Soft Label and Discriminant Embedding Estimation for Semi-Supervised Classification

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Outline

1. Introduction
2. Proposed method
3. Experiments & Comparisons
4. Conclusion

Introduction

- What are some best practices for machine learning?
- How can data labeling be done efficiently?
- What is Semi-supervised learning?
- What is the benefits of dimensionality reduction or manifold learning methods.

Introduction

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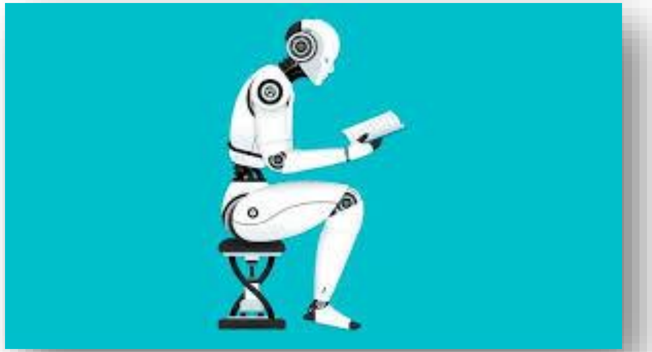
Dimensionality Reduction

machine learning models

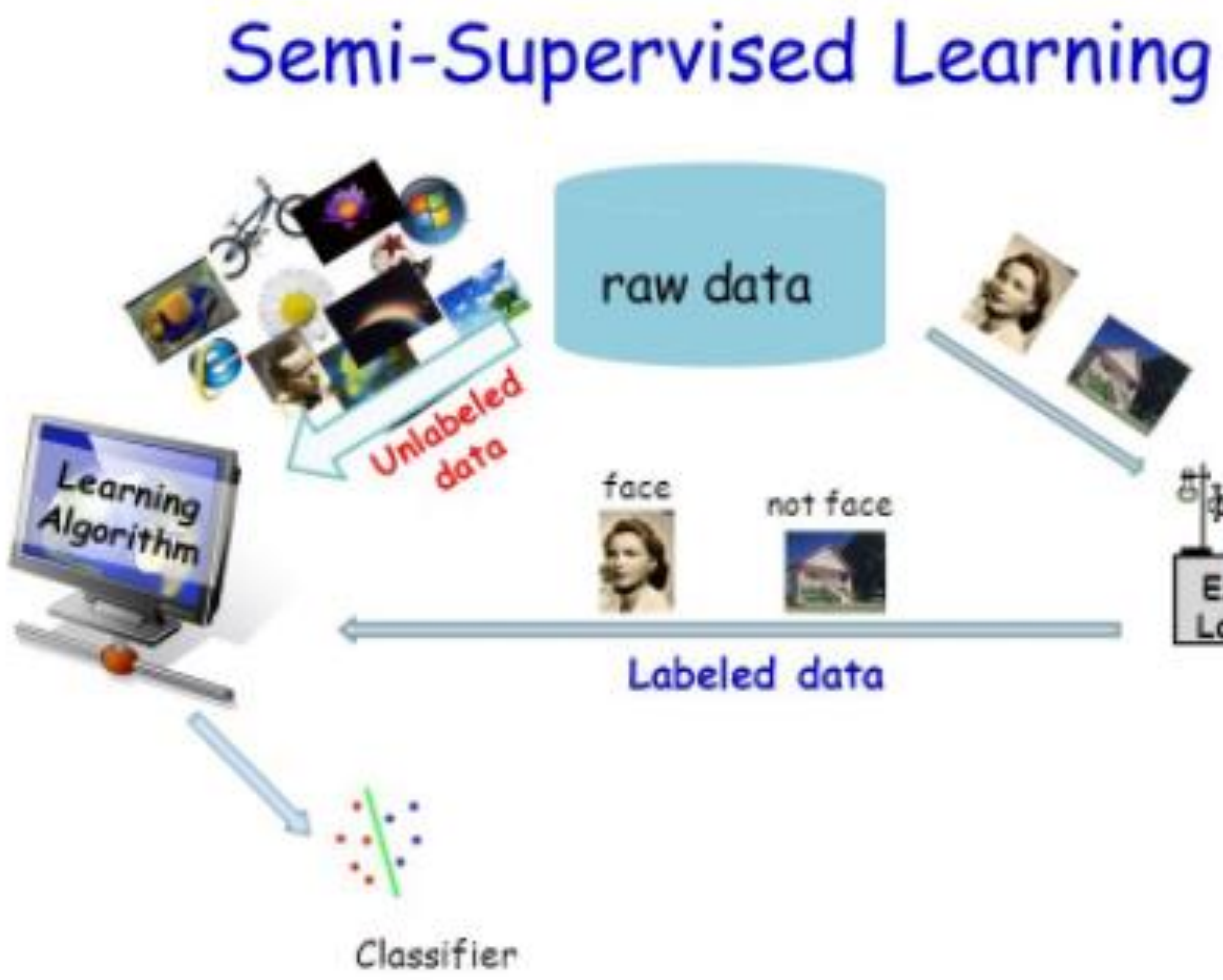


High dimensional data

The processing is a challenging task

Need for a low dimensional representation of high dimensional data that preserves the intrinsic information of data. **This is what we call dimensionality reduction or manifold learning methods.**

Introduction



Introduction

Related work

- An iterative paradigm of joint feature extraction and labeling for semi-supervised discriminant analysis (ISDA) [Ren 2018]
- Semi-supervised linear discriminant analysis(SLDA) [Wang 2016]
- Semi-supervised Discriminant Analysis (SDA) [Cai 2007]
- Semi-supervised Discriminant Embedding (SDE) [Huang 2012]
- Flexible Manifold Embedding (FME) [Nie 2010]

Proposed method

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Criterion

$$g(\mathbf{W},\mathbf{F}) = tr\left(\mathbf{W}^T\mathbf{X}\,(\mathbf{E}-\mathbf{F}\,\mathbf{F}^T)\,\mathbf{X}^T\,\mathbf{W}\right) + \beta\, tr\left(\mathbf{F}^T\mathbf{L}\,\mathbf{F}\right) + \gamma\, tr\left(\mathbf{W}^T\mathbf{X}\,\mathbf{L}\,\mathbf{X}^T\,\mathbf{W}\right) + \alpha\, tr\left((\mathbf{F}^T\mathbf{F}-\mathbf{I})^T(\mathbf{F}^T\mathbf{F}-\mathbf{I})\right)$$

