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Mathematical and Statistical Estimation Approaches in Epidemiology



Springer

Mathematical And Statistical Estimation Approaches In Epidemiology

Ping Yan, Gerardo Chowell



Mathematical And Statistical Estimation Approaches In Epidemiology:

Mathematical and Statistical Estimation Approaches in Epidemiology Gerardo Chowell, James M. Hayman, Luís M. A. Bettencourt, Carlos Castillo-Chavez, 2009-06-06 Mathematical and Statistical Estimation Approaches in Epidemiology compiles theoretical and practical contributions of experts in the analysis of infectious disease epidemics in a single volume. Recent collections have focused in the analyses and simulation of deterministic and stochastic models whose aim is to identify and rank epidemiological and social mechanisms responsible for disease transmission. The contributions in this volume focus on the connections between models and disease data with emphasis on the application of mathematical and statistical approaches that quantify model and data uncertainty. The book is aimed at public health experts, applied mathematicians and scientists in the life and social sciences, particularly graduate or advanced undergraduate students who are interested not only in building and connecting models to data but also in applying and developing methods that quantify uncertainty in the context of infectious diseases. Chowell and Brauer open this volume with an overview of the classical disease transmission models of Kermack-McKendrick including extensions that account for increased levels of epidemiological heterogeneity. Their theoretical tour is followed by the introduction of a simple methodology for the estimation of the basic reproduction number R . The use of this methodology is illustrated using regional data for 1918-1919 and 1968 in influenza pandemics.

Quantitative Methods for Investigating Infectious Disease Outbreaks Ping Yan, Gerardo Chowell, 2019-08-16 This book provides a systematic treatment of the mathematical underpinnings of work in the theory of outbreak dynamics and their control, covering balanced perspectives between theory and practice, including new material on contemporary topics in the field of infectious disease modelling. Specifically, it presents a unified mathematical framework linked to the distribution theory of non-negative random variables. The many examples used in the text are introduced and discussed in light of theoretical perspectives. The book is organized into 9 chapters. The first motivates the presentation of the material on subsequent chapters. Chapter 2-3 provides a review of basic concepts of probability and statistical models for the distributions of continuous lifetime data and the distributions of random counts and counting processes which are linked to phenomenological models. Chapter 4 focuses on dynamic behaviors of a disease outbreak during the initial phase, while Chapters 5-6 broadly cover compartment models to investigate the consequences of epidemics as the outbreak moves beyond the initial phase. Chapter 7 provides a transition between mostly theoretical topics in earlier chapters and Chapters 8 and 9, where the focus is on the data-generating processes and statistical issues of fitting models to data as well as specific mathematical epidemic modeling applications, respectively. This book is aimed at a wide audience ranging from graduate students to established scientists from quantitatively oriented fields of epidemiology, mathematics, and statistics. The numerous examples and illustrations make understanding of the mathematics of disease transmission and control accessible. Furthermore, the examples and exercises make the book suitable for motivated students in applied mathematics, either

