

Investigation of Graph Neural Networks

Master's Thesis

Project

In recent years, neural networks, especially deep neural networks (DNNs), have emerged as a universal and powerful tool for solving complex problems. In contrast to fully meshed networks, many practical DNN architectures are structured, such as "convolutional neural networks" which exploit the spatial or temporal correlation between adjacent inputs to massively reduce the complexity of the DNN. This concept can be generalized to general dependencies between variables in so-called graph neural networks (GNNs).

In this thesis, you will first familiarize yourself with the concept of factor graphs, which can be used to represent system models in a graph structure. Algorithms distributed on these graphs ("message passing") form the basis for a large number of modern and extremely powerful algorithms in communications engineering, but also in many other areas of science. However, these approaches reach their limits when the underlying graph contains cycles or the assumed model is a poor approximation of reality. Data-driven approaches, such as DNNs, can achieve significantly improved performance in such cases.

The aim of this thesis is to evaluate the potential of GNNs based on a concrete problem (e.g., symbol detection on channels with linear interference) and to compare them with classic "message passing" algorithms and with a fully meshed DNN.

Tasks

1. Familiarization with the concept of factor graphs and GNNs
2. Modeling and implementation of GNNs for a specific problem
3. Analysis of the GNN w.r.t. performance and complexity

Requirements

- ✓ Knowledge of communications engineering and machine learning
- ✓ Experience in programming with Python
- ✓ Interest in scientific work

Institute

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