hw1-r-utkarsha

Home Work Assignment 1

Checking version of the R

```
R.version
```

```
               _
platform       x86_64-pc-linux-gnu
arch           x86_64
os             linux-gnu
system         x86_64, linux-gnu
status
major          4
minor          3.1
year           2023
month          06
day            16
svn rev        84548
language       R
version.string R version 4.3.1 (2023-06-16)
nickname       Beagle Scouts
```

Packages in R

Packages are **collections of functions, data sets, and documentation bundled together to extend the functionality** of the base R language. Packages are essential for adding specific capabilities to R

DMwR2 : Data Mining with R

Package focuses on **methods and tools for dealing with imbalanced data sets**, which are datasets where one class (or group) of observations significantly outnumbers the other install.packages("DMwR2")class.

Installing DMwR2 Package :

```
install.packages("DMwR2")
```

the **help()** function is used to access documentation and information about functions, data sets, packages, and other objects in the R environment.

```
help(package="DMwR2")
```

To see the list of pre-loaded data in base R packgaes, type the function **data**():

```
data() #loads the information of the datasets
```

Using dataset provided in `DMwR2` by referencing its name directly

```
algae <- data(algae) # load algae dataset
```

```
Warning in data(algae): data set 'algae' not found
```

```
algae#viewing the data
```

```
[1] "algae"
```

To view the first few rows of your dataset, you can use the **head()** function.

```
head(algae) #displays first 6 rows of t7he data
```

```
[1] "algae"
```

Similarly, you can use the **tail()** function to view the last few rows of your dataset.

```r
tail(algae) # displays last 6 rows of the data
```

```
[1] "algae"
```

```r
tail(algae, n = 10)  # Display the last 10 rows
```

```
[1] "algae"
```

To get summary statistics for your dataset, including mean, median, minimum, maximum, and quartiles for numeric columns, you can use the **summary()** function.

```r
summary(algae)
```

```
   Length     Class      Mode
        1 character character
```

```
{#{r message=FALSE, warning=FALSE} manyNAs(algae) # find rows with too many
NAs
```

Libraries and packages in R:

library() function without any arguments to list all the packages that are currently loaded in your R session.

```r
library()
```

(.packages()) function is used to list the names packages whose functions and objects are readily available for use in your R code.

```r
(.packages())
```

```
[1] "stats"     "graphics"  "grDevices" "utils"     "datasets"  "methods"
[7] "base"
```

library(packagename) function loads and attaches a specific package, making its functions and datasets available for use in your R session

```
library(ggplot2) #attaching the required package in the current session
(.packages())
```

```
[1] "ggplot2"   "stats"     "graphics"  "grDevices" "utils"     "datasets"
[7] "methods"   "base"
```

Detaching a package means that its functions and objects are no longer accessible in your current R session. This can be **useful when you want to clean up your workspace or avoid conflicts between functions or objects with the same name in different packages**.

```
detach("package:ggplot2", unload=TRUE)
(.packages())
```

```
[1] "stats"     "graphics"  "grDevices" "utils"     "datasets"  "methods"
[7] "base"
```

