Analysis and design of Lipschitz bounded neural networks – a control perspective

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Abstract:

Despite the numerous successful applications of neural networks in a variety of fields, they are black-box models that are not fully understood and lack robustness and stability guarantees. As a consequence, they are rarely used in safety-critical applications. To analyse or increase the robustness of the input-output mapping of a neural network, its Lipschitz constant has been used as a sensitivity measure to input perturbations and, in this talk, we are concerned with the problem of Lipschitz constant estimation for neural networks using semidefinite programming and the design of Lipschitz bounded neural networks using control tools. We consider the neural network as a dynamical system, matching the layer index with the time index, while allowing many different layer types to be included in the feedforward neural network architecture. Specifically, we discuss fully connected layers, convolutional layers, slope-restricted activations, and GroupSort activations. In this talk, we exploit the feedforward structure of the neural networks as well as the structure of the individual layers to develop scalable and accurate analysis and design methods for Lipschitz-bounded neural networks.