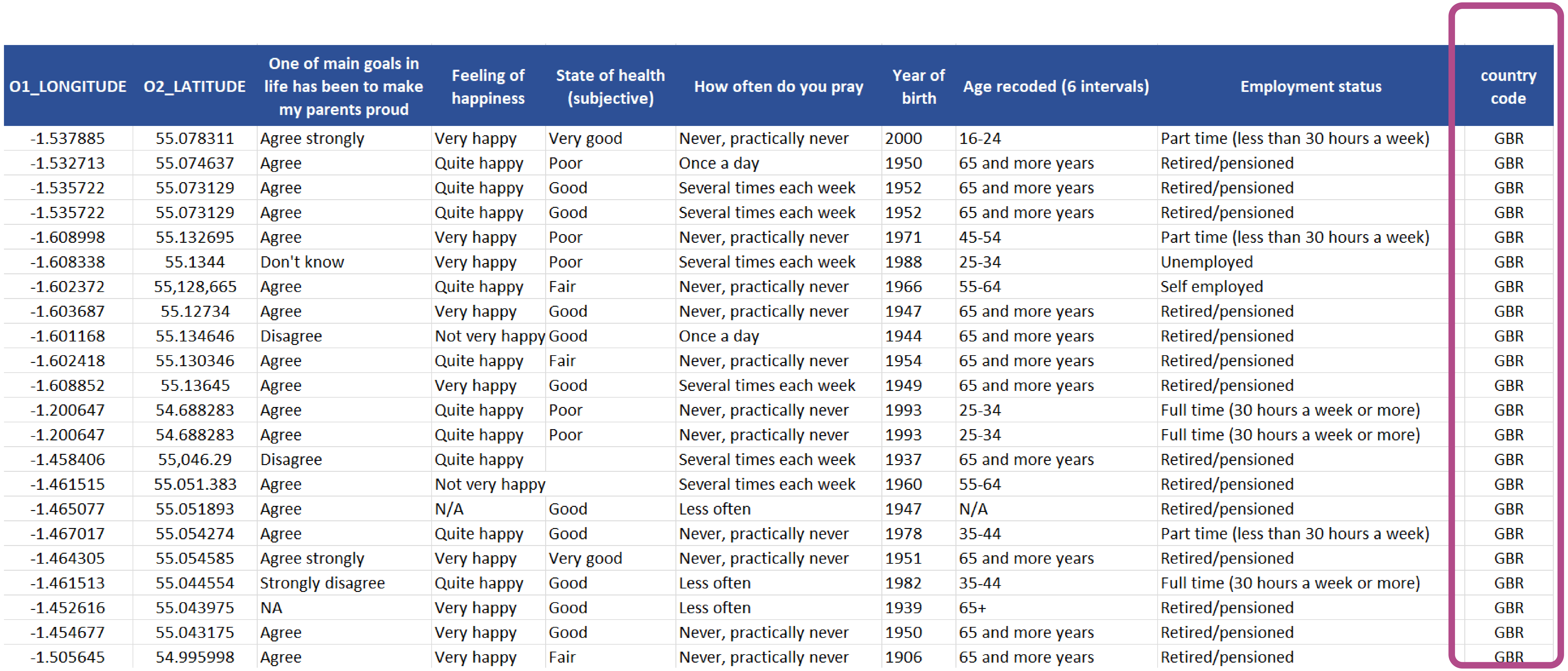
{Tidy} data management

An Introduction and The Why

{Tidy} data management: The Why

{Tidy} data management: The Why



O1_LONGITUDE	O2_LATITUDE	One of main goals in life has been to make my parents proud	Feeling of happiness	State of health (subjective)	How often do you pray	Year of birth	Age recoded (6 intervals)	Employment status	country code
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-1.532713	55.074637	Agree	Quite happy	Poor	Once a day	1950	65 and more years	Retired/pensioned	GBR
-1.535722	55.073129	Agree	Quite happy	Good	Several times each week	1952	65 and more years	Retired/pensioned	GBR
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-1.608338	55.1344	Don't know	Very happy	Poor	Several times each week	1988	25-34	Unemployed	GBR
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-1.603687	55.12734	Agree	Very happy	Good	Never, practically never	1947	65 and more years	Retired/pensioned	GBR
-1.601168	55.134646	Disagree	Not very happy	Good	Once a day	1944	65 and more years	Retired/pensioned	GBR
-1.602418	55.130346	Agree	Quite happy	Fair	Never, practically never	1954	65 and more years	Retired/pensioned	GBR
-1.608852	55.13645	Agree	Very happy	Good	Several times each week	1949	65 and more years	Retired/pensioned	GBR
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-1.458406	55,046.29	Disagree	Quite happy		Several times each week	1937	65 and more years	Retired/pensioned	GBR
-1.461515	55.051.383	Agree	Not very happy		Several times each week	1960	55-64	Retired/pensioned	GBR
-1.465077	55.051893	Agree	N/A	Good	Less often	1947	N/A	Retired/pensioned	GBR
-1.467017	55.054274	Agree	Quite happy	Good	Never, practically never	1978	35-44	Part time (less than 30 hours a week)	GBR
-1.464305	55.054585	Agree strongly	Very happy	Very good	Never, practically never	1951	65 and more years	Retired/pensioned	GBR
-1.461513	55.044554	Strongly disagree	Quite happy	Good	Less often	1982	35-44	Full time (30 hours a week or more)	GBR
-1.452616	55.043975	NA	Very happy	Good	Less often	1939	65+	Retired/pensioned	GBR
-1.454677	55.043175	Agree	Very happy	Good	Never, practically never	1950	65 and more years	Retired/pensioned	GBR
-1.505645	54.995998	Agree	Very happy	Fair	Never, practically never	1906	65 and more years	Retired/pensioned	GBR

An irrelevant column

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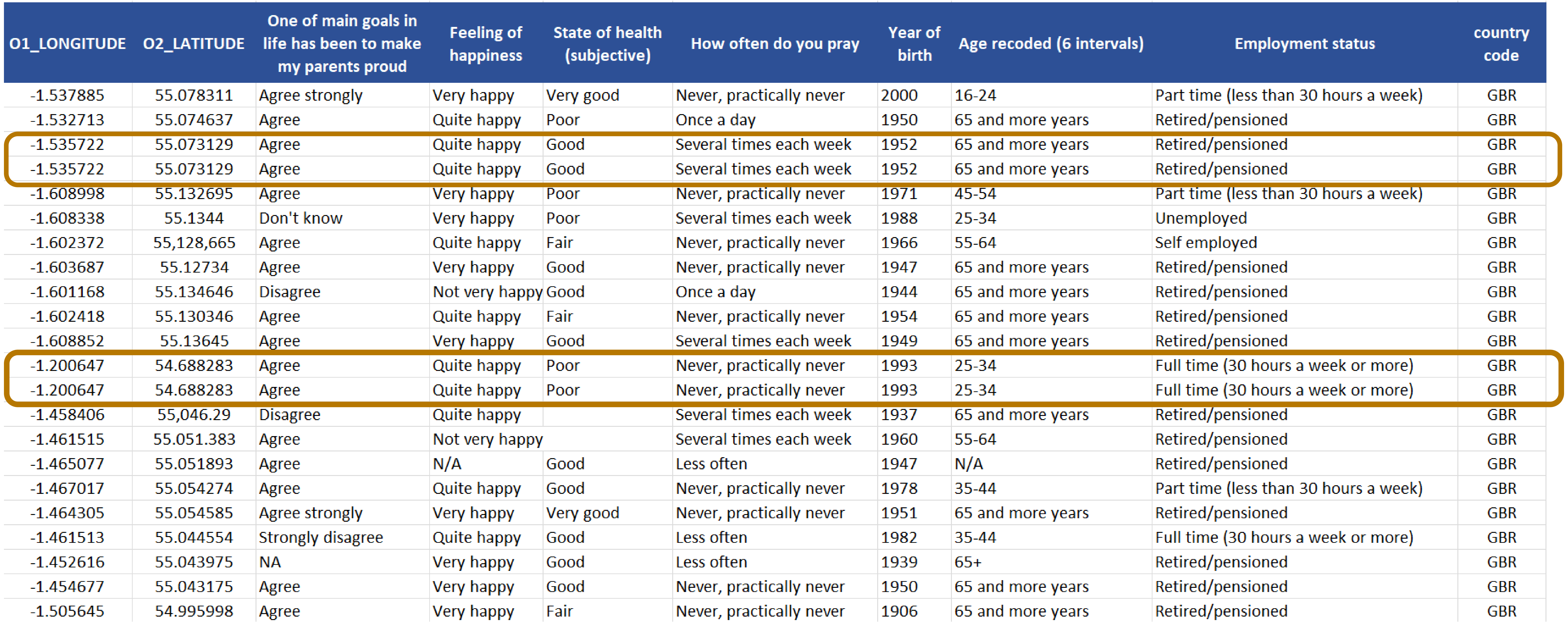

