Society of Actuaries Exam PA

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Contents

Chapter 1

Welcome

This is the online version of *SOA Exam PA*, a book **currently under early development** and intended for a late 2024 release on SOA Exam PA Github.

This book is designed to take you through the entire syllabus and prepare you to take (and pass) the Society of Actuaries Predictive Analytics Exam (Exam PA). Throughout this book, you will gain a deeper understanding of the basics of R programming, the theory of and relevent case studies in predictive analytics, and be provided final preperation for the exam in the form of a discussion on past exams, sample mock exams, and a cheatsheet.

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Preface

1.1 Prerequisites

Before we continue, make sure you have all the software you need for this book:

- **R**: If you don't have R installed already, you may be reading the wrong book; I assume a basic familiarity with R throughout this book. If you'd like to learn how to use R, I'd recommend my *R for Data Science* which is designed to get you up and running with R with a minimum of fuss.

- **RStudio**: RStudio is a free and open source integrated development environment (IDE) for R. While you can write and use Shiny apps with any R environment (including R GUI and ESS), RStudio has some nice features specifically for authoring, debugging, and deploying Shiny apps. We recommend giving it a try, but it's not required to be successful with Shiny or with this book. You can download RStudio Desktop from https://www.rstudio.com/products/rstudio/download

1.2 Colophon

This book was written in RStudio using bookdown.

The website is hosted with Github Pages, and automatically updated after every commit by Github Actions. The complete source is available from GitHub.

This version of the book was built with R version 4.3.3 (2024-02-29 ucrt) and the following packages:

```
## -- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.1     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
## v purrr     1.0.2
## -- Conflicts --------------------------------------------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
```

```
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts
```

package	version	source
abind	1.4-8	CRAN (R 4.3.3)
adabag	5.0	CRAN (R 4.3.3)
addinexamples	0.1.0	Github (rstu-dio/addinexamples@fae960911302ed2ca3139b47500e7606233e1390)
addinslist	0.5.0	CRAN (R 4.3.3)
admisc	0.36	CRAN (R 4.3.3)
afex	1.4-1	CRAN (R 4.3.3)
alphashape3d	1.3.2	CRAN (R 4.3.3)
alr4	1.0.6	CRAN (R 4.3.3)
AmesHousing	0.0.4	CRAN (R 4.3.3)
AsioHeaders	1.22.1-2	CRAN (R 4.3.1)
askpass	1.2.0	CRAN (R 4.3.3)
assertthat	0.2.1	CRAN (R 4.3.3)
assist	3.1.9	CRAN (R 4.3.3)
audio	0.1-11	CRAN (R 4.3.1)
backports	1.5.0	CRAN (R 4.3.3)
base64enc	0.1-3	CRAN (R 4.3.1)
BayesFactor	0.9.12-4.7	CRAN (R 4.3.3)
bayestestR	0.14.0	CRAN (R 4.3.3)
bdsmatrix	1.3-7	CRAN (R 4.3.3)
beepr	2.0	CRAN (R 4.3.3)
bit	4.5.0	CRAN (R 4.3.3)
bit64	4.5.2	CRAN (R 4.3.3)
bitops	1.0-9	CRAN (R 4.3.3)
blob	1.2.4	CRAN (R 4.3.3)
bookdown	0.40	CRAN (R 4.3.3)
boot	1.3-29	CRAN (R 4.3.3)
BradleyTerry2	1.1-2	CRAN (R 4.3.3)
brew	1.0-10	CRAN (R 4.3.3)
brglm	0.7.2	CRAN (R 4.3.3)
brio	1.1.5	CRAN (R 4.3.3)
broom	1.0.7	CRAN (R 4.3.3)
bslib	0.8.0	CRAN (R 4.3.3)
BWStest	0.2.3	CRAN (R 4.3.3)
C50	0.1.8	CRAN (R 4.3.3)
cachem	1.1.0	CRAN (R 4.3.3)
callr	3.7.6	CRAN (R 4.3.3)
car	3.1-3	CRAN (R 4.3.3)
carData	3.0-5	CRAN (R 4.3.3)
caret	6.0-94	CRAN (R 4.3.3)

