

scientific data analysis

Decoding the Universe: A Comprehensive Guide to Scientific Data Analysis

Introduction:

Are you drowning in a sea of scientific data, unsure how to navigate its depths and extract meaningful insights? In today's research landscape, the ability to effectively analyze scientific data is no longer a luxury, but a necessity. This comprehensive guide will equip you with the knowledge and understanding needed to master the art of scientific data analysis, transforming raw data into compelling scientific discoveries. We'll explore various techniques, tools, and best practices, empowering you to unlock the hidden potential within your datasets. From understanding fundamental statistical concepts to leveraging powerful software packages, this post provides a roadmap to becoming a proficient scientific data analyst.

What this post offers:

A clear understanding of the core principles of scientific data analysis.

A practical overview of commonly used statistical methods and their applications.

An introduction to essential software tools for data analysis.

Best practices for data cleaning, visualization, and interpretation.

Real-world examples and case studies to illustrate key concepts.

Guidance on avoiding common pitfalls in data analysis.

1. Understanding the Foundation: Types of Scientific Data & Descriptive Statistics

Scientific data comes in many forms: numerical (continuous or discrete), categorical (nominal or ordinal), and even textual or image-based. Understanding the nature of your data is crucial for selecting the appropriate analytical methods. Descriptive statistics – measures of central tendency (mean, median, mode), dispersion (variance, standard deviation, range), and shape (skewness, kurtosis) – provide the initial overview of your dataset, revealing patterns and potential outliers. Visualizations like histograms, box plots, and scatter plots are essential tools in this stage, helping you understand data distribution and identify potential anomalies.

1. Inferential Statistics: Hypothesis Testing and Confidence Intervals

Descriptive statistics paint a picture of your current data, but inferential statistics allow you to draw conclusions about a larger population based on your sample. Hypothesis testing involves formulating a null hypothesis (a statement of no effect) and an alternative hypothesis (a statement of the effect

you expect to observe). Statistical tests (t-tests, ANOVA, chi-square tests) are then used to assess the evidence against the null hypothesis. Confidence intervals provide a range of plausible values for a population parameter, offering a measure of uncertainty associated with your estimates. Choosing the appropriate statistical test depends on your data type, research question, and the assumptions of the chosen test.

1. Regression Analysis: Unveiling Relationships Between Variables

Regression analysis explores the relationship between a dependent variable and one or more independent variables. Linear regression models the relationship using a straight line, while more complex models (e.g., polynomial regression, logistic regression) can capture non-linear relationships. Regression analysis allows us to quantify the strength and direction of the relationship, predict the dependent variable based on the independent variables, and identify significant predictors. Interpreting regression coefficients and assessing the model's goodness of fit are crucial aspects of this technique.

1. Data Visualization: Communicating Your Findings Effectively

Data visualization is not just about creating pretty pictures; it's about communicating your findings in a clear, concise, and compelling manner. Choosing the right type of chart or graph (scatter plots, bar charts, line graphs, heatmaps) depends on the type of data and the message you want to convey. Effective visualizations should be easily understandable, avoid unnecessary clutter, and accurately represent the underlying data. Software packages like R and Python offer extensive visualization capabilities, enabling you to create high-quality graphics for publications and presentations.

1. Advanced Techniques: Machine Learning & Big Data Analysis

For increasingly large and complex datasets, advanced techniques like machine learning become essential. Machine learning algorithms, such as clustering, classification, and prediction models, can uncover hidden patterns, make predictions, and automate tasks that would be impossible with traditional statistical methods. Dealing with big data requires specialized tools and techniques to manage and process massive datasets efficiently, often involving distributed computing and cloud-based solutions.

1. Data Cleaning and Preprocessing: Essential Steps for Accurate Analysis

Before any analysis can begin, the data needs to be cleaned and preprocessed. This critical step involves handling missing values, identifying and correcting errors, transforming variables, and dealing with outliers. Data cleaning can be time-consuming but is crucial for ensuring the accuracy

and reliability of your results. Neglecting this stage can lead to biased and misleading conclusions.

1. Choosing the Right Software: A Toolkit for Scientific Data Analysis

A wide range of software packages are available for scientific data analysis. R and Python, with their extensive libraries (e.g., ggplot2, seaborn, scikit-learn), are popular choices among researchers due to their flexibility and open-source nature. Commercial packages like SPSS and SAS offer user-friendly interfaces and powerful statistical capabilities. The choice of software depends on your familiarity with programming languages, the complexity of your analysis, and the specific features needed.