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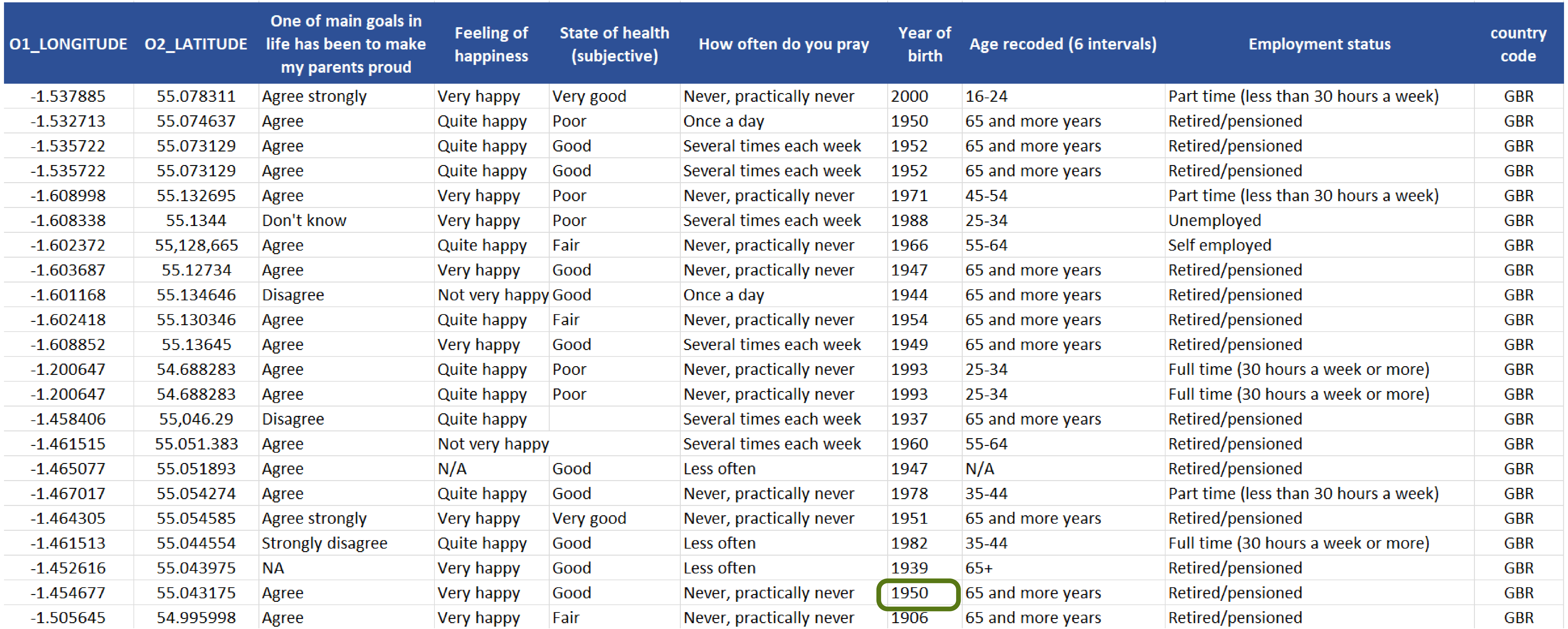
Duplicate observations

{Tidy} data management: The Why



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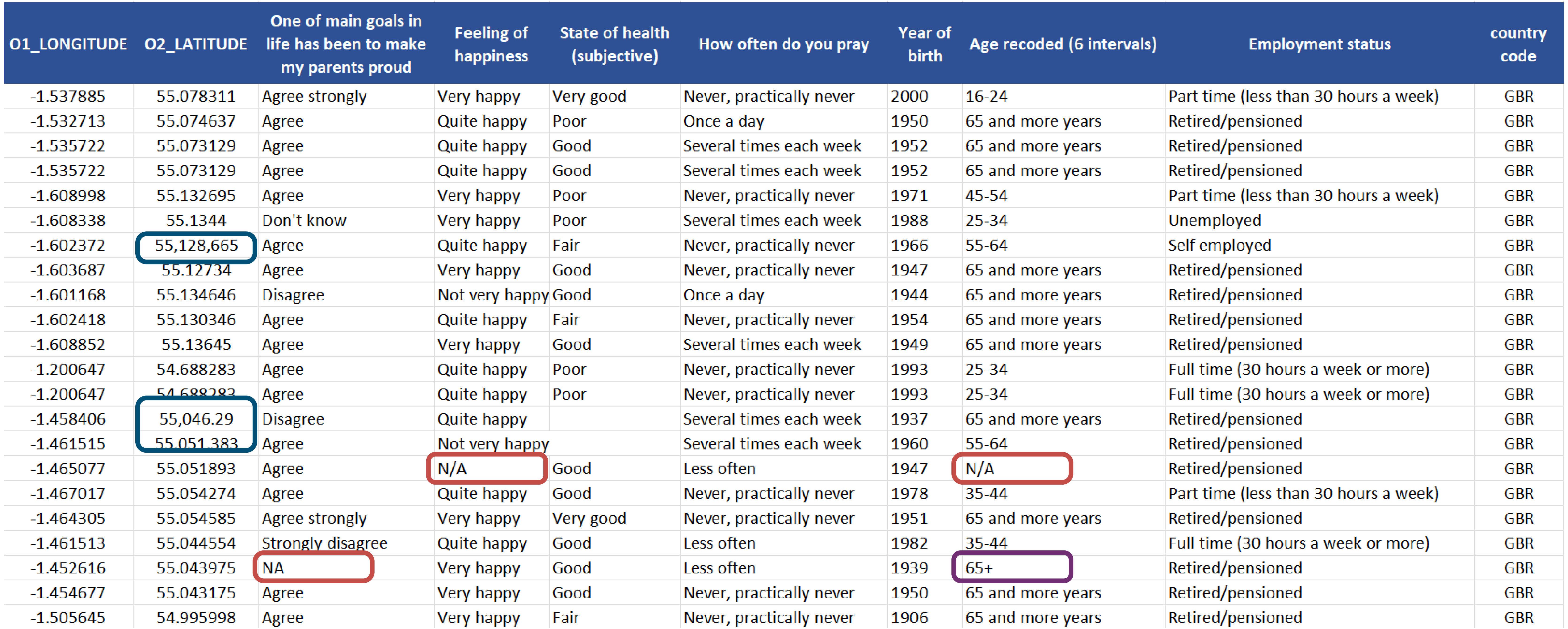
Outliers

{Tidy} data management: The Why

Structural Errors



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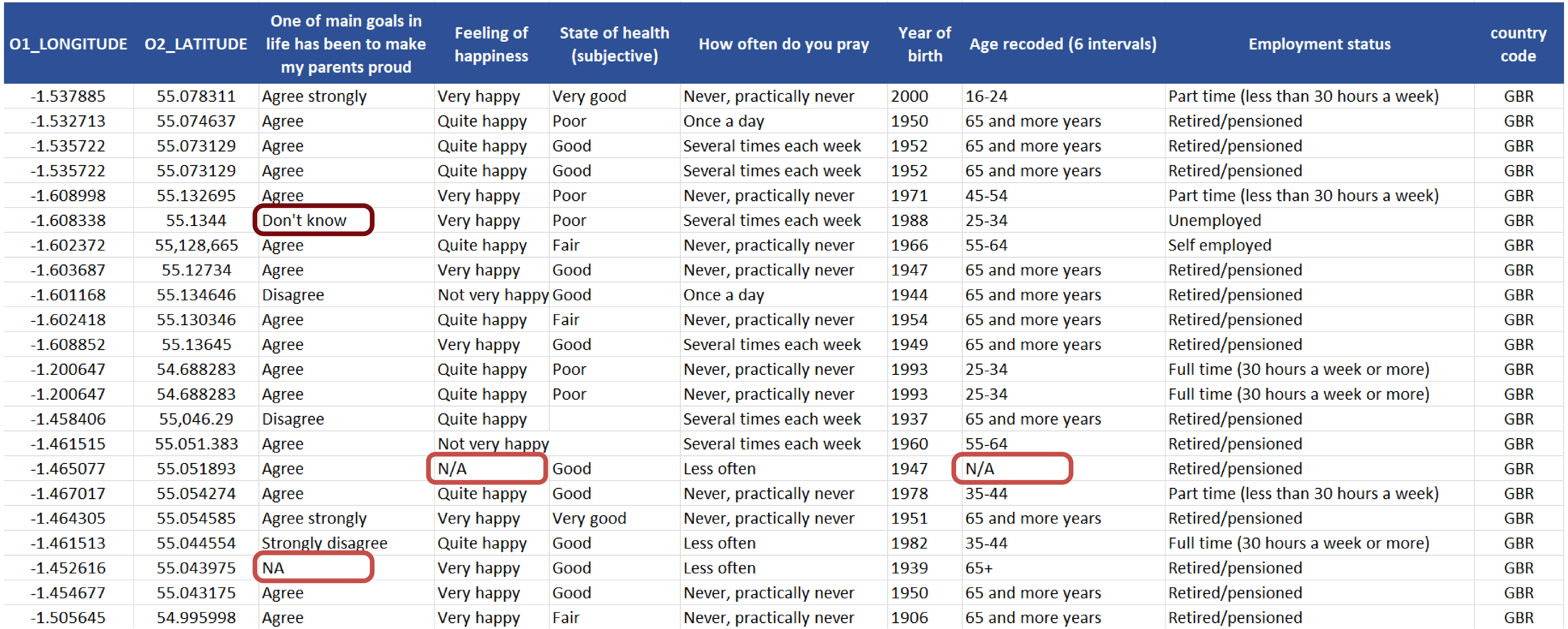