through a lecture course or through self study This text could be used in graduate schools or special summer schools covering research problems in mathematical biology Mathematical Modeling and Validation in Physiology Jerry J. Batzel, Mostafa Bachar, Franz Kappel, 2012-12-14 This volume synthesizes theoretical and practical aspects of both the mathematical and life science viewpoints needed for modeling of the cardiovascular respiratory system specifically and physiological systems generally Theoretical points include model design model complexity and validation in the light of available data as well as control theory approaches to feedback delay and Kalman filter applications to parameter identification State of the art approaches using parameter sensitivity are discussed for enhancing model identifiability through joint analysis of model structure and data Practical examples illustrate model development at various levels of complexity based on given physiological information The sensitivity based approaches for examining model identifiability are illustrated by means of specific modeling examples The themes presented address the current problem of patient specific model adaptation in the clinical setting where data is typically limited *Biomat 2010 - International Symposium On Mathematical And Computational Biology* Rubem P Mondaini, 2011-03-11 This volume contains the selected contributed papers of the BIOMAT 2010 International Symposium which has been organized as a joint conference with the 2010 Annual Meeting of the Society for Mathematical Biology www.smb.org by invitation of the Director Board of this Society The works presented at Tutorial and Plenary Sessions by expert keynote speakers have been also included This book contains state of the art articles on special research topics on mathematical biology biological physics and mathematical modelling of biosystems comprehensive reviews on interdisciplinary areas written by prominent leaders of scientific research groups The treatment is both pedagogical and sufficiently advanced to enhance future scientific research Mathematical Tools for Understanding Infectious Disease Dynamics Odo Diekmann, Hans Heesterbeek, Tom Britton, 2012-11-18 Mathematical modeling is critical to our understanding of how infectious diseases spread at the individual and population levels This book gives readers the necessary skills to correctly formulate and analyze mathematical models in infectious disease epidemiology and is the first treatment of the subject to integrate deterministic and stochastic models and methods Mathematical Tools for Understanding Infectious Disease Dynamics fully explains how to translate biological assumptions into mathematics to construct useful and consistent models and how to use the biological interpretation and mathematical reasoning to analyze these models It shows how to relate models to data through statistical inference and how to gain important insights into infectious disease dynamics by translating mathematical results back to biology This comprehensive and accessible book also features numerous detailed exercises throughout full elaborations to all exercises are provided Covers the latest research in mathematical modeling of infectious disease epidemiology Integrates deterministic and stochastic approaches Teaches skills in model construction analysis inference and interpretation Features numerous exercises and their detailed elaborations Motivated by real world applications throughout The Oxford Handbook of Archaeological Network Research Tom

Brughmans, Barbara J. Mills, Jessica Munson, Matthew A. Peeples, 2024 This Handbook is the first authoritative reference work for archaeological network research featuring current topical trends and covering the archaeological application of network methods and theories

Mathematics of Public Health Jummy David, Jianhong Wu, 2023-12-30 This volume addresses SDG 3 from a mathematical standpoint sharing novel perspectives of existing communicable disease modelling technologies of the next generation and disseminating new developments in modelling methodologies and simulation techniques These methodologies are important for training and research in communicable diseases and can be applied to other threats to human health The contributions contained in this collection book cover a range of modelling techniques that have been and may be used to support decision making on critical health related issues such as Resource allocation Impact of climate change on communicable diseases Interaction of human behaviour change and disease spread Disease outbreak trajectories projection Public health interventions evaluation Preparedness and mitigation of emerging and re emerging infectious diseases outbreaks Development of vaccines and decisions around vaccine allocation and optimization The diseases and public health issues in this volume include but are not limited to COVID 19 HIV Influenza antimicrobial resistance AMR the opioid epidemic Lyme Disease Zika and Malaria In addition this volume compares compartmental models agent based models machine learning and network Readers have an opportunity to learn from the next generation perspective of evolving methodologies and algorithms in modelling infectious diseases the mathematics behind them the motivation for them and some applications to supporting critical decisions on prevention and control of communicable diseases This volume was compiled from the weekly seminar series organized by the Mathematics for Public Health MfPH Next Generation Network This network brings together the next generation of modellers from across Canada and the world developing the latest mathematical models modeling methodologies and analytical and simulation tools for communicable diseases of global public health concerns The weekly seminar series provides a unique forum for this network and their invited guest speakers to share their perspectives on the status and future directions of mathematics of public health

