Network Science in Archaeology

Network Science in Archaeology provides the first comprehensive guide to a field of research that has firmly established itself within archaeological practice in recent years. Network science methods are commonly used to explore big archaeological datasets and are essential for the formal study of past relational phenomena: social networks, transport systems, communication, and exchange. The volume offers a step-by-step description of network science methods and explores its theoretical foundations and applications in archaeological research, which are elaborately illustrated with archaeological examples. It also covers a vast range of network science techniques that can enhance archaeological research, including network data collection and management, exploratory network analysis, sampling issues and sensitivity analysis, spatial networks, and network visualization. An essential reference handbook for both beginning and experienced archaeological network researchers, the volume includes boxes with definitions, boxed examples, exercises, and online supplementary learning and teaching materials.

Tom Brughmans is Associate Professor of Classical Archaeology at the Centre for Urban Network Evolutions (UrbNet), Aarhus University. His research explores how social networks connected people throughout history, how large integrated economies like the Roman Empire could function for centuries, and how expansive communication systems using fire and smoke-signaling worked.

Matthew A. Peeples is Associate Professor of Anthropology in the School of Human Evolution and Social Change, and Director of the Center for Archaeology and Society at Arizona State University. His research focuses on integrating archaeological data with methods and models from the broader social sciences to address questions regarding the nature of human social networks over the long term.

Cambridge Manuals in Archaeology

Series Editors
Graeme Barker, *University of Cambridge*
Enrico R. Crema, *University of Cambridge*

Advisory Board
Peter Bogucki, *Princeton University*

Cambridge Manuals in Archaeology is a series of reference handbooks designed for an international audience of upper-level undergraduate and graduate students and professional archaeologists and archaeological scientists in universities, museums, research laboratories and field units. Each book includes a survey of current archaeological practice alongside essential reference material on contemporary techniques and methodology.

Books in the series

Vertebrate Taphonomy, R. LEE LYMAN
Photography in Archaeology and Conservation, 2nd edition, PETER G. DORRELL
Alluvial Geoarchaeology, A. G. BROWN
Shells, CHERYL CLAASEN
Sampling in Archaeology, CLIVE ORTON
Excavation, STEVE ROSKAMS
Teeth, 2nd edition, SIMON HILLSON
Lithics, 2nd edition, WILLIAM ANDREFSKY, JR.
Geographical Information Systems in Archaeology, JAMES CONOLLY and MARK LAKE
Demography in Archaeology, ANDREW CHAMBERLAIN
Analytical Chemistry in Archaeology, A. M. POLLARD, C.M. BATT, B. STERN and S. M. M. YOUNG
Zooarchaeology, 2nd edition, ELIZABETH J. REITZ and ELIZABETH S. WING
Quantitative Paleozoology, R. LEE LYMAN
Paleopathology, TONY WALDRON
Fishes, ALWYNE WHEELER and ANDREW K. G. JONES,
Archaeological Illustrations, LESLEY ADKINS and ROY ADKINS
Birds, DALE SERJEANTSON
Pottery in Archaeology, 2nd Edition, CLIVE ORTON and MICHAEL HUGHES
Quantitative Methods in Archaeology Using R, DAVID L. CARLSON
Applied Soils and Micromorphology in Archaeology, RICHARD I. MACPHAIL and PAUL GOLDBERG
Palaeopathology, 2nd edition, TONY WALDRON
Wood in Archaeology, LEE A. NEWSOM

Network Science in Archaeology

Tom Brughmans
Aarhus University

Matthew A. Peeples
Arizona State University

CAMBRIDGE
UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

103 Penang Road, #05-06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781009170666

DOI: 10.1017/9781009170659

First published 2023

Printed in the United Kingdom by TJ Books Ltd, Padstow Cornwall

A catalogue record for this publication is available from the British Library.

Library of Congress Cataloging-in-Publication Data
NAMES: Brughmans, Tom, author. | Peeples, Matthew A., author.
TITLE: Network science in archaeology / Tom Brughmans, University of Oxford, Matthew A. Peeples, Arizona State University.
DESCRIPTION: Cambridge, United Kingdom ; New York, NY : Cambridge University Press, 2022. | Series: Cambridge manuals in archaeology | Includes bibliographical references and index.
IDENTIFIERS: LCCN 2022050151 (print) | LCCN 2022050152 (ebook) | ISBN 9781009170666 (hardback) | ISBN 9781009170642 (paperback) | ISBN 9781009170659 (epub)
SUBJECTS: LCSH: Archaeology–Methodology. | Social sciences–Network analysis. | Social networks. | Social archaeology.
CLASSIFICATION: LCC CC79.S95 B78 2022 (print) | LCC CC79.S95 (ebook) | DDC 930.1028–dc23/eng/20221109
LC record available at https://lccn.loc.gov/2022050151
LC ebook record available at https://lccn.loc.gov/2022050152

