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Faster Matroid Partition Algorithms

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Abstract: In the matroid partitioning problem, we are given k matroids $\mathcal{M}_1 = (V, \mathcal{I}_1), \dots, \mathcal{M}_k = (V, \mathcal{I}_k)$ defined over a common ground set V of n elements, and we need to find a partitionable set $S \subseteq V$ of largest possible cardinality, denoted by p. Here, a set $S \subseteq V$ is called partitionable if there exists a partition $(S_1, \dots, S_k)$ of S with $S_i \in \mathcal{I}_i$ for $i = 1, \dots, k$. In 1986, Cunningham presented a matroid partition algorithm that uses $O(np^{3/2} + kn)$ independence oracle queries, which was the previously known best algorithm. This query complexity is $O(n^{5/2})$ when $k \leq n$.

Our main result is to present a matroid partition algorithm that uses $\tilde{O}(k^{1/3}np + kn)$ independence oracle queries, which is $\tilde{O}(n^{7/3})$ when $k \leq n$. This improves upon previous Cunningham's algorithm. To obtain this, we present a new approach \emph{edge recycling augmentation}, which can be attained through new ideas: an efficient utilization of the binary search technique by Nguyen and Chakrabarty-Lee-Sidford-Singla-Wong and a careful analysis of the number of independence oracle queries. Our analysis differs significantly from the one for matroid intersection algorithms, because of the parameter k. We also present a matroid partition algorithm that uses $\tilde{O}((n+k)\sqrt{p})$ rank oracle queries.

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