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Anti-Concentration and Honest Adaptive Confidence Bands

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Modern construction of uniform confidence bands for nonparametric densities (and other functions) often relies on the Smirnov-Bickel-Rosenblatt (SBR) condition; see e.g. Gine and Nickl (2010). This condition requires existence of a limit distribution of an extreme value type for a supremum of a studentized empirical process (equivalently, for a supremum of a Gaussian process with an equivalent covariance kernel). The principal contribution of this paper is to remove the need for SBR condition. We show that a weaker sufficient condition is the anticoncentration inequality for the supremum of the approximating Gaussian process, and we derive such an inequality under weak assumptions. Our new result shows that the supremum does not concentrate too fast around its expected value. We then apply this result to derive a Gaussian bootstrap procedure for constructing honest and adaptive confidence bands for nonparametric density estimators, completely avoiding the need for SBR condition. An essential advantage of our approach is that it applies even in those cases where the limit distribution does not exist (or is unknown). Furthermore, our approach provides an approximation to the exact finite sample distribution with an error that converges to zero at a fast, polynomial speed (with respect to the sample size). In sharp contrast, the Smirnov-Bickel-Rosenblatt approach provides an approximation with an error that converges to zero at a slow, logarithmic speed.

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