Improving the Runtime Efficiency and Solution Quality of Independent Task Assignment Heuristics

E. Kartal Tabak[a], B. Barla Cambazoglu[b], Cevdet Aykanat[c]

[a] *HAVELSAN A.S., Ankara, Turkey*
[b] *Yahoo! Labs, Barcelona, Spain*
[c] *Department of Computer Engineering, Bilkent University, Ankara 06800, Turkey*

We focus on the independent task assignment problem which is defined as assigning N independent tasks to K heterogeneous processors. In this problem, given an Expected-Time-to-Compute matrix that identifies the expected execution times of each independent task on each processor, the objective is to generate a task-to-processor assignment that achieves a minimum makespan. This problem is known to be NP-complete and MinMin, MaxMin, and Sufferage are successful heuristics that are widely used in the literature to solve this problem [1, 2, 3, 4]. All of these heuristics are constructive in nature and they all run in $O(KN^2)$ time. In [5], we propose a $O(KN \log N)$-time MinMin algorithm that achieves the same solution quality as the conventional MinMin algorithm. The proposed algorithm achieves this asymptotic improvement through utilizing a processor-oriented approach instead of the task-oriented approach of the original MinMin algorithm. In [5], we also propose to improve the performance of MaxMin and Sufferage heuristics, by combining the proposed asymptotically faster MinMin heuristics with these two heuristics. The proposed MaxMin heuristic improves the runtime performance of the conventional MaxMin and also improves the solution quality by adaptive use of MinMin and MaxMin assignment decisions during the assignment iterations. We propose a similar improvement on Sufferage heuristic that leads to an improvement on the runtime without disturbing the solution quality. The proposed algorithm achieves critical assignment decisions by conventional Sufferage in order not to disturb the solution quality and achieve non-critical assignment decisions by the fast MinMin algorithm. For the assignment of the 2.5 million tasks of a real-world dataset to 16 heterogeneous processors, the conventional MinMin algorithm generates a solution in three weeks, whereas the proposed MinMin heuristic generates the same assignment in less than a minute. Experimental results on these real-world datasets also show that the proposed MaxMin and Sufferage heuristics run considerably faster than the original heuristics. On the average, the proposed MaxMin heuristic is found to generate considerably better solutions than the original MaxMin, whereas the proposed Sufferage heuristic is found to generate slightly better solutions than the original Sufferage heuristic.

References

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