1. Best Practices and Avoiding Common Pitfalls:

Successful scientific data analysis requires careful planning, rigorous methodology, and a critical approach. Avoiding common pitfalls, such as confirmation bias, overfitting, and inappropriate statistical tests, is essential for producing reliable and trustworthy results. Proper documentation of your analysis process, including data cleaning steps, statistical methods used, and interpretation of results, is crucial for reproducibility and transparency.

1. Conclusion: From Data to Discovery

Scientific data analysis is a journey, not a destination. By mastering the fundamental concepts, techniques, and tools discussed in this guide, you can transform raw data into valuable insights, fostering new discoveries and advancing scientific knowledge. Remember that continuous learning and adaptation are key to staying at the forefront of this rapidly evolving field. Embrace the challenges, explore new methods, and never stop questioning your results. The power to decode the universe lies within your data – learn how to unlock it.

Book Outline: "Unraveling the Data: A Practical Guide to Scientific Data Analysis"

Introduction: The importance of scientific data analysis in modern research.

Chapter 1: Types of scientific data and descriptive statistics.

Chapter 2: Inferential statistics: Hypothesis testing and confidence intervals.

Chapter 3: Regression analysis and exploring relationships between variables.

Chapter 4: Data visualization techniques for effective communication.

Chapter 5: Advanced techniques: Machine learning and big data analysis.

Chapter 6: Data cleaning and preprocessing: Best practices and techniques.

Chapter 7: Choosing the right software tools for your analysis.

Chapter 8: Avoiding common pitfalls and ensuring data integrity.

Conclusion: The future of scientific data analysis and its impact on research.

(Detailed explanation of each chapter would follow here, expanding on the points mentioned in the main blog post. Each chapter would be at least 150-200 words long, providing detailed examples and explanations.)

FAQs:

1. What is the difference between descriptive and inferential statistics? Descriptive statistics summarize data, while inferential statistics draw conclusions about a population from a sample.
1. What software is best for scientific data analysis? R and Python are popular open-source options, while SPSS and SAS are commercial alternatives. The best choice depends on your needs and skills.
1. How do I handle missing data in my dataset? Methods include imputation (replacing missing values with estimates), exclusion of incomplete cases, and using statistical methods robust to missing data.
1. What is p-value and how is it interpreted? A p-value is the probability of observing the data if the null hypothesis is true. A low p-value (typically <0.05) suggests evidence against the null hypothesis.
1. What is overfitting in machine learning? Overfitting occurs when a model performs well on training data but poorly on unseen data. It's caused by excessive complexity.
1. How do I choose the appropriate statistical test? The choice depends on data type, research question, and assumptions of the test (e.g., normality, independence).

1. What are the ethical considerations in scientific data analysis? Data privacy, transparency, and avoiding bias are crucial ethical considerations.
1. How can I improve the reproducibility of my data analysis? Thorough documentation, use of version control for code, and sharing data and code publicly enhance reproducibility.
1. What are some common pitfalls to avoid in data analysis? Confirmation bias, inappropriate statistical tests, ignoring outliers, and not checking assumptions are common pitfalls.

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experienced researcher. Basic calculus is used in some of the derivations, and no previous background in probability and statistics is required. The book includes many numerical tables of data, as well as exercises and examples to aid the readers' understanding of the topic.

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scientific data analysis: *Scientific Data Analysis* Richard L. Jr. Branham, 2012-12-06 This monograph is concerned with overdetermined systems, inconsistent systems with more equations than unknowns, in scientific data reduction. It is not a text on statistics, numerical methods, or matrix computations, although elements of all three, especially the latter, enter into the discussion. The reader I have in mind is a scientist or engineer who has gathered data that he or she wants to model by a mathematical system, perhaps linear, perhaps nonlinear, and solve to obtain the best estimates, in some sense of the term best, of various parameters. Because the calculations will be performed on a digital computer, the first chapter discusses floating-point numbers and their effect on mathematical operations. The chapter ends with some methods for accurately summing floating-point numbers, an operation frequently required in numerical work and one often done by the worst possible method, recursive summation. Chapter 2 gives a brief review of linear algebra and includes vector and matrix norms and condition numbers of matrices and linear systems. ' Chapter 3 presents some ideas for manipulating sparse matrices. Frequently, time or memory can be saved by use of sparse matrix techniques. The subject is extensive and the chapter is only indicative of the many techniques available. Although Chapter 3 is somewhat extraneous to the rest of the book, Chapter 5, on linear least squares, makes use of the compressed storage mode for the symmetric matrices discussed in Chapter 3.

