Bill's Drills Book

William McDonald

2020-04-18

Contents

Chapter 1

Drills: Part of Every Healthy Intellectual Diet

The goal of this book is to organize my R drills into reasonable chunks, the better to understand my strengths and weaknesses, and to plan new forays into data science.

Notes on **bookdown**:

- the `_bookdown.yml` file contains a snippet that is important to inserting the word "Chapter" before the chapter number in each of the Rmd files.
- packages are indicated in bold, like **dplyr**
- inline code and filenames are indicated in typerwriter face using backticks, like `_bookdown.yml`
- `_output.yml` is modified from that used by Xie in his `bookdown-demo` (Xie, 2020); it evokes `style.css`, `toc.css`, `preamble.tex`, which are also borrowed from Xie.

Chapter 2

Data Exploration

Data exploration is one of the most important aspects of data science and forms the cornerstone of my drills. Nonetheless, I have lots of room for improvement.

I like Hadely Wickham's writing and find his approach exceptionally clear. Therefore, I'll use the **tidyverse**.

```
library(tidyverse)
```

2.1 Counting things. The naming of parts.

```
starwars %>%
  filter(!is.na(species)) %>%
  count(species = fct_lump(species, 5), sort = TRUE) %>%
  mutate(species = fct_reorder(species, n)) %>%
  ggplot(aes(species, n)) +
  geom_col() + coord_flip()
```

I like stacked bars for their economy, but it's easy to over do it. Supperimposing gender onto the columns seems easy...

```
starwars %>%
  filter(!is.na(species)) %>%
  count(species = fct_lump(species, 5), gender = fct_lump(gender, 2), sort = TRUE) %>%
  mutate(species = fct_reorder(species, n)) %>%
  ggplot(aes(species, n, fill = gender)) +
  geom_col() + coord_flip()
```

```
## Warning: Factor `gender` contains implicit NA, consider using
## `forcats::fct_explicit_na`
```

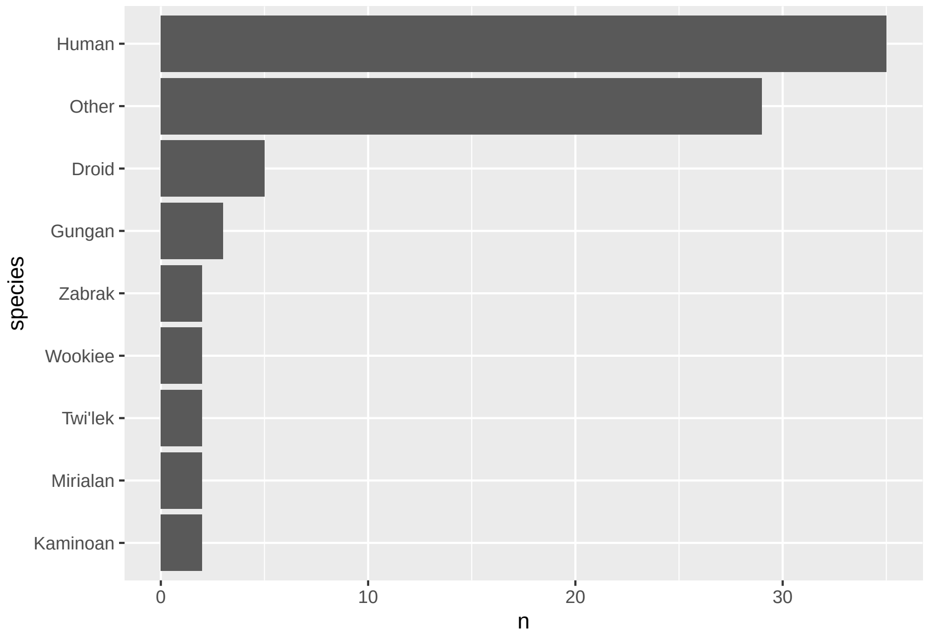
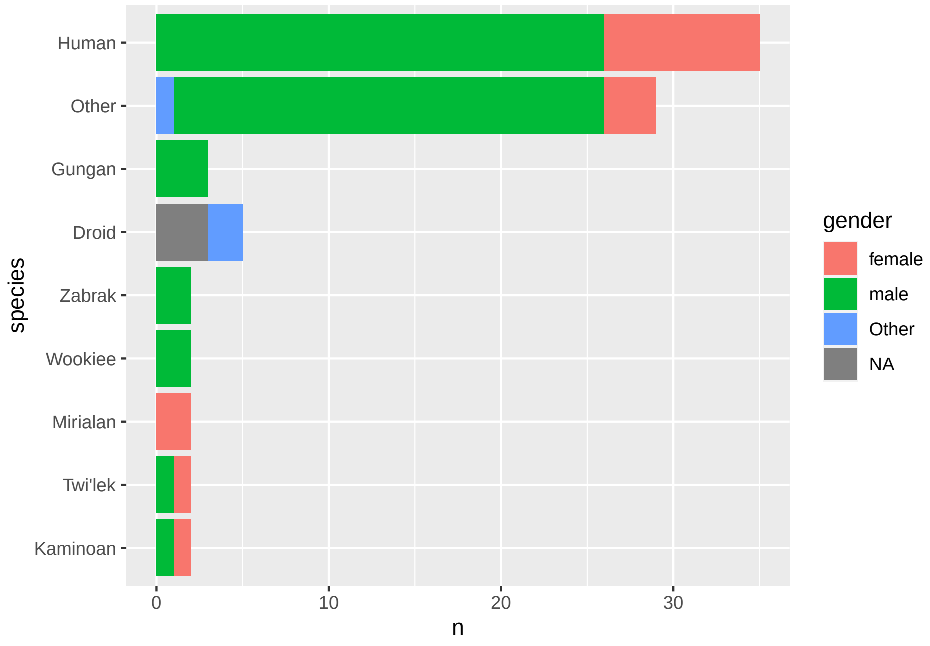