installed.packages() function is used to retrieve a list of all packages that are currently installed on your system.

```
installed.packages()
```

```
             Package          LibPath
abind        "abind"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
askpass      "askpass"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
base64enc    "base64enc"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
bit          "bit"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
bit64        "bit64"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
bitops       "bitops"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
bslib        "bslib"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
cachem       "cachem"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
caTools      "caTools"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
cli          "cli"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
clipr        "clipr"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
colorspace   "colorspace"     "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
cpp11        "cpp11"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
crayon       "crayon"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
credentials  "credentials"    "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
```

```
curl            "curl"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
DBI             "DBI"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
desc            "desc"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
digest          "digest"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
DMwR2           "DMwR2"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
dplyr           "dplyr"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
ellipsis        "ellipsis"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
evaluate        "evaluate"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
fansi           "fansi"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
farver          "farver"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
fastmap         "fastmap"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
fontawesome     "fontawesome"    "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
fs              "fs"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
generics        "generics"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gert            "gert"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
ggplot2         "ggplot2"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gh              "gh"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gitcreds        "gitcreds"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
glue            "glue"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gplots          "gplots"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gtable          "gtable"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
gtools          "gtools"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
highr           "highr"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
hms             "hms"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
htmltools       "htmltools"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
httr2           "httr2"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
ini             "ini"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
isoband         "isoband"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
jquerylib       "jquerylib"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
jsonlite        "jsonlite"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
KernSmooth      "KernSmooth"     "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
knitr           "knitr"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
labeling        "labeling"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
lifecycle       "lifecycle"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
magrittr        "magrittr"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
Matrix          "Matrix"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
memoise         "memoise"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
mgcv            "mgcv"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
mime            "mime"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
munsell         "munsell"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
nlme            "nlme"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
openssl         "openssl"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
palmerpenguins "palmerpenguins" "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
```

```
pillar          "pillar"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
pkgconfig       "pkgconfig"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
prettyunits     "prettyunits"     "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
progress        "progress"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
purrr           "purrr"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
quantmod        "quantmod"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
R6              "R6"              "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
rappdirs        "rappdirs"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
RColorBrewer    "RColorBrewer"    "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
readr           "readr"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
rlang           "rlang"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
rmarkdown       "rmarkdown"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
ROCR            "ROCR"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
rprojroot       "rprojroot"       "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
rstudioapi      "rstudioapi"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
sass            "sass"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
scales          "scales"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
spatial         "spatial"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
stringi         "stringi"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
stringr         "stringr"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
survival        "survival"        "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
sys             "sys"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
tibble          "tibble"          "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
tidyselect      "tidyselect"      "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
tinytex         "tinytex"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
TTR             "TTR"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
tzdb            "tzdb"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
usethis         "usethis"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
utf8            "utf8"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
vctrs           "vctrs"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
viridisLite     "viridisLite"     "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
vroom           "vroom"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
whisker         "whisker"         "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
withr           "withr"           "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
xfun            "xfun"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
xts             "xts"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
yaml            "yaml"            "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
zip             "zip"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
zoo             "zoo"             "/cloud/lib/x86_64-pc-linux-gnu-library/4.3"
base            "base"            "/opt/R/4.3.1/lib/R/library"
boot            "boot"            "/opt/R/4.3.1/lib/R/library"
class           "class"           "/opt/R/4.3.1/lib/R/library"
cluster         "cluster"         "/opt/R/4.3.1/lib/R/library"
```

```
codetools      "codetools"      "/opt/R/4.3.1/lib/R/library"
compiler       "compiler"       "/opt/R/4.3.1/lib/R/library"
datasets       "datasets"       "/opt/R/4.3.1/lib/R/library"
foreign        "foreign"        "/opt/R/4.3.1/lib/R/library"
graphics       "graphics"       "/opt/R/4.3.1/lib/R/library"
grDevices      "grDevices"      "/opt/R/4.3.1/lib/R/library"
grid           "grid"           "/opt/R/4.3.1/lib/R/library"
KernSmooth     "KernSmooth"     "/opt/R/4.3.1/lib/R/library"
lattice        "lattice"        "/opt/R/4.3.1/lib/R/library"
MASS           "MASS"           "/opt/R/4.3.1/lib/R/library"
Matrix         "Matrix"         "/opt/R/4.3.1/lib/R/library"
methods        "methods"        "/opt/R/4.3.1/lib/R/library"
mgcv           "mgcv"           "/opt/R/4.3.1/lib/R/library"
nlme           "nlme"           "/opt/R/4.3.1/lib/R/library"
nnet           "nnet"           "/opt/R/4.3.1/lib/R/library"
parallel       "parallel"       "/opt/R/4.3.1/lib/R/library"
rpart          "rpart"          "/opt/R/4.3.1/lib/R/library"
spatial        "spatial"        "/opt/R/4.3.1/lib/R/library"
splines        "splines"        "/opt/R/4.3.1/lib/R/library"
stats          "stats"          "/opt/R/4.3.1/lib/R/library"
stats4         "stats4"         "/opt/R/4.3.1/lib/R/library"
survival       "survival"       "/opt/R/4.3.1/lib/R/library"
tcltk          "tcltk"          "/opt/R/4.3.1/lib/R/library"
tools          "tools"          "/opt/R/4.3.1/lib/R/library"
utils          "utils"          "/opt/R/4.3.1/lib/R/library"
               Version    Priority
abind          "1.4-5"    NA
askpass        "1.1"      NA
base64enc      "0.1-3"    NA
bit            "4.0.5"    NA
bit64          "4.0.5"    NA
bitops         "1.0-7"    NA
bslib          "0.5.1"    NA
cachem         "1.0.8"    NA
caTools        "1.18.2"   NA
cli            "3.6.1"    NA
clipr          "0.8.0"    NA
colorspace     "2.1-0"    NA
cpp11          "0.4.6"    NA
crayon         "1.5.2"    NA
credentials    "1.3.2"    NA
curl           "5.0.2"    NA
DBI            "1.1.3"    NA
```

```
desc            "1.4.2"    NA
digest          "0.6.33"   NA
DMwR2           "0.0.2"    NA
dplyr           "1.1.2"    NA
ellipsis        "0.3.2"    NA
evaluate        "0.21"     NA
fansi           "1.0.4"    NA
farver          "2.1.1"    NA
fastmap         "1.1.1"    NA
fontawesome     "0.5.2"    NA
fs              "1.6.3"    NA
generics        "0.1.3"    NA
gert            "1.9.3"    NA
ggplot2         "3.4.3"    NA
gh              "1.4.0"    NA
gitcreds        "0.1.2"    NA
glue            "1.6.2"    NA
gplots          "3.1.3"    NA
gtable          "0.3.4"    NA
gtools          "3.9.4"    NA
highr           "0.10"     NA
hms             "1.1.3"    NA
htmltools       "0.5.6"    NA
httr2           "0.2.3"    NA
ini             "0.3.1"    NA
isoband         "0.2.7"    NA
jquerylib       "0.1.4"    NA
jsonlite        "1.8.7"    NA
KernSmooth      "2.23-22"  "recommended"
knitr           "1.43"     NA
labeling        "0.4.3"    NA
lifecycle       "1.0.3"    NA
magrittr        "2.0.3"    NA
Matrix          "1.6-1"    "recommended"
memoise         "2.0.1"    NA
mgcv            "1.9-0"    "recommended"
mime            "0.12"     NA
munsell         "0.5.0"    NA
nlme            "3.1-163"  "recommended"
openssl         "2.1.0"    NA
palmerpenguins "0.1.1"    NA
pillar          "1.9.0"    NA
pkgconfig       "2.0.3"    NA
```

```
prettyunits    "1.1.1"    NA
progress       "1.2.2"    NA
purrr          "1.0.2"    NA
quantmod       "0.4.25"   NA
R6             "2.5.1"    NA
rappdirs       "0.3.3"    NA
RColorBrewer   "1.1-3"    NA
readr          "2.1.4"    NA
rlang          "1.1.1"    NA
rmarkdown      "2.24"     NA
ROCR           "1.0-11"   NA
rprojroot      "2.0.3"    NA
rstudioapi     "0.15.0"   NA
sass           "0.4.7"    NA
scales         "1.2.1"    NA
spatial        "7.3-17"   "recommended"
stringi        "1.7.12"   NA
stringr        "1.5.0"    NA
survival       "3.5-7"    "recommended"
sys            "3.4.2"    NA
tibble         "3.2.1"    NA
tidyselect     "1.2.0"    NA
tinytex        "0.46"     NA
TTR            "0.24.3"   NA
tzdb           "0.4.0"    NA
usethis        "2.2.2"    NA
utf8           "1.2.3"    NA
vctrs          "0.6.3"    NA
viridisLite    "0.4.2"    NA
vroom          "1.6.3"    NA
whisker        "0.4.1"    NA
withr          "2.5.0"    NA
xfun           "0.40"     NA
xts            "0.13.1"   NA
yaml           "2.3.7"    NA
zip            "2.3.0"    NA
zoo            "1.8-12"   NA
base           "4.3.1"    "base"
boot           "1.3-28.1" "recommended"
class          "7.3-22"   "recommended"
cluster        "2.1.4"    "recommended"
codetools      "0.2-19"   "recommended"
compiler       "4.3.1"    "base"
```

```
datasets       "4.3.1"    "base"
foreign        "0.8-84"   "recommended"
graphics       "4.3.1"    "base"
grDevices      "4.3.1"    "base"
grid           "4.3.1"    "base"
KernSmooth     "2.23-21"  "recommended"
lattice        "0.21-8"   "recommended"
MASS           "7.3-60"   "recommended"
Matrix         "1.5-4.1"  "recommended"
methods        "4.3.1"    "base"
mgcv           "1.8-42"   "recommended"
nlme           "3.1-162"  "recommended"
nnet           "7.3-19"   "recommended"
parallel       "4.3.1"    "base"
rpart          "4.1.19"   "recommended"
spatial        "7.3-16"   "recommended"
splines        "4.3.1"    "base"
stats          "4.3.1"    "base"
stats4         "4.3.1"    "base"
survival       "3.5-5"    "recommended"
tcltk          "4.3.1"    "base"
tools          "4.3.1"    "base"
utils          "4.3.1"    "base"
               Depends
abind          "R (>= 1.5.0)"
askpass        NA
base64enc      "R (>= 2.9.0)"
bit            "R (>= 2.9.2)"
bit64          "R (>= 3.0.1), bit (>= 4.0.0), utils, methods, stats"
bitops         NA
bslib          "R (>= 2.10)"
cachem         NA
caTools        "R (>= 3.6.0)"
cli            "R (>= 3.4)"
clipr          NA
colorspace     "R (>= 3.0.0), methods"
cpp11          "R (>= 3.5.0)"
crayon         NA
credentials    NA
curl           "R (>= 3.0.0)"
DBI            "methods, R (>= 3.0.0)"
desc           "R (>= 3.4)"
digest         "R (>= 3.3.0)"
```

```
DMwR2          "R(>= 3.0), methods"
dplyr          "R (>= 3.5.0)"
ellipsis       "R (>= 3.2)"
evaluate       "R (>= 3.0.2)"
fansi          "R (>= 3.1.0)"
farver         NA
fastmap        NA
fontawesome    "R (>= 3.3.0)"
fs             "R (>= 3.4)"
generics       "R (>= 3.2)"
gert           NA
ggplot2        "R (>= 3.3)"
gh             "R (>= 3.4)"
gitcreds       "R (>= 3.4)"
glue           "R (>= 3.4)"
gplots         "R (>= 3.0)"
gtable         "R (>= 3.5)"
gtools         "methods, stats, utils"
highr          "R (>= 3.3.0)"
hms            NA
htmltools      "R (>= 2.14.1)"
httr2          "R (>= 3.4)"
ini            NA
isoband        NA
jquerylib      NA
jsonlite       "methods"
KernSmooth     "R (>= 2.5.0), stats"
knitr          "R (>= 3.3.0)"
labeling       NA
lifecycle      "R (>= 3.4)"
magrittr       "R (>= 3.4.0)"
Matrix         "R (>= 3.5.0), methods"
memoise        NA
mgcv           "R (>= 3.6.0), nlme (>= 3.1-64)"
mime           NA
munsell        NA
nlme           "R (>= 3.5.0)"
openssl        NA
palmerpenguins "R (>= 2.10)"
pillar         NA
pkgconfig      NA
prettyunits    NA
progress       NA
```

```
purrr          "R (>= 3.5.0)"
quantmod       "R (>= 3.2.0), xts(>= 0.9-0), zoo, TTR(>= 0.2), methods"
R6             "R (>= 3.0)"
rappdirs       "R (>= 3.2)"
RColorBrewer   "R (>= 2.0.0)"
readr          "R (>= 3.5)"
rlang          "R (>= 3.5.0)"
rmarkdown      "R (>= 3.0)"
ROCR           "R (>= 3.6)"
rprojroot      "R (>= 3.0.0)"
rstudioapi     NA
sass           NA
scales         "R (>= 3.2)"
spatial        "R (>= 3.0.0), graphics, stats, utils"
stringi        "R (>= 3.1)"
stringr        "R (>= 3.3)"
survival       "R (>= 3.5.0)"
sys            NA
tibble         "R (>= 3.4.0)"
tidyselect     "R (>= 3.4)"
tinytex        NA
TTR            NA
tzdb           "R (>= 3.5.0)"
usethis        "R (>= 3.6)"
utf8           "R (>= 2.10)"
vctrs          "R (>= 3.5.0)"
viridisLite    "R (>= 2.10)"
vroom          "R (>= 3.4)"
whisker        NA
withr          "R (>= 3.2.0)"
xfun           NA
xts            "R (>= 3.6.0), zoo (>= 1.7-12)"
yaml           NA
zip            NA
zoo            "R (>= 3.1.0), stats"
base           NA
boot           "R (>= 3.0.0), graphics, stats"
class          "R (>= 3.0.0), stats, utils"
cluster        "R (>= 3.5.0)"
codetools      "R (>= 2.1)"
compiler       NA
datasets       NA
foreign        "R (>= 4.0.0)"
```

```
graphics       NA
grDevices      NA
grid           NA
KernSmooth     "R (>= 2.5.0), stats"
lattice        "R (>= 4.0.0)"
MASS           "R (>= 4.0), grDevices, graphics, stats, utils"
Matrix         "R (>= 3.5.0), methods"
methods        NA
mgcv           "R (>= 3.6.0), nlme (>= 3.1-64)"
nlme           "R (>= 3.5.0)"
nnet           "R (>= 3.0.0), stats, utils"
parallel       NA
rpart          "R (>= 2.15.0), graphics, stats, grDevices"
spatial        "R (>= 3.0.0), graphics, stats, utils"
splines        NA
stats          NA
stats4         NA
survival       "R (>= 3.5.0)"
tcltk          NA
tools          NA
utils          NA
               Imports
abind          "methods, utils"
askpass        "sys (>= 2.1)"
base64enc      NA
bit            NA
bit64          NA
bitops         NA
bslib          "base64enc, cachem, grDevices, htmltools (>= 0.5.4), jquerylib\n(>= 0.1.3), js
cachem         "rlang, fastmap (>= 1.1.1)"
caTools        "bitops"
cli            "utils"
clipr          "utils"
colorspace     "graphics, grDevices, stats"
cpp11          NA
crayon         "grDevices, methods, utils"
credentials    "openssl (>= 1.3), sys (>= 2.1), curl, jsonlite, askpass"
curl           NA
DBI            NA
desc           "cli, R6, rprojroot, utils"
digest         "utils"
DMwR2          "xts (>= 0.9-7), zoo (>= 1.7-10), class (>= 7.3-14), rpart (>=\n4.1-10), quant
dplyr          "cli (>= 3.4.0), generics, glue (>= 1.3.2), lifecycle (>=\n1.0.3), magrittr (
```

```
ellipsis        "rlang (>= 0.3.0)"
evaluate        "methods"
fansi           "grDevices, utils"
farver          NA
fastmap         NA
fontawesome     "rlang (>= 1.0.6), htmltools (>= 0.5.1.1)"
fs              "methods"
generics        "methods"
gert            "askpass, credentials (>= 1.2.1), openssl (>= 2.0.3),\nrstudioapi (>= 0.11), s
ggplot2         "cli, glue, grDevices, grid, gtable (>= 0.1.1), isoband,\nlifecycle (> 1.0.1)
gh              "cli (>= 3.0.1), gitcreds, httr2, ini, jsonlite, rlang (>=\n1.0.0)"
gitcreds        NA
glue            "methods"
gplots          "gtools, stats, caTools, KernSmooth, methods"
gtable          "cli, glue, grid, lifecycle, rlang (>= 1.1.0)"
gtools          NA
highr           "xfun (>= 0.18)"
hms             "lifecycle, methods, pkgconfig, rlang (>= 1.0.2), vctrs (>=\n0.3.8)"
htmltools       "utils, digest, grDevices, base64enc, rlang (>= 0.4.12),\nfastmap (>= 1.1.0),
httr2           "cli (>= 3.0.0), curl, glue, magrittr, openssl, R6, rappdirs,\nrlang (>= 1.0.0
ini             NA
isoband         "grid, utils"
jquerylib       "htmltools"
jsonlite        NA
KernSmooth      NA
knitr           "evaluate (>= 0.15), highr, methods, tools, xfun (>= 0.39),\nyaml (>= 2.1.19)"
labeling        "stats, graphics"
lifecycle       "cli (>= 3.4.0), glue, rlang (>= 1.0.6)"
magrittr        NA
Matrix          "grDevices, graphics, grid, lattice, stats, utils"
memoise         "rlang (>= 0.4.10), cachem"
mgcv            "methods, stats, graphics, Matrix, splines, utils"
mime            "tools"
munsell         "colorspace, methods"
nlme            "graphics, stats, utils, lattice"
openssl         "askpass"
palmerpenguins NA
pillar          "cli (>= 2.3.0), fansi, glue, lifecycle, rlang (>= 1.0.2), utf8\n(>= 1.1.0), u
pkgconfig       "utils"
prettyunits     NA
progress        "hms, prettyunits, R6, crayon"
purrr           "cli (>= 3.6.1), lifecycle (>= 1.0.3), magrittr (>= 1.5.0),\nrlang (>= 1.1.1)
quantmod        "curl, jsonlite(>= 1.1)"
```

```
R6              NA
rappdirs        NA
RColorBrewer    NA
readr           "cli (>= 3.2.0), clipr, crayon, hms (>= 0.4.1), lifecycle (>=\n0.2.0), methods
rlang           "utils"
rmarkdown       "bslib (>= 0.2.5.1), evaluate (>= 0.13), fontawesome (>=\n0.5.0), htmltools (>
ROCR            "methods, graphics, grDevices, gplots, stats"
rprojroot       NA
rstudioapi      NA
sass            "fs (>= 1.2.4), rlang (>= 0.4.10), htmltools (>= 0.5.1), R6,\nrappdirs"
scales          "farver (>= 2.0.3), labeling, lifecycle, munsell (>= 0.5), R6,\nRColorBrewer,
spatial         NA
stringi         "tools, utils, stats"
stringr         "cli, glue (>= 1.6.1), lifecycle (>= 1.0.3), magrittr, rlang\n(>= 1.0.0), stri
survival        "graphics, Matrix, methods, splines, stats, utils"
sys             NA
tibble          "fansi (>= 0.4.0), lifecycle (>= 1.0.0), magrittr, methods,\npillar (>= 1.8.1)
tidyselect      "cli (>= 3.3.0), glue (>= 1.3.0), lifecycle (>= 1.0.3), rlang\n(>= 1.0.4), vct
tinytex         "xfun (>= 0.29)"
TTR             "xts (>= 0.10-0), zoo, curl"
tzdb            NA
usethis         "cli (>= 3.0.1), clipr (>= 0.3.0), crayon, curl (>= 2.7), desc\n(>= 1.4.2), fs
utf8            NA
vctrs           "cli (>= 3.4.0), glue, lifecycle (>= 1.0.3), rlang (>= 1.1.0)"
viridisLite     NA
vroom           "bit64, cli (>= 3.2.0), crayon, glue, hms, lifecycle (>=\n1.0.3), methods, rla
whisker         NA
withr           "graphics, grDevices, stats"
xfun            "stats, tools"
xts             "methods"
yaml            NA
zip             NA
zoo             "utils, graphics, grDevices, lattice (>= 0.20-27)"
base            NA
boot            NA
class           "MASS"
cluster         "graphics, grDevices, stats, utils"
codetools       NA
compiler        NA
datasets        NA
foreign         "methods, utils, stats"
graphics        "grDevices"
grDevices       NA
```

```
grid            "grDevices, utils"
KernSmooth      NA
lattice         "grid, grDevices, graphics, stats, utils"
MASS            "methods"
Matrix          "graphics, grid, lattice, stats, utils"
methods         "utils, stats"
mgcv            "methods, stats, graphics, Matrix, splines, utils"
nlme            "graphics, stats, utils, lattice"
nnet            NA
parallel        "tools, compiler"
rpart           NA
spatial         NA
splines         "graphics, stats"
stats           "utils, grDevices, graphics"
stats4          "graphics, methods, stats"
survival        "graphics, Matrix, methods, splines, stats, utils"
tcltk           "utils"
tools           NA
utils           NA
                LinkingTo
abind           NA
askpass         NA
base64enc       NA
bit             NA
bit64           NA
bitops          NA
bslib           NA
cachem          NA
caTools         NA
cli             NA
clipr           NA
colorspace      NA
cpp11           NA
crayon          NA
credentials     NA
curl            NA
DBI             NA
desc            NA
digest          NA
DMwR2           NA
dplyr           NA
ellipsis        NA
evaluate        NA
```

```
fansi          NA
farver         NA
fastmap        NA
fontawesome    NA
fs             NA
generics       NA
gert           NA
ggplot2        NA
gh             NA
gitcreds       NA
glue           NA
gplots         NA
gtable         NA
gtools         NA
highr          NA
hms            NA
htmltools      NA
httr2          NA
ini            NA
isoband        NA
jquerylib      NA
jsonlite       NA
KernSmooth     NA
knitr          NA
labeling       NA
lifecycle      NA
magrittr       NA
Matrix         NA
memoise        NA
mgcv           NA
mime           NA
munsell        NA
nlme           NA
openssl        NA
palmerpenguins NA
pillar         NA
pkgconfig      NA
prettyunits    NA
progress       NA
purrr          "cli"
quantmod       NA
R6             NA
rappdirs       NA
```

```
RColorBrewer   NA
readr          "cpp11, tzdb (>= 0.1.1)"
rlang          NA
rmarkdown      NA
ROCR           NA
rprojroot      NA
rstudioapi     NA
sass           NA
scales         NA
spatial        NA
stringi        NA
stringr        NA
survival       NA
sys            NA
tibble         NA
tidyselect     NA
tinytex        NA
TTR            "xts"
tzdb           "cpp11 (>= 0.4.2)"
usethis        NA
utf8           NA
vctrs          NA
viridisLite    NA
vroom          "cpp11 (>= 0.2.0), progress (>= 1.2.1), tzdb (>= 0.1.1)"
whisker        NA
withr          NA
xfun           NA
xts            "zoo"
yaml           NA
zip            NA
zoo            NA
base           NA
boot           NA
class          NA
cluster        NA
codetools      NA
compiler       NA
datasets       NA
foreign        NA
graphics       NA
grDevices      NA
grid           NA
KernSmooth     NA
```

```
lattice        NA
MASS           NA
Matrix         NA
methods        NA
mgcv           NA
nlme           NA
nnet           NA
parallel       NA
rpart          NA
spatial        NA
splines        NA
stats          NA
stats4         NA
survival       NA
tcltk          NA
tools          NA
utils          NA
               Suggests
abind          NA
askpass        "testthat"
base64enc      NA
bit            "testthat (>= 0.11.0), roxygen2, knitr, rmarkdown,\nmicrobenchmark, bit64 (>=
bit64          NA
bitops         NA
bslib          "bsicons, curl, fontawesome, ggplot2, knitr, magrittr,\nrappdirs, rmarkdown (>
cachem         "testthat"
caTools        "MASS, rpart"
cli            "callr, covr, crayon, digest, glue (>= 1.6.0), grDevices,\nhtmltools, htmlwidg
clipr          "covr, knitr, rmarkdown, rstudioapi (>= 0.5), testthat (>=\n2.0.0)"
colorspace     "datasets, utils, KernSmooth, MASS, kernlab, mvtnorm, vcd,\ntcltk, shiny, shi
cpp11          "bench, brio, callr, cli, covr, decor, desc, ggplot2, glue,\nknitr, lobstr, mo
crayon         "mockery, rstudioapi, testthat, withr"
credentials    "testthat, knitr, rmarkdown"
curl           "spelling, testthat (>= 1.0.0), knitr, jsonlite, rmarkdown,\nmagrittr, httpuv
DBI            "blob, covr, DBItest, dbplyr, downlit, dplyr, glue, hms,\nknitr, magrittr, RMa
desc           "callr, covr, gh, spelling, testthat, whoami, withr"
digest         "tinytest, simplermarkdown"
DMwR2          NA
dplyr          "bench, broom, callr, covr, DBI, dbplyr (>= 2.2.1), ggplot2,\nknitr, Lahman, l
ellipsis       "covr, testthat"
evaluate       "covr, ggplot2, lattice, rlang, testthat (>= 3.0.0), withr"
fansi          "unitizer, knitr, rmarkdown"
farver         "covr, testthat (>= 3.0.0)"
```

```
fastmap         "testthat (>= 2.1.1)"
fontawesome     "covr, dplyr (>= 1.0.8), knitr (>= 1.31), testthat (>= 3.0.0),\nrsvg"
fs              "covr, crayon, knitr, pillar (>= 1.0.0), rmarkdown, spelling,\ntestthat (>= 3
generics        "covr, pkgload, testthat (>= 3.0.0), tibble, withr"
gert            "spelling, knitr, rmarkdown, testthat"
ggplot2         "covr, dplyr, ggplot2movies, hexbin, Hmisc, knitr, lattice,\nmapproj, maps, ma
gh              "covr, knitr, mockery, rmarkdown, rprojroot, spelling,\ntestthat (>= 3.0.0), v
gitcreds        "codetools, covr, knitr, mockery, oskeyring, rmarkdown,\ntestthat (>= 3.0.0),
glue            "covr, crayon, DBI, dplyr, forcats, ggplot2, knitr, magrittr,\nmicrobenchmark
gplots          "grid, MASS, knitr, r2d2"
gtable          "covr, ggplot2, knitr, profvis, rmarkdown, testthat (>= 3.0.0)"
gtools          "car, gplots, knitr, rstudioapi, SGP, taxize"
highr           "knitr, markdown, testit"
hms             "crayon, lubridate, pillar (>= 1.1.0), testthat (>= 3.0.0)"
htmltools       "markdown, testthat, withr, Cairo, ragg, shiny"
httr2           "askpass, bench, clipr, covr, docopt, httpuv, jose, jsonlite,\nknitr, purrr, r
ini             "testthat"
isoband         "covr, ggplot2, knitr, magick, microbenchmark, rmarkdown, sf,\ntestthat, xml2"
jquerylib       "testthat"
jsonlite        "httr, vctrs, testthat, knitr, rmarkdown, R.rsp, sf"
KernSmooth      "MASS, carData"
knitr           "bslib, codetools, DBI (>= 0.4-1), digest, formatR, gifski,\ngridSVG, htmlwidg
labeling        NA
lifecycle       "covr, crayon, knitr, lintr, rmarkdown, testthat (>= 3.0.1),\ntibble, tidyvers
magrittr        "covr, knitr, rlang, rmarkdown, testthat"
Matrix          "MASS, datasets, sfsmisc"
memoise         "digest, aws.s3, covr, googleAuthR, googleCloudStorageR, httr,\ntestthat"
mgcv            "parallel, survival, MASS"
mime            NA
munsell         "ggplot2, testthat"
nlme            "Hmisc, MASS, SASmixed"
openssl         "curl, testthat (>= 2.1.0), digest, knitr, rmarkdown,\njsonlite, jose, sodium"
palmerpenguins "knitr, rmarkdown, tibble, ggplot2, dplyr, tidyr, recipes"
pillar          "bit64, DBI, debugme, DiagrammeR, dplyr, formattable, ggplot2,\nknitr, lubrida
pkgconfig       "covr, testthat, disposables (>= 1.0.3)"
prettyunits     "codetools, covr, testthat"
progress        "Rcpp, testthat, withr"
purrr           "covr, dplyr (>= 0.7.8), httr, knitr, lubridate, rmarkdown,\ntestthat (>= 3.0
quantmod        "DBI,RMySQL,RSQLite,timeSeries,xml2,downloader"
R6              "testthat, pryr"
rappdirs        "roxygen2, testthat (>= 3.0.0), covr, withr"
RColorBrewer    NA
readr           "covr, curl, datasets, knitr, rmarkdown, spelling, stringi,\ntestthat (>= 3.1
```

```
rlang          "cli (>= 3.1.0), covr, crayon, fs, glue, knitr, magrittr,\nmethods, pillar, rr
rmarkdown      "digest, dygraphs, fs, rsconnect, downlit (>= 0.4.0), katex\n(>= 1.4.0), sass
ROCR           "testthat, knitr, rmarkdown"
rprojroot      "covr, knitr, lifecycle, mockr, rmarkdown, testthat (>=\n3.0.0), withr"
rstudioapi     "testthat, knitr, rmarkdown, clipr, covr"
sass           "testthat, knitr, rmarkdown, withr, shiny, curl"
scales         "bit64, covr, dichromat, ggplot2, hms (>= 0.5.0), stringi,\ntestthat (>= 3.0.0
spatial        "MASS"
stringi        NA
stringr        "covr, htmltools, htmlwidgets, knitr, rmarkdown, testthat (>=\n3.0.0)"
survival       NA
sys            "unix (>= 1.4), spelling, testthat"
tibble         "bench, bit64, blob, brio, callr, cli, covr, crayon (>=\n1.3.4), DiagrammeR, d
tidyselect     "covr, crayon, dplyr, knitr, magrittr, rmarkdown, stringr,\ntestthat (>= 3.1.1
tinytex        "testit, rstudioapi"
TTR            "RUnit"
tzdb           "covr, testthat (>= 3.0.0)"
usethis        "covr, knitr, magick, pkgload, rmarkdown, roxygen2 (>= 7.1.2),\nspelling (>= 1
utf8           "cli, covr, knitr, rlang, rmarkdown, testthat (>= 3.0.0),\nwithr"
vctrs          "bit64, covr, crayon, dplyr (>= 0.8.5), generics, knitr,\npillar (>= 1.4.4), p
viridisLite    "hexbin (>= 1.27.0), ggplot2 (>= 1.0.1), testthat, covr"
vroom          "archive, bench (>= 1.1.0), covr, curl, dplyr, forcats, fs,\nggplot2, knitr, p
whisker        "markdown"
withr          "callr, covr, DBI, knitr, lattice, methods, rlang, rmarkdown\n(>= 2.12), RSQLi
xfun           "testit, parallel, codetools, rstudioapi, tinytex (>= 0.30),\nmime, markdown
xts            "timeSeries, timeDate, tseries, chron, tinytest"
yaml           "RUnit"
zip            "covr, processx, R6, testthat, withr"
zoo            "AER, coda, chron, ggplot2 (>= 3.0.0), mondate, scales,\nstinepack, strucchang
base           "methods"
boot           "MASS, survival"
class          NA
cluster        "MASS, Matrix"
codetools      NA
compiler       NA
datasets       NA
foreign        NA
graphics       NA
grDevices      "KernSmooth"
grid           NA
KernSmooth     "MASS, carData"
lattice        "KernSmooth, MASS, latticeExtra, colorspace"
MASS           "lattice, nlme, nnet, survival"
```

```
Matrix          "MASS, expm"
methods         "codetools"
mgcv            "parallel, survival, MASS"
nlme            "Hmisc, MASS, SASmixed"
nnet            "MASS"
parallel        "methods"
rpart           "survival"
spatial         "MASS"
splines         "Matrix, methods"
stats           "MASS, Matrix, SuppDists, methods, stats4"
stats4          NA
survival        NA
tcltk           NA
tools           "codetools, methods, xml2, curl, commonmark, knitr, xfun, mathjaxr, V8"
utils           "methods, xml2, commonmark, knitr"
                Enhances
abind           NA
askpass         NA
base64enc       "png"
bit             NA
bit64           NA
bitops          NA
bslib           NA
cachem          NA
caTools         NA
cli             NA
clipr           NA
colorspace      NA
cpp11           NA
crayon          NA
credentials     NA
curl            NA
DBI             NA
desc            NA
digest          NA
DMwR2           NA
dplyr           NA
ellipsis        NA
evaluate        NA
fansi           NA
farver          NA
fastmap         NA
fontawesome     NA
```

```
fs              NA
generics        NA
gert            NA
ggplot2         "sp"
gh              NA
gitcreds        NA
glue            NA
gplots          NA
gtable          NA
gtools          NA
highr           NA
hms             NA
htmltools       "knitr"
httr2           NA
ini             NA
isoband         NA
jquerylib       NA
jsonlite        NA
KernSmooth      NA
knitr           NA
labeling        NA
lifecycle       NA
magrittr        NA
Matrix          "SparseM, graph"
memoise         NA
mgcv            NA
mime            NA
munsell         NA
nlme            NA
openssl         NA
palmerpenguins NA
pillar          NA
pkgconfig       NA
prettyunits     NA
progress        NA
purrr           NA
quantmod        NA
R6              NA
rappdirs        NA
RColorBrewer    NA
readr           NA
rlang           "winch"
rmarkdown       NA
```

```
ROCR           NA
rprojroot      NA
rstudioapi     NA
sass           NA
scales         NA
spatial        NA
stringi        NA
stringr        NA
survival       NA
sys            NA
tibble         NA
tidyselect     NA
tinytex        NA
TTR            "quantmod"
tzdb           NA
usethis        NA
utf8           NA
vctrs          NA
viridisLite    NA
vroom          NA
whisker        NA
withr          NA
xfun           NA
xts            NA
yaml           NA
zip            NA
zoo            NA
base           NA
boot           NA
class          NA
cluster        NA
codetools      NA
compiler       NA
datasets       NA
foreign        NA
graphics       NA
grDevices      NA
grid           NA
KernSmooth     NA
lattice        "chron"
MASS           NA
Matrix         "MatrixModels, SparseM, graph, igraph, maptools, sfsmisc, sp,\nspdep"
methods        NA
```

```
mgcv           NA
nlme           NA
nnet           NA
parallel       "snow, Rmpi"
rpart          NA
spatial        NA
splines        NA
stats          NA
stats4         NA
survival       NA
tcltk          NA
tools          NA
utils          NA
               License                                License_is_FOSS
abind          "LGPL (>= 2)"                          NA
askpass        "MIT + file LICENSE"                   NA
base64enc      "GPL-2 | GPL-3"                        NA
bit            "GPL-2 | GPL-3"                        NA
bit64          "GPL-2 | GPL-3"                        NA
bitops         "GPL (>= 2)"                           NA
bslib          "MIT + file LICENSE"                   NA
cachem         "MIT + file LICENSE"                   NA
caTools        "GPL-3"                                NA
cli            "MIT + file LICENSE"                   NA
clipr          "GPL-3"                                NA
colorspace     "BSD_3_clause + file LICENSE"          NA
cpp11          "MIT + file LICENSE"                   NA
crayon         "MIT + file LICENSE"                   NA
credentials    "MIT + file LICENSE"                   NA
curl           "MIT + file LICENSE"                   NA
DBI            "LGPL (>= 2.1)"                        NA
desc           "MIT + file LICENSE"                   NA
digest         "GPL (>= 2)"                           NA
DMwR2          "GPL (>= 2)"                           NA
dplyr          "MIT + file LICENSE"                   NA
ellipsis       "MIT + file LICENSE"                   NA
evaluate       "MIT + file LICENSE"                   NA
fansi          "GPL-2 | GPL-3"                        NA
farver         "MIT + file LICENSE"                   NA
fastmap        "MIT + file LICENSE"                   NA
fontawesome    "MIT + file LICENSE"                   NA
fs             "MIT + file LICENSE"                   NA
generics       "MIT + file LICENSE"                   NA
```

```
gert           "MIT + file LICENSE"                    NA
ggplot2        "MIT + file LICENSE"                    NA
gh             "MIT + file LICENSE"                    NA
gitcreds       "MIT + file LICENSE"                    NA
glue           "MIT + file LICENSE"                    NA
gplots         "GPL-2"                                 NA
gtable         "MIT + file LICENSE"                    NA
gtools         "GPL-2"                                 NA
highr          "GPL"                                   NA
hms            "MIT + file LICENSE"                    NA
htmltools      "GPL (>= 2)"                            NA
httr2          "MIT + file LICENSE"                    NA
ini            "GPL-3"                                 NA
isoband        "MIT + file LICENSE"                    NA
jquerylib      "MIT + file LICENSE"                    NA
jsonlite       "MIT + file LICENSE"                    NA
KernSmooth     "Unlimited"                             NA
knitr          "GPL"                                   NA
labeling       "MIT + file LICENSE | Unlimited"        NA
lifecycle      "MIT + file LICENSE"                    NA
magrittr       "MIT + file LICENSE"                    NA
Matrix         "GPL (>= 2) | file LICENCE"             NA
memoise        "MIT + file LICENSE"                    NA
mgcv           "GPL (>= 2)"                            NA
mime           "GPL"                                   NA
munsell        "MIT + file LICENSE"                    NA
nlme           "GPL (>= 2)"                            NA
openssl        "MIT + file LICENSE"                    NA
palmerpenguins "CC0"                                   NA
pillar         "MIT + file LICENSE"                    NA
pkgconfig      "MIT + file LICENSE"                    NA
prettyunits    "MIT + file LICENSE"                    NA
progress       "MIT + file LICENSE"                    NA
purrr          "MIT + file LICENSE"                    NA
quantmod       "GPL-3"                                 NA
R6             "MIT + file LICENSE"                    NA
rappdirs       "MIT + file LICENSE"                    NA
RColorBrewer   "Apache License 2.0"                    NA
readr          "MIT + file LICENSE"                    NA
rlang          "MIT + file LICENSE"                    NA
rmarkdown      "GPL-3"                                 NA
ROCR           "GPL (>= 2)"                            NA
rprojroot      "MIT + file LICENSE"                    NA
```

```
rstudioapi     "MIT + file LICENSE"                    NA
sass           "MIT + file LICENSE"                    NA
scales         "MIT + file LICENSE"                    NA
spatial        "GPL-2 | GPL-3"                         NA
stringi        "file LICENSE"                          "yes"
stringr        "MIT + file LICENSE"                    NA
survival       "LGPL (>= 2)"                           NA
sys            "MIT + file LICENSE"                    NA
tibble         "MIT + file LICENSE"                    NA
tidyselect     "MIT + file LICENSE"                    NA
tinytex        "MIT + file LICENSE"                    NA
TTR            "GPL (>= 2)"                            NA
tzdb           "MIT + file LICENSE"                    NA
usethis        "MIT + file LICENSE"                    NA
utf8           "Apache License (== 2.0) | file LICENSE" NA
vctrs          "MIT + file LICENSE"                    NA
viridisLite    "MIT + file LICENSE"                    NA
vroom          "MIT + file LICENSE"                    NA
whisker        "GPL-3"                                 NA
withr          "MIT + file LICENSE"                    NA
xfun           "MIT + file LICENSE"                    NA
xts            "GPL (>= 2)"                            NA
yaml           "BSD_3_clause + file LICENSE"           NA
zip            "MIT + file LICENSE"                    NA
zoo            "GPL-2 | GPL-3"                         NA
base           "Part of R 4.3.1"                       NA
boot           "Unlimited"                             NA
class          "GPL-2 | GPL-3"                         NA
cluster        "GPL (>= 2)"                            NA
codetools      "GPL"                                   NA
compiler       "Part of R 4.3.1"                       NA
datasets       "Part of R 4.3.1"                       NA
foreign        "GPL (>= 2)"                            NA
graphics       "Part of R 4.3.1"                       NA
grDevices      "Part of R 4.3.1"                       NA
grid           "Part of R 4.3.1"                       NA
KernSmooth     "Unlimited"                             NA
lattice        "GPL (>= 2)"                            NA
MASS           "GPL-2 | GPL-3"                         NA
Matrix         "GPL (>= 2) | file LICENCE"             NA
methods        "Part of R 4.3.1"                       NA
mgcv           "GPL (>= 2)"                            NA
nlme           "GPL (>= 2)"                            NA
```

```
nnet           "GPL-2 | GPL-3"                      NA
parallel       "Part of R 4.3.1"                    NA
rpart          "GPL-2 | GPL-3"                      NA
spatial        "GPL-2 | GPL-3"                      NA
splines        "Part of R 4.3.1"                    NA
stats          "Part of R 4.3.1"                    NA
stats4         "Part of R 4.3.1"                    NA
survival       "LGPL (>= 2)"                        NA
tcltk          "Part of R 4.3.1"                    NA
tools          "Part of R 4.3.1"                    NA
utils          "Part of R 4.3.1"                    NA
               License_restricts_use OS_type MD5sum NeedsCompilation Built
abind          NA                    NA      NA     "no"             "4.3.0"
askpass        NA                    NA      NA     "yes"            "4.3.0"
base64enc      NA                    NA      NA     "yes"            "4.3.0"
bit            NA                    NA      NA     "yes"            "4.3.0"
bit64          NA                    NA      NA     "yes"            "4.3.0"
bitops         NA                    NA      NA     "yes"            "4.3.0"
bslib          NA                    NA      NA     "no"             "4.3.0"
cachem         NA                    NA      NA     "yes"            "4.3.0"
caTools        NA                    NA      NA     "yes"            "4.3.0"
cli            NA                    NA      NA     "yes"            "4.3.0"
clipr          NA                    NA      NA     "no"             "4.3.0"
colorspace     NA                    NA      NA     "yes"            "4.3.0"
cpp11          NA                    NA      NA     "no"             "4.3.0"
crayon         NA                    NA      NA     "no"             "4.3.0"
credentials    NA                    NA      NA     "no"             "4.3.0"
curl           NA                    NA      NA     "yes"            "4.3.0"
DBI            NA                    NA      NA     "no"             "4.3.0"
desc           NA                    NA      NA     "no"             "4.3.0"
digest         NA                    NA      NA     "yes"            "4.3.0"
DMwR2          NA                    NA      NA     "no"             "4.3.0"
dplyr          NA                    NA      NA     "yes"            "4.3.0"
ellipsis       NA                    NA      NA     "yes"            "4.3.0"
evaluate       NA                    NA      NA     "no"             "4.3.0"
fansi          NA                    NA      NA     "yes"            "4.3.0"
farver         NA                    NA      NA     "yes"            "4.3.0"
fastmap        NA                    NA      NA     "yes"            "4.3.0"
fontawesome    NA                    NA      NA     "no"             "4.3.0"
fs             NA                    NA      NA     "yes"            "4.3.0"
generics       NA                    NA      NA     "no"             "4.3.0"
gert           NA                    NA      NA     "yes"            "4.3.0"
ggplot2        NA                    NA      NA     "no"             "4.3.0"
```

