Adaptation in multivariate log-concave density estimation

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Abstract: We study the adaptation properties of the multivariate log-concave maximum likelihood estimator over two subclasses of log-concave densities. The first consists of densities with polyhedral support whose logarithms are piecewise affine. The complexity of such densities f can be measured in terms of the sum of the numbers of facets of the subdomains in the polyhedral subdivision of the support induced by f. Given n independent observations from a d-dimensional log-concave density with d=2 and d=3, we prove a sharp oracle inequality, which in particular implies that the Kullback-Leibler risk of the log-concave maximum likelihood estimator for such densities is bounded above by □(f)=n, up to a polylogarithmic factor. Thus, the rate can be essentially parametric, even in this multivariate setting. The second type of subclass consists of densities whose contours are well-separated; these new classes are constructed to be affine invariant and turn out to contain a wide variety of densities, including those that satisfy Holder regularity conditions. Here, we prove another sharp oracle inequality.