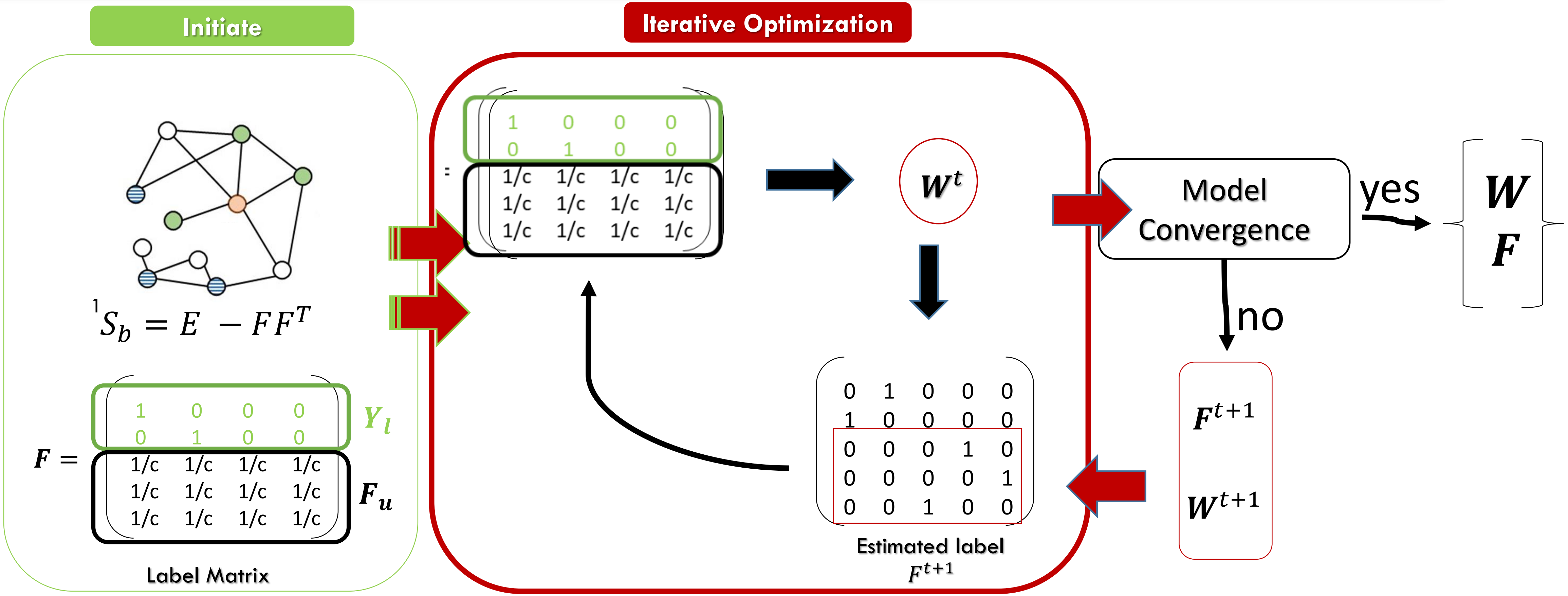
Inter-Class Distances Maximization

Label Smoothness

Projection Smoothness