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Missing Values

{Tidy} data management

An Introduction and The How

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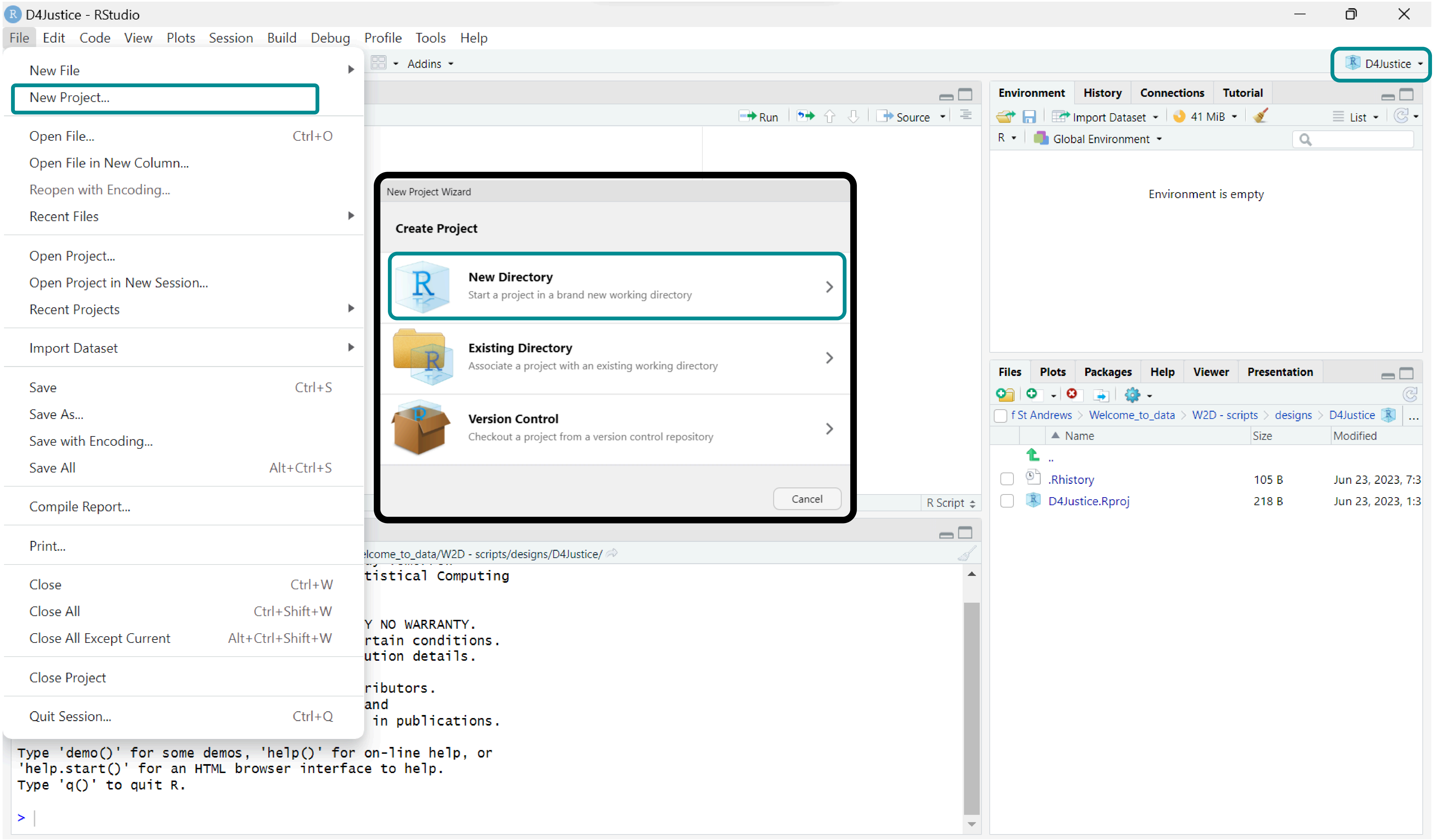

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```
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Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```
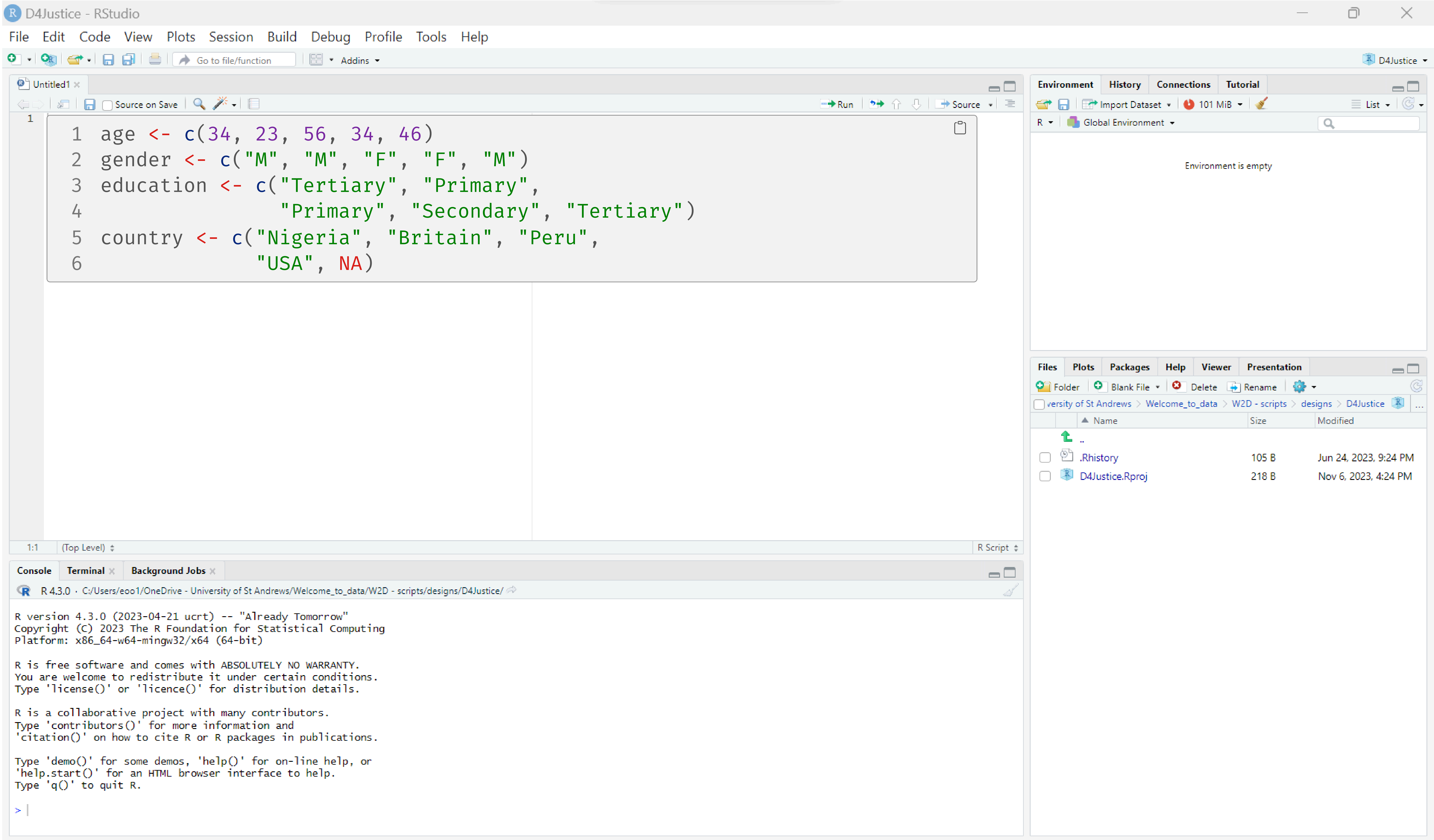

{Tidy} data management: The How



D4Justice - RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
D4Justice
Untitled1
Source on Save
Run
Source
Environment History Connections Tutorial
Import Dataset
101 MiB
List
R
Global Environment
Environment is empty
Files Plots Packages Help Viewer Presentation
Folder
Blank File
Delete
Rename
versity of St Andrews > Welcome_to_data > W2D - scripts > designs > D4Justice
Name
Size
Modified
.Rhistory
105 B
Jun 24, 2023, 9:24 PM
D4Justice.Rproj
218 B
Nov 6, 2023, 4:24 PM
1:1
(Top Level)
R Script
Console Terminal Background Jobs
R 4.3.0 · C:/Users/eoo1/OneDrive - University of St Andrews/Welcome_to_data/W2D - scripts/designs/D4Justice/

```r
age <- c(34, 23, 56, 34, 46)
gender <- c("M", "M", "F", "F", "M")
education <- c("Tertiary", "Primary",
               "Primary", "Secondary", "Tertiary")
country <- c("Nigeria", "Britain", "Peru",
             "USA", NA)
```

```
R version 4.3.0 (2023-04-21 ucrt) -- "Already Tomorrow"
Copyright (C) 2023 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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> |
```

Tidy data management: The How

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education <- c("Tertiary", "Primary",
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country <- c("Nigeria", "Britain", "Peru",
             "USA", NA)

participants <- data.frame (age, gender,
                            education, country)
```

Tidy data management: The How

```r
age <- c(34, 23, 56, 34, 46)
gender <- c("M", "M", "F", "F", "M")
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dim (participants)
```

```
[1] 5 4
```

Tidy data management: The How

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age <- c(34, 23, 56, 34, 46)
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participants <- data.frame (age, gender,
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head (participants, 3)
```

```
  age gender education country
1  34      M  Tertiary Nigeria
2  23      M   Primary Britain
3  56      F   Primary    Peru
```

