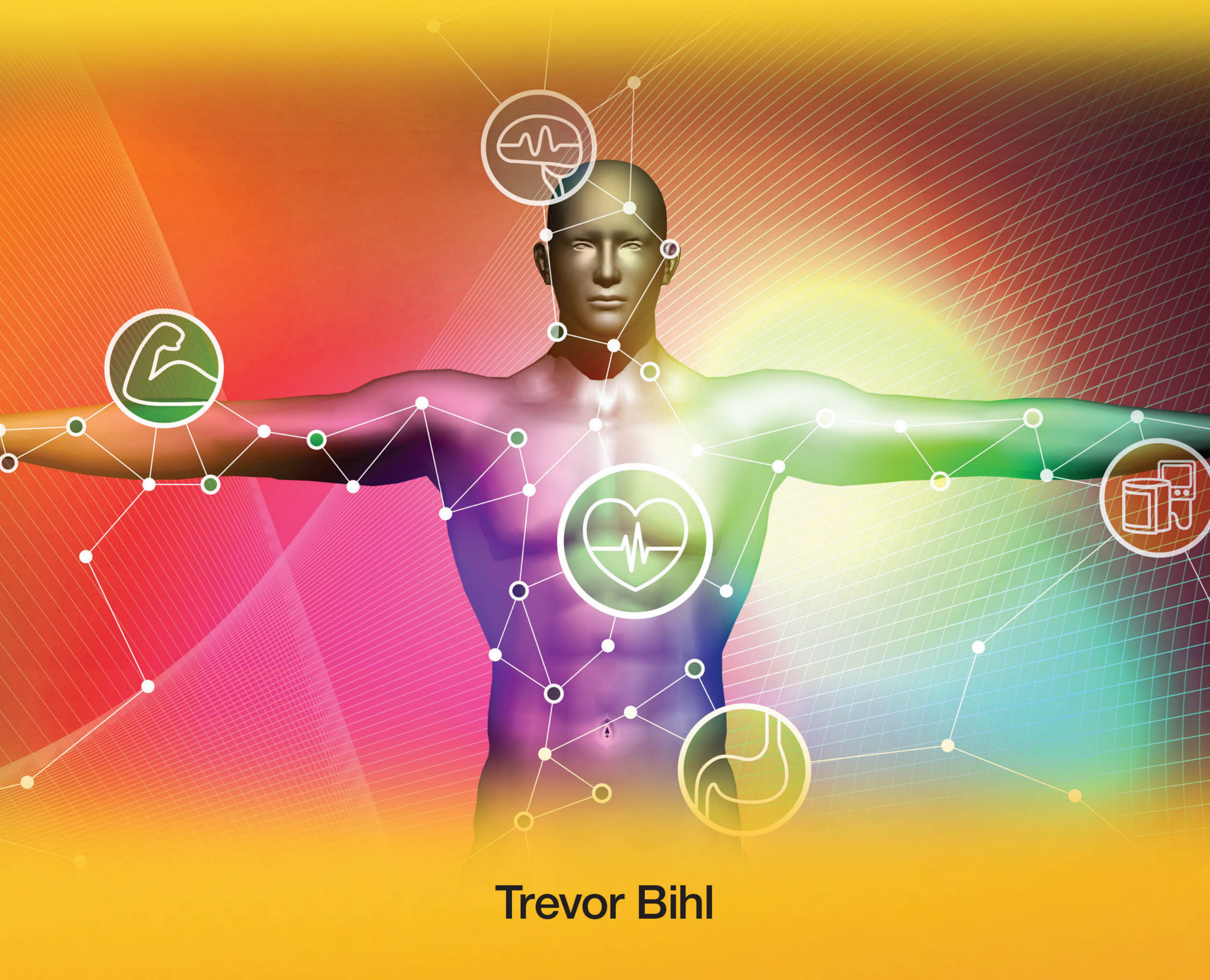
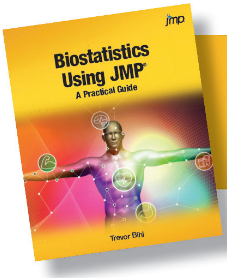
Biostatistics Using JMP®