Figure 2.1: Starwars Figure 1

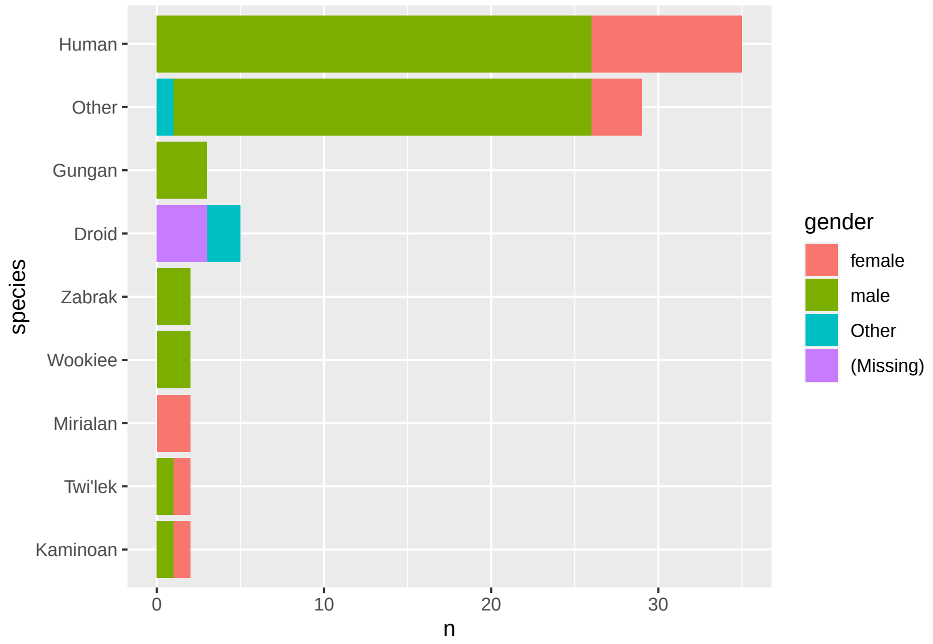


But note that I've got a problem: the Droids, which outnumber the Gungans, are now reordered to *after* the Gungans. This happens because the n that we're counting comprises subcategories of species *and* gender. Only three Gungan males exist (and no females), but that is enough to tie the Droid NA category. The Droid NA category come after the Gungan category, presumably because *male* comes before *NA*, or because NA comes last (more likely).

Exploring this, I see that I'm getting warning messages about the implicit NA's in gender. Note that the following renders a slightly different plot. I *still* have not fixed the order of the species.

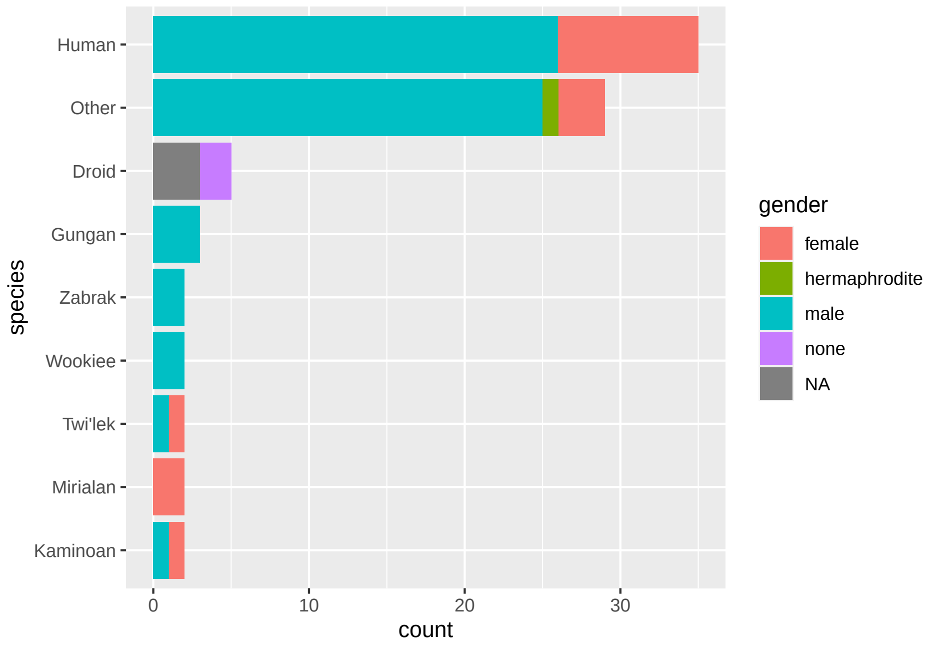
```
starwars %>%
  filter(!is.na(species)) %>%
  count(species = fct_lump(species, 5), gender = fct_lump(gender, 2), sort = TRUE) %>%
  mutate(gender = fct_explicit_na(gender),
         species = fct_reorder(species, n)) %>%
  ggplot(aes(species, n, fill = gender)) +
  geom_col() + coord_flip()
```

```
## Warning: Factor `gender` contains implicit NA, consider using
## `forcats::fct_explicit_na`
```



The trick here is to use `group_by()` and `ungroup()` wisely.

```
starwars %>% filter(!is.na(species)) %>%
  mutate(species = fct_lump(species, 5)) %>%
  group_by(species) %>%
  mutate(typeCount = n()) %>%
  ungroup() %>%
  mutate(species = fct_reorder(species, typeCount)) %>%
  ggplot()+
  geom_bar(aes(species, fill = gender))+
  coord_flip()
```



As opposed to using `count()`, which progressively narrows the information available to be used, by using `group_by()`/`mutate()`/`ungroup()` with `geom_bar()` we have all of the variables still available for plotting.

2.2 Summarize is another very useful function:

```
starwars %>%
  filter(!(is.na(species))) %>%
  group_by(species) %>%
  summarize(n=n(), mean = mean(height, na.rm = TRUE)) %>%
  arrange(desc(n))
```

```
## # A tibble: 37 x 3
##    species      n  mean
##    <chr>    <int> <dbl>
##  1 Human       35  177.
##  2 Droid        5  140
##  3 Gungan       3  209.
##  4 Kaminoan     2  221
##  5 Mirialan     2  168
##  6 Twi'lek      2  179
##  7 Wookiee      2  231
##  8 Zabrak       2  173
##  9 Aleena       1   79
## 10 Besalisk     1  198
## # ... with 27 more rows
```

2.3 Referencing other parts of the document

This is a good place to practice referencing figures. Say that I want to refer the reader back to my first starwars figure. See Figure 2.1.

I can reference other pages in a similar fashion. See Chapter 9. Note that this works by referencing a {#label} placed in the chapter title.

See Chapter 1

See Chapter 2

Note that the {#label} uses a single run-together word. It does not tolerate spaces and this cannot be overcome by 'quoting' it.

2.4 Referencing citations:

In order to insert citations, one needs a .bib file in the project. I've included one in this project as *book.bib*. The yml header in Chapter 1 needs to have a $bibliography :$ and $biblio - style :$ line added.

To insert a citation, use the **citr** Addin from RStudio. **bookdown**, for instance, is cited thusly (Xie, 2020). Note that I need to figure out an adequate workflow of references. The convenience of Endnote in MS Word will not be available. Nonetheless, if I populate the book.bib and packages.bib files carefully, with .txt files generated in Endnote, I should be OK.