Tidy data management: The How

```r
age <- c(34, 23, 56, 34, 46)
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```
  age gender education country
1  34      M  Tertiary Nigeria
2  23      M   Primary Britain
3  56      F   Primary    Peru
```

```r
tail (participants, 3)
```

```
  age gender education country
3  56      F   Primary    Peru
4  34      F Secondary     USA
5  46      M  Tertiary    <NA>
```

Tidy data management: The How

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age <- c(34, 23, 56, 34, 46)
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2  23      M   Primary Britain
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```
  age gender education country
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4  34      F Secondary     USA
5  46      M  Tertiary    <NA>
```

```
str (participants)
```

```
'data.frame':   5 obs. of  4 variables:
 $ age      : num  34 23 56 34 46
 $ gender   : chr  "M" "M" "F" "F" ...
 $ education: chr  "Tertiary" "Primary" "Primary" "Secondary"
...
 $ country  : chr  "Nigeria" "Britain" "Peru" "USA" ...
```

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...
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```

```r
str (participants$age)
```

```
 num [1:5] 34 23 56 34 46
```

{Tidy} data management

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

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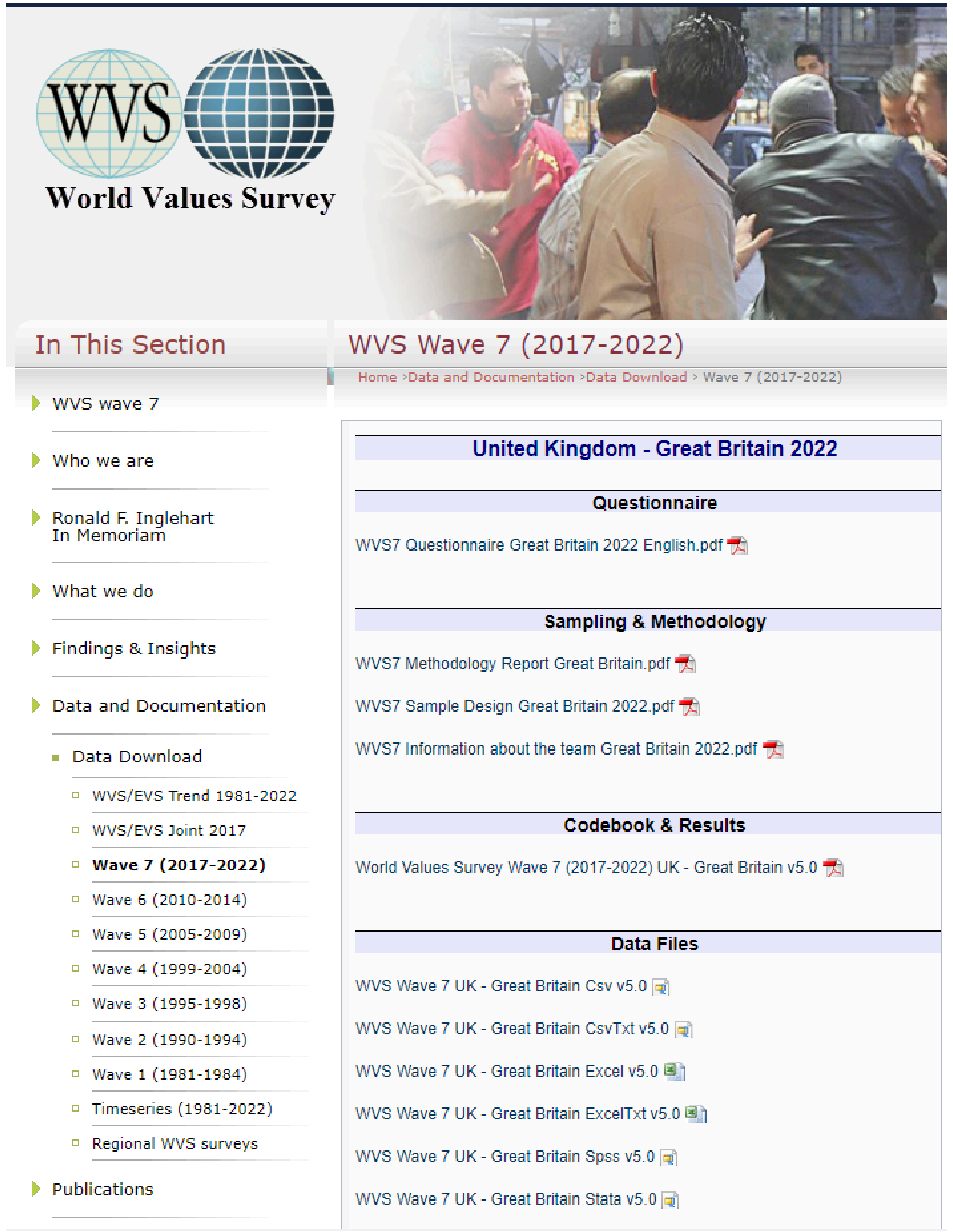
- Validate



WVS Wave 7 (2017-2022)

United Kingdom - Great Britain 2022

Questionnaire

WVS7 Questionnaire Great Britain 2022 English.pdf

Sampling & Methodology

WVS7 Methodology Report Great Britain.pdf

WVS7 Sample Design Great Britain 2022.pdf

WVS7 Information about the team Great Britain 2022.pdf

Codebook & Results

World Values Survey Wave 7 (2017-2022) UK - Great Britain v5.0

Data Files

WVS Wave 7 UK - Great Britain Csv v5.0

WVS Wave 7 UK - Great Britain CsvTxt v5.0

WVS Wave 7 UK - Great Britain Excel v5.0

WVS Wave 7 UK - Great Britain ExcelTxt v5.0

WVS Wave 7 UK - Great Britain Spss v5.0

WVS Wave 7 UK - Great Britain Stata v5.0

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

Package	Functions
readxl	read_excel('my-spreadsheet.xls', sheet = 1), read_xls('my-spreadsheet.xls'), read_xlsx('my-spreadsheet.xlsx')
readstata13	read.dta13('my-stata-data.dta')
readr	read_csv('my-csv-file.csv'), read_csv2('my-csv-file.csv'), read_delim(), read_rds()
vroom	vroom('my-csv-file.csv')
tidyxl	xlsx_cells('my_nightmare_file.xlsx')
haven	read_dta(), read_sas(), read_sav(), read_spss(), read_stata()
utils	read.csv, read.delim, read.table

{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
install.packages("haven")
install.packages("readstata13")
install.packages("tidyxl")
install.packages("readxl")
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

```r
install.packages("haven")
install.packages("readstata13")
install.packages("tidyxl")
install.packages("readxl")

library (haven)
library (readstata13)
library (tidyxl)
library (readxl)
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
install.packages("haven")
install.packages("readstata13")
install.packages("tidyxl")
install.packages("readxl")

library (haven)
library (readstata13)
library (tidyxl)
library (readxl)

?read_dta
?read_xls
?read.dta13
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

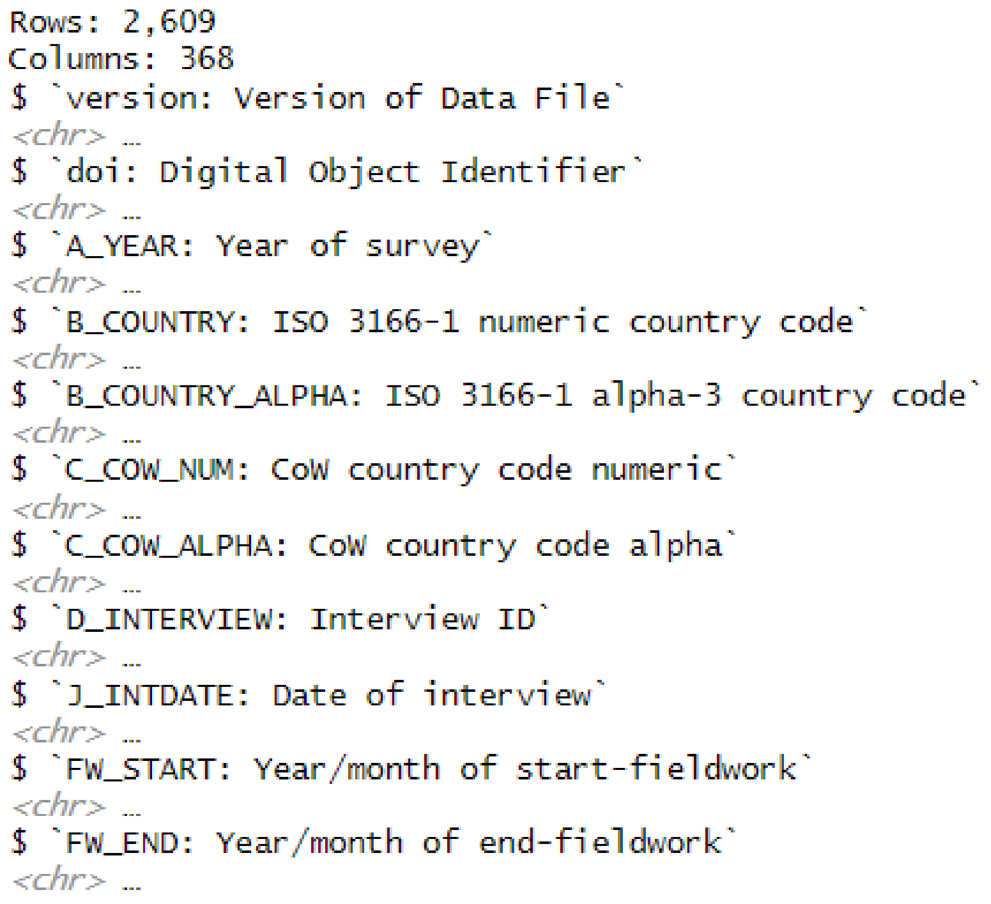
- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
library (readxl)
library(dplyr)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
glimpse(wvs_data)
```

Assess the structure of the data with `glimpse()` from dplyr 📦



