School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 06/05/2026

TO: Faculty and Students

FROM: Professor Johannes Brust
Chair of the Defense for Ryan Swart for the MA in Mathematics
Committee Members:
Malena Espanol
Rodrigo Platte

DEFENSE ANNOUNCEMENT

Candidate: Ryan Swart, MA Mathematics, Thesis

Defense Date: Wednesday, June 17, 2026

Defense Time: 11:00 AM

Virtual Meeting Link: https://asu.zoom.us/j/86179279604

Room: WXLR A546

Title: A Nonmonotone Gradient-Based Algorithm for Symmetric Nonnegative Matrix Factorization and Graph Clustering

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40-minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. Guests invited to attend as observers are excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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ABSTRACT

Symmetric nonnegative matrix factorization (Symmetric NMF) approximates a matrix as WW^T with nonnegative rectangular factor W. It has broad applications in graph clustering and machine learning. In contrast to the nonnegative matrix factorization (NMF), projected gradient methods for the symmetric problem had been associated with slow convergence. To address this, the symmetric nonmonotone projected Barzilai-Borwein (SNMPBB) method is introduced as the first adaptation of nonmonotone projected Barzilai-Borwein methods to Symmetric NMF, demonstrating that gradient algorithms are significantly more e!ective than previously understood. SNMPBB is further extended to graph clustering using the graph Laplacian regularization as Graph-SNMPBB and to large problems with low-rank approximations as low-rank approximate input SNMPBB (LAI-SNMPBB). For all variants global convergence to first-order stationary points is proved and also that Barzilai-Borwein curvature information is preserved with randomized approximations. On synthetic data, SNMPBB achieves 6 times speedup over the alternative Symmetric Alternating Nonnegative Least Squares (SymANLS) algorithm for similar residuals, with advantages growing at higher ranks. Across six real-world clustering benchmarks, Graph-SNMPBB matches or exceeds SymANLS accuracy. Lastly, LAI-SNMPBB outperforms state-of-the-art low-rank approximate input Symmetric Projected Gauss-Newton with Conjugate Gradient (LAI-SymPGNCG) method on 34 SuiteSparse matrices in both runtime and residual quality.