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Patterns in Random Permutations

Abstract:

Every $k$ entries in a permutation can have one of $k!$ different relative orders, called patterns. How many times does each pattern occur in a large random permutation of size $n$? The distribution of this $k!$-dimensional vector of pattern densities was studied by Janson, Nakamura, and Zeilberger (2015). Their analysis showed that some component of this vector is asymptotically multinormal of order $1/\sqrt{n}$, while the orthogonal component is smaller. Using representations of the symmetric group, and the theory of U-statistics, we refine the analysis of this distribution. We show that it decomposes into $k$ asymptotically uncorrelated components of different orders in $n$, that correspond to representations of $S_k$. Some combinations of pattern densities that arise in this decomposition have interpretations as practical nonparametric statistical tests.