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Learning with Limited Labeled Data

by Yanbin Liu

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under the supervision of Yi Yang

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Certificate of Authorship/Originality

I, Yanbin Liu declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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ABSTRACT

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The recent success of convolutional neural networks (CNNs) relies on a large amount of annotated training data. However, many research problems suffer from the scarcity of labeled data, since annotating a large number of data is time-consuming or infeasible. This dissertation focuses on learning with limited labeled data and addresses two problems: few-shot classification and object matching.

For few-shot classification, a transductive propagation network (TPN) is first proposed to deal with the low-data issue. The idea is learning to propagate labels from labeled instances to unlabeled ones by exploiting the manifold structure of the data. Then, online feature selection with imbalanced streaming data, as a special few-shot problem, is tackled by the proposed adaptive sparse confidence-weighted (ASCW) algorithm. This algorithm utilizes the confidence-weighted (CW) learning to explore the feature correlation and maintains multiple confidence-weighted learners with different costs to address the imbalanced issue.

For object matching, since the labeled matching pairs are usually scarce, finding the potential matching among unpaired objects is important. Based on this idea, two models are proposed to solve object matching with limited labeled data. First, a squared-loss mutual information (SMI) estimator is proposed to utilize a small number of paired samples and the available unpaired ones. The estimator is formulated with optimal transport and quadratic programming in an iterative way. Second, the specific object matching problem, namely semantic correspondence, can be solved in a unified optimal transport framework. The many to one matching and background matching issues are well addressed in the proposed framework.

To evaluate the effectiveness of the aforementioned algorithms with limited labeled data, extensive experiments are conducted on various benchmark datasets, ranging from the UCI machine learning repository, few-shot image classification datasets, semantic correspondence datasets, etc.

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List of Publications

Conference Papers

C-1. **Liu, Y.**, Lee, J., Park, M., Kim, S., Yang, E., Hwang, S. and Yang, Y., Learning to Propagate Labels: Transductive Propagation Network for Few-shot Learning. International Conference on Learning Representations (ICLR), 2019.

C-2. **Liu, Y.**, Yan, Y., Chen, L., Han, Y. and Yang, Y., Adaptive Sparse Confidence-Weighted Learning for Online Feature Selection. AAAI Conference on Artificial Intelligence (AAAI), 2019.

C-3. **Liu, Y.**, Zhu, L., Yamada, M. and Yang, Y., Semantic Correspondence as an Optimal Transport Problem. IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2020.

Preprint Papers

P-1. **Liu, Y.**, Yamada, M., Tsai, Y.H.H., Le, T., Salakhutdinov, R. and Yang, Y., LSMI-Sinkhorn: Semi-supervised Squared-Loss Mutual Information Estimation with Optimal Transport. arXiv preprint arXiv:1909.02373, 2019.

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