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Cutting bamboo down to size. (English) [Zbl 07482354]


Summary: This paper studies the problem of programming a robotic panda gardener to keep a bamboo garden from obstructing the view of the lake by your house. The garden consists of $n$ bamboo stalks with known daily growth rates and the gardener can cut at most one bamboo per day. As a computer scientist, you found out that this problem has already been formalized in [Gasieniec et al., SOFSEM’17] as the Bamboo Garden Trimming (BGT) problem, where the goal is that of computing a perpetual schedule (i.e., the sequence of bamboos to cut) for the robotic gardener to follow in order to minimize the makespan, i.e., the maximum height ever reached by a bamboo.

Two natural strategies are REDUCE-MAX and REDUCE-FASTEST ($x$). REDUCE-MAX trims the tallest bamboo of the day, while REDUCE-FASTEST ($x$) trims the fastest growing bamboo among the ones that are taller than $x$. It is known that and ($x$) achieve a makespan of $O(\log n)$ and 4 for the best choice of $x = 2$, respectively. We prove the first constant upper bound of 9 for REDUCE-FASTEST and improve the one for REDUCE-FASTEST ($x$) to $\frac{3 + \sqrt{45}}{2} < 2.62$ for $x = 1 + \frac{1}{\sqrt{5}}$.

Another critical aspect stems from the fact that your robotic gardener has a limited amount of processing power and memory. It is then important for the algorithm to be able to quickly determine the next bamboo to cut while requiring at most linear space. We formalize this aspect as the problemdesigning a Trimming Oracle data structure, and we provide three efficient Trimming Oracles implementing different perpetual schedules, including those produced by REDUCE-MAX and REDUCE-FASTEST ($x$).

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bamboo garden trimming;trimming oracles;approximation algorithms;pinwheel scheduling

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References:


