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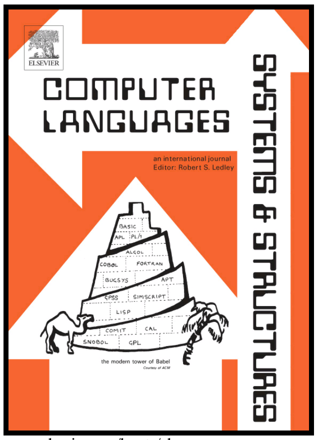

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Mapping stream programs onto multicore platforms by local search and genetic algorithm

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Abstract

This paper presents a number of novel metaheuristic approaches that can efficiently map stream graphs on multicores. A stream graph consists of a set of actors performing different functions communicating through edges. Orchestrating stream graphs on multicores can be formulated as an Integer Linear Programming (ILP) problem but ILP solver takes exponential time to provide an optimal solution. We propose metaheuristic algorithms to achieve near optimal solutions within a reasonable amount of time. We employ six different variants of the Hill-Climbing (HC) algorithm employing different tweak operators that produce excellent result extremely quickly. We also propose six different variants of Genetic Algorithm (GA) to examine how effective these variants can be in escaping the local optima. We finally combine HC and GA techniques (which is also known as *'memetic algorithm'*) to produce hybrid techniques that outperform the individual performance of HC and GA techniques. We compare our results with the results generated by the CPLEX optimization tool. Our best technique has achieved a geometric mean speedup of 7.42x across a range of StreamIt benchmarks on an eight-core processor.

Keywords: Stream Programming, Metaheuristics, Local Search Operator, Compiler Optimization, Parallel Programming, Genetic Algorithm, Hybrid Genetic Algorithm.

1. Introduction

Multicore processor architectures have now become the industry standard. All major processor manufacturers produce multicore platforms. At the end of 2012 Intel announced many integrated core architecture, the brand name of the processor product family Intel Xeon Phi [26]. IBM and Cisco have also advanced to this inevitable direction of multicore technologies like Cell processor with nine cores [24], the Sun Niagara with eight cores [31], the IBM-Microsoft Xbox 360 CPU with three cores, and the next generation network processor with CISCO-192 Tensilica Xtensa cores [2].

General-purpose languages that are based on an underlying von Neumann computing model [4] are poorly suited for the emerging class of parallel architectures. There are multiple program counters and distributed memory banks in these parallel platforms. Stream programming has been successfully applied in parallel systems [55, 59, 17]. It is well suited for the application domains characterized by regular sequences

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