Deep Learning with Noisy Supervision

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A thesis submitted for the degree of
Doctor of Philosophy
April, 2019

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as part of the collaborative doctoral degree and/or fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This research is supported by the Australian Government Research Training Program.

This thesis is the result of a Collaborative Doctoral Research Degree program with Shanghai Jiao Tong University

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Date: June, 28th 2019

I would like to dedicate this thesis to my loving parents and family.

Acknowledgements

I would like to take this good opportunity to appreciate my advisors, several professors, my colleagues, my friends and my family for their significant help during my doctoral study in University of Technology Sydney and Shanghai Jiao Tong University.

First, I am deeply indebted to my supervisor Prof. Ivor W. Tsang, who improves my machine learning taste into a new stage. During my research life in University of Technology Sydney, I am deeply impressed by his broad knowledge in machine learning and his pure altitude toward the research. His patient guides on how to propose a novel idea across or to bridge two different fields and how to generalize its impact to many tasks, really make an great effect on my deep understanding of the research philosophy. Besides, he constantly encourages us to focus on the fundamental problem and make the enough effort to purse the top research in the advance area, which moves me deeply in the journey of my research life. With his help, I found the happiness to do the pure research.

Second, I would like to express my foremost and deepest gratitude to my co-supervisor Prof. Ya Zhang, who plays an important role in showing me how to solve the difficulty in the doctoral life and how to do a significant academic research. In particular, at the beginning of my research career, her vision on the proposal of a novel idea in the research field and the endless labor on teaching me the writing of a regular academic paper helps me build the solid foundation of the research. Besides, her special interesting view on many works breaks through my original shallow sense and motivates the research going deep. It is hard to imagine I could finish this thesis without her high standards, unlimited patience, generous support and guidance.

I have been fortunate to attend the joint degree program between Shanghai Jiao Tong University and University of Technology Sydney for about two years. Wherein I would like to express my sincere appreciation to Prof. Ivor W. Tsang, Prof. Ya Zhang and Prof. Chengqi Zhang, who provides me this opportunity to work in such a great team and around so many brilliant minds. Within these two years, I have met and made

friends with many famous researchers in different areas and learned many useful experiences from them. In particularly, with the help of Bo Han, Yuangang Pan and Yueming lyu, I have broaden the scope of the whole research community and dived in more rigorous solution for the difficulty to be solved. With the guide of Gang Niu and Mingyuan Zhou, I realized what I lack for the top research in detail, which is very important in my development.

Then, it comes to my dear colleagues and friends in my doctoral study. I would like to thank Dr. Zhe Xu for his selfless help in my research, Jiawei Hu, Shuai Xiao, Weichang Wu, Xiaoyu Chen, Xiao Luo and Siyuan Zhou for being good friends, discussions and in their company, Zhiyi Tan and Fei Ye for being close friends and offering me the generous help, lovely juniors Jie Hou, Yichao Xiong, Zhiwei Rao, Xiaohui Zhu, Yan Wang, Yexun Zhang, Hongxiang Cai, Zhuoxiang Chen, Xinyan Yu, Zhonghao Wang, and young brothers Huangjie Zheng, Jiajie Wang, Xu Chen, Jie Chang, Conan Cui, Maosen Li, Hao Wu and many others. I am happy to experience the research life with you all and wish you all have a bright future. I am also grateful to all the other friends in Sydney: Bo Han, Donna Xu, Yuangang Pan, Zhuanghua Liu, Yueming Lyu, Muming Zhao, Xiaoqi Jiang, Yaxin Shi, Yan Zhang, Jing Chai, Weijie Chen, Tao Zheng, Xingrui Yu, Xiaowei Zhou, Jing Li, Yinghua Yao, Xiaofeng Xu, Xiaofeng Cao, Yurui Ming, Guang Li, Xinyuan Chen, Xuan Wang and Razia Osman for their support and company.

Finally, I would like to express my deeply felt gratitude to my parents, my sister, my wife and my daughter. You all always stand behind me and gives me the unconditional support. It is you contribute the happy lifetime to me so that I could purse my research goal without any concerns. This love will be remembered by me forever.

Abstract

Central to many state-of-the-art classification systems via deep learning is sufficient accurate annotations for training. This is almost the bottleneck of all machine learning algorithms deployed with deep neural networks. The dilemma behind such a phenomenon is essentially the trade-off between the low expensive model design and the low expensive sample collection. For practical purposes to alleviate this issue, learning with noisy supervision is a critical solution in the Big Data era, since the noisily annotated data on the social websites and Amazon Mechanical Turk platforms can be easily acquired. Therefore, in this dissertation, we explore to solve the fundamental problems when training deep neural networks with noisy supervision.

Our first work is to introduce the low expensive noise structure information to overcome the decoupling bias issue existed learning with noise transition. We study the noise effect via a variable whose structure is implicitly aligned by the provided structure knowledge. Specifically, a Bayesian lower bound is deduced as the objective and it naturally degenerates to previous transition models in the case that there is no structure information available. Furthermore, a generative adversarial implementation is given to stably inject the structure information when training deep neural networks. The experimental results show the consistently improvement in the different simulated noises and the real-world scenario.

Our second work targets to substitute the previous ill-posed stochastic approximation to the noise transition with a rigorous stochastic re-allocation regarding the confusion matrix. This work discovers the reason that causes the unstable issue in modeling the noise effect by a neural Softmax layer and introduces a Latent Class-Conditional Noise model to overcome it. In addition, a computational effective dynamic label regression method is deduced for optimization, which stochastic trains the deep neural network and safeguards the noise transition estimation. The proposed method achieves the state-of-the-art results on two toy datasets and two large real-world datasets.

The last work aims to alleviate the difficulty that the ideal assumption on the accurate noise transition is usually not fulfilled and the noise could

still pollute the classifier in the back-propagation. We specially introduce a quality embedding factor to apportion the reasoning in the back-propagation, yielding a quality-augmented class-conditional noise model. On the network implementation, we elaborately design a contrastive-additive layer to infer the latent variable and deduce a stochastic optimization via reparameterization tricks. The results on a noisy web dataset and a noisy crowdsourcing dataset confirm the superiority of our model in the accuracy and interpretability.

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