ISBN 978-1-009-17066-6 Hardback
ISBN 978-1-009-17064-2 Paperback

CONTENTS

TABLES

BOXES

ACKNOWLEDGMENTS

This book has been a long time coming, and many have helped us along the way. Community is key to feeling you are making something for which there is a need: thank you to The Connected Past, Historical Network Research, Réseaux et Histoire, Computer Applications and Quantitative Methods in Archaeology (CAA), and to all those making Past Networks research shine at bigger conferences and communities such as the Society for American Archaeology (SAA) and the European Archaeology Association (EAA) meetings, SunBelt, and NetSci. We hope this book helps the community of archaeological network scientists grow even larger. Highly detailed and constructive reviews by Tim Evans, Enrico Crema, and Claire Lemercier significantly improved this book. We are also grateful to John Roberts Jr. and Keith Kintigh for providing detailed comments and help on specific sections of this book where we requested their insights. Any remaining errors are our own. We want to thank Beatrice Rehl at Cambridge University Press for guiding us through the process from idea to publication, Cory Stade for excellent copy editing and indexing work, and Jens Emil Bødstrup Christoffersen for detailed comments on the online resources and book. This publication was made possible thanks to the support of several generous funding sources, including the Carlsberg Foundation, in the context of the Past Social Networks Project (CF21–0382); the Danish National Research Foundation under the grant DNRF119 (UrbNet); the National Science Foundation through both the Archaeology and the Measurement, Methodology, and Statistics programs (grant nos. 1758690 and 1758606); and the School of Human Evolution and Social Change at Arizona State University.

Tom Brughmans: I am grateful to Anna Collar and Fiona Coward for kickstarting The Connected Past with me, a community that has greatly inspired this book. Thanks to everyone in the Nexus team of the Algorithmics group at the University

of Konstanz, Ulrik Brandes, Viviana Amati, Angus Mol, Mereke van Garderen, Daniel Weidele, Jan Athenstädt, Termeh Shafie, Habiba, Christina Agorastos; and to the UBICS team at the University of Barcelona, Albert Diaz-Guilera, Ignacio Morrer and Luce Prignano. These two teams have been instrumental in pushing me further outside my archaeology bubble, for my own good. Ian and Sten Brughmans and Iza Romanowska, thank you for everything. In memory of Simon Keay: your kindness and support made me thrive.

Matthew A. Peeples: I would like to thank my collaborators on cyberSW and related projects, including Barbara Mills, Jeffery Clark, Scott Ortman, Bill Doelle, John Roberts Jr., and so many others. Much of the work in this book spun out of conversations that started in our working groups, and this project would not be what it is without your input and insights. I would also like to thank my wonderful students and post-docs, including Caitlin Wichlacz, Robert Bischoff, Britt Davis, Kathrine Crawford, and Sarah Oas, for providing feedback on early drafts of this book, for helping to test methods and code, and for being a sounding board for questions and source of ideas and inspiration while this book developed. Finally, I would like to thank Melissa Kruse-Peeples and Owen Peeples for their constant love and support. Thank you both for being there for me and for always being ready to make me laugh and smile. I love you.

INTRODUCTION TO THE ONLINE RESOURCES ASSOCIATED WITH THIS BOOK

This book provides a detailed introduction to the concept of network research in archaeology as well as a guide to many specific network data management and analytical methods and models. The text of the book itself has been designed to stand alone and can be read and used without reference to any other external resources. We realize that many readers may want more guidance to help them get started doing actual analyses. To meet this need, we have created an elaborate Online Companion to the book (Peeples and Brughmans, 2022), which provides downloadable archaeological network datasets and an extensive Markdown document for the R programming language (R Core Team, 2021). This R Markdown document goes through examples of network data management and basic analysis techniques for all of the common methods and models covered in the book and also provides unique custom tools designed for more complex analyses such as assessments of uncertainty. Along with this, the Online Companion also contains all of the code and descriptions necessary to replicate the analyses in this book in R (or in a few cases, other software) as well as code needed to recreate data-based figures. The HTML version of the Online Companion is available at https://archnetworks.net and the raw R Markdown document and associated data, images, and code are also available on GitHub: https://github.com/mpeeples2008/ArchNetSci. These resources will be periodically updated by the authors and also include a public feedback function to allow users to ask questions, contribute data or methods, and develop resources for classroom teaching or self-teaching. We hope to build a community of active archaeological network researchers around these resources.