TALL SOM FORTELLER

# Introduction course

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DAY 3: 16TH DECEMBER 2020

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## Agenda: Part 1

| | **Monday 14th December** | **Tuesday 16th December** | **Wednesday 17th December** |
|---|---|---|---|
| 12:00 | • Introduction<br>• Github<br>• Basic calculations<br>• Objects | • Review<br>• Data manipulation | • **Review**<br>• **Sampling**<br>• **Outlier detection** |
| 12:45 | Exercise 1 | Exercise 3 | **Exercise 5** |
| 13:30 | • Logical statements<br>• Read in data | • Merging datasets<br>• Plotting | • **Imputation** |
| 14:00 | Exercise 2 | Exercise 4 | **Exercise 6** |
| 14:50 – 15:00 | | | **Summary** |

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# Review (day 2)

- Use ..._join() for merging
- Select some rows: filter( )
- Select variables/columns with select()
- Summary statistic: summarise ( )
- Plot: ggplot( ), aes( ), geom_...( )

## Exercise 4 review

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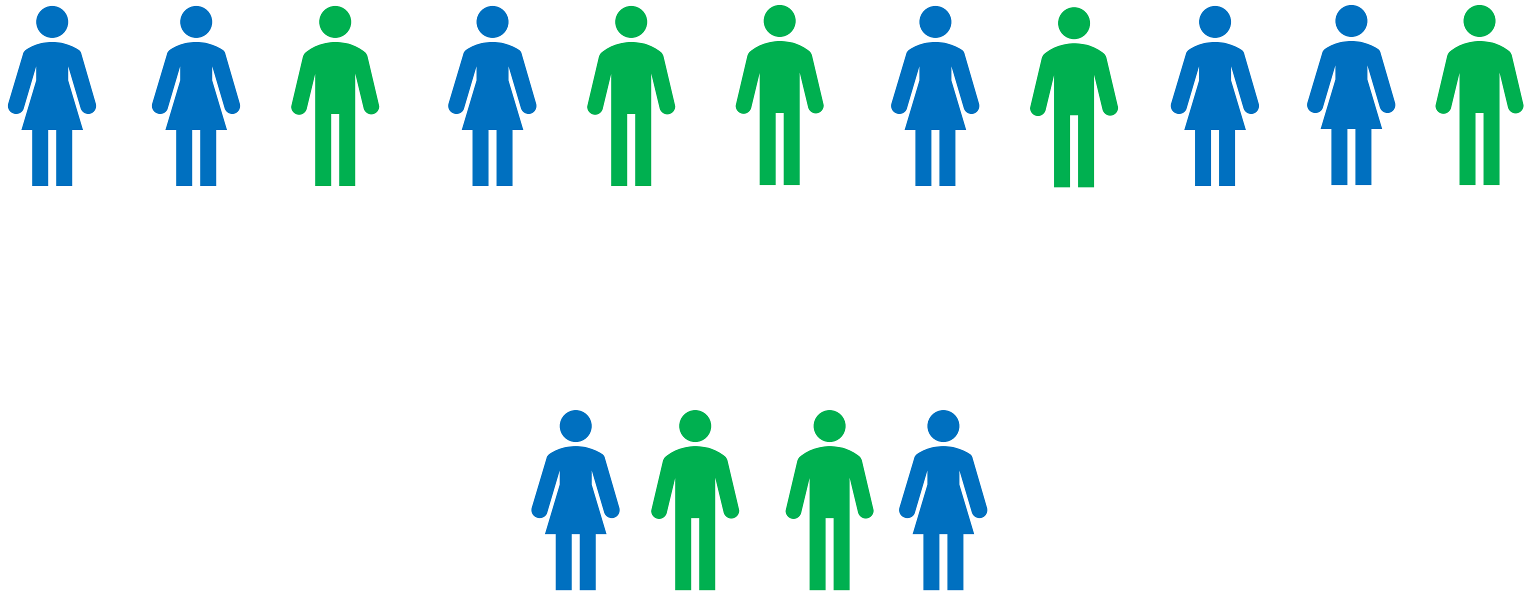
# Sampling



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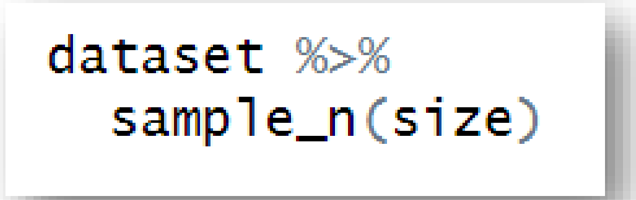
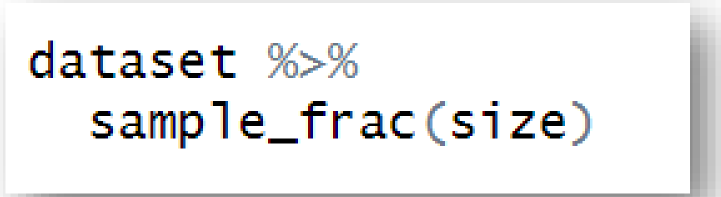
# Random sample

- Based on sample size number



```
dataset %>%
  sample_n(size)
```

- Based on sampling fraction

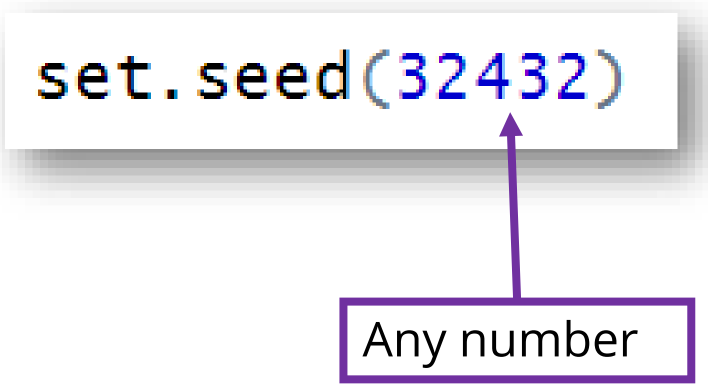


```
dataset %>%
  sample_frac(size)
```

- Default is replace = FALSE

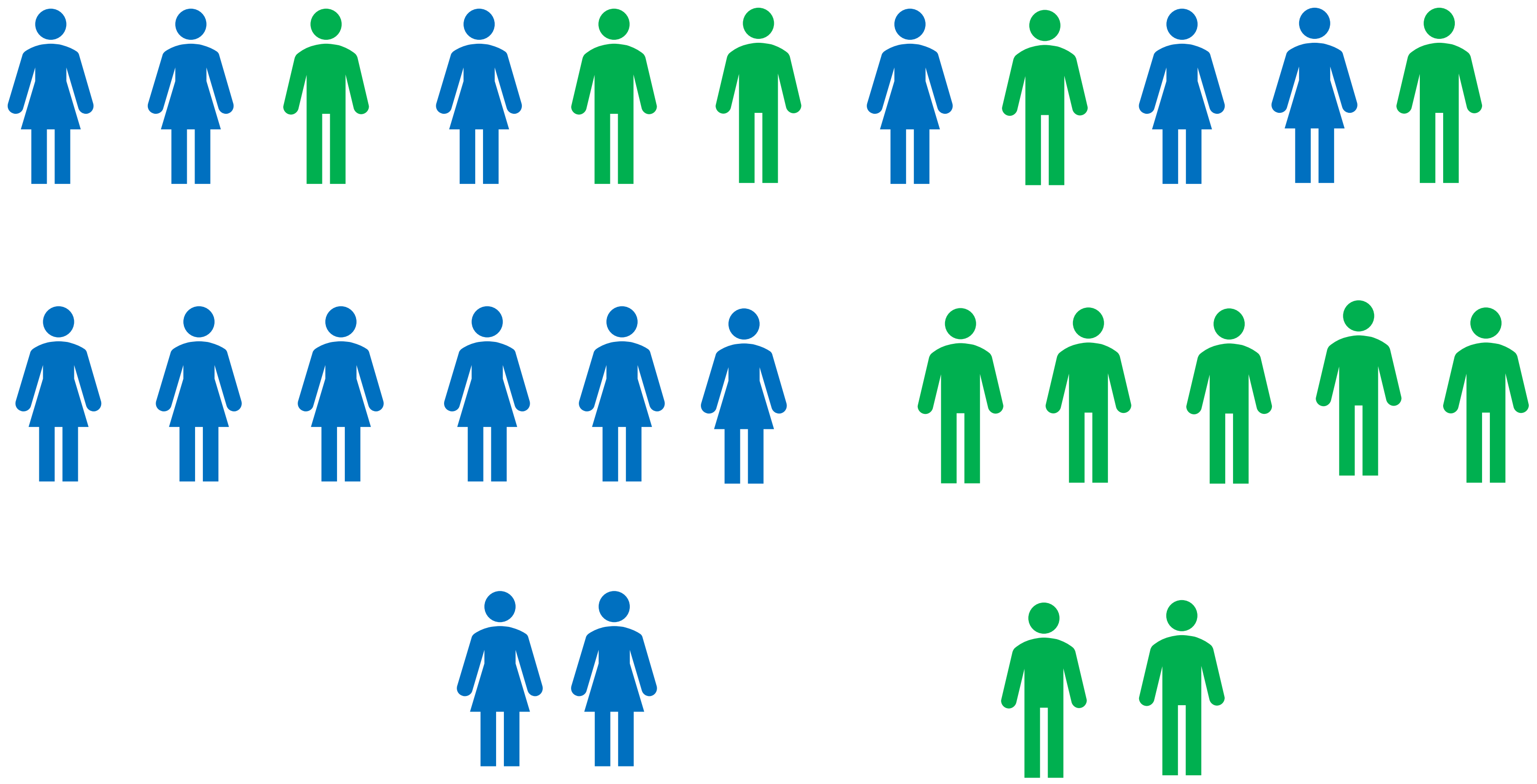
## Set seed

- For reproducible results set the seed first!



```
set.seed(32432)
```

# Stratified sampling



Population

Stratified sample

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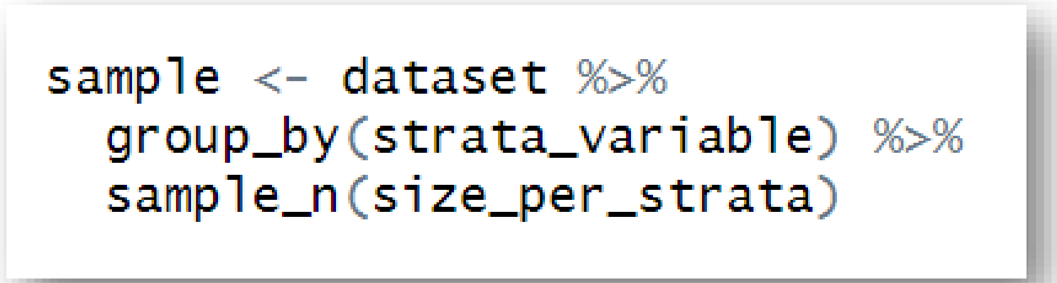
# Stratified sampling

- Combine with group_by()

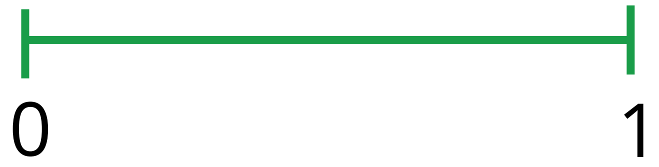


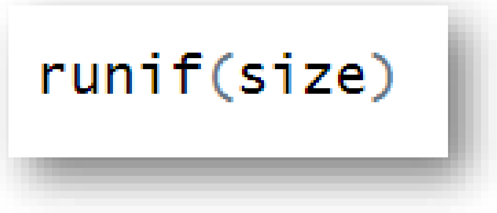
```
sample <- dataset %>%
  group_by(strata_variable) %>%
  sample_n(size_per_strata)
```

- Possible also to add weights or use sampling fractions

# Random numbers

- Pseudo-random numbers:





```
runif(size)
```

- Again: set the seed for process to be reproducible

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## Outlier detecion - validation

- **Data validation** is an activity aimed at **verifying** whether the value of a data item comes from the given set of **acceptable values**. (OECD glossary)

- Methodology for data validation, EUROSTAT (https://ec.europa.eu/eurostat/cros/content/ess-handbook-methodology-data-validation-v11-rev2018-0_en )

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## Validate package in R

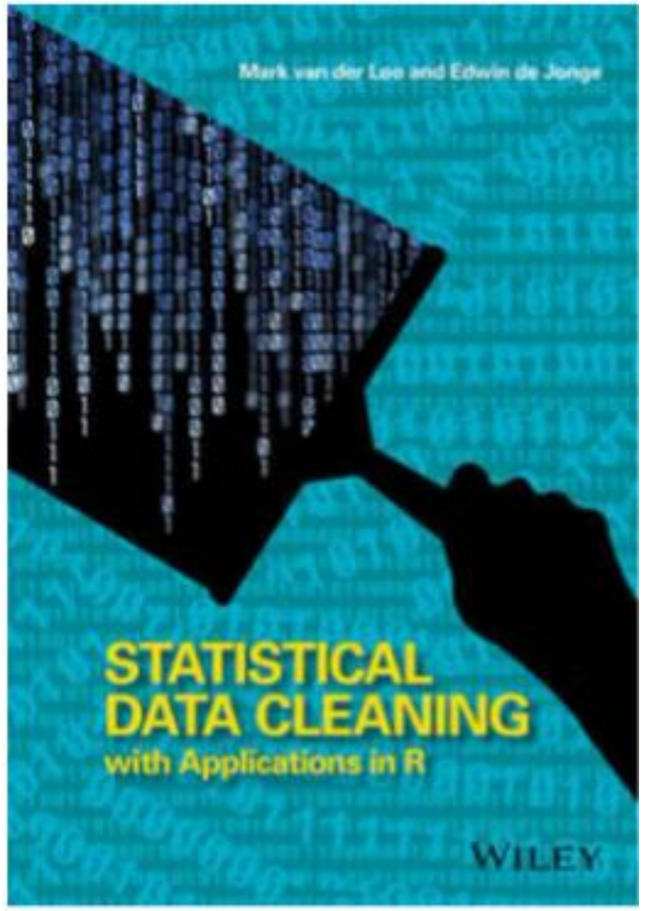
- The validate package is intended to make:
  - Checking the data easy
  - Maintaining the rules easy
  - Possible to reproduce the results

- Build by Mark van der Loo and Edwin de Jonge, Statistics Netherlands

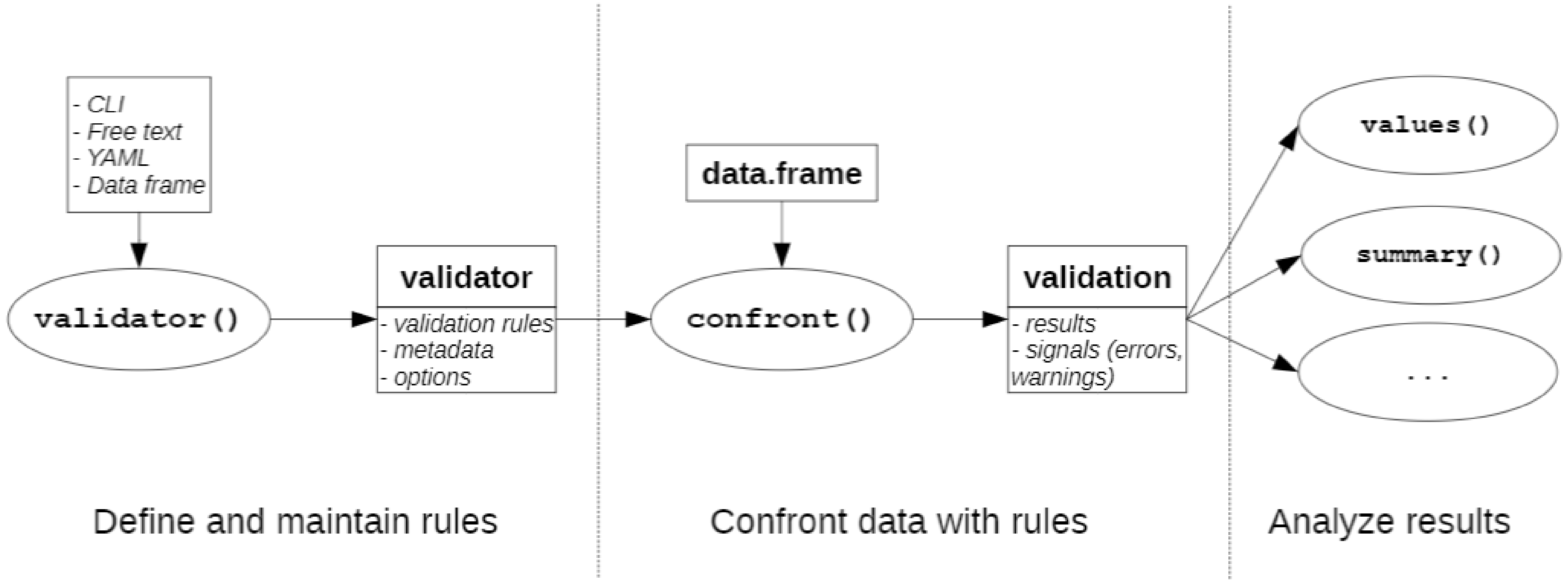
## More information

- Introduction:

  https://cran.r-project.org/web/packages/validate/vignettes/introduction.html


Mark van der Loo and Edwin de Jonge
STATISTICAL DATA CLEANING with Applications in R
WILEY

# The validate package



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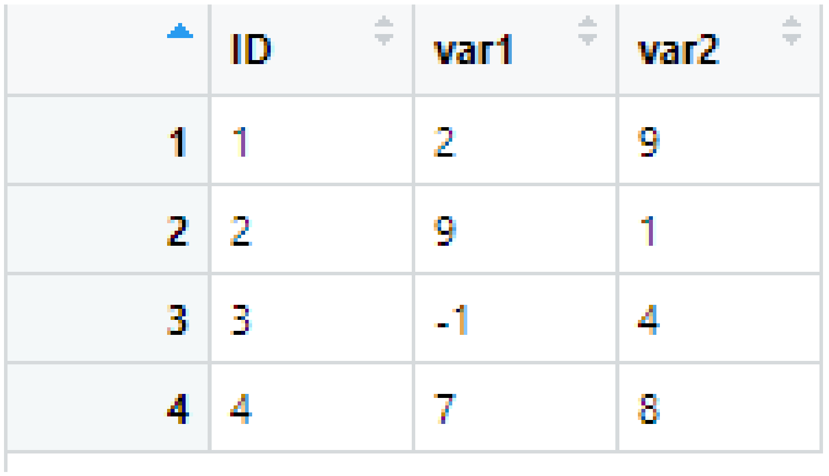
## Dataset

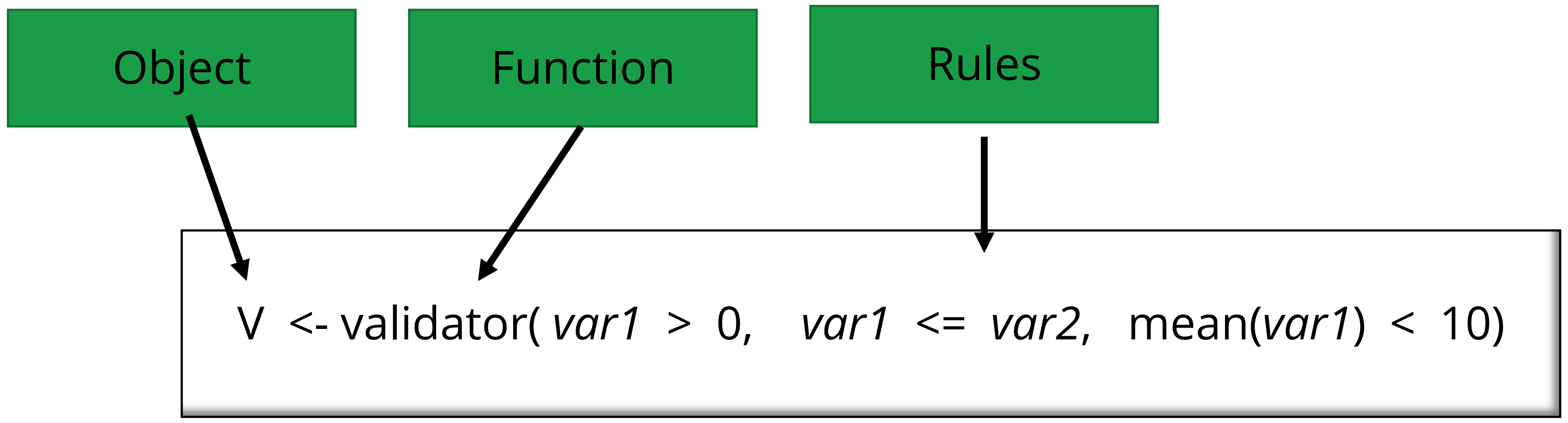
- ID<-c("1","2","3","4")
- var1<-c(2,9,-1,7)
- var2<-c(9,1,4,8)

- mydata <- data.frame(ID, var1, var2)

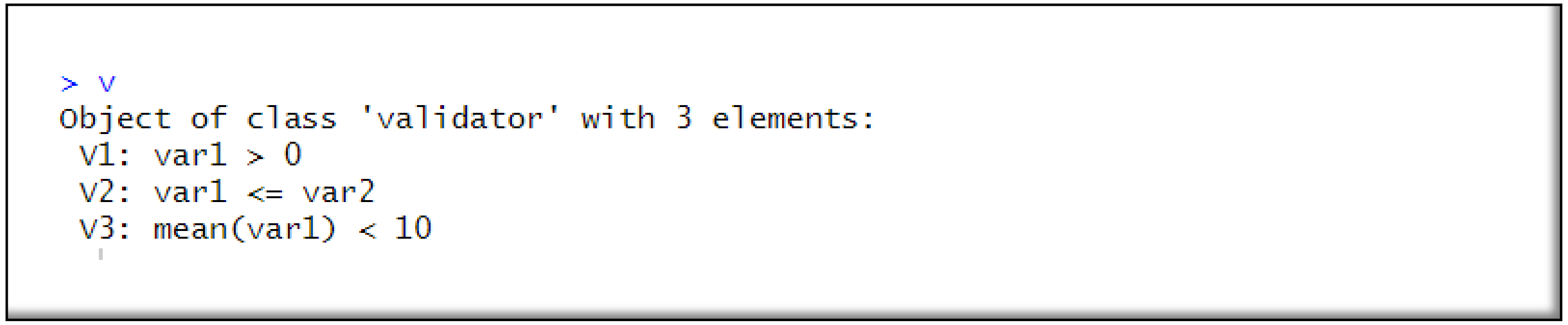


|  | ID | var1 | var2 |
|---|---|---|---|
| 1 | 1 | 2 | 9 |
| 2 | 2 | 9 | 1 |
| 3 | 3 | -1 | 4 |
| 4 | 4 | 7 | 8 |

## Validator



```
V <- validator( var1 > 0,  var1 <= var2,  mean(var1) < 10)
```



```
> v
Object of class 'validator' with 3 elements:
 V1: var1 > 0
 V2: var1 <= var2
 V3: mean(var1) < 10
```

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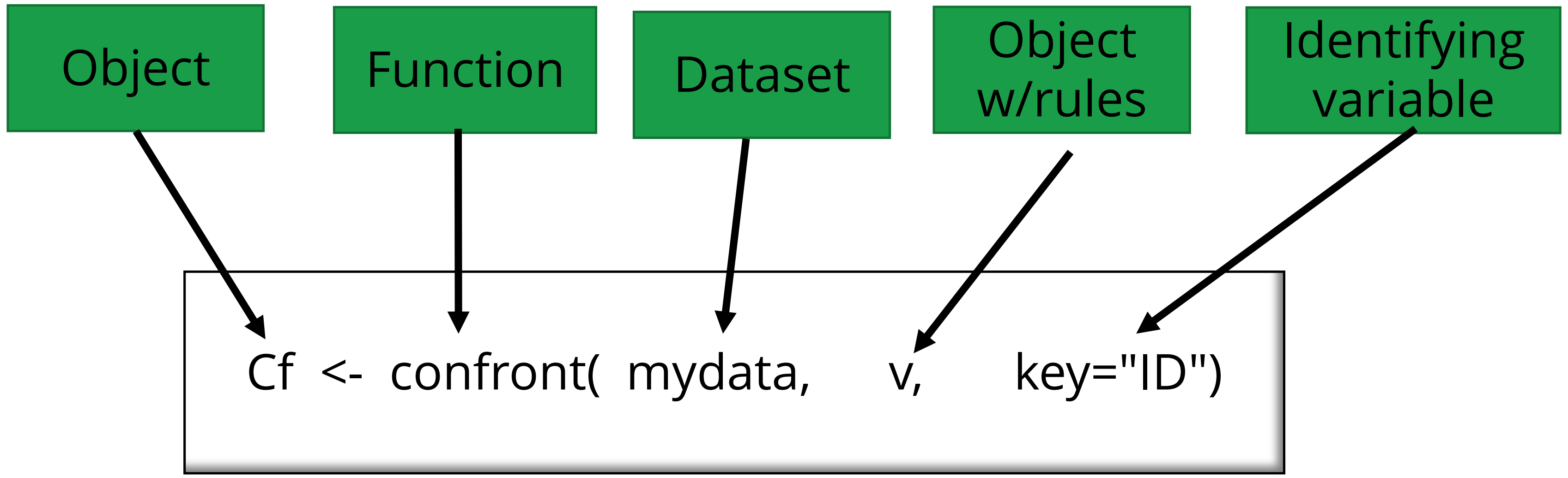
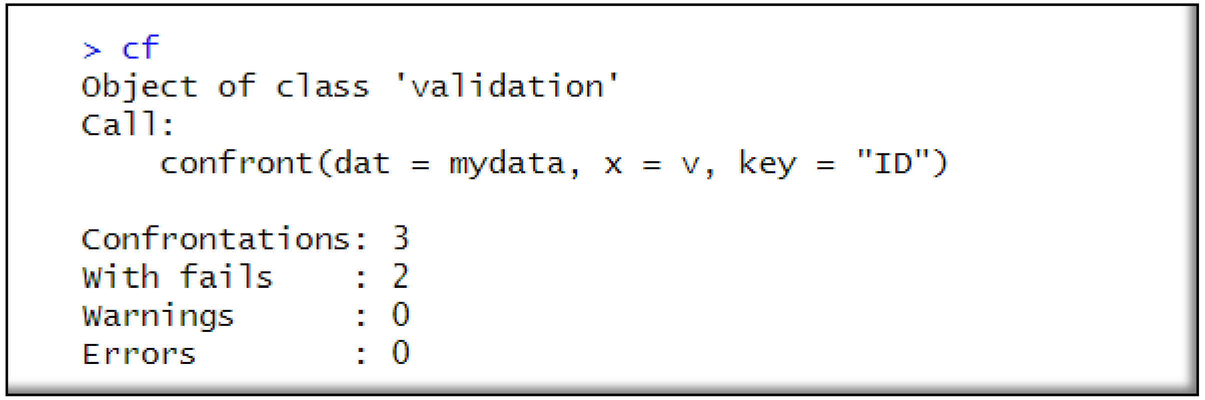
## Validation rule syntax

- Type checks: any function starting with is..
- Binary comparisons: <, <=, ==, !=, >=, > and %in%.
- Unary logical operators: !, all(), any().
- Binary logical operators: &, &&, |, || and logical implication, e.g. if (staff > 0) staff.costs > 0.

## Confront data with rules



```
Cf <- confront( mydata,   v,    key="ID")
```



```
> cf
Object of class 'validation'
Call:
    confront(dat = mydata, x = v, key = "ID")

Confrontations: 3
With fails    : 2
Warnings      : 0
Errors        : 0
```

## The outcome of confronting data set with rules

- Possible to extract information with:
  - summary: summarize output; returns a data.frame
  - aggregate: aggregate validation in several ways
  - values: Get the values in an array, or a list of arrays if rules have different output dimension structure
  - errors: Retrieve error messages caught during the confrontation
  - warnings: Retrieve warning messages caught during the confrontation.
  - sort : aggregate and sort in several ways

## Metadata for the rules

- The following functions can be used to **get** or **set metadata**:
  - origin : Where was a rule defined?
  - names : The name per rule
  - created : when were the rules created?
  - label : Short description of the rule
  - description: Long description of the rule
  - meta: Set or get generic metadata

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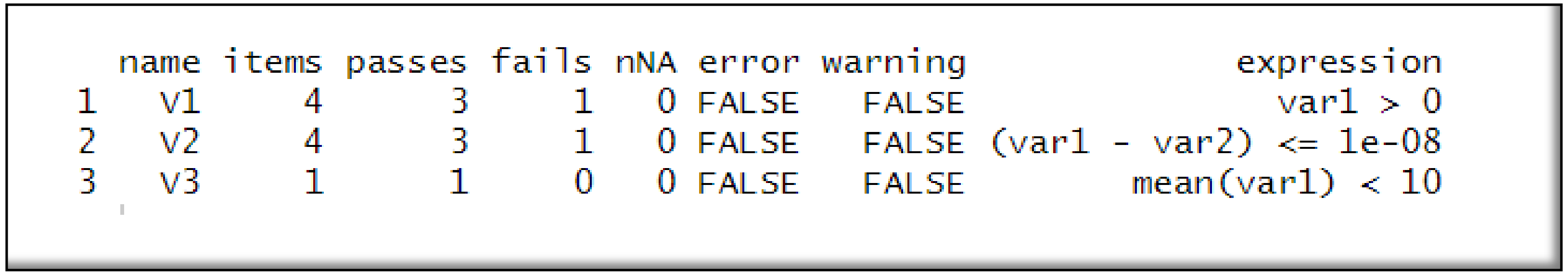
## Summary

```
summary(cf)
```



```
    name items passes fails nNA error warning              expression
1   V1      4      3     1   0 FALSE   FALSE                var1 > 0
2   V2      4      3     1   0 FALSE   FALSE (var1 - var2) <= 1e-08
3   V3      1      1     0   0 FALSE   FALSE          mean(var1) < 10
```

- How many data items were checked against each rule
- How many items passed, failed or resulted in NA
- Whether the check resulted in an error (could not be performed) or gave an error
- The expression that was actually evaluated to perform the check.

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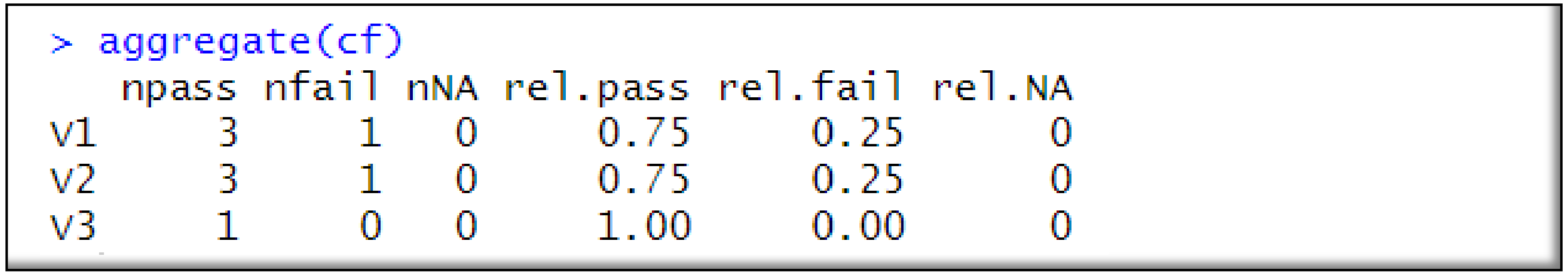
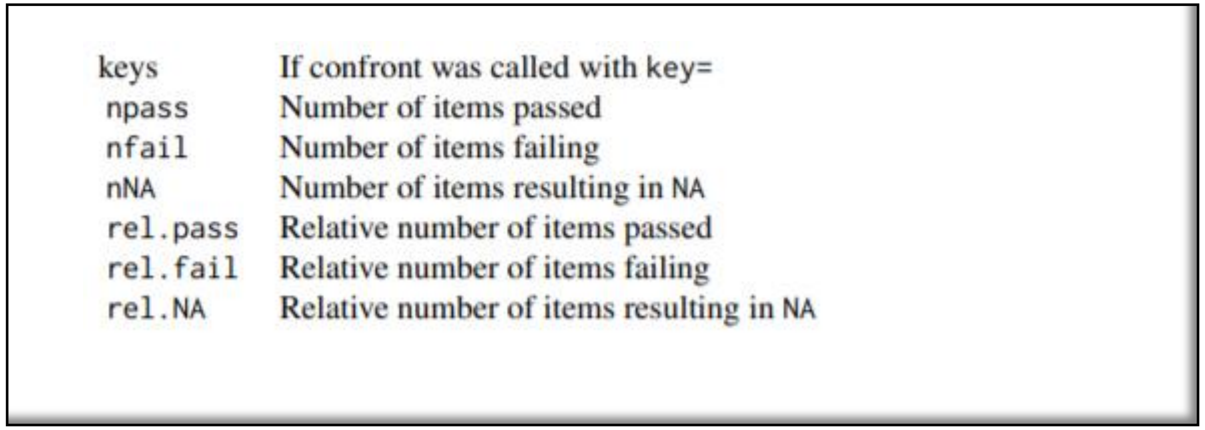
## Aggregate

aggregate(cf)



```
> aggregate(cf)
   npass nfail nNA rel.pass rel.fail rel.NA
v1     3     1   0     0.75     0.25      0
v2     3     1   0     0.75     0.25      0
v3     1     0   0     1.00     0.00      0
```



| | |
|---|---|
| keys | If confront was called with key= |
| npass | Number of items passed |
| nfail | Number of items failing |
| nNA | Number of items resulting in NA |
| rel.pass | Relative number of items passed |
| rel.fail | Relative number of items failing |
| rel.NA | Relative number of items resulting in NA |

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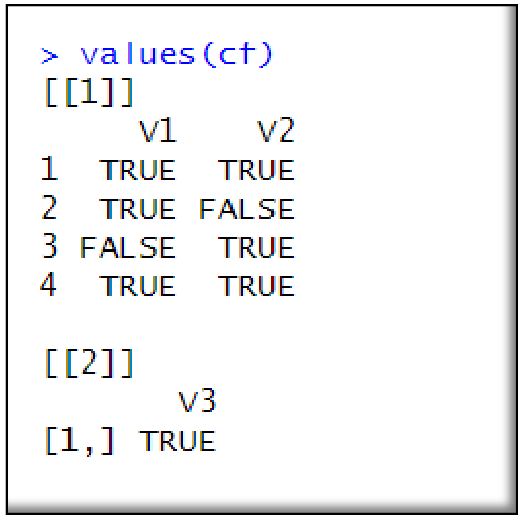
## Values

```
values(cf)
```

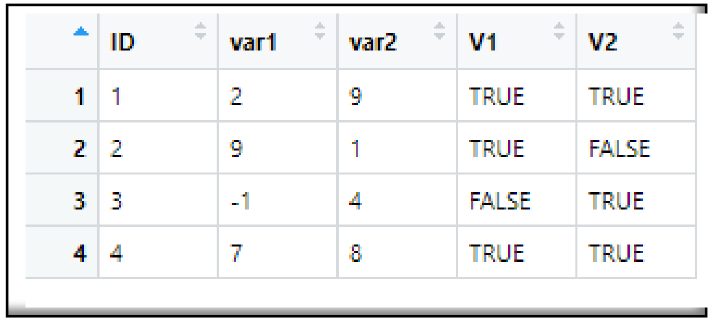


```
> values(ct)
[[1]]
     V1    V2
1  TRUE  TRUE
2  TRUE FALSE
3 FALSE  TRUE
4  TRUE  TRUE

[[2]]
       V3
[1,] TRUE
```

```
#Dataset with indikators
ind<-as.data.frame(values(cf))

# add indikators to datasett
mydata2 <- mydata %>%
  mutate(greater_0 = pull(ind, V1),
         V2= pull(ind, V2))
```



|  | ID | var1 | var2 | V1 | V2 |
|---|---|---|---|---|---|
| 1 | 1 | 2 | 9 | TRUE | TRUE |
| 2 | 2 | 9 | 1 | TRUE | FALSE |
| 3 | 3 | -1 | 4 | FALSE | TRUE |
| 4 | 4 | 7 | 8 | TRUE | TRUE |

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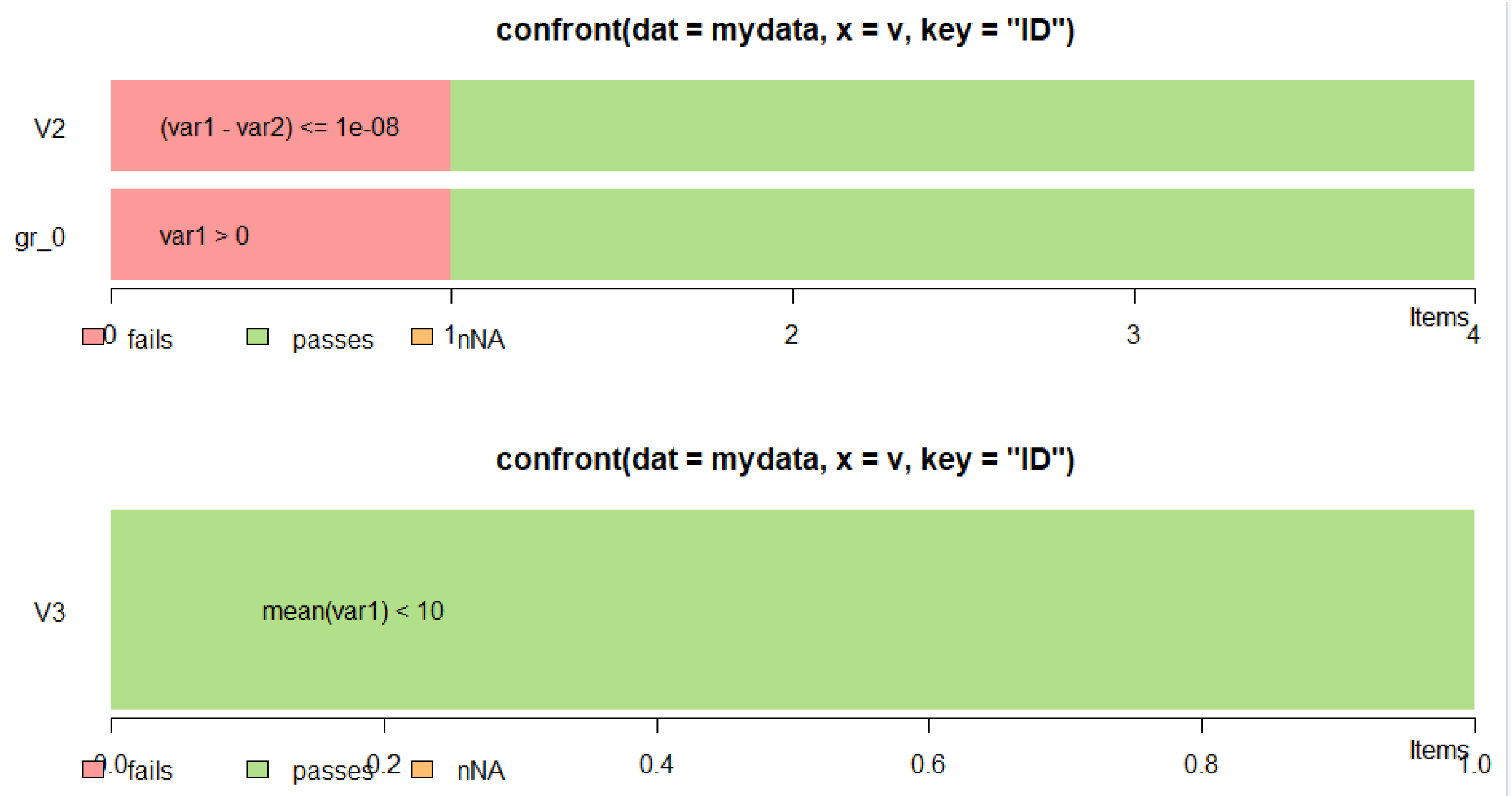
# Graphics

```
plot(cf)
```



## Exercise 5:

- Exercise 5 is in the file : Exercises_day3.R
- Need to download R-package:

✓validate

## Exercise 5 review

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## Rule based imputation with «dcmodify»

- **‘if this do that’** type of statements.
- Based on **expert knowledge**.
- All ‘data modifying rules’ are **gathered**.
- Easy to maintain and document the rules

- Build by Mark van der Loo and Edwin de Jonge, Statistics Netherlands
- https://cran.r-project.org/web/packages/dcmodify/vignettes/introduction.html

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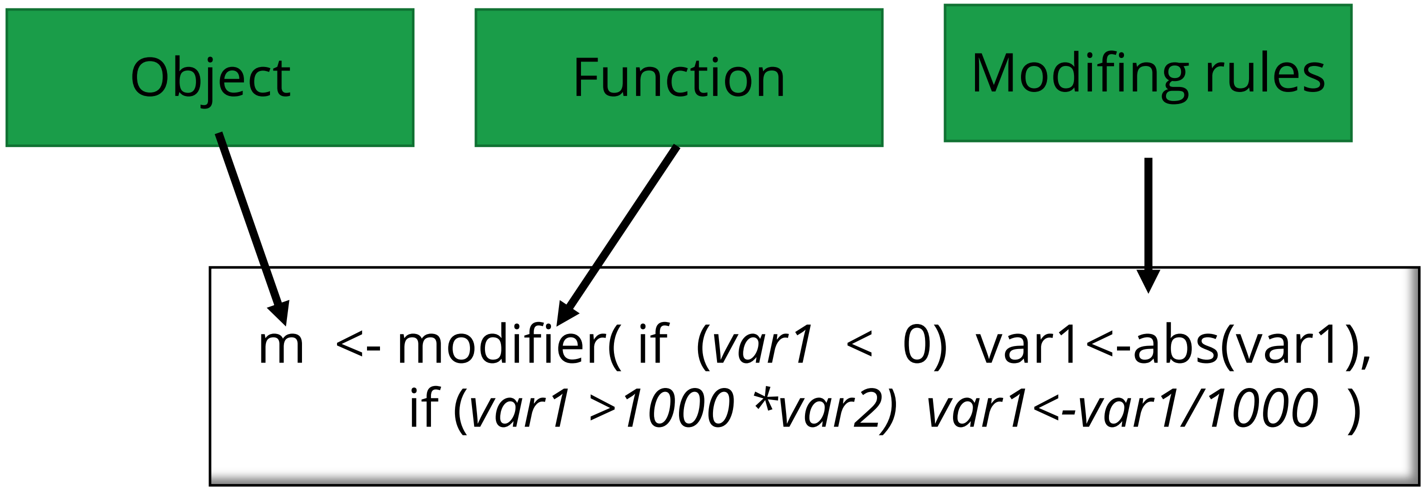
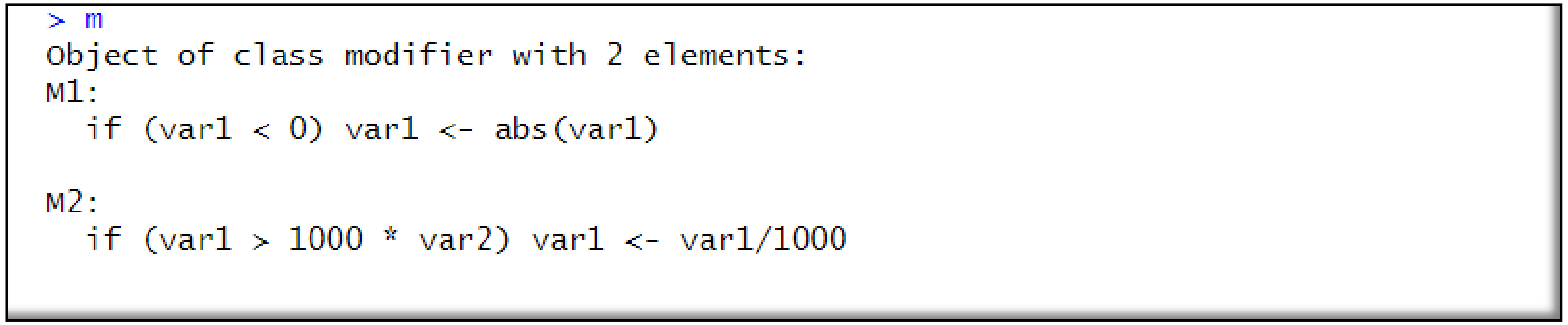
## Basic workflow

- data: This is your data, currently this must be stored in a data.frame.
- modifier: This is an object that stores data modification rules.
- modify: This is a function that applies the rules in a modifier to your data.

# Modifier – defining rules



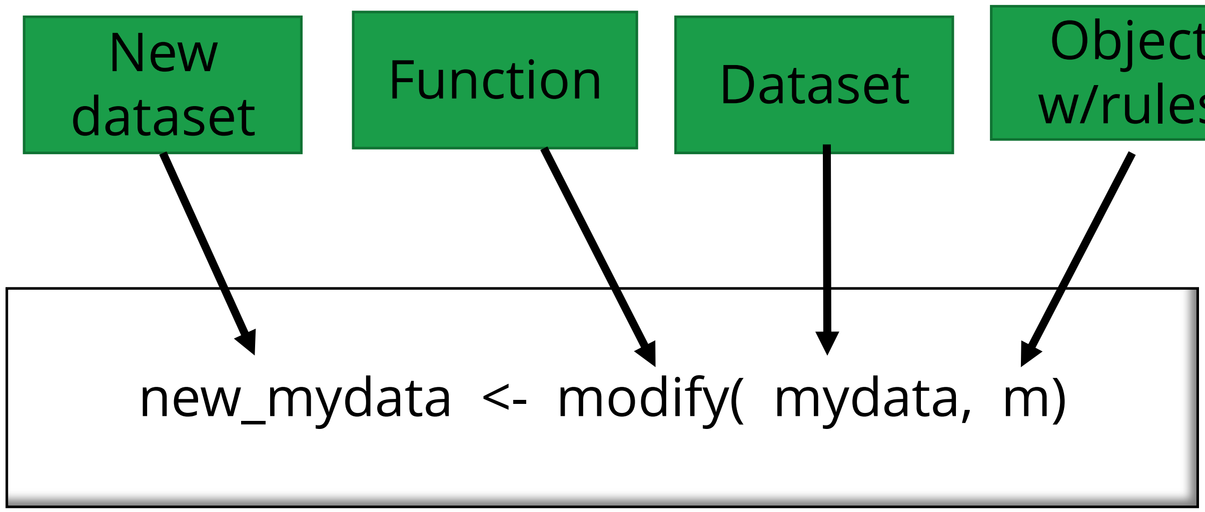
```
m  <- modifier( if  (var1  <  0)  var1<-abs(var1),
          if (var1 >1000 *var2)  var1<-var1/1000  )
```



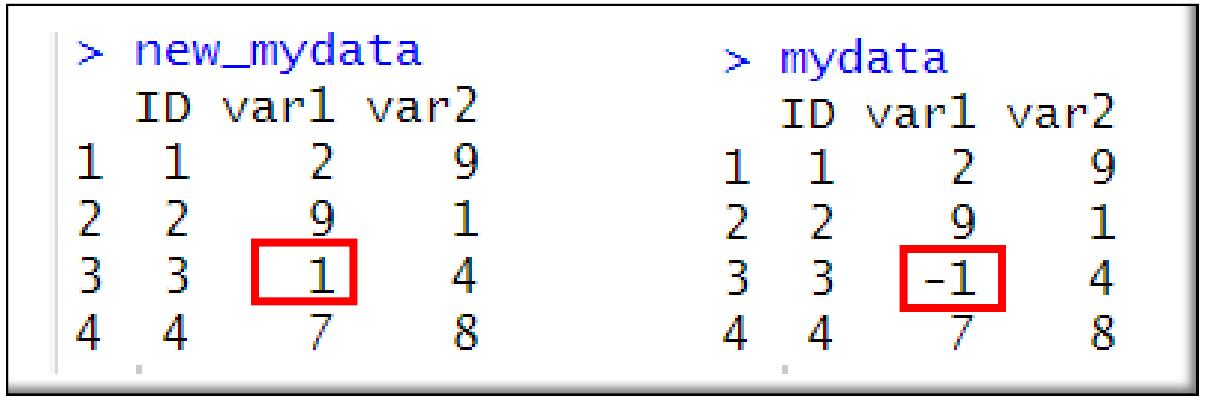
```
> m
Object of class modifier with 2 elements:
M1:
  if (var1 < 0) var1 <- abs(var1)

M2:
  if (var1 > 1000 * var2) var1 <- var1/1000
```

## Modifying data with rules



```
new_mydata <- modify( mydata, m)
```



```
> new_mydata
  ID var1 var2
1  1    2    9
2  2    9    1
3  3    1    4
4  4    7    8
```

```
> mydata
  ID var1 var2
1  1    2    9
2  2    9    1
3  3   -1    4
4  4    7    8
```

## Model based imputation with "simputation"

- A package to make imputation simpler!
- Number of commonly used single imputation methods
- Each with a similar and simple interface

- Build by Mark van der Loo and Edwin de Jonge, Statistics Netherlands
- More information: https://cran.r-project.org/web/packages/simputation/vignettes/intro.html

# Imputation methods available

**Model based imputation**

- linear regression
- robust linear regression
- ridge/elasticnet/lasso regression
- CART models (decision trees)
- Random forest

**Multivariate imputation**

- Imputation based on the expectation-maximization algorithm
- missForest (=iterative random forest imputation)

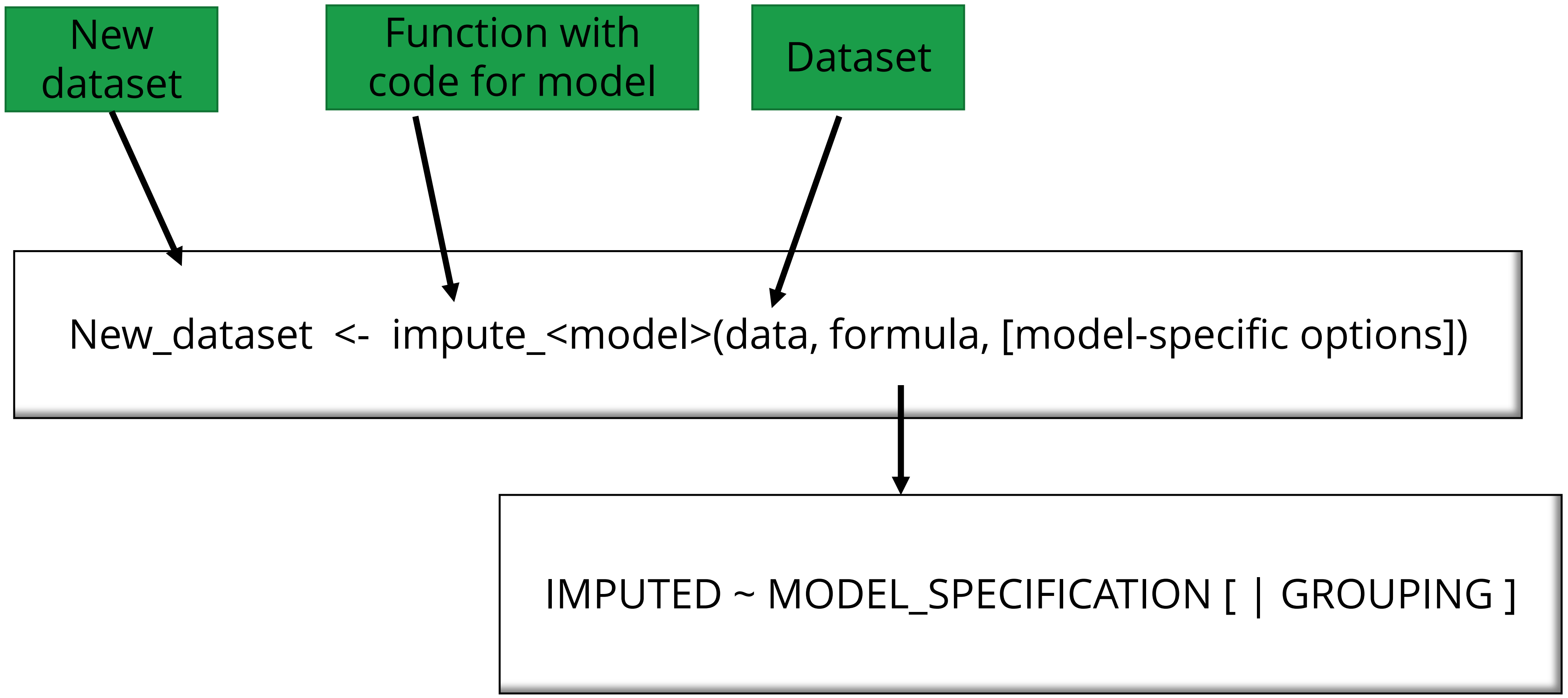
**Donor imputation**

- k-nearest neigbour (based on gower's distance)
- sequential hotdeck (LOCF, NOCB)
- random hotdeck
- Predictive mean matching

**Other**

- (groupwise) median imputation (optional random residual)
- Proxy imputation: copy another variable or use a simple transformation to compute imputed values.
- Apply trained models for imputation purposes.

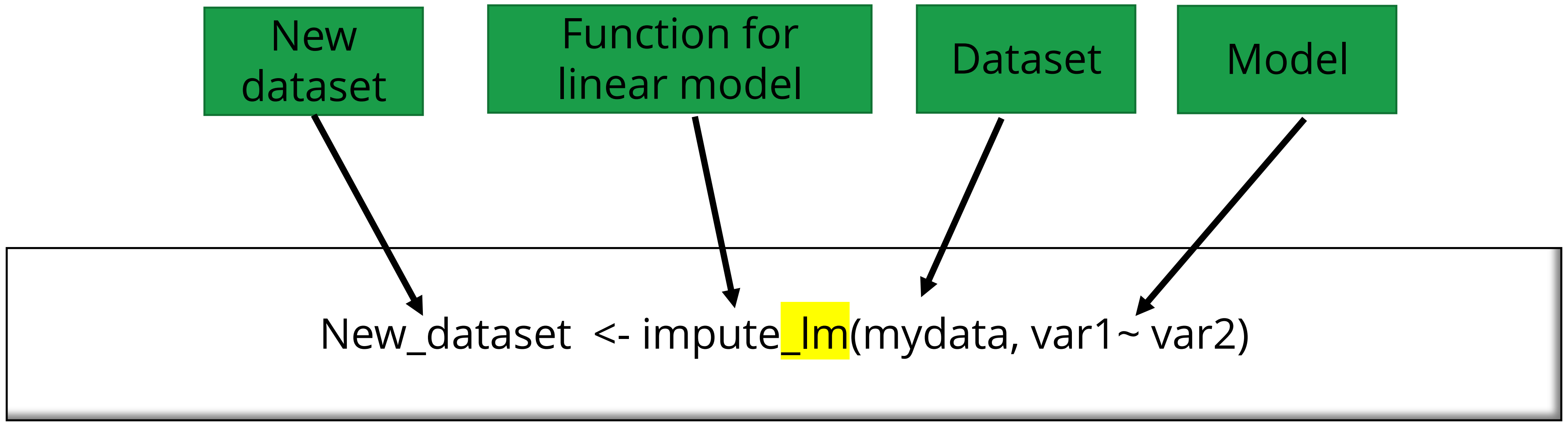
# General setup



```
New_dataset  <-  impute_<model>(data, formula, [model-specific options])
```

```
IMPUTED ~ MODEL_SPECIFICATION [ | GROUPING ]
```

## Example linear regression, lm



```
New_dataset  <- impute_lm(mydata, var1~ var2)
```

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## Grouping data for imputation

- Use | in the formula argument to specify groups.

```
New_dataset  <- impute_lm(mydata, var1~ var2 | GROUPS )
```

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## Chaining imputation methods

Using the %>% operator from the popular magrittr allows for a very compact specification.

```
library(magrittr)

newdata<- mydata %>%
  impute_lm(var1 ~ var2) %>%
  impute_median(var2) %>%
  impute_cart(var3 ~ .)
```

## Similar model for multiple variables

- imputation model for multiple variables at once.
- For example, to impute both var1 and var2 with a similar robust linear model, do the following.

```
newdata <- impute_rlm(mydata, var1 + var2 ~ var3)
```

## Logging changes with «lumberjack»

- Easy logging of changes in data.
- Possible to study the effect of imputation
- Operator %>>%

```
library(lumberjack)
Logger<-cellwise$new(key="ID")

out <- mydata %>>%
  start_log() %>>%
  impute_lm(var1 ~ var2) %>>%
  dump_log(file="mylog.csv", stop=TRUE)
```

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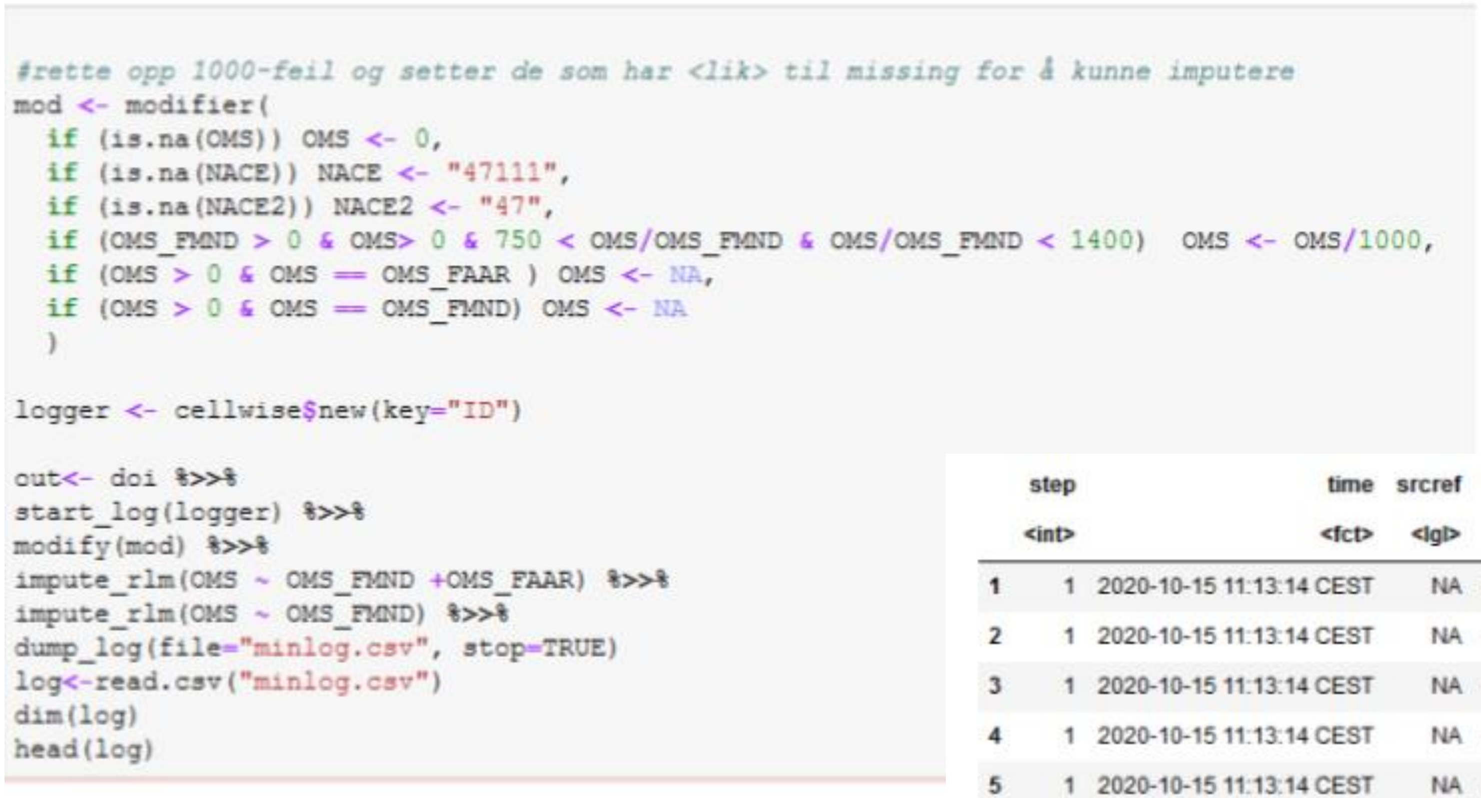
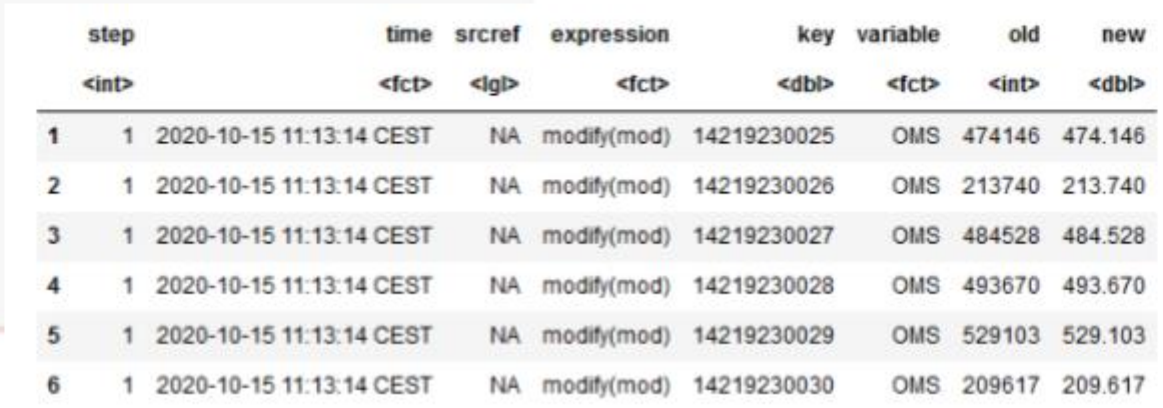
# Example: Index of retail sales



```
#rette opp 1000-feil og setter de som har <lik> til missing for å kunne imputere
mod <- modifier(
  if (is.na(OMS)) OMS <- 0,
  if (is.na(NACE)) NACE <- "47111",
  if (is.na(NACE2)) NACE2 <- "47",
  if (OMS_FMND > 0 & OMS> 0 & 750 < OMS/OMS_FMND & OMS/OMS_FMND < 1400)  OMS <- OMS/1000,
  if (OMS > 0 & OMS == OMS_FAAR ) OMS <- NA,
  if (OMS > 0 & OMS == OMS_FMND) OMS <- NA
  )

logger <- cellwise$new(key="ID")

out<- doi %>>%
start_log(logger) %>>%
modify(mod) %>>%
impute_rlm(OMS ~ OMS_FMND +OMS_FAAR) %>>%
impute_rlm(OMS ~ OMS_FMND) %>>%
dump_log(file="minlog.csv", stop=TRUE)
log<-read.csv("minlog.csv")
dim(log)
head(log)
```



| | step | time | srcref | expression | key | variable | old | new |
|---|---|---|---|---|---|---|---|---|
| | &lt;int&gt; | &lt;fct&gt; | &lt;lgl&gt; | &lt;fct&gt; | &lt;dbl&gt; | &lt;fct&gt; | &lt;int&gt; | &lt;dbl&gt; |
| 1 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230025 | OMS | 474146 | 474.146 |
| 2 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230026 | OMS | 213740 | 213.740 |
| 3 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230027 | OMS | 484528 | 484.528 |
| 4 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230028 | OMS | 493670 | 493.670 |
| 5 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230029 | OMS | 529103 | 529.103 |
| 6 | 1 | 2020-10-15 11:13:14 CEST | NA | modify(mod) | 14219230030 | OMS | 209617 | 209.617 |

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# Exercise 6:

- Exercise 6 is in the file : Exercises_day3.R
- Need to download R-packages:

✓dcmodify

✓simputation

✓lumberjack

## Exercise 6 review

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## Summary

- Remember library( )
- Read in files: read_csv( )   read_dta( )
- New variable: mutate( )
- Select some rows: filter( )
- Summary: summarise( )
- Plot: ggplot( ), aes( ), geom_...( )

- Draw sample: sample_n(),  sample_frac()
- Validate: validator(), confront(), summary()
- Rule based imputation: modifier(), modify()
- Model based imputation: impute_<model>()
- Logging changes with «lumberjack»

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