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Walpole · Myers · Myers · Ye

理工科概率统计

(第7版)

PROBABILITY & STATISTICS
FOR ENGINEERS & SCIENTISTS



WALPOLE · MYERS · MYERS · YE



清华大学出版社

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（第7版）

**Probability & Statistics
For Engineers & Scientists
(Seventh Edition)**

Walpole · Myers
Myers · Ye

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国外大学优秀教材——统计学系列(影印版)

出版说明

从科学研究、工农业生产、新产品开发、产品质量的提高到政治、教育、社会科学各个领域,使用统计方法和不使用统计方法获得的结果是大不相同的。只要统计方法使用得当,就能够得到事半功倍的效果。这也是统计学能在经济发达国家兴旺发达的原因。

在我国的高等教育中,统计学的教学内容和国外先进水平相比还有一定的差距,统计学的研究和应用还没有得到足够的重视,统计学的方法还不为更多的应用工作者所了解。为了尽快地改进统计学的教学内容,促进统计学在我国的研究和应用,我们将陆续引进一批在国外知名大学受到普遍欢迎的统计学教材。希望对我国统计学的高等教育、科学研究和应用做出一点贡献。

这批教材的引进将遵循以下的基本原则:适合作为我国大学本科或研究生统计学课程的教材或主要教学参考书;原则上是近年国际上出版的最新图书或新版图书;对于某些基础课程,选择不同体系、不同风格和不同层次的教材,以满足不同层次和不同学时需要。每本入选教材都有国内相应领域知名专家或资深教授的审阅和推荐。对于部分教学需要量较大的教材还将考虑用翻译的方式引进。统计学系列教材将分期分批出版,内容将覆盖统计学专业大多数基础课和选修课。

概率论是和统计学密切相关的学科,也是学习研究统计学的基础,所以概率论方面的教材也是这次引进的重点。我们将注重引进一批应用性强,和统计学联系紧密的优秀概率论教材,以满足各方面的需要。

本系列教材的内容将包含概率统计、随机过程、Bayes 统计、多元统计、数据分析等,同时兼顾金融经济统计、社会统计、商业统计、生物统计、质量控制、实验设计、市场调查等等。系列教材的读者是统计学专业及需要学习统计学课程和知识的其他各专业的本科生、研究生以及从事与概率统计学科相关工作的科研工作者和应用工作者。

我们希望本系列教材的引进能够对我国统计学的高等教育、科学研究和实际应用有所帮助。也希望得到广大读者的反馈意见,以便改进我们的工作。

何书元

北京大学数学学院

影印版序

20世纪中叶,日本出现了“工业奇迹”,其成功的重要原因之一就是生产管理人员将统计思维和统计方法用于产品的高品质管理。20世纪80年代以后,美国工业界奋起直追,致力于实际地改进产品的质量。由 Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers 和 Keying Ye 合写的“Probability & Statistics for Engineers & Scientists”一书正是应运而生教材之一,在1972年出版后深受欢迎,到2002年已出版到了第7版。

本书内容包括:1. 统计与数据分析引论;2. 概率;3. 随机变量与概率分布;4. 数学期望;5. 离散概率分布;6. 连续概率分布;7. 随机变量的函数(选读);8. 基本抽样分布和数据描述;9. 单样本与双样本估计问题;10. 单样本与双样本假设检验;11. 简单线性回归与相关;12. 多维线性回归与非线性回归;13. 单因素试验:一般理论;14. 因子试验(双因素与多因素);15. 2^k 因子试验和部分试验;16. 非参数统计;17. 统计质量控制。

与国内同类教材相比,本书具有以下特点:

(1) 统计是书的主体,概率论部分的篇幅非常少,有关的数学知识只需简单的微积分和矩阵的知识即可。

(2) 基本统计部分除了典型的统计问题外,对直观性较强的,通过数据显示的图形方法得到统计特征量的所谓“描述统计学”的基本思维相当重视。这样,一方面有直觉统计的形象思维,另一方面有与之对比的形式统计,使读者更能洞悉和体会统计思维与统计方法的本质。各章都配置了一些案例分析,并作了细致的阐述。

(3) 强调了试验设计、数据收集,并能将其应用到统计建模、科学审检、图示诊断中去。

(4) 介绍了贝叶斯(Bayes)估计方法以及用矩阵表示多维线性回归的方法。

(5) 介绍了科学与工程领域中常用的统计方法。例如,逐步(筛选)回归与交叉验证,其中包括在物理科学与工程领域建模中,为避免过度拟合和拟合不足而采取的折中的常用的确定因素集合的 C_p 统计量。此外,本书还介绍了有关质量管理的设计与统计分析,其中包括回归分析与方差分析、实验的设计与分析、统计诊断和统计质量控制等内容。而且,一些更为实用的近代统计模型与方法在本书中也得到了充分的重视,例如,筛选设计(screening design),非均匀方差情形的逻辑回归与 Poisson 响应,日本实用统计学家田口(Taguchi)的稳健的参数设计,以及各种质量控制图表等。

本书可读性强,适合作为理工科的双语教材或参考书,也可以作为科学和工程领域的决策人员、教师、工程师、技术人员等的自学材料。

茆光鲁

清华大学数学科学系

Preface

Goals, Approach and Mathematical Level

The seventh edition emphasizes and illustrates the use of probabilistic models and statistical methodology that is employed in countless applications in all areas of science and engineering. There remains an important balance between theory and methodology that is featured in the text. We do not avoid the use of some theory but our goal is to let the mathematics provide insight rather than be a distraction. We feel that engineers and scientists are trained in mathematics and thus the providing of mathematical support when needed keeps the pedagogy from becoming a series of illustrated recipes in which the concepts are not understood and could never be applied or extended by the student except within very narrow bounds.

The text contains an abundance of exercises in which the methodology discussed is illustrated by the use of real-life scientific scenarios and data sets. The complete set of data files which accompany the text are available for download from the text companion website, located at <http://www.prenhall.com/walpole>. Though we attempt to appeal to engineers, the exercises are not confined to engineering applications. The student is exposed to problems encountered in many sciences including social sciences and biomedical applications. The motivation here stems from the fact that trained engineers are more and more becoming exposed to nontraditional settings, including areas like bioinformatics and bioengineering.

While we do let calculus play an important role but it should be noted that its use is confined to elementary probability theory and properties of probability distributions (Chapters 3, 4, 6, and 7). In addition, a modest amount of matrix algebra is used to support the linear regression material in Chapters 11 and 12. This is despite the fact that an “optional” section appears in Chapter 11 that includes the development of the multiple linear regression model with more substantive use of matrices. The student who uses this text should have completed one semester or two quarters of differential and integral calculus. An exposure to matrix algebra would be helpful but not necessary if the course content excludes the aforementioned optional section.

Content and Course Planning

The text is designed for either a one or two semester course. A reasonable curriculum for a one semester course might include Chapters 1 through 10. One may even choose to teach an early portion of Chapter 11 in order to introduce the student to the concept of simple linear regression. Chapter 1 is an overview of statistical inference, sampling and data analysis. Indeed, some very rudimentary aspects of experimental design are included, along with an appreciation of graphics and certain vital characteristics of data collection. Chapters 2, 3, and 4 deal with basic probability and discrete and continuous random variables. Chapters 5 and 6 cover

specific discrete and continuous distributions with illustrations of their use and relationships among them. Chapter 7 deals with transformations of random variables. This chapter is listed as “optional” and would only be covered in a more theoretical course. This chapter is clearly the most mathematical chapter in the text. Chapter 8 includes additional material on graphical methods as well as an introduction to the notion of a sampling distribution. The t and F distributions are introduced along with motivation regarding their use in chapters that follow. Chapters 9 and 10 contain material on one and two sample point and interval estimation and hypothesis testing. The flexibility in a single semester course lies in the option of exclusion of Chapter 7 as well as teaching only a subset of the several specific discrete and continuous distributions discussed and illustrated in Chapters 5 and 6. There is additional flexibility involved in dealing with Chapter 9 where maximum likelihood and Bayes estimation are covered in detail. An instructor may decide to give only a cursory development of one or both of these topics. In addition, estimation in Chapter 9 includes new material on prediction intervals and tolerance intervals along with a thorough discussion on the distinction among them, with examples. Flexibility may be exercised here.

Chapters 11–17 contain ample material for a second semester of a two-semester course. Chapters 11 and 12 cover simple and multiple linear regression respectively. However, Chapter 12 contains new material that deals with special nonlinear models involved when one deals with nonnormal responses. As a result, logistic and Poisson regression are treated along with important practical illustrations. This in addition to new material in categorical variable regression again provides considerable flexibility for the instructor in his or her treatment of regression. The treatment of regression in this text is extensive and many special regression topics in Chapter 12 are self-contained. Chapters 13 through 17 contain topics in analysis of variance, design of experiments, nonparametric statistics, and quality control.

Case Studies and Computer Software

As in previous editions there are many case studies that demonstrate statistical analysis of interesting real-life data sets. In most cases graphical techniques are used. These case studies are featured in two sample hypothesis testing, multiple linear regression, analysis of variance, and the analysis of 2-level experimental designs. Where appropriate, the use of residual plots, quantile plots, and normal probability plots are described in the analysis. Computer output is used for illustration purposes for these case studies and for other examples in the text. In that regard both SAS and MINITAB are featured. We have always felt that the experience of reading computer printout is invaluable to the student even if the package or packages featured in the text are not what is used by the instructor. Exposure to more than one type of software can broaden the experience base for the student. There is certainly no reason to believe that the software in the course is that which he or she will be called upon to use in practice.

New To This Edition

1. Chapter 1 has been revised and expanded. Even more emphasis has been placed on the concept of variability. Much of the material on graphical

methods in other chapters was moved (where appropriate) to Chapter 1 and is now allowed to flow as illustrative technology with the material on descriptive statistics. We have placed more emphasis in Chapter 1 on a discussion of the necessary role of probability in the “bottom line” provided by data analysis tools. Though much of Chapter 1 is overview, we prepare the student via examples with the notion of a P -value which will be so important in later chapters. In addition, more exercises are added in this chapter to cover the new or transferred material.

2. More and better examples are given in nearly all chapters. This is a new effort to illustrate with better scientific applications.
3. Chapter 9 contains new material on Bayesian statistics with additional examples. A section on prediction intervals is given as indicated earlier. Great pains are taken to distinguish among confidence intervals, tolerance intervals, and now, prediction intervals. We find that many students (and practitioners) struggle with these concepts.
4. Though P -values were introduced several editions earlier, more and better discussion of their interpretation is given early in Chapter 10 on hypothesis testing.
5. Major changes appear in Chapters 11 and 12 on regression analysis. Simple linear regression contains a more thorough discussion of the meaning of the model as well as the concept of least squares estimation. These explanations, replete with improved graphics, give the reader a clearer understanding of what regression is all about. Also new and better examples and exercises are given. The discussion of data transformation is also enhanced. Chapter 12 contains two major new topics. One of them is the use of categorical or indicator variables. The other is the introduction of two important nonlinear models for nonnormal responses—logistic regression and Poisson regression. These are accompanied by an explanatory account of how frequently nonnormal responses are encountered in practice. These developments are not overly mathematical but rather highlight examples of their use. Industrial, biological, and biomedical examples are discussed. Chapters 11, 12, and 13 have been “trimmed” to a certain extent by the elimination of certain computational drudgery that has no current pedagogic merit. For example, the development of the normal equations in multiple regression is outlined without the concern for certain laborious computations that are handled by computer software. In addition, in Chapters 13 and 14 the use of so-called computational formulae involving treatment and grand totals, results that bring very little in the way of concept understanding, have been removed. This allows for a more streamlined discussion of ANOVA.
6. New and better ANOVA examples are included.
7. New and better examples are given in Chapter 15 on two level factorial and fractional factorial experiments. Some of these deal with the very important and timely use of semiconductor manufacturing.
8. We have made use of much additional highlighting of important material through the use of “boxing in” important results and the use of subsections. We feel that continual page after page of dry text is unattractive, and

these reminders of transition to a different or new concept makes for easier learning.

Available Supplements

1. Student Solutions Manual (0-13-041537-5) Contains carefully-worked solutions to all odd-numbered exercises.
2. Instructor's Solutions Manual (0-13-041536-7) Contains carefully-worked solutions to all exercises.
3. Companion Website: Available free to all adopters, the companion website can be found at <http://www.prenhall.com/walpole>, and includes: the data sets from the book in a downloadable format, MINITAB projects, syllabus manager, hints, quizzes, objectives, and destinations.
4. SPSS 10.0 Windows Full Student Version (0-13-028040-2)
5. 2000 MINITAB Student Version Integrated CD (0-13-026082-7)

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RHM
SLM
KY

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