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scientific data analysis: *Introduction to Data Science* Rafael A. Irizarry, 2019-11-20 *Introduction to Data Science: Data Analysis and Prediction Algorithms with R* introduces concepts and skills that can help you tackle real-world data analysis challenges. It covers concepts from probability, statistical inference, linear regression, and machine learning. It also helps you develop skills such as R programming, data wrangling, data visualization, predictive algorithm building, file organization with UNIX/Linux shell, version control with Git and GitHub, and reproducible document preparation. This book is a textbook for a first course in data science. No previous knowledge of R is necessary, although some experience with programming may be helpful. The book is divided into six parts: R, data visualization, statistics with R, data wrangling, machine learning, and productivity tools. Each part has several chapters meant to be presented as one lecture. The author uses motivating case studies that realistically mimic a data scientist's experience. He starts by asking specific questions and answers these through data analysis so concepts are learned as a means to answering the questions. Examples of the case studies included are: US murder rates by state, self-reported student heights, trends in world health and economics, the impact of vaccines on infectious disease rates, the financial crisis of 2007-2008, election forecasting, building a baseball team, image processing of hand-written digits, and movie recommendation systems. The statistical concepts used to answer the case study questions are only briefly introduced, so complementing with a probability and statistics textbook is highly recommended for in-depth understanding of these concepts. If you read and understand the chapters and complete the exercises, you will be prepared to learn the more advanced concepts and skills needed to become an expert.

scientific data analysis: R for Data Science Hadley Wickham, Garrett Golemund, 2016-12-12 Learn how to use R to turn raw data into insight, knowledge, and understanding. This book introduces you to R, RStudio, and the tidyverse, a collection of R packages designed to work together to make data science fast, fluent, and fun. Suitable for readers with no previous programming experience, *R for Data Science* is designed to get you doing data science as quickly as possible. Authors Hadley Wickham and Garrett Golemund guide you through the steps of importing, wrangling, exploring, and modeling your data and communicating the results. You'll get a complete, big-picture understanding of the data science cycle, along with basic tools you need to manage the details. Each section of the book is paired with exercises to help you practice what you've learned along the way. You'll learn how to: Wrangle—transform your datasets into a form convenient for analysis Program—learn powerful R tools for solving data problems with greater clarity and ease Explore—examine your data, generate hypotheses, and quickly test them Model—provide a low-dimensional summary that captures true signals in your dataset Communicate—learn R Markdown for integrating prose, code, and results

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concepts related to computed p-values to advanced topics related to analyzing highthroughput data. They include the R code that performs this analysis and connect the lines of code to the statistical and mathematical concepts explained.

scientific data analysis: *Data Analysis for Social Science* Elena Llaudet, Kosuke Imai, 2022-11-29 Data analysis has become a necessary skill across the social sciences, and recent advancements in computing power have made knowledge of programming an essential component. Yet most data science books are intimidating and overwhelming to a non-specialist audience, including most undergraduates. This book will be a shorter, more focused and accessible version of Kosuke Imai's Quantitative Social Science book, which was published by Princeton in 2018 and has been adopted widely in graduate level courses of the same title. This book uses the same innovative approach as Quantitative Social Science, using real data and 'R' to answer a wide range of social science questions. It assumes no prior knowledge of statistics or coding. It starts with straightforward, simple data analysis and culminates with multivariate linear regression models, focusing more on the intuition of how the math works rather than the math itself. The book makes extensive use of data visualizations, diagrams, pictures, cartoons, etc., to help students understand and recall complex concepts, provides an easy to follow, step-by-step template of how to conduct data analysis from beginning to end, and will be accompanied by supplemental materials in the appendix and online for both students and instructors--

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scientific data analysis: *Topological Data Analysis for Scientific Visualization* Julien Tierny, 2018-01-16 Combining theoretical and practical aspects of topology, this book provides a comprehensive and self-contained introduction to topological methods for the analysis and visualization of scientific data. Theoretical concepts are presented in a painstaking but intuitive manner, with numerous high-quality color illustrations. Key algorithms for the computation and

simplification of topological data representations are described in detail, and their application is carefully demonstrated in a chapter dedicated to concrete use cases. With its fine balance between theory and practice, Topological Data Analysis for Scientific Visualization constitutes an appealing introduction to the increasingly important topic of topological data analysis for lecturers, students and researchers.