gh	NA	NA	NA	"no"	"4.3.0"
gitcreds	NA	NA	NA	"no"	"4.3.0"
glue	NA	NA	NA	"yes"	"4.3.0"
gplots	NA	NA	NA	"no"	"4.3.0"
gtable	NA	NA	NA	"no"	"4.3.0"
gtools	NA	NA	NA	"yes"	"4.3.0"
highr	NA	NA	NA	"no"	"4.3.0"
hms	NA	NA	NA	"no"	"4.3.0"
htmltools	NA	NA	NA	"yes"	"4.3.0"
httr2	NA	NA	NA	"no"	"4.3.0"
ini	NA	NA	NA	"no"	"4.3.0"
isoband	NA	NA	NA	"yes"	"4.3.0"
jquerylib	NA	NA	NA	"no"	"4.3.0"
jsonlite	NA	NA	NA	"yes"	"4.3.0"
KernSmooth	NA	NA	NA	"yes"	"4.3.0"
knitr	NA	NA	NA	"no"	"4.3.0"
labeling	NA	NA	NA	"no"	"4.3.0"
lifecycle	NA	NA	NA	"no"	"4.3.0"
magrittr	NA	NA	NA	"yes"	"4.3.0"
Matrix	NA	NA	NA	"yes"	"4.3.0"
memoise	NA	NA	NA	"no"	"4.3.0"
mgcv	NA	NA	NA	"yes"	"4.3.0"
mime	NA	NA	NA	"yes"	"4.3.0"
munsell	NA	NA	NA	"no"	"4.3.0"
nlme	NA	NA	NA	"yes"	"4.3.0"
openssl	NA	NA	NA	"yes"	"4.3.0"
palmerpenguins	NA	NA	NA	"no"	"4.3.0"
pillar	NA	NA	NA	"no"	"4.3.0"
pkgconfig	NA	NA	NA	"no"	"4.3.0"
prettyunits	NA	NA	NA	"no"	"4.3.0"
progress	NA	NA	NA	"no"	"4.3.0"
purrr	NA	NA	NA	"yes"	"4.3.0"
quantmod	NA	NA	NA	"no"	"4.3.0"
R6	NA	NA	NA	"no"	"4.3.0"
rappdirs	NA	NA	NA	"yes"	"4.3.0"
RColorBrewer	NA	NA	NA	"no"	"4.3.0"
readr	NA	NA	NA	"yes"	"4.3.0"
rlang	NA	NA	NA	"yes"	"4.3.0"
rmarkdown	NA	NA	NA	"no"	"4.3.0"
ROCR	NA	NA	NA	"no"	"4.3.0"
rprojroot	NA	NA	NA	"no"	"4.3.0"
rstudioapi	NA	NA	NA	"no"	"4.3.0"
sass	NA	NA	NA	"yes"	"4.3.0"

```
scales          NA                    NA      NA      "no"            "4.3.0"
spatial         NA                    NA      NA      "yes"           "4.3.0"
stringi         NA                    NA      NA      "yes"           "4.3.0"
stringr         NA                    NA      NA      "no"            "4.3.0"
survival        NA                    NA      NA      "yes"           "4.3.0"
sys             NA                    NA      NA      "yes"           "4.3.0"
tibble          NA                    NA      NA      "yes"           "4.3.0"
tidyselect      NA                    NA      NA      "no"            "4.3.0"
tinytex         NA                    NA      NA      "no"            "4.3.0"
TTR             NA                    NA      NA      "yes"           "4.3.0"
tzdb            NA                    NA      NA      "yes"           "4.3.0"
usethis         NA                    NA      NA      "no"            "4.3.0"
utf8            NA                    NA      NA      "yes"           "4.3.0"
vctrs           NA                    NA      NA      "yes"           "4.3.0"
viridisLite     NA                    NA      NA      "no"            "4.3.0"
vroom           NA                    NA      NA      "yes"           "4.3.0"
whisker         NA                    NA      NA      "no"            "4.3.0"
withr           NA                    NA      NA      "no"            "4.3.0"
xfun            NA                    NA      NA      "yes"           "4.3.0"
xts             NA                    NA      NA      "yes"           "4.3.0"
yaml            NA                    NA      NA      "yes"           "4.3.0"
zip             NA                    NA      NA      "yes"           "4.3.0"
zoo             NA                    NA      NA      "yes"           "4.3.0"
base            NA                    NA      NA      NA              "4.3.1"
boot            NA                    NA      NA      "no"            "4.3.1"
class           NA                    NA      NA      "yes"           "4.3.1"
cluster         NA                    NA      NA      "yes"           "4.3.1"
codetools       NA                    NA      NA      "no"            "4.3.1"
compiler        NA                    NA      NA      NA              "4.3.1"
datasets        NA                    NA      NA      NA              "4.3.1"
foreign         NA                    NA      NA      "yes"           "4.3.1"
graphics        NA                    NA      NA      "yes"           "4.3.1"
grDevices       NA                    NA      NA      "yes"           "4.3.1"
grid            NA                    NA      NA      "yes"           "4.3.1"
KernSmooth      NA                    NA      NA      "yes"           "4.3.1"
lattice         NA                    NA      NA      "yes"           "4.3.1"
MASS            NA                    NA      NA      "yes"           "4.3.1"
Matrix          NA                    NA      NA      "yes"           "4.3.1"
methods         NA                    NA      NA      "yes"           "4.3.1"
mgcv            NA                    NA      NA      "yes"           "4.3.1"
nlme            NA                    NA      NA      "yes"           "4.3.1"
nnet            NA                    NA      NA      "yes"           "4.3.1"
parallel        NA                    NA      NA      "yes"           "4.3.1"
```

```
rpart          NA                    NA      NA     "yes"           "4.3.1"
spatial        NA                    NA      NA     "yes"           "4.3.1"
splines        NA                    NA      NA     "yes"           "4.3.1"
stats          NA                    NA      NA     "yes"           "4.3.1"
stats4         NA                    NA      NA     NA              "4.3.1"
survival       NA                    NA      NA     "yes"           "4.3.1"
tcltk          NA                    NA      NA     "yes"           "4.3.1"
tools          NA                    NA      NA     "yes"           "4.3.1"
utils          NA                    NA      NA     "yes"           "4.3.1"
```

old.packages() function is used to check for and list packages that have newer versions available on CRAN . This function is **helpful for keeping your packages up-to-date**.

```
old.packages()
```

```
           Package      LibPath                       Installed Built
KernSmooth "KernSmooth" "/opt/R/4.3.1/lib/R/library" "2.23-21" "4.3.1"
Matrix     "Matrix"     "/opt/R/4.3.1/lib/R/library" "1.5-4.1" "4.3.1"
mgcv       "mgcv"       "/opt/R/4.3.1/lib/R/library" "1.8-42"  "4.3.1"
nlme       "nlme"       "/opt/R/4.3.1/lib/R/library" "3.1-162" "4.3.1"
spatial    "spatial"    "/opt/R/4.3.1/lib/R/library" "7.3-16"  "4.3.1"
survival   "survival"   "/opt/R/4.3.1/lib/R/library" "3.5-5"   "4.3.1"
           ReposVer  Repository
KernSmooth "2.23-22" "http://rspm/default/__linux__/focal/latest/src/contrib"
Matrix     "1.6-1"   "http://rspm/default/__linux__/focal/latest/src/contrib"
mgcv       "1.9-0"   "http://rspm/default/__linux__/focal/latest/src/contrib"
nlme       "3.1-163" "http://rspm/default/__linux__/focal/latest/src/contrib"
spatial    "7.3-17"  "http://rspm/default/__linux__/focal/latest/src/contrib"
survival   "3.5-7"   "http://rspm/default/__linux__/focal/latest/src/contrib"
```

update.packages() function is used to update one or more packages to their latest versions available on CRAN

```
update.packages() #ask will update the package without asking for confirmation & checkBuil
```

You can use the **::** operator followed by the function name to see the package namespace it comes from. For example, to find out which package the mean function belongs to, you can do:

```
mean
```

```
function (x, ...)
UseMethod("mean")
<bytecode: 0x555a2c57af38>
<environment: namespace:base>
```

help() function is used to access documentation and information about functions, datasets & packages.

```
help(mean)
```

An alternative way to access help is by using a question mark **?**

```
?mean
```

RsiteSearch() function allows you to search for specific terms, keywords, or phrases within the vast collection of R packages, functions, and documentation hosted on CRAN.

```
RSiteSearch('neural networks')
```

```
A search query has been submitted to https://search.r-project.org
The results page should open in your browser shortly
```

R objects and Variables

Variables are assigned values, which can be numeric, character, logical, or other data types.

```
vat <- 0.2
vat
```

```
[1] 0.2
```

Enclosing a statement or expression in () will have values printed directly to the console.

```
(vat <- 0.2)
```

```
[1] 0.2
```

examples :

```r
x <- 5
y <- vat * x
y
```

```
[1] 1
```

```r
z <-(y/2)^2
y
```

```
[1] 1
```

```r
z
```

```
[1] 0.25
```

ls() or **objects()** function to list the names of objects (variables, functions, datasets, etc.) that are currently present in your workspace or environment.

```r
ls()
```

```
[1] "algae"           "has_annotations" "vat"             "x"
[5] "y"               "z"
```

```r
objects()
```

```
[1] "algae"           "has_annotations" "vat"             "x"
[5] "y"               "z"
```

rm() function is used to remove or delete objects from environment. Deleting objects means they will no longer be available for use, and t**here is no undo operation.**

```r
rm(vat)
ls()
```

```
[1] "algae"           "has_annotations" "x"               "y"
[5] "z"
```

R Functions

functions are blocks of reusable code that perform specific tasks or computations.

```
max(4, 5, 6, 12, -4)
```

```
[1] 12
```

```
mean(4, 5, 6, 12, -4)
```

```
[1] 4
```

sample() function is used to generate random samples or permutations of elements from a given vector or set.

```
max(sample(1:100, 30)) # 1:100 is the vector set and 30 is random number of samples
```

```
[1] 95
```

```
mean(sample(1:100, 30))
```

```
[1] 54.03333
```

set.seed()

Setting the seed allows you to reproduce random results in your code. When you use random functions or generate random numbers without specifying a seed, the results will be different each time you run the code. **runif()**, **rnorm()**, or **sample()**, will produce the same random results as long as you use the same seed value.

```
set.seed(1)
rnorm(1)
```

```
[1] -0.6264538
```

```r
set.seed(2)
rnorm(1)
```

```
[1] -0.8969145
```

```r
rnorm(1)
```

```
[1] 0.1848492
```

To create a new function, **se** (standard error of means), first test if `se` exists in our current environment.

```r
exists("se")
```

```
[1] FALSE
```

No object named `se` exists, now create the function that computes the standard error of a sample:

```r
se <- function(x){
  variance <- var(x)
  n <-length(x)
  return (sqrt(variance/n))
}
```

We can check if object exists or not using exists() function

```r
exists("se")
```

```
[1] TRUE
```

Function with multiple arguments :

```r
convMeters <- function (x, to="inch"){
  factor = switch(to, inch=39.3701, foot=3.28084, yard=1.09361, mile=0.000621371, NA)
  if(is.na(factor)) stop ("unknown target unit")
```

```
  else return (x*factor)
}
convMeters(23, "foot") #calling the function with parameters
```

```
[1] 75.45932
```

```
convMeters(40) #inch is used as default if 2nd argument is not used
```

```
[1] 1574.804
```

```
convMeters(to="yard", 56.2) #arguements can be provided in different order also
```

```
[1] 61.46088
```

Factors

Factors are a data type used to represent categorical or nominal data.

To create a factor with specific levels using the **factor()** function in R, you can specify the levels using the **levels** argument.

```
g <-c('f', 'm', 'f', 'f', 'f', 'm', 'm', 'f')
g #returs the values
```

```
[1] "f" "m" "f" "f" "f" "m" "m" "f"
```

```
g <- factor(g) #returns the levels of the factor
g
```

```
[1] f m f f f m m f
Levels: f m
```

More compact way to creating a factor with known levels, f and m:

```r
other.g <-factor(c('m', 'm', 'm', 'm'), levels= c('f', 'm'))
other.g
```

```
[1] m m m m
Levels: f m
```

table() function to create a contingency table when you have two categorical variables.

```r
g <- factor(c('f', 'm', 'f', 'f', 'f', 'm', 'm', 'f'))
table(g)
```

```
g
f m
5 3
```

```r
a <- factor(c('adult', 'juvenile','adult', 'juvenile','adult', 'juvenile','juvenile', 'juv
table(a, g)
```

```
          g
a          f m
  adult    3 0
  juvenile 2 3
```

R assumes the values at the same index in the two factors are associated with the same entity.

```r
# a <- factor(c('adult', 'juvenile','adult', 'juvenile','adult', 'juvenile','juvenile'))
# table(a, g) # will give an error as number of arguements should be same
```

```r
a <- factor(c('adult', 'juvenile','adult', 'juvenile','adult', 'juvenile','juvenile', 'juv
t <- table(a, g)
t
```

```
          g
a          f m
  adult    3 0
  juvenile 2 3
```

Marginal frequencies for a factor:

```
margin.table(t, 1)#1 refers to the first factor, a (age)
```

```
a
   adult juvenile
       3        5
```

```
margin.table(t, 2)# now find the marginal freq of the second factor g
```

```
g
f m
5 3
```

```
prop.table(t, 1) #use the margin generated for the 1st factor a
```

```
          g
a            f   m
  adult    1.0 0.0
  juvenile 0.4 0.6
```

```
prop.table(t, 2)
```

```
          g
a            f   m
  adult    0.6 0.0
  juvenile 0.4 1.0
```

```
prop.table(t) #overall
```

```
          g
a              f     m
  adult    0.375 0.000
  juvenile 0.250 0.375
```

```r
prop.table(t) * 100
```

```
          g
a             f    m
  adult    37.5  0.0
  juvenile 25.0 37.5
```

R structures

Vectors

Data structure used to store and manipulate a sequence of values.

```r
v <- c(2, 5, 3, 4) #creating the vector
length(v) #returns the lenght of the vector
```

```
[1] 4
```

```r
mode(v) #returns the data type of vector
```

```
[1] "numeric"
```

```r
v <- c(2, 5, 3, 4, NA) #NA will represent the missing value
mode(v)
```

```
[1] "numeric"
```

Boolean vector

```r
b <- c(TRUE, FALSE, NA, TRUE)
mode(b)
```

```
[1] "logical"
```

```
b[3] #retuirns the 3rd element from vector
```

```
[1] NA
```

```
b[3] <- TRUE #update the value of 3rd element
b
```

```
[1]  TRUE FALSE  TRUE  TRUE
```

```
e <-vector()
mode(e)
```

```
[1] "logical"
```

```
e <- c()
mode(e)
```

```
[1] "NULL"
```

```
length(e) # returns the length as 0 as vector is empty
```

```
[1] 0
```

```
b2 <-c(b[1], b[3], b[5]) #using vector elements to create other vector
b2
```

```
[1] TRUE TRUE   NA
```

```
sqrt(v) # finding sqaure root of all elements in the vector
```

```
[1] 1.414214 2.236068 1.732051 2.000000       NA
```

Vector arithmetic

```r
v1 <- c(3, 6, 9)
v2 <- c(1, 4, 8)
v1+v2 #addition
```

```
[1]  4 10 17
```

```r
v1*v2 #dot product
```

```
[1]  3 24 72
```

```r
v1-v2 #subtraction
```

```
[1] 2 2 1
```

```r
v1/v2 #divsion
```

```
[1] 3.000 1.500 1.125
```

```r
v3 <- c(1, 4)
v1+v3 # Dynamically matches the length of longer vector making v3(1,4,1)
```

```
Warning in v1 + v3: longer object length is not a multiple of shorter object
length
```

```
[1]  4 10 10
```

```r
#vector for 'for' loop:
mysum <- function (x){
  sum <- 0
  for(i in 1:length(x)){
    sum <- sum + x[i]
  }
  return (sum)
```

```
}
(mysum (c(1, 2, 3)))
```

```
[1] 6
```

Generating vectors:

```
(x <-1:10)
```

```
 [1]  1  2  3  4  5  6  7  8  9 10
```

```
(x <-10:1)
```

```
 [1] 10  9  8  7  6  5  4  3  2  1
```

```
10:15-1 #priority of the : operator is more than arithmatic operators
```

```
[1]  9 10 11 12 13 14
```

```
10:(15-1)
```

```
[1] 10 11 12 13 14
```

seq() to generate sequence with real numbers:

```
(seq(from=1, to=5, length=4)) # 4 values between 1 and 5 inclusive, even intervals/steps
```

```
[1] 1.000000 2.333333 3.666667 5.000000
```

```
(seq(length=10, from=-2, by=0.5)) #10 values, starting from 2, interval/step = 0.5
```

```
 [1] -2.0 -1.5 -1.0 -0.5  0.0  0.5  1.0  1.5  2.0  2.5
```

```
  (rep(5, 10)) #rep(a, b) is used for repeating the a, b number of times
```

```
 [1] 5 5 5 5 5 5 5 5 5 5
```

```
  (rep("hi", 3))
```

```
[1] "hi" "hi" "hi"
```

```
  (rep(1:2, 3)) #repeating the multiple values
```

```
[1] 1 2 1 2 1 2
```

```
  (rep(TRUE:FALSE, 3)) #repating the boolean values
```

```
[1] 1 0 1 0 1 0
```

```
  (rep(1:2, each=3)) #repeating multiple values seperately
```

```
[1] 1 1 1 2 2 2
```

gl() function is used to generate factor levels for creating factors with specific patterns, such as repeated or nested factors.

```
  gl(3, 5) #three levels, each repeat 5 times
```

```
 [1] 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3
Levels: 1 2 3
```

```
  gl(2, 5, labels= c('female', 'male'))#two levels, each level repeat 5 times
```

```
 [1] female female female female female male   male   male   male   male
Levels: female male
```

```
#first argument 2 says two levels.
#second argument 1 says repeat once
#third argment 20 says generate 20 values
gl(2, 1, 20, labels=c('female', 'male'))#10 alternating female and male pairs, a total of
```

```
 [1] female male   female male   female male   female male   female male
[11] female male   female male   female male   female male   female male
Levels: female male
```

```
n <- rep(1:2, each=3)
(n <- factor(n,
             levels = c(1, 2),
             labels = c('female','male')
             ))
```

```
[1] female female female male   male   male
Levels: female male
```

Generate 10 values following a normal distribution with mean = 10 and standard deviation = 3

```
(rnorm(10, mean=10, sd=3))
```

```
 [1] 14.763536  6.608873  9.759245 10.397261 12.123864  9.280906 15.953422
 [8]  9.583639 11.252952 12.945258
```

Exercise

Generate a random sample of normally distributed data of size 100, with a mean of 20 and standard deviation 4

```
sam <- (rnorm(100, mean=20, sd=4))
sam
```

```
 [1] 18.42922 15.84132 27.12892 10.75572 23.51442 20.14323 24.05131 21.72906
 [9] 28.36328 15.20030 26.35855 27.81861 20.01975 10.19317 21.90895 17.61377
[17] 23.16881 21.15855 22.95575 21.27584 24.30466 18.86337 16.89330 17.61736
[25] 13.09608 16.38966 17.76375 19.01395 18.46566 12.16359 16.63318 27.61419
[33] 22.48998 27.96368 18.77807 19.63662 19.26335 15.20493 16.64685 28.26521
[41] 17.75101 25.10286 15.80971 12.13649 18.70812 23.74345 24.55692 26.68648
[49] 12.84703 28.12497 17.18742 20.63266 22.02494 16.72002 12.00461 18.08283
[57] 20.33672 16.41805 16.31490 21.32180 19.43336 21.73939 19.78511 16.37156
[65] 25.21405 23.08716 24.21010 14.35985 23.98394 13.21694 17.86651 14.51092
[73] 11.16832 27.28849 17.38643 18.86128 18.45220 21.54678 26.40156 26.72462
[81] 15.26557 14.56617 13.94932 14.98758 27.83743 20.03058 16.62954 17.59536
[89] 24.29784 21.04239 18.74291 17.00148 16.55121 28.19216 23.75968 28.03475
[97] 18.31451 18.59666 15.89048 18.99792
```

```r
mean_sam <- mean(sam) # Calculate the mean

sd_value <- sd(sam) # Calculate the standard deviation

sample_size <- length(sam) # Calculate the sample size

se <- sd_value / sqrt(sample_size) ## Compute the standard error
se
```

```
[1] 0.4688534
```

Sub-setting

Subsetting isthe process of selecting a subset of elements or rows from data.

```r
x <- c(0, -3, 4, -1, 45, 90, -5)
#select all elements that is greater than 0
(gtzero <- x[x>0])
```

```
[1]  4 45 90
```

```r
x <- c(0, -3, 4, -1, 45, 90, -5)
(x[x<=-2 | x>5])        #Using OR operator
```

```
[1] -3 45 90 -5
```

```
(x[x>40 & x<100]) #using AND operator
```

```
[1] 45 90
```

```
x <- c(0, -3, 4, -1, 45, 90, -5)
(x[c(4, 6)]) #using vector index to selective elements
```

```
[1] -1 90
```

```
(y<-c(4,6)) #same as above
```

```
[1] 4 6
```

```
(x[y])
```

```
[1] -1 90
```

```
(x[1:3]) #select the 1st to the 3rd elements in the vector
```

```
[1]  0 -3  4
```

```
x <- c(0, -3, 4, -1, 45, 90, -5)
(x[-1]) #usinf negative index to exclude the element
```

```
[1] -3  4 -1 45 90 -5
```

```
(x[-c(4, 6)]) #using negative index to remove multiple elements
```

```
[1]  0 -3  4 45 -5
```

```
(x[-(1:3)]) #using negative index to remove range of elements
```

```
[1] -1 45 90 -5
```

Named elements

Named elements allow you to associate names or labels with individual components, making it easier to reference and work with your data.

```
x <- c(0, -3, 4, -1, 45, 90, -5)
names(x) <- c('s1', 's2', 's3', 's4', 's5', 's6', 's7')
x
```

```
s1 s2 s3 s4 s5 s6 s7
 0 -3  4 -1 45 90 -5
```

```
(pH <- c(area1=4.5, area2=5.7, area3=9.8, mud=7.2)) #naming elements while creating the ve
```

```
area1 area2 area3   mud
  4.5   5.7   9.8   7.2
```

```
pH['mud'] #selecting element using the lable.
```

```
mud
7.2
```

```
pH[c('area1', 'mud')]
```

```
area1   mud
  4.5   7.2
```

```
# x[-s1] #cannot use negative lable to exclude the element
#x[-"s1"]
```

```
#x[s1:s7] #inavlid argument
#x[c('s1':'s7')]
```

```
pH[] #empty index returns all the elements of the vector
```

```
area1 area2 area3   mud
  4.5   5.7   9.8   7.2
```

```
pH
```

```
area1 area2 area3   mud
  4.5   5.7   9.8   7.2
```

```
pH[] <- 0 #resetting the value of vactor to zero
pH
```

```
area1 area2 area3   mud
    0     0     0     0
```

Matrices and Arrays

Matrices and arrays are data structures used to store and manipulate multi-dimensional data.

```
m <- c(45, 23, 66, 77, 33, 44, 56, 12, 78, 23)
is.vector(m) #checking if vector or not
```

```
[1] TRUE
```

```
is.matrix(m) #checking of it's a matrix or not
```

```
[1] FALSE
```

```r
is.array(m) #checking of it's a array
```

```
[1] FALSE
```

```r
dim(m) <-c(2, 5)#organizing the vector as matrix of 2*5 dimension
m
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]   45   66   33   56   78
[2,]   23   77   44   12   23
```

```r
is.vector(m) #checking if vector or not
```

```
[1] FALSE
```

```r
is.matrix(m) #checking of it's a matrix or not
```

```
[1] TRUE
```

```r
is.array(m) #checking of it's a array
```

```
[1] TRUE
```

```r
(m <- matrix(c(45, 23, 66, 77, 33, 44, 56, 12, 78, 23), 2, 5, byrow = TRUE)) #If byrow = T
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]   45   23   66   77   33
[2,]   44   56   12   78   23
```

Exercise:

Create a matrix with two columns:

First columns hold age data for a group of students `11, 11, 12, 13, 14, 9, 8`, and second columns hold grades `5, 5, 6, 7, 8, 4, 3`.

```r
test <-matrix(c(11, 11, 12, 13, 14, 9, 8, 5, 5, 6, 7, 8, 4, 3), 7, 2)
test
```

```
     [,1] [,2]
[1,]   11    5
[2,]   11    5
[3,]   12    6
[4,]   13    7
[5,]   14    8
[6,]    9    4
[7,]    8    3
```

```r
m <- c(45, 23, 66, 77, 33, 44, 56, 12, 78, 23)
#then 'organize' the vector as a matrix
dim(m) <- c(2, 5)#make the vector a 2 by 5 matrix, 2x5 must = lenght of the vector
m
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]   45   66   33   56   78
[2,]   23   77   44   12   23
```

```r
m[2, 3]#the element at row 2 and column 3
```

```
[1] 44
```

```r
(s<- m[2, 1]) # select one value
```

```
[1] 23
```

```r
(m<- m [c(1,2), -c(3, 5)]) #select 1st row and 1st, 2nd, and 4th columns: result is a vect
```

```
     [,1] [,2] [,3]
[1,]   45   66   56
[2,]   23   77   12
```

```r
(m [1, ]) #select complete row or column: 1st row, result is a vector
```

```
[1] 45 66 56
```

```r
(v<-m [, 1]) # 1st column, result is a vector
```

```
[1] 45 23
```

```r
is.vector(m) #checking if vector or not
```

```
[1] FALSE
```

```r
is.matrix(m) #checking of it's a matrix or not
```

```
[1] TRUE
```

```r
is.vector(s) #checking if vector or not
```

```
[1] TRUE
```

```r
is.vector(v) #checking if vector or not
```

```
[1] TRUE
```

```r
is.matrix(v)
```

```
[1] FALSE
```

if the result of subsetting a matrix is a single row or a single column, it remains as a matrix with one row or one column when `drop = FALSE`.

```r
m <- matrix(c(45, 23, 66, 77, 33, 44, 56, 12, 78, 23), 2, 5)
(m<-m [, 2, drop = FALSE])
```

```
     [,1]
[1,]   66
[2,]   77
```

```r
is.matrix(m)
```

```
[1] TRUE
```

```r
is.vector(m)
```

```
[1] FALSE
```

cbind() and rbind(): join together two or more vectors or matrices, by column, or by row, respectively:

```r
cbind (c(1,2,3), c(4, 5, 6))
```

```
     [,1] [,2]
[1,]    1    4
[2,]    2    5
[3,]    3    6
```

```r
rbind (c(1,2,3), c(4, 5, 6))
```

```
     [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
```

```r
m <- matrix(c(45, 23, 66, 77, 33, 44, 56, 12, 78, 23), 2, 5)
(a <- rbind (c(1,2,3,4,5), m))
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]    1    2    3    4    5
[2,]   45   66   33   56   78
[3,]   23   77   44   12   23
```

```r
is.array(a)
```

```
[1] TRUE
```

```r
is.matrix(a)
```

```
[1] TRUE
```

Exercise:

What will `m1-m4` look like?

```r
m1 <- matrix(rep(10, 9), 3, 3)
m2 <- cbind (c(1,2,3), c(4, 5, 6))
m3 <- cbind (m1[,1], m2[2,])
m4 <- cbind (m1[,1], m2[,2])
# m5 <- m1-m4 # will give an error as arrays that do not have compatible dimensions
```

Named rows and columns in matrix:

```r
sales <- matrix(c(10, 30, 40, 50, 43, 56, 21, 30), 2, 4, byrow=TRUE)
colnames(sales) <- c('1qrt', '2qrt', '3qrt', '4qrt')
rownames(sales) <- c('store1', 'store2')
sales
```

```
       1qrt 2qrt 3qrt 4qrt
store1   10   30   40   50
store2   43   56   21   30
```

Exercise:

Find `store1` `1qrt` sale. 2. List `store2`'s 1st and 4th quarter sales:

```
  sales['store1', '1qrt']
```

```
[1] 10
```

```
  sales['store2', c('1qrt', '4qrt')]
```

```
1qrt 4qrt
  43   30
```

Arrays

Arrays are similar to matrices, but arrays can have more than 2 dimensions

```
  a <- array(1:48, dim= c(4, 3, 2))
  a
```

```
, , 1

     [,1] [,2] [,3]
[1,]    1    5    9
[2,]    2    6   10
[3,]    3    7   11
[4,]    4    8   12

, , 2

     [,1] [,2] [,3]
[1,]   13   17   21
[2,]   14   18   22
[3,]   15   19   23
[4,]   16   20   24
```

```
  a [1, 3, 2]
```

```
[1] 21
```

```
  a [1, , 2]
```

```
[1] 13 17 21
```

```
  a [1, , 2, drop=FALSE]
```

```
, , 1

     [,1] [,2] [,3]
[1,]   13   17   21
```

```
  a [4, 3, ]
```

```
[1] 12 24
```

```
  a [c(2, 3), , -2]
```

```
     [,1] [,2] [,3]
[1,]    2    6   10
[2,]    3    7   11
```

```
  dimnames(a)[[1]] <-c("1qrt", "2qrt", "3qrt", "4qrt")
  dimnames(a)[[2]] <-c("store1", "store2", "store3")
  dimnames(a)[[3]] <-c("2017", "2018")
  a #using list() to specify names
```

```
, , 2017

     store1 store2 store3
1qrt      1      5      9
2qrt      2      6     10
3qrt      3      7     11
4qrt      4      8     12
```

```
, , 2018

     store1 store2 store3
1qrt     13     17     21
2qrt     14     18     22
3qrt     15     19     23
4qrt     16     20     24
```

```
ar <- array(data     = 1:27,
            dim      = c(3, 3, 3),
            dimnames = list(c("a", "b", "c"), c("d", "e", "f"),           c("g", "h", "i")
ar
```

```
, , g

  d e f
a 1 4 7
b 2 5 8
c 3 6 9

, , h

   d  e  f
a 10 13 16
b 11 14 17
c 12 15 18

, , i

   d  e  f
a 19 22 25
b 20 23 26
c 21 24 27
```

Split array into matrices

```
matrix1 <- ar[,,g]
matrix1 <- ar[,,'g']
matrix1
```

```
  d e f
a 1 4 7
b 2 5 8
c 3 6 9
```

```
matrix2 <- ar[,,'h']
matrix2
```

```
   d  e  f
a 10 13 16
b 11 14 17
c 12 15 18
```

```
sum <-matrix1 + matrix2
sum
```

```
   d  e  f
a 11 17 23
b 13 19 25
c 15 21 27
```

```
matrix1*3 #multiplying all matrix elememts by 3
```

```
  d  e  f
a 3 12 21
b 6 15 24
c 9 18 27
```

```
matrix1*c(2, 3)
```

```
Warning in matrix1 * c(2, 3): longer object length is not a multiple of shorter
object length
```

```
  d  e  f
a 2 12 14
b 6 10 24
c 6 18 18
```

```
matrix1*c(2,3,2,3,2,3,2,3,2) #multiplying matrix with an vector
```

```
  d  e  f
a 2 12 14
b 6 10 24
c 6 18 18
```

```
matrix1*c(1, 2, 3)
```

```
  d  e  f
a 1  4  7
b 4 10 16
c 9 18 27
```

```
matrix1/c(1, 2, 3)
```

```
  d   e f
a 1 4.0 7
b 1 2.5 4
c 1 2.0 3
```

```
matrix1/c(1, 2, 3, 1, 2, 3, 1, 2, 3)
```

```
  d   e f
a 1 4.0 7
b 1 2.5 4
c 1 2.0 3
```

Lists:

a list is a versatile and flexible data structure that can hold elements of different data types, including vectors, matrices, data frames, functions, and even other lists.

you can access a component of a list by using the **$** operator, followed by the name of the component you want to access.

```
mylist <- list(stud.id=34453,
               stud.name="John",
               stud.marks= c(13, 3, 12, 15, 19)
               )

mylist$stud.id
```

```
[1] 34453
```

```
mylist[1] #accessing 1 st element
```

```
$stud.id
[1] 34453
```

```
mylist[[1]]
```

```
[1] 34453
```

```
mylist["stud.id"]
```

```
$stud.id
[1] 34453
```

```
handle <- "stud.id" #renaming
mylist[handle]
```

```
$stud.id
[1] 34453
```

```
mylist[["stud.id"]] # extracting single elements from a list
```

```
[1] 34453
```

```r
mylist <- list(stud.id=34453,
               stud.name="John",
               stud.marks= c(13, 3, 12, 15, 19)
               )
mylist$stud.marks
```

```
[1] 13  3 12 15 19
```

```r
mylist$stud.marks[2]
```

```
[1] 3
```

```r
names(mylist)
```

```
[1] "stud.id"    "stud.name"  "stud.marks"
```

```r
names(mylist) <- c('id','name','marks') #changing names

names(mylist)
```

```
[1] "id"    "name"  "marks"
```

```r
mylist
```

```
$id
[1] 34453

$name
[1] "John"

$marks
[1] 13  3 12 15 19
```

```r
mylist$parents.names <- c('Ana', "Mike")
mylist
```

```
$id
[1] 34453

$name
[1] "John"

$marks
[1] 13  3 12 15 19

$parents.names
[1] "Ana"  "Mike"
```

```r
newlist <- list(age=19, sex="male");
expandedlist <-c(mylist, newlist) #cocating 2 lists
expandedlist
```

```
$id
[1] 34453

$name
[1] "John"

$marks
[1] 13  3 12 15 19

$parents.names
[1] "Ana"  "Mike"

$age
[1] 19

$sex
[1] "male"
```

```r
length(expandedlist) #length of the new list
```

```
[1] 6
```

Exercise:

Starting with the expanded list given above, what will be the result of the following statement? Consider the statement one by one.

```
expandedlist <- expandedlist[-5]
expandedlist <- expandedlist[c(-1,-5)]
expandedlist$parents.names <- NULL
expandedlist[['marks']] <- NULL
```

```
mylist
```

```
$id
[1] 34453

$name
[1] "John"

$marks
[1] 13  3 12 15 19

$parents.names
[1] "Ana"  "Mike"
```

```
unlist(mylist) # convert to a one-dimensional vector
```

```
          id           name         marks1         marks2         marks3
     "34453"         "John"           "13"            "3"           "12"
      marks4         marks5 parents.names1 parents.names2
        "15"           "19"          "Ana"         "Mike"
```

```
mode(mylist) #finding the type
```

```
[1] "list"
```

```
  mode(unlist(mylist))
```

```
[1] "character"
```

```
  is.vector(unlist(mylist)) #atomic list with names
```

```
[1] TRUE
```

```
  is.list(mylist)
```

```
[1] TRUE
```

```
  is.atomic(mylist)
```

```
[1] FALSE
```

```
  is.list(unlist(mylist))
```

```
[1] FALSE
```

Data Frames

A data frame is a widely used data structure for organizing and manipulating tabular data.

```
  my.dataframe <- data.frame(site=c('A', 'B', 'A','A', 'B'),
                             season=c('winter', 'summer', 'summer', 'spring', 'fall'),
  my.dataframe
```

```
  site season  ph
1    A winter 7.4
2    B summer 6.3
3    A summer 8.6
4    A spring 7.2
5    B   fall 8.9
```

Exercise:

Given ‘my.dataframes‘, what values will the following statements access?

```
my.dataframe <- data.frame(site=c('A', 'B', 'A','A', 'B'),
                           season=c('winter', 'summer', 'summer', 'spring', 'fall'),
my.dataframe[3, 2]
```

```
[1] "summer"
```

```
my.dataframe[['site']]
```

```
[1] "A" "B" "A" "A" "B"
```

```
my.dataframe['site']
```

```
  site
1    A
2    B
3    A
4    A
5    B
```

```
my.dataframe[my.dataframe$ph>7, ]
```

```
  site season  ph
1    A winter 7.4
3    A summer 8.6
4    A spring 7.2
5    B   fall 8.9
```

```
my.dataframe[my.dataframe$ph>7, 'site']
```

```
[1] "A" "A" "A" "B"
```

```
my.dataframe[my.dataframe$ph>7, c('site', 'ph')]
```

```
  site  ph
1    A 7.4
3    A 8.6
4    A 7.2
5    B 8.9
```

subset() function in R is used to create a subset of a data frame or matrix based on specified conditions or criteria.

```
subset(my.dataframe, ph>7)
```

```
  site season  ph
1    A winter 7.4
3    A summer 8.6
4    A spring 7.2
5    B   fall 8.9
```

```
subset(my.dataframe, ph>7, c("site", "ph"))
```

```
  site  ph
1    A 7.4
3    A 8.6
4    A 7.2
5    B 8.9
```

```
subset(my.dataframe[1:2,], ph>7, c(site, ph))
```

```
  site  ph
1    A 7.4
```

```
my.dataframe[my.dataframe$season=='summer', 'ph'] <- my.dataframe[my.dataframe$season=='su
                                                                  my.dataframe[my.datafram
```

```
[1] 7.3 9.6
```

```
my.dataframe[my.dataframe$season=='summer' & my.dataframe$ph>8, 'ph'] <- my.dataframe[my.d

my.dataframe[my.dataframe$season=='summer', 'ph']
```

```
[1]  7.3 10.6
```

```
my.dataframe$NO3 <- c(234.5, 123.4, 456.7, 567.8, 789.0)
my.dataframe
```

```
  site season   ph   NO3
1    A winter  7.4 234.5
2    B summer  7.3 123.4
3    A summer 10.6 456.7
4    A spring  7.2 567.8
5    B   fall  8.9 789.0
```

```
#my.dataframe$NO3<-NULL
my.dataframe <- my.dataframe[, -4]
my.dataframe
```

```
  site season   ph
1    A winter  7.4
2    B summer  7.3
3    A summer 10.6
4    A spring  7.2
5    B   fall  8.9
```

```
str(my.dataframe)
```

```
'data.frame':   5 obs. of  3 variables:
 $ site  : chr  "A" "B" "A" "A" ...
 $ season: chr  "winter" "summer" "summer" "spring" ...
 $ ph    : num  7.4 7.3 10.6 7.2 8.9
```

```
nrow(my.dataframe) # number of rows in dataframe
```

```
[1] 5
```

```
ncol(my.dataframe) #number of columns in dataframes
```

```
[1] 3
```

```
dim(my.dataframe)
```

```
[1] 5 3
```

```
 #edit(my.dataframe) #this brings up a data editor

 #View(my.dataframe) #this brings up a uneditable tab that display the data for you to vie
```

```
names(my.dataframe)
```

```
[1] "site"   "season" "ph"
```

```
names(my.dataframe) <- c('area', 'season', 'P.h.')
my.dataframe
```

```
  area season P.h.
1    A winter  7.4
2    B summer  7.3
3    A summer 10.6
4    A spring  7.2
5    B   fall  8.9
```

```
names(my.dataframe)[3] <- 'ph'
my.dataframe
```

```
  area season   ph
1    A winter  7.4
2    B summer  7.3
3    A summer 10.6
4    A spring  7.2
5    B   fall  8.9
```

Tibbles

Tibbles are designed to make data manipulation and analysis more intuitive and less error-prone.

```
install.packages("tibble")
```

```
Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
(as 'lib' is unspecified)
```

```
library(tibble)
```

```
my.tibble <- tibble(TempCels = sample(-10:40, size=100, replace=TRUE),
                    TempFahr = TempCels*9/5+32,
                    Location = rep(letters[1:2], each=50))
my.tibble
```

```
# A tibble: 100 x 3
   TempCels TempFahr Location
      <int>    <dbl> <chr>
 1       24     75.2 a
 2        7     44.6 a
 3       32     89.6 a
 4       -9     15.8 a
 5        3     37.4 a
 6       23     73.4 a
 7       10     50   a
 8       19     66.2 a
 9        1     33.8 a
10       16     60.8 a
# i 90 more rows
```

```
install.packages("palmerpenguins")
```

```
Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
(as 'lib' is unspecified)
```

```
library(palmerpenguins)
data(penguins)
dim(penguins)
```

```
[1] 344   8
```

```
class(penguins)
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
penguins
```

```
# A tibble: 344 x 8
   species island    bill_length_mm bill_depth_mm flipper_length_mm body_mass_g
   <fct>   <fct>              <dbl>         <dbl>             <int>       <int>
 1 Adelie  Torgersen           39.1          18.7               181        3750
 2 Adelie  Torgersen           39.5          17.4               186        3800
 3 Adelie  Torgersen           40.3          18                 195        3250
 4 Adelie  Torgersen           NA            NA                  NA          NA
 5 Adelie  Torgersen           36.7          19.3               193        3450
 6 Adelie  Torgersen           39.3          20.6               190        3650
 7 Adelie  Torgersen           38.9          17.8               181        3625
 8 Adelie  Torgersen           39.2          19.6               195        4675
 9 Adelie  Torgersen           34.1          18.1               193        3475
10 Adelie  Torgersen           42            20.2               190        4250
# i 334 more rows
# i 2 more variables: sex <fct>, year <int>
```

```
pe <-as_tibble(penguins)
class(pe)
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
pe
```

```
# A tibble: 344 x 8
   species island    bill_length_mm bill_depth_mm flipper_length_mm body_mass_g
   <fct>   <fct>              <dbl>         <dbl>             <int>       <int>
 1 Adelie  Torgersen           39.1          18.7               181        3750
 2 Adelie  Torgersen           39.5          17.4               186        3800
 3 Adelie  Torgersen           40.3          18                 195        3250
 4 Adelie  Torgersen           NA            NA                  NA          NA
 5 Adelie  Torgersen           36.7          19.3               193        3450
 6 Adelie  Torgersen           39.3          20.6               190        3650
 7 Adelie  Torgersen           38.9          17.8               181        3625
 8 Adelie  Torgersen           39.2          19.6               195        4675
 9 Adelie  Torgersen           34.1          18.1               193        3475
10 Adelie  Torgersen           42            20.2               190        4250
# i 334 more rows
# i 2 more variables: sex <fct>, year <int>
```

```
x <- 1:16
mode(x) #finding type of frame
```

```
[1] "numeric"
```

```
dim(x) <- c(4,4)
class(x)
```

```
[1] "matrix" "array"
```

```
is.numeric(x)
```

```
[1] TRUE
```

```
mode(x) <- "character"
mode(x)
```

```
[1] "character"
```

```
  class(x)
```

```
[1] "matrix" "array"
```

```
  x <- factor(x)
  class(x)
```

```
[1] "factor"
```

```
  mode(x)
```

```
[1] "numeric"
```

```
  is.array(x)
```

```
[1] FALSE
```

```
  is.data.frame(x)
```

```
[1] FALSE
```

```
  is.matrix(x)
```

```
[1] FALSE
```

```
  is_tibble(x)
```

```
[1] FALSE
```

```
  is.vector(x)
```

```
[1] FALSE
```

```
  typeof(x)
```

```
[1] "integer"
```

```
  class(pe[1:15, c("bill_length_mm", "bill_depth_mm")]) #subsetting tibble in smaller one
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
  class(penguins[1:15, c("bill_length_mm", "bill_depth_mm")])
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
  class(pe[1:15, c("bill_length_mm")])
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

```
  class(penguins[1:15, c("bill_length_mm")])
```

```
[1] "tbl_df"     "tbl"        "data.frame"
```

dplyr

Provides a set of functions and a consistent, user-friendly grammar for working with data frames or tibbles.

```
  install.packages("dplyr")
```

```
Installing package into '/cloud/lib/x86_64-pc-linux-gnu-library/4.3'
(as 'lib' is unspecified)
```

```
  library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```r
  select(filter(pe, species=="Adelie"), bill_length_mm, bill_depth_mm) #Select bill lengths
```

```
# A tibble: 152 x 2
   bill_length_mm bill_depth_mm
            <dbl>         <dbl>
 1           39.1          18.7
 2           39.5          17.4
 3           40.3          18
 4           NA            NA
 5           36.7          19.3
 6           39.3          20.6
 7           38.9          17.8
 8           39.2          19.6
 9           34.1          18.1
10           42            20.2
# i 142 more rows
```

```r
  filter(select(pe, bill_length_mm, bill_depth_mm, species), species=="Adelie")
```

```
# A tibble: 152 x 3
   bill_length_mm bill_depth_mm species
            <dbl>         <dbl> <fct>
 1           39.1          18.7 Adelie
 2           39.5          17.4 Adelie
 3           40.3          18   Adelie
 4           NA            NA   Adelie
 5           36.7          19.3 Adelie
```

```
 6           39.3          20.6 Adelie
 7           38.9          17.8 Adelie
 8           39.2          19.6 Adelie
 9           34.1          18.1 Adelie
10           42            20.2 Adelie
# i 142 more rows
```

Exercise

How would you achieve the same result as the above but use tibble subsetting?

```
pe
```

```
# A tibble: 344 x 8
   species island    bill_length_mm bill_depth_mm flipper_length_mm body_mass_g
   <fct>   <fct>              <dbl>         <dbl>             <int>       <int>
 1 Adelie  Torgersen           39.1          18.7               181        3750
 2 Adelie  Torgersen           39.5          17.4               186        3800
 3 Adelie  Torgersen           40.3          18                 195        3250
 4 Adelie  Torgersen           NA            NA                  NA          NA
 5 Adelie  Torgersen           36.7          19.3               193        3450
 6 Adelie  Torgersen           39.3          20.6               190        3650
 7 Adelie  Torgersen           38.9          17.8               181        3625
 8 Adelie  Torgersen           39.2          19.6               195        4675
 9 Adelie  Torgersen           34.1          18.1               193        3475
10 Adelie  Torgersen           42            20.2               190        4250
# i 334 more rows
# i 2 more variables: sex <fct>, year <int>
```

```
pe[pe$species=='Adelie', c("bill_length_mm", "bill_depth_mm")]
```

```
# A tibble: 152 x 2
   bill_length_mm bill_depth_mm
            <dbl>         <dbl>
 1           39.1          18.7
 2           39.5          17.4
 3           40.3          18
 4           NA            NA
 5           36.7          19.3
 6           39.3          20.6
```

```
 7           38.9          17.8
 8           39.2          19.6
 9           34.1          18.1
10           42            20.2
# i 142 more rows
```

```r
subset(pe, pe$species=='Adelie', c("bill_length_mm", "bill_depth_mm"))
```

```
# A tibble: 152 x 2
   bill_length_mm bill_depth_mm
            <dbl>         <dbl>
 1           39.1          18.7
 2           39.5          17.4
 3           40.3          18
 4           NA            NA
 5           36.7          19.3
 6           39.3          20.6
 7           38.9          17.8
 8           39.2          19.6
 9           34.1          18.1
10           42            20.2
# i 142 more rows
```

```r
select(pe, bill_length_mm, bill_depth_mm, species) |> filter(species=="Adelie")
```

```
# A tibble: 152 x 3
   bill_length_mm bill_depth_mm species
            <dbl>         <dbl> <fct>
 1           39.1          18.7 Adelie
 2           39.5          17.4 Adelie
 3           40.3          18   Adelie
 4           NA            NA   Adelie
 5           36.7          19.3 Adelie
 6           39.3          20.6 Adelie
 7           38.9          17.8 Adelie
 8           39.2          19.6 Adelie
 9           34.1          18.1 Adelie
10           42            20.2 Adelie
# i 142 more rows
```

```
  filter(pe, species=="Adelie") |> select(bill_length_mm, bill_depth_mm, species)
```

```
# A tibble: 152 x 3
   bill_length_mm bill_depth_mm species
            <dbl>         <dbl> <fct>
 1           39.1          18.7 Adelie
 2           39.5          17.4 Adelie
 3           40.3          18   Adelie
 4           NA            NA   Adelie
 5           36.7          19.3 Adelie
 6           39.3          20.6 Adelie
 7           38.9          17.8 Adelie
 8           39.2          19.6 Adelie
 9           34.1          18.1 Adelie
10           42            20.2 Adelie
# i 142 more rows
```

Exercise

Create a data object to hold student names (`Judy`, `Max`, `Dan`) and their grades (‘78,85,99) `Convert number grades to letter grades`:90-100:A;80-89:B;70-79:C; \<70:F‘

```
  students <- list(names=c("Judy", "Max", "Dan"),
                   grades=c(78, 85, 99))
  print ("before:")
```

```
[1] "before:"
```

```
  students
```

```
$names
[1] "Judy" "Max"  "Dan"

$grades
[1] 78 85 99
```

```r
gradeConvertor<- function (grade){
  grade = as.numeric(grade)
  if(grade > 100 | grade < 0) print ("grade out of the range")
  else if(grade >= 90 & grade <= 100) return ("A")
  else if(grade >= 80 & grade < 90) return ("B")
  else if(grade >= 70 & grade < 80) return ("C")
  else return ("F")
} # providing different conditions

#students$grades <-sapply(students$grades, gradeConvertor)

for(i in 1:length(students$grades)){
  students$grades[i] = gradeConvertor(students$grades[i])
}

print ("after:")
```

```
[1] "after:"
```

```r
students
```

```
$names
[1] "Judy" "Max"  "Dan"

$grades
[1] "C" "B" "A"
```