ERCIM NEWS

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Dr. Bruno Codenotti, Director of the Institute for Computational Mathematics of the CNR, Italy: Computational Mathematics provides a sort of bridge between Computer Science and Mathematics

SPECIAL :

Computational Mathematics 8

CONTENTS

Next Issue:

Software Quality

EDITORIAL

In the second half of this century, Computer Science has effected a new and significant change both on science and everyday life. What is primarily astonishing is the speed at which this development has taken place. First of all a few facts:

- The computational power available today was unimaginable even just a few decades ago. We can now solve problems we could not even think about tackling before.
- The availability of powerful computational resources has opened new and exciting perspectives in mathematical modelling. It is now possible to design and perform computer simulations of complex and/or risky phenomena, for both scientific and industrial applications, at very low costs.
- Despite a widespread crisis within the high perfomance computing industry, parallel and distributed computing is changing our view of computation itself, and opening the door to new problems and new frontiers of computing.

Computational Mathematics plays a central role in all of this. The examples mentioned above are mathematically posed problems, and fall within the domain of Computational Mathematics. The subject deals with the design and analysis of efficient algorithmic methods. One of the issues in Computational Mathematics is numerical stability - investigations make it possible to evaluate the effect of the necessary approximations and of the accumulation of errors.

As distinct from pure Mathematics, Computational Mathematics has a central interest in the complexity of constructive methods. In other words, embedding mathematics in the realm of computations makes one concerned with the amount of computational resources necessary and sufficient to solve the problems. Thus, the constructive aspects must be traded off against efficiency (space and time) and reliability (accuracy) requirements. From this line of argument it becomes clear that Computational Mathematics provides a sort of bridge between Computer Science and Mathematics. Its importance is also increasingly evident nowadays because new problems arising in areas such as life science and economics have to be tackled using the tools of computational mathematics. Thus, computing science has taken on the status of an autonomous scientific field, which is crucial to the practice of many other branches of science.

In my opinion Computational Mathematics will be highly influenced by parallel computing, by advances in pure mathematics and by the development of solid theoretical foundations in application domains such as life sciences. We still have not completely understood the full potential of parallelism and we still do not know if the dream of massively parallel computation is feasible; we do not even know yet which of the competing parallel machine architectures will win out in the long term. The intersection between computational mathematics and parallel computing is so considerable that any uncertainty about the future of parallel computing becomes an uncertainty as to how and where computational mathematics will evolve. This uncertainty poses severe constraints on the exploitation of parallelism itself: How cost-effective is it to develop software tools and algorithmic methodologies for classes of machines whose destiny is uncertain? Furthermore, the diversity in architectures of the current state-of-the-art parallel machines has created a new phenomenon almost absent in the case of sequential computations: parallel algorithms become machine-dependent in the sense that their efficiency can be radically different on different machines.

Let me conclude by saying that the scientists working in this field are living in very dynamic and exiting times, and are looking forward to the coming years.

Bruno Codenotti

The South Pole Information System

by Stefania Biagioni, Carlo Carlesi, Giorgio Leone and Ovidio Salvetti

An integrated multi-disciplinary information system, known as the South Pole system, has been developed within the framework of the Italian Programme for Research in the Antarctic promoted by ENEA (National Agency for Alternative Energy). The system consists of a series of heterogeneous data banks sited in Local Centres, each one dedicated to a particular theme, geographically distributed throughout the territory. The Local Centres are connected via telematic networks (Internet, TCP/IP).

The main objective of the South Pole system is to make all the data and information concerning the Italian Antarctic expeditions available to the scientific community, through the creation of a series of specific thematic databanks.
The system thus provides:

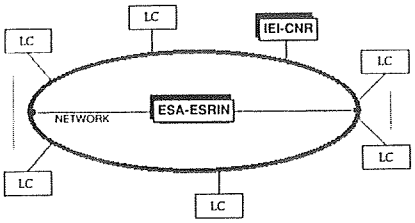

Figure 1: System Architecture

- local and remote access to all the information
- the possibility to perform comparative and interdisciplinary searches
- compatibility with international standards
- efficient organization of the data and operational flows
- homogeneous user-friendly interfaces.

