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Outperforming LRU via Competitive Analysis on Parametrized Inputs for Paging

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Abstract:

Competitive analysis was often criticized because of its too pessimistic guarantees which do not reflect the behavior of paging algorithms in practice. For instance, many deterministic paging algorithms achieve the optimal competitive ratio of k , yet LRU and its variants clearly outperform the rest in practice. In this paper we aim to reuse and refine insights from the competitive analysis to obtain new algorithms that cause few cache misses in practice. We propose a new measure of the "evilness" of the adversary, which results in a parametrization of the input that we denote attack rate. This measure is based on a characterization by Koutsoupias and Papadimitriou of the optimal offline algorithm and uses the fact that a number of pages are for sure in its memory. We show that the attack rate r is a tight bound on the competitive ratio of deterministic paging algorithms and give experimental results which show that r is usually much smaller than the cache size k and thus provides more realistic upper bounds for the competitive ratio of existing algorithms. Furthermore, we show that our input parametrization compares favorably concerning the fault rate with approaches based on locality of reference. We use a priority-based framework, which always yields r -competitive algorithms regardless of the priority assignment. In this framework, LRU can be obtained under a certain priority assignment and is thus only one algorithm among many other r -competitive ones. Using the enhanced flexibility given by this framework, we give a priority policy which leads to an algorithm outperforming LRU, RLRU and other practical algorithms on a wide selection of real-world cache traces.

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