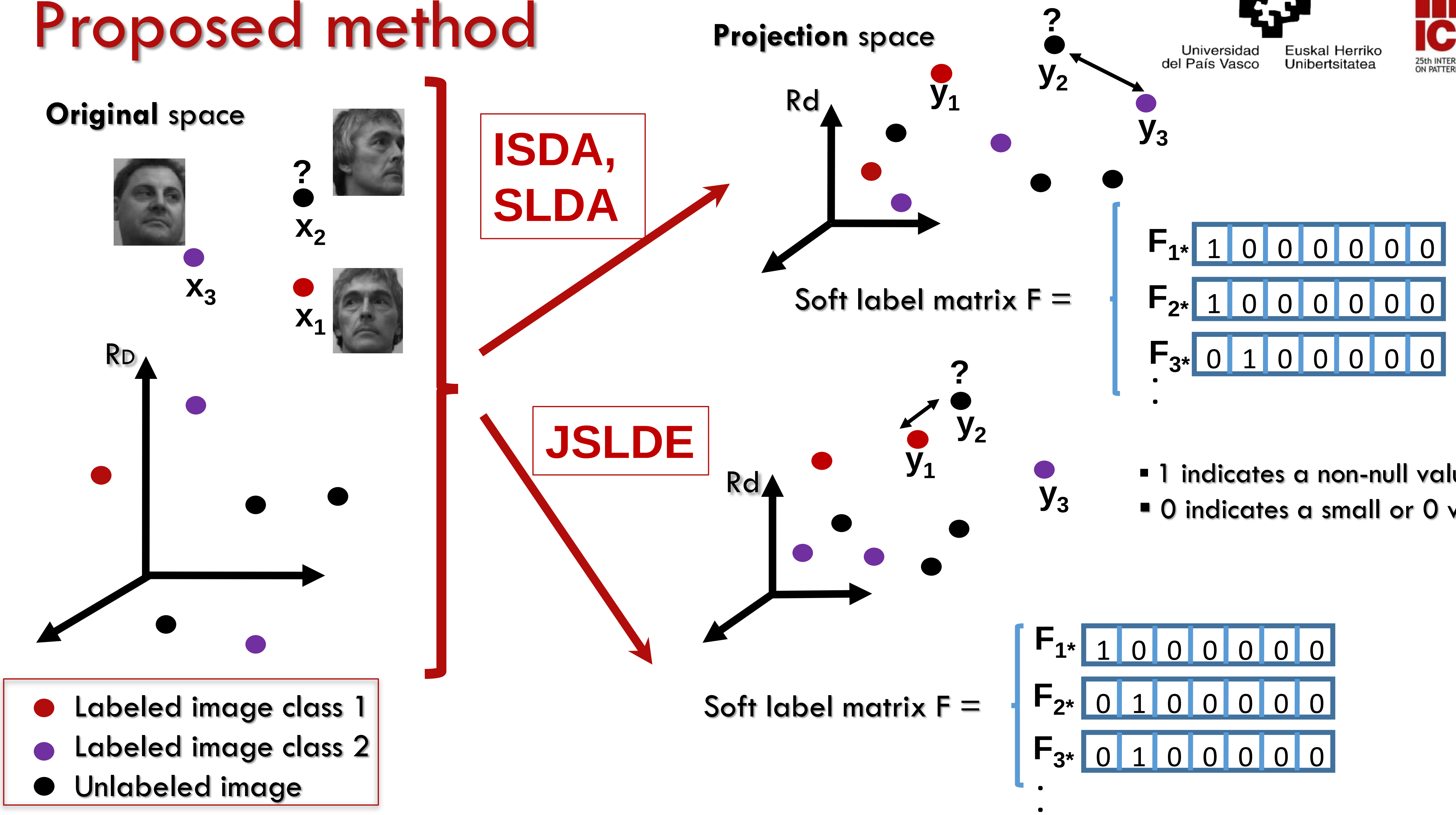
Orthogonality Constraint

Proposed method



(1) S_b is between-class graph, E is a matrix of ones.

