
Table of Contents

Preface	xiii
1. Getting Started and Getting Help	1
1.1 Downloading and Installing R	2
1.2 Starting R	4
1.3 Entering Commands	7
1.4 Exiting from R	8
1.5 Interrupting R	9
1.6 Viewing the Supplied Documentation	10
1.7 Getting Help on a Function	11
1.8 Searching the Supplied Documentation	13
1.9 Getting Help on a Package	14
1.10 Searching the Web for Help	16
1.11 Finding Relevant Functions and Packages	18
1.12 Searching the Mailing Lists	19
1.13 Submitting Questions to the Mailing Lists	20
2. Some Basics	23
2.1 Printing Something	23
2.2 Setting Variables	25
2.3 Listing Variables	26
2.4 Deleting Variables	27
2.5 Creating a Vector	28
2.6 Computing Basic Statistics	30
2.7 Creating Sequences	32
2.8 Comparing Vectors	34
2.9 Selecting Vector Elements	35
2.10 Performing Vector Arithmetic	38
2.11 Getting Operator Precedence Right	40
2.12 Defining a Function	41
2.13 Typing Less and Accomplishing More	43

2.14	Avoiding Some Common Mistakes	46
3.	Navigating the Software	51
3.1	Getting and Setting the Working Directory	51
3.2	Saving Your Workspace	52
3.3	Viewing Your Command History	53
3.4	Saving the Result of the Previous Command	53
3.5	Displaying the Search Path	54
3.6	Accessing the Functions in a Package	55
3.7	Accessing Built-in Datasets	57
3.8	Viewing the List of Installed Packages	58
3.9	Installing Packages from CRAN	59
3.10	Setting a Default CRAN Mirror	61
3.11	Suppressing the Startup Message	62
3.12	Running a Script	62
3.13	Running a Batch Script	63
3.14	Getting and Setting Environment Variables	66
3.15	Locating the R Home Directory	67
3.16	Customizing R	68
4.	Input and Output	71
4.1	Entering Data from the Keyboard	72
4.2	Printing Fewer Digits (or More Digits)	73
4.3	Redirecting Output to a File	74
4.4	Listing Files	75
4.5	Dealing with “Cannot Open File” in Windows	76
4.6	Reading Fixed-Width Records	77
4.7	Reading Tabular Data Files	78
4.8	Reading from CSV Files	80
4.9	Writing to CSV Files	82
4.10	Reading Tabular or CSV Data from the Web	83
4.11	Reading Data from HTML Tables	84
4.12	Reading Files with a Complex Structure	86
4.13	Reading from MySQL Databases	89
4.14	Saving and Transporting Objects	92
5.	Data Structures	95
5.1	Appending Data to a Vector	101
5.2	Inserting Data into a Vector	103
5.3	Understanding the Recycling Rule	103
5.4	Creating a Factor (Categorical Variable)	105
5.5	Combining Multiple Vectors into One Vector and a Factor	107
5.6	Creating a List	108

5.7	Selecting List Elements by Position	109
5.8	Selecting List Elements by Name	111
5.9	Building a Name/Value Association List	112
5.10	Removing an Element from a List	114
5.11	Flatten a List into a Vector	115
5.12	Removing NULL Elements from a List	116
5.13	Removing List Elements Using a Condition	117
5.14	Initializing a Matrix	118
5.15	Performing Matrix Operations	119
5.16	Giving Descriptive Names to the Rows and Columns of a Matrix	120
5.17	Selecting One Row or Column from a Matrix	121
5.18	Initializing a Data Frame from Column Data	122
5.19	Initializing a Data Frame from Row Data	123
5.20	Appending Rows to a Data Frame	125
5.21	Preallocating a Data Frame	126
5.22	Selecting Data Frame Columns by Position	127
5.23	Selecting Data Frame Columns by Name	131
5.24	Selecting Rows and Columns More Easily	132
5.25	Changing the Names of Data Frame Columns	133
5.26	Editing a Data Frame	135
5.27	Removing NAs from a Data Frame	136
5.28	Excluding Columns by Name	137
5.29	Combining Two Data Frames	138
5.30	Merging Data Frames by Common Column	140
5.31	Accessing Data Frame Contents More Easily	141
5.32	Converting One Atomic Value into Another	143
5.33	Converting One Structured Data Type into Another	144
6.	Data Transformations	147
6.1	Splitting a Vector into Groups	148
6.2	Applying a Function to Each List Element	149
6.3	Applying a Function to Every Row	151
6.4	Applying a Function to Every Column	152
6.5	Applying a Function to Groups of Data	154
6.6	Applying a Function to Groups of Rows	156
6.7	Applying a Function to Parallel Vectors or Lists	158
7.	Strings and Dates	161
7.1	Getting the Length of a String	163
7.2	Concatenating Strings	163
7.3	Extracting Substrings	164
7.4	Splitting a String According to a Delimiter	165
7.5	Replacing Substrings	166

7.6	Seeing the Special Characters in a String	167
7.7	Generating All Pairwise Combinations of Strings	168
7.8	Getting the Current Date	169
7.9	Converting a String into a Date	170
7.10	Converting a Date into a String	171
7.11	Converting Year, Month, and Day into a Date	172
7.12	Getting the Julian Date	173
7.13	Extracting the Parts of a Date	174
7.14	Creating a Sequence of Dates	175
8.	Probability	177
8.1	Counting the Number of Combinations	179
8.2	Generating Combinations	180
8.3	Generating Random Numbers	180
8.4	Generating Reproducible Random Numbers	182
8.5	Generating a Random Sample	183
8.6	Generating Random Sequences	184
8.7	Randomly Permuting a Vector	185
8.8	Calculating Probabilities for Discrete Distributions	186
8.9	Calculating Probabilities for Continuous Distributions	188
8.10	Converting Probabilities to Quantiles	189
8.11	Plotting a Density Function	190
9.	General Statistics	195
9.1	Summarizing Your Data	197
9.2	Calculating Relative Frequencies	199
9.3	Tabulating Factors and Creating Contingency Tables	200
9.4	Testing Categorical Variables for Independence	201
9.5	Calculating Quantiles (and Quartiles) of a Dataset	201
9.6	Inverting a Quantile	202
9.7	Converting Data to Z-Scores	203
9.8	Testing the Mean of a Sample (<i>t</i> Test)	203
9.9	Forming a Confidence Interval for a Mean	205
9.10	Forming a Confidence Interval for a Median	206
9.11	Testing a Sample Proportion	207
9.12	Forming a Confidence Interval for a Proportion	208
9.13	Testing for Normality	209
9.14	Testing for Runs	210
9.15	Comparing the Means of Two Samples	212
9.16	Comparing the Locations of Two Samples Nonparametrically	213
9.17	Testing a Correlation for Significance	215
9.18	Testing Groups for Equal Proportions	216
9.19	Performing Pairwise Comparisons Between Group Means	218

10. Graphics	221
10.1 Creating a Scatter Plot	223
10.2 Adding a Title and Labels	225
10.3 Adding a Grid	226
10.4 Creating a Scatter Plot of Multiple Groups	227
10.5 Adding a Legend	229
10.6 Plotting the Regression Line of a Scatter Plot	231
10.7 Plotting All Variables Against All Other Variables	233
10.8 Creating One Scatter Plot for Each Factor Level	233
10.9 Creating a Bar Chart	236
10.10 Adding Confidence Intervals to a Bar Chart	237
10.11 Coloring a Bar Chart	239
10.12 Plotting a Line from x and y Points	241
10.13 Changing the Type, Width, or Color of a Line	242
10.14 Plotting Multiple Datasets	243
10.15 Adding Vertical or Horizontal Lines	245
10.16 Creating a Box Plot	246
10.17 Creating One Box Plot for Each Factor Level	247
10.18 Creating a Histogram	248
10.19 Adding a Density Estimate to a Histogram	250
10.20 Creating a Discrete Histogram	252
10.21 Creating a Normal Quantile-Quantile (Q-Q) Plot	252
10.22 Creating Other Quantile-Quantile Plots	254
10.23 Plotting a Variable in Multiple Colors	256
10.24 Graphing a Function	258
10.25 Pausing Between Plots	259
10.26 Displaying Several Figures on One Page	260
10.27 Opening Additional Graphics Windows	262
10.28 Writing Your Plot to a File	263
10.29 Changing Graphical Parameters	264
11. Linear Regression and ANOVA	267
11.1 Performing Simple Linear Regression	269
11.2 Performing Multiple Linear Regression	270
11.3 Getting Regression Statistics	272
11.4 Understanding the Regression Summary	275
11.5 Performing Linear Regression Without an Intercept	278
11.6 Performing Linear Regression with Interaction Terms	279
11.7 Selecting the Best Regression Variables	281
11.8 Regressing on a Subset of Your Data	284
11.9 Using an Expression Inside a Regression Formula	285

