Fast Structure Learning for Deep Feedforward Networks via Tree Skeleton Expansion

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Abstract. Despite the popularity of deep learning, structure learning for deep models remains a relatively under-explored area. In contrast, structure learning has been studied extensively for probabilistic graphical models (PGMs). In particular, an efficient algorithm has been developed for learning a class of tree-structured PGMs called hierarchical latent tree models (HLTMs), where there is a layer of observed variables at the bottom and multiple layers of latent variables on top. In this paper, we propose a simple unsupervised method for learning the structures of feedforward neural networks (FNNs) based on HLTMs. The idea is to expand the connections in the tree skeletons from HLTMs and to use the resulting structures for FNNs. Our method is very fast and it yields deep structures of virtually the same quality as those produced by the very time-consuming grid search method.

Keywords: Fast structure learning · Feedforward neural networks

1 Introduction

Deep learning has achieved great successes in the past few years [10,15,17,22]. More and more researchers are now starting to investigate the possibility of learning structures for deep models instead of constructing them manually [3,6,24,31]. There are three main objectives in structure learning: improving model performance, reducing model size, and saving manual labor and/or computation time. Most previous methods focus on the first and second objectives. For example, the goal of constructive algorithms [16] and neural architecture search [31] is to find network structures which can achieve good performance for specific tasks. Network pruning [9,18], on the other hand, aims to learn models which contain fewer parameters but still achieve comparable performance compared with dense models.

In this paper, we focus on the third objective. In practice, people usually determine model structure by manual tuning or grid-search. This is time-consuming as there can be a large number of hyper-parameter combinations to consider. We propose a fast unsupervised structure learning method for neural

G. Kern-Isberner and Z. Ognjanović (Eds.): ECSQARU 2019, LNAI 11726, pp. 277–289, 2019.
https://doi.org/10.1007/978-3-030-29765-7_23