Editorial

Parallel Computing – Special Issue

The 8th International Symposium on Parallel and Distributed Computing (ISPDC) took place in July 2009 in Lisbon, and the 7th International Workshop on Algorithms, Models and Tools for Parallel Computing on Heterogeneous Platforms (HeteroPar) was held in August of the same year in Delft (co-located with Euro-Par). These events were focused on parallel and distributed computing, the former in a broader sense and the latter more focused on algorithms and tools for heterogeneous systems. Both events addressed topics with a strong scientific value and with a renewed practical interest, when personal computers become parallel systems, and when heterogeneity makes all computing platforms harder to program and to manage. The availability of more powerful and faster computer networks also facilitates the deployment of distributed systems.

Two excellent technical programs were setup in ISPDC’09 and HeteroPar’09, with a total acceptance rate of 35 regular papers out of 86 submissions. Most of these papers deserved to be extended and published in a leading journal, and we have invited authors to extend their accepted papers. Half of them have accepted the invitation, and after a rigorous review process, eleven papers were accepted for publication. This special issue therefore hosts these papers.

A first group of papers is devoted to scheduling, resource usage and workload distribution. In this first group, we have three papers.

The paper from Anne Benoit, Henri Casanova, Veronika Rehn-Sonigo and Yves Robert analyses the operator-mapping problem for multiple concurrent in-network stream-processing applications, optimizing the usage of resources for a given Quality of Service (QoS). In the case of multiple concurrent stream-processing applications, different operator trees corresponding to different applications may share common subtrees, so that intermediate results can be reused by different applications distributed on the servers across the network. The obtained results show the importance of mapping the operators to appropriate processors, and also sharing common sub-trees.

The paper from Lucia Drummond, Cristina Boeres and Idalmis Sardina proposes a new scheduling algorithm (MRCD) for heterogeneous parallel platforms. It is based on the well-known list paradigm, and it simultaneously optimizes two objectives, namely the classical makespan (maximum completion time) and the reliability of the application. This is achieved by an adequate weighted bi-objective function. The authors also present a method for providing useful informations for guiding the choice of the most suitable trade-offs that users could obtain in regard to their needs or wishes. This algorithm has been compared to the most popular scheduling algorithms. These experiments achieve better makespan at the price of a slight deterioration of the reliability.

The paper from Anne Benoit, Yves Robert, Arnold Rosenberg and Frédéric Vivien extends classical results from divisible load theory for master-slave platforms, in order to optimally distribute workload through computers that may differ in speed, and are subject to interruptions that may kill all the work in progress on one of them. Therefore, the proposed static work-sharing strategy considers heterogeneous computers with unrecoverable interruptions. Authors provide expressions for the optimal work expectation for different conditions, in explicit closed form or through recurrence that computes this optimal value.

A second group of papers is devoted to modeling complex systems, and configuring their operation at runtime through dynamic strategies. In this second group, we have four papers.

The paper from Luis García-Erice proposes to use machine-learning algorithms to model middleware behavior in complex systems depending on the configuration of the tasks running, thus becoming able to predict the system performance under any configuration. This paper proposes an admission control mechanism, by predicting how the execution affects the other tasks already running. The performance is evaluated to determine the suitability of the propose techniques and mechanisms for real-time or responsive systems.

The paper from Mukaram Khan, Alexander Rast, Javier Navaridas, Xi Jin, Luis Plana, Mikel. Lujan, Steve Temple, Cameron Patterson, Dominic Richards, J.V. Woods, J. Miguel-Alonso and Steve Furber presents a novel boot-up process for the event-driven configuration of the SpiNNaker, a parallel Chip Multiprocessor system for neural network simulation. SpiNNaker has a single homogeneous network interconnect for both application inter-processor communications and system control functions such as boot load and runtime-user-system interaction. Therefore, in this paper a novel two-stage “unfolding” bootup process effi-
ciently configures the SpiNNaker hardware and loads the application using a high-speed flood-fill technique with support for runtime reconfiguration.

