**Open thesis (BA)**

**Lipschitz recurrent neural networks**

**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). Based on these SDPs, one can design Lipschitz NNs that have favorable robustness properties. Recurrent neural networks (RNNs) can learn dynamics, making them especially interesting for control engineers, but also appear in audio processing tasks and speech recognition. In this work, we design deep Lipschitz RNNs. The student’s tasks include to research RNNs and typical benchmarks for RNNs and study methods for training Lipschitz NNs based on SDPs (literature). Afterwards, they are to extend these methods to design Lipschitz deep RNNs (theory), and apply the resulting training method to toy and benchmark examples and compare the method in terms of robustness (simulation).

**Prerequisites:**

- Basic courses in *Automatic Control* and *Machine Learning/Deep Learning*
- Interested in NNs and coding (Matlab/Python/Julia)

**Supervisor:**

**Patricia Pauli**  
Zimmer 3.234

**Area:**

Control theory for neural networks

**Properties:**

- Type: BA
- 30% literature
- 40% theory
- 30% simulation

**Beginning:**

anytime

Weitere Informationen: [www.ist.uni-stuttgart.de/lehre/bama](http://www.ist.uni-stuttgart.de/lehre/bama)

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