Biostatistics & Epidemiological Data Analysis using R

3

Advanced tables & plots

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Learning objectives

Make

- Advanced tables
- Advanced plots

in R.

Tables

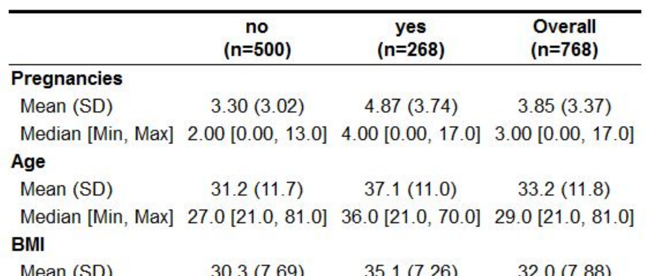
Table 1 with `table1::table1()`

Nice Table 1's can be easily generated using the `table1::table1()` function.

For example

```
table1::table1(~ Pregnancies + Age + BMI +
BloodPressure + Glucose | Diabetes, data =
Pima_diabetes)
```

yields:



	no (n=500)	yes (n=268)	Overall (n=768)
Pregnancies			
Mean (SD)	3.30 (3.02)	4.87 (3.74)	3.85 (3.37)
Median [Min, Max]	2.00 [0.00, 13.0]	4.00 [0.00, 17.0]	3.00 [0.00, 17.0]
Age			
Mean (SD)	31.2 (11.7)	37.1 (11.0)	33.2 (11.8)
Median [Min, Max]	27.0 [21.0, 81.0]	36.0 [21.0, 70.0]	29.0 [21.0, 81.0]
BMI			
Mean (SD)	30.3 (7.69)	35.1 (7.26)	32.0 (7.88)

Comparison of table1() and summary_table()

There also exist many other functions to create a Table 1, e.g. the qwraps2::summary_table() function.

Comparison

- table1::table1() only allows knitting to html.
- To make a table using table1::table1() is generally easier than using qwraps2::summary_table().
- Custom-specification (i.e. to include IQR instead of Min, Max) is easier in qwraps2::summary_table().

Table 1 with qwraps2::summary_table()

Overview

- The summary_table() function in the qwraps2 package is a user-friendly wrapper to generate tables with some customization possibilities.
- Vignette with many examples: https://cran.r-project.org/web/packages/qwraps2/vignettes/summary-statistics.html

Table 1 with qwraps2::summary_table()

Use in R Markdown

- In header of the R chunk, include `results = "asis"` - otherwise, the table with not be printed as a table but as the commands underlying the formatting of the table:

~~~
```{r, results = "asis"}
```
~~~

- In the R chunk, after loading the `qwraps2` package, generate the table in R Markdown format with

```
> options(qwraps2_markup = "markdown")
```

Table 1 with `qwraps2::summary_table()`

How to use the `summary_table()` function

1. Create a structured list, which captures for each variable in the table, which descriptive statistics should be calculated and printed in the table.
2. In the list, the function names for computing the descriptive statistics have to be provided. Using the available functions for frequencies, mean & SD, and median & IQR is the most convenient.
3. Use the `summary_table()` function with this list and the dataset of interest as arguments to compute the desired table.

Table 1 with qwraps2::summary_table()

Example 1

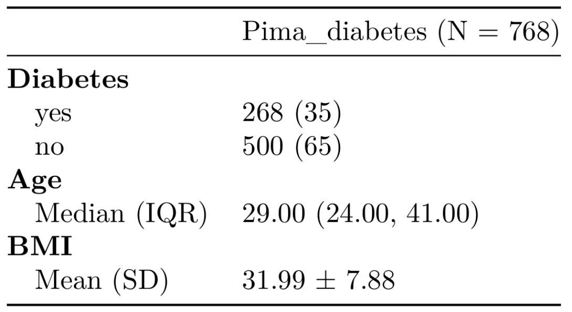
Preparation: Load Pima diabetes dataset ”Pima_diabetes” and transform Diabetes variable to factor with levels ”yes”, ”no”.

- `> library(qwraps2)`
- `> options(qwraps2_markup = "markdown")`
-
  ```
  > our_summary <-
  +  list("Diabetes" =
  +       list("yes" = ~ qwraps2::n_perc0(Diabetes == "yes"),
  +            "no" = ~ qwraps2::n_perc0(Diabetes == "no")),
  +       "Age" =
  +       list("Median (IQR)" = ~ median_iqr(Age)),
  +       "BMI" =
  +       list("Mean (SD)" = ~ qwraps2::mean_sd(BMI))
  +      )
  ```
- `> summary_table(Pima_diabetes, our_summary)`

Table 1 with `qwraps2::summary_table()`

Example 1

This produces the following table:



	Pima_diabetes (N = 768)
Diabetes	
yes	268 (35)
no	500 (65)
Age	
Median (IQR)	29.00 (24.00, 41.00)
BMI	
Mean (SD)	31.99 ± 7.88

See exercise 1 in `R_3b_exercises.Rmd` for more details and options.

Table 1 with qwraps2::summary_table()

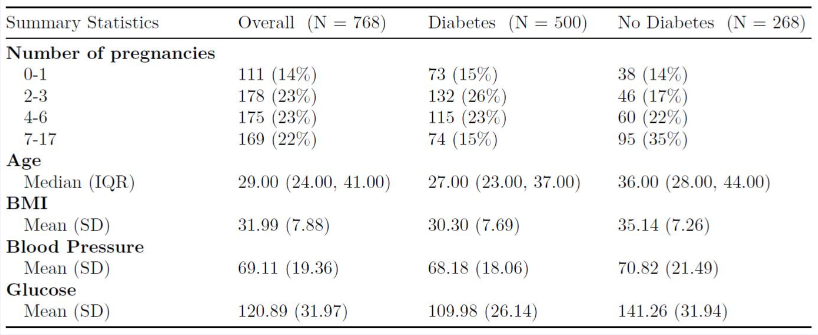
Stratified tables

- In order to stratify the descriptive statistics in a table by a variable groupvariable, use the dplyr::group_by() function:
- summary_table(dplyr::group_by(Pima_diabetes, groupvariable), our_summary)

Table 1 with `qwraps2::summary_table()`

Stratified tables

This allows to create tables such as:



Summary Statistics	Overall (N = 768)	Diabetes (N = 500)	No Diabetes (N = 268)
Number of pregnancies			
0-1	111 (14%)	73 (15%)	38 (14%)
2-3	178 (23%)	132 (26%)	46 (17%)
4-6	175 (23%)	115 (23%)	60 (22%)
7-17	169 (22%)	74 (15%)	95 (35%)
Age			
Median (IQR)	29.00 (24.00, 41.00)	27.00 (23.00, 37.00)	36.00 (28.00, 44.00)
BMI			
Mean (SD)	31.99 (7.88)	30.30 (7.69)	35.14 (7.26)
Blood Pressure			
Mean (SD)	69.11 (19.36)	68.18 (18.06)	70.82 (21.49)
Glucose			
Mean (SD)	120.89 (31.97)	109.98 (26.14)	141.26 (31.94)

Alternative packages to produce tables

- `arsenal::tableby()` function
- `xtables::xtable()` function
- Functions in `tableone` package
- many many others, e.g. also check out the functions in the `kableExtra` package

Exercise 2

Generate tables using the `summary_table()` function:

- Add descriptive statistics for the Insulin variable to the table generated in exercise 1.
- Generate a table including descriptive statistics of diabetes prevalence, age, BMI, blood pressure, glucose levels stratified by number of pregnancy quartiles.
- See exercise 2 in `R_3b_exercises.Rmd`.

Generate nice plots using ggplot2

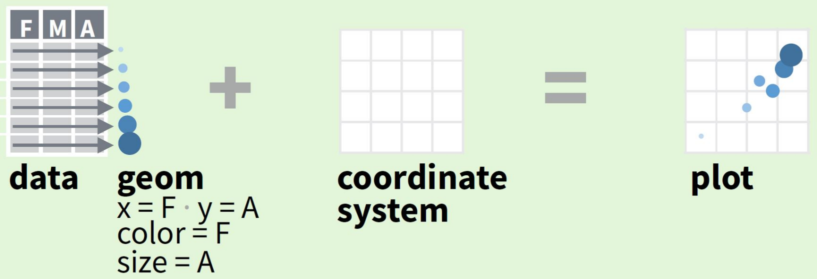
ggplot2 - Overview

- "The" package to produce nice graphics in R.
- Allows to generate many different plots and customize all aspects of the plot.
- Online reference: e.g. `https://ggplot2.tidyverse.org/reference/`.
- Book: `https://github.com/hadley/ggplot2-book`.
- Cheatsheets: `https://github.com/rstudio/cheatsheets/blob/master/data-visualization-2.1.pdf`

ggplot2 - Overview

Based on grammar of graphics: any graph can be built from

- a dataset
- a coordinate system
- and a visual representation of the data (in the coordinate system), i.e. a mapping of data to elements in the plot:

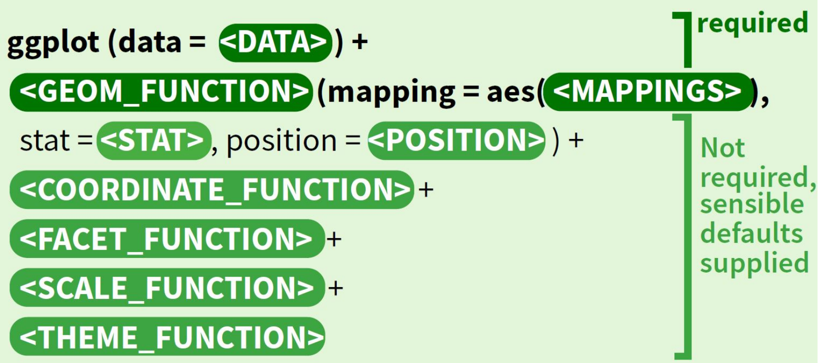


(from `https://github.com/rstudio/cheatsheets/blob/master/data-visualization-2.1.pdf`)

ggplot2 - Structure

- The basis of all plots in `ggplot2` is the `ggplot2::ggplot()` function, which initializes a `ggplot` object.
- In this initialization, the data, variables to be used in the plot and in all layers, and the mapping are specified.
- Then, different layers can be specified, which determine which type(s) of plot(s) will be generated, in which coordinate system, if they will be stratified, and how the axes/graphic elements and further settings should be fine-formatted.

ggplot2 - Components



ggplot (data = <DATA>) +
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
stat = <STAT>, position = <POSITION>) +
<COORDINATE_FUNCTION> +
<FACET_FUNCTION> +
<SCALE_FUNCTION> +
<THEME_FUNCTION>

required

Not required, sensible defaults supplied

(from `https://github.com/rstudio/cheatsheets/blob/master/data-visualization-2.1.pdf`)

ggplot2 - Components

- **Data**: dataset with variables of interest
- **Aesthetics**: x, y, colour, size, shape, ...
- **Geom(etrie)s**: point, line, bar, boxplot, ...
- **Facets**: stratification in panels in rows/columns
- **Statistics**: Transformation of variables: binning, descriptive ...
- **Coordinates**: Cartesian ...
- **Themes**: Fine-formatting

See examples in the following and exercise 3 in `R_3b_exercises.Rmd`.

ggplot2 - Examples

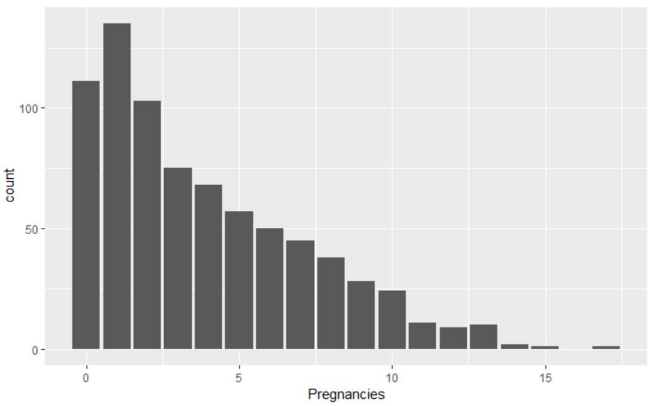
Bar plot

```
> library(ggplot2)

> ggplot(data = Pima_diabetes, mapping = aes(x =
+  Pregnancies)) + geom_bar()

> # in short:

> ggplot(Pima_diabetes, aes(Pregnancies)) + geom_bar()
```

ggplot2 - Examples

Bar plot

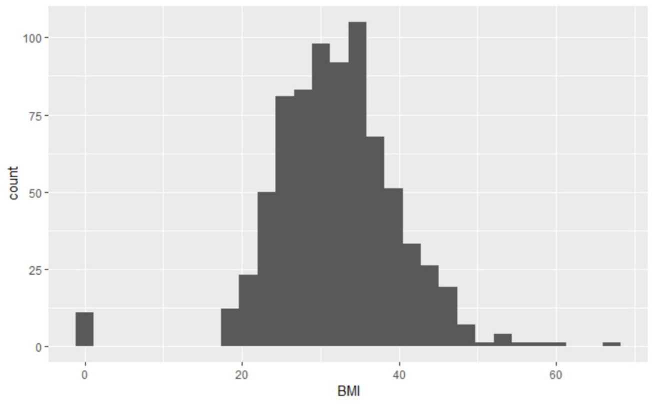
```
> ggplot(Pima_diabetes, aes(Pregnancies)) + geom_bar()
```



ggplot2 - Examples

Histogram

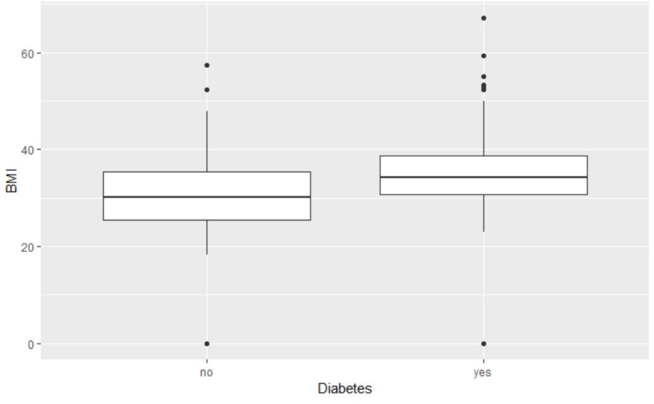
```
> ggplot(Pima_diabetes, aes(BMI)) + geom_histogram()
```



ggplot2 - Examples

Stratified boxplots

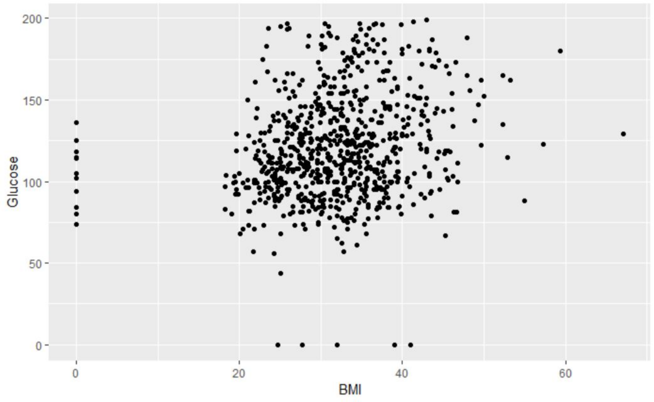
```
> ggplot(Pima_diabetes, aes(Diabetes, BMI)) +
+ geom_boxplot()
```



ggplot2 - Examples

Scatter plot

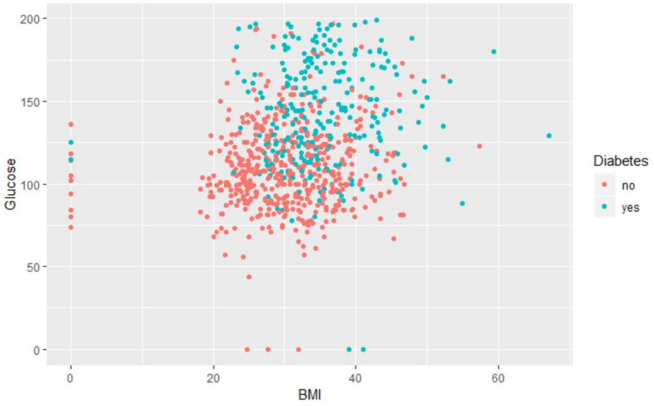
```
> ggplot(Pima_diabetes, aes(BMI, Glucose)) +
+ geom_point()
```



ggplot2 - Examples

Scatter plot using colours for third variable

```
> ggplot(Pima_diabetes, aes(BMI, Glucose, col =
+ Diabetes)) + geom_point()
```



Exercise 3b

- Produce a boxplot of BMI for each group of number of pregnancies.
- In the scatterplot of BMI and glucose levels, add a regression line which describes the linear association between the two variables.
- See exercise 3b in `R_3b_exercises.Rmd`.

Glimpse at the many more graphics options in R

- Use the patchwork package to stack ggplots: https://cran.r-project.org/web/packages/patchwork/vignettes/patchwork.html
- Check out the ggpubr package to generate publication ready plots: http://www.sthda.com/english/articles/24-ggpubr-publication-ready-plots/
- Create maps and visualize your geospatial data in maps using the leaflet package.
- Create interactive ggplot plots using the ggplotly() function in the plotly package.
- See examples in exercise 4 in R_3b_exercises.Rmd.

Questions?