# DISSERTATION PROPOSAL

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## "On Combinatorial and Stochastic Optimization"

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Via Zoom

In this dissertation, we study four problems in combinatorial and stochastic optimization. The first two chapters give improved approximation algorithms for classic combinatorial optimization problems. The final two chapters consider combinatorial optimization under stochastic uncertainty. For these problems, we give improved approximations as well as characterize the power of adaptivity.

In the first chapter, we consider generalizations of the k-Median problem. In these problems, the goal is to open facilities to serve clients (subject to some constraints) to minimize the total connection cost of each served client to its nearest open facility. We improve the best-known approximations for k-Median with Outliers and Knapsack Median to 6.994 and 6.387, respectively by an iterative linear program rounding algorithm.

In the second chapter, we consider the Online Throughput Maximization problem. In this problem, jobs arrive online with sizes and deadlines, and the goal is to schedule jobs preemptively on m machines to maximize the number of jobs completed by their deadline. We give the first deterministic O(1)-competitive algorithm for this problem for any number of machines m > 1. This concludes a 20-year line of research since the m=1 case was settled.

In the third chapter, we consider the Load Balancing problem with stochastic jobs on m machines. In this problem, the goal is to assign the jobs to machines (knowing only the job-size distributions) to minimize the expected max load over all machines. First, we give a non-adaptive algorithm that is O(log m / log log m)-approximate in the most general unrelated machines setting. This gives an asymptotically tight upper bound on the adaptivity gap for this problem (the maximum ratio between the optimal non-adaptive and adaptive policies.) Next, for the special case of related machines, we use adaptivity to give an improved O(log log m / log log log m)-approximation.

In the fourth chapter, we consider the Completion Time Minimization problem with stochastic jobs on m identical machines. In this problem, the goal is to schedule the jobs to minimize the expected total completion time of all jobs. We have preliminary evidence for a O(m^(1/2) poly (log n))-approximation for the special case of Bernoulli jobs. This would be the first approximation for this problem that is both independent of the job-size distributions and sublinear in the number of machines m, even for more restrictive special cases.