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scientific data analysis: *Frontiers in Massive Data Analysis* National Research Council, Division on Engineering and Physical Sciences, Board on Mathematical Sciences and Their Applications, Committee on Applied and Theoretical Statistics, Committee on the Analysis of Massive Data, 2013-09-03 Data mining of massive data sets is transforming the way we think about crisis response, marketing, entertainment, cybersecurity and national intelligence. Collections of documents, images, videos, and networks are being thought of not merely as bit strings to be stored, indexed, and retrieved, but as potential sources of discovery and knowledge, requiring sophisticated analysis techniques that go far beyond classical indexing and keyword counting, aiming to find relational and semantic interpretations of the phenomena underlying the data. *Frontiers in Massive Data Analysis* examines the frontier of analyzing massive amounts of data, whether in a static database or streaming through a system. Data at that scale-terabytes and petabytes-is increasingly common in science (e.g., particle physics, remote sensing, genomics), Internet commerce, business analytics, national security, communications, and elsewhere. The tools that work to infer knowledge from data at smaller scales do not necessarily work, or work well, at such massive scale. New tools, skills, and approaches are necessary, and this report identifies many of them, plus promising research directions to explore. *Frontiers in Massive Data Analysis* discusses pitfalls in trying to infer knowledge from massive data, and it characterizes seven major classes of computation that are common in the analysis of massive data. Overall, this report illustrates the cross-disciplinary knowledge-from computer science, statistics, machine learning, and application disciplines-that must be brought to bear to make useful inferences from massive data.

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next presents basic concepts and techniques used for measurements of particle production cross-sections, correlation functions, and particle identification. Much attention is devoted to notions of statistical and systematic errors, beginning with intuitive discussions and progressively introducing the more formal concepts of confidence intervals, credible range, and hypothesis testing. The book also includes an in-depth discussion of the methods used to unfold or correct data for instrumental effects associated with measurement and process noise as well as particle and event losses, before ending with a presentation of elementary Monte Carlo techniques.

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scientific data analysis: Python for Data Analysis Wes McKinney, 2017-09-25 Get complete instructions for manipulating, processing, cleaning, and crunching datasets in Python. Updated for Python 3.6, the second edition of this hands-on guide is packed with practical case studies that show you how to solve a broad set of data analysis problems effectively. You'll learn the latest versions of pandas, NumPy, IPython, and Jupyter in the process. Written by Wes McKinney, the creator of the Python pandas project, this book is a practical, modern introduction to data science tools in Python. It's ideal for analysts new to Python and for Python programmers new to data science and scientific computing. Data files and related material are available on GitHub. Use the IPython shell and Jupyter notebook for exploratory computing Learn basic and advanced features in NumPy (Numerical Python) Get started with data analysis tools in the pandas library Use flexible tools to load, clean, transform, merge, and reshape data Create informative visualizations with matplotlib Apply the pandas groupby facility to slice, dice, and summarize datasets Analyze and manipulate regular and irregular time series data Learn how to solve real-world data analysis problems with thorough, detailed examples

scientific data analysis: Data Science Thinking Longbing Cao, 2018-08-17 This book explores answers to the fundamental questions driving the research, innovation and practices of the latest revolution in scientific, technological and economic development: how does data science transform existing science, technology, industry, economy, profession and education? How does one remain competitive in the data science field? What is responsible for shaping the mindset and skillset of data scientists? Data Science Thinking paints a comprehensive picture of data science as a new scientific paradigm from the scientific evolution perspective, as data science thinking from the scientific-thinking perspective, as a trans-disciplinary science from the disciplinary perspective, and as a new profession and economy from the business perspective.

scientific data analysis: Bayesian Ideas and Data Analysis Ronald Christensen, Wesley Johnson, Adam Branscum, Timothy E Hanson, 2011-07-07 Emphasizing the use of WinBUGS and R to analyze real data, Bayesian Ideas and Data Analysis: An Introduction for Scientists and Statisticians presents statistical tools to address scientific questions. It highlights foundational issues in statistics, the importance of making accurate predictions, and the need for scientists and

