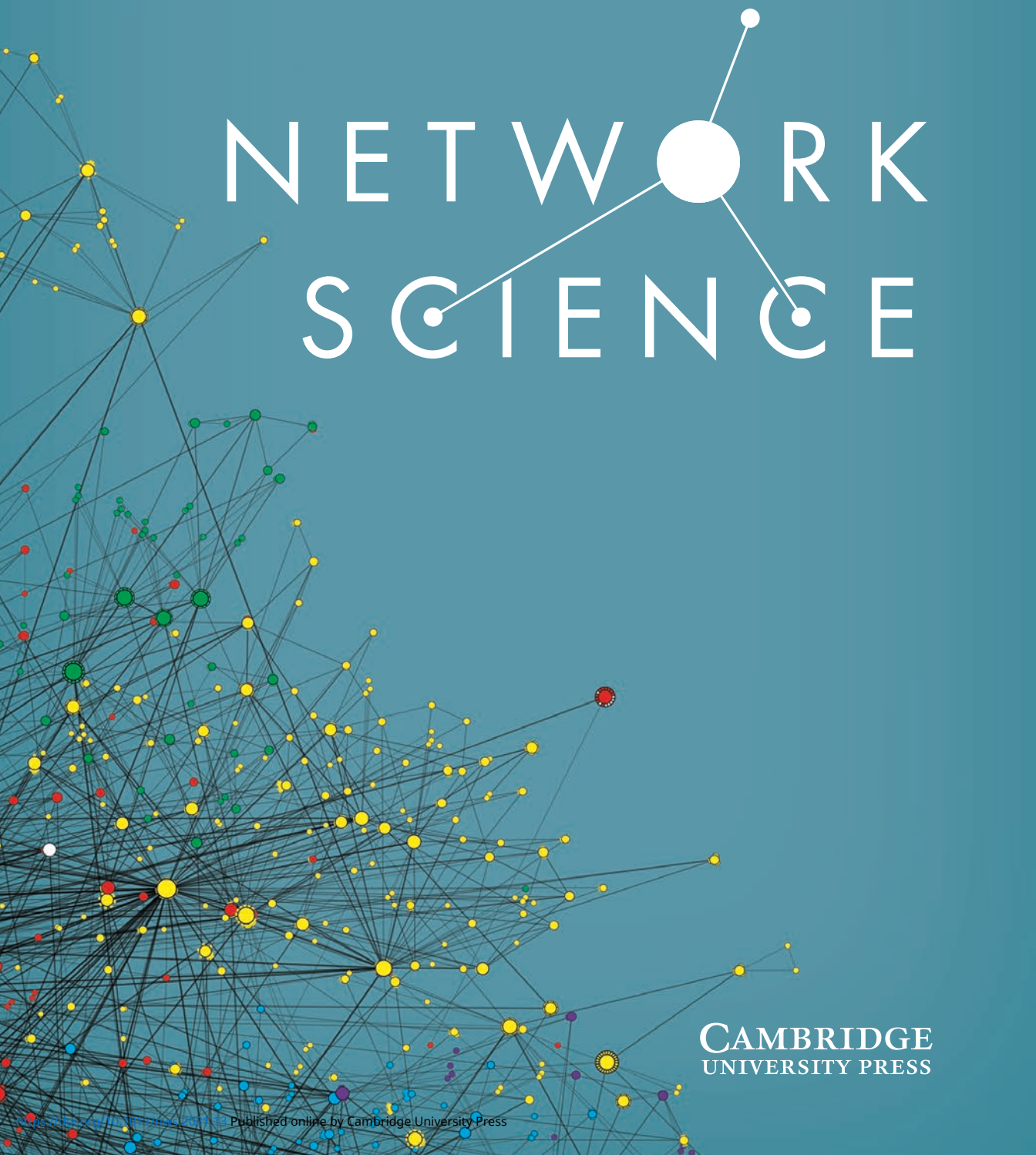


VOL. 9 • 2021 • NO. S1



# NETWORK SCIENCE

CAMBRIDGE  
UNIVERSITY PRESS

## Network Science Editorial Team

### EDITORS

**Ulrik Brandes** (Coordinating Editor),  
Computer Science and Mathematics, ETH Zürich, Switzerland  
**Noshir Contractor**, Communication, Management, and  
Computational Social Science, Northwestern University, USA  
**Marta Gonzalez**, Physics, UC Berkeley, USA  
**Laura Koehly**, Psychology, Public Health, and Medicine,  
National Human Genome Research Institute, USA  
**Filippo Menczer**, Information Science, Indiana University, USA  
**Fernando Vega-Redondo**, Economics, Bocconi University, Italy  
**Stanley Wasserman**, Statistics and Behavioral Science,  
Indiana University, USA

### DEPUTY EDITOR

**Christoph Stadtfeld**, ETH Zürich, Switzerland

### ASSOCIATE EDITORS

**Sinan Aral**, Information Science, Management, New York  
University, USA  
**Alain Barrat**, Physics, CNRS, France  
**Yann Bramoulle**, Economics, Aix-Marseille University, France  
**Dirk Brockmann**, Computer Science, Applied Mathematics,  
Northwestern University, USA  
**Nicholas Christakis**, Sociology, Medicine, Public Health, Yale  
University, USA  
**Jonathon Cummings**, Business, Duke University, USA  
**Padraig Cunningham**, Computer Science, University College  
Dublin, Ireland  
**Matthew Elliott**, Economics, California Institute of  
Technology, USA  
**Christos Faloutsos**, Computer Science, Data Mining,  
Carnegie-Mellon University, USA  
**Katherine Faust**, Sociology, University of California, Irvine, USA  
**James Fowler**, Political Science, Public Health, Genetics,  
University of California, San Diego, USA  
**Andrea Galeotti**, Economics, University of Essex, UK

