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Gaussian Process-based calculation of look-elsewhere trials factor

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In high-energy physics it is a recurring challenge to efficiently and precisely (enough) calculate the global significance of, e.g., a potential new resonance. We propose a new method that models the significance in the search region as a Gaussian Process (GP). The kernel of the GP is approximated with a covariance matrix and is calculated with a carefully designed set of background-only data sets, comparable in number to the random background-only data sets used in a typical analysis that relies on the average upcrossings of the significance. The trials factor for both low and moderate significances can subsequently be calculated to the desired precision with a computationally inexpensive random sampling of the GP. In addition, once the covariance of the GP is determined, the average number of upcrossings can be computed analytically. In our work we give some highlights of the analytic calculation and also discuss some peculiarities of the trials factor estimation on a finite grid. We illustrate the method with studies of three complementary statistical models.

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