BORSA N. 10

DAUSY

D.M. 351/2022

Ambito: PNRR
Tematica: “Model-based and data-driven learning and control of complex network systems”

Research theme title:

Model-based and data-driven learning and control of complex network systems

Contacts:

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Curriculum of DAUSY

C2 AS for Smart Environments

Hosting University/Research Centre

University of Salento

Department:

Department of Engineering for Innovation

Via per Monteroni

https://www.dii.unisalento.it/

Prospective Supervisors:

Prof. Gianfranco Parlangeli (https://www.unisalento.it/scheda-utente/-/people/gianfranco.parlangeli/)

Prof. Giuseppe Notarstefano (https://www.unibo.it/sitoweb/giuseppe.notarstefano/en)

Description:

The recent technology advances involving interconnected intelligent devices have posed new challenges in the design paradigms for complex systems. The interconnection topology and the local protocols fundamentally affect the dynamical processes of these complex networks and generate relevant collective features (such as aggregation/collaboration, consensus or clustering). Moreover, subsets of nodes may condition the global evolution or may be used to retrieve information on other nodes. Exploring the capabilities of the complex network and identifying main features of the network structure is a research challenge to address that can have a significant impact in several domains as traffic control, social networks, or swarm robotics. The interconnection among network clusters is often affected by adjustable local interaction, so that the value of local parameters may have a strong impact on the overall system performance. The design and tuning of these local interactions and parameters, e.g., by minimizing suitable global performance metrics (e.g., energy consumption) is a challenge to be addressed. Moreover, a timely research direction involves the combination of model-based system-theoretical tools with data-driven approaches (e.g., from Artificial Intelligence) that have shown to be extremely successful in several domains and that allow the designer to take advantage from the availability of massive data.

Considering the above framework, the proposed PhD program will deal with: (i) the investigation of network features with their impact on global behaviors and fundamental limitations of the complex system, (ii) novel approaches for the design of local interactions by taking into account performance indexes and global constraints, and (iii) the exploration of combined system theoretical approaches and data-driven tools to learn and control the network system. The developed methodological studies will be applied to concrete applications scenarios from cooperative robotics.

Specific Information:

Applicants must hold a master's degree in scientific disciplines, preferably in the area of Automation, Electrical or Information Engineering, Computer Science or Mathematics. Prior knowledge on control theory is required, prior knowledge on optimization and spectral graph theory is a plus. Confidence with the English language (B2 level) is required, proficiency in both spoken and written English is welcome. Good experience and confidence with mathematical simulation software is strongly recommended.

References:

[1]. Spectrum of controlling and observing complex networks. Yan, G., Tsekenis, G., Barzel, B., Slotine, J. J., Liu, Y. Y., & Barabási, A. L. (2015). Nature Physics, 11(9), 779-786.
[2]. Sultangazin, A., Pannocchi, L., Fraile, L., & Tabuada, P. (2022). Learning to control from expert demonstrations. *arXiv preprint arXiv:2203.05012*.
[3]. Tian, Y., Wang, L., & Bullo, F. (2022). How social influence affects the wisdom of crowds in influence networks. *arXiv preprint arXiv:2204.13610*.
[4]. -Yan, R., Duan, X., Shi, Z., Zhong, Y., Marden, J. R., & Bullo, F. (2021). Policy Evaluation and Seeking for Multi-Agent Reinforcement Learning via Best Response. *IEEE Transactions on Automatic Control Volume: 67, Issue: 4, April 2022*
[5]. Network Design for Controllability Metrics C. O. Becker, S. Pequito, G. J. Pappas, V. M. Preciado IEEE Transactions on Control of Network Systems, Vol. 7: 3, Sept. 2020
[6]. Asymmetric Coupling Optimizes Interconnected Consensus Systems Z Song, D Taylor - arXiv preprint arXiv:2106.13127, 2021

Type of scholarship:

DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

Study and research period outside the Hosting Institution:

DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

The study and research period abroad are expected to last from 6 to 9 months;

Hosting institution: Prof. Gesualdo Scutari

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