Proposed method



- 1 indicates a non-null value
- 0 indicates a small or 0 value

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Experiments & Comparisons

Databases

Dataset Name	Number of samples	Number of classes	~Samples/class	Dimension of a sample	Dataset type
ORL	400	40	10	32×32	Face Images
UMIST	575	20	29	28×23	Face Images
Extended Yale	1774	28	63	32×32	Face Images
USPS	1100	10	110	16×16	Handwritten digits
COIL-20	360	20	18	51×51	Object Images

Experiments & Comparisons

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Results

EXT - Yale	1 Sample		2 Samples		3 Samples	
Method	*T*	*U*	*T*	*U*	*T*	*U*
FME	36.8%	40.7%	51.2%	54.7%	56.2%	59.9%
KFME	27.5%	29.3%	45.3%	46.5%	52.2%	56.3%
SDA	32.8%	35.0%	48.5%	50.7%	54.6%	58.2%
SDE	43.8%	46.0%	61.4%	60.5%	65.4%	67.1%
TR-FSDA	41.8%	45.2%	59.4%	58.6%	63.4%	64.0%
GLPP	25.5%	28.1%	41.0%	42.6%	49.7%	54.4%
SLDA	**47.9%**	**51.1%**	63.4%	64.3%	67.1%	69.7%
ISDA	**47.9%**	**51.1%**	63.3%	63.9%	67.2%	69.4%
JSLDE	46.4%	49.4%	**65.4%**	**67.0%**	**68.8%**	**71.9%**

Experiments & Comparisons

Results

UMIST	1 Sample		2 Samples		3 Samples	
Method	*T*	*U*	*T*	*U*	*T*	*U*
FME	37.8%	60.2%	45.2%	72.7%	51.4%	87.5%
KFME	39.3%	58.8%	48.7%	72.5%	57.0%	87.1%
SDA	39.6%	60.1%	57.3%	79.1%	63.0%	84.4%
SDE	40.1%	65.0%	51.0%	78.9%	58.9%	82.4%
TR-FSDA	38.3%	57.5%	46.7%	68.1%	53.3%	77.3%
GLPP	40.3%	59.7%	57.1%	78.7%	65.0%	88.3%
SLDA	37.6%	57.8%	47.8%	74.9%	58.0%	79.8%
ISDA	38.1%	59.3%	47.5%	75.1%	57.6%	80.6%
JSLDE	**44.2%**	**72.3%**	**53.3%**	**80.0%**	**63.0%**	**89.2%**

Experiments & Comparisons

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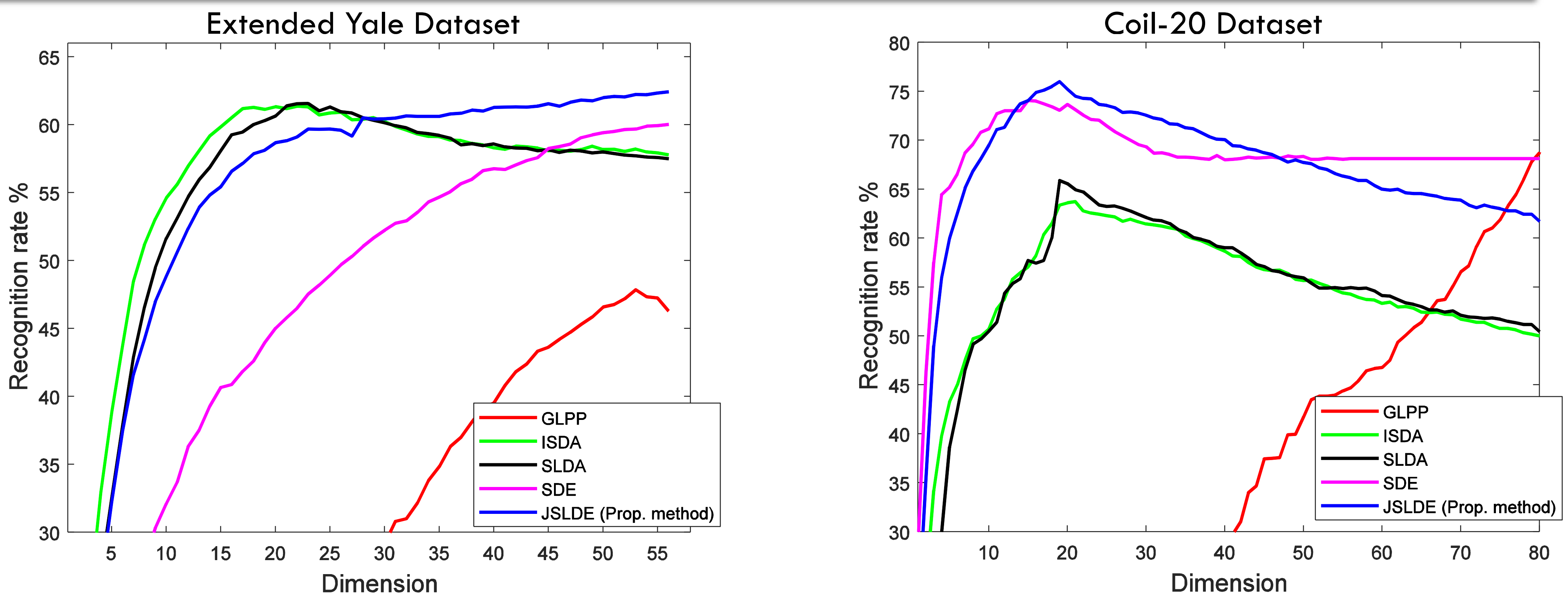

