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Padé approximants and exact two-locus sampling distributions

Paul A. Jenkins, Yun S. Song

For population genetics models with recombination, obtaining an exact, analytic sampling distribution has remained a challenging open problem for several decades. Recently, a new perspective based on asymptotic series has been introduced to make progress on this problem. Specifically, closed-form expressions have been derived for the first few terms in an asymptotic expansion of the two-locus sampling distribution when the recombination rate ρ is moderate to large. In this paper, a new computational technique is developed for finding the asymptotic expansion to an arbitrary order. Computation in this new approach can be automated easily. Furthermore, it is proved here that only a finite number of terms in the asymptotic expansion is needed to recover (via the method of Pad\'{e} approximants) the exact two-locus sampling distribution as an analytic function of ρ; this function is exact for all values of $\rho\in[0,\infty)$. It is also shown that the new computational framework presented here is flexible enough to incorporate natural selection.

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