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INTRODUCTION

Introduction to the special issue on scientific networks

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Scholars have explored the science of science from a networks perspective from the early days of the study of social networks. Price (1965) pioneered the methodology and theoretical import of citation networks. Crane (1969) examined the social structure among scientists to test the invisible college hypothesis wherein groups of researchers working in a common area shared informal ties with one another. Indeed, science has been described as "a complex, self-organizing, and evolving network of scholars, projects, papers, and ideas" (Fortunato et al., 2018, p. 1). Hence, it is not surprising that scientific networks play a significant role within the larger domain of network science, focusing on the relational nature of scientific endeavors. And by doing so they have contributed to advances in network science while also contributing to the emergent debates about the transformation of science.

Recent trends in analysis of science transformation are focused on a rising demand for interdisciplinary collaboration, knowledge application, decreasing the gap between knowledge production and transfer to practice, and increasing interaction between science and other societal actors and spheres (industry and government). Research on scientific networks, with its relational nature, helps us to understand and enable these modern trends of science transformation across disciplines. It enables us to analyze the multidimensional networks encompassing scientists, scientific organizations, funding entities, publication outlets, and projects; to discover the reasons for their collaboration, integration, importance; and to measure their prestige, popularity, success, and social impact. In short, how and why collaborations form—and how they perform.

In light of these intellectual developments, a group of scholars, led by Anuška Ferligoj, Valentina Kuskova, and Dmitry Zaytsev, convened an International Workshop on Scientific Networks in Moscow, Russia, on July 20–21, 2019. Another special session on scientific networks was held at the Seventh International Workshop on Social Network Analysis at the University of Salerno, Italy, on October 29–31, 2019. The papers presented at these workshops, and the ensuing intellectual dialog, led to the development of a call for papers to this special issue of Network Science.

This special issue demonstrates the diversity of recent scholarship on scientific networks. This diversity is reflected in the types of scientific networks studied, the multiple theoretic frameworks utilized to formulate questions, the development, and deployment of advanced methods to analyze them, and their applicability to various scientific disciplines and other fields. The articles in this special issue represent only a quarter of all inquiries we received in response to the advertisement for this special issue. Yet, they cover the wide range of possible types of scientific networks: the nature and effectiveness of collaboration networks, issues related to quality of scientific networks data, development of new methodology for applied scientific network analysis, examining the effects of individual journals on the development of scientific networks, or development of entire fields.

The scope of the special issue was intentionally broad. The aim was to build bridges between scholars who study scientific networks in national, international, interdisciplinary, and other diverse contexts using relational approaches. They could accomplish these aims by developing new methodological, empirical, and/or theoretical insights. As such, articles in this special issue are a showcase for future research by addressing various topics on scientific networks across disciplines, methodological approaches, and possible applications.

1. Contributions by levels of analysis

Articles in this issue vary in terms of their level of analysis: they range from focusing on a journal, to one or multiple disciplines, to interdisciplinary projects and patents. The study by **Kuskova et al.** evaluates the contribution of the *Network Science* journal to the field of network science from two different perspectives. Three articles present their analyzes at a discipline level. **Lerner and Hancean** illustrate the use of a newly proposed relational hyperevent outcome models (RHOM) to examine the productivity of scientists in three disciplines: physics, medicine, and social sciences. The study by **Vitale et al.** examines the scientific community of statisticians; **Zaytsev et al.** assesses the field of political science. Two articles focus on interdisciplinary collaboration. The article by **Smith et al.** analyzes organizational project-level collaboration; **Lungeanu et al.** examines collaboration of 2.8 million team-invented patents.

In terms of levels of analysis, the articles in this special issue are also diverse from a geographical standpoint. Three of the studies focus on specific countries: **Smith et al.** - the UK, **Lungeanu et al.** - the US, **Vitale et al.** - Italy. **Lerner and Hancean** examine collaboration of scientists from the European Union. Articles by **Kuskova et al.** and **Zaytsev et al.** transcend geographical boundaries.

2. Contributions by types of network

Given the focus of the special issue, the types of networks presented in the studies fall primarily into two broad categories: collaboration networks and word co-occurrence networks. However, even within this broad classification, articles remain quite diverse. In the "collaboration networks" group authors examine networks of coauthorship (**Lerner and Hancean** and **Vitale et al.),** interorganizational collaboration (**Smith et al.),** and co-inventors (**Lungeanu et al.**). The individual focus of each study varies greatly.

Lerner and Hancean use the RHOM to evaluate the impact of a published paper using the hyperedge statistics as explanatory variables. They use the same explanatory variables to specify event rates (or explain which group of scientists copublish) and relational outcomes (impact of published papers). This enables them to answer the overarching question whether the factors that affect the likelihood of copublication also influence the impact of the published papers.

