A Sequential and Parallel Interval-Based Constraint Language: Analyses and Implementations

A Dissertation

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by

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ABSTRACT

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A dissertation presented to the Faculty of the Graduate School of Arts and Sciences of Brandeis University, Waltham, Massachusetts

by Suresh Kalathur

Abstract

This thesis presents the design and implementation of a non-deterministic constraint programming language. The proposed language combines the features of logic programming and imperative programming paradigms. It is posited that the desirable features required in such a language are: *assignment*, *non-determinism*, *constraints*, and *intervals*. The significant number of problems described in this dissertation and that have been solved using the language reinforce that proposition. *Non-determinism* enables the succint description of multiple choices thus facilitating space searches. *Constraints* summarize the equations and relations that have to be satisfied to obtain an answer for the problem being considered. Finally, *intervals* enable the *en masse* processing of a range of values instead of a single value.

The main original contributions of this work can be summarized as follows: 1) design and development of a concise but general programming language based on non-determinism, constraints and intervals. That design includes a GUI that is available for download through the Web; 2) presentation of a varied corpus of examples that are representative of the breadth of problems that may be solved using the proposed language; 3) in-depth study of data parallelism and shared memory parallelism in the language implementation. This has been carried out using actual parallel computers; 4) estimates through actual benchmarks of the attainable speed-ups in both kinds of parallelisms. In addition, formal models of speed-up analyses were investigated using

context-free grammars for shared memory implementation, and Markovian models for data parallel implementation; and 5) demonstration of the feasibility of developing useful preprocessors that transform annotated specialized programs into programs in the proposed language. They include CSP, partial evaluation, and scheduling problems.

The ultimate test of a language is its acceptance by a larger number of practitioners. This dissertation provides the ground work for making that acceptance a reality. It is hoped that the simplicity and broad scope of the language will attract followers interested in solving combinatorial problems involving interval constraints.