

Improved Implicit-Deadline Elastic Scheduling Supplement: Utilization Dependence

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1 Introduction

This supplemental technical report accompanies the paper, “Improved Implicit-Deadline Elastic Scheduling,” which will appear at the IEEE International Symposium on Industrial Embedded Systems (SIES) in October, 2024. In that paper, we evaluate the execution times of Buttazzo’s algorithm for elastic scheduling [1, 2], as presented in [3, Figure 9.29], to our improved algorithm in [4, Algorithm 1]. Conclusions were drawn from the observation that execution times do not depend on the total minimum or maximum utilizations, nor the difference between them, of the tested sets of tasks. Plots attesting to this observation were omitted for length, and are instead included here.

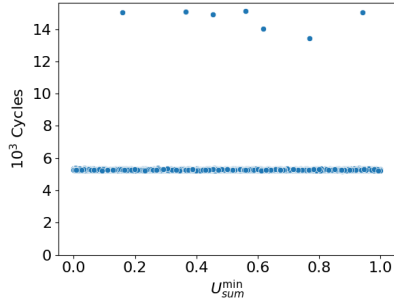
2 Results

For the 10 000 sets of 50 tasks generated according to the procedure in the submitted paper, we produce 3 scatter plots for the initialization (“Init”) and compression (“Compress”) times of each implementation: these plot elapsed CPU cycles against the values U_{SUM}^{\min} , U_{SUM}^{\max} , and the absolute distance between them, $(U_{\text{SUM}}^{\max} - U_{\text{SUM}}^{\min})$. These are shown in the figures on the next two pages. We do not observe a significant dependence of execution time on the minimum and maximum utilization of the task set.

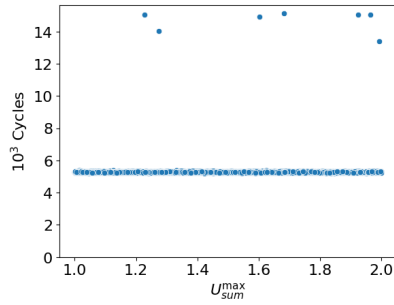
As such, for all evaluation of these algorithms in our submitted manuscript, we consider data in aggregate, rather than grouping by utilization values. Furthermore, this allows us to conclude in Section III.B of our paper, that the conclusions drawn from the presented performance results extend to fluid scheduling.

References

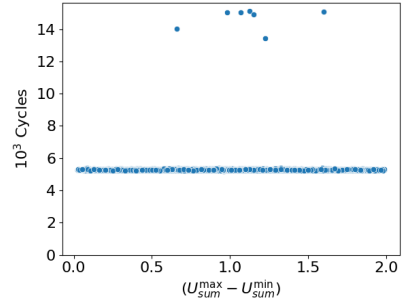
- [1] G. C. Buttazzo, G. Lipari, and L. Abeni, “Elastic Task Model for Adaptive Rate Control,” in *IEEE Real-Time Systems Symposium*, 1998.
- [2] G. C. Buttazzo, G. Lipari, M. Caccamo, and L. Abeni, “Elastic Scheduling for Flexible Workload Management,” *IEEE Transactions on Computers*, vol. 51, no. 3, pp. 289–302, Mar. 2002. [Online]. Available: <http://dx.doi.org/10.1109/12.990127>
- [3] G. C. Buttazzo, *Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications*, 3rd ed. New York: Springer US, 2011, ch. Handling Overload Conditions, pp. 287–347.
- [4] M. Sudvarg, C. Gill, and S. Baruah, “Linear-time admission control for elastic scheduling,” *Real-Time Systems*, vol. 57, no. 4, pp. 485–490, 10 2021. [Online]. Available: <https://doi.org/10.1007/s11241-021-09373-4>



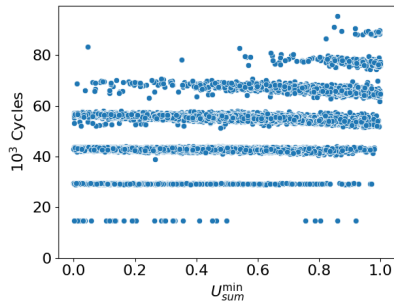
(a) Buttazzo Init.



