Analysis and Control of Nonnegative Dynamical Models with a Network Structure

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Abstract

Nonnegative dynamical models are frequently applied for the modeling of processes where the described quantities (state variables) changing in time and/or in space always remain in the nonnegative orthant. Such models can be used for the modeling of population dynamics, disease spreading, (bio)chemical and certain economic or transportation systems. It is known that nonnegative models possess several special control-related properties [1, 2]. For a wide class of nonnegative models, a directed graph structure can be naturally but often non-uniquely assigned, which is strongly related to fundamental dynamical properties such as the existence of equilibria, persistence, boundedness of solutions or even robust stability. The following recent results are summarized in the lecture. Firstly, an optimization-based approach is presented for the systematic design of network structures producing a given dynamics and possibly obeying structural constraints. Secondly, a control design method is shown which is suitable to computationally solve the feedback equivalence problem to a closed loop nonnegative system having a network structure and parametrization guaranteeing stability with a known Lyapunov function. Thirdly, some of the previously mentioned results are extended to nonnegative systems with time delay.

References

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Short Bio

Gábor Szederkényi is a professor at the Faculty of Information Technology and Bionics of the Pázmány Péter Catholic University, and a part-time scientific advisor at the Systems and Control Laboratory of the Institute for Computer Science and Control (SZTAKI), both in Budapest, Hungary. His background is computer engineering and nonlinear control. His main research interest is the computation-based analysis and control of nonlinear dynamical systems with special emphasis on models with biological and biochemical motivation. He is the author or co-author of three books with international publishers, more than 60 journal papers and about 105 conference papers. He was the advisor of 6 PhD graduates. He is the member of IEEE Control Systems Society, and served as the secretary of IEEE Hungary Section between 2010 and 2016.