Vitale et al. focus their attention on the quality of coauthorship data, demonstrating ways to minimize bias in retrieving the data when constructing a coauthorship network of a target scientific community. Specifically, they adopted a novel data management process, demonstrating how to address quality issues such as duplicate records, disambiguation, and inclusion of authors external to the target population.

Smith et al. utilize an exponential random graph modeling approach to examine interorganizational collaboration in the UK research system. Expanding on existing knowledge, this study identified factors that underpin the formation of collaborative ties within and between different research councils in the UK, including the role of geography and belonging to an elite university "mission group."

Lungeanu et al., using extensive US patent data, leverage researchers' collaboration networks together with texts of their research output to measure expertise and diversity of research teams, capturing the breadth, and depth of inventors' prior knowledge. They identify patterns in scientific team expertise and provide novel empirical insight into expertise diversity and evolution of scientific networks over time.

Two articles examine the "word co-occurrence" group. The study by **Kuskova et al.** uses bibliometric networks as one of the ways to evaluate the contribution of *Network Science* journal to its discipline. This approach helps to answer a philosophical question of scientific contribution—whether the journal, less than ten years into its existence, has already established a solid "hard core" for the new discipline (Lakatos, 1968). Existence of a "hard core" may be indicative of a journal's solid contribution to the field.

The study by **Zaytsev et al.** uses bibliometric networks to systematically analyze the paradigms and subdisciplines in a fragmented field of political science. This is an exploratory study, not limited by subfield, region, or some other narrowing criterion, and it demonstrates the use of networks for extracting scientific paradigms, subdisciplines within a field, and presence of scientific integration in an evolving discipline.

3. Contributions by methods, metrics, and theories

Articles in this issue are also quite diverse in their methodological and theoretical contributions. Half of the articles are based on analysis of texts and all make use of longitudinal data. Taken together the papers propose new network metrics, develop new methods, and/or compare different methods on the same data.

Indeed this diversity is recognized in the study by **Kuskova et al.** which extends an existing typology to evaluate theoretical contribution and methodological rigor of articles published in *Network Science,* demonstrating that articles using both high level of theory building and methodological rigor tend to be more highly cited. In that regard, articles in this issue are well-positioned to help advance scientific networks: in addition to advancing network methodology, they test existing and develop new theories, reconceptualize old constructs, and expand existing typologies. By doing so, articles in this special issue serve as a beacon for advances in new network methods and metrics that will both contribute to, and be motivated by, the development of new network theories on the science of science (Wang & Barabasi, 2021). Indeed, the articles in this special issue reflects broader trends in the science of science. These include leveraging at scale the increasingly digital availability of novel data, including full text (Evans & Aceves, 2016), across different levels of analysis ranging from teams (Edgerton et al., 2022), organizations (Hollway et al., 2017), nations (Wagner & Jonkers, 2017), as well as across temporal scales (Wang et al., 2013).

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References

Crane, D. (1969). Social structure in a group of scientists: A test of the, invisible college. *hypothesis American Sociological Review*, *34*(3), 335–352.

Edgerton, J. F., Cranmer, S. J., & Finomore, V. (2022). How teams adapt to exogenous shocks: Experimental evidence with node knockouts of central members. *Network Science*, *10*(3), 261–282.

Evans, J. A., & Aceves, P. (2016). Machine translation: Mining text for social theory. *Annual Review of Sociology*, *42*(1), 21–50.

Fortunato, S., Bergstrom, C. T., Börner, K., Evans, J. A., Helbing, D., Milojević, S. . . . Barabási, A.-L. (2018). Science of science. *Science*, *359*(6379), p. eaao0185, doi: 10.1126/science.aao0185.

Hollway, J., Lomi, A., Pallotti, F., & Stadtfeld, C. (2017). Multilevel social spaces: The network dynamics of organizational fields. *Network Science*, *5*(2), 187–212.

Lakatos, I. (1968). Criticism and the methodology of scientific research programmes. In *Proceedings of the Aristotelian Society*, Vol. *69*, (pp. 149–186). Aristotelian Society, Oxford University Press on behalf of Wiley, Oxford, England.

Wagner, C. S., & Jonkers, K. (2017). Open countries have strong science. *Nature*, *550*(7674), 32–33.
Price, D. J. (1965). Networks of scientific papers. *Science*, *149*(3683), 510–515.
Wang, D., & Barabási, A. L. (2021). *The science of science*. Cambridge University Press, Cambridge, England.
Wang, D., Song, C., & Barabási, A. L. (2013). Quantifying long-term scientific impact. *Science*, *342*(6154), 127–132.

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