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Title: Making large problems seem small: Convex duality in learning and inference

Abstract:

Machine learning algorithms are often used to extract rules and structure from large datasets, and have been successfully used in fields such as machine vision, natural language processing and computational biology. With the growing availability of text and images on the web, and high-throughput experiments in biology, learning algorithms are becoming a key tool for organizing, searching, and interpreting this data.

Learning algorithms are typically required to work with very large datasets of high dimensional signals. Thus scalability of algorithms is a key issue that must be addressed. In this talk I will show how the concept of convex duality can be used to design simple and scalable algorithms, and to help understand convergence of previously existing ones.

I will first address the problem of probabilistic inference in multivariate distributions, and show how convex duality results in simple convergent message passing algorithms for this problem. Specifically, I will show that approximate inference may be cast as a geometric program, where coordinate descent yields message passing updates. These results resolve a long standing problem regarding the convergence of message passing algorithms for approximate inference.

I will next address the problem of learning classifiers from labeled data, and present an exponentiated gradient algorithm that is also derived using convex duality. The algorithm can be shown to converge, and its convergence rate can be analyzed. I will conclude by showing an application of the algorithm to a large scale natural language parsing task, and demonstrate that it converges significantly faster than previous state of the art algorithms.