Recovery Guarantee of Weighted Low-Rank Approximation via
Alternating Minimization

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Abstract

Many applications require recovering a ground truth low-rank matrix from
noisy observations of the entries. In practice, this is typically formulated as a
weighted low-rank approximation problem and solved using non-convex opti-
mization heuristics such as alternating minimization. Such non-convex tech-
niques have few guarantees. Even worse, weighted low-rank approximation
is NP-hard for even the most simple case when the ground truth is a rank-1
matrix.

Under moderate assumptions on the weight matrix and the ground truth,
we prove that the vanilla alternating minimization algorithm with a simple
and cheap "clipping" step, which zeroes out rows with high l2 norms norms
in the intermediate solutions, recovers the ground truth. In particular, we
bound the spectral norm of the difference between the recovered matrix and
the ground truth, by the spectral norm of the weighted noise plus an additive
error term that decreases exponentially with the number of rounds of alter-
nating minimization. This provides the first recovery guarantee for weighted
low-rank approximation via alternating minimization with non-binary deter-
ministic weights. It is a significant generalization of the results for matrix
completion, the special case with binary weights, since our assumptions are
similar or weaker than those made in existing works. Additionally, our proof
applies for random initialization, unlike prior approaches that typically re-
quire an SVD-based initialization.