns, (2) the country-wide prediction of mineral resources, (3) the vulnerability analysis for forest pests, (4) the spatial distribution of bird species, and (5) the spatial prediction of manganese nodules on the sea bottom.

In chapter 9, titled "Multidimensional Data Analysis Based on Links: Models and Languages," Paulo Caetano da Silva addresses the need for a solution for OLAP systems in order to assist in the strategic analysis of the organizational data represented in XML format. Aiming at overcoming this issue, the author proposes an analytical system composed by LMDQL (Link-Based Multidimensional Query Language), an analytical query language; XLDM (XLink Data Metamodel), a metamodel given to model cubes of XML documents with XLink and to deal with syntactic, semantic, and structural heterogeneities commonly found in XML documents; and XLPath (XLink Path Language), a navigation language for XML documents connected by XLink. As current W3C query languages for navigating in XML documents do not support XLink, the author also discusses XLPath to provide features for the LMDQL query

processing and a prototype system enabling OLAP queries over XML documents linked by XLink and XML schema. In order to validate the proposed system, a case study and its performance evaluation are presented to analyze the impact of analytical processing over XML/XLink documents.

In "A Scouting-Based Multi-Agent System Model to Deal with Service Collaboration in Cloud Computing," Mauricio Paletta discusses MAS-Scout, a framework that defines Multi-Agent Systems based on the principles of Scouting. In this chapter, MAS-Scout is used to design a system to deal with service collaboration in a cloud computing environment focusing on the premise that Scouting has been a very successful social movement in the world and that collaboration is part of its principles. The results presented in this chapter show that MAS-Scout, which is based on the Scouting principles can be satisfactorily used to automate cloud computing needs.

The last chapter, "Power Quality Improvement using Improved Approximated Fuzzy Logic Controller for Shunt Active Power Filter," authored by Asheesh K. Singh and Rambir Singh, presents the design approach of an Improved Approximated Simplest Fuzzy Logic Controller (IASFLC). The chapter authors propose a cascade combination of simplest 4-rule Fuzzy Logic Controller (FLC) and an n^{th} degree polynomial as an IASFLC to approximate the control characteristics of a 49-rule FLC. The proposed IASFLC is used to control the dc link voltage of a 3-phase shunt Active Power Filter (APF). A detailed analysis is performed during transient and steady state conditions to check Power Quality (PQ) and dynamic performance indices under randomly varying balanced and unbalanced loading conditions. The performance of proposed IASFLC is compared with a 49-rule FLC and Approximated Simplest Fuzzy Logic Controller (ASFLC) based on minimization of the deviation at central values of Membership Functions (MFs).

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Table of Contents

Detailed Table of Contents

evolutionary change. The fourth section examines policymaking as human guidance imitating nature. Policymaking limits individual self-governance to guide a specified social community of people (polis) doing work. Policymaking is explored to see how humans use policymaking to govern themselves and their cultural social groups including governments by using nature's use of laws as guidance. Policymaking is also a form of laying down basic parameters of work as re-organization through energy exchanges in the ambient environment. Policies are human artifacts designed help a social group work well together. Part five presents an issue analysis as an invited Organization Development consultant to help find ways for the Sri Lankan government, the University of Moratuwa, and the apparel and textile industry to work together in their extreme makeover of human resource development of their apparel and textile industry. Action training and research, stakeholder management, and wicked problem issue analysis are the organization development methods used to demonstrate this field theory of work re-organization through energy exchange.

Context Awareness is the ability of systems and applications to sense the environment and infer the activity going on in the environment. Context encompasses all knowledge bounded within an environment and includes attributes of both machines and users. A context-aware system is composed of context gathering and context inference modules. This chapter proposes a Context Inference Engine (CiE) that classifies the current context as one of several known context activities. This engine follows a Minkowski distance-based classification approach with standard deviation-based ranks to identify likeliness of classified activity of the current context. Empirical results on different data sets show that the proposed algorithm performs closer to Support Vector Machines (SVM) while it is better than probabilistic reasoning methods where the performance is quantified as success in classification.

This chapter examines the established Systems Dynamics (SD) methods applied to software projects in order to simplify them. These methods are highly non-linear and contain large numbers of variables and built-in decisions. A SIMULINK version of an SD model is used here and conclusions are made with respect to the initial main controlling factors, compared to a NASA project. Control System methods are used to evaluate the critical features of the SD models. The eigenvalues of the linearised system indicate that the important factors are the hiring delay time, the assimilation time, and the employment time. This illustrates how the initial state of the system is at best neutrally stable with control only being achieved with complex non-linear decisions. The purpose is to compare the simplest SD and control models available required for "good" simulation of project behaviour with the Abdel-Hamid software project model. These models give clues to the decision structures that are necessary for good agreement with reality. The final simplified model, with five states, is a good match for the prime states of the Abdel-Hamid model, the NASA data, and compares favourably to the Ruiz model. The linear control system model has a much simpler structure, with the same limitations. Both the simple SD and control models are more suited to preliminary estimates of project performance.

Movement or Scouting has been a very successful youth movement in which the collaboration of its members can be observed. This motivated a previous work aiming to design MAS-Scout, a framework that defines Multi-Agent Systems based on the principles of Scouting. In this chapter, MAS-Scout is used to design a system to deal with service collaboration in a cloud computing environment focusing on the premise that Scouting has been a very successful social movement in the world and that collaboration is part of its principles. The results presented in this chapter show that MAS-Scout, which is based on the Scouting principles, can be satisfactorily used to automate cloud computing needs.