A Practical Guide



Trevor Bihl



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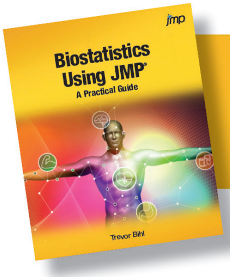


Chapter 1: Introduction

1.1 Background and Overview

This book evolved from personal experiences in both teaching and consulting in biostatistics. Although many biostatistics textbooks show computer outputs and results, they rarely show how to generate the results. Biostatistics instruction is also commonly theoretical and based on solving simple problems by hand. However, real-world data is usually more complicated than the simple examples, and I found that frequent collaborators–PhD-educated researchers who performed and managed experiments–needed more understanding of software to analyze their data. This is difficult because such researchers often spend a majority of their time performing experiments and use statistical software sparingly. They also often do not have access to a dedicated biostatistician in their office or are competing for the time of their office’s single biostatistician. Although such researchers might know the mechanics of a statistical method, they might not how to generate meaningful results using software.

Therefore, a practical, how-to guide to biostatistics was needed. There are many software applications available for statistics and biostatistics, so why JMP? As an educator, I found JMP an advantage to teaching. I could spend more time on theory and interpretation because JMP does not require scripts and syntax. As a collaborator and consultant, I found my colleagues would readily gravitate toward JMP and its results because of the graphical user interface (GUI) format and its ease of use. And finally, unless you want to code algorithms themselves, as a researcher, you will find JMP to be more user-friendly, correct, and developed when compared to many other competing packages. Incidentally, if you want to code, SAS programming abilities do exist in JMP. Thus, you can fully use JMP for analysis ranging from simple to complex and customized.

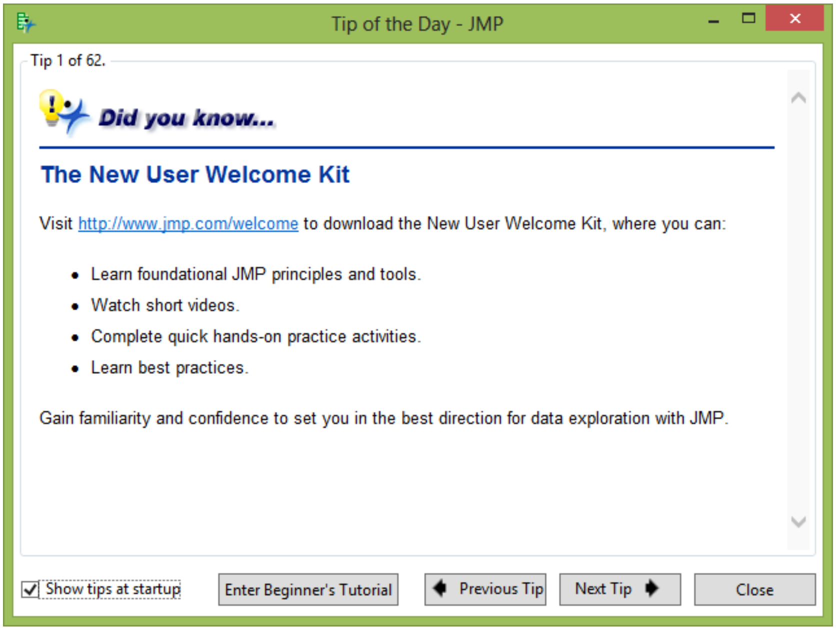
This book presents and solves problems germane to biostatistics with easy-to-reproduce examples. The book is also a general biostatistics reference that leverages the topics found in leading biostatistics books. This chapter introduces JMP, presents a general outline of the book contents, and provides a brief guide to using this book.

1.2 Getting Started with JMP

When you first run JMP, you will be greeted with a **Tip of the Day** (Figure 1.1). There are 62 tips of the day, and they show up whenever you start JMP. These tips can be useful to new JMP users in gaining familiarity with the software. However, if you don't want to see these tips further, you can do the following:

1. Clear **Show tips at start-up**.
2. Click **Close**.

Figure 1.1 Initial Tip of the Day



The New User Welcome Kit

Visit http://www.jmp.com/welcome to download the New User Welcome Kit, where you can:

- Learn foundational JMP principles and tools.
- Watch short videos.
- Complete quick hands-on practice activities.
- Learn best practices.

