

R IN A NUTSHELL

A Desktop Quick Reference



Table of Contents

Preface xv			
art	I. R Basics		
1.	Getting and Installing R	3	
	R Versions	3	
	Getting and Installing Interactive R Binaries	3	
	Windows	4	
	Mac OS X	5	
	Linux and Unix Systems	5	
2.	The R User Interface	7	
	The R Graphical User Interface	7	
	Windows	8	
	Mac OS X	8	
	Linux and Unix	8	
	The R Console	11	
	Command-Line Editing	13	
	Batch Mode	13	
	Using R Inside Microsoft Excel	14	
	Other Ways to Run R	15	
3.	A Short R Tutorial	17	
	Basic Operations in R	17	
	Functions	19	
	Variables	20	
	Introduction to Data Structures	22	

	Objects and Classes	25
	Models and Formulas	26
	Charts and Graphics	28
	Getting Help	32
4.	R Packages	35
	An Overview of Packages	35
	Listing Packages in Local Libraries	36
	Loading Packages	38
	Loading Packages on Windows and Linux	38
	Loading Packages on Mac OS X	38
	Exploring Package Repositories	39
	Exploring Packages on the Web	40
	Finding and Installing Packages Inside R	40
	Custom Packages	43
	Creating a Package Directory	43
	Building the Package	45
Part	II. The R Language	
5.	An Overview of the R Language	49
	Expressions	49
	Objects	50
	Symbols	50
	Functions	50
	Objects Are Copied in Assignment Statements	52
	Everything in R Is an Object	52
	Special Values	53
	NA	53
	Inf and -Inf	53
	NaN	54
	NULL	54
	Coercion The P. Interpreter	54 55
	The R Interpreter	
	Seeing How R Works	57
6.	R Syntax	61
	Constants	61
	Numeric Vectors	61
	Character Vectors	62
	Symbols	63
	Operators	64
	Order of Operations	65
	Assignments	67
	Expressions	67

	Separating Expressions	67
	Parentheses	68
	Curly Braces	68
	Control Structures	69
	Conditional Statements	69
	Loops	70
	Accessing Data Structures	72
	Data Structure Operators	73
	Indexing by Integer Vector	73
		75 76
	Indexing by Logical Vector	
	Indexing by Name	76
	R Code Style Standards	77
7.	R Objects	79
	Primitive Object Types	79
	Vectors	82
	Lists	83
	Other Objects	84
	Matrices	84
	Arrays	84
	Factors	85
	Data Frames	87
	Formulas	88
	Time Series	89
	Shingles	91
	Dates and Times	91
	Connections	92
	Attributes	92
	Class	95
0	Sumbals and Engironments	97
8.	Symbols and Environments	97
	Working with Environments	98
	The Global Environment	99
		100
		100
		101
		103
	ē ,	$103 \\ 104$
	•	$104 \\ 104$
		105
_		
9.		107
	•	107
	0	107
	Return Values	109

	Functions As Arguments	109
	Anonymous Functions	110
	Properties of Functions	111
	Argument Order and Named Arguments	113
	Side Effects	114
	Changes to Other Environments	114
	Input/Output	115
	Graphics	115
10.	Object-Oriented Programming	117
	Overview of Object-Oriented Programming in R	118
	Key Ideas	118
	Implementation Example	119
	Object-Oriented Programming in R: S4 Classes	125
	Defining Classes	125
	New Objects	126
	Accessing Slots	126
	Working with Objects	127
	Creating Coercion Methods	127
	Methods	128
	Managing Methods	129
	Basic Classes	130
	More Help	130
	Old-School OOP in R: S3	131
	S3 Classes	131
	S3 Methods	132
	Using S3 Classes in S4 Classes	133
	Finding Hidden S3 Methods	133
11.	High-Performance R	135
	Use Built-in Math Functions	135
	Use Environments for Lookup Tables	136
	Use a Database to Query Large Data Sets	136
	Preallocate Memory	137
	Monitor How Much Memory You Are Using	137
	Monitoring Memory Usage	137
	Increasing Memory Limits	138
	Cleaning Up Objects	138
	Functions for Big Data Sets	139
	Parallel Computation with R	139
	High-Performance R Binaries	140
	Revolution R	140
	Building Your Own	141

