Universität Stuttgart

INSTITUT FÜR
KOMMUNIKATIONSNETZE
UND RECHNERSYSTEME
Prof. Dr.-Ing. Andreas Kirstädter

Master thesis No. 1063

Designing and Implementing Graph Neural Networks for Efficient IP-Optical Networking

Methods
Graph Neural Networks
Machine Learning
Network Modeling
Simulation

Topics
Multi-layer networks
Network control

Background

Today, communication networks have evolved into complex systems handling vast amounts of data, making efficient management and optimization crucial. The network topology and state can be naturally represented as a graph structure, with nodes representing network elements and edges representing connections. Graph Neural Networks (GNNs) have emerged as a powerful tool for learning from graph-structured data, making them particularly suitable for network optimization problems. The Routing and Spectrum Assignment (RSA) problem in IP-optical networks presents a significant challenge that could benefit from GNN-based approaches, as it requires understanding both topology and state information.

Problem Description

In the context of this thesis, you are called to apply GNNs to solve network optimization problems. More specifically, the thesis consists of the following steps:

- Familiarize yourself with Julia and related GNN packages
- Design appropriate graph representations for network states
- Implement and train GNN models for the RSA problem
- Compare different GNN architectures and aggregation functions
- Evaluate the impact of GNNs on solving the RSA problem

Acquired Knowledge and Skills

In this thesis, you will gain deep understanding of Graph Neural Networks and their application to networking problems. You will experiment with the scientific programming language Julia and its graph learning libraries. Additionally, you will get great insight into networking and network services.

Requirements
Programming Experience
Communication Networks Architecture and Design
Basic Machine Learning Knowledge

Desirable knowledge
Programming Experience in Julia
Graph Theory Basics
Neural Networks Fundamentals

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