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Stability and Consensus of Multi-Agent Systems via Nonlinear Perron-Frobenius Theory

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内容简介：

The study of how multiple autonomous agents, composing a Multi-Agent System (MAS), coordinate between them to achieve a desired global behavior has spurred much interest within the control community. A compelling global asymptotic behavior is the consensus, i.e., agreement, among all agents. From a control system perspective, the consensus problem consists in the design of local interaction rules between agents such that their state variables converge to the same value.

The case of agents modeled by linear discrete-time dynamical systems has been thoroughly investigated. The evolution of a linear MAS is described by a matrix, which is usually assumed to be nonnegative (all entries are zero or positive) and row-stochastic (all row-sums are equal to one). As a consequence, the theory for consensus in linear MAS has its roots in the theory developed by Perron and Frobenius for nonnegative matrices.

In this plenary I discuss the case of agents modeled by nonlinear discrete-time dynamical systems, whose evolution is described by a nonlinear map. In such a case, the properties of interest for consensus analysis are monotonicity and plus-homogeneity, which can be seen as the nonlinear counterpart of nonnegativity and row-stochasticity. Based on these notions, several nonlinear extensions of the classical Perron-Frobenius theory have been developed.

I will show that the evolution of an arbitrary nonlinear discrete-time dynamical system whose map is type-K monotone and plus-homogeneous eventually converges to an equilibrium point of the system, if any exists. Given a MAS it is possible to give necessary and sufficient conditions on the local interaction rule to guarantee that the map of the overall system satisfies the above-mentioned properties. Under mild conditions the existence of a globally reachable node in the communication graph is sufficient to converge to consensus. This approach can provide stability results --- and convergence to consensus as a special case --- based on the (distributed) structure of the system rather than on Lyapunov theory.

报告人简介：

Alessandro Giua received a *Laurea* degree in electrical engineering from the University of Cagliari, Italy, in 1988 and master’s and Ph.D. degrees in computer and systems engineering from the Rensselaer Polytechnic Institute, Troy, NY, USA, in 1990 and 1992, respectively. He is currently Professor of Automatic Control with the Department of Electrical and Electronic Engineering of the University of Cagliari.   His research interests include discrete-event systems, hybrid systems, networked control systems, Petri nets and failure diagnosis.

He has served as Editor-in-Chief of the IFAC journal *Nonlinear Analysis: Hybrid Systems*, Senior Editor of the *IEEE Trans. on Automatic Control*, and Department Editor of the journal *Discrete Event Dynamic Systems*.

He is a *Fellow of the IEEE* and a *Fellow of the IFAC* for contributions to Discrete-Event and Hybrid Systems. He is a recipient of the People's Republic of China *Friendship Award*.

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