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PROYECTOS EN TECNOLOGÍAS DE LA INFORMACIÓN

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2. BOOK CHAPTERS

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3. GRADUATION ESSAYS

- Esqueleto paralelo Divide y Vencerás.
- Genetic Algorithms in sequential environments and local search networks. A design based on skeletons.

This work was a first proposal of a skeleton for Genetic Algorithms. This initial proposal has been changed later in order to adapt the code to the new design decisions taken after the experience obtained with this first skeleton. These design decisions were established by consensus at the coordination meeting that took place this year and they have been applied to the rest of skeletons developed.

Both, the sequential and the LAN parallel settings, were developed for this skeleton. The sequential setting just describes a generic algorithmic skeleton for Genetic Algorithms. The algorithmic base of this skeleton just consists of the well known population-based schema for Genetic Algorithms. Different implementations for the inner operators of the Genetic Algorithms method *selection, crossover, mutation, replacement* as well as different intermediate population sizes were also provided. The parallel setting was implemented using PVM. Two different parallel models were implemented: the *Split* model and the *Island* model. The parallel platform also changed later, so these implementations have to be recoded to use MPI as a communication library instead of PVM.

Three well-known problems were instantiated with the proposed skeleton: the 0-1 Maximization (this toy problem was just implemented to check the initial feasibility of the design), the Graph Bisection and the Travelling Salesman Problem.

- Estudio sobre la situación actual del comercio electrónico.
- Monitorización de un cluster WAN con MPI.

The aim of this work was to obtain more information about the working conditions of the communication platform in which the MALLBA project is taking place. More precisely, we were specially interested in testing different existing implementations of the communication library \MPI . This included the study of the local cluster, and also the WAN network conditions connecting clusters of the different sites.

A performance analysis of the load in the network is presented in this work. This analysis was done from the information obtained by the multiple experiments performed among the clusters of the project over the WAN at different moments of the day/week.

An MPI-based tool was developed inside this work. This tool allowed to collect information about the state of the underlying network and store it for its later analysis. The monitoring tool also allows to see this information in a graphical form.

Another important point of this work is the study of the fault tolerance of the existing implementations of the MPI communication library. It is important to be able to recover from any kind of fault while communicating over the network. These faults may occur because problems occurs on some machine participating in the communication or in the communication line among machines.

To know all the behaviours we can observe using the monitoring tool are very useful in the context of the MALLBA project, specially for the development of the LAN and WAN parts. The information collected helps in taking good decisions with respect to software decisions, load balancing of work in parallel computations, etc.

- Sistema integral de información CSI.
- Paralelització d'un esquelet per al mètode heurístic Simulated Annealing.
- Paralelització d'un esquelet per al mètode heurístic Tabu Search.

A sequential implementation of an skeleton for the Tabu Search method was already available before this work started. This sequential implementation was proven to be effective when implementing some well-known problems, such as the Minimum Weighted k-Cardinality Tree, the Travelling Salesman problem, the 0-1 Multidimensional Knapsack, the Resource-Constrained Project Scheduling problem, the Maximum Cut and the Maximum Satisfiability problems.

Different parallel models are presented and implemented in this graduation essay. Two of these models are classical in the area of parallel computation: the *Independent Runs* model and the *Master-Slave* model. Implementing parallel settings of a generic skeleton is doubly interesting. Genericity allows any problem to be instantiated via the skeletons, and the skeleton design itself allows to hide those features of the code related to parallelisation. This is very useful for a user because she does not have to deal with this knowledge; she just have to concentrate on the features of her problem. Users take profit of parallel computations for their problems for free.

- Una Aplicación Web para la Gestión del Servicio de Deportes de la ULL.
- The MALLBA library: from C++ and MPI to Java.

The library developed in the MALLBA project is been implemented in C++ due to efficiency reasons and compatibility with existing libraries; mainly those related to for efficient data types (LEDA) and message-passing communications (MPI). But it is known that the Java programming language is getting more and more importance every day in the programming community. Due to this, we think it is important to check the feasibility of developing the MALLBA library also in Java. Java is an interpreted language, and that represents an important drawback in computation efficiency. Our experiments show that a problem instantiated with a skeleton in Java usually runs ten times slower than the same problem instantiated with a skeleton in C++. Fortunately, if the Java code is compiled using the *Just in Time* (JIT) option, both execution times are then comparable.

Moreover, the Java programming language offers nice mechanisms to design the skeletons. On one side, the skeletons can be implemented using the Object Oriented philosophy with *abstract classes* and inheritance among them. This is a very powerful mechanism but requires the user to have some knowledge and ability on this programming technique. Java also offers the possibility of implementing the skeletons as *Interfaces*. This seems to be an easier approximation to the concept of skeleton, and it is also easier for users. A skeleton, seen as a Java interface, is just a void

template which will be fulfilled when instantiating a concrete problem. The concept of *Interfaces* does not exist in C++, so there is a double interest in checking this. More precisely, we want to check if the use of inheritance (versus the use of interfaces) introduces some overload in the later computation.

Skeletons designed in this way will also have their respective parallel versions. No additional libraries are needed to perform parallel computation with Java. The *Remote Method Invocation* (RMI) package of the language provides classes and methods to perform remote calls as if they were local calls. Sequential versions of skeletons for Metropolis and Tabu Search methods are already implemented, and some initial proposals for the parallel versions have been done recently.

A dynamic load scheduler has been also implemented in order to equilibrate the load of the distributed computations and to take the maximum profit of the available processors. Implementing the library in Java would also offer the possibility of performing remote on-line executions through a web page interface over Internet.