The project is part of a collaboration between ENEA and CNR. IEI-CNR is responsible for implementing the interconnections and the interfaces between

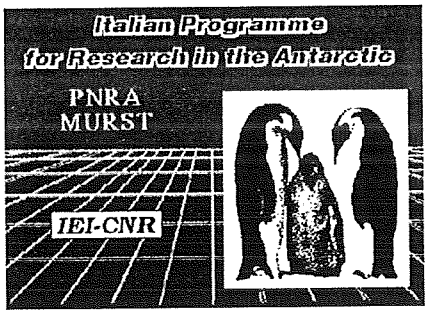

Figure 2: IEI-CNR Home Page

the Local Centres (LCs), and for supplying them with the necessary technical assistance to create and maintain their databanks.

Much of our efforts have been concentrated on creating a user-friendly environment which can simulate the entire information system so that the end-user, at any Local Centre, can access any of the other geographically distributed centres.

The overall structure of the system is shown in Figure 1.

The nucleus of the system is at the European Space Agency (ESA-ESRIN) of Frascati. ESA-ESRIN functions as a bridge between the Local Centres, allowing remote users to connect directly to any LC, utilizing their own local access modes. At the moment, IEI-CNR acts as a filter between the LCs and ESA-ESRIN, organizing and converting the data structures used by the LCs according to predefined standards.

In order to evaluate system performance, a prototype has been implemented at IEI which can simulate the entire distributed information system. This prototype has allowed us to set-up a laboratory to experiment and test possible developments of the system and applications.

In the design of the data representation schema and access modes, we have had the following objectives:

- to provide a unitary view of the system
- to guide the user querying the data by supplying the information at varying degrees of generality or on the basis of user selected topics
- to permit the experimentation of tools that construct access paths to remote systems for data retrieval.

Consultation is through access to a Meta-Database Management System which contains the descriptors for the single databases belonging to the Local Centres. These descriptors represent the information structure at two levels:

- macro-information: in which the information is classified and organised hierarchically
- micro-information: the information is represented in more detail.

This data organisation is shown in Figure 3.

In order to develop the system interfaces, we have had to analyse:

- user-system communication (access to the information system)
- system-data bank communication (access to the data banks).

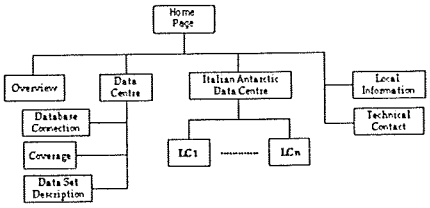

Figure 3: Data Organization

We have attempted to define a universal model which covers both internal aspects (i.e. data access and retrieval by local users) and external aspects (remote access). A client-server architecture has been adopted, giving the user guided access to the distributed data via the network on public servers, in totally transparent mode. Efficient browsing, search and retrieval mechanisms have been developed.

The system has been implemented under WWW. The IEI-CNR home page can be seen in figure 2. The thematic databases have been developed mainly under the Oracle DBMS. The importance of the contribution of IEI-CNR, Pisa, to the National Antarctic Project has led to the Area of Research of Pisa becoming the National Coordinating Centre for the International Antarctic Project.

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European Research Consortium for Informatics and Mathematics

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The European Research Consortium for Informatics and Mathematics (ERCIM) is an organisation dedicated to the advancement of European research and development, in the areas of information technology and applied mathematics. Through the definition of common scientific goals and strategies, its national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry. To further these objectives, ERCIM organises joint technical Workshops and Advanced Courses, sponsors a Fellowship Programme for talented young researchers, undertakes joint strategic projects, and publishes workshop, research and strategic reports, as well as a newsletter.

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