Part III. Working with Data

12.	Saving, Loading, and Editing Data	147
	Entering Data Within R	147
	Entering Data Using R Commands	147
	Using the Edit GUI	148
	Saving and Loading R Objects	151
	Saving Objects with save	151
	Importing Data from External Files	152
	Text Files	152
	Other Software	161
	Exporting Data	161
	Importing Data from Databases	162
	Export Then Import	162
	Database Connection Packages	162
	RODBC	163
	DBI	173
	TSDBI	178
13.	Preparing Data	179
	Combining Data Sets	179
	Pasting Together Data Structures	180
	Merging Data by Common Fields	183
	Transformations	185
	Reassigning Variables	185
	The Transform Function	185
	Applying a Function to Each Element of an Object	186
	Binning Data	189
	Shingles	189
	Cut	190
	Combining Objects with a Grouping Variable	191
	Subsets	191
	Bracket Notation	192
	subset Function	192
	Random Sampling	193
	Summarizing Functions	194
	tapply, aggregate	194
	Aggregating Tables with rowsum	197
	Counting Values	198
	Reshaping Data	200
	Data Cleaning	205
	Finding and Removing Duplicates	206
	Sorting	206

14.	Graphics	211
	An Overview of R Graphics	211
	Scatter Plots	212
	Plotting Time Series	218
	Bar Charts	219
	Pie Charts	223
	Plotting Categorical Data	224
	Three-Dimensional Data	229
	Plotting Distributions	237
	Box Plots	240
	Graphics Devices	243
	Customizing Charts	244
	Common Arguments to Chart Functions	244
	Graphical Parameters	244
	Basic Graphics Functions	254
15.	Lattice Graphics	263
	History	263
	An Overview of the Lattice Package	264
	How Lattice Works	264
	A Simple Example	264
	Using Lattice Functions	266
	Custom Panel Functions	268
	High-Level Lattice Plotting Functions	268
	Univariate Trellis Plots	269
	Bivariate Trellis Plots	293
	Trivariate Plots	301
	Other Plots	306
	Customizing Lattice Graphics	308
	Common Arguments to Lattice Functions	308
	trellis.skeleton	309
	Controlling How Axes Are Drawn	310
	Parameters	311
	plot.trellis	315
	strip.default	316
	simpleKey	317
	Low-Level Functions	318
	Low-Level Graphics Functions	318
	Panel Functions	318
Part	IV. Statistics with R	
16.	Analyzing Data	323
10.	Summary Statistics	323
	Correlation and Covariance	325
	Correlation and Covariance	<i>3</i> 23

	Principal Components Analysis	328
	Factor Analysis	332
	Bootstrap Resampling	333
17.	Probability Distributions	335
	Normal Distribution	335
	Common Distribution-Type Arguments	338
	Distribution Function Families	338
18.	Statistical Tests	343
	Continuous Data	343
	Normal Distribution-Based Tests	344
	Distribution-Free Tests	357
	Discrete Data	360
	Proportion Tests	360
	Binomial Tests	361
	Tabular Data Tests	362
	Distribution-Free Tabular Data Tests	368
19.	Power Tests	369
	Experimental Design Example	369
	t-Test Design	370
	Proportion Test Design	371
	ANOVA Test Design	372
20.	Regression Models	373
	Example: A Simple Linear Model	373
	Fitting a Model	375
	Helper Functions for Specifying the Model	376
	Getting Information About a Model	376
	Refining the Model	382
	Details About the lm Function	382
	Assumptions of Least Squares Regression	384
	Robust and Resistant Regression	386
	Subset Selection and Shrinkage Methods	387
	Stepwise Variable Selection	388
	Ridge Regression	389
	Lasso and Least Angle Regression	390
	Principal Components Regression and Partial Least Squares	
	Regression	391
	Nonlinear Models	392
	Generalized Linear Models	392
	Nonlinear Least Squares	395
	Survival Models	396
	Smoothing	401

	Splines	401
	Fitting Polynomial Surfaces	403
	Kernel Smoothing	404
	Machine Learning Algorithms for Regression	405
	Regression Tree Models	406
	MARS	418
	Neural Networks	423
	Project Pursuit Regression	427
	Generalized Additive Models	430
	Support Vector Machines	432
21.	Classification Models	435
	Linear Classification Models	435
	Logistic Regression	435
	Linear Discriminant Analysis	440
	Log-Linear Models	444
	Machine Learning Algorithms for Classification	445
	k Nearest Neighbors	445
	Classification Tree Models	446
	Neural Networks	450
	SVMs	451
	Random Forests	451
22.	Machine Learning	453
	Market Basket Analysis	453
	Clustering	458
	Distance Measures	458
	Clustering Algorithms	459
23.	Time Series Analysis	463
	Autocorrelation Functions	463
	Time Series Models	464
24.	Bioconductor	469
	An Example	469
	Loading Raw Expression Data	470
	Loading Data from GEO	474
	Matching Phenotype Data	476
	Analyzing Expression Data	477
	Key Bioconductor Packages	481
		TOI
	Data Structures	–
	,	485 485
	Data Structures eSet	485
	Data Structures	485 485

Other Classes Used by Bioconductor Packages	489
Where to Go Next	490
Resources Outside Bioconductor	490
Vignettes	490
Courses	491
Books	491
Appendix: R Reference	493
Bibliography	591
Index	593