ROPE: A Rule-Oriented Programming Environment for Adaptive, Integrated Multiple Systems

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Growth and change; these two words are at the root of today's information system problems. The challenge is not only how to integrate "islands" of information across the enterprise, but also keep them in sync with the changing needs and technology. Presently, integration in most environments is conceived without also considering evolution. Even when change is included in design, the technology available currently is not sufficient to support evolution in distributed, heterogeneous environments. A case in point is the fact that most connections of systems are achieved by hard-coding the links among them. Even when these links are implemented using rule-based shells, these shells themselves are fixed in the sense that they cannot evolve while maintaining global synergies. This makes future growth and change extremely costly.

Our objective is to develop new capabilities enabling the enterprise to grow and change its integrated information system as its needs change. The problem is to coordinate and integrate multiple application systems by using a knowledge-based, concurrent method not requiring the use of a central controller.

The metadatabase work at Rensselaer serves as the basis of the new approach to solving the problem. The metadatabase is a repository containing the global model of the different applications of the enterprise and the metadata describing each application. The global model includes the interrelationships among the different applications' data models as well as the consolidated enterprise-level data semantics. In addition, the metadatabase also contains the contextual knowledge of data and the logic underlying the different applications and their interactions. Therefore, the metadatabase describes both the behavior (application logic) of each application and the enterprise's integrated behavior.

A concurrent architecture is called for by the metadatabase model for information integration of multiple systems. This architecture features a distributed shell system that is based on the metadatabase. The metadatabase itself provides an integrated enterprise model for the multiple information systems, their databases, and the interactions between the different systems. The shells in the concurrent architecture implement the distributed (localized) knowledge which, in turn, is managed by the metadatabase. New concurrent knowledge methods are needed to support this environment, especially concerning distributed rulebase management.

We define the Rule-Oriented Programming Environment (ROPE) as the new method implementing the above concurrent architecture. In ROPE, system integration is achieved by (1) providing the user with global query capabilities and (2) enhancing every application system with a local shell, in charge of processing the integration knowledge. Furthermore, ROPE supports adaptability by (1) abstracting the application logic that govern an application's global behavior into knowledge, (2) modeling the knowledge globally but storing and processing these rules directly in local languages, and (3) automatically updating these rules whenever the metadata is modified. ROPE includes a static and a dynamic aspect: the distributed shells empowering and masking the individual applications, and the algorithms and languages implementing and operating the shells.

We have obtained promising results over the past few years, which cover most aspects of the problem analysis and conceptual solution. The empirical verification is also underway through a prototype computer-integrated manufacturing environment using the metadatabase model. The preliminary results have demonstrated the feasibility of (1) the concurrent architecture of the metadatabase, (2) the concepts of ROPE (shell architecture, algorithms, and languages), and (3) the adaptability of the shells. thus the behavior of the local applications.

The conceptual design of ROPE is largely complete. We separated the static and dynamic elements of ROPE, defined the different modules used in a shell and their basic functionality, and established the need for the different languages used by ROPE.

This research stresses the need to consider both (one shot) development and (continual) evolution; that is, integration with adaptiveness. Therefore, the new ROPE method contributes not only to the metadatabase solutions to the problem, but also to more general concepts in the field: (1) interoperability, (2) local autonomy, (3) systems evolution, and (4) open system architecture. Immediately, the results extend the current metadatabase technology and result in a particular method effecting adaptiveness in integrating multiple system environment. In addition, the results will facilitate the general interoperability problem in application areas beyond multidatabases. Unresolved issues in software engineering such as the management of processing logic (contextual knowledge) which is currently embedded in the procedures of application programs will also be able to utilize the new principles.

Reference

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