For instance, a recent dump of my Endnote library is in bookFromEndnote.txt. This can be opened in RStudio, and I can copy-and-paste references from the .txt file to my book.bib. For instance, if I have a breast paper that I want to cite here (Stevens and Parekh, 2016), I'd copy-and-paste the reference from bookFromEndnot.text to book.bib.

Of note, Yihui Xie includes a nifty bit of code to automatically generate a bib database for R packages:

```
knitr::write_bib(c(.packages(), 'bookdown', 'knitr', 'rmarkdown', 'tidyverse', 'Comple
```

References appear automatically at the end of a chapter.

Chapter 3

Sampling

3.1 Think about throwing a bunch of dice.

```
sample(1:6, size=100, replace=TRUE)
```

```
##   [1] 3 4 6 6 4 2 5 3 4 1 1 6 2 5 1 3 2 4 1 5 2 5 4 4 2 1 4 4 2 4 1 3 5 3 2 5 3
##  [38] 3 2 6 2 6 3 2 1 4 4 2 6 3 3 6 6 4 1 6 6 6 2 1 2 1 3 6 3 5 5 2 4 1 3 4 5 1
##  [75] 1 4 5 4 2 2 2 3 5 3 2 1 1 1 4 4 4 3 2 4 4 3 4 4 5 5
```

```
sample(1:6, size=100, replace=TRUE) %>% table()
```

```
## .
##  1  2  3  4  5  6
## 22 14 12 15 18 19
```

```
sample(1:6, size=100, replace=TRUE) %>% table() %>% prop.table()
```

```
## .
##    1    2    3    4    5    6
## 0.12 0.18 0.18 0.18 0.15 0.19
```

3.2 A keen way to divide up a dataset into testing and training components.

```
x <- 1:50
y <- 51:100
```

```r
df <- data.frame(x,y)
df
```

```
##     x  y
## 1   1 51
## 2   2 52
## 3   3 53
## 4   4 54
## 5   5 55
## 6   6 56
## 7   7 57
## 8   8 58
## 9   9 59
## 10 10 60
## 11 11 61
## 12 12 62
## 13 13 63
## 14 14 64
## 15 15 65
## 16 16 66
## 17 17 67
## 18 18 68
## 19 19 69
## 20 20 70
## 21 21 71
## 22 22 72
## 23 23 73
## 24 24 74
## 25 25 75
## 26 26 76
## 27 27 77
## 28 28 78
## 29 29 79
## 30 30 80
## 31 31 81
## 32 32 82
## 33 33 83
## 34 34 84
## 35 35 85
## 36 36 86
## 37 37 87
## 38 38 88
## 39 39 89
## 40 40 90
## 41 41 91
## 42 42  92
## 43 43  93
## 44 44  94
## 45 45  95
## 46 46  96
## 47 47  97
## 48 48  98
## 49 49  99
## 50 50 100
```

```
set.seed(0)
train_indexes = sample(1:nrow(df), .7 * nrow(df))

train_set <- df[train_indexes,]
test_set <- df[-train_indexes,]

train_set
```

```
##     x   y
## 14 14  64
## 4   4  54
## 39 39  89
## 1   1  51
## 34 34  84
## 23 23  73
## 43 43  93
## 50 50 100
## 18 18  68
## 33 33  83
## 21 21  71
## 40 40  90
## 10 10  60
## 7   7  57
## 9   9  59
## 15 15  65
## 48 48  98
## 25 25  75
## 44 44  94
## 5   5  55
## 31 31  81
## 2   2  52
## 38 38  88
## 41 41  91
## 12 12  62
## 35 35  85
## 47 47  97
## 20 20  70
## 3   3  53
## 6   6  56
## 28 28  78
## 45 45  95
## 46 46  96
## 27 27  77
## 49 49  99
```

```
test_set
```

```
##     x  y
## 8   8 58
## 11 11 61
## 13 13 63
## 16 16 66
## 17 17 67
## 19 19 69
## 22 22 72
## 24 24 74
## 26 26 76
## 29 29 79
## 30 30 80
## 32 32 82
## 36 36 86
## 37 37 87
## 42 42 92
```

Chapter 4

Factor Practice

```r
cups <- c("small", "medium", "large")
manyCups <- sample(cups, size = 100, replace = TRUE)
sizesCups <- factor(manyCups, levels = c("small", "medium", "large"))
sizesCups
```

```
##   [1] medium small  large  medium small  small  large  medium medium large 
##  [11] large  medium medium medium medium small  medium medium medium medium
##  [21] small  large  large  medium large  large  medium large  large  small 
##  [31] small  small  small  large  medium large  small  small  medium small 
##  [41] small  small  small  large  medium small  small  large  large  large 
##  [51] medium medium medium large  medium medium large  large  large  small 
##  [61] medium medium small  large  large  medium large  medium small  medium
##  [71] small  large  large  small  medium small  large  medium large  large 
##  [81] small  small  medium medium medium small  small  small  medium small 
##  [91] large  medium large  large  medium large  large  small  small  medium
## Levels: small medium large
```

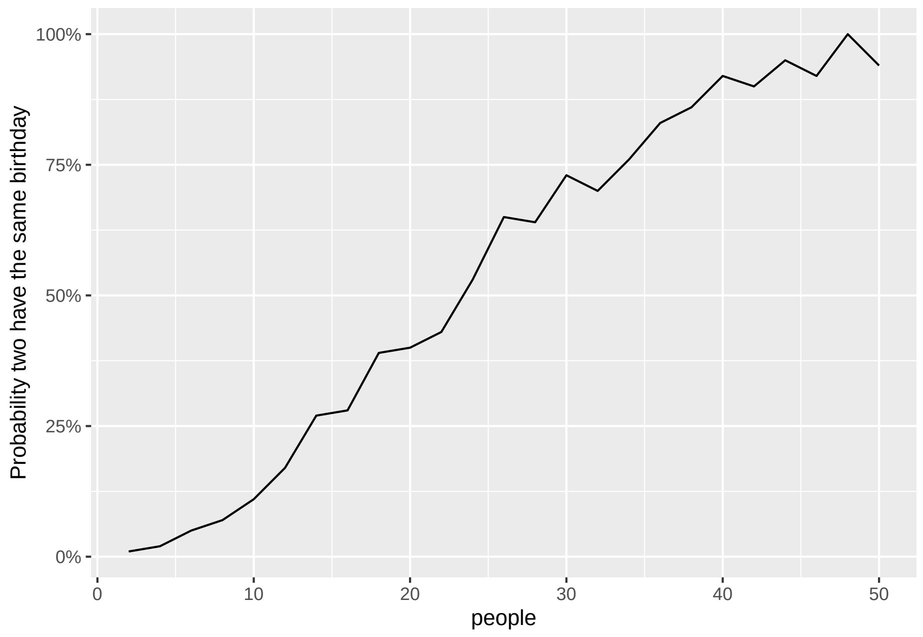
Chapter 5

Crossing Trial

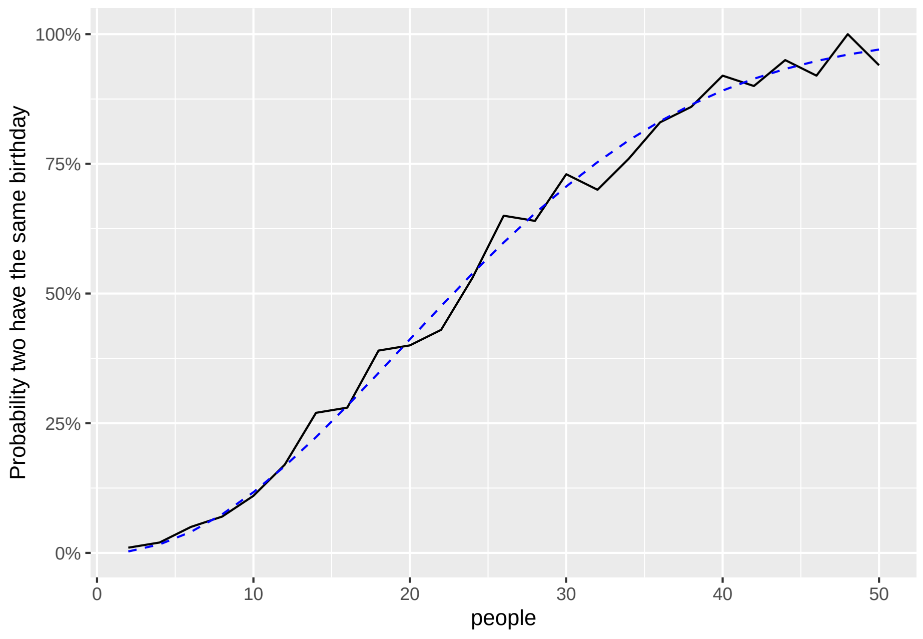
From David Robinson birthday paradox Rblogger at https://www.r-bloggers.com/the-birthday-paradox-puzzle-tidy-simulation-in-r/

```r
summarized <- crossing(people = seq(2, 50, 2),
                       trial = 1:100) %>%
  mutate(birthday = map(people, ~ sample(365, .x, replace = TRUE)),
         multiple = map_lgl(birthday, ~ any(duplicated(.x)))) %>%
  group_by(people) %>%
  summarize(chance = mean(multiple))

ggplot(summarized, aes(people, chance)) +
  geom_line() +
  scale_y_continuous(labels = scales::percent_format()) +
  labs(y = "Probability two have the same birthday")
```



```
# Checking the work with pbirthday function
summarized %>%
  mutate(exact = map_dbl(people, pbirthday)) %>%
  ggplot(aes(people, chance)) +
  geom_line() +
  geom_line(aes(y = exact), lty = 2, color = "blue") +
  scale_y_continuous(labels = scales::percent_format()) +
  labs(y = "Probability two have the same birthday")
```


Probability two have the same birthday
100%
75%
50%
25%
0%
0
10
20
30
40
50
people

Chapter 6

By Any Other Name

This deceptively simple-seeming idea gets complex quickly. The following YouTube was a nice description of the process: https://www.youtube.com/watch?v=Okc0IL5uTnA

```
my.data <- data.frame(colOne=1:3, column2=4:6, column_3=7:9)
rownames(my.data) <- c("ant", "bee", "cat")
names(my.data)
```

```
## [1] "colOne"   "column2"  "column_3"
```

```
colnames(my.data)
```

```
## [1] "colOne"   "column2"  "column_3"
```

```
#make some changes
names(my.data) <- c("col_1", "col_2", "col_3")
my.data
```

```
##     col_1 col_2 col_3
## ant     1     4     7
## bee     2     5     8
## cat     3     6     9
```

```
names(my.data)[3] <- "col.3"
my.data
```

```
##     col_1 col_2 col.3
## ant     1     4     7
## bee     2     5     8
## cat     3     6     9
```

```
names(my.data)[names(my.data)=="col_2"]
```

```
## [1] "col_2"
```

```
my.data["col_2"]
```

```
##     col_2
## ant     4
## bee     5
## cat     6
```

```
my.data$col_2
```

```
## [1] 4 5 6
```

```
my.data[,2]
```

```
## [1] 4 5 6
```

```
names(my.data)[names(my.data)=="col_2"] <- "col.2"
my.data
```

```
##     col_1 col.2 col.3
## ant     1     4     7
## bee     2     5     8
## cat     3     6     9
```

```
names(my.data) <- gsub("_", ".", names(my.data))
my.data
```

```
##     col.1 col.2 col.3
## ant     1     4     7
## bee     2     5     8
## cat     3     6     9
```

```
rownames(my.data)
```

```
## [1] "ant" "bee" "cat"
```

```
my.data$species <- rownames(my.data)
my.data
```

```
##     col.1 col.2 col.3 species
## ant     1     4     7     ant
## bee     2     5     8     bee
## cat     3     6     9     cat
```

```
rownames(my.data) <- NULL
my.data
```

```
##   col.1 col.2 col.3 species
## 1     1     4     7     ant
## 2     2     5     8     bee
## 3     3     6     9     cat
```

```
colnames(my.data) <- c("good", "better", "best", "species")
my.data
```

```
##   good better best species
## 1    1      4    7     ant
## 2    2      5    8     bee
## 3    3      6    9     cat
```

```
keep <- 2:ncol(my.data)
my.data[,keep]
```

```
##   better best species
## 1      4    7     ant
## 2      5    8     bee
## 3      6    9     cat
```

Chapter 7

Correlation Plots

```
head(iris)
```

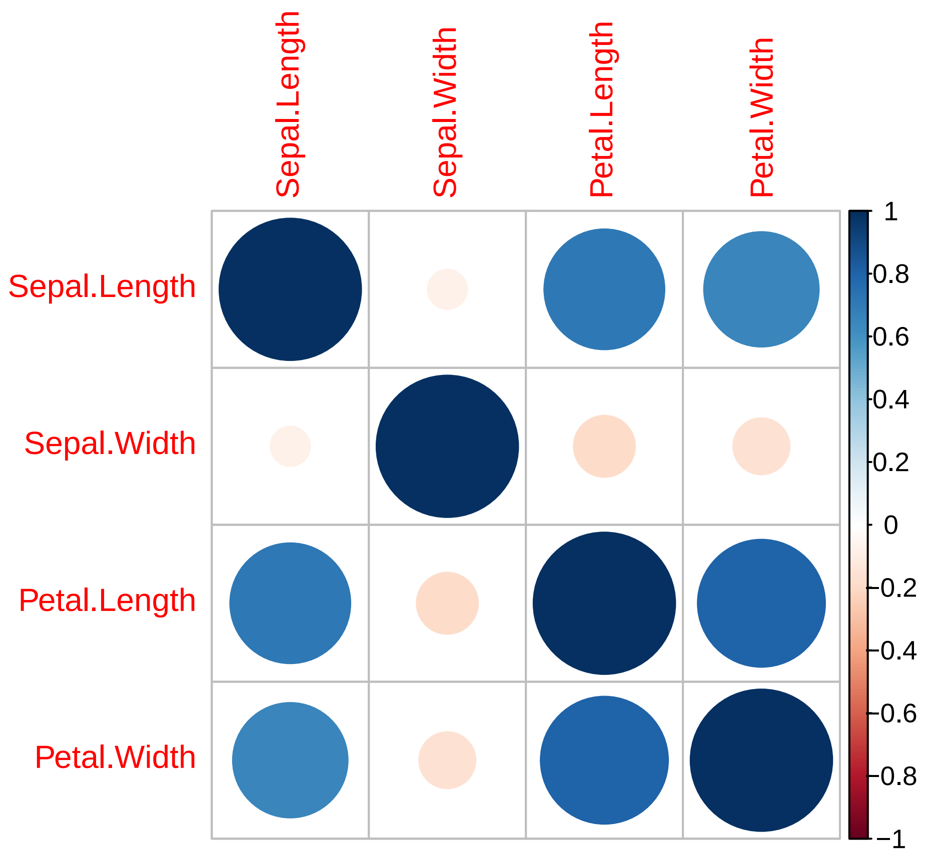
```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1          5.1         3.5          1.4         0.2  setosa
## 2          4.9         3.0          1.4         0.2  setosa
## 3          4.7         3.2          1.3         0.2  setosa
## 4          4.6         3.1          1.5         0.2  setosa
## 5          5.0         3.6          1.4         0.2  setosa
## 6          5.4         3.9          1.7         0.4  setosa
```

```
iris %>% select(-Species) %>% cor()
```

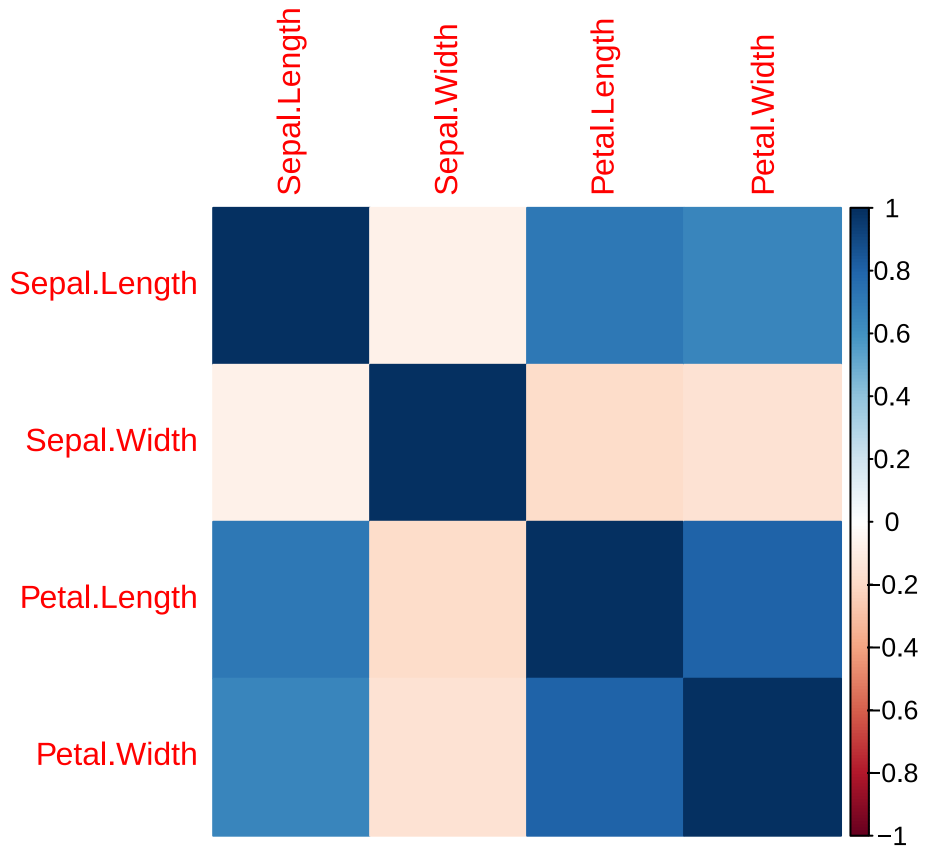
```
##              Sepal.Length Sepal.Width Petal.Length Petal.Width
## Sepal.Length    1.0000000  -0.1175698    0.8717538   0.8179411
## Sepal.Width    -0.1175698   1.0000000   -0.4284401  -0.3661259
## Petal.Length    0.8717538  -0.4284401    1.0000000   0.9628654
## Petal.Width     0.8179411  -0.3661259    0.9628654   1.0000000
```

```
M <- iris %>% select(-Species) %>% cor(method = "kendall")
```

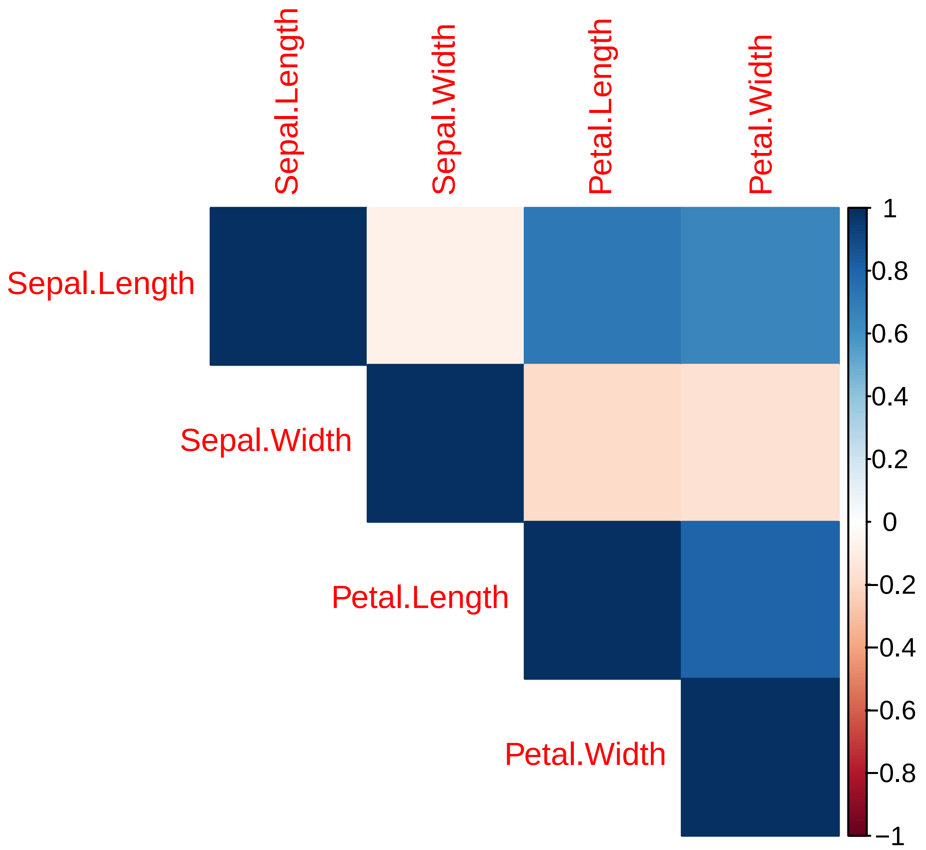
```
corrplot::corrplot(M)
```



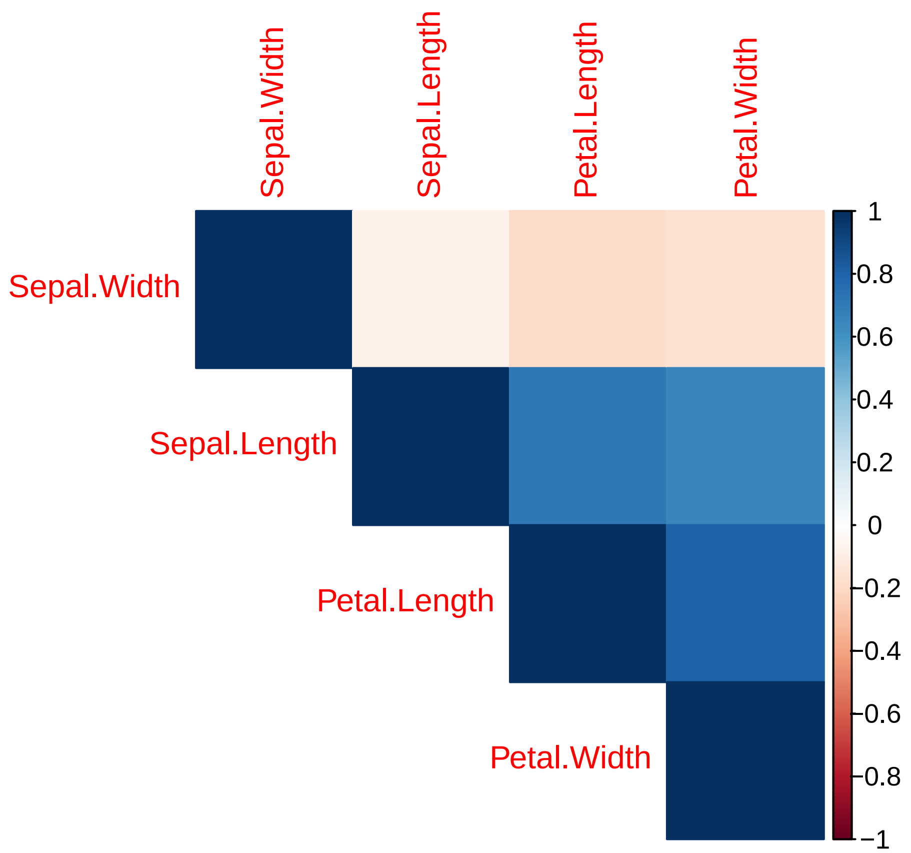
```r
corrplot::corrplot(M, method = "color")
```



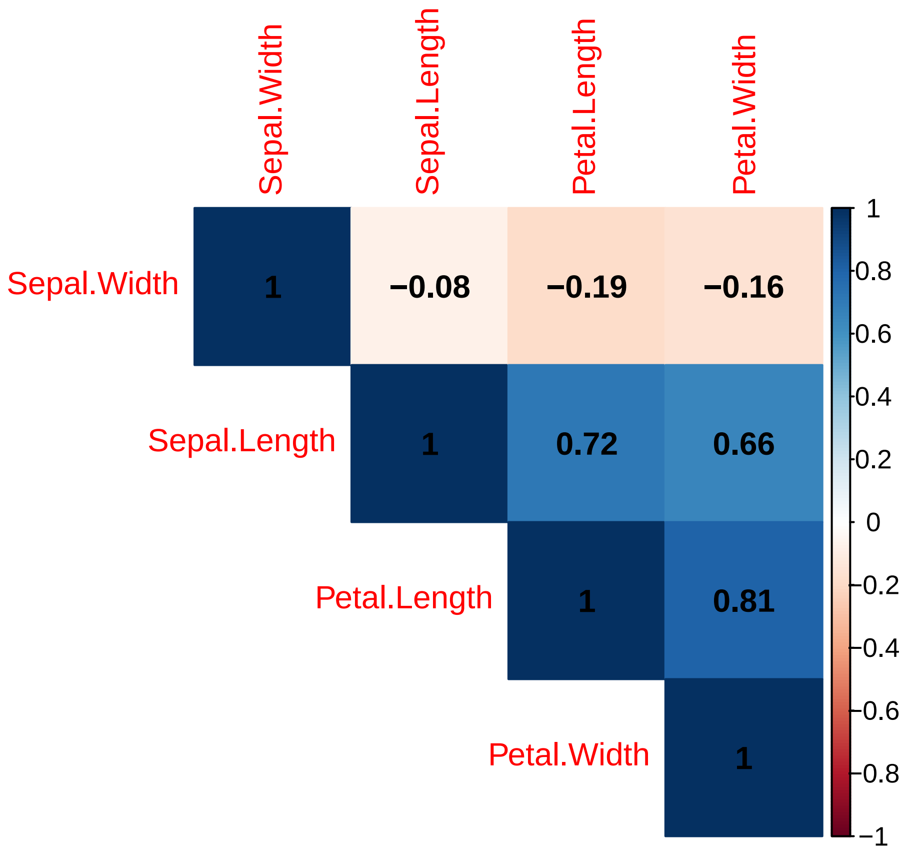
```r
corrplot::corrplot(M, method = "color", type = "upper")
```



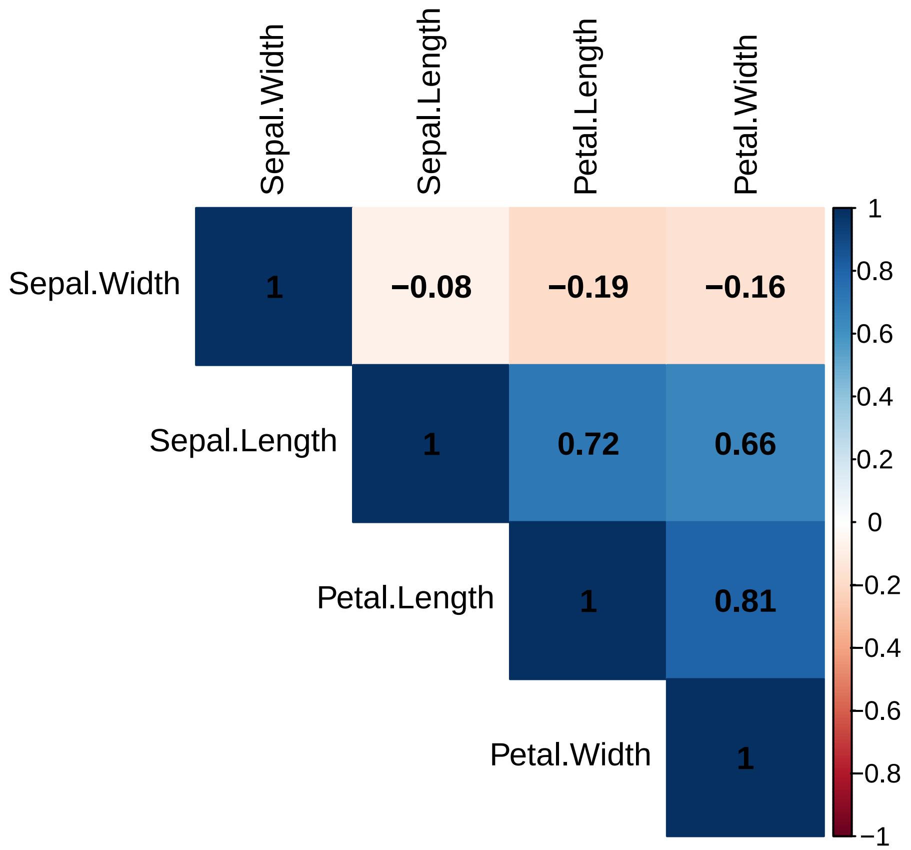
```r
corrplot::corrplot(M, method = "color", type = "upper", order = "hclust")
```



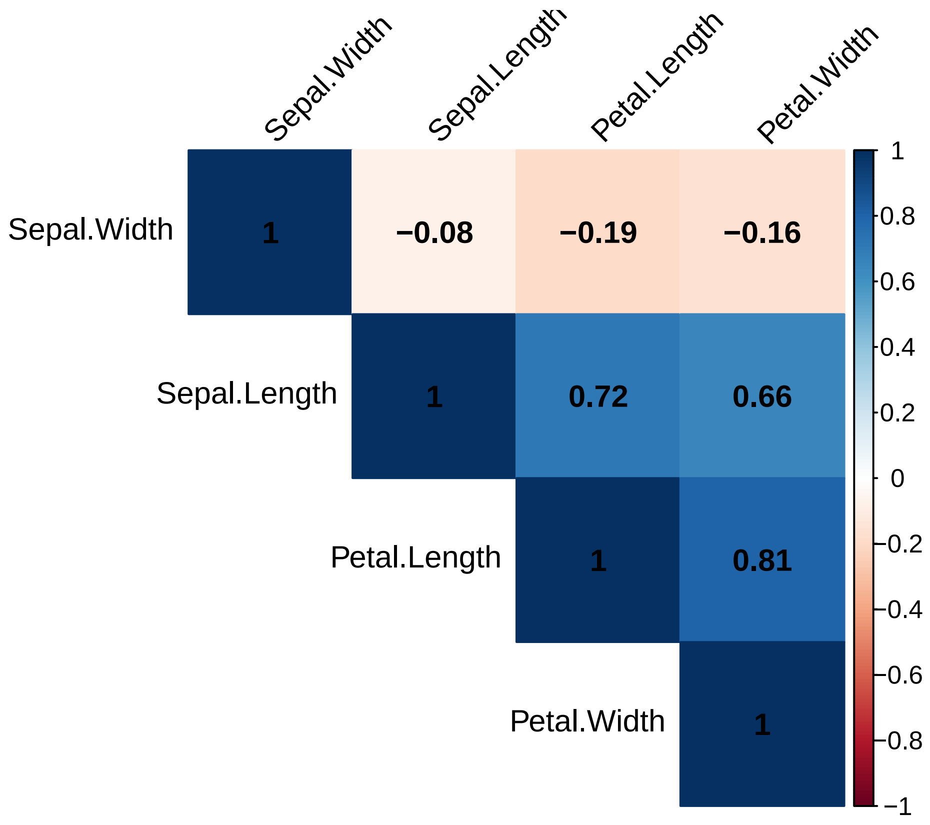
```
corrplot::corrplot(M, method = "color", type = "upper", order = "hclust", addCoef.col = "black")
```



```
corrplot::corrplot(M, method = "color", type = "upper", order = "hclust", addCoef.col =
```



```
corrplot::corrplot(M, method = "color", type = "upper", order = "hclust", addCoef.col = "black",
```


Sepal.Width
Sepal.Length
Petal.Length
Petal.Width
Sepal.Width
Sepal.Length
Petal.Length
Petal.Width
1
−0.08
−0.19
−0.16
1
0.72
0.66
1
0.81
1
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