```
Rows: 2,609
Columns: 368
$ `version: Version of Data File`
<chr> …
$ `doi: Digital Object Identifier`
<chr> …
$ `A_YEAR: Year of survey`
<chr> …
$ `B_COUNTRY: ISO 3166-1 numeric country code`
<chr> …
$ `B_COUNTRY_ALPHA: ISO 3166-1 alpha-3 country code`
<chr> …
$ `C_COW_NUM: CoW country code numeric`
<chr> …
$ `C_COW_ALPHA: CoW country code alpha`
<chr> …
$ `D_INTERVIEW: Interview ID`
<chr> …
$ `J_INTDATE: Date of interview`
<chr> …
$ `FW_START: Year/month of start-fieldwork`
<chr> …
$ `FW_END: Year/month of end-fieldwork`
<chr> …
```

{ *Numeric*
Integer
Character
Factor
Logical

{Tidy} data management:

A case study using the `World Value Survey`

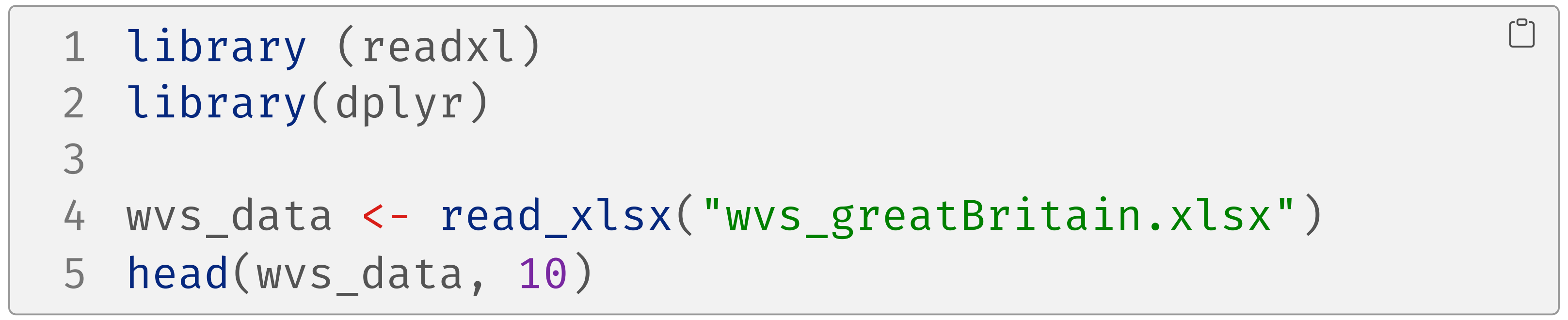
- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

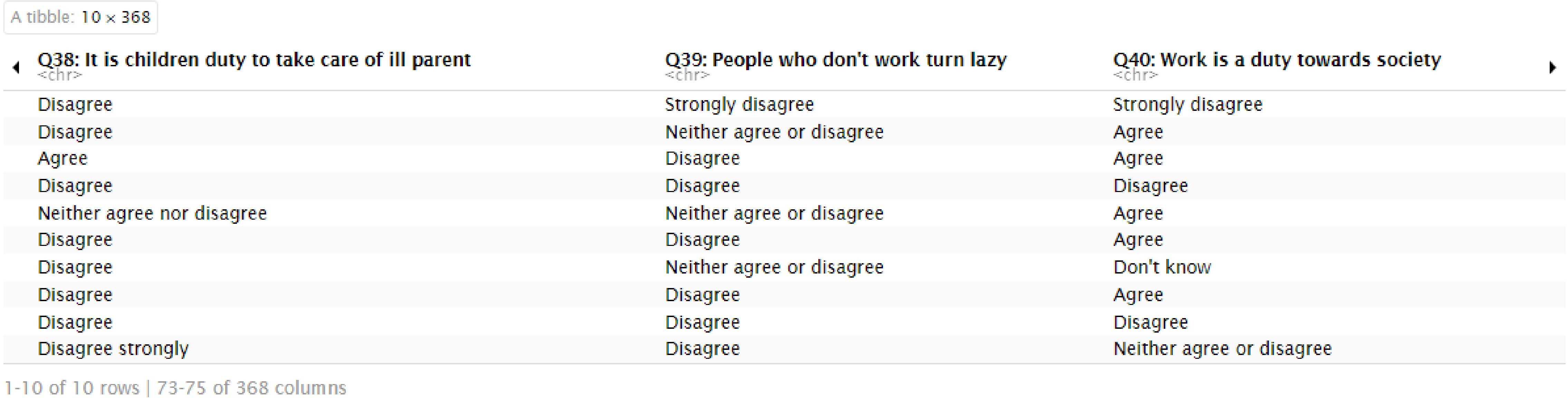
- Handle (remove) missing data

- Validate



```r
library (readxl)
library(dplyr)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
head(wvs_data, 10)
```

Assess the structure of the data with `head()` from `{utils}`



A tibble: 10 × 368

Q38: It is children duty to take care of ill parent <chr>	Q39: People who don't work turn lazy <chr>	Q40: Work is a duty towards society <chr>
Disagree	Strongly disagree	Strongly disagree
Disagree	Neither agree or disagree	Agree
Agree	Disagree	Agree
Disagree	Disagree	Disagree
Neither agree nor disagree	Neither agree or disagree	Agree
Disagree	Disagree	Agree
Disagree	Neither agree or disagree	Don't know
Disagree	Disagree	Agree
Disagree	Disagree	Disagree
Disagree strongly	Disagree	Neither agree or disagree

1-10 of 10 rows | 73-75 of 368 columns

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

SO YOU DON'T WANT TO CLEAN THE DATA
BUT YOU WANT A HIGH-QUALITY REPORT?
imgflip.com

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Inspect the first 10 rows in the data with `head()` *from* `{utils}` 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
library (readxl)
library(dplyr)
library (janitor)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
head(wvs_data, 10)
```