package	version	source
caTools	1.18.3	CRAN (R 4.3.3)
cellranger	1.1.0	CRAN (R 4.3.3)
checkmate	2.3.2	CRAN (R 4.3.3)
chromote	0.3.1	CRAN (R 4.3.3)
class	7.3-22	CRAN (R 4.3.3)
classInt	0.4-10	CRAN (R 4.3.3)
cli	3.6.3	CRAN (R 4.3.3)
clipr	0.8.0	CRAN (R 4.3.3)
clock	0.7.1	CRAN (R 4.3.3)
cluster	2.1.6	CRAN (R 4.3.3)
coda	0.19-4.1	CRAN (R 4.3.3)
codetools	0.2-19	CRAN (R 4.3.3)
coin	1.4-3	CRAN (R 4.3.3)
colorspace	2.1-1	CRAN (R 4.3.3)
combinat	0.0-8	CRAN (R 4.3.1)
commonmark	1.9.1	CRAN (R 4.3.3)
config	0.3.2	CRAN (R 4.3.3)
conflicted	1.2.0	CRAN (R 4.3.3)
ConsRank	2.1.4	CRAN (R 4.3.3)
contfrac	1.1-12	CRAN (R 4.3.1)
correlation	0.8.5	CRAN (R 4.3.3)
corrplot	0.94	CRAN (R 4.3.3)
covr	3.6.4	CRAN (R 4.3.3)
cowplot	1.1.3	CRAN (R 4.3.3)
coxme	2.2-22	CRAN (R 4.3.3)
cpp11	0.5.0	CRAN (R 4.3.3)
crayon	1.5.3	CRAN (R 4.3.3)
credentials	2.0.2	CRAN (R 4.3.3)
crosstalk	1.2.1	CRAN (R 4.3.3)
Cubist	0.4.4	CRAN (R 4.3.3)
curl	5.2.3	CRAN (R 4.3.3)
DALEX	2.4.3	CRAN (R 4.3.3)
data.table	1.16.0	CRAN (R 4.3.3)
datamods	1.5.3	CRAN (R 4.3.3)
datawizard	0.12.3	CRAN (R 4.3.3)
DBI	1.2.3	CRAN (R 4.3.3)
dbplyr	2.5.0	CRAN (R 4.3.3)
deldir	2.0-4	CRAN (R 4.3.3)
dendextend	1.17.1	CRAN (R 4.3.3)
Deriv	4.1.6	CRAN (R 4.3.3)
desc	1.4.3	CRAN (R 4.3.3)
DescTools	0.99.57	CRAN (R 4.3.3)
deSolve	1.40	CRAN (R 4.3.3)
devtools	2.4.5	CRAN (R 4.3.3)

package	version	source
diagram	1.6.5	CRAN (R 4.3.2)
diffobj	0.3.5	CRAN (R 4.3.3)
digest	0.6.37	CRAN (R 4.3.3)
doBy	4.6.22	CRAN (R 4.3.3)
doParallel	1.0.17	CRAN (R 4.3.3)
dotCall64	1.1-1	CRAN (R 4.3.3)
downlit	0.4.4	CRAN (R 4.3.3)
dplyr	1.1.4	CRAN (R 4.3.3)
dslabs	0.8.0	CRAN (R 4.3.3)
DT	0.33	CRAN (R 4.3.3)
dtplyr	1.3.1	CRAN (R 4.3.3)
dunn.test	1.3.6	CRAN (R 4.3.3)
e1071	1.7-16	CRAN (R 4.3.3)
earth	5.3.3	CRAN (R 4.3.3)
effects	4.2-2	CRAN (R 4.3.3)
effectsize	0.8.9	CRAN (R 4.3.3)
ellipse	0.5.0	CRAN (R 4.3.3)
ellipsis	0.3.2	CRAN (R 4.3.3)
elliptic	1.4-0	CRAN (R 4.3.3)
emmeans	1.10.4	CRAN (R 4.3.3)
entropy	1.3.1	CRAN (R 4.3.1)
esquisse	2.0.1	CRAN (R 4.3.3)
estimability	1.5.1	CRAN (R 4.3.3)
evaluate	1.0.0	CRAN (R 4.3.3)
Exact	3.3	CRAN (R 4.3.3)
expm	1.0-0	CRAN (R 4.3.3)
extrafont	0.19	CRAN (R 4.3.1)
extrafontdb	1.0	CRAN (R 4.3.1)
factoextra	1.0.7	CRAN (R 4.3.3)
FactoMineR	2.11	CRAN (R 4.3.3)
fansi	1.0.6	CRAN (R 4.3.3)
farver	2.1.2	CRAN (R 4.3.3)
fastICA	1.2-5.1	CRAN (R 4.3.3)
fastmap	1.2.0	CRAN (R 4.3.3)
fields	16.3	CRAN (R 4.3.3)
flashClust	1.01-2	CRAN (R 4.3.1)
fontawesome	0.5.2	CRAN (R 4.3.3)
forcats	1.0.0	CRAN (R 4.3.3)
foreach	1.5.2	CRAN (R 4.3.3)
foreign	0.8-86	CRAN (R 4.3.3)
formatR	1.14	CRAN (R 4.3.3)
formattable	0.2.1	CRAN (R 4.3.3)
Formula	1.2-5	CRAN (R 4.3.1)
fs	1.6.4	CRAN (R 4.3.3)

package	version	source
FSA	0.9.5	CRAN (R 4.3.3)
funModeling	1.9.5	CRAN (R 4.3.3)
future	1.34.0	CRAN (R 4.3.3)
future.apply	1.11.2	CRAN (R 4.3.3)
gam	1.22-5	CRAN (R 4.3.3)
gargle	1.5.2	CRAN (R 4.3.3)
gbm	2.2.2	CRAN (R 4.3.3)
generics	0.1.3	CRAN (R 4.3.3)
geometry	0.5.0	CRAN (R 4.3.3)
gert	2.1.2	CRAN (R 4.3.3)
ggcorrplot	0.1.4.1	CRAN (R 4.3.3)
ggfortify	0.4.17	CRAN (R 4.3.3)
ggfun	0.1.6	CRAN (R 4.3.3)
ggimage	0.3.3	CRAN (R 4.3.3)
ggplot2	3.5.1	CRAN (R 4.3.3)
ggplotify	0.1.2	CRAN (R 4.3.3)
ggpubr	0.6.0	CRAN (R 4.3.3)
ggrepel	0.9.6	CRAN (R 4.3.3)
ggsci	3.2.0	CRAN (R 4.3.3)
ggside	0.3.1	CRAN (R 4.3.3)
ggsignif	0.6.4	CRAN (R 4.3.3)
ggstatsplot	0.12.4	CRAN (R 4.3.3)
gh	1.4.1	CRAN (R 4.3.3)
gitcreds	0.1.2	CRAN (R 4.3.3)
gld	2.6.6	CRAN (R 4.3.3)
glmnet	4.1-8	CRAN (R 4.3.3)
globals	0.16.3	CRAN (R 4.3.3)
glue	1.8.0	CRAN (R 4.3.3)
gmp	0.7-5	CRAN (R 4.3.3)
goeveg	0.7.5	CRAN (R 4.3.3)
googleAuthR	2.0.2	CRAN (R 4.3.3)
googledrive	2.1.1	CRAN (R 4.3.3)
googlesheets4	1.1.1	CRAN (R 4.3.3)
gower	1.0.1	CRAN (R 4.3.1)
GPArotation	2024.3-1	CRAN (R 4.3.3)
gplots	3.1.3.1	CRAN (R 4.3.3)
gridExtra	2.3	CRAN (R 4.3.3)
gridGraphics	0.5-1	CRAN (R 4.3.3)
gtable	0.3.5	CRAN (R 4.3.3)
gtools	3.9.5	CRAN (R 4.3.3)
h2o	3.44.0.3	CRAN (R 4.3.3)
hardhat	1.4.0	CRAN (R 4.3.3)
haven	2.5.4	CRAN (R 4.3.3)
here	1.0.1	CRAN (R 4.3.3)

package	version	source
hexbin	1.28.4	CRAN (R 4.3.3)
hexSticker	0.4.9	CRAN (R 4.3.3)
highr	0.11	CRAN (R 4.3.3)
Hmisc	5.1-3	CRAN (R 4.3.3)
hms	1.1.3	CRAN (R 4.3.3)
htmlTable	2.4.3	CRAN (R 4.3.3)
htmltools	0.5.8.1	CRAN (R 4.3.3)
htmlwidgets	1.6.4	CRAN (R 4.3.3)
httpuv	1.6.15	CRAN (R 4.3.3)
httr	1.4.7	CRAN (R 4.3.3)
httr2	1.0.5	CRAN (R 4.3.3)
hypergeo	1.2-13	CRAN (R 4.3.3)
iBreakDown	2.1.2	CRAN (R 4.3.3)
ICEbox	1.1.5	CRAN (R 4.3.3)
ids	1.0.1	CRAN (R 4.3.3)
imputeMissings	0.0.4	CRAN (R 4.3.3)
ingredients	2.3.0	CRAN (R 4.3.3)
ini	0.3.1	CRAN (R 4.3.3)
insight	0.20.5	CRAN (R 4.3.3)
interp	1.1-6	CRAN (R 4.3.3)
inum	1.0-5	CRAN (R 4.3.3)
ipred	0.9-15	CRAN (R 4.3.3)
irr	0.84.1	CRAN (R 4.3.3)
ISLR	1.4	CRAN (R 4.3.3)
isoband	0.2.7	CRAN (R 4.3.3)
iterators	1.0.14	CRAN (R 4.3.3)
janitor	2.2.0	CRAN (R 4.3.3)
jpeg	0.1-10	CRAN (R 4.3.1)
jquerylib	0.1.4	CRAN (R 4.3.3)
js	1.2.1	CRAN (R 4.3.3)
jsonlite	1.8.9	CRAN (R 4.3.3)
kableExtra	1.4.0	CRAN (R 4.3.3)
KappaGUI	2.0.2	CRAN (R 4.3.3)
keras	2.15.0	CRAN (R 4.3.3)
kernlab	0.9-33	CRAN (R 4.3.3)
KernSmooth	2.23-22	CRAN (R 4.3.3)
klaR	1.7-3	CRAN (R 4.3.3)
knitr	1.48	CRAN (R 4.3.3)
kSamples	1.2-10	CRAN (R 4.3.3)
labeling	0.4.3	CRAN (R 4.3.1)
labelled	2.13.0	CRAN (R 4.3.3)
lares	5.2.9	CRAN (R 4.3.3)
lars	1.3	CRAN (R 4.3.1)
later	1.3.2	CRAN (R 4.3.3)

package	version	source
lattice	0.22-5	CRAN (R 4.3.3)
lava	1.8.0	CRAN (R 4.3.3)
lazyeval	0.2.2	CRAN (R 4.3.3)
leaps	3.2	CRAN (R 4.3.3)
libcoin	1.0-10	CRAN (R 4.3.3)
lifecycle	1.0.4	CRAN (R 4.3.3)
linprog	0.9-4	CRAN (R 4.3.3)
listenv	0.9.1	CRAN (R 4.3.3)
lme4	1.1-35.5	CRAN (R 4.3.3)
lmerTest	3.1-3	CRAN (R 4.3.3)
lmom	3.2	CRAN (R 4.3.3)
lmtest	0.9-40	CRAN (R 4.3.3)
lobstr	1.1.2	CRAN (R 4.3.3)
lpSolve	5.6.21	CRAN (R 4.3.3)
ltm	1.2-0	CRAN (R 4.3.3)
lubridate	1.9.3	CRAN (R 4.3.3)
magic	1.6-1	CRAN (R 4.3.3)
magick	2.8.5	CRAN (R 4.3.3)
magrittr	2.0.3	CRAN (R 4.3.3)
manipulateWidget	0.11.1	CRAN (R 4.3.3)
maps	3.4.2	CRAN (R 4.3.3)
markdown	1.13	CRAN (R 4.3.3)
MASS	7.3-60.0.1	CRAN (R 4.3.3)
Matrix	1.6-5	CRAN (R 4.3.3)
MatrixModels	0.5-3	CRAN (R 4.3.3)
matrixStats	1.4.1	CRAN (R 4.3.3)
mda	0.5-4	CRAN (R 4.3.3)
memoise	2.0.1	CRAN (R 4.3.3)
mgcv	1.9-1	CRAN (R 4.3.3)
microbenchmark	1.5.0	CRAN (R 4.3.3)
mime	0.12	CRAN (R 4.3.1)
miniUI	0.1.1.1	CRAN (R 4.3.3)
minqa	1.2.8	CRAN (R 4.3.3)
misc3d	0.9-1	CRAN (R 4.3.3)
mitools	2.4	CRAN (R 4.3.3)
mlbench	2.1-5	CRAN (R 4.3.3)
MLmetrics	1.1.3	CRAN (R 4.3.3)
mnormt	2.1.1	CRAN (R 4.3.1)
ModelMetrics	1.2.2.2	CRAN (R 4.3.3)
modelr	0.1.11	CRAN (R 4.3.3)
modeltools	0.2-23	CRAN (R 4.3.1)
moments	0.14.1	CRAN (R 4.3.1)
msm	1.8	CRAN (R 4.3.3)

package	version	source
multcomp	1.4-26	CRAN (R 4.3.3)
multcompView	0.1-10	CRAN (R 4.3.3)
munsell	0.5.1	CRAN (R 4.3.3)
mvtnorm	1.3-1	CRAN (R 4.3.3)
nlme	3.1-164	CRAN (R 4.3.3)
nloptr	2.1.1	CRAN (R 4.3.3)
nnet	7.3-19	CRAN (R 4.3.3)
nortest	1.0-4	CRAN (R 4.3.1)
numDeriv	2016.8-1.1	CRAN (R 4.3.1)
openssl	2.2.2	CRAN (R 4.3.3)
openxlsx	4.2.7.1	CRAN (R 4.3.3)
ordinal	2023.12-4.1	CRAN (R 4.3.3)
orientlib	0.10.5	CRAN (R 4.3.3)
packrat	0.9.2	CRAN (R 4.3.3)
paletteer	1.6.0	CRAN (R 4.3.3)
pamr	1.57	CRAN (R 4.3.3)
pander	0.6.5	CRAN (R 4.3.3)
parallelly	1.38.0	CRAN (R 4.3.3)
parameters	0.22.2	CRAN (R 4.3.3)
party	1.3-17	CRAN (R 4.3.3)
partykit	1.2-22	CRAN (R 4.3.3)
patchwork	1.3.0	CRAN (R 4.3.3)
pbapply	1.7-2	CRAN (R 4.3.3)
pbkrtest	0.5.3	CRAN (R 4.3.3)
pdp	0.8.1	CRAN (R 4.3.3)
performance	0.12.3	CRAN (R 4.3.3)
permute	0.9-7	CRAN (R 4.3.3)
phosphoricons	0.2.1	CRAN (R 4.3.3)
pillar	1.9.0	CRAN (R 4.3.3)
pkgbuild	1.4.4	CRAN (R 4.3.3)
pkgconfig	2.0.3	CRAN (R 4.3.3)
pkgdown	2.1.1	CRAN (R 4.3.3)
pkgload	1.4.0	CRAN (R 4.3.3)
PKI	0.1-14	CRAN (R 4.3.3)
plotmo	3.6.4	CRAN (R 4.3.3)
plotrix	3.8-4	CRAN (R 4.3.2)
pls	2.8-5	CRAN (R 4.3.3)
plyr	1.8.9	CRAN (R 4.3.3)
PMCMRplus	1.9.12	CRAN (R 4.3.3)
png	0.1-8	CRAN (R 4.3.1)
polycor	0.8-1	CRAN (R 4.3.3)
polynom	1.4-1	CRAN (R 4.3.3)

package	version	source
praise	1.0.0	CRAN (R 4.3.3)
prettyunits	1.2.0	CRAN (R 4.3.3)
prismatic	1.1.2	CRAN (R 4.3.3)
pROC	1.18.5	CRAN (R 4.3.3)
processx	3.8.4	CRAN (R 4.3.3)
prodlim	2024.06.25	CRAN (R 4.3.3)
profileModel	0.6.1	CRAN (R 4.3.3)
profvis	0.4.0	CRAN (R 4.3.3)
progress	1.2.3	CRAN (R 4.3.3)
progressr	0.14.0	CRAN (R 4.3.3)
promises	1.3.0	CRAN (R 4.3.3)
proxy	0.4-27	CRAN (R 4.3.3)
pryr	0.1.6	CRAN (R 4.3.3)
ps	1.8.0	CRAN (R 4.3.3)
psy	1.2	CRAN (R 4.3.1)
psych	2.4.6.26	CRAN (R 4.3.3)
purrr	1.0.2	CRAN (R 4.3.3)
pwr	1.3-0	CRAN (R 4.3.3)
quantmod	0.4.26	CRAN (R 4.3.3)
quantreg	5.98	CRAN (R 4.3.3)
questionr	0.7.8	CRAN (R 4.3.3)
qvcalc	1.0.3	CRAN (R 4.3.3)
R.cache	0.16.0	CRAN (R 4.3.3)
R.methodsS3	1.8.2	CRAN (R 4.3.3)
R.oo	1.26.0	CRAN (R 4.3.3)
R.utils	2.12.3	CRAN (R 4.3.3)
R6	2.5.1	CRAN (R 4.3.3)
ragg	1.3.3	CRAN (R 4.3.3)
randomForest	4.7-1.2	CRAN (R 4.3.3)
ranger	0.16.0	CRAN (R 4.3.3)
RANN	2.6.2	CRAN (R 4.3.3)
rappdirs	0.3.3	CRAN (R 4.3.3)
rapportools	1.1	CRAN (R 4.3.3)
rcmdcheck	1.4.0	CRAN (R 4.3.3)
RcmdrMisc	2.9-1	CRAN (R 4.3.3)
RColorBrewer	1.1-3	CRAN (R 4.3.1)
rcompanion	2.4.36	CRAN (R 4.3.3)
Rcpp	1.0.13	CRAN (R 4.3.3)
RcppArmadillo	14.0.2-1	CRAN (R 4.3.3)
RcppEigen	0.3.4.0.2	CRAN (R 4.3.3)
RcppProgress	0.4.2	CRAN (R 4.3.3)
RcppTOML	0.2.2	CRAN (R 4.3.3)
RCurl	1.98-1.16	CRAN (R 4.3.3)

package	version	source
reactable	0.4.4	CRAN (R 4.3.3)
reactR	0.6.1	CRAN (R 4.3.3)
readr	2.1.5	CRAN (R 4.3.3)
readstata13	0.10.1	CRAN (R 4.3.3)
readxl	1.4.3	CRAN (R 4.3.3)
recipes	1.1.0	CRAN (R 4.3.3)
rematch	2.0.0	CRAN (R 4.3.3)
rematch2	2.1.2	CRAN (R 4.3.3)
remedy	0.1.0	CRAN (R 4.3.3)
remotes	2.5.0	CRAN (R 4.3.3)
renv	1.0.9	CRAN (R 4.3.3)
reprex	2.1.1	CRAN (R 4.3.3)
reshape	0.8.9	CRAN (R 4.3.3)
reshape2	1.4.4	CRAN (R 4.3.3)
reticulate	1.39.0	CRAN (R 4.3.3)
rex	1.2.1	CRAN (R 4.3.3)
rgl	1.3.1	CRAN (R 4.3.3)
rio	1.2.3	CRAN (R 4.3.3)
rlang	1.1.4	CRAN (R 4.3.3)
rlist	0.4.6.2	CRAN (R 4.3.3)
rmarkdown	2.28	CRAN (R 4.3.3)
Rmpfr	0.9-5	CRAN (R 4.3.3)
ROCR	1.0-11	CRAN (R 4.3.3)
rootSolve	1.8.2.4	CRAN (R 4.3.1)
ROSE	0.0-4	CRAN (R 4.3.3)
roxygen2	7.3.2	CRAN (R 4.3.3)
rpart	4.1.23	CRAN (R 4.3.3)
rpart.plot	3.1.2	CRAN (R 4.3.3)
rprojroot	2.0.4	CRAN (R 4.3.3)
rsconnect	1.3.1	CRAN (R 4.3.3)
rstatix	0.7.2	CRAN (R 4.3.3)
rstudioapi	0.16.0	CRAN (R 4.3.3)
rticles	0.27	CRAN (R 4.3.3)
Rttf2pt1	1.3.12	CRAN (R 4.3.1)
rversions	2.1.2	CRAN (R 4.3.3)
rvest	1.0.4	CRAN (R 4.3.3)
sandwich	3.1-1	CRAN (R 4.3.3)
sass	0.4.9	CRAN (R 4.3.3)
scales	1.3.0	CRAN (R 4.3.3)
scatterplot3d	0.3-44	CRAN (R 4.3.1)
selectr	0.4-2	CRAN (R 4.3.3)
servr	0.32	CRAN (R 4.3.3)
sessioninfo	1.2.2	CRAN (R 4.3.3)
sfsmisc	1.1-19	CRAN (R 4.3.3)

package	version	source
shape	1.4.6.1	CRAN (R 4.3.2)
shiny	1.9.1	CRAN (R 4.3.3)
shinybusy	0.3.3	CRAN (R 4.3.3)
shinyjs	2.1.0	CRAN (R 4.3.3)
shinyWidgets	0.8.7	CRAN (R 4.3.3)
showtext	0.9-7	CRAN (R 4.3.3)
showtextdb	3.0	CRAN (R 4.3.3)
snakecase	0.11.1	CRAN (R 4.3.3)
sourcetools	0.1.7-1	CRAN (R 4.3.3)
spam	2.11-0	CRAN (R 4.3.3)
sparkline	2.0	CRAN (R 4.3.3)
SparseM	1.84-2	CRAN (R 4.3.3)
spatial	7.3-17	CRAN (R 4.3.3)
spls	2.2-3	CRAN (R 4.3.3)
SQUAREM	2021.1	CRAN (R 4.3.2)
statsExpressions	1.6.0	CRAN (R 4.3.3)
stringi	1.8.4	CRAN (R 4.3.3)
stringr	1.5.1	CRAN (R 4.3.3)
strucchange	1.5-4	CRAN (R 4.3.3)
styler	1.10.3	CRAN (R 4.3.3)
summarytools	1.0.1	CRAN (R 4.3.3)
superpc	1.12	CRAN (R 4.3.3)
SuppDists	1.1-9.8	CRAN (R 4.3.3)
survey	4.4-2	CRAN (R 4.3.3)
survival	3.5-8	CRAN (R 4.3.3)
svglite	2.1.3	CRAN (R 4.3.3)
sys	3.4.2	CRAN (R 4.3.3)
sysfonts	0.8.9	CRAN (R 4.3.3)
systemfonts	1.1.0	CRAN (R 4.3.3)
tensorflow	2.16.0	CRAN (R 4.3.3)
testthat	3.2.1.1	CRAN (R 4.3.3)
textshaping	0.4.0	CRAN (R 4.3.3)
tfautograph	0.3.2	CRAN (R 4.3.3)
tfruns	1.5.3	CRAN (R 4.3.3)
TH.data	1.1-2	CRAN (R 4.3.3)
themis	1.0.2	CRAN (R 4.3.3)
tibble	3.2.1	CRAN (R 4.3.3)
tidyr	1.3.1	CRAN (R 4.3.3)
tidyselect	1.2.1	CRAN (R 4.3.3)
tidyverse	2.0.0	CRAN (R 4.3.3)
timechange	0.3.0	CRAN (R 4.3.3)
timeDate	4041.110	CRAN (R 4.3.3)
tinytest	1.4.1	CRAN (R 4.3.1)
tinytex	0.53	CRAN (R 4.3.3)

package	version	source
toastui	0.3.4	CRAN (R 4.3.3)
translations	4.3.3	local
tripack	1.3-9.1	CRAN (R 4.3.1)
TTR	0.24.4	CRAN (R 4.3.3)
tufte	0.13	CRAN (R 4.3.3)
tzdb	0.4.0	CRAN (R 4.3.3)
ucminf	1.2.2	CRAN (R 4.3.3)
urlchecker	1.0.1	CRAN (R 4.3.3)
usethis	3.0.0	CRAN (R 4.3.3)
utf8	1.2.4	CRAN (R 4.3.3)
uuid	1.2-1	CRAN (R 4.3.3)
V8	5.0.1	CRAN (R 4.3.3)
vcd	1.4-13	CRAN (R 4.3.3)
vctrs	0.6.5	CRAN (R 4.3.3)
vegan	2.6-8	CRAN (R 4.3.3)
vip	0.4.1	CRAN (R 4.3.3)
viridis	0.6.5	CRAN (R 4.3.3)
viridisLite	0.4.2	CRAN (R 4.3.3)
vroom	1.6.5	CRAN (R 4.3.3)
waldo	0.5.3	CRAN (R 4.3.3)
webshot	0.5.5	CRAN (R 4.3.3)
webshot2	0.1.1	CRAN (R 4.3.3)
websocket	1.4.2	CRAN (R 4.3.3)
whisker	0.4.1	CRAN (R 4.3.3)
withr	3.0.1	CRAN (R 4.3.3)
writexl	1.5.0	CRAN (R 4.3.3)
WRS2	1.1-6	CRAN (R 4.3.3)
xfun	0.48	CRAN (R 4.3.3)
xgboost	1.7.8.1	CRAN (R 4.3.3)
XML	3.99-0.17	CRAN (R 4.3.3)
xml2	1.3.6	CRAN (R 4.3.3)
xopen	1.0.1	CRAN (R 4.3.3)
xtable	1.8-4	CRAN (R 4.3.3)
xts	0.14.0	CRAN (R 4.3.3)
yaml	2.3.10	CRAN (R 4.3.3)
yardstick	1.3.1	CRAN (R 4.3.3)
yulab.utils	0.1.7	CRAN (R 4.3.3)
zeallot	0.1.0	CRAN (R 4.3.3)
zip	2.3.1	CRAN (R 4.3.3)
zoo	1.8-12	CRAN (R 4.3.3)

1.3   Acknowledgements

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1.4   Colophon

This book was written in RStudio using bookdown. The website is hosted with netlify, and automatically updated after every commit by Github Actions. The complete source is available from GitHub.

This version of the book was built with R version 4.3.3 (2024-02-29 ucrt) and the following packages:

package	version	source
dplyr	1.1.4	CRAN (R 4.3.3)
forcats	1.0.0	CRAN (R 4.3.3)
ggplot2	3.5.1	CRAN (R 4.3.3)
lubridate	1.9.3	CRAN (R 4.3.3)
purrr	1.0.2	CRAN (R 4.3.3)
readr	2.1.5	CRAN (R 4.3.3)
stringr	1.5.1	CRAN (R 4.3.3)
tibble	3.2.1	CRAN (R 4.3.3)
tidyr	1.3.1	CRAN (R 4.3.3)
tidyverse	2.0.0	CRAN (R 4.3.3)

Part I

A Crash Course in R