王俞揚

2024-09-17

Table of contents

Statistical Thinking

Reference: https://www.fharrell.com/post/rflow/

install required packages

```
if (!require("palmerpenguins", character.only = TRUE))
    install.packages("palmerpenguins")
```

```
Loading required package: palmerpenguins
```

```
    library("palmerpenguins", character.only = TRUE)
if (!require("quarto", character.only = TRUE))
    install.packages("quarto")
```

```
Loading required package: quarto
```

```
    library("quarto", character.only = TRUE)
if (!require("Hmisc", character.only = TRUE))
    install.packages("Hmisc")
```

```
Loading required package: Hmisc


Attaching package: 'Hmisc'

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

    format.pval, units
```

```
if (!require("table1", character.only = TRUE))
    install.packages("table1")
```

```
Loading required package: table1


Attaching package: 'table1'

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

    label, label<-, units

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

    units, units<-
```

```
if (!require("DataExplorer", character.only = TRUE))
    install.packages("DataExplorer")
```

```
Loading required package: DataExplorer
```

```
#penguins_raw
```

Summary Staistic

```
library(Hmisc)
latex(describe(penguins_raw), file = "", caption.placement = "top")
```

penguins_raw
17 Variables 344 Observations

---

studyName

n	missing	distinct
344	0	3

Value	PAL0708	PAL0809	PAL0910
Frequency	110	114	120
Proportion	0.320	0.331	0.349

Sample Number

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
344	0	152	1	63.15	46.35	6.15	12.00	29.00	58.00	95.25	121.00	134.85

lowest : 1 2 3 4 5, highest: 148 149 150 151 152

Species

n	missing	distinct
344	0	3

Value	Adelie Penguin (Pygoscelis adeliae)	Chinstrap penguin (Pygoscelis antarctica)
Frequency	152	68
Proportion	0.442	0.198

Value	Gentoo penguin (Pygoscelis papua)
Frequency	124
Proportion	0.360

Region

n	missing	distinct	value
344	0	1	Anvers

Value	Anvers
Frequency	344
Proportion	1

Island

n	missing	distinct
344	0	3

Value	Biscoe	Dream	Torgersen
Frequency	168	124	52
Proportion	0.488	0.360	0.151

Stage

n	missing	distinct	value
344	0	1	Adult, 1 Egg Stage

Value	Adult, 1 Egg Stage
Frequency	344
Proportion	1

Individual ID

n	missing	distinct
344	0	190

lowest : N100A1 N100A2 N10A1 N10A2 N11A1 , highest: N98A2 N99A1 N99A2 N9A1 N9A2

Clutch Completion

n	missing	distinct
344	0	2

Value	No	Yes
Frequency	36	308
Proportion	0.105	0.895

Date Egg

n	missing	distinct	Info	Mean	Gmd	.05	.10
344	0	50	0.999	2008-11-27	328	2007-11-12	2007-11-16

.25	.50	.75	.90	.95
2007-11-28	2008-11-09	2009-11-16	2009-11-22	2009-11-26

lowest : 2007-11-09 2007-11-10 2007-11-11 2007-11-12 2007-11-13
highest: 2009-11-22 2009-11-23 2009-11-25 2009-11-27 2009-12-01

Culmen Length (mm)

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	164	1	43.92	6.274	35.70	36.60	39.23	44.45	48.50	50.80	51.99

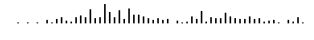
lowest : 32.1 33.1 33.5 34 34.1, highest: 55.1 55.8 55.9 58 59.6

Culmen Depth (mm)

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	80	1	17.15	2.267	13.9	14.3	15.6	17.3	18.7	19.5	20.0

```
lowest : 13.1 13.2 13.3 13.4 13.5, highest: 20.7 20.8 21.1 21.2 21.5
```

Flipper Length (mm)



n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	55	0.999	200.9	16.03	181.0	185.0	190.0	197.0	213.0	220.9	225.0

```
lowest : 172 174 176 178 179, highest: 226 228 229 230 231
```

Body Mass (g)

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	94	1	4202	911.8	3150	3300	3550	4050	4750	5400	5650

```
lowest : 2700 2850 2900 2925 2975, highest: 5850 5950 6000 6050 6300
```

Sex

n	missing	distinct
333	11	2

Value	FEMALE	MALE
Frequency	165	168
Proportion	0.495	0.505

Δ 15 N (o/oo):

