Introduction To Mathematical Epidemiology

An Introduction to Mathematical EpidemiologyMathematical EpidemiologyMathematical Epidemiology of Infectious DiseasesMathematical Models in EpidemiologyA Historical Introduction to Mathematical Modeling of Infectious DiseasesIntroduction to Mathematical BiologyA Course in Mathematical BiologyMathematical Modeling for Epidemiology and EcologyMathematical Tools for Understanding Infectious Disease DynamicsAge Structured Epidemic ModelingMathematical Population Dynamics and Epidemiology in Temporal and Spatio-Temporal DomainsMathematical and Statistical Modeling for Emerging and Re-emerging Infectious DiseasesAn Invitation to Mathematical BiologyAn Introduction to Mathematical Modeling of Infectious DiseasesModern Infectious Disease EpidemiologyDynamical Modeling and Analysis of EpidemicsMathematical Structures of Epidemic SystemsModeling Infectious Disease Parameters Based on Serological and Social Contact DataJournal of Mathematical BiologyMathematical Modeling and Soft Computing in Epidemiology Maia Martcheva Fred Brauer O. Diekmann Fred Brauer Ivo M. Foppa Ching Shan Chou Gerda de Vries Glenn Ledder Odo Diekmann Xue-Zhi Li Harkaran Singh Gerardo Chowell David G Costa Michael Y. Li Alexander Kr mer Zhien Ma Vincenzo Capasso Niel Hens Jyoti Mishra

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Introduction to Mathematical Modeling of Infectious Diseases Modern Infectious Disease Epidemiology Dynamical Modeling and Analysis of Epidemics Mathematical Structures of Epidemic Systems Modeling Infectious Disease Parameters Based on Serological and Social Contact Data Journal of Mathematical Biology Mathematical Modeling and Soft Computing in Epidemiology *Maia Martcheva Fred Brauer O. Diekmann Fred Brauer Ivo M. Foppa Ching Shan Chou Gerda de Vries Glenn Ledder Odo Diekmann Xue-Zhi Li Harkaran Singh Gerardo Chowell David G Costa Michael Y. Li Alexander Kr mer Zhien Ma Vincenzo Capasso Niel Hens Jyoti Mishra*

the book is a comprehensive self contained introduction to the mathematical modeling and analysis of infectious diseases it includes model building fitting to data local and global analysis techniques various types of deterministic dynamical models are considered ordinary differential equation models delay differential equation models difference equation models age structured pde models and diffusion models it includes various techniques for the computation of the basic reproduction number as well as approaches to the epidemiological interpretation of the reproduction number matlab code is included to facilitate the data fitting and the simulation with age structured models

based on lecture notes of two summer schools with a mixed audience from mathematical sciences epidemiology and public health this volume offers a comprehensive introduction to basic ideas and techniques in modeling infectious diseases for the comparison of strategies to plan for an anticipated epidemic or pandemic and to deal with a disease outbreak in real time it covers detailed case studies for diseases including pandemic influenza west nile virus and childhood diseases models for other diseases including severe acute respiratory syndrome fox rabies and sexually transmitted infections are included as applications its chapters are coherent and complementary independent units in order to accustom students to look at the current literature and to experience different perspectives no attempt has been made to achieve united writing style or unified notation notes on some mathematical background calculus matrix algebra differential equations and probability have been prepared and may be downloaded at the web site of the centre for disease modeling cdm yorku ca

