BDML-MLE Algorithm Flowchart

Balanced Distance Metric Learning with Manifold Learning Ensemble

Legend:
- Input/Output
- Phase Header
- Process
- Decision/Balance

High-Dimensional Dataset $X \in \mathbb{R}^{n \times d}$

Phase 1: Manifold Learning Ensemble

- **PCA**
- **LDA**
- **LLE**
- **Isomap**
- **MDS/ KPCA**

Low-Dimensional Embedding $Y \in \mathbb{R}^{n \times k}$

Phase 2: Balanced Neighborhood Construction

- **k-NN Graph Construction**
- **Similar Set $S\_i = \{same\ class\}$**
- **Dissimilar Set $D\_i = \{diff\ class\}$**

Balance: $|S\_i| = |D\_i| = k$ (Address Class Imbalance)

Distance Metric Learning min $\sum d_M^2(similar) - \alpha \sum d_M^2(dissimilar)$

Converged?
YES
NO

Learned Metric M