Chapter 8

if_else() and case_when(): Comparison

8.1 case_when()

case_when() from https://www.rdocumentation.org/packages/dplyr/versions/0.7.8/topics/case_when

```
x <- 1:50
y <- 51:100

df <- data.frame(x,y)
df
```

```
##     x   y
## 1   1  51
## 2   2  52
## 3   3  53
## 4   4  54
## 5   5  55
## 6   6  56
## 7   7  57
## 8   8  58
## 9   9  59
## 10 10  60
## 11 11  61
## 12 12  62
## 13 13  63
## 14 14  64
## 15 15  65
## 16 16  66
## 17 17  67
## 18 18  68
## 19 19  69
## 20 20  70
## 21 21  71
## 22 22  72
## 23 23  73
## 24 24  74
## 25 25  75
## 26 26  76
## 27 27  77
## 28 28  78
## 29 29  79
## 30 30  80
## 31 31  81
## 32 32  82
## 33 33  83
## 34 34  84
## 35 35  85
## 36 36  86
## 37 37  87
## 38 38  88
## 39 39  89
## 40 40  90
## 41 41  91
## 42 42  92
## 43 43  93
## 44 44  94
## 45 45  95
## 46 46  96
## 47 47  97
## 48 48  98
## 49 49  99
## 50 50 100
```

```
case_when(
  x %% 35 == 0 ~ "fizz buzz",
  x %% 5 == 0 ~ "fizz",
  x %% 7 == 0 ~ "buzz",
  TRUE ~ as.character(x)
)
```

```
##  [1] "1"         "2"         "3"         "4"         "fizz"      "6"
##  [7] "buzz"      "8"         "9"         "fizz"      "11"        "12"
## [13] "13"        "buzz"      "fizz"      "16"        "17"        "18"
## [19] "19"        "fizz"      "buzz"      "22"        "23"        "24"
## [25] "fizz"      "26"        "27"        "buzz"      "29"        "fizz"
## [31] "31"        "32"        "33"        "34"        "fizz buzz" "36"
## [37] "37"        "38"        "39"        "fizz"      "41"        "buzz"
## [43] "43"        "44"        "fizz"      "46"        "47"        "48"
## [49] "buzz"      "fizz"
```

8.2 Compare this with if_else()

```
if_else(x %% 2 == 0, "even", "odd")
```

```
##  [1] "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even"
## [11] "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even"
## [21] "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even"
## [31] "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even"
## [41] "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even" "odd"  "even"
```

Chapter 9

Subsetting

From https://www.r-bloggers.com/5-ways-to-subset-a-data-frame-in-r/

Note: since this is down for maintenance, I will turn off evaluation on these chunks:

```
education <- read.csv("https://vincentarelbundock.github.io/Rdatasets/csv/robustbase/education.cs

colnames(education) <- c("X","State","Region","Urban.Population","Per.Capita.Income","Minor.Popul

glimpse(education)
```

```
## Rows: 50
## Columns: 7
## $ X                      <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 1...
## $ State                  <chr> "ME", "NH", "VT", "MA", "RI", "CT", "NY", "N...
## $ Region                 <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2,...
## $ Urban.Population       <int> 508, 564, 322, 846, 871, 774, 856, 889, 715,...
## $ Per.Capita.Income      <int> 3944, 4578, 4011, 5233, 4780, 5889, 5663, 57...
## $ Minor.Population       <int> 325, 323, 328, 305, 303, 307, 301, 310, 300,...
## $ Education.Expenditures <int> 235, 231, 270, 261, 300, 317, 387, 285, 300,...
```

9.1 Subsetting using brackets

```
education[c(10:21),c(2,6:7)]
```

```
##    State Minor.Population Education.Expenditures
## 10    OH              324                    221
## 11    IN              329                    264
## 12    IL              320                    308
## 13    MI               337                    379
## 14    WI               328                    342
## 15    MN               330                    378
## 16    IA               318                    232
## 17    MO               309                    231
## 18    ND               333                    246
## 19    SD               330                    230
## 20    NB               318                    268
## 21    KS               304                    337
```

9.2 Subset using brackets by omitting the rows and columns we don't want

```
education[-c(1:9,22:50),-c(1,3:5)]
```

```
##    State Minor.Population Education.Expenditures
## 10    OH              324                    221
## 11    IN              329                    264
## 12    IL              320                    308
## 13    MI              337                    379
## 14    WI              328                    342
## 15    MN              330                    378
## 16    IA              318                    232
## 17    MO              309                    231
## 18    ND              333                    246
## 19    SD              330                    230
## 20    NB              318                    268
## 21    KS              304                    337
```

9.3 Subset using brackets in combination with the which() function and the %in% operator

```
education[which(education$Region == 2),names(education) %in% c("State","Minor.Populati
```

```
##    State Minor.Population Education.Expenditures
## 10    OH              324                    221
## 11    IN              329                    264
## 12    IL              320                    308
## 13    MI              337                    379
## 14    WI              328                    342
## 15    MN              330                    378
## 16    IA              318                      232
## 17    MO              309                      231
## 18    ND              333                      246
## 19    SD              330                      230
## 20    NB              318                      268
## 21    KS              304                      337
```

9.4 Subset using the subset() function

```
subset(education, Region == 2, select = c("State","Minor.Population","Education.Expenditures"))
```

```
##    State Minor.Population Education.Expenditures
## 10    OH              324                      221
## 11    IN              329                      264
## 12    IL              320                      308
## 13    MI              337                      379
## 14    WI              328                      342
## 15    MN              330                      378
## 16    IA              318                      232
## 17    MO              309                      231
## 18    ND              333                      246
## 19    SD              330                      230
## 20    NB              318                      268
## 21    KS              304                      337
```

9.5 Subset using dyplyr's filter() and select()

```
select(filter(education, Region == 2),c(State,Minor.Population:Education.Expenditures))
```

```
##    State Minor.Population Education.Expenditures
## 1     OH              324                      221
## 2     IN              329                      264
## 3     IL              320                      308
## 4     MI              337                      379
## 5     WI              328                      342
## 6     MN              330                      378
## 7     IA              318                      232
## 8     MO              309                      231
## 9     ND              333                      246
## 10    SD              330                      230
## 11    NB              318                      268
## 12    KS              304                      337
```

Bibliography

Stevens, T. M. and Parekh, V. (2016). Mammary analogue secretory carcinoma. *Arch Pathol Lab Med.*, 140(9):997–1001. doi: 10.5858/arpa.2015–0075–RS.

Xie, Y. (2020). *bookdown: Authoring Books and Technical Documents with R Markdown.* R package version 0.18.