Control and Optimization with PDE Constraints Kristian Bredies, Christian Clason, Karl Kunisch, Gregory Winckel, 2013-06-12 Many mathematical models of physical biological and social systems involve partial differential equations PDEs The desire to understand and influence these systems naturally leads to considering problems of control and optimization This book presents important topics in the areas of control of PDEs and of PDE constrained optimization covering the full spectrum from analysis to numerical realization and applications Leading scientists address current topics such as non smooth optimization Hamilton Jacobi Bellmann equations issues in optimization and control of stochastic partial differential equations reduced order models and domain decomposition discretization error estimates for optimal control problems and control of quantum dynamical systems These contributions originate from the International Workshop on Control and Optimization of PDEs in Mariatrost in October 2011 This book is an excellent resource for students and researchers in control or optimization of differential

equations Readers interested in theory or in numerical algorithms will find this book equally useful *Mathematical and Experimental Modeling of Physical and Biological Processes* H.T. Banks, H.T. Tran, 2009-01-12 Through several case study problems from industrial and scientific research laboratory applications Mathematical and Experimental Modeling of Physical and Biological Processes provides students with a fundamental understanding of how mathematics is applied to problems in science and engineering For each case study problem the authors discuss why a model is needed and what goals can be achieved with the model Exploring what mathematics can reveal about applications the book focuses on the design of appropriate experiments to validate the development of mathematical models It guides students through the modeling process from empirical observations and formalization of properties to model analysis and interpretation of results The authors also describe the hardware and software tools used to design the experiments so faculty students can duplicate them Integrating real world applications into the traditional mathematics curriculum this textbook deals with the formulation and analysis of mathematical models in science and engineering It gives students an appreciation of the use of mathematics and encourages them to further study the applied topics Real experimental data for projects can be downloaded from CRC Press Online *Advances in the Mathematical Sciences* Gail Letzter, Kristin Lauter, Erin Chambers, Nancy Flourney, Julia Elisenda Grigsby, Carla Martin, Kathleen Ryan, Konstantina Trivisa, 2016-08-19 Presenting the latest findings in topics from across the mathematical spectrum this volume includes results in pure mathematics along with a range of new advances and novel applications to other fields such as probability statistics biology and computer science All contributions feature authors who attended the Association for Women in Mathematics Research Symposium in 2015 this conference the third in a series of biennial conferences organized by the Association attracted over 330 participants and showcased the research of women mathematicians from academia industry and government *Computational Science - ICCS 2023* Jiří Mikyška, Clélia de Mulatier, Maciej Paszynski, Valeria V. Krzhizhanovskaya, Jack J. Dongarra, Peter M.A. Sloot, 2023-06-27 The five volume set LNCS 14073 14077 constitutes the proceedings of the 23rd International Conference on Computational Science ICCS 2023 held in Prague Czech Republic during July 3 5 2023 The total of 188 full papers and 94 short papers presented in this book set were carefully reviewed and selected from 530 submissions 54 full and 37 short papers were accepted to the main track 134 full and 57 short papers were accepted to the workshops thematic tracks The theme for 2023 Computation at the Cutting Edge of Science highlights the role of Computational Science in assisting multidisciplinary research This conference was a unique event focusing on recent developments in scalable scientific algorithms advanced software tools computational grids advanced numerical methods and novel application areas These innovative novel models algorithms and tools drive new science through efficient application in physical systems computational and systems biology environmental systems finance and others *Handbook of Research on Computational Science and Engineering: Theory and Practice* Leng, J., Sharrock, Wes, 2011-10-31 By using computer simulations in research and development computational science and engineering CSE

allows empirical inquiry where traditional experimentation and methods of inquiry are difficult inefficient or prohibitively expensive The Handbook of Research on Computational Science and Engineering Theory and Practice is a reference for interested researchers and decision makers who want a timely introduction to the possibilities in CSE to advance their ongoing research and applications or to discover new resources and cutting edge developments Rather than reporting results obtained using CSE models this comprehensive survey captures the architecture of the cross disciplinary field explores the long term implications of technology choices alerts readers to the hurdles facing CSE and identifies trends in future development

Uncertainty Quantification Ralph C. Smith,2024-09-13 Uncertainty quantification serves a fundamental role when establishing the predictive capabilities of simulation models This book provides a comprehensive and unified treatment of the mathematical statistical and computational theory and methods employed to quantify uncertainties associated with models from a wide range of applications Expanded and reorganized the second edition includes advances in the field and provides a comprehensive sensitivity analysis and uncertainty quantification framework for models from science and engineering It contains new chapters on random field representations observation models parameter identifiability and influence active subspace analysis and statistical surrogate models and a completely revised chapter on local sensitivity analysis Other updates to the second edition are the inclusion of over 100 exercises and many new examples several of which include data and UQ Crimes listed throughout the text to identify common misconceptions and guide readers entering the field Uncertainty Quantification Theory Implementation and Applications Second Edition is intended for advanced undergraduate and graduate students as well as researchers in mathematics statistics engineering physical and biological sciences operations research and computer science Readers are assumed to have a basic knowledge of probability linear algebra differential equations and introductory numerical analysis The book can be used as a primary text for a one semester course on sensitivity analysis and uncertainty quantification or as a supplementary text for courses on surrogate and reduced order model construction and parameter identifiability analysis

Statistical Estimation of Epidemiological Risk Kung-Jong Lui,2004-04-02 Statistical Estimation of Epidemiological Risk provides coverage of the most important epidemiological indices and includes recent developments in the field A useful reference source for biostatisticians and epidemiologists working in disease prevention as the chapters are self contained and feature numerous real examples It has been written at a level suitable for public health professionals with a limited knowledge of statistics Other key features include Provides comprehensive coverage of the key epidemiological indices Includes coverage of various sampling methods and pointers to where each should be used Includes up to date references and recent developments in the field Features many real examples emphasising the practical nature of the book Each chapter is self contained allowing the book to be used as a useful reference source Includes exercises enabling use as a course text

Infectious Disease Informatics and Biosurveillance Daniel Zeng,Hsinchun Chen,Carlos Castillo-Chavez,William B. Lober,Mark Thurmond,2010-11-16 This book on Infectious

Disease Informatics IDI and biosurveillance is intended to provide an integrated view of the current state of the art identify technical and policy challenges and opportunities and promote cross disciplinary research that takes advantage of novel methodology and what we have learned from innovative applications This book also fills a systemic gap in the literature by emphasizing informatics driven perspectives e g information system design data standards computational aspects of biosurveillance algorithms and system evaluation Finally this book attempts to reach policy makers and practitioners through the clear and effective communication of recent research findings in the context of case studies in IDI and biosurveillance providing hands on in depth opportunities to practitioners to increase their understanding of value applicability and limitations of technical solutions This book collects the state of the art research and modern perspectives of distinguished individuals and research groups on cutting edge IDI technical and policy research and its application in biosurveillance The contributed chapters are grouped into three units Unit I provides an overview of recent biosurveillance research while highlighting the relevant legal and policy structures in the context of IDI and biosurveillance ongoing activities It also identifies IDI data sources while addressing information collection sharing and dissemination issues as well as ethical considerations Unit II contains survey chapters on the types of surveillance methods used to analyze IDI data in the context of public health and bioterrorism Specific computational techniques covered include text mining time series analysis multiple data streams methods ensembles of surveillance methods spatial analysis and visualization social network analysis and agent based simulation Unit III examines IT and decision support for public health event response and bio defense Practical lessons learned in developing public health and biosurveillance systems technology adoption and syndromic surveillance for large events are discussed The goal of this book is to provide an understandable interdisciplinary IDI and biosurveillance reference either used as a standalone textbook or reference for students researchers and practitioners in public health veterinary medicine biostatistics information systems computer science and public administration and policy

Disease Modelling and Public Health, Part A, 2017-10-13 Disease Modelling and Public Health Part A Volume 36 addresses new challenges in existing and emerging diseases with a variety of comprehensive chapters that cover Infectious Disease Modeling Bayesian Disease Mapping for Public Health Real time estimation of the case fatality ratio and risk factor of death Alternative Sampling Designs for Time To Event Data with Applications to Biomarker Discovery in Alzheimer s Disease Dynamic risk prediction for cardiovascular disease An illustration using the ARIC Study Theoretical advances in type 2 diabetes Finite Mixture Models in Biostatistics and Models of Individual and Collective Behavior for Public Health Epidemiology As a two part volume the series covers an extensive range of techniques in the field It present a vital resource for statisticians who need to access a number of different methods for assessing epidemic spread in population or in formulating public health policy Presents a comprehensive two part volume written by leading subject experts Provides a unique breadth and depth of content coverage Addresses the most cutting edge developments in the field Includes chapters on Ebola and the Zika virus

topics which have grown in prominence and scholarly output New Trends in the Applications of Differential Equations in Sciences Angela Slavova, 2023-03-17 This book convenes peer reviewed selected papers presented at the Ninth International Conference New Trends in the Applications of Differential Equations in Sciences NTADES held in Sozopol Bulgaria June 17 20 2022 The works are devoted to many applications of differential equations in different fields of science A number of phenomena in nature physics chemistry biology and in society economics result in problems leading to the study of linear and nonlinear differential equations stochastic equations statistics analysis numerical analysis optimization and more The main topics are presented in the five parts of the book applications in mathematical physics mathematical biology financial mathematics neuroscience and fractional analysis In this volume the reader will find a wide range of problems concerning recent achievements in both theoretical and applied mathematics The main goal is to promote the exchange of new ideas and research between scientists who develop and study differential equations and researchers who apply them for solving real life problems The book promotes basic research in mathematics leading to new methods and techniques useful for applications of differential equations The NTADES 2022 conference was organized in cooperation with the Society of Industrial and Applied Mathematics SIAM the major international organization for Industrial and Applied Mathematics and for the promotion of interdisciplinary collaboration between applied mathematics and science engineering finance and neuroscience **Computational Methods in Systems Biology** Milan Češka, David Šafránek, 2018-08-27 This book constitutes the refereed proceedings of the 16th International Conference on Computational Methods in Systems Biology CMSB 2018 held in BRNO Czech Republic in September 2018 The 15 full and 7 short papers presented together with 5 invited talks were carefully reviewed and selected from 46 submissions Topics of interest include formalisms for modeling biological processes models and their biological applications frameworks for model verification validation analysis and simulation of biological systems high performance computational systems biology parameter and model inference from experimental data automated parameter and model synthesis model integration and biological databases multi scale modeling and analysis methods design analysis and verification methods for synthetic biology methods for biomolecular computing and engineered molecular devices Chapters 3 9 and 10 are available open access under a Creative Commons Attribution 4 0 International License via link [springer.com](https://www.springer.com) Advanced Computing in Industrial Mathematics Ivan Georgiev, Hristo Kostadinov, Elena Lilkova, 2023-01-18 This book gathers the peer reviewed proceedings of the 15th Annual Meeting of the Bulgarian Section of the Society for Industrial and Applied Mathematics BGSIAM 20 held in Sofia Bulgaria The general theme of BGSIAM 20 was industrial and applied mathematics with particular focus on mathematical physics numerical analysis high performance computing optimization and control mathematical biology stochastic modeling machine learning digitization and imaging advanced computing in environmental and biomedical and engineering applications Mobile Computing Solutions for Healthcare Systems Sivakumar R., 2023-02-28 This book focuses on recent developments

in integrating AI machine learning methods medical image processing advanced network security and advanced antenna design techniques to implement practical Mobile Health M Health systems The editors bring together researchers and practitioners who address several developments in the field of M Health Chapters highlight intelligent healthcare IoT and Machine Learning based systems for personalized healthcare delivery and remote monitoring applications The contents also explain medical applications of computing technologies such as Wireless Body Area Networks WBANs wearable sensors multi factor authentication and cloud computing The book is intended as a handy resource for undergraduate and graduate biomedical engineering students and mobile technology researchers who want to know about the recent trends in mobile health technology

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