statisticians to collaborate in analyzing data. The WinBUGS code provided offers a convenient platform to model and analyze a wide range of data. The first five chapters of the book contain core material that spans basic Bayesian ideas, calculations, and inference, including modeling one and two sample data from traditional sampling models. The text then covers Monte Carlo methods, such as Markov chain Monte Carlo (MCMC) simulation. After discussing linear structures in regression, it presents binomial regression, normal regression, analysis of variance, and Poisson regression, before extending these methods to handle correlated data. The authors also examine survival analysis and binary diagnostic testing. A complementary chapter on diagnostic testing for continuous outcomes is available on the book's website. The last chapter on nonparametric inference explores density estimation and flexible regression modeling of mean functions. The appropriate statistical analysis of data involves a collaborative effort between scientists and statisticians. Exemplifying this approach, *Bayesian Ideas and Data Analysis* focuses on the necessary tools and concepts for modeling and analyzing scientific data. Data sets and codes are provided on a supplemental website.

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scientific data analysis: *Analysis of Biological Data* Sanghamitra Bandyopadhyay, 2007 Bioinformatics, a field devoted to the interpretation and analysis of biological data using computational techniques, has evolved tremendously in recent years due to the explosive growth of biological information generated by the scientific community. Soft computing is a consortium of methodologies that work synergistically and provides, in one form or another, flexible information processing capabilities for handling real-life ambiguous situations. Several research articles dealing with the application of soft computing tools to bioinformatics have been published in the recent past;

however, they are scattered in different journals, conference proceedings and technical reports, thus causing inconvenience to readers, students and researchers. This book, unique in its nature, is aimed at providing a treatise in a unified framework, with both theoretical and experimental results, describing the basic principles of soft computing and demonstrating the various ways in which they can be used for analyzing biological data in an efficient manner. Interesting research articles from eminent scientists around the world are brought together in a systematic way such that the reader will be able to understand the issues and challenges in this domain, the existing ways of tackling them, recent trends, and future directions. This book is the first of its kind to bring together two important research areas, soft computing and bioinformatics, in order to demonstrate how the tools and techniques in the former can be used for efficiently solving several problems in the latter.

Sample Chapter(s). Chapter 1: Bioinformatics: Mining the Massive Data from High Throughput Genomics Experiments (160 KB). Contents: Overview: Bioinformatics: Mining the Massive Data from High Throughput Genomics Experiments (H Tang & S Kim); An Introduction to Soft Computing (A Konar & S Das); Biological Sequence and Structure Analysis: Reconstructing Phylogenies with Memetic Algorithms and Branch-and-Bound (J E Gallardo et al.); Classification of RNA Sequences with Support Vector Machines (J T L Wang & X Wu); Beyond String Algorithms: Protein Sequence Analysis Using Wavelet Transforms (A Krishnan & K-B Li); Filtering Protein Surface Motifs Using Negative Instances of Active Sites Candidates (N L Shrestha & T Ohkawa); Distill: A Machine Learning Approach to Ab Initio Protein Structure Prediction (G Pollastri et al.); In Silico Design of Ligands Using Properties of Target Active Sites (S Bandyopadhyay et al.); Gene Expression and Microarray Data Analysis: Inferring Regulations in a Genomic Network from Gene Expression Profiles (N Noman & H Iba); A Reliable Classification of Gene Clusters for Cancer Samples Using a Hybrid Multi-Objective Evolutionary Procedure (K Deb et al.); Feature Selection for Cancer Classification Using Ant Colony Optimization and Support Vector Machines (A Gupta et al.); Sophisticated Methods for Cancer Classification Using Microarray Data (S-B Cho & H-S Park); Multiobjective Evolutionary Approach to Fuzzy Clustering of Microarray Data (A Mukhopadhyay et al.). Readership: Graduate students and researchers in computer science, bioinformatics, computational and molecular biology, artificial intelligence, data mining, machine learning, electrical engineering, system science; researchers in pharmaceutical industries.

scientific data analysis: Object Oriented Data Analysis J. S. Marron, Ian L. Dryden, 2021-11-18 Object Oriented Data Analysis is a framework that facilitates inter-disciplinary research through new terminology for discussing the often many possible approaches to the analysis of complex data. Such data are naturally arising in a wide variety of areas. This book aims to provide ways of thinking that enable the making of sensible choices. The main points are illustrated with many real data examples, based on the authors' personal experiences, which have motivated the invention of a wide array of analytic methods. While the mathematics go far beyond the usual in statistics (including differential geometry and even topology), the book is aimed at accessibility by graduate students. There is deliberate focus on ideas over mathematical formulas. J. S. Marron is the Amos Hawley Distinguished Professor of Statistics, Professor of Biostatistics, Adjunct Professor of Computer Science, Faculty Member of the Bioinformatics and Computational Biology Curriculum and Research Member of the Lineberger Cancer Center and the Computational Medicine Program, at the University of North Carolina, Chapel Hill. Ian L. Dryden is a Professor in the Department of Mathematics and Statistics at Florida International University in Miami, has served as Head of School of Mathematical Sciences at the University of Nottingham, and is joint author of the acclaimed book Statistical Shape Analysis.

