Guest Editor's Introduction

Future Directions in Database Systems—Architectures for Information Engineering

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H as the true “information age” arrived? Earlier this decade, many people were assuring us that its “dawn” had arrived and that it would completely change our lives. The world would be knowledge-driven by accessing accurate information in a snap. The enormous repositories of information and knowledge needed to design and use tomorrow’s complicated systems would be found by “letting your fingers do the database walk.”

In anticipation of this, there has been a lot more data gathering. Even more than future information systems would be able to digest. Is data gathering sufficient to bring us out of the still gray period of dawn? The answer is no. Data gathering is useful only for “post-mortem analysis.” The complexity of today’s systems requires engineering information models capable of rapidly recognizing and reusing abstractions acquired from massive amounts of experimental data and from lengthy analyses performed on that data.

How long is dawn going to last anyway? Five years of hardware development got you the processing power of a computer center in a PC for less than $1000. After more than two decades why can’t we make knowledge systems for a reasonable price, even though data and communication, the basic ingredients of knowledge, are as inexpensive as integrated circuits and boards? A 2000-year-old quotation from Aristotle gives a hint: “The whole thing is more than the sum of its parts.” It seems that we’ve got the parts and we can sum them up, but we fall short of the whole thing. Summation or the gathering of information does not do it.

I dare to predict that the dawn will be definitely gone when we all recognize that the knowledge database is the most fundamental component of any system and that all other components are engineered in and around the management and control of information. It will be gone when the policy makers understand that a lift-off of a shuttle is not the physical movement per se, but the control of all the events preceding it, the controlled decisions that drive it, and the effects of those decisions on future states of it. The physical movement is the result of a set of controlled actions and is as important, or unimportant if you like, as the rotating movement of the wheel of a car during your search for the right exit on a highway in New York City. Only the realization of the importance of information engineering and appropriate funding will bring us into the information age.

In response to the information age vision, database system requirements have changed. The management of complex and continuously evolving factual knowledge is very different from that of the “snapshot” databases captured in commercial systems. The question is: how are we going to evolve from where we are to the database systems of the information age? What are the promising approaches? What are the right directions to pursue? In dealing with trends and predictions, one always runs a risk of missing an important approach. However, the risks of not making such predictions is
greater. It blocks imaginative concepts from being pursued. Ten years ago, when some of us were advocating AI techniques for better information processing, some considered the idea as "illusionary" and others as "prophetic." Let's hope that our visions will materialize again.

In this issue

This special issue is focusing on novel database system architectures to support information engineering. Different databases using a variety of forms and special-purpose processing have to be linked. Instead of a cumbersome monolithic architecture that encompasses many independently constructed databases and processors, flexible architectures provide a cooperative environment that is easier and more economical to evolve. Clearly, we cover only a subset of the future directions in databases. We hope, however, that other future issues will deal with the others.

In the first article, Witold Litwin and Abdelaziz Abdellatif discuss the issue of interoperability of multiple databases in a loosely coupled architecture that allows access and manipulation of the databases. The second article, by Hyunchul Kang and myself, describes a tightly coupled database system architecture that distributes the database, its accessing, and the application processing between a mainframe and a large number of workstations. It uses a set of bindings between downloaded and mainframe data objects to incrementally maintain the workstation subsets of the database.

In the third article Leo Mark and I present a multilevel architecture that allows data to be modeled and managed by meta-data.

Gio Wiederhold, in the fourth article, discusses an architecture that stores and manipulates engineering information objects.

The fifth article, by Stavros Christodoulakis and Christos Faloutsos, presents an architecture of a system that efficiently stores and accesses multimedia objects. It is my hope that the articles of this issue will help the reader understand the principles behind the techniques presented. This is important because, if nothing else, these principles have a chance of enduring the evolution of engineering.

Acknowledgments

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