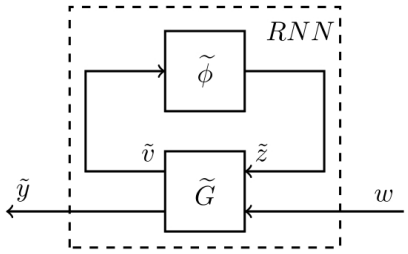
Universität Stuttgart
Institut für Systemtheorie und Regelungstechnik
Prof. Dr.–Ing. Frank Allgöwer

Open thesis (MA)

Accurate Lipschitz constant estimation for NNs using integral quadratic constraints

Description:



Until today neural networks (NNs) are hardly applied in safety-critical systems due to their black-box nature that is not fully understood. Yet, in recent literature control theoretic tools are used to verify or improve the safety of NNs. One common measure for robustness of NNs is the Lipschitz constant of its input-output mapping, that can be accurately estimated using semidefinite programs (SDPs). These SDPs, however, rely on simple static incremental quadratic constraints for slope-restricted activation functions. In this thesis, we want to use more sophisticated dynamic integral quadratic constraints (IQCs) to reduce the conservatism of Lipschitz bounds for recurrent and convolutional neural networks. The student's tasks include to study IQCs and methods for Lipschitz constant estimation for NNs (literature), extend them to the use of dynamic IQCs and Zames-Falb multipliers (theory), and apply the resulting method to toy and benchmark examples and compare the method in terms of conservatism and scalability (simulation).

Prerequisites:

- Background in *Machine Learning/Deep Learning*
- Courses *Linear Matrix Inequalities in Control* or *Robust Control* recommended
- Interested in NNs and coding (Matlab/Python/Julia)

Supervisor:

Patricia Pauli, Simon Lang
Zimmer 3.234, 3.244

Area:

Control theory for neural networks

Properties:

Type: MA

25% literature
50% theory
25% simulation

Beginning:

anytime

Weitere Informationen: www.ist.uni-stuttgart.de/lehre/bama

Aushang vom 6. September 2023