**David Hunter**, Statistics, Pennsylvania State University, USA  
**Yoshihisa Kashima**, Psychology, University  
of Melbourne, Australia  
**Peter Key**, Mathematics, Microsoft Research, UK  
**Laura Koehly**, Psychology, National Human Genome Research  
Institute, USA  
**Eric Kolaczyk**, Statistics, Boston University, USA  
**David Krackhardt**, Public Policy, Business, Carnegie-Mellon  
University, USA  
**David Lazer**, Information Science, Political Science, Northeastern  
University, USA  
**Roger Leenders**, Business, Organization Studies, Tilburg  
University, Netherlands  
**Kristina Lerman**, Computer Science, ISI and University of  
Southern California, USA  
**Mark Lubell**, Political Science, Environmental Policy, University  
of California, Davis, USA  
**Winter Mason**, Psychology, Cognitive Science, Stevens Institute, USA  
**James Moody**, Sociology, Duke University, USA  
**Sue Moon**, Computer Science, Korea Advanced Institute of  
Science and Technology, Republic of Korea  
**Romualdo Pastor-Satorras**, Mathematics, Physics, Polytechnic  
University of Catalonia, Spain  
**Bernice Pescosolido**, Sociology, Indiana University, USA  
**Richard Rothenberg**, Public Health, Epidemiology, Georgia  
State University, USA  
**Olaf Sporns**, Psychology, Neuroscience, Indiana University, USA  
**Douglas Steinley**, Psychology, Statistics, University of Missouri, USA  
**Adam Szeidl**, Economics, Central European University, Hungary  
**Zoltan Toroczkai**, Physics, University of Notre Dame, USA

### MANAGING EDITOR

**Denise Weber**, ETH Zürich, Switzerland

## Network Science

*Network Science* is an important journal for an important discipline – one using the network paradigm, focusing on actors and relational linkages, to inform research, methodology, and applications from many fields across the natural, social, engineering and informational sciences. Given growing understanding of the interconnectedness and globalization of the world, network methods are an increasingly recognized way to research aspects of modern society along with the individuals, organizations, and other actors within it.

The discipline is ready for a comprehensive journal, open to papers from all relevant areas. *Network Science* is a defining work, shaping this new discipline. The journal welcomes contributions from researchers in all areas working on network theory, methods, and data.

### SUBSCRIPTION INFORMATION

*Network Science* (ISSN: 2050-1242) is published four times per year, in March, June, September, and December, by Cambridge University Press, One Liberty Plaza, 20th Floor, New York, NY 10006, USA. Periodicals postage rate paid at New York, NY, and at additional mailing offices. POSTMASTER: Send address changes in the USA, Canada, and Mexico to: *Network Science*, Cambridge University Press, Journals Fulfillment Department, One Liberty Plaza, 20th floor, New York, NY 10006. Send address changes elsewhere to *Network Science*, Cambridge University Press, Journals Fulfillment Department, UPH, Shaftesbury Road, Cambridge CB2 8BS, England.

The subscription price of Volume 9 (2021) including delivery by air where appropriate (but excluding VAT), is \$872.00 (£546.00) for institutions print and online; \$828.00 (£517.00) for institutions online only.

Orders, which must be accompanied by payment, may be sent to a bookseller, subscription agent or direct to the publisher: Cambridge University Press, Journals Fulfillment Department, Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA; or Cambridge University Press, University Printing House, Shaftesbury Road, Cambridge CB2 8BS, UK.

For further information, please contact [journals@cambridge.org](mailto:journals@cambridge.org).

### ADVERTISING

For information on display ad sizes, rates, and deadlines for copy, please contact [USAdSales@cambridge.org](mailto:USAdSales@cambridge.org).

### SUBMISSIONS

For submissions information, please visit [cambridge.org/NWS](http://cambridge.org/NWS).

ISSN: 2050-1242

EISSN: 2050-1250

Copyright © Cambridge University Press 2021. All rights reserved. No part of this publication may be reproduced, in any form or by any means, electronic, photocopying, or otherwise, without permission in writing from Cambridge University Press. Policies, request forms and contacts are available at: [cambridge.org/about-us/rights-permissions](http://cambridge.org/about-us/rights-permissions)

Permission to copy (for users in the U.S.A.) is available from Copyright Clearance Center <http://www.copyright.com>, email: [info@copyright.com](mailto:info@copyright.com).

# NETWORK SCIENCE

Volume 9

Number S1

COMPLEX NETWORKS 2019  
EDITED BY HOCINE CHERIFI AND LUIS M. ROCHA

## CONTENTS

<b>Introduction to the special issue on COMPLEX NETWORKS 2019</b> HOCINE CHERIFI AND LUIS M. ROCHA	S1
<b>Original Articles</b>	
Gradient and Harnack-type estimates for PageRank PAUL HORN AND LAUREN M. NELSEN	S4
Learning to count: A deep learning framework for graphlet count estimation XUTONG LIU, YU-ZHEN JANICE CHEN, JOHN C. S. LUI AND KONSTANTIN AVRACHENKOV	S23
On the impact of network size and average degree on the robustness of centrality measures CHRISTOPH MARTIN AND PETER NIEMEYER	S61
Isolation concepts applied to temporal clique enumeration HENDRIK MOLTER, ROLF NIEDERMEIER AND MALTE RENKEN	S83
A simple differential geometry for complex networks EMIL SAUCAN, AREEJIT SAMAL AND JÜRGEN JOST	S106
Sampling methods and estimation of triangle count distributions in large networks NELSON ANTUNES, TIANJIAN GUO AND VLADAS PIPIRAS	S134
Logic and learning in network cascades GALEN J. WILKERSON AND SOTIRIS MOSCHOYIANNIS	S157