Figure: Recognition accuracy vs. feature dimension obtained with the EXT Yale and Coil-20 datasets (test evaluation).

Experiments & Comparisons

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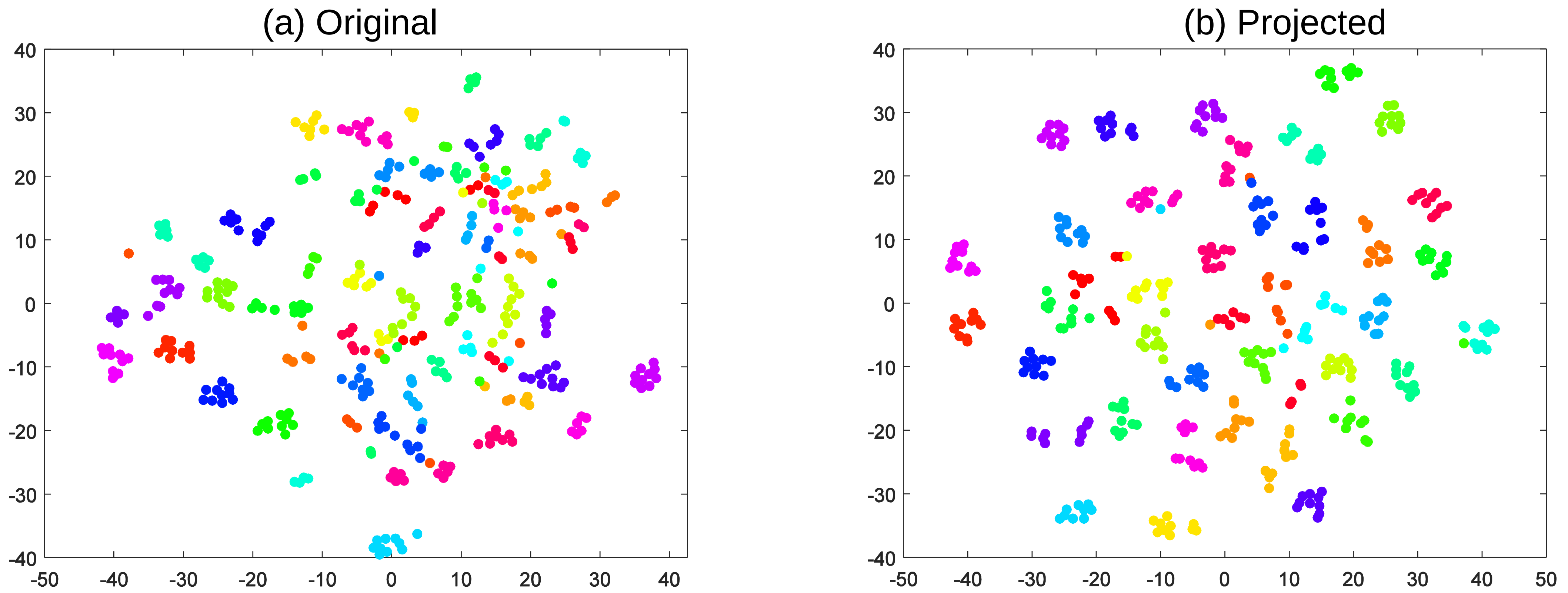

Figure: t-SNE visualization of the ORL dataset. (a) Face images using their original features. (b) Face images using their projection obtained by JSLDE.

Conclusion

- We introduced a framework that is able to jointly estimate the soft labels and linear embedding for a semi-supervised context.
- The iterative criterion enforces the smoothness of both the predicted labels and the linear projection of the data samples.

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Thanks for your attention

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