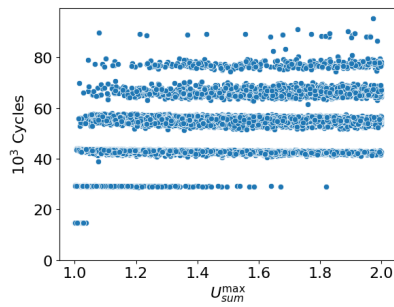
(b) Buttazzo Init.



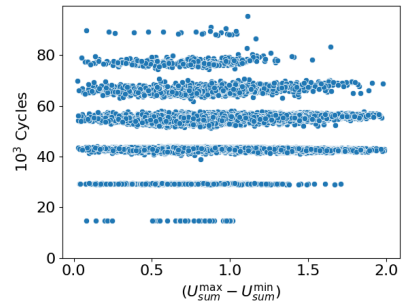
(c) Buttazzo Init.



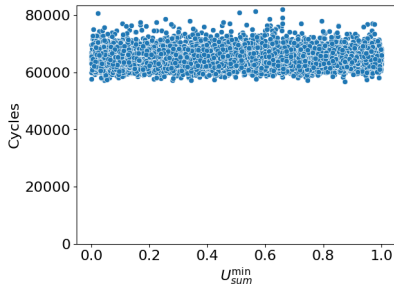
(d) Buttazzo Compress.



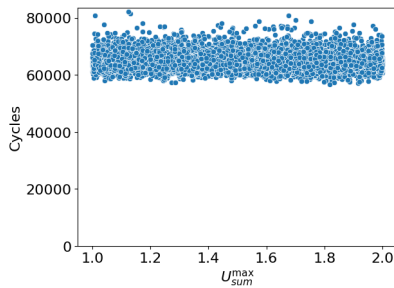
(e) Buttazzo Compress.



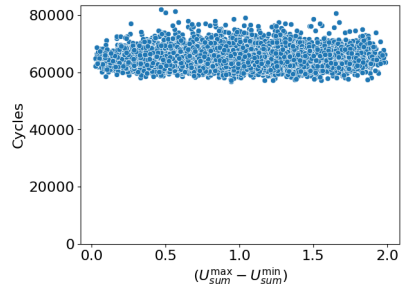
(f) Buttazzo Compress.



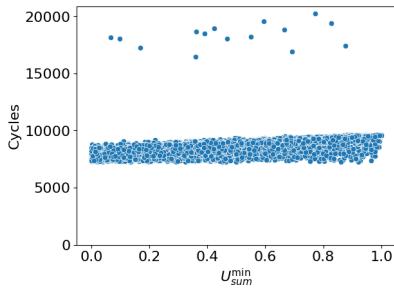
(g) Improved Init: Array.



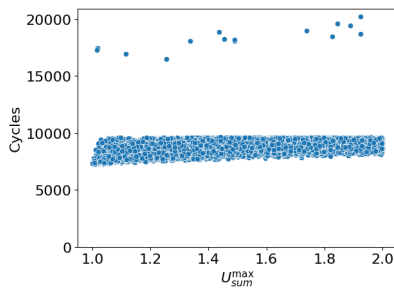
(h) Improved Init: Array.



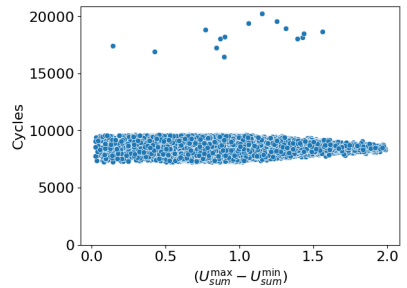
(i) Improved Init: Array.



(j) Improved Compress: Array.



(k) Improved Compress: Array.



(l) Improved Compress: Array.