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Fix column names with `clean_names()` from janitor 📦

```r
library (readxl)
library(dplyr)
library (janitor)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
head(wvs_data, 10)

?clean_names

wvs_clean_data <- clean_names(wvs_data)
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

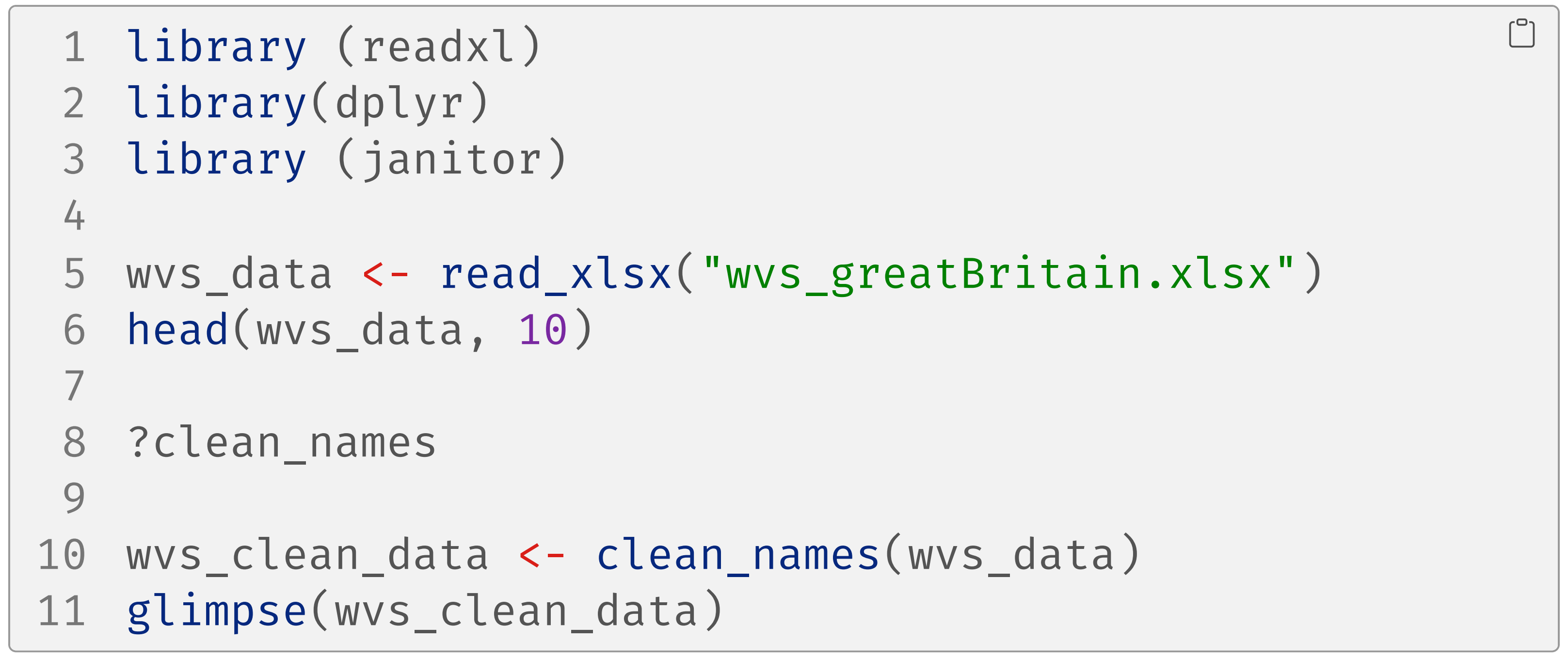
  Assess the structure of the data with `glimpse()` from dplyr 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

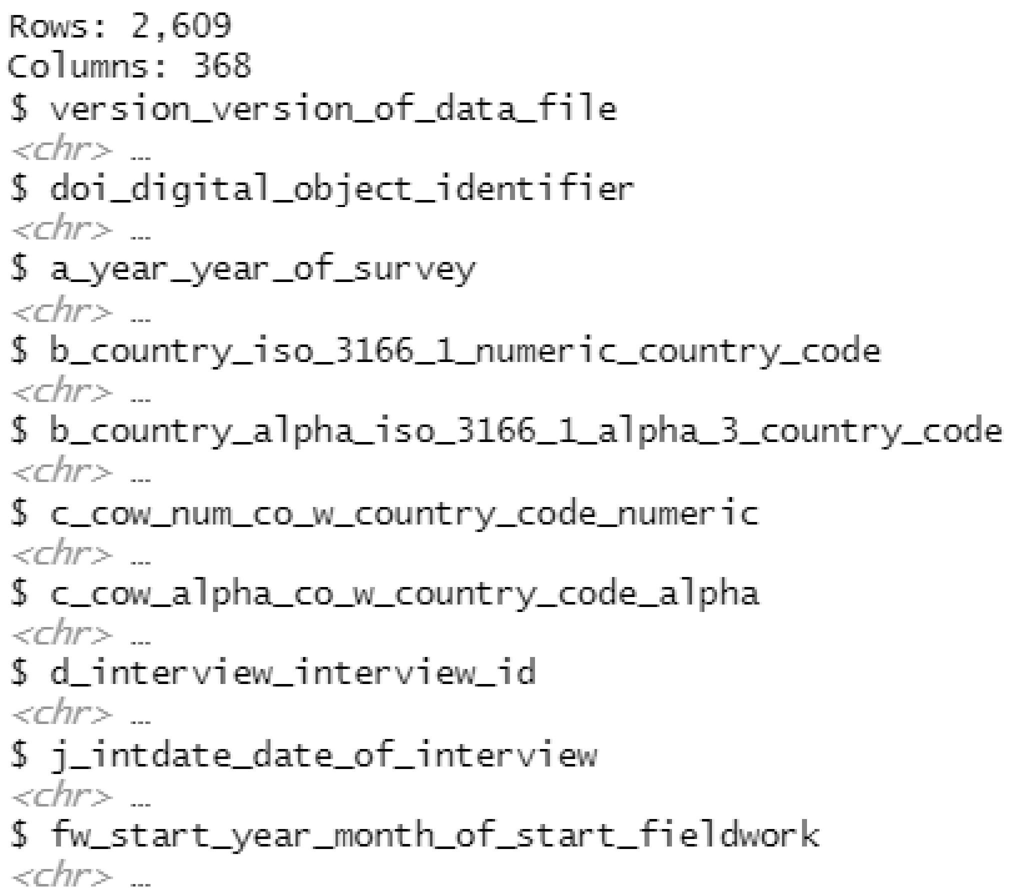
- Handle (remove) missing data

- Validate



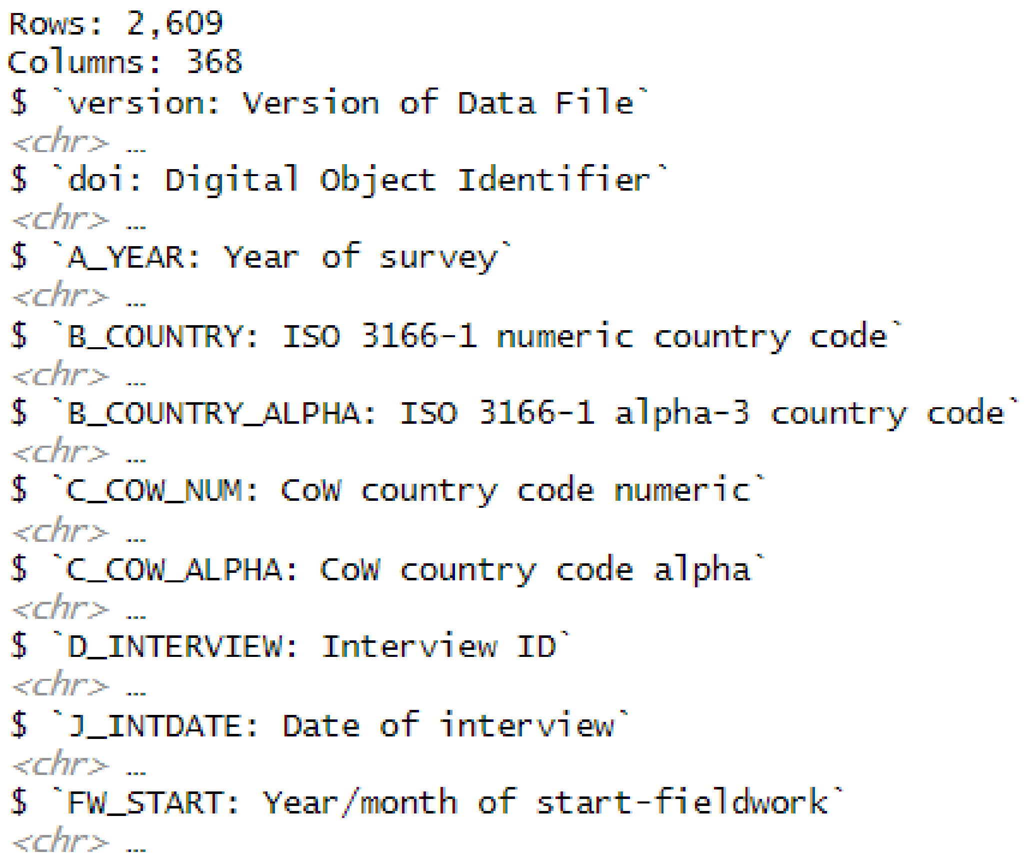
```r
library (readxl)
library(dplyr)
library (janitor)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
head(wvs_data, 10)

?clean_names

wvs_clean_data <- clean_names(wvs_data)
glimpse(wvs_clean_data)
```

Cleaned column names



```
Rows: 2,609
Columns: 368
$ version_version_of_data_file
<chr> …
$ doi_digital_object_identifier
<chr> …
$ a_year_year_of_survey
<chr> …
$ b_country_iso_3166_1_numeric_country_code
<chr> …
$ b_country_alpha_iso_3166_1_alpha_3_country_code
<chr> …
$ c_cow_num_co_w_country_code_numeric
<chr> …
$ c_cow_alpha_co_w_country_code_alpha
<chr> …
$ d_interview_interview_id
<chr> …
$ j_intdate_date_of_interview
<chr> …
$ fw_start_year_month_of_start_fieldwork
<chr> …
```

Uncleaned column names