mathematical epidemiology of infectious diseases model building analysis and interpretation o diekmann university of utrecht the netherlands j a p heesterbeek centre for biometry wageningen the netherlands the mathematical modelling of epidemics in populations is a vast and important area of study it is about translating biological assumptions into mathematics about mathematical analysis aided by interpretation and about obtaining insight into epidemic phenomena when translating mathematical results back into population biology model assumptions are formulated in terms of usually stochastic behaviour of individuals and then the resulting phenomena at the population level are unravelled conceptual clarity is attained assumptions are stated clearly hidden working hypotheses are attained and mechanistic links between different observables are exposed features model construction analysis and interpretation receive detailed attention uniquely covers both deterministic and stochastic viewpoints examples of applications given throughout extensive coverage of the latest research into the mathematical modelling of epidemics of infectious diseases provides a solid foundation of modelling skills the reader will learn to translate model analyse and interpret with the help of the numerous exercises in literally working through this text the reader acquires modelling skills that are also valuable outside of epidemiology certainly within population dynamics but even beyond that in addition the reader receives training in mathematical argumentation the text is aimed at applied mathematicians with an interest in population biology and epidemiology at theoretical biologists and epidemiologists previous exposure to epidemic concepts is not required as all background information is given the book is primarily aimed at self study and ideally suited for small discussion groups or for use as a course text

the book is a comprehensive self contained introduction to the mathematical modeling and analysis of disease transmission models it includes i an introduction to the main concepts of compartmental models including models with heterogeneous mixing of individuals and models for vector transmitted diseases ii a detailed analysis of models for important specific diseases including tuberculosis hiv aids influenza ebola virus disease malaria dengue fever and the zika virus iii an introduction to more advanced mathematical topics including age structure spatial structure and mobility and iv some challenges and opportunities for the future there are exercises of varying degrees of difficulty and projects leading to

new research directions for the benefit of public health professionals whose contact with mathematics may not be recent there is an appendix covering the necessary mathematical background there are indications which sections require a strong mathematical background so that the book can be useful for both mathematical modelers and public health professionals

a historical introduction to mathematical modeling of infectious diseases seminal papers in epidemiology offers step by step help on how to navigate the important historical papers on the subject beginning in the 18th century the book carefully and critically guides the reader through seminal writings that helped revolutionize the field with pointed questions prompts and analysis this book helps the non mathematician develop their own perspective relying purely on a basic knowledge of algebra calculus and statistics by learning from the important moments in the field from its conception to the 21st century it enables readers to mature into competent practitioners of epidemiologic modeling presents a refreshing and in depth look at key historical works of mathematical epidemiology provides all the basic knowledge of mathematics readers need in order to understand the fundamentals of mathematical modeling of infectious diseases includes questions prompts and answers to help apply historical solutions to modern day problems

this book is based on a one semester course that the authors have been teaching for several years and includes two sets of case studies the first includes chemostat models predator prey interaction competition among species the spread of infectious diseases and oscillations arising from bifurcations in developing these topics readers will also be introduced to the basic theory of ordinary differential equations and how to work with matlab without having any prior programming experience the second set of case studies were adapted from recent and current research papers to the level of the students topics have been selected based on public health interest this includes the risk of atherosclerosis associated with high cholesterol levels cancer and immune interactions cancer therapy and tuberculosis readers will experience how mathematical models and their numerical simulations can provide explanations that guide biological and biomedical research considered to be the undergraduate companion to the more advanced book mathematical modeling of biological

processes a friedman c y kao springer 2014 this book is geared towards undergraduate students with little background in mathematics and no biological background

this is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology included is an integrated package of theoretical modeling and analysis tools computational modeling techniques and parameter estimation and model validation methods with a focus on integrating analytical and computational tools in the modeling of biological processes divided into three parts it covers basic analytical modeling techniques introduces computational tools used in the modeling of biological problems and includes various problems from epidemiology ecology and physiology all chapters include realistic biological examples including many exercises related to biological questions in addition 25 open ended research projects are provided suitable for students an accompanying site contains solutions and a tutorial for the implementation of the computational modeling techniques calculations can be done in modern computing languages such as maple mathematica and matlab

