Parallel algorithms for solving computationally hard problems regarding formal languages

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Parallel algorithms using the proposed methods for pruning the solution space size, significantly reduce the time to find the decomposition of finite language or to induce the minimal, nondeterministic finite automaton consistent with the given sample.

To prove the above thesis, an adaptive parallel algorithm for finding the decomposition of finite language is devised. The algorithm employs original solution space pruning methods as well as an adaptive method of changing algorithm parameters based on the run time acquired information. The processes executing the algorithm work according to the master-workers scheme of cooperation. However, the amount of communication is minimized. The processes communicate only at the initial stage of input data distribution and at the final stage of results collection. The algorithm is capable of finding the decompositions of languages composed of tens of thousands of words. Decompositions of languages of such size have not been reported in the literature so far.

Two parallel algorithms using original variable ordering methods are developed to solve the problem of the induction of minimal, nondeterministic finite automata. A reduced variable and constraint set is proposed transforming the problem to a constraint satisfaction problem. The processes running the algorithms work asynchronously by investigating independent instances of the constraint satisfaction problem. The communication between processes is restricted to accessing a shared variable signaling the end of the computation. Both algorithms finish their operation upon finding the first minimal, nondeterministic automaton consistent with the given sample.

Comprehensive experiments performed on the sets of over 1400 finite languages and almost 900 samples confirm the thesis stated above. Statistical analysis of the experimental results has shown that the adaptive parallel decomposition algorithm is significantly faster than the basic parallel algorithm that uses neither the solution space pruning methods nor the adaptive method of changing algorithm parameters. Moreover, statistical tests have also shown that the proposed induction algorithms outperform the algorithms based on the state-of-the-art variable ordering methods.