```
Rows: 2,609
Columns: 368
$ `version: Version of Data File`
<chr> …
$ `doi: Digital Object Identifier`
<chr> …
$ `A_YEAR: Year of survey`
<chr> …
$ `B_COUNTRY: ISO 3166-1 numeric country code`
<chr> …
$ `B_COUNTRY_ALPHA: ISO 3166-1 alpha-3 country code`
<chr> …
$ `C_COW_NUM: CoW country code numeric`
<chr> …
$ `C_COW_ALPHA: CoW country code alpha`
<chr> …
$ `D_INTERVIEW: Interview ID`
<chr> …
$ `J_INTDATE: Date of interview`
<chr> …
$ `FW_START: Year/month of start-fieldwork`
<chr> …
```

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Keep only the relevant columns with `select()` from dplyr 📦

- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
library (readxl)
library(dplyr)
library (janitor)

wvs_data <- read_xlsx("wvs_greatBritain.xlsx")
head(wvs_data, 10)

?clean_names

wvs_clean_data <- clean_names(wvs_data)

sub_wvs_data <- wvs_clean_data %>%
                ## Select a few columns
                select(a_year_year_of_survey,
                       q261_year_of_birth,
                       q260_sex,
                       h_urbrural_urban_rural,
                       q269_respondent_citizen
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

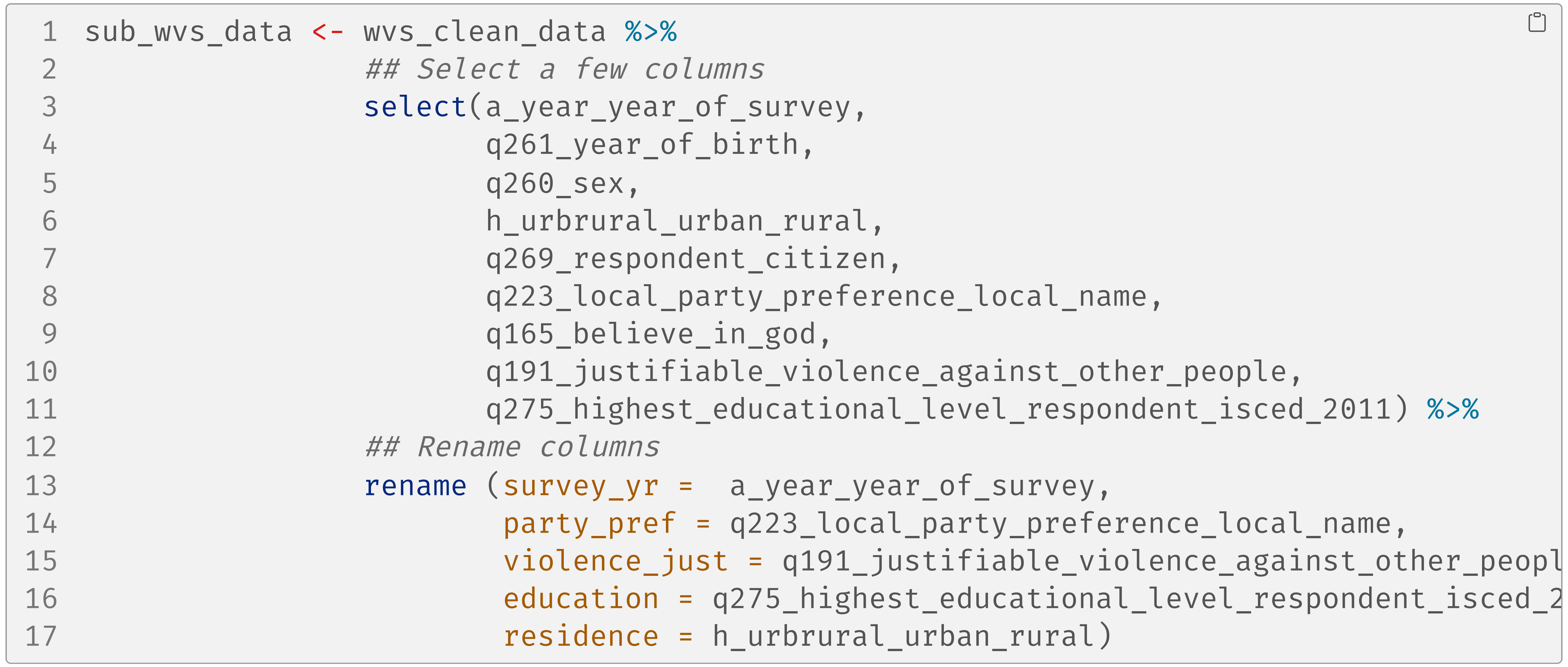
  Rename columns with long or complicated names with `rename()` from dplyr 📦

- Remove duplicate or irrelevant observations

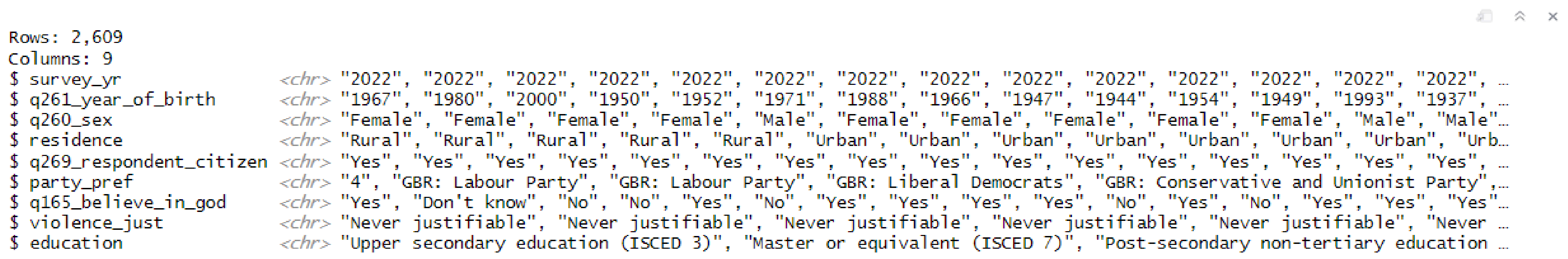
- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate



```r
sub_wvs_data <- wvs_clean_data %>%
                ## Select a few columns
                select(a_year_year_of_survey,
                       q261_year_of_birth,
                       q260_sex,
                       h_urbrural_urban_rural,
                       q269_respondent_citizen,
                       q223_local_party_preference_local_name,
                       q165_believe_in_god,
                       q191_justifiable_violence_against_other_people,
                       q275_highest_educational_level_respondent_isced_2011) %>%
                ## Rename columns
                rename (survey_yr =  a_year_year_of_survey,
                        party_pref = q223_local_party_preference_local_name,
                        violence_just = q191_justifiable_violence_against_other_peopl
                        education = q275_highest_educational_level_respondent_isced_2
                        residence = h_urbrural_urban_rural)
```



```
Rows: 2,609
Columns: 9
$ survey_yr               <chr> "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", "2022", …
$ q261_year_of_birth      <chr> "1967", "1980", "2000", "1950", "1952", "1971", "1988", "1966", "1947", "1944", "1954", "1949", "1993", "1937", …
$ q260_sex                <chr> "Female", "Female", "Female", "Female", "Male", "Female", "Female", "Female", "Female", "Female", "Male", "Male"…
$ residence               <chr> "Rural", "Rural", "Rural", "Rural", "Rural", "Urban", "Urban", "Urban", "Urban", "Urban", "Urban", "Urban", "Urb…
$ q269_respondent_citizen <chr> "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", "Yes", …
$ party_pref              <chr> "4", "GBR: Labour Party", "GBR: Labour Party", "GBR: Liberal Democrats", "GBR: Conservative and Unionist Party",…
$ q165_believe_in_god     <chr> "Yes", "Don't know", "No", "No", "Yes", "No", "Yes", "Yes", "Yes", "Yes", "No", "Yes", "No", "Yes", "Yes", "Yes"…
$ violence_just           <chr> "Never justifiable", "Never justifiable", "Never justifiable", "Never justifiable", "Never justifiable", "Never …
$ education               <chr> "Upper secondary education (ISCED 3)", "Master or equivalent (ISCED 7)", "Post-secondary non-tertiary education …
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

  Tabulate a few columns to understand the structure and identify potential structural errors with `table()` from `{base}` 📦

```r
table (sub_wvs_data$q260_sex)
```

```
                                    Female 
                                      1471 
                                      Male 
                                      1105 
                                 No answer 
                                        17 
Other missing; Multiple answers Mail (EVS) 
                                        16 
```

```r
table (sub_wvs_data$party_pref)
```

```
                                  -1                                   -2 
                                 261                                  111 
                                  -5                                    4 
                                  19                                  271 
                                   5          GBR: British National Party 
                                  19                                    3 
GBR: Conservative and Unionist Party       GBR: Democratic Unionist Party 
                                 552                                    2 
                    GBR: Green Party              GBR: Independence Party 
                                 178                                   20 
                   GBR: Labour Party               GBR: Liberal Democrats 
                                 702                                  229 
                    GBR: Plaid Cymru                       GBR: Reform UK 
                                  40                                   24 
        GBR: Scottish National Party                       GBR: Sinn Féin 
```

- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the World Value Survey

- **Fix structural errors**

  Create a new object wvs_clean_1 from wvs_clean_1

```r
wvs_clean_1 <- sub_wvs_data
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Create a variable (replace if existing) with `mutate()` from dplyr

```r
wvs_clean_1 <- sub_wvs_data %>%
               mutate (q260_sex = if_else((q260_sex != "Female" & q260_sex != "Male"),
                                          true = NA,
                                          false = q260_sex,
                                          missing = NA))
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Replace values that don't meet a condition to NA with `ifelse()` from dplyr

```r
wvs_clean_1 <- sub_wvs_data %>%
               mutate (q260_sex = if_else((q260_sex != "Female" & q260_sex != "Male"),
                                          true = NA,
                                          false = q260_sex,
                                          missing = NA))
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the World Value Survey

- **Fix structural errors**

  Replace all less meaningful values to missing (NA) with `ifelse()` from dplyr 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wvs_clean_1 <- sub_wvs_data %>%
               mutate (q260_sex = if_else((q260_sex != "Female" & q260_sex != "Male"),
                                          true = NA,
                                          false = q260_sex,
                                          missing = NA),

                       residence = if_else((residence == "No answer; Missing"),
                                          true = NA,
                                          false = residence,
                                          missing = NA),

                       q269_respondent_citizen = if_else((q269_respondent_citizen != "No" &
                                                            q269_respondent_citizen != "Yes"),
                                                          true = NA,
                                                          false = q269_respondent_citizen,
                                                          missing = NA),

                       q261_year_of_birth = if_else((q261_year_of_birth == "No answer" |
                                                            q261_year_of_birth == "Other missing;
                                                          true = NA,
```

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Assess the structure of the data, again with `glimpse()` and tabulate with `table()`

```r
glimpse(wvs_clean_1$q261_year_of_birth)
```

```
chr [1:2609] "1967" "1980" "2000" "1950" "1952" "1971" "1988" "1966" ...
```

```r
table(wvs_clean_1$violence_just)
```

```
                  2                   3                   4                   5 
                277                 168                  63                 107 
                  6                   7                   8 Always justifiable 
                 22                  21                   5                  12 
Never justifiable 
               1913 
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Create a variable (replace if existing) with `mutate()` from dplyr 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wvs_clean_2 <- wvs_clean_1 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence))
```

