On Structure and Trade-offs in Analysis and Control of Large-scale Dynamical Networks

Andrej Jokić[1]

[1]*Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia*
andrej.jokic@fsb.hr

There exists a widely recognised need to better understand and manage complex large-scale dynamical networks, such as "smart" energy grids, biological networks or automated highways. Complexity, large-scale, interconnection/communication constraints and often non-existence of a suitable global model (e.g, due to confidentiality issues), require development of analytical and computational methods for tractable analysis and controller synthesis under structural constraints (e.g., plug-and-play requirements; structured stability/performance conditions; decentralized or distributed controllers). The key challenge is to develop a suitable framework which enables us to efficiently cope with inherent efficiency-robustness-scalability trade-offs in both analysis and control synthesis.

In this talk we will address the above challenges in parallel with presenting several recent results regarding structured stability and performance conditions for dynamical networks. The presented approach is based on the dissipativity theory and closely related integral quadratic constraints (IQC). For dissipativity conditions defined with static supply rates, we will relate dissipativity properties of individual systems in a network with existence of a structured Lyapunov function and with certain robustness properties. Furthermore, we will introduce the notion of differential supply rates and derive novel structured stability conditions based on storage functions with higher order derivatives. Relations with stability/performance conditions based on more standard IQCs will be presented and discussed. Several real-life examples will be presented in parallel to the theoretical results.