Bin Packing with Multiple Colors

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The Bin Packing problem is a classical optimization problem with many practical applications related to minimizing time or space. The *Black and White Bin Packing* problem is a variation proposed by Balogh et al. (2012), where we are given a set of items each with a weight and a color - either white or black. We have an unlimited number of bins each with a weight limit and we assume that no item weighs more than the bin weight limit. Formally, the input is a set S of n black and white items with weights $w_1, \ldots, w_n$ and bins of weight limit C where each $w_i \leq C$. The goal is to pack the items in as few bins as possible while maintaining that no two items of the same color are packed adjacently within a bin. We consider a relaxed version of the problem where there is no ordering among the items, however we add the constraint that there are more than 2 colors. We first consider the case where the items have zero weight. We present a linear time algorithm, ALTERNATE-ZERO, that solves this problem optimally. We then present another linear time algorithm, ALTERNATE-UNIT, that optimally solves the problem for unit-weight items. We also find closed-form expressions for the optimal number of bins for both the zero and unit-weight cases. Since our algorithms are optimal for two or more colors, they demonstrate that the problem does not get harder as the number of colors increases.