Gain familiarity and confidence to set you in the best direction for data exploration with JMP.

After you close the **Tip of the Day**, you are greeted with the primary JMP interface seen in Figure 1.2. Here, you can load data, create a new data table, or look for recently used files. If this is the first time you have opened JMP, there will be no recent files to consider. Thus, you must load or create a new data table.

To load a file:

- Click **File ▶ Open**.

or

- Click on the third icon on the taskbar.

To create a blank data table:

- Click **File ▶ New**.

or

- Click on the first icon on the taskbar.

Alternatively, if you want to load a built in JMP example data file, you can do so. A variety of files are available.

To load example data files:

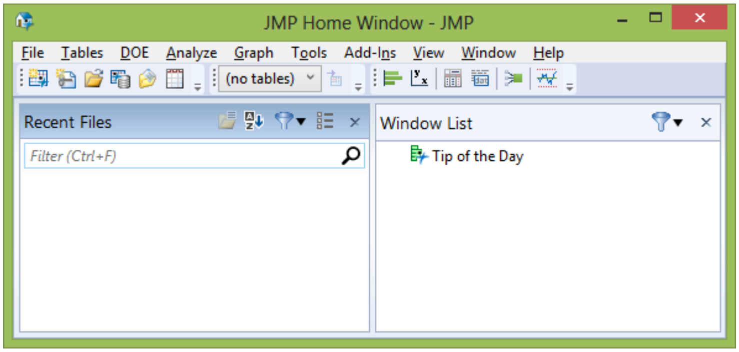
1. Click **Help ► Sample Data**.
2. Select a data file under the method of interest.

Also, you can select individual or multiple data tables in the **Window List** and then close all of these files. This is advantageous if you inadvertently opened many files, such as in a mistakenly setup Internet open.

To close many open data tables:

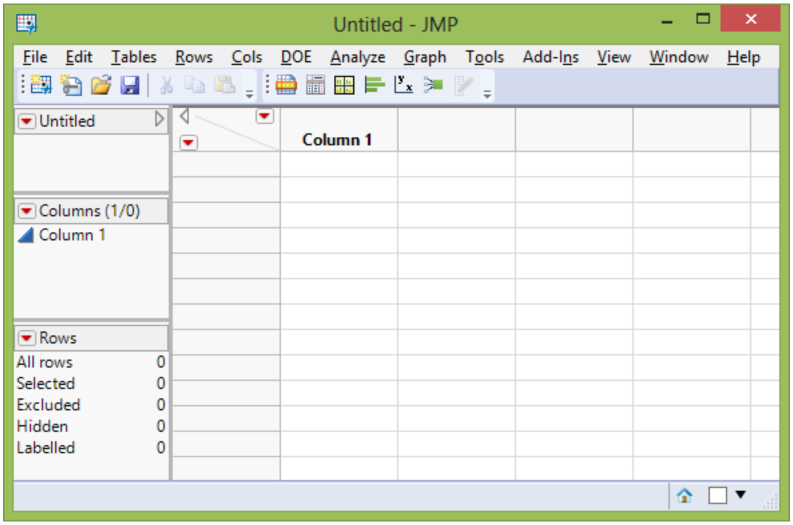
1. Select the windows of interest.
2. Right-click and select **Close**.
3. You will then be prompted to save these files.

Figure 1.2 JMP Primary Interface



If you create a new data table, you will be presented with Figure 1.3. Here, you see that there is a spreadsheet-like table, with a *Column 1* ready for you to start considering. Also, when you have loaded and analyzed data, you can save these results to the JMP data table and instantly reload at a later date, as will be discussed in Section 14.2.