11.10	Regressing on a Polynomial	286
11.11	Regressing on Transformed Data	287
11.12	Finding the Best Power Transformation (Box–Cox Procedure)	289
11.13	Forming Confidence Intervals for Regression Coefficients	292
11.14	Plotting Regression Residuals	293
11.15	Diagnosing a Linear Regression	293
11.16	Identifying Influential Observations	296
11.17	Testing Residuals for Autocorrelation (Durbin–Watson Test)	298
11.18	Predicting New Values	300
11.19	Forming Prediction Intervals	301
11.20	Performing One-Way ANOVA	302
11.21	Creating an Interaction Plot	303
11.22	Finding Differences Between Means of Groups	304
11.23	Performing Robust ANOVA (Kruskal–Wallis Test)	308
11.24	Comparing Models by Using ANOVA	309
12.	Useful Tricks	313
12.1	Peeking at Your Data	313
12.2	Widen Your Output	314
12.3	Printing the Result of an Assignment	315
12.4	Summing Rows and Columns	315
12.5	Printing Data in Columns	316
12.6	Binning Your Data	317
12.7	Finding the Position of a Particular Value	318
12.8	Selecting Every nth Element of a Vector	319
12.9	Finding Pairwise Minimums or Maximums	320
12.10	Generating All Combinations of Several Factors	321
12.11	Flatten a Data Frame	322
12.12	Sorting a Data Frame	323
12.13	Sorting by Two Columns	324
12.14	Stripping Attributes from a Variable	325
12.15	Revealing the Structure of an Object	326
12.16	Timing Your Code	329
12.17	Suppressing Warnings and Error Messages	329
12.18	Taking Function Arguments from a List	331
12.19	Defining Your Own Binary Operators	332
13.	Beyond Basic Numerics and Statistics	335
13.1	Minimizing or Maximizing a Single-Parameter Function	335
13.2	Minimizing or Maximizing a Multiparameter Function	336
13.3	Calculating Eigenvalues and Eigenvectors	338
13.4	Performing Principal Component Analysis	338
13.5	Performing Simple Orthogonal Regression	340

13.6	Finding Clusters in Your Data	342
13.7	Predicting a Binary-Valued Variable (Logistic Regression)	345
13.8	Bootstrapping a Statistic	346
13.9	Factor Analysis	349
14.	Time Series Analysis	355
14.1	Representing Time Series Data	356
14.2	Plotting Time Series Data	359
14.3	Extracting the Oldest or Newest Observations	361
14.4	Subsetting a Time Series	363
14.5	Merging Several Time Series	364
14.6	Filling or Padding a Time Series	366
14.7	Lagging a Time Series	368
14.8	Computing Successive Differences	369
14.9	Performing Calculations on Time Series	370
14.10	Computing a Moving Average	372
14.11	Applying a Function by Calendar Period	373
14.12	Applying a Rolling Function	375
14.13	Plotting the Autocorrelation Function	376
14.14	Testing a Time Series for Autocorrelation	377
14.15	Plotting the Partial Autocorrelation Function	378
14.16	Finding Lagged Correlations Between Two Time Series	379
14.17	Detrending a Time Series	382
14.18	Fitting an ARIMA Model	383
14.19	Removing Insignificant ARIMA Coefficients	386
14.20	Running Diagnostics on an ARIMA Model	387
14.21	Making Forecasts from an ARIMA Model	389
14.22	Testing for Mean Reversion	391
14.23	Smoothing a Time Series	393
Index		397