mathematical modeling for epidemiology and ecology provides readers with the mathematical tools needed to understand and use mathematical models and read advanced mathematical biology books it presents mathematics in biological contexts focusing on the central mathematical ideas and the biological implications with detailed explanations the author assumes no mathematics background beyond elementary differential calculus an introductory chapter on basic principles of mathematical modeling is followed by chapters on empirical modeling and mechanistic modeling these chapters contain a thorough treatment of key ideas and techniques that are often neglected in mathematics books such as the akaike information criterion the second half of the book focuses on analysis of dynamical systems emphasizing tools to simplify analysis such as the routh hurwitz conditions and asymptotic analysis courses can be focused on either half of the book or thematically chosen material from both halves such as a course on mathematical epidemiology the biological content is self contained and includes many topics in epidemiology and ecology some of this material appears in case studies that focus

on a single detailed example and some is based on recent research by the author on vaccination modeling and scenarios from the covid 19 pandemic the problem sets feature linked problems where one biological setting appears in multi step problems that are sorted into the appropriate section allowing readers to gradually develop complete investigations of topics such as hiv immunology and harvesting of natural resources some problems use programs written by the author for matlab or octave these combine with more traditional mathematical exercises to give students a full set of tools for model analysis each chapter contains additional case studies in the form of projects with detailed directions new appendices contain mathematical details on optimization numerical solution of differential equations scaling linearization and sophisticated use of elementary algebra to simplify problems

this book 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 book introduces advanced mathematical methods and techniques for analysis and simulation of models in mathematical epidemiology chronological age and class age play an important role in the description of infectious diseases and this text provides the tools for the analysis of this type of partial differential equation models this book presents general theoretical tools as well as large number of specific examples to guide the reader to develop their own tools that they may then apply to study structured models in mathematical epidemiology the book will be a valuable addition to the arsenal of all researchers interested in developing theory or studying specific models with age structure

mankind now faces even more challenging environment and health related problems than ever before readily available transportation systems facilitate the swift spread of diseases as large populations migrate from one part of the world to another studies on the spread of the communicable diseases are very important this book mathematical population

dynamics and epidemiology in temporal and spatio temporal domains provides a useful experimental tool for making practical predictions building and testing theories answering specific questions determining sensitivities of the parameters forming control strategies and much more this volume focuses on the study of population dynamics with special emphasis on the migration of populations and the spreading of epidemics among human and animal populations it also provides the background needed to interpret construct and analyze a wide variety of mathematical models most of the techniques presented in the book can be readily applied to model other phenomena in biology as well as in other disciplines

the contributions by epidemic modeling experts describe how mathematical models and statistical forecasting are created to capture the most important aspects of an emerging epidemic readers will discover a broad range of approaches to address questions such as can we control ebola via ring vaccination strategies how quickly should we detect ebola cases to ensure epidemic control what is the likelihood that an ebola epidemic in west africa leads to secondary outbreaks in other parts of the world when does it matter to incorporate the role of disease induced mortality on epidemic models what is the role of behavior changes on ebola dynamics how can we better understand the control of cholera or ebola using optimal control theory how should a population be structured in order to mimic the transmission dynamics of diseases such as chlamydia ebola or cholera how can we objectively determine the end of an epidemic how can we use metapopulation models to understand the role of movement restrictions and migration patterns on the spread of infectious diseases how can we capture the impact of household transmission using compartmental epidemic models how could behavior dependent vaccination affect the dynamical outcomes of epidemic models the derivation and analysis of the mathematical models addressing these questions provides a wide ranging overview of the new approaches being created to better forecast and mitigate emerging epidemics this book will be of interest to researchers in the field of mathematical epidemiology as well as public health workers

the textbook is designed to provide a non intimidating entry to the field of mathematical biology it is also useful for those wishing to teach an introductory course although there are many good mathematical biology texts available most books are

too advanced mathematically for most biology majors unlike undergraduate math majors most biology major students possess a limited math background given that computational biology is a rapidly expanding field more students should be encouraged to familiarize themselves with this powerful approach to understand complex biological phenomena ultimately our goal with this undergraduate textbook is to provide an introduction to the interdisciplinary field of mathematical biology in a way that does not overly terrify an undergraduate biology major thereby fostering a greater appreciation for the role of mathematics in biology