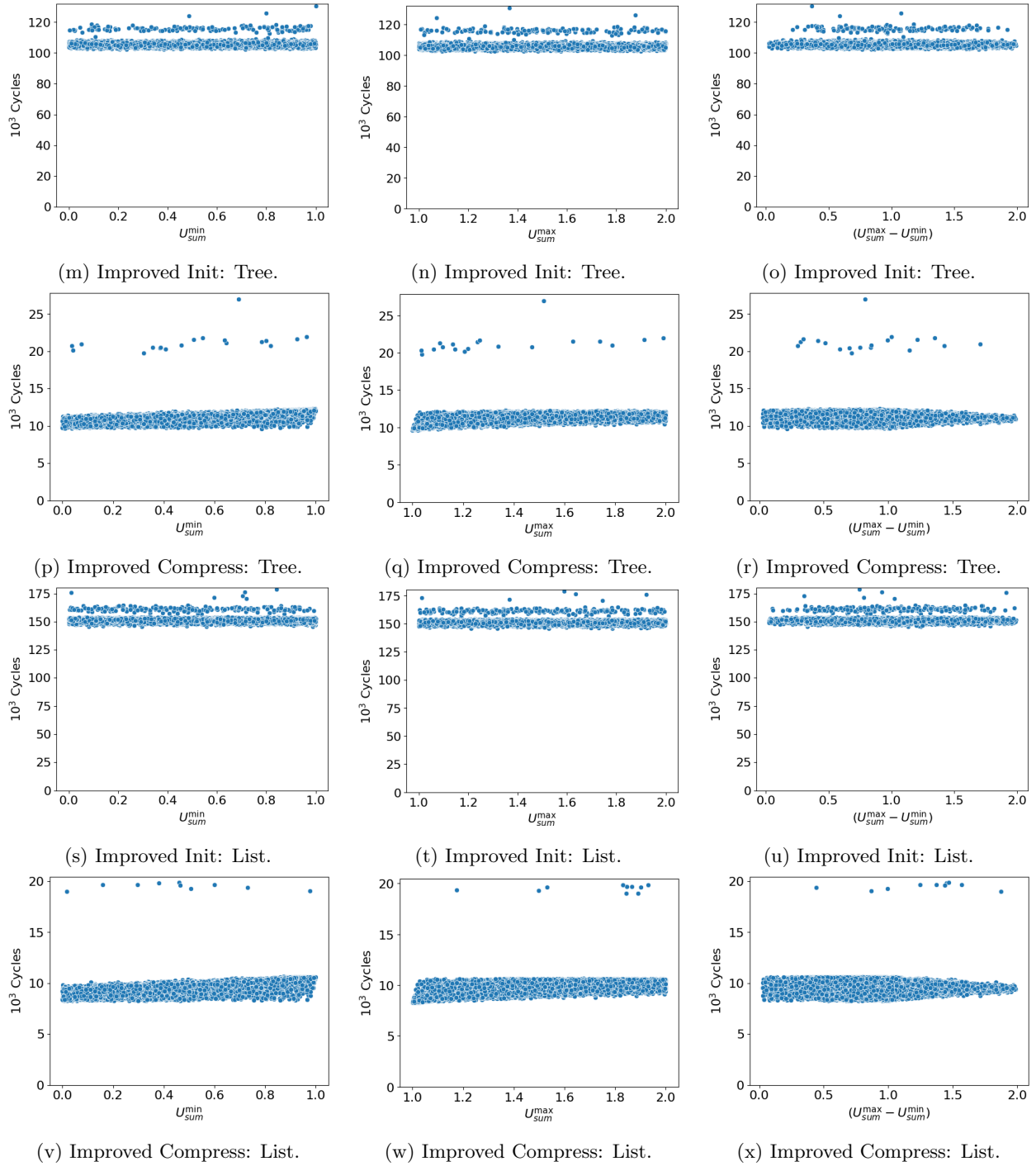


Figure 1: Execution times by utilization metrics for 50 tasks.