# Introduction to R

## Data Processing

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# FIRST THINGS TO DO

> Don’t try to kiss your data on the first date; rather, you just want to get to know the data:

1. Import the data
2. Review the codebook
3. **Learn about the data**
4. Quick (visual) understanding of the data

# LEARN ABOUT THE DATA

## So what are the first things we want to know about our data?

- dimensions
- data types (i.e. character, integer, factor, etc.)
- missing values
- summary statistics

What are some functions to extract this information?

# LEARN ABOUT THE DATA

- So what are the first things we want to know about our data?
- dimensions: `dim()`, `ncol()`, `nrow()`, `names()`
- data types: `str()`, `class()`, `is.`, `as.`
- missing values: `is.na()`, `sum(is.na())`, `colSums(is.na())`
- summary statistics: `summary()`, `quantile()`, `var()`, `sd()`, `table()`

# Data Frames

## Example data:

```
install.packages("AmesHousing")
```

```
ames_data <- AmesHousing::make_ames()
```

```
typeof(ames_data)
```

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

```
head(names(ames_data))
```

```
## [1] "Lot_Area"     "Street"       "Alley"        "Lot_Shape"    "Land_Cont
```

## Transfer to `data.frame`

- Transfer data to a `data.frame`:

# Number of rows/columns

- Find out the number of rows/columns

```
nrow(ames_df) # rows
```

```
## [1] 2930
```

```
ncol(ames_df) # columns
```

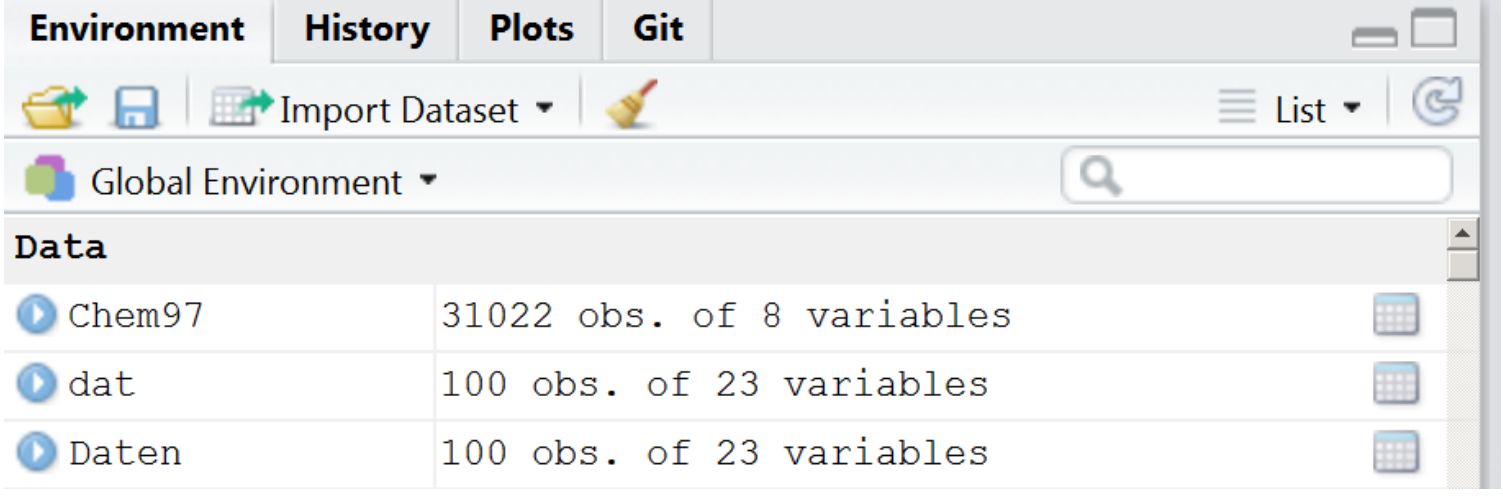
```
## [1] 81
```

# View the data

- See some lines:

```
head(ames_df) # first lines
tail(ames_df) # last lines
```

- Overview with Rstudio:



# Indexing

## Accessing Columns with the dollar sign

- The dollar sign can also be used to address individual columns

```
head(ames_df$Lot_Area)
```

```
## [1] 31770 11622 14267 11160 13830  9978
```

```
ames_df$Lot_Area[1:6]
```

```
## [1] 31770 11622 14267 11160 13830  9978
```

## Accessing Columns with the number or the name

```
head(ames_df[,5])
head(ames_df[,"Street"]) # the same result
```

# Subsetting dataset

```
Street <- ames_df$Street
table(Street)
```

```
## Street
## Grvl Pave
##   12 2918
```

```
ames_df[Street=="Grvl",]
# same result:
ames_df[Street!="Pave",]
```

# Logical operations in indexing

```
head(ames_df[ames_df$Lot_Area>9000,1:4])
```

```
##                            MS_SubClass                 MS_Zoning Lot_Frontag
## 1 One_Story_1946_and_Newer_All_Styles  Residential_Low_Density          14
## 2 One_Story_1946_and_Newer_All_Styles Residential_High_Density           8
## 3 One_Story_1946_and_Newer_All_Styles  Residential_Low_Density           8
## 4 One_Story_1946_and_Newer_All_Styles  Residential_Low_Density           9
## 5            Two_Story_1946_and_Newer  Residential_Low_Density           7
## 6            Two_Story_1946_and_Newer  Residential_Low_Density           7
```

# Exercise: Vectors and Indexing

Assume that we have registered the height and weight for four people: Heights in cm are 180, 165, 160, 193; weights in kg are 87, 58, 65, 100. Make two vectors, height and weight, with the data. The bodymass index (BMI) is defined as

$$\frac{\text{weight in kg}}{(\text{height in m})^2}$$

Make a vector with the BMI values for the four people, and a vector with the natural logarithm to the BMI values. Finally make a vector with the weights for those people who have a BMI larger than 25.

# The `airquality` data

```
data(airquality)
Ozone <- airquality$Ozone
```

airquality {datasets} R Documentation

## New York Air Quality Measurements

### Description

Daily air quality measurements in New York, May to September 1973.

### Usage

```
airquality
```

### Format

A data frame with 154 observations on 6 variables.

| | |
|---|---|
| `[,1] Ozone` | numeric Ozone (ppb) |
| `[,2] Solar.R` | numeric Solar R (lang) |
| `[,3] Wind` | numeric Wind (mph) |
| `[,4] Temp` | numeric Temperature (degrees F) |

# Other important options

- save result to an object

```
subDat <- airquality[Ozone>30,]
```

- multiple conditions can be linked with &

```
airquality[Ozone>18 & airquality$Month==5,]
```

- the or argument - one of the two conditions must be fullfilled

```
airquality[Ozone>18 | airquality$Month==5,]
```

# Missing values

- Missing values are defined as `NA` in R
- Math functions usually have a way to exclude missing values in their calculations.
- `mean()`, `median()`, `colSums()`, `var()`, `sd()`, `min()` and `max()` all take the `na.rm` argument.

```
mean(Ozone)
```

```
## [1] NA
```

```
mean(Ozone,na.rm=T)
```

```
## [1] 42.12931
```

# Find the missing values:

```
head(is.na(Ozone))
```

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

```
which(is.na(Ozone))
```

```
##  [1]   5  10  25  26  27  32  33  34  35  36  37  39  42  43  45  46  52
## [22]  57  58  59  60  61  65  72  75  83  84 102 103 107 115 119 150
```

```
table(is.na(Ozone))
```

```
##
## FALSE  TRUE
##   116    37
```

# Missing Data Visualisations

```
# Data Structures, Summaries, and Visualisations
# for Missing Data
library(naniar)
vis_miss(airquality)
```

# The command `complete.cases()`

## The command `complete.cases()`

- returns a logical vector indicating which cases are complete.

```
nrow(airquality)
# list rows of data without missing values
airq_comp <- gpdat[complete.cases(airquality),]
nrow(airq_comp)
```

# A shorthand alternative

- An shorthand alternative is to simply use `na.omit()` to omit all rows containing missing values.

```
airq_comp <- na.omit(airquality)
nrow(airq_comp)
```

```
## [1] 111
```

# Very simple imputation

```
airq <- airquality
airq$Ozone[is.na(airq$Ozone)] <-mean(airq$Ozone,
                                     na.rm = T)
```

## Comparing mean and variance

```
mean(airquality$Ozone, na.rm = T)
```

```
## [1] 42.12931
```

```
mean(airq$Ozone)
```

```
## [1] 42.12931
```

```
var(airquality$Ozone, na.rm = T)
```

```
## [1] 1088.201
```

```
var(airq$Ozone)
```

# NAs per column

- For data frames, a convenient shortcut to compute the total missing values in each column is to use `colSums()`:

```
colSums(is.na(airquality))
```

```
##   Ozone Solar.R    Wind    Temp   Month     Day
##      37       7       0       0       0       0
```

```
colSums(is.na(airq))
```

```
##   Ozone Solar.R    Wind    Temp   Month     Day
##       0       7       0       0       0       0
```

# CRAN Task View: Missing Data

**CRAN Task View: Missing Data**

**Maintainer:** Julie Josse, Nicholas Tierney and Nathalie Vialaneix (r-miss-tastic team)
**Contact:** r-miss-tastic at clementine.wf
**Version:** 2019-07-02
**URL:** https://CRAN.R-project.org/view=MissingData

Missing data are very frequently found in datasets. Base R provides a few options to handle them using computations that involve only observed data ( `na.rm = TRUE` in functions `mean`, `var`, ... or `use = complete.obs|na.or.complete|pairwise.complete.obs` in functions `cov`, `cor`, ...). The base package stats also contains the generic function `na.action` that extracts information of the `NA` action used to create an object.

These basic options are complemented by many packages on CRAN, which we structure into main topics:

- Exploration of missing data
- Likelihood based approaches
- Single imputation
- Multiple imputation
- Weighting methods
- Specific types of data
- Specific application fields

# Exercise: Missing values

1. How many missing values are in the built-in data set airquality?
2. Which variables are the missing values concentrated in?

# Rename the column names

- With the command `colnames` you get the column names

```
colnames(airquality)
```

- We can rename the column names:

```
colnames(airquality)[1] <- "var1"
```

- The same applies to the row names

```
rownames(airquality)
```

# The apply family

```
apply(airq,2,mean)
```

```
##     Ozone   Solar.R      Wind      Temp     Month       Day
## 42.129310        NA  9.957516 77.882353  6.993464 15.803922
```

```
# the following is possible but doesn`t make sense
# for this case:
apply(airq,1,mean)
```

# The command `apply()`

```
apply(airq,2,var)
```

```
##      Ozone    Solar.R       Wind       Temp      Month        Day
## 823.309608         NA  12.411539  89.591331   2.006536  78.579721
```

```
apply(airq,2,sd)
```

```
##     Ozone   Solar.R      Wind      Temp     Month       Day
## 28.693372        NA  3.523001  9.465270  1.416522  8.864520
```

```
apply(X = airq,MARGIN = 2,FUN = range)
```

```
##      Ozone Solar.R Wind Temp Month Day
## [1,]     1      NA  1.7   56     5   1
## [2,]   168      NA 20.7   97     9  31
```

# The arguments of the command `apply()`

- If `MARGIN=1` the function `mean` is applied for rows,
- If `MARGIN=2` the function `mean` is applied for columns,
- Instead of `mean` you could also use `var`, `sd` or `length`.

# Example command `tapply()`

```
tapply(airq$Wind, airq$Month,mean)
```

```
##         5         6         7         8         9
## 11.622581 10.266667  8.941935  8.793548 10.180000
```

- Other commands can also be used..... also self-scripted commands

# Exercise: using the `tapply()` command

- Calculate the average ozone value by month using the airquality dataset and the tapply command.

# Links and resources

- **Tidy data** - the package `tidyr`
- Homepage for **the `tidyverse` collection**
- **Data wrangling with R and RStudio**
- Hadley Wickham - **Tidy Data**
- Hadley Wickham - **Advanced R**
- Colin Gillespie and Robin Lovelace **Efficient R programming**
- **Quick-R about missing values**
- **Recode missing values**