this text provides essential modeling skills and methodology for the study of infectious diseases through a one semester modeling course or directed individual studies the book includes mathematical descriptions of epidemiological concepts and uses classic epidemic models to introduce different mathematical methods in model analysis matlab codes are also included for numerical implementations it is primarily written for upper undergraduate and beginning graduate students in mathematical sciences who have an interest in mathematical modeling of infectious diseases although written in a rigorous mathematical manner the style is not unfriendly to non mathematicians

hardly a day goes by without news headlines concerning infectious disease threats currently the spectre of a pandemic of influenza a h1n1 is raising its head and heated debates are taking place about the pro s and con s of vaccinating young girls against human papilloma virus for an evidence based and responsible communication of infectious disease topics to avoid misunderstandings and overreaction of the public we need solid scientific knowledge and an understanding of all aspects of infectious diseases and their control the aim of our book is to present the reader with the general picture and the main ideas of the subject the book introduces the reader to methodological aspects of epidemiology that are specific for infectious diseases and provides insight into the epidemiology of some classes of infectious diseases characterized by their main modes of transmission this choice of topics bridges the gap between scientific research on the clinical biological mathematical social and economic aspects of infectious diseases and their applications in public health the book will help the reader to understand the impact of infectious diseases on modern society and the instruments that policy makers have

at their disposal to deal with these challenges it is written for students of the health sciences both of curative medicine and public health and for experts that are active in these and related domains and it may be of interest for the educated layman since the technical level is kept relatively low

this timely book covers the basic concepts of the dynamics of epidemic disease presenting various kinds of models as well as typical research methods and results it introduces the latest results in the current literature especially those obtained by highly rated chinese scholars a lot of attention is paid to the qualitative analysis of models the sheer variety of models and the frontiers of mathematical epidemiology the process and key steps in epidemiological modeling and prediction are highlighted using transmission models of hiv aids sars and tuberculosis as application examples

the dynamics of infectious diseases represents one of the oldest and ri est areas of mathematical biology from the classical work of hamer 1906 and ross 1911 to the spate of more modern developments associated with anderson and may dietz hethcote castillo chavez and others the subject has grown dramatically both in volume and in importance given the pace of development the subject has become more and more di use and the need to provide a framework for organizing the diversity of mathematical approaches has become clear enzo capasso who has been a major contributor to the mathematical theory has done that in the present volume providing a system for organizing and analyzing a wide range of models depending on the str ture of the interaction matrix the rst class the quasi monotone or positive feedback systems can be analyzed e ectively through the use of comparison theorems that is the theory of order preserving dynamical systems the s ond the skew symmetrizable systems rely on lyapunov methods capasso develops the general mathematical theory and considers a broad range of amples that can be treated within one or the other framework in so doing he has provided the rst steps towards the uni cation of the subject and made an invaluable contribution to the lecture notes in biomathematics simon a levin princeton january 1993 author s preface to second printing in the preface to the first printing of this volume i wrote

mathematical epidemiology of infectious diseases usually involves describing the flow of individuals between mutually exclusive infection states one of the key parameters describing the transition from the susceptible to the infected class is the hazard of infection often referred to as the force of infection the force of infection reflects the degree of contact with potential for transmission between infected and susceptible individuals the mathematical relation between the force of infection and effective contact patterns is generally assumed to be subjected to the mass action principle which yields the necessary information to estimate the basic reproduction number another key parameter in infectious disease epidemiology it is within this context that the center for statistics censtat i biostat hasselt university and the centre for the evaluation of vaccination and the centre for health economic research and modelling infectious diseases cev chermid vaccine and infectious disease institute university of antwerp have collaborated over the past 15 years this book demonstrates the past and current research activities of these institutes and can be considered to be a milestone in this collaboration this book is focused on the application of modern statistical methods and models to estimate infectious disease parameters we want to provide the readers with software guidance such as r packages and with data as far as they can be made publicly available

this book describes the use of different mathematical modeling and soft computing techniques used in epidemiology for experiential research in projects such as how infectious diseases progress to show the likely outcome of an epidemic and to contribute to public health interventions

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