

# RESEARCH METHODS FOR INFORMATION SYSTEMS

Ronald S. King



MERCURY LEARNING AND INFORMATION  
Dulles, Virginia  
Boston, Massachusetts  
New Delhi

# CONTENTS

## Preface

## UNIT 1 DESCRIPTIVE STATISTICS

### Chapter I Introduction to Statistics

1.1 Introduction	4
1.2 What Is Statistics?	5
1.3 The Role of Probability in Statistical Inference	6
1.4 "A'pes of Data	6
1.5 How to Perform a Statistical Study	8
1.6 Exercises	9

### Chapter 2 Measures of Central Tendency

2.1 Sample Study	12
2.2 Introduction	12
2.3 Measures of Central Tendency	12
2.3.1 Mode	12
2.3.2 Median	13
2.3.3 Mean	13
2.4 Measures of the Middle and Distributional Shape	14
2.5 Exercises	35

### Chapter 3 Measures of Dispersion

3.1 Introduction	18
3.2 Measures of Variation	18
3.2.1 Range	18
3.2.2 Variance and standard deviation	18

3.3 Chebyshev's Inequality and the Empirical Rule	20
3.4' Comparing Variability	21
3.5 Measures of Distributional Shape: Skewness	22
3.6 Measures of Distributional Shape: Kurtosis	22
3.7 Exercises	<u>25</u>
<b>Chapter 4 Frequency Distributions</b>	<b>29</b>
4.1 Introduction	30
4.2 Sample Study	30
4.3 Presenting Qualitative Data	30
4.4 Exercises	35
<b>Chapter 5 Grouped Frequency Distributions</b>	<b>37</b>
5.1 Introduction	38
5.2 Summarizing Quantitative Data	38
5.3 Exercises	42
<b>Chapter (i) Data Mining</b>	<b>43</b>
6.1- Introduction	44
6.2 Single Variate Exploratory Data Analysis	44
6.2.1 Stem-and-lcaf plots	44
6.2.2 Quartiles, deciles, and percentiles	46
6.2.3 Box plots	47
6.2.4 Time plots	48
6.3 Bivariate Exploratory Data Analysis	48
6.3.1 Pivot tables and pivot charts	48
6.3.2 Scatter diagrams	56
6.4 Exercises	59
<b>UNIT 2 ELEMENTARY PROBABILITY</b>	<b>65</b>
<b>Chapter 7 Random Experiments, Counting Techniques, and Probability</b>	<b>67</b>
7.1 Introduction	68
7.2 Random Experiments	68
7.3 Sample Spaces and Events	68
7.4 What Probability Means	69
7.5 Equally Likely Outcomes	70
7.6 Putting Events Together: Union, Intersection, and Complement	71
7.7 Venn Diagrams	72
7.8 The Axioms of Probability	72
7.8.1 Laws, or theorems, derived from the axioms	73
7.9 Counting Techniques: Permutations and Combinations	76

7.10 Counting Techniques and Probability	78
7.11 Conditional Probabilities	79
7.12 Independent Events	82
7.13 Exercises	84
<b>Chapter 8 Probability Toolkit</b>	
8.1 Introduction	88
8.2 Random Variables	88
8.3 Probability Distributions	89
8.4 Expected Value	92
8.5 Variance	93
8.6 Independent Random Variables	94
8.7 Exercises	96
<b>Chapter 9 Discrete Probability Distributions</b>	99
9.1 Introduction	100
9.2 Problem Solving through Modeling	100
9.3 Important Discrete Distributions	102
9.3.1 The uniform discrete distribution	102
9.3.2 The binomial distribution	103
9.3.3 The hypergeometric distribution	109
9.3.4 The poisson distribution	112
9.3.5 Summary of discrete distributions	115
9.4 Exercises	116
Reference	117
<b>Chapter 10 Continuous Probability Distributions</b>	119
.10.1 Introduction	.120
.10.2 Introduction to Continuous Probability Distributions	120
10.3 Expected Value and Variance of Continuous Distributions	124
10.4 Particular Continuous Distributions	125
10.4.1 The continuous uniform distribution	125
10.4.2 The exponential distribution	126
10.5 Exercises	129
<b>Chapter 11 The Normal Distribution</b>	131
11.1 Introduction	132
11.2 The Normal Distribution	132
.11.3 Exercises	142
<b>Chapter 12 Distributional Approximations</b>	145
12.1 Introduction	146
12.2 Review of Discrete and Continuous Distributions	146
12.2.1 Summary of discrete distributions	146
12.2.2 Summary of continuous distributions	147

12.3	Discrete Approximations of Discrete Distributions	147
12.4	Continuous Approximations of Discrete Distributions	149
12.4.1	Normal approximation of a Poisson distribution	149
.12.4.2	Normal approximation of a binomial distribution	15.1
12.5	Exercises	J51
<b>UNITS</b>	<b>INTRODUCTION TO ESTIMATION</b>	<b>153</b>
<b>Chapter 13</b>	<b>Sampling Distributions</b>	<b>155</b>
13.1	Introduction	156
13.2	An Example of a Sampling Distribution	156
13.3	The Sampling Distribution of $X$	158
13.4	The Central Limit Theorem	159
13.5	The Distribution of the Sample Median	162
13.6	Sampling Distributions of Measures of Dispersion	162
13.6.1	The expected value of the sample variance	162
13.6.2	The sample range	164
13.6.3	The distribution of the sample proportion	164
13.7	Exercises	165
<b>Chapter 14</b>	<b>Point Estimation'and Interval Estimation</b>	<b>169</b>
14.1	Introduction	170
14.2	Point Estimation	170
14.3	Interval Estimation	174
14.4	Exercises	179
<b>Chapter 15</b>	<b>Introduction to Hypothesis Testing</b>	<b>181</b>
15.1	Introduction	182
15.2	The Probability of a Type II Error	188
15.3	Exercises	192
<b>UNIT 4</b>	<b>HYPOTHESIS TESTING</b>	<b>195</b>
<b>Chapter 16</b>	<b>Single Large Sample Tests</b>	<b>197</b>
16.1	Introduction	198
16.2	Sample Study	198
16.3	Lower-Tail Tests for the Population Mean	199
16.4	Two-Tail Tests for the Population Mean	202
16.5	Exercises	204
<b>Chapter 17</b>	<b>Single Small Sample Tests</b>	<b>207</b>
17.1	Introduction	208
17.2	Small Sample Tests for the Population Mean	208
17.3	Hypothesis Tests with the Population Variance	209
17.4	Exercises	213

<b>Chapter 18</b>	<b>Independent Sample Tests</b>	<b>215</b>
18.1	Introduction	216
18.2	Tests with Two Population Variances	216
18.3	Independent Sample Test for the Difference of Two Means	
18.4	Exercises	229
<b>Chapter 19</b>	<b>Matched-Pair Tests</b>	<b>233</b>
19.1	Introduction	234
19.2	Matched-pair Tests for the Difference of Two Means	234
19.3	t-Tests for the Difference of Population Proportions	238
19.4	Exercises	238
<b>Chapter 20</b>	<b>Hypothesis Testing versus Confidence Intervals</b>	<b>241</b>
20.1	Introduction	242
20.2	Choosing a Confidence Level	242
20.3	Hypothesis Testing versus Confidence Intervals	242
20.4	Two-sided Confidence Intervals	243
20.5	One-sided Confidence Intervals	244
20.6	Confidence Intervals for Proportions	245
20.7	Exercises	247
<b>UNIT 5</b>	<b>APPLICATIONS OF CHI-SQUARE STATISTICS</b>	<b>249</b>
<b>Chapter 21</b>	<b>Chi-Square Tests of Multinomial Data</b>	<b>251</b>
21.1	Introduction	252
21.2	Chi-Square Tests of Multinomial Data	252
21.3	Exercises	257
<b>Chapter 22</b>	<b>Chi-Square Tests of Independence</b>	<b>259</b>
22.1	Introduction	260
22.2	Chi-Square Tests of Independence	260
22.3	Guidelines for Using the Chi-Square Test of Independence	265
22.4	Exercises	265
<b>Chapter 23</b>	<b>Chi-Square Tests of Goodness-of-Fit and Missing Data</b>	<b>269</b>
23.1	Introduction	270
23.2	Chi-Square Tests of Goodness-of-Fit	270
23.3	Chi-Square Analysis of Missing Data	273
23.4	Exercises	274

<b>UNIT 6</b>	<b>REGRESSION AND CORRELATION ANALYSIS</b>	<b>277</b>
Regression and Curve Fitting		278
Test of the CEHs Statistical Quality		278
Selection of the Best CER		278
<b>Chapter 24</b>	<b>Correlation Analysis</b>	<b>279</b>
24.1 Introduction		280
24.2 Scatter Diagrams		280
24.3 The Pearson Correlation Coefficient		283
24.4 Estimating the Population Correlation Coefficient		287
24.5 Partial Correlation Coefficients		288
24.6 Recommendations When Using Correlation Coefficients		290
24.7 Exercises		290
Reference		295
<b>Chapter 25</b>	<b>Introduction to Simple Linear Regression</b>	<b>297</b>
25.1 Introduction		298
25.2 Sample Study		298
25.3 The Regression Line and Regression Equation		299
25.4 Simple Linear Regression		300
25.5 Exercises		306
Simple Linear Regression Project I		309
Simple Linear Regression Project II		310
References		311
<b>Chapter 26</b>	<b>Simple Linear Regression: Hypothesis Testing</b>	<b>313</b>
26.1 Introduction		314
26.2 The Standard Error of Estimate $s_i$		314
26.3 Sampling Distribution and Hypothesis Tests for $\beta_3$		315
26.3.1 The slope of the regression equation		315
26.4 Sampling Distribution and Hypothesis Tests for P		319
26.4.1 The Y-intercept of the regression equation		319
26.5 Hypothesis Test for the Conditional Mean of the Regression Equation		319
26.6 The Coefficient of Determination		321
26.7 Observations about Linear Regression		325
26.8 Exercises		325
<b>Chapter 27</b>	<b>Simple Linear Regression: Case Study</b>	<b>331</b>
27.1 Introduction		332
27.2 The Statement for the Case Study		332
27.3 Case Study Analysis		332
27.4 Exercises		337

<b>Chapter 28</b>	<b>Introduction to Multiple Linear Regression</b>	339
28.1	Introduction	340
28.2	Sample Study	340
28.3	Multiple Linear Regression Model	340
28.4	The Relative Importance of Predictors	346
28.5	The Significance of R <sup>2</sup>	348
28.6	Inferences about the Regression Coefficients	349
28.7	Exercises	352
	Reference	355
<b>Chapter 29</b>	<b>Multiple Linear Regression: Case Study</b>	357
29.1	Introduction	358
29.2	Case Study: Prediction of Rental Car's Basic Price	358
29.3	Forward, Stepwise, and Backward Selection	363
29.3.1	Forward selection	363
29.3.2	Stepwise selection	364
29.3.3	Backward elimination	364
29.3.4	Setwise selection	364
29.4	Exercises	365
<b>Chapter 30</b>	<b>Multiple Linear Regression: Handling Violations of Restrictions</b>	373
30.1	Introduction	374
30.2	Visual Tests for Verifying the Regression Assumptions	374
30.2.1	Test for linearity	374
30.2.2	Test for independent errors	374
30.2.3	Test for normally distributed errors	375
30.2.4	Test for homoscedasticity	375
30.3	The Problem of Multicollinearity	375
30.4	Ridge Regression	376
30.5	Categorical Predictors	376
30.6	Cumlinear Regression	378
30.7	Transformations	378
30.8	Outliers	379
30.9	Exercises	380
<b>UNIT 7</b>	<b>EXPERIMENTAL DESIGNS</b>	383
<b>Chapter 31</b>	<b>One-Way Analysis of Variance</b>	385
31.1	Introduction	386
31.2	Sample Study: ( <i>Winning Database Configurations, Continued</i> )	386
31.3	Introduction to A NOVA	386
31.4	Tests of Homogeneity of Variance	394

31.5	Multiple Comparisons	396
31.6	Exercises	398
	Reference	*
		402
<b>Chapter 32</b>	<b>Two-Way Analysis of Variance</b>	<b>403</b>
32.1	Introduction	404
32.2	Two-Way ANOVA with One Entry Per Cell	41 J.
32.3	Randomized-Block Designs	412
32.4	Latin Square Design	414
32.5	Exercises	415
32.6	Two-Way ANOVA Project I	421
	Reference	422
<b>Chapter 33</b>	<b>Analysis of Covariance</b>	<b>423</b>
33.1	Introduction	424
33.2	Exercises	431
<b>Chapter 34</b>	<b>Experimental Designs</b>	<b>435</b>
34.3	Introduction	436
34.2	Classification of Designs	436
34.3	Experimental Design Definitions	438
34.4	Avoiding Pitfalls	441
34.5	Experimental Goals	441
34.5.1	Experimental design in practice	442
34.6	Exercises	443
	Experimental Design Project	445
<b>UNIT 8</b>	<b>NONPARAMETRIC TESTS AND COMMONLY USED DISTRIBUTIONS</b>	<b>447</b>
<b>Chapter 35</b>	<b>Random Number Generation</b>	<b>451</b>
35.1	Introduction	452
35.2	Random Number Generation	452
35.3	Desired Properties of a Good Generator	452
35.4	Linear Congruential Generators	453
35.5	Multiplicative Linear Congruential Generators	454
35.6	Extended Fibonacci Generators	454
35.7	Combined Generators	454
35.8	Seed Selection	455
35.9	Myths about Random Number Generation	455
35.10	Exercise	456
	Random Number Project I	456
	Random Number Project TI	456
	References	457

<b>Chapter 36 Random Variable Generation</b>	459
36.1 Introduction	460
36.2 The Inverse Transformation	460
36.3 The Rejection Method	461
36.4 The Composition Method	462
36.5 The Convolution Method	464
36.6 Exercises	464
<b>Chapter 37 Testing for Randomness</b>	467
37.1 Introduction	468
37.2 The Frequency Test	468
37.3 The Gap Test	470
37.4 The Poker Test	472
37.5 The Runs Test	473
37.6 Runs Above and Below a Central Value	475
37.7 Runs Up and Down	475
37.8 The Kohnogorov Goodness-of-Fit Test	476
37.9 The Kolmogorov-Smirnov Two-Sample Test	478
37.10 Exercises	480
<b>Chapter 38 Nonparametric Substitutes for Some Familiar Parametric Tests</b>	481
38.1 Introduction	482
38.2 The Mann-Whitney Test	482
38.3 The Wilcoxon Matched-Pairs Signed-Rank Test	484
38.4 The Kruskal-Wallis Test	485
38.5 The Spearman Rank Correlation Coefficient	487
38.6 Exercises	490
<b>Chapter 39 Commonly Used Distributions</b>	493
39.1 Introduction	494
39.2 The Bernoulli Distribution	494
39.3 The Binomial Distribution	494
39.4 The Chi-Square Distribution	495
39.5 The Exponential Distribution	496
39.6 The F Distribution	497
39.7 The Gamma Distribution	498
39.8 The Geometric Distribution	499
39.9 The Normal Distribution	500
39.10 The Poisson Distribution	502
39.11 The Student <i>t</i> Distribution	502
39.12 The Continuous Uniform Distribution	503
39.13 The Discrete Uniform Distribution	504
39.14 Exercises	505
Reference	506

<b>Chapter 40 A Guide to Research</b>	<b>509</b>
40.1 Introduction	510
40.2 Conceptual Framework	511
40.3 Reliability, Validity, Utility, and Usage	512
40.4 The Scientific Method	513
40.4.1 Research	514
40.4.2 Problem	514
40.4.3 Project experimentation	514
40.4.4 Project conclusion	515
40.5 Topic Research	515
40.6 Project Research	516
40.7 Scientific Writing	517
40.8 Matters of Ethical Concern in Research	517
40.9 Exercises	518
40.10 Project	519
40.11 Problem Solving	520
<b>Chapter 41 Survey and Field Research</b>	<b>521</b>
41.1 Introduction	522
41.2 Types of Surveys	522
41.2.1 Questionnaires	523
41.2.2 Interviews	523
41.2.3 Writing your own survey questions	524
41.3 Survey Research Sample	525
41.4 Sampling	525
41.4.1 Simple random sampling	526
41.4.2 Stratified sampling	527
41.4.3 Cluster sampling	528
41.4.4 Alternative sampling methods	529
41.4.4.1 Systematic Sampling	529
41.4.4.2 Double Sampling	529
41.5 Sampling Errors	530
41.6 Field Studies	530
41.7 Field Research Example	532
41.8 Survey Research Exercises	533
41.9 Sampling Exercises	533
41.10 Hypothetical Research Project	534
41.11 Field Study Exercises	535
41.12 Survey Research Project	535
41.13 Sampling References	536

<b>Chapter 42 A Methodology for Model Construction</b>	<b>537</b>
42.1 Introduction	538
42.2 Sample Study	538
42.3 Lessons Learned	539
42.3.1 Step 1: Validate your data	539
42.3.1.1 Statement of Problem	539
42.3.1.2 Purpose	540
42.3.2 Step 2: Select the variables and model	540
42.3.2.1 Operational Definitions	540
42.3.2.2 Questions Answered	541
42.3.2.3 Limitations	541
42.3.2.4 Judgment Analysis	542
42.3.3 Step 3: Perform preliminary analyses	543
42.3.3.1 Predictor Variables	543
42.3.3.2 Criterion Variables	544
42.3.3.3 Questions Asked	545
42.3.3.4 Method Used for Organizing Data	545
42.3.4 Step 4: Determine design and methodologies of the study	549
42.3.4.1 Subjects judged	549
42.3.4.2 Judges	549
42.3.4.3 Strategy Used for Obtaining Data	549
42.3.5 Step 5: Check the model	552
42.3.6 Step 6: Extract the equation	553
42.3.7 Conclusion	556
42.4 General Modeling Considerations	557
42.4.1 Planning the model building process	557
42.5 Development of the mathematical model	558
42.6 Verification and Maintenance of the Mathematical Model	558
42.7 Exercises	558
42.8 Clustering Project	559
42.9 JPC Project	562
References	563
<b>Chapter 43 A Guide to Statistical Software</b>	<b>565</b>
43.1 Introduction	566
43.2 Design Constructs	566
43.2.1 Sets of programs	567
43.2.2 Sets of subroutines	567
43.2.3 Large, multiple-use programs	567
43.2.4 Application compilers	567

43.3 Problem Areas	568
43.4 Desirable Package Features	570
43.5 Evaluation Checklist	*
43.6 Exercises	573
43.7 Statistical Computing Exercises	573
<b>Chapter 44 Product Development</b>	<b>575</b>
44.1 Introduction	576
44.2 Sample Study	576
44.3 Types of Research	577
44.4 Adequacy Testing Theory in a Field of Study	578
44.5 Product Development Methodology	579
44.6 Exercises	582
44.7 Conjoint Analysis Project	583
<b>Chapter 45 The Axiomatic Research Method</b>	<b>585</b>
45.1 Introduction	586
45.2 Sample Study	586
45.3 Axiomatic Development as a Research Method	586
45.4 Definition Jbr the Relational Data Model	587
45.5 Strong Relations	589
45.6 Strong Inter-related Relations	591
45.6.1 BCNF algorithm	592
45.6.2 Test for functional dependency preserving	592
45.6.3 To find a key	592
45.7 Summary	592
45.8 The Axiomatic Method as a Tool for Research	593
45.9 Exercises	593
45.10 Semantic Data Models Project	594
45.11 Extended Relational Models	594
Reference	595
<b>UNIT 10 SIMULATION AND RESEARCH ISSUES</b>	<b>597</b>
<b>Chapter 46 Monte Carlo Simulation Overview</b>	<b>599</b>
46.1 Introduction	600
46.2 Application: Determination of the Number of Production Units	600
46.3 Exercises	604
46.3.1 Games and Simulation Project	604
46.3.2 Risk Analysis Project	604
<b>Chapter 47 How to Conduct a Simulation</b>	<b>607</b>
47.1 Introduction	608
47.2 Manufacturing Example	608

47.3 Discrete Event Simulation	615
47.4 Discrete Event Simulation of a Simplified Token Ring	616
47.5 Summary	* 619
47.6 Projects	620
<b>Chapter 48 A Research Study Vignette</b>	<b>623</b>
48.1 Introduction	624
48.2 The Vignette Setting	624
48.3 Preliminary Research Study Statement	624
48.4 Background Review	625
48.5 Formulating a Project that can be Resolved	625
48.6 Attribute Screening	626
48.7 Study Design	628
48.8 Reporting Results	631
48.9 Promoting Research Results	632
48.10 Vignette Closing	632
48.11 Chapter Summary	632
48.12 Exercises	633
<b>Appendix A Statistical Tables</b>	<b>635</b>
Table A-1 The Normal Distribution	636
Table A-2 Binomial Probabilities	638
Table A-4a Critical Values of the t Distribution	644
Table A-4b Critical Values of the F Distribution	647
Table A-5 Critical Values of the Studentized Range Statistic and Dunnett's Test	649
Table A-6 Critical Values of Dunn's Test	651
Table A-7 Critical Values of the Chi-Square Distribution	653
Table A-8 Critical Values of the Binomial Test	654
Table A-9 Critical Values of the Mann-Whitney U Test	655
Table A-10 Critical Values of the Wilcoxon Ranked Sums Test	657
Table A-11 Critical Values of the Wilcoxon Signed Ranks Test	659
Table A-12 Critical Values of the Correlation Coefficient	660
Table A-13 Transforming r to Z	661
Table A-14 Statistical Power of the Z Test	663
Table A-15 Statistical Power of the t Test for One Sample or Two Related Samples	664
Table A-16 Statistical Power of the t Test for Two Independent Samples	665
Table A-17 Statistical Power of the Analysis of Variance	667
Table A-18 Statistical Power of the Correlation Coefficient	670
Table A-19 Required Sample Size	674
Table A-20 The Poisson Distribution	676

Table A-21 Critical Values of the Spearman Correlation Coefficient	680
Table A-22 Critical Values for Total Number of Runs (U) »	681
Table A-23 Critical Values for the Hartley Test of Homogeneity of Variance	682
Table A-24 The Cochran Test for Homogeneity of Variances	683
Table A-25 Table of Percentage Points of Kolmogorov Statistics	685
Table A-26 Quantiles of the SmirnovTest Statistic for Two Samples of Equal Size n	686
Table A-27 Quantiles of the SmirnovTest Statistic for Two Samples of Different Size	687
<b>Appendix B Data Files</b>	<b>691</b>
Table B-1 American Cities Database	691
Table B-2 American Cities Database- Version 2	694
Table B-3 Auto Eile	696
Table B-4 Cost of Living	697
Table B-5 East Food	TOO
Table B-6 Health File	702
Table B-7 Interest Rate Volatility	706
Table B-8 Stock Prices	708
<b>Appendix C Articles</b>	<b>713</b>
Comparative Study of Graduate Information Systems and MBA Students Cognitive Styles	7.14
Ethnographic Study of MSIS Student Project Team Dynamics	723
<b>Appendix D Solutions to Selected Exercises (On Companion DVD)</b>	<b>735</b>
<b>Index</b>	<b>737</b>