

# On Sparsification of Stochastic Packing Problems

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Shaddin Dughmi, Yusuf Hakan Kalaycı and Neel Patel

**Abstract:** Motivated by recent progress on stochastic matching with few queries, we embark on a systematic study of the sparsification of stochastic packing problems more generally. Specifically, we consider packing problems where elements are independently active with a given probability  $p$ , and ask whether one can (non-adaptively) compute a “sparse” set of elements guaranteed to contain an approximately optimal solution to the realized (active) subproblem. We seek structural and algorithmic results of broad applicability to such problems.

Our focus is on computing sparse sets containing on the order of  $d$  feasible solutions to the packing problem, where  $d$  is linear or at most polynomial in  $\frac{1}{p}$ . Crucially, we require  $d$  to be independent of the number of elements, or any parameter related to the “size” of the packing problem. We refer to  $d$  as the “degree” of the sparsifier, as is consistent with graph theoretic degree in the special case of matching.

First, we exhibit a generic sparsifier of degree  $\frac{1}{p}$  based on contention resolution. This sparsifier’s approximation ratio matches the best contention resolution scheme (CRS) for any packing problem for additive objectives, and approximately matches the best monotone CRS for submodular objectives. Second, we embark on outperforming this generic sparsifier for additive optimization over matroids and their intersections, as well as weighted matching. These improved sparsifiers feature different algorithmic and analytic approaches, and have degree linear in  $\frac{1}{p}$ . In the case of a single matroid, our sparsifier tends to the optimal solution. In the case of weighted matching, we combine our contention-resolution-based sparsifier with technical approaches of prior work to improve the state of the art ratio from 0.501 to 0.536. Third, we examine packing problems with submodular objectives. We show that even the simplest such problems do not admit sparsifiers approaching optimality. We then outperform our generic sparsifier for some special cases with submodular objectives.

**Presenter:** KALAYCI, Yusuf Hakan

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