UNIVERSITY OF TECHNOLOGY SYDNEY
Faculty of Engineering and Information Technology

CHEST X-RAY IMAGE CLASSIFICATION WITH DEEP LEARNING

by

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A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE

Doctor of Philosophy

Sydney, Australia

2021

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Qingji Guan, 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 reference 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.

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

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ABSTRACT

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Computer-aided diagnosis (CAD) systems have been successfully helped to clinical diagnosis. This dissertation considers one essential task in CAD, the chest X-ray (CXR) image classification problem, with the deep learning technologies from the following three aspects.

First, considering most diseases existing in CXRs usually happen in small localized areas, we propose to localize the local discriminative regions and integrate the global and local cues into an attention guided convolution neural network (AG-CNN) to identify thorax diseases. AG-CNN consists of three branches (global, local, and fusion branches). The global branch learns the global features for classification. The local branch localizes the discriminative regions, which avoids noise and improves misalignment in the global branch. AG-CNN fuses the global and local features for diagnosis in a fusion branch.

Second, due to the common and complex relationships of multiple diseases in CXRs, it is worth exploiting their correlations to help the diagnosis. This thesis will present a category-wise residual attention learning method to concentrate on learning the correlations of multiple diseases. It is expected to suppress the obstacles of irrelevant categories and strengthen the relevant features at the same time.

Last, a robust and stable CXR image analysis system should be able to: 1) automatically focus on the disease-critical regions, which usually are of small sizes; 2) adaptively capture the intrinsic relationships among different disease features and utilize them to boost the multi-label disease recognition rates jointly. We introduce a discriminative feature learning framework, ConsultNet, to achieve those two purposes simultaneously. ConsultNet consists of a variational selective information bottleneck branch and a spatial-

and-channel encoding branch. These two branches learn discriminative features collaboratively.

In addition, each of the proposed methods is comprehensively verified and analyzed by conducting various experiments.

Dissertation directed by Professor Yi Yang
Australian Artificial Intelligence Institute (AAII), School of Computer Science

Acknowledgements

I would like to dedicate this dissertation to those who have offered assistance and support while pursuing the Ph.D. degree.

First and foremost, I would like to thank my supervisor, Prof. Yi Yang, for his guidance, encouragement, and most of all, his support during my preparation for the thesis. Prof. Yang taught me to insist on being myself and always do the right things in research work. He has also given me many valuable suggestions in lifetime. He has my deepest gratitude.

Besides, I would like to thank my co-supervisor, Dr. Liang Zheng, who has given me valuable suggestions and guidance in my research. His profound thinking and painstaking inspire and encourage me to do my best to do perfect work.

Thanks to all my colleagues in the ReLER Lab at the University of Technology Sydney. Thanks to Qianyu Feng, Peike Li, Pingbo Pan, Zhedong Zheng, Fan Ma, Xiaohan Wang, Yu Wu, Yutian Lin, Hehe Fan, Yanbin Liu, Jiaxu Miao, Hu Zhang, Guang Li, Xiaolin Zhang, Ruoyu Liu, Yang He, Zongxin Yang. Special thanks to Zhun Zhong, Yawei Luo and Ping Liu, who have many discussions with my research together. I am grateful and delighted to meet these lovely, passionate people.

I would like to thank my parents Fengxian Sheng and Chengwen Guan, my brother Qingli Guan for their love over the years.

Finally and most importantly, I would like to thank my husband, Liming Yang, for his selfless love. Without his tremendous support, I could not complete my study. I thank my son, Yichen Yang, who always cheers me up.

Qingji Guan

March 2021 at Beijing.

List of Publications

Journal Papers

J-1. **Q. Guan**, Y. Huang, Y. Luo, P. Liu, M. Xu and Y. Yang, "Discrimative feature learning for thorax disease classification in chest X-ray images," *IEEE Transactions on Image Processing*, vol. 30, 2021.

J-2. **Q. Guan**, Y. Huang, Z. Zhong, Z. Zheng, L. Zheng and Y. Yang. "Thorax disease classification with attention guided convolutional neural network ," *Pattern Recognition Letters*, vol. 131, 38-45, 2020.

J-3. **Q. Guan** and Y. Huang. "Multi-label chest X-ray image classification via category-wise residual attention learning ," *Pattern Recognition Letters*, vol. 130, 259-266, 2020.

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