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COMPUTER SCIENCE

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A METHODOLOGY FOR THE DEVELOPMENT OF COMPONENT-ORIENTED APPLICATIONS IN A DISTRIBUTED COMPUTING ENVIRONMENT

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This dissertation presents a methodology for the development of component-oriented applications based on the proposed software architecture model—the Component Coordination Model (CCM). The basic idea of the CCM is to clearly separate the space of computation that is related to the internal behavior of software components from the space of coordination that is related to how components must interact with one another in a given application context. Furthermore, the policies imposed on the use-context are explicitly abstracted to be another separate concern. The model outlines the importance of defining programmable coordination abstraction as a specification, which defines the laws that are intended to rule the collaborating activities between participating software components.

The RUCoP methodology has been introduced to provide developers with guideline processes, including intent and optional details such as deliveries, considerations, explanation, method, and examples, that assist them to notably simplify the design and construct of distributed component-based applications. To avoid building the methodology from scratch, it has followed the approach of extending existing object-oriented methodology to support the relevant aspects of the CCM-based software architecture. The method directly reflects the role-based model that abstracts application behaviors as a computational organization comprising various role relationships. It also extends the Unified Modeling Language (UML) notations to support CCM-based software development and uses the Object Constraint Language (OCL) to formalize component related specifications. Hence, the reusability of existing experience and knowledge of the availability of developers and CASE tools are preserved.

Finally, a case study using this methodology for developing component-oriented applications in a distributed computing environment has been described in order to provide empirical evidence for the feasibility of the introduced approach by mean of an experiment. In addition, the prototype of the inventory management system was used to illustrate the modeling capabilities of the methodology with regard to a set of defined guideline processes that facilitate the CCM-based components.

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GENETIC ALGORITHMS IN FEATURE SELECTION

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In recent years, Genetic Algorithms (GAs) have grown rapidly, and are extensively used in various fields. GAs are a search method based on the paradigm of natural selection and natural genetics. With their special characteristics: a coding of parameter set, searching from a population, appropriate measure of fitness, and probabilistic transition rules, GAs can perform evolving a solution for several types of problems. Although the basic operators, crossover and mutation, work so well in the vast majority of genetic algorithm implementations, an important problem still remains in balancing exploration and exploitation in genetic search. This problem concerns to a selective pressure and population diversity. Selection pressure can have a decisive effect on the outcome of an evolutionary search. The higher the pressure, the faster the convergence but perhaps on a local optimum. Conversely, the lower the pressure, the slower the convergence but more variation of population, which provides raw materials for adaptation.

Three new computational operators for GAs are proposed. Concentrating a chance to avoid complete loss of the characters on the worst chromosomes, self-adaptive-inversion and upgrading operators are presented. In addition to altering values on population chromosomes, a translocation operator is also introduced as another way for this purpose, as well as mutation operator. Performance of any combination of the basic GAs and each proposed operator are compared with the pure basic GAs. Results on the optimization functions and real applications in feature selection problem provide valuable evidence that the proposed methods perform more robustly than the basic GAs, within a comparable execution time.

A classification system requires selection of a subset of relevant attributes or features from a large data set to represent the patterns to be classified. In applying GAs to solve a specific problem, it is important to design the appropriate fitness function to guide well in genetic search. With the proposed multi-objective fitness function using multiple correlation, the empirical results on a number of real data sets demonstrate the effectiveness of the proposed GAs. Their effectiveness involve (1) handling the data sets with large numbers of features, mixed types of attributes, and multi class data; (2) eliminating irrelevant and redundant attributes while keeping the discriminating power of the original data; and (3) improving the discriminating power after elimination.

Keywords: Genetic Algorithms, Selective Pressure, Population Diversity, Self-Adaptive-Inversion, Upgrading, Translocation, Feature Selection, Fitness Function, Multiple Correlation.

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FRAMEWORKS DEVELOPMENT BASED ON FRAMELETS

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This dissertation presents a unified process for framework development based on framelets. In addition, the definition and model of a framelet, the model of a framework based on framelets and the methods and tools to support framework development based on framelets are also the results of this dissertation.

The framelet definition proposed in this dissertation is different than previous work. The first different is this framelet is not limited by the number of classes, but functionality instead. The second different is that the number of framelet interfaces is not limited to one. On the other hand, the number of small interfaces is allowed. This dissertation presents three framework based software development architectures and selects one as the core architecture for framework development based on framelets.