This chapter presents the design approach of an Improved Approximated Simplest Fuzzy Logic Controller (IASFLC). A cascade combination of simplest 4-rule Fuzzy Logic Controller (FLC) and an nth degree polynomial is proposed as an IASFLC to approximate the control characteristics of a 49-rule FLC. The approximation scheme is based on minimizing the sum of square errors between the control outputs of a 49-rule FLC and a simplest 4-rule FLC in the entire range of Universe Of Discourse (UOD). The coefficients of compensating polynomial are evaluated by solving instantaneous square error equations at various test points in the entire UOD. This IASFLC maps the output of a 49-rule FLC with absolute deviation of less than 5%. The proposed IASFLC is used to control the dc link voltage of a three-phase shunt Active Power Filter (APF). A detailed analysis is performed during transient and steady state conditions to check Power Quality (PQ) and dynamic performance indices under randomly varying balanced and unbalanced loading conditions. The performance of proposed IASFLC is compared with a 49-rule FLC and Approximated Simplest Fuzzy Logic Controller (ASFLC) based on minimization of the deviation at central values of Membership Functions (MFs). It is found comparatively better for harmonic and reactive compensation with a comparable dynamic response. The memory requirement and computational time of proposed IASFLC are even lesser than the ASFLC.

Chapter 1
Semantically Integrated Conceptual Modeling Method and Modeling Patterns

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ABSTRACT

Managing evolutionary changes, identification of discontinuities, and separation of concerns is not an easy task in the area conceptual modeling in information system development. One of the fundamental problems is that most conventional conceptual modeling techniques deal with the collection of loosely linked meta-models, which are defined by different types of diagrams. Typically, system development methods project interactive, behavioral, and structural aspects of information systems' conceptual representations into disparate views. Therefore, the semantic integrity of various architecture dimensions is difficult to achieve. In this chapter, the authors present a semantically integrated conceptual modeling method. The advantage of this method is stability and flexibility of the diagrams to manage the constant changes of system requirements. This method provides the possibility to visualize the interplay among structural, interactive, and behavioral aspects. This is very important for the control of semantic integrity and to maintain a holistic representation where external and internal views of service conceptualizations are visualized together. Such visualization is also important for separation of concerns, which provides foundation for creation of modeling patterns. Modeling patterns are important for several reasons. First, they can be used for demonstration of the interplay of fundamental constructs that are used for system analysis and design. Secondly, modeling patterns are important for the evaluation of the expressive power of semantic modeling languages. It is demonstrated by case studies that sequential, underlying, enclosing, overriding, and overlaying interaction loops between actors provide the foundation for the composition of complex scenarios, which span across organizational and technical system boundaries.

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INTRODUCTION

Every enterprise system can be seen as a composition of the organizational and technical components, which are viewed as various types of enterprise actors (Gustas & Gustiene, 2007). Although many requirements can be attributed to an individual component, still there are many requirements that impact many components. Such requirements cut across components and a called crosscutting concerns (Jacobson & Ng, 2005). Conventional information system (IS) analysis and design methods are restricted in their ability to distinguish among crosscutting concerns, which span across various types of diagrams. It does not matter whether designers apply structured analysis and design (SAD) methods (Gane & Sarson, 1979), (Yourdon & Constantine, 1979), object-oriented or component based methods (OMG, 2010): their expressive power is limited in separating various concerns. To break down a problem into smaller parts is called separation of concerns (Jacobson & Ng, 2005). Disability to manage separation of concerns is one of the reasons why the way systems are currently built is rather primitive and meet a lot of problems. Consequently, managing the complexity of specifications in software engineering is the problem that can be attributed to various limitations of traditional IS modeling and design methods. To obtain value from the graphical representations they must be integrated and semantically correct.

In the traditional areas of engineering, developers are able to present their design decisions by using a finalized computation-neutral representation. This is not a case in the area of system engineering. The limitations of conventional system modeling methods result in two side effects, which in aspect-oriented software development (Jacobson & Ng, 2005) are known as tangling and scattering. Tangling occurs when the software component or class, instead of fulfilling a particular concern, encapsulates a diverse set of concerns. If a particular concern is spread across multiple components, then this situation is called scattering. When the requirements caused by that concern are modified, the designer must identify all related components and to find out how these components are affected by introduced changes. Especially, modifying requirements, which are related to a big number of diagrams, become quite problematic. Poor understanding of concerns makes it difficult to make even simple evolutionary extensions of IS specifications. Separation of crosscutting concerns (Gustas & Gustiene, 2012) is the first fundamental problem, which cannot be solved without modifying modeling foundation in system analysis and design. In this paper, we introduce a new way of modeling and decomposition principles, which suggest a new and more natural way of managing complexity in system engineering. We also present four modeling patters that we constructed using this semantically integrated conceptual modeling method (SICM).

The declarative nature of value flow exchanges help technical system designers to analyze underlying business events, which are quite comprehensible for such stakeholders as business process modeling experts, enterprise architects, and users. Diagnosing value flows among different organizational components in IS engineering is important for solving the alignment problem (Wieringa, 2008), (Wieringa & Gordijn, 2005) of value models (Gordijn & Akkermans, 2000) with the behavioral effects and structural changes in various classes of objects. Value exchanges and related coordinating events can be used as the guidance for system designers to move smoothly from system analysis to design, without a requirement to represent a complete solution. By sending and receiving value flows, the actors enter into commitments regarding their privileges, rights, responsibilities and obligations. One of the reasons why the conventional system analysis and design methods are not suitable for modeling the deontic aspects of organizations (Wagner, 2003), such as commitments and claims (Chopra et al., 2010), is that they not able to capture value and coordi-