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
330	14	330	1	8.733	0.6323	7.897	8.047	8.300	8.652	9.172	9.491	9.689

```
lowest : 7.6322  7.63452 7.63884 7.68528 7.6887 , highest: 9.93727 9.98044 10.0202 10.0237 10.0254
```

Δ 13 C (o/oo):

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
331	13	331	1	-25.69	0.9093	-26.79	-26.69	-26.32	-25.83	-25.06	-24.53	-24.36

```
lowest : -27.0185 -26.9547 -26.8964 -26.8648 -26.8635, highest: -24.1657 -24.1026 -23.9031 -23.8902 -23.7877
```

Comments

n	missing	distinct
54	290	10

```
lowest : Adult not sampled.                                    Adult not sampled. Nest never observed with ful
highest: No blood sample obtained.                             No delta15N data received from lab.
```

中文

Table 1

```
library(table1)
str(penguins_raw)
```

```
tibble [344 x 17] (S3: tbl_df/tbl/data.frame)
 $ studyName          : chr [1:344] "PAL0708" "PAL0708" "PAL0708" "PAL0708" ...
 $ Sample Number      : num [1:344] 1 2 3 4 5 6 7 8 9 10 ...
 $ Species            : chr [1:344] "Adelie Penguin (Pygoscelis adeliae)" "Adelie Penguin (Py
 $ Region             : chr [1:344] "Anvers" "Anvers" "Anvers" "Anvers" ...
 $ Island             : chr [1:344] "Torgersen" "Torgersen" "Torgersen" "Torgersen" ...
 $ Stage              : chr [1:344] "Adult, 1 Egg Stage" "Adult, 1 Egg Stage" "Adult, 1 Egg S
 $ Individual ID      : chr [1:344] "N1A1" "N1A2" "N2A1" "N2A2" ...
 $ Clutch Completion  : chr [1:344] "Yes" "Yes" "Yes" "Yes" ...
 $ Date Egg           : Date[1:344], format: "2007-11-11" "2007-11-11" ...
 $ Culmen Length (mm) : num [1:344] 39.1 39.5 40.3 NA 36.7 39.3 38.9 39.2 34.1 42 ...
 $ Culmen Depth (mm)  : num [1:344] 18.7 17.4 18 NA 19.3 20.6 17.8 19.6 18.1 20.2 ...
 $ Flipper Length (mm): num [1:344] 181 186 195 NA 193 190 181 195 193 190 ...
 $ Body Mass (g)      : num [1:344] 3750 3800 3250 NA 3450 ...
 $ Sex                : chr [1:344] "MALE" "FEMALE" "FEMALE" NA ...
 $ Delta 15 N (o/oo)  : num [1:344] NA 8.95 8.37 NA 8.77 ...
 $ Delta 13 C (o/oo)  : num [1:344] NA -24.7 -25.3 NA -25.3 ...
 $ Comments           : chr [1:344] "Not enough blood for isotopes." NA NA "Adult not sampled
 - attr(*, "spec")=List of 3
  ..$ cols   :List of 17
  .. ..$ studyName          : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Sample Number      : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Species            : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Region             : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Island             : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Stage              : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Individual ID      : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Clutch Completion  : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
```

```
  .. ..$ Date Egg           :List of 1
  .. .. ..$ format: chr ""
  .. .. ..- attr(*, "class")= chr [1:2] "collector_date" "collector"
  .. ..$ Culmen Length (mm) : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Culmen Depth (mm)  : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Flipper Length (mm): list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Body Mass (g)      : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Sex                : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  .. ..$ Delta 15 N (o/oo)  : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Delta 13 C (o/oo)  : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ Comments           : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
  ..$ default: list()
  .. ..- attr(*, "class")= chr [1:2] "collector_guess" "collector"
  ..$ skip   : num 1
  ..- attr(*, "class")= chr "col_spec"
```

```
names(penguins_raw) <- make.names(names(penguins_raw)) #       "."
Mypenguins_raw <- penguins_raw
Mypenguins_raw$Sex <- as.factor(Mypenguins_raw$Sex)
str(Mypenguins_raw)
```

```
tibble [344 x 17] (S3: tbl_df/tbl/data.frame)
 $ studyName          : chr [1:344] "PAL0708" "PAL0708" "PAL0708" "PAL0708" ...
 $ Sample.Number      : num [1:344] 1 2 3 4 5 6 7 8 9 10 ...
 $ Species            : chr [1:344] "Adelie Penguin (Pygoscelis adeliae)" "Adelie Penguin (Py
 $ Region             : chr [1:344] "Anvers" "Anvers" "Anvers" "Anvers" ...
 $ Island             : chr [1:344] "Torgersen" "Torgersen" "Torgersen" "Torgersen" ...
 $ Stage              : chr [1:344] "Adult, 1 Egg Stage" "Adult, 1 Egg Stage" "Adult, 1 Egg S
 $ Individual.ID      : chr [1:344] "N1A1" "N1A2" "N2A1" "N2A2" ...
 $ Clutch.Completion  : chr [1:344] "Yes" "Yes" "Yes" "Yes" ...
 $ Date.Egg           : Date[1:344], format: "2007-11-11" "2007-11-11" ...
 $ Culmen.Length..mm. : num [1:344] 39.1 39.5 40.3 NA 36.7 39.3 38.9 39.2 34.1 42 ...
 $ Culmen.Depth..mm.  : num [1:344] 18.7 17.4 18 NA 19.3 20.6 17.8 19.6 18.1 20.2 ...
 $ Flipper.Length..mm.: num [1:344] 181 186 195 NA 193 190 181 195 193 190 ...
```

```
$ Body.Mass..g.      : num [1:344] 3750 3800 3250 NA 3450 ...
$ Sex                : Factor w/ 2 levels "FEMALE","MALE": 2 1 1 NA 1 2 1 2 NA NA ...
$ Delta.15.N..o.oo.  : num [1:344] NA 8.95 8.37 NA 8.77 ...
$ Delta.13.C..o.oo.  : num [1:344] NA -24.7 -25.3 NA -25.3 ...
$ Comments           : chr [1:344] "Not enough blood for isotopes." NA NA "Adult not sample
- attr(*, "spec")=List of 3
 ..$ cols   :List of 17
 .. ..$ studyName          : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Sample Number      : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Species            : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Region             : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Island             : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Stage              : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Individual ID      : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Clutch Completion  : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Date Egg           :List of 1
 .. .. ..$ format: chr ""
 .. .. ..- attr(*, "class")= chr [1:2] "collector_date" "collector"
 .. ..$ Culmen Length (mm) : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Culmen Depth (mm)  : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Flipper Length (mm): list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Body Mass (g)      : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Sex                : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 .. ..$ Delta 15 N (o/oo)  : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Delta 13 C (o/oo)  : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
 .. ..$ Comments           : list()
 .. .. ..- attr(*, "class")= chr [1:2] "collector_character" "collector"
 ..$ default: list()
```

```
  .. ..- attr(*, "class")= chr [1:2] "collector_guess" "collector"
  ..$ skip   : num 1
  ..- attr(*, "class")= chr "col_spec"
```

```
table1(~ Culmen.Length..mm.+Culmen.Depth..mm.+Flipper.Length..mm.+Body.Mass..g.| Species, da
```

	Adelie Penguin (Pygoscelis adeliae)	Chinstrap penguin (Pygoscelis antarctica)	Gentoo penguin (Pygoscelis papua)	Overall
	(N=152)	(N=68)	(N=124)	(N=344)
Culmen.Length..mm.				
Mean (SD)	38.8 (2.66)	48.8 (3.34)	47.5 (3.08)	43.9 (5.46)
Median [Min, Max]	38.8 [32.1, 46.0]	49.6 [40.9, 58.0]	47.3 [40.9, 59.6]	44.5 [32.1, 59.6]
Missing	1 (0.7%)	0 (0%)	1 (0.8%)	2 (0.6%)
Culmen.Depth..mm.				
Mean (SD)	18.3 (1.22)	18.4 (1.14)	15.0 (0.981)	17.2 (1.97)
Median [Min, Max]	18.4 [15.5, 21.5]	18.5 [16.4, 20.8]	15.0 [13.1, 17.3]	17.3 [13.1, 21.5]
Missing	1 (0.7%)	0 (0%)	1 (0.8%)	2 (0.6%)
Flipper.Length..mm.				
Mean (SD)	190 (6.54)	196 (7.13)	217 (6.48)	201 (14.1)
Median [Min, Max]	190 [172, 210]	196 [178, 212]	216 [203, 231]	197 [172, 231]
Missing	1 (0.7%)	0 (0%)	1 (0.8%)	2 (0.6%)
Body.Mass..g.				
Mean (SD)	3700 (459)	3730 (384)	5080 (504)	4200 (802)
Median [Min, Max]	3700 [2850, 4780]	3700 [2700, 4800]	5000 [3950, 6300]	4050 [2700, 6300]
Missing	1 (0.7%)	0 (0%)	1 (0.8%)	2 (0.6%)

```
# help(table1)
```

Missing Values

```
library(Hmisc)
library(DataExplorer)
latex(describe(Mypenguins_raw), file = "", caption.placement = "top")
```

Mypenguins_raw
17 Variables 344 Observations

---

studyName

n	missing	distinct
344	0	3

Value	PAL0708	PAL0809	PAL0910
Frequency	110	114	120
Proportion	0.320	0.331	0.349

Sample.Number

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
344	0	152	1	63.15	46.35	6.15	12.00	29.00	58.00	95.25	121.00	134.85

lowest : 1 2 3 4 5, highest: 148 149 150 151 152

Species

n	missing	distinct
344	0	3

Value	Adelie Penguin (Pygoscelis adeliae)	Chinstrap penguin (Pygoscelis antarctica)	Gentoo penguin (Pygoscelis papua)
Frequency	152	68	124
Proportion	0.442	0.198	0.360

Region

n	missing	distinct	value
344	0	1	Anvers

Value	Anvers
Frequency	344
Proportion	1

Island

n	missing	distinct
344	0	3

Value	Biscoe	Dream	Torgersen
Frequency	168	124	52
Proportion	0.488	0.360	0.151

Stage

n	missing	distinct	value
344	0	1	Adult, 1 Egg Stage

Value	Adult, 1 Egg Stage
Frequency	344
Proportion	1

Individual.ID

n	missing	distinct
344	0	190

lowest : N100A1 N100A2 N10A1 N10A2 N11A1 , highest: N98A2 N99A1 N99A2 N9A1 N9A2

Clutch.Completion

n	missing	distinct
344	0	2

Value	No	Yes
Frequency	36	308
Proportion	0.105	0.895

Date.Egg

n	missing	distinct	Info	Mean	Gmd	.05	.10
344	0	50	0.999	2008-11-27	328	2007-11-12	2007-11-16

.25	.50	.75	.90	.95
2007-11-28	2008-11-09	2009-11-16	2009-11-22	2009-11-26

lowest : 2007-11-09 2007-11-10 2007-11-11 2007-11-12 2007-11-13
highest: 2009-11-22 2009-11-23 2009-11-25 2009-11-27 2009-12-01

Culmen.Length..mm.

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	164	1	43.92	6.274	35.70	36.60	39.23	44.45	48.50	50.80	51.99

lowest : 32.1 33.1 33.5 34 34.1, highest: 55.1 55.8 55.9 58 59.6

Culmen.Depth..mm.

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	80	1	17.15	2.267	13.9	14.3	15.6	17.3	18.7	19.5	20.0

```
lowest : 13.1 13.2 13.3 13.4 13.5, highest: 20.7 20.8 21.1 21.2 21.5
```

Flipper.Length..mm.

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	55	0.999	200.9	16.03	181.0	185.0	190.0	197.0	213.0	220.9	225.0

```
lowest : 172 174 176 178 179, highest: 226 228 229 230 231
```

Body.Mass..g.

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
342	2	94	1	4202	911.8	3150	3300	3550	4050	4750	5400	5650

```
lowest : 2700 2850 2900 2925 2975, highest: 5850 5950 6000 6050 6300
```

Sex

n	missing	distinct
333	11	2

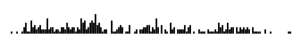
```
Value       FEMALE   MALE
Frequency      165    168
Proportion   0.495  0.505
```

Δ.15.N..o.oo.:

n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
330	14	330	1	8.733	0.6323	7.897	8.047	8.300	8.652	9.172	9.491	9.689

```
lowest : 7.6322  7.63452 7.63884 7.68528 7.6887 , highest: 9.93727 9.98044 10.0202 10.0237 10.0254
```

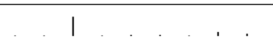
Δ.13.C..o.oo.:



n	missing	distinct	Info	Mean	Gmd	.05	.10	.25	.50	.75	.90	.95
331	13	331	1	-25.69	0.9093	-26.79	-26.69	-26.32	-25.83	-25.06	-24.53	-24.36

```
lowest : -27.0185 -26.9547 -26.8964 -26.8648 -26.8635, highest: -24.1657 -24.1026 -23.9031 -23.8902 -23.7877
```

Comments



n	missing	distinct
54	290	10

```
lowest : Adult not sampled.                                             Adult not sampled. Nest never observed with ful
highest: No blood sample obtained.                                      No delta15N data received from lab.
```

```
plot_missing(Mypenguins_raw)
```