Research on SVD matrix analysis method and some applications in machine learning

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Abstract: This thesis investigates the Singular Value Decomposition (SVD) matrix factorization method and its key applications in machine learning. SVD is a fundamental linear algebra technique that decomposes a matrix into three constituent matrices, revealing its intrinsic low-rank structure. The study provides a rigorous mathematical foundation of SVD, including its derivation, properties, and computational aspects. It then explores three principal applications. First, it examines SVD for dimensionality reduction via Truncated SVD, demonstrating its effectiveness in noise reduction and feature extraction compared to Principal Component Analysis. Second, it applies SVD in collaborative filtering for recommender systems, showing how latent factor models capture user-item interactions. Third, it analyzes SVD's role in data compression and image processing. Experimental results on benchmark datasets validate the method's efficiency in reducing computational complexity while preserving essential data patterns. The findings confirm that SVD remains a powerful and versatile tool for preprocessing, feature engineering, and model optimization in modern machine learning pipelines.

Keywords: SVD, machine learning, matrix analysis, applications