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Dirichlet law for factorization of integers, polynomials and permutations

Let $k \geq 2$ be an integer. We prove that factorization of integers into k parts follows the Dirichlet distribution $\text{Dir}(\frac{1}{k}, \dots, \frac{1}{k})$ by multidimensional contour integration, thereby generalizing the Deshouillers-Dress-Tenenbaum (DDT) arcsine law on divisors where $k = 2$. The same holds for the factorization of polynomials or permutations. Dirichlet distribution with arbitrary parameters can be modelled similarly. If time permits, we will also explore the evolution from the Dirichlet distribution to the multivariate normal distribution by restricting to smooth numbers.