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Reconfiguration of Basis Pairs in Regular Matroids

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In recent years, combinatorial reconfiguration problems have attracted great attention due to their connection to various topics such as optimization, counting, enumeration, or sampling. One of the most intriguing open questions concerns the exchange distance of two matroid basis sequences, a problem that appears in several areas of computer science and mathematics. White (1980) proposed a conjecture for the characterization of two basis sequences being reachable from each other by symmetric exchanges, which received a significant interest also in algebra due to its connection to toric ideals and Gröbner bases. In this work, we verify White's conjecture for basis sequences of length two in regular matroids, a problem that was formulated as a separate question by Farber, Richter, and Shank (1985) and Andres, Hochstättler, and Merkel (2014). Most of previous work on White's conjecture has not considered the question from an algorithmic perspective. We study the problem from an optimization point of view: our proof implies a polynomial algorithm for determining a sequence of symmetric exchanges that transforms a basis pair into another, thus providing the first polynomial upper bound on the exchange distance of basis pairs in regular matroids. As a byproduct, we verify a conjecture of Gabow (1976) on the serial symmetric exchange property of matroids for the regular case.

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