The paper from Anne Benoit, Alexandru Dobrila, Jean-Marc Nicod and Laurent Philippe deals with specialized processors. It aims at optimizing the throughput of coarse-grain workflow applications, where each task of the workflow is of a given type, and subject to failures. The goal is to map such an application onto a heterogeneous platform, where each processor may be specialized to process one type of tasks. The objective function is to maximize the throughput of the system. First, the complexity of several mapping strategies is assessed. Then several polynomial-time heuristics are presented for the most realistic specialized setting, in which tasks of the same type can be mapped onto the same processor, but a processor cannot process two tasks of different types. Experimental results show that the best heuristics obtain a good throughput, and this is confirmed on smaller problem instances by comparison to the optimal solution, obtained via an integer linear program formulation.

The paper from Jorge G. Barbosa and Belmiro R. Moreira addresses the problem of minimizing the execution time for a batch of jobs with different arrival times. A job is described by a direct acyclic graph of parallel tasks. The authors propose a dynamic scheduling method that adapts the schedule when new jobs are submitted and that may change the processors assigned to a job during its execution. They also introduce an adaptation of the Heterogeneous Earliest-Finish-Time (HEFT) algorithm, to handle parallel tasks in heterogeneous clusters with good efficiency and without compromising the makespan. Their results show significant improvements for heavily loaded machines when compared to classical resource reservation approaches.

The last group of papers is devoted to parallel algorithms for different architectures and applications. In this third group, we have four papers.

The paper from Peter Benner, Pablo Ezzatti, Daniel Kressner, Enrique Quintana-Ortí and Alfredo Remón addresses the important problem of running numerical algorithms on a multi-core parallel system composed of CPU associated to GPU. Such computing platforms have been shown to have a great potential for accelerating actual applications. However, obtaining efficient implementations is not an easy task, especially for non regular routines. The focus here is on hybrid Lyapunov solvers. Such matrix equations play a crucial role in several applications in control theory and other fields. An in depth analysis is proposed and experimental results based on real-world data are developed on a system equipped with two Intel Xeon Quad-Core processors and an Nvidia Tesla C1060 GPU. They evidence that such hybrid platforms are promising to solve numerical problems like Lyapunov equations.

The paper from Chenqi Wang, Neil Cafferkey, James Kennedy and John Morrison emphasizes the interest of using parallel computing platforms for 3 dimensional reconstruction. There exist several implementations based on classical approaches. However, they are insufficient for capturing in depth the inner structures of some complex structures like icosahedral virus. The biologists have to set manually many parameters and locate data issued from different packages. This work proposes a workflow implemented on a platform based on the metacomputer condensed graph model (called Webcom). It allows a reconstruction with a structure that reflects an abstract description of the workflow. It also creates an environment that integrates all possible packages and facilitates the reuse of various components. This is illustrated for the construction of a workflow for the alternative Unbiased Model reconstruction method. Finally, it demonstrates that using a separate machine for the coordination of such workflows reduces the execution times.

The paper from Mathieu Giraud and Jean-Stéphane Varré deals with Position Weight Matrices (PWMs), which are broadly used in computational biology. The basic problem aims at finding the occurrences of a given PWM in large sequences. Some other PWM tasks share a common NP-hard subproblem, namely computing the distribution of affinity scores. Existing algorithms rely on the enumeration on a large set of scores or words, and they are mostly not suitable for parallelization. The authors propose a new algorithm that is both very efficient and suitable for parallelization, and they have realized a GPU prototype, for which they report important speedups.

Finally, the paper from Anna Beletska, Włodzimierz Bielecki, Albert Cohen, Marek Pałkowski and Krzysztof Siedlecki targets automatic coarse-grained parallelization techniques for program loops. The authors present the theory of Iteration Space Slicing (ISS) aimed at extracting synchronization-free parallelism available in arbitrarily nested program loops. They demonstrate that ISS algorithms permit to extract more coarse-grained parallelism than affine transformations, provided that one is able to calculate the transitive closure of the union of relations describing all dependencies in the affine loop. Experimental results show that ISS algorithms succeed in extracting coarse-grained parallelism for many loops of NAS and UTDSP benchmarks.

We hope that readers will find inspiration for future research in the collection of papers from this special issue. We would like to thank the Parallel Computing journal for the opportunity to edit this special issue, the referees and the staff of Elsevier for their hard work, which helped in producing a high quality volume.

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