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Immediate Release

A breakthrough in estimating the size of a (mostly hidden) network

NYU Tandon School of Engineering professor gives researchers a new tool to understand computing, the spread of diseases like COVID-19, and other complex systems

BROOKLYN, New York, Wednesday, April 22, 2020 – A newly discovered connection between control theory and network dynamical systems could help estimate the size of a network even when a small portion is accessible.

Understanding the spread of coronavirus may be the most alarming and recent example of a problem that could benefit from fuller knowledge of network dynamical systems, but scientists and mathematicians have been grappling for years with ways to draw accurate inferences about these complex systems by working with partial data from available measurements.

In a new *Physical Review Letters* paper, New York University Tandon School of Engineering Institute Professor Maurizio Porfiri demonstrates a profound connection between mathematical control theory and the problem of determining the size of a network dynamical system from the time series of some accessible units. For homogeneous networks – in which every unit plays the same role – accessing a mere 10% of the units could be sufficient to exactly infer the size of the entire network, Porfiri concludes.

But the same approach fails for heterogenous networks, which are far more common in the field of complex systems: Think of the early stage of the novel coronavirus outbreak, in which every person experienced a widely different range of contacts due to their social and professional lives. Hence, the author recommends prudence in the inference of the size of a network dynamical system from available measurements when information on the nature of the network is lacking.

“From natural to technological settings, network dynamical systems constitute a powerful approach to study collective dynamics. The size of the system is arguably its most fundamental property, but seldom do we have access to such critical information," Porfiri explained. His research provides mathematical proof for a model-free approach published last year by researchers from the University of Oldenberg and the Technical University of Dresden.

Porfiri holds appointments in NYU Tandon's Departments of Mechanical and Aerospace Engineering; Biomedical Engineering; and Civil and Urban Engineering, as well as its Center for Urban Science and Progress.

"Validity and Limitations of the Detection Matrix to Determine Hidden Units and Network Size from Perceptible Dynamics" is available at https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.124.168301. The National Science Foundation funded the research.

About the New York University Tandon School of Engineering

The NYU Tandon School of Engineering dates to 1854, the founding date for both the New York University School of Civil Engineering and Architecture and the Brooklyn Collegiate and Polytechnic Institute (widely known as Brooklyn Poly). A January 2014 merger created a comprehensive school of education and research in engineering and applied sciences, rooted in a tradition of invention and entrepreneurship and dedicated to furthering technology in service to society. In addition to its main location in Brooklyn, NYU Tandon collaborates with other schools within NYU, one of the country's foremost private research universities, and is closely connected to engineering programs at NYU Abu Dhabi and NYU Shanghai. It operates Future Labs focused on start-up businesses in Brooklyn and an award-winning online graduate program. For more information, visit engineering.nyu.edu.

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