For the unified process, there are three main phases: analysis, design and construction. Each phase contains models to be developed; however, the most important is the requirement model in the analysis phase. The reason is that the correct requirements will lead to quality frameworks/framelets since they will require less modification at the design and implementation levels. Therefore, this dissertation presents the methods and tools that can help to capture the framework and framelet requirements from normal application requirements. The methods used are Framelet Requirement Capturing Method and Framework Detection and Division Method. The former is used to capture framelet requirements from related use case requirements. The latter applies the former to identify frameworks from high-level use case requirements, and divide each framework into related framelets. The tool used is the Framelet Requirement Generator Program, which helps the transformation process from normal use case requirements to framework and framelet requirements. This program requires each use case to be described using eXtensible Markup Language (XML). The structure for describing a use case is called Use case Markup Language (UsecaseML). In addition, existing methods and tools have been chosen and improved for framework developers to apply for developing the desired frameworks/framelets.

To present the unified process, methods, and tools in more practical way the Material Circulation Framework are developed. This framework is based on two similar applications, library books circulation and video rental systems.

The major contributions of this research to the area of framework development are the models, methods, and tools for developing frameworks based on framelets. The models are applicable for both theory and practice. On the theory side, the formal models of a framelet, framework based on framelets, and a use case, are proposed. These models serve as the basic theory for the proposed unified development process. On the practical side, the models that need to be developed for creating the desired framework/framelets are described. New methods and tool are developed to capture framework and framelet requirements from normal application requirements. Finally, existing methods and tools are selected, with some modification, to support the proposed development process.

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BUSINESS COMPONENT-BASED WEB APPLICATION DEVELOPMENT

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Global competition among today's enterprises forces their business processes to evolve constantly, leading to changes in corresponding business information systems. Most information systems of modern enterprises are based on Web computing environment, which requires appropriate Web technologies for developing such systems. Examples of Web technologies are the browsers, search engines, related communication protocols and their implementations, mechanisms for creating dynamic and active Web sites, security mechanisms, and so on. These technologies lead to requirements for substantial changes in the methodologies for development and deployment of all systems and subsystems, which constitute any business process. Changes and/or new decisions are necessary to make possible the modern Web-based technological tools to be used effectively for Web-based business processes. Most existing approaches that extend the traditional software engineering to develop Web-based information systems are based on object-oriented methods. Such methods emphasize modeling individual object behaviors instead of system behavior. A methodology, called Business Process-Based Methodology (BPBM), for developing business software components as basic building elements of Web-based application systems including Web-based information systems, implemented and deployed in Web-based computing environment has been proposed in this dissertation. The methodology is based on the idea of creating a unified framework for representing business activities as a basis for business process modeling. The primary purpose of such modeling is for analyzing relationships between a business process and associated business objects, for identifying business activities and designing object-oriented components called business components. Respective models, methods and techniques ensure the business objects and components to apply to currently mostly accept multi-tier Web application architecture using XML document as distributed object. For illustrative purposes, the proposed methodology including methods and techniques is applied step by step to developing a part of an inventory subsystem of an industrial information system as a case study.

INFORMATION MANAGEMENT

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A SECURITY MODEL FOR AN OBJECT-ORIENTED INFORMATION SYSTEM
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The change in the programming paradigm from structure programming to object-oriented technology has migrated to several application areas. Security awareness has become a topic of interest in object-oriented systems because of the differences in programming paradigms. In an object-oriented information system, analysts should take security requirements into consideration when they start designing an object model. A component of an object model, the method, can be a crucial part that contributes much to the success of implementation of an application system with security requirements.

In this dissertation, an Object-Oriented Security Model (OOSM) is proposed with a security-oriented extension, which emphasizes the design of a security mechanism at the user interface level and the design of an object model at the application-under-development level. The objective of this dissertation is to present additional methods and techniques for object-oriented design, which recognize software security as an important aspect in the development phase and throughout the software life cycle. The expected result is to have the design guidelines developed during the analysis and design phase of the system. A university library system has been used as an illustrative example to explain how to implement OOSM in both security levels. Visual C++ is used as the programming language and prototyping tool.

The process of an access control mechanism at the user interface level started with an analysis of users' security requirements by employing the software prototype, which is designed using the principle of a multilevel menu with the necessary access control mechanism. To implement an access control mechanism, additional objects are created including the security object, the user information object, and the login information object. In the security analysis of both security levels, additional methods and techniques were used such as the role diagram, the operation structure diagram, the sensitivity level diagram, the basic access matrix, and the access-checking rule. The resulting software prototype, after discussion with the user, provides the analyst with the security requirements of an application system. The analyst considers which operation has significance from a security perspective and continues to work with a carefully designed operation (object model). The design guidelines are produced as a result of security analysis at the application-under-development level.

In the design guidelines, security functions are classified as set membership test, terminate membership test, relationship cardinality test, state change permission test, correctness of input data test, correctness of output data test, notification, control condition for synchronizing series of operations, organizational policy, audit trail, and permission test for operational invocation. Embedding security functions into normal operation requires applying pre-conditions and post-conditions to an existing operation. To make a mechanism more useful and efficient, it should be equipped with other security aspects such as authentication, network security, and distributed system security. These security aspects make the security mechanism generated from the OOSM more efficient and effective.