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Convert values in a variable to numeric with `as.numeric()` and to categories with `as.factor()` from `{base}` 📦

```r
wvs_clean_2 <- wvs_clean_1 %>%
                mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                        survey_yr = as.numeric(survey_yr),
                        q260_sex = as.factor(q260_sex),
                        q269_respondent_citizen = as.factor(q269_respondent_citizen),
                        residence = as.factor(residence))
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

  Recode values in a variable with `case_when()` from dplyr

```r
wvs_clean_3 <- wvs_clean_2 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence)) %>%
               mutate (violence_just = case_when(violence_just == "Always justifiable" ~ 9,
                                                 violence_just == "Never justifiable" ~ 1,
                                                 .default = as.numeric(violence_just)))
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the World Value Survey

- **Fix structural errors**

  Assess the structure of the data with *glimpse()* *from dplyr*

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wvs_clean_3 <- wvs_clean_2 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence)) %>%
               mutate (violence_just = case_when(violence_just == "Always justifiable" ~ 9,
                                                 violence_just == "Never justifiable" ~ 1,
                                                 .default = as.numeric(violence_just)))

str (wvs_clean_3$violence_just)
```

```
num [1:2609] 1 1 1 1 1 1 1 1 1 1 ...
```

```r
table (wvs_clean_3$violence_just)
```

```

   1    2    3    4    5    6    7    8    9 
1913  277  168   63  107   22   21    5   12 
```

{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors

```r
wvs_clean_3 <- wvs_clean_2 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence)) %>%
               mutate (violence_just = case_when(violence_just == "Always justifiable" ~ 9,
                                                 violence_just == "Never justifiable" ~ 1,
                                                 .default = as.numeric(violence_just)))
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Create a variable–age (replace if existing) with `mutate()` from dplyr 📦

```r
wvs_clean_3 <- wvs_clean_2 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence)) %>%
               mutate (violence_just = case_when(violence_just == "Always justifiable" ~ 9,
                                                 violence_just == "Never justifiable" ~ 1,
                                                 .default = as.numeric(violence_just))) %>%

               mutate (age = survey_yr - q261_year_of_birth)
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- **Fix structural errors**

  Assess the distribution of age with `table()` from `{base}`

```r
wvs_clean_3 <- wvs_clean_2 %>%
               mutate (q261_year_of_birth = as.numeric(q261_year_of_birth),
                       survey_yr = as.numeric(survey_yr),
                       q260_sex = as.factor(q260_sex),
                       q269_respondent_citizen = as.factor(q269_respondent_citizen),
                       residence = as.factor(residence)) %>%
               mutate (violence_just = case_when(violence_just == "Always justifiable" ~ 9,
                                                 violence_just == "Never justifiable" ~ 1,
                                                 .default = as.numeric(violence_just))) %>%

               mutate (age = survey_yr - q261_year_of_birth)

table (wvs_clean_3$age)
```

```

19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
25 15 16 30 33 33 22 33 36 27 29 40 48 58 41 45 36 32 45 37 43 35 46 33 45 42
45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70
39 43 29 40 30 34 35 43 38 41 47 40 46 39 43 52 37 43 22 45 47 49 34 42 37 47
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 94 95 96 99
42 31 42 39 39 38 22 40 18 27 19 13 17 19 18 15  5 10  7  6  7  3  1  3  3  1
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

That colleague who is able
to fix structural errors in the data
Will you please listen? I'm not the messiah
Everyone else:
HE IS THE MESSIAH!
imgflip.com

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- *Remove duplicate or irrelevant observations*

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- ***Remove duplicate or irrelevant observations***

  Keep only data (or observations) from young adults aged 18-34 years with `filter()` from dplyr 📦

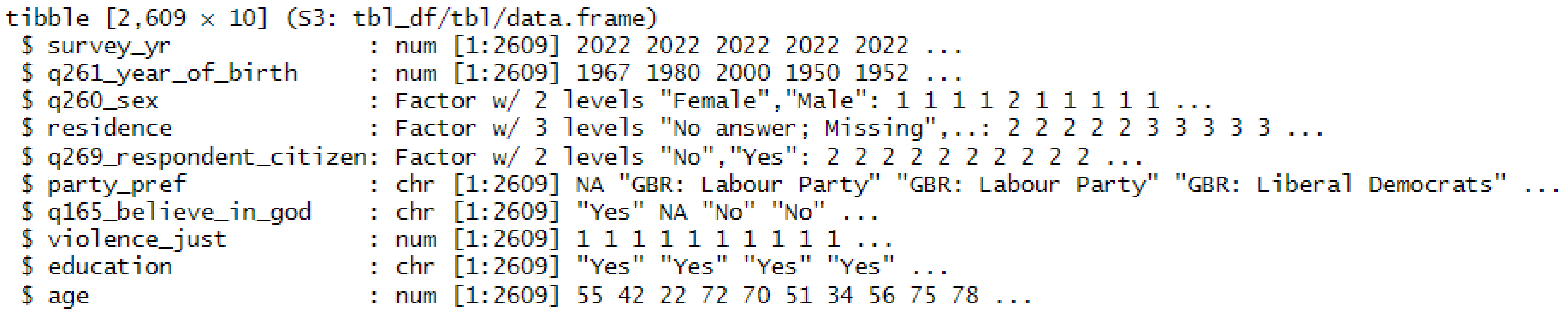
- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wvs_clean_4 <- wvs_clean_3 %>%
               filter (age >= 18 & age <= 34)

str (wvs_clean_4)
```

```
tibble [531 × 10] (S3: tbl_df/tbl/data.frame)
 $ survey_yr               : num [1:531] 2022 2022 2022 2022 2022 ...
 $ q261_year_of_birth      : num [1:531] 2000 1988 1993 1996 1990 ...
 $ q260_sex                : Factor w/ 2 levels "Female","Male": 1 1 2 2 2 1 1 1 1 1 ...
 $ residence               : Factor w/ 2 levels "Rural","Urban": 1 2 2 2 2 1 1 1 1 2 ...
 $ q269_respondent_citizen: Factor w/ 2 levels "No","Yes": 2 2 2 2 2 2 2 2 2 2 ...
 $ party_pref              : chr [1:531] "GBR: Labour Party" NA "GBR: Labour Party" "GBR: Conservative
and Unionist Party" ...
 $ q165_believe_in_god     : chr [1:531] "No" "Yes" "No" "No" ...
 $ violence_just           : num [1:531] 1 1 5 3 6 1 1 1 3 3 ...
 $ education               : chr [1:531] "Post-secondary non-tertiary education (ISCED 4)" "Upper
secondary education (ISCED 3)" "Bachelor or equivalent (ISCED 6)" "Bachelor or equivalent (ISCED 6)"
```



```
tibble [2,609 × 10] (S3: tbl_df/tbl/data.frame)
 $ survey_yr              : num [1:2609] 2022 2022 2022 2022 2022 ...
 $ q261_year_of_birth     : num [1:2609] 1967 1980 2000 1950 1952 ...
 $ q260_sex               : Factor w/ 2 levels "Female","Male": 1 1 1 1 2 1 1 1 1 1 ...
 $ residence              : Factor w/ 3 levels "No answer; Missing",..: 2 2 2 2 2 3 3 3 3 3 ...
 $ q269_respondent_citizen: Factor w/ 2 levels "No","Yes": 2 2 2 2 2 2 2 2 2 2 ...
 $ party_pref             : chr [1:2609] NA "GBR: Labour Party" "GBR: Labour Party" "GBR: Liberal Democrats" ...
 $ q165_believe_in_god    : chr [1:2609] "Yes" NA "No" "No" ...
 $ violence_just          : num [1:2609] 1 1 1 1 1 1 1 1 1 1 ...
 $ education              : chr [1:2609] "Yes" "Yes" "Yes" "Yes" ...
 $ age                    : num [1:2609] 55 42 22 72 70 51 34 56 75 78 ...
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- ***Handle (remove) unwanted outliers***
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

- ***Handle (remove) unwanted outliers***

  Tabulate a variable to assess the distribution with `table()` from `{base}`

- Handle (remove) missing data

- Validate

```r
table(wvs_clean_4$education)
```

```
                  Bachelor or equivalent (ISCED 6)
                                               150
                  Doctoral or equivalent (ISCED 8)
                                                 4
Early childhood education (ISCED 0) / no education
                                                 4
               Lower secondary education (ISCED 2)
                                               105
                    Master or equivalent (ISCED 7)
                                                75
   Post-secondary non-tertiary education (ISCED 4)
                                                11
                       Primary education (ISCED 1)
                                                 3
          Short-cycle tertiary education (ISCED 5)
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- ***Handle (remove) unwanted outliers***

  Recode education to Secondary or less vs Post-secondary with `case_when()` from dplyr 📦
- Handle (remove) missing data
- Validate

```r
wvs_clean_4 <- wvs_clean_4 %>%
               mutate (education = case_when((education == "Early childhood education (ISCED 0) /
                                               education == "Primary education (ISCED 1)" |
                                                education == "Upper secondary education (ISCED 3)
                                               education == "Lower secondary education (ISCED 2)"


                                             (education == "Short-cycle tertiary education (ISCED
                                                education == "Post-secondary non-tertiary educati
                                                education == "Bachelor or equivalent (ISCED 6)" |
                                                education == