The statistical value chain and data validation

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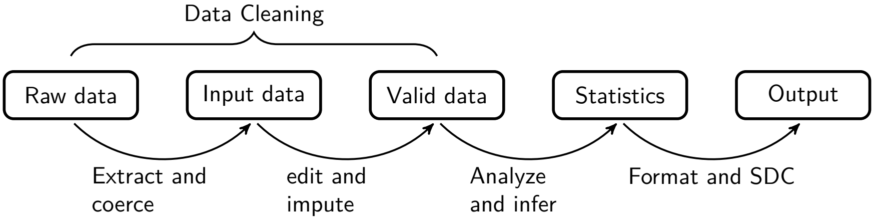
This tutorial

https://github.com/data-cleaning/uRos2019_tutorial

The Statistical Value Chain

Statistical Value Chain



Data Cleaning

Raw data

Input data

Valid data

Statistics

Output

Extract and coerce

edit and impute

Analyze and infer

Format and SDC

Notes

- This part only pertains to the data processing stage. Collection, design, dissemination is not included.
- The fixed points are well-defined statistical products.

The SVC: Remarks

- Actual data processing is not necessarily linear accross the chain
- In production architectures a more flexible model is often used where the definition of interfaces between processing steps play a crucial role. The chain shown here is a general example covering most steps in some way.

Data validation

Definition (ESS handbook on validation)

Data validation is an activity in which it is verified whether or not a combination of values is a member of a set of acceptable value combinations.

Validation rules

The set of acceptable values combinations are defined by *validation rules*, e.g. `IF age <= 14 THEN has_job == "no"`.

Observe

validation rules define, to large extend, the products in the SVC

`validate`: *data validation infrastructure for R*

A domain-specific language for rule definition

Define *any* check on your data, using the *full power* of the R language.

Rules as first-class citizens

- CRUD operations (create, read, update, delete)
- Summarize, plot, investigate rules
- Rich metadata

Validate data

- Confront data with rules
- CRUD on results, summarize, plot
- Export to ESS standard reporting format (upcoming)

Assignment 1

Try the following code.

```
library(validate)
library(magrittr)
data(retailers)
head(retailers)
retailers %>%
  check_that(turnover + other.rev == total.rev
             , turnover > 0, other.rev > 0 ) %>%
  summary()
```

Assignment 1

```
library(validate)
library(magrittr)
data(retailers)
retailers %>%
  check_that(turnover + other.rev == total.rev
             , turnover > 0, other.rev > 0 ) %>%
  summary()
```

```
##   name items passes fails nNA error warning
## 1   V1    60     19     4  37 FALSE   FALSE
## 2   V2    60     56     0   4 FALSE   FALSE
## 3   V3    60     23     1  36 FALSE   FALSE
##                                       expression
## 1 abs(turnover + other.rev - total.rev) < 1e-08
## 2                                   turnover > 0
## 3                                  other.rev > 0
```

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Data validation with `validate`

```
library(validate)
data(retailers)
head(retailers,3)[3:7]
```

```
##   staff turnover other.rev total.rev staff.costs
## 1    75       NA        NA      1130          NA
## 2     9     1607        NA      1607         131
## 3    NA     6886       -33      6919         324
```

Data validation with `validate`

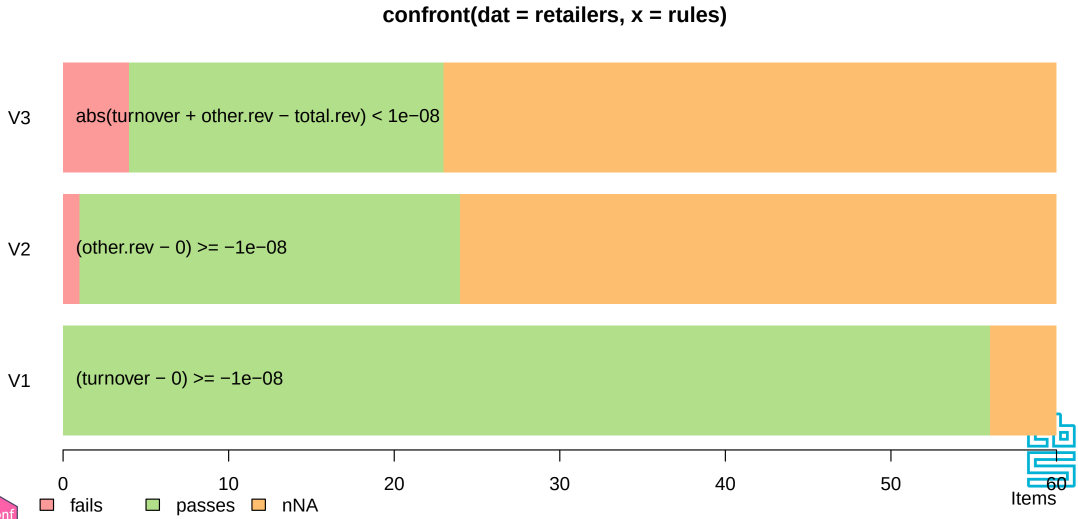
```r
rules <- validator(
   turnover >= 0
  , other.rev >= 0
  , turnover + other.rev == total.rev
)

out <- confront(retailers, rules)
summary(out)
```

Assignment 2

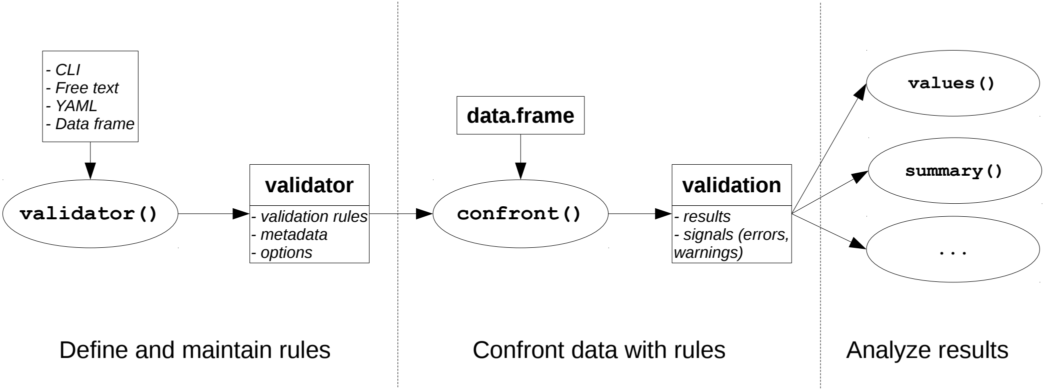
1. Adapt the previous exercise so you use `validator`.
2. Use `confront` for validation and store the results in a variable called `out`.
3. Try `plot(out)`.
4. Try `as.data.frame(out)` (use `View` to inspect the result)

Plotting output

```
plot(out)
```



The validate package



- *CLI*
- *Free text*
- *YAML*
- *Data frame*

validator()

validator

- *validation rules*
- *metadata*
- *options*

data.frame

confront()

validation

- *results*
- *signals (errors, warnings)*

Define and maintain rules

Confront data with rules

Analyze results

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Reading rules from file

```
### myrulez.txt

# some basic checks
staff >= 0
turnover >= 0
other.rev >= 0
# account balance checks
turnover + other.rev == total.rev
# other commom sense stuff
if (staff >= 1) staff.costs >= 1
```

```
rulez <- validator(.file="myrulez.txt")
```

Assignment 3

1. Create a new textfile
2. Define 10 rules for the `retailers` dataset
3. Read the rules (`validator(.file="your file")`)
4. `confront` rules with data
5. Summarize and plot the results.
6. Use `as.data.frame` and `View` to convert and display the results.
7. Make a `plot` of the `validator` object.

A few extra's (if we have time)

Domain Specific Language

Validation *Domain Specific Language* (DSL)

Any R statement resulting in a `logical`.

Examples

```
# Range checks
has_job %in% c('yes','no')
turnover >= 0
# Multivariate checks
abs(profit) <= 0.6 * turnover
# Multi-row checks
mean(profit) > 10
# Logical implications
if (staff > 0) staff.costs > 0
```

Validation DSL

Comparisons

`>, >=,==, <=, <, %in%`

Boolean operations

`!, all(), any(), &, &&, |, ||, if () else`

Text search

`grepl`

Functional dependencies (Armstrong)

`city + zipcode ~ streetname`

Refer to the dataset with .

`nrow(.) == 40, "turnover" %in% names(.)`

Transient assignments (macros) using :=

Example 1

$$\max\left(\frac{x}{x^*}, \frac{x^*}{x}\right) \leq 10$$

```
med := median(turnover,na.rm=TRUE)
hb := pmax(turnover/med, med/turnover, na.rm=TRUE)
hb <= 10
```

Example 2

```
beta_2 := coefficients(lm(turnover ~ profit))[2]
beta_2 >= 0
```

Variable groups

Many variables, same rule

```
G := var_group(staff, turnover, other.rev, total.costs)
G >= 0
```

Error handling

```
out <- check_that(women, hite > 0, weight>0)
out
```

```
## Object of class 'validation'
## Call:
##     check_that(women, hite > 0, weight > 0)
##
## Confrontations: 2
## With fails    : 0
## Warnings      : 0
## Errors        : 1
```

```
errors(out)
```

```
## $V1
## [1] "object 'hite' not found"
```