Handling Inaccurate Runtime Estimates by Event-based Optimization

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In this work we present an event-based optimization procedure designed to improve the performance of Conservative backfilling [1] under inaccurate runtime estimates. Conservative backfilling (CONS) is a modification of the well known EASY backfilling (EASY) algorithm [1]. While EASY makes reservation for the first job only, CONS makes reservation for every job—creating a "plan of execution"—to avoid "overtaking" and large waiting times of jobs in the queue. However, EASY is more popular than CONS [2,3] because it usually outperforms CONS when the runtime estimates are not accurate [1,2].

Our solution is based on the use of CONS which we have extended with a fast optimization procedure. It is launched every time some job finishes earlier than expected. When the runtime estimates are inaccurate, this is a common situation, since the estimates are typically higher than the actual runtime. Upon each such event, a "gap" appears in the reservation plan. Our optimization procedure tries to fill such gaps with suitable jobs, modifying the reservation plan. Jobs are selected randomly (Random Search (RS)) and are moved into a suitable gap—if such gap exists. Each move is evaluated, measuring the expected impact on the average slowdown and the average wait time. The optimization procedure finishes after the fixed number of iterations or the predefined time limit (50ms) is reached. The time limit is necessary to guarantee that the optimization will not significantly delay the job execution.

The proposed optimization procedure of CONS (CONS+RS) has been evaluated in a simulation against EASY and CONS using six workload traces: Meta09, Meta08, HPC2N, LLNL Thunder, LLNL Atlas and SDSC DataStar. Meta09 [4] and Meta08 are two workloads collected in the Czech national Grid infrastructure MetaCentrum while all remaining workloads come from the Parallel Workloads Archive [5]. The avg. slowdown and the avg. wait time has been used as the metric. The following table summarizes the experiments for the avg. wait time. The second row (CONS+RS) shows the avg. wait time achieved when RS is applied to optimize reservations plan produced by CONS, while the third and the fourth row shows the additional waiting time when EASY or CONS are applied (no optimization).

	Meta09	**Meta08**	**HPC2N**	**LLNL Thunder**	**LLNL Atlas**	**SDSC DataStar**
CONS+RS	95 min	209 min	122 min	31 min	4 min	43 min
CONS	+28 min	+74 min	+143 min	+104 min	+279 min	+87 min
EASY	+27 min	+44 min	+153 min	+88 min	+43 min	+44 min

Experiments showed that CONS+RS outperformed both CONS and EASY in all data sets. With one exception (HPC2N), EASY has always outperformed CONS. It is worth noticing the difference between CONS+RS and the original CONS or EASY algorithm. Similar results were achieved for the avg. slowdown metric. As observed, the proposed optimization routine can significantly decrease the undesirable influence of inaccurate runtime estimates.

Conservative backfilling is nowadays less popular than EASY, since it usually degrades when inaccurate estimates are used. Our optimization procedure aims to handle the influence of inaccurate runtime estimates by reacting on the early job completions using a gap-filling approach combined with a move evaluation. It demonstrates significant improvement over CONS as well as EASY.

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