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Core-Sets for Polytope Distance

Following recent work of Clarkson, we translate the core-set framework to the problems of finding the point closest to the origin inside a polytope, finding the shortest distance between two polytopes, Perceptrons, and soft- as well as hard-margin Support Vector Machines (SVM).

We prove asymptotically matching upper and lower bounds on the size of core-sets, stating that ε-core-sets of size $\lceil (1 + o(1)) \, E^* / \varepsilon \rceil$ do always exist, and that this is best possible. The crucial quantity E^* is what we call the excentricity of a polytope, or a pair of polytopes.

Additionally, we prove linear convergence speed of Gilbert's algorithm, one of the earliest known approximation algorithms for polytope distance, and generalize both the algorithm and the proof to the two polytope case.

Interestingly, our coreset bounds also imply that we can for the first time prove matching upper and lower bounds for the sparsity of Perceptron and SVM solutions.