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automated collection, analysis, and distribution of very large datasets. It offers a brief and accessible overview of many common statistical and algorithmic data science techniques, explains human-centered approaches to data science problems, and presents practical guidelines and real-world case studies to help readers apply these methods. The authors explain how data scientists' choices are involved at every stage of the data science workflow—and show how a human-centered approach can enhance each one, by making the process more transparent, asking questions, and considering the social context of the data. They describe how tools from social science might be incorporated into data science practices, discuss different types of collaboration, and consider data storytelling through visualization. The book shows that data science practitioners can build rigorous and ethical algorithms and design projects that use cutting-edge computational tools and address social concerns.

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scientific data analysis: Intelligent Data Analysis Michael R. Berthold, David J Hand, 2007-06-07 This second and revised edition contains a detailed introduction to the key classes of intelligent data analysis methods. The twelve coherently written chapters by leading experts provide complete coverage of the core issues. The first half of the book is devoted to the discussion of classical statistical issues. The following chapters concentrate on machine learning and artificial intelligence, rule induction methods, neural networks, fuzzy logic, and stochastic search methods. The book concludes with a chapter on visualization and an advanced overview of IDA processes.

scientific data analysis: Econometric Forecasting and High-frequency Data Analysis Roberto S. Mariano, Yiu Kuen Tse, 2008 This important book consists of surveys of high-frequency financial data analysis and econometric forecasting, written by pioneers in these areas including Nobel laureate Lawrence Klein. Some of the chapters were presented as tutorials to an audience in the Econometric Forecasting and High-Frequency Data Analysis Workshop at the Institute for Mathematical Science, National University of Singapore in May 2006. They will be of interest to researchers working in macroeconometrics as well as financial econometrics. Moreover, readers will find these chapters useful as a guide to the literature as well as suggestions for future research. Sample Chapter(s). Foreword (32 KB). Chapter 1: Forecast Uncertainty, Its Representation and Evaluation* (97 KB). Contents: Forecasting Uncertainty, Its Representation and Evaluation (K F Wallis); The University of Pennsylvania Models for High-Frequency Macroeconomic Modeling (L R Klein & S Ozmurur); Forecasting Seasonal Time Series (P H Franses); Car and Affine Processes (C Gourioux); Multivariate Time Series Analysis and Forecasting (M Deistler). Readership: Professionals and researchers in econometric forecasting and financial data analysis.

scientific data analysis: Reproducibility and Replicability in Science National Academies of Sciences, Engineering, and Medicine, Policy and Global Affairs, Committee on Science, Engineering, Medicine, and Public Policy, Board on Research Data and Information, Division on Engineering and Physical Sciences, Committee on Applied and Theoretical Statistics, Board on Mathematical Sciences and Analytics, Division on Earth and Life Studies, Nuclear and Radiation Studies Board, Division of Behavioral and Social Sciences and Education, Committee on National Statistics, Board on Behavioral, Cognitive, and Sensory Sciences, Committee on Reproducibility and Replicability in Science, 2019-10-20 One of the pathways by which the scientific community confirms the validity of a new scientific discovery is by repeating the research that produced it. When a scientific effort fails to independently confirm the computations or results of a previous study, some fear that it may be a symptom of a lack of rigor in science, while others argue that such an observed inconsistency can be an important precursor to new discovery. Concerns about reproducibility and replicability have been expressed in both scientific and popular media. As these concerns came to light, Congress requested that the National Academies of Sciences, Engineering, and Medicine conduct a study to assess the extent of issues related to reproducibility and replicability and to offer recommendations for improving rigor and transparency in scientific research. Reproducibility and Replicability in Science defines reproducibility and replicability and examines the factors that may lead to non-reproducibility and non-replicability in research. Unlike the typical expectation of reproducibility between two computations, expectations about replicability are more nuanced, and in

some cases a lack of replicability can aid the process of scientific discovery. This report provides recommendations to researchers, academic institutions, journals, and funders on steps they can take to improve reproducibility and replicability in science.

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