Figure 1.3 New Data Table



1.3 General Outline

With this basic usability knowledge from Section 1.2, you are now ready to consider biostatistical data analysis. Biostatistics covers a wide variety of topics ranging from simple hypothesis tests to complex nonlinear algorithms. This book aims to cover the range of methods with varying levels of detail. To do so, this book is organized sequentially as outlined in Table 1.1.

Table 1.1 General Outline of *Biostatistics Using JMP: A Practical Guide*

Method	Chapter
Introduction	1
Data Wrangling: Data Collection	2
Data Wrangling: Data Cleaning	3
Initial Data Analysis with Descriptive Statistics	4
Data Visualization Tools	5
Rates, Proportions and Epidemiology	6
Statistical Tests and Confidence Intervals	7
Analysis of Variance (ANOVA) and Design of Experiments (DoE)	8
Regression and Curve Fitting	9
Diagnostic Methods for Regression, Curve Fitting and ANOVA	10
Categorical Data Analysis	11
Advanced Modeling Methods	12
Survival Analysis	13
Collaboration and Additional Functionality	14

1.4 How to Use This Book

In Chapters 2 and 3, this book moves to data-wrangling issues, such as data collection and cleaning. Since upward of 80% of your time can be spent in making messy data usable (Lohr, 2014), learning the tools JMP has for assembling and cleaning data is key and is covered in Chapters 2 and 3.

In Chapters 4 and 5, you can learn the basics of descriptive statistics and data visualizations in JMP. Following this, the primary focus is on modeling, which involves creating a mathematical representation (a model) of data or a system in order to make inferences about it.

After this, you have a few different paths available:

Chapter 6 discusses epidemiological and geographical interpretations.

Chapter 4 also discusses developing custom equations.

Chapter 7 discusses the various hypothesis test and confidence interval methods.

Chapters 8 to 10 discuss linear models such as analysis of variance (ANOVA), regression, and model validation.

Because of the interrelation of the underlying methods of regression (Chapter 9) and ANOVA (Chapter 8), diagnostic and remedial measures for these methods are discussed in Chapter 10.

Chapter 11 discusses classification methods, such as logistic regression, and clustering methods, such as k-means.

Chapters 7 to 10 largely deal with a continuous dependent (e.g., Y, variable (prediction)). Methods to analyze a discrete dependent variable are presented in Chapter 11.

Chapter 12 presents advanced modeling methods (e.g., factor analysis, neural networks, and control charts).

Chapter 13 introduces the vast array of survival analysis methods in JMP.

Chapter 14 presents methods that facilitate collaborating in addition to sources of additional functionality.

If you are using a previously created data set, then it is advantageous to start with data-wrangling methods and then look at the various analytical tools this book discusses. However, if you are starting a new experiment and will be collecting data, then you should start looking at Section 8.4.1, which discusses experimental design considerations and how to develop and select factor levels for an experiment.

1.5 Reference

Lohr, S. (2014, Aug. 18). For big-data scientists, 'janitor work' is key hurdle to insights. *New York Times*, p. B4.

About This Book

Rationale for This Book

This book focuses on the basics of statistical data analysis of biomedical/biological data using JMP. After both teaching and consulting in biostatistics, I saw a gap that existed between biostatistics books, which tend to be theoretical, and statistical software. To address this gap, I use statistical methods to analyze various biostatistics problems.

Importance of Statistical Analysis

Analytics, data mining, data science, and statistics are essentially synonyms, and describe finding meaning in data by developing mathematical models to find and describe relationships in the data. While many biostatistical applications are simple in nature, for example, a t-test to evaluate the mean differences in response due to a treatment, a wide variety of methods exists.

Biostatistics Focus

Biostatistics is the application of statistical methods to biological, or medical, data. While some methods see more frequent use in biostatistics, for example, survival analysis, these methods are not limited in use to just biostatistical problems. Essentially, all data is a matrix at the end of the day, and thus methods seen in biostatistical analysis can be applied to other domains.

The Power of JMP for Analytics

Familiarity with statistical methods enables one to analyze data via methods familiar in textbooks. However, many textbook examples are simple in nature, but real-world data rarely is. Thus, applying methods in a textbook can be frustrating if you have to wrestle both with the data and software.

This book was written with JMP due to the many advantages JMP has over other statistical software. JMP provides a GUI (graphical user interface) in which one can analyze data without coding algorithms. Additionally, the SAS underpinnings to JMP provide a wide and stable platform that can be trusted in its analysis. In total, JMP provides a tool that is easy to use and comes with a wide variety of built-in methods, the results of which can be trusted (something you can’t say about all statistical software). And, for those who wish to code boutique algorithms, JMP also supports this as well.

Who Should Read This Book

This book is written for a variety of different persona groups. Although biostatistics is the focus, and is in the title, this book has broader appeal.

Biological/Medical Researchers and Laboratory Managers

Researchers in the sciences, for example, biology and medicine, spend a large majority of their time performing experiments and a small fraction of their time analyzing data. Remembering how to use software that is only accessed a few times a year can be challenging. Thus, this book is aimed particularly at this group and provides a practical guide to analyzing collected biological/medical data.

Statisticians and Data Scientists

This group might be interested in a broad look at how to use JMP to solve various problems and analyze data in JMP. While theory is light in this book, this group could easily learn the steps and nuances of JMP. Additionally, they would see practical data analysis and experimental data analysis using various JMP capabilities.

Students in Biostatistics or Statistics Classes

Many biostatistical courses use excellent textbooks that cover the theory and examples for a wide variety of problems. However, these textbooks rarely discuss how to solve the problems, leaving students with the need to either code equations or learn various statistical software programs on the fly. This book is written from a general standpoint and can thus be combined with any biostatistical textbook. Additionally, since the statistical methods themselves can be used in many domains, this book can be combined with multiple statistics courses and textbooks.

Biostatistics Methods and JMP Functionality Covered in This Book

This Book Covers the Following Biostatistics Methods

- Data Cleaning – Data Wrangling – Descriptive Statistics – Data Visualization
- Rates – Proportion – Geographical Visualization – Epidemiology
- Confidence Intervals – Hypothesis Tests
- Linear Regression – Curve Fitting – General Linear Models
- Analysis of Variance (ANOVA) – Analysis of Covariance (ANCOVA) – Remedial Measures for Regression and ANOVA
- Cluster Analysis – Hierarchical Clustering – K-means
- Classification Analysis – Logistic Regression – Discriminant Analysis
- Survival Analysis – Meta Analysis – Control Charts – Neural Networks – Decision Trees

Structure of This Book

Chapter 1 introduces this book and mirrors some content in this section. Additionally, Chapter 1 introduces how to start using JMP. Chapters 2 and 3 introduce data-wrangling issues, such as data collection and cleaning. These chapters are very helpful when analyzing real-world data using JMP. The basics of descriptive statistics and data visualization are presented in Chapters 4 and 5.

After Chapter 5, the focus of this book is on developing statistical models to describe data. Chapters 6 through 13 present various approaches, and your data and goals will drive which chapter you should read. Chapter 6 discusses epidemiology and geographical data analysis. Chapter 7 discusses hypothesis tests and confidence intervals. Chapters 8 to 10 present models such as analysis of variance, regression, curve fitting, and model validation. Chapter 11 discusses classification and clustering methods. Chapter 12 presents advanced modeling methods. Chapter 13 discusses survival analysis. Finally, Chapter 14 presents collaboration methods, incorporating custom JMP tools and meta-analysis, as an example.

Additional Resources

For downloads of sample data presented in this book, please visit my author page at:

https://support.sas.com/bihl

This site also includes downloadable color versions of selected figures that appear in this book. Since this book is printed in black and white, you might find that some color figures are easier to interpret and understand.

Please visit this site regularly, as I will provide updates on the content.

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About the Author

Trevor Bihl is both a research scientist/engineer and an educator who teaches biostatistics, engineering statistics, and programming courses. He has been a SAS and JMP user since 2009 and provides various biostatistics and data mining consulting services. His background includes multivariate statistics, signal processing, data mining, and analytics. His educational background includes a BS and MS from Ohio University and a PhD from the Air Force Institute of Technology. He is the author of multiple journal and conference papers, book chapters, and technical reports.

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