

# Ensemble Projection for Semi-supervised Image Classification

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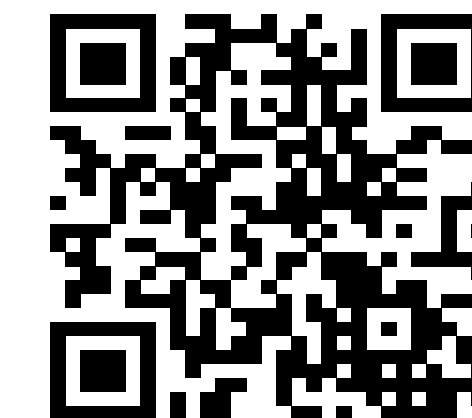
## Task

- Improve classification performance by using unlabeled data

## Summary

- A semi-supervised method by learning new image representations rather than regularizing classifying functions
- The method outperforms previous semi-supervised methods, is complementary with them, and is more generally applicable
- The framework is simple, easy-to-use, and can be used for image retrieval and image clustering as well

- The code and data are available at [www.vision.ee.ethz.ch/~dai/EnPro/](http://www.vision.ee.ethz.ch/~dai/EnPro/)



## Results

- **Features:** The concatenation of GIST, PHOG, and LBP
- **Classifiers:** Logistic Regression (LR), SVMs, Laplacian SVMs (LSVM) [1], and Harmonic Functions (HF) [2]
- **Datasets:** Good results on four datasets Scene-15 [3], LandUse-21 [4], Texture-25, and Caltech-101

## How?

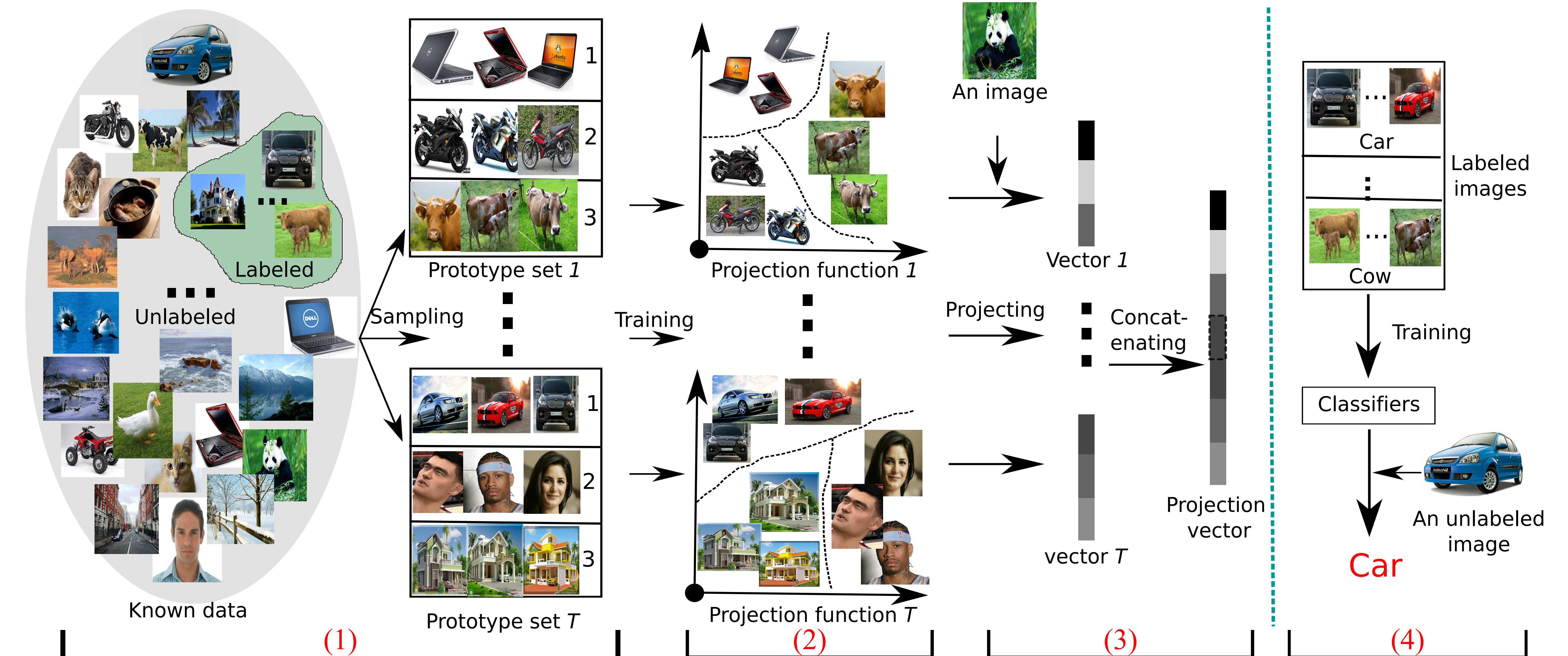


Fig.1 Ensemble Projection consists of unsupervised feature learning (1)-(3) and supervised classification (4).  
 (1) Sample  $T$  diverse prototype sets from all known data: prototypes are inter-distinctive and intra-similar.  
 (2) Train classifiers on the sets to obtain  $T$  projection functions.  
 (3) Project images by the functions to build their representations.  
 (4) Classify images using the projected representations.

## Semi-supervised

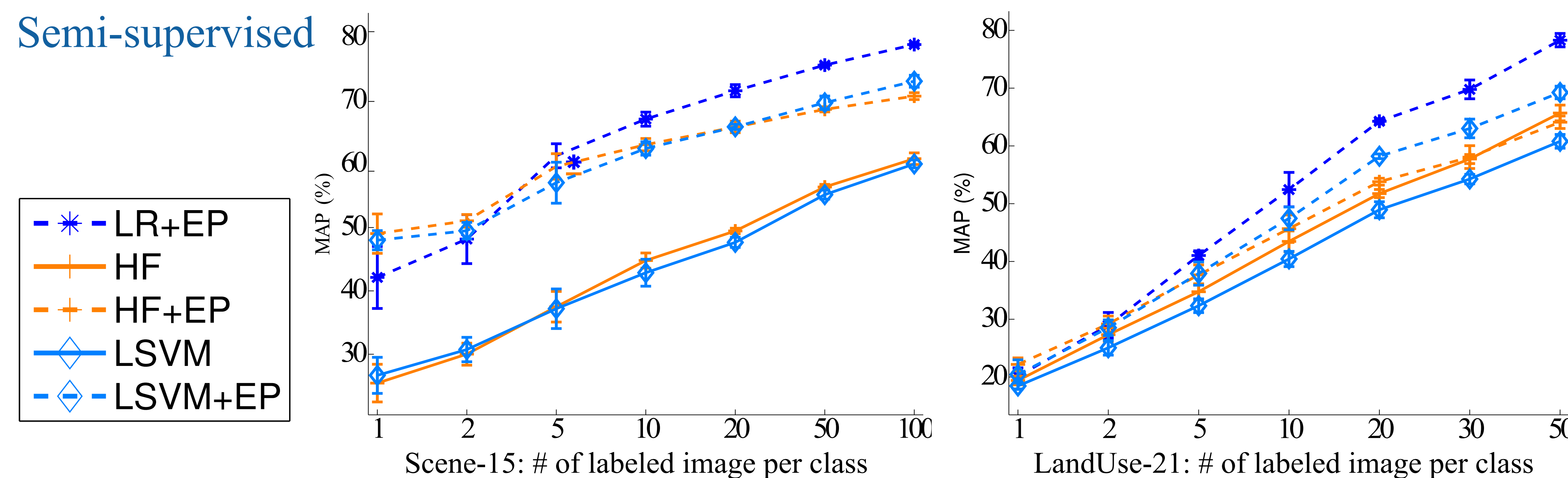


Fig.2 Performance of semi-supervised image classification (+EP means using our feature, indicated by dash lines), where the unlabeled data are coming from the same distribution as the labeled ones.

## Self-taught

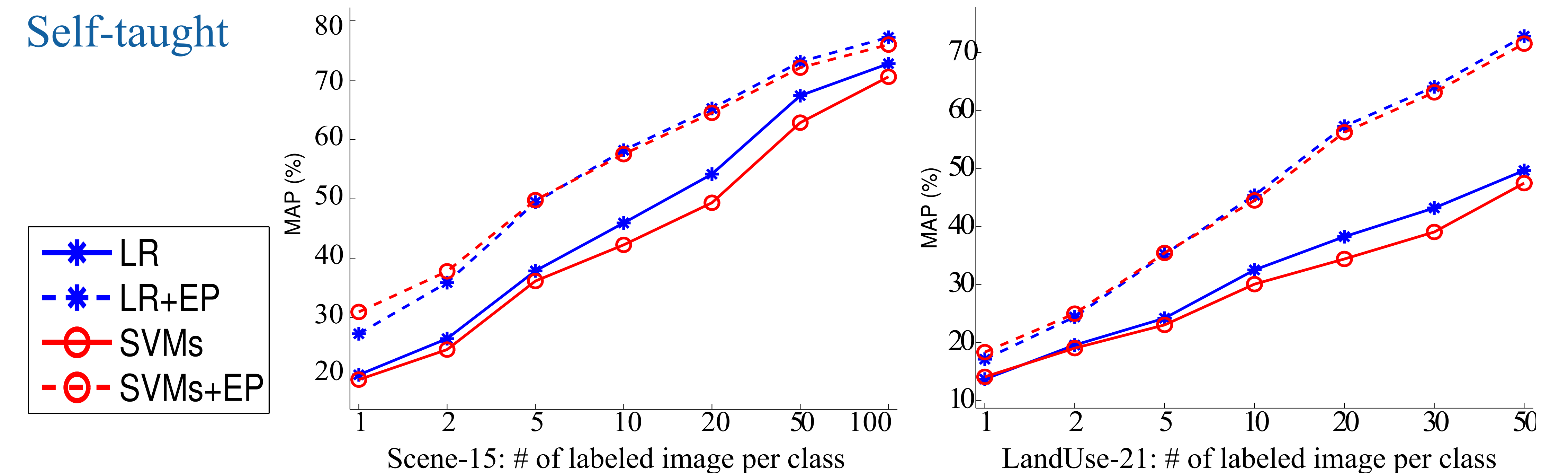


Fig.3 Performance of self-taught image classification (+EP means using our feature, indicated by dash lines), where the unlabeled data are coming from a random collection of images.

## References

- [1] M. Belkin, P. Niyogi, and V. Sindhwani. Manifold regularization: A geometric framework for learning from labeled and unlabeled examples. JMLR, 7(36):2399–2434, 2006.
- [2] X. Zhu, Z. Ghahramani, and J. Lafferty. Semi-supervised learning using gaussian fields and harmonic functions. In ICML, 2003.
- [3] S. Lazebnik, C. Schmid, and J. Ponce. Beyond bags of features: Spatial pyramid matching for recognizing natural scene categories. In CVPR, 2006.
- [4] Y. Yang and S. Newsam. Bag-of-visual-words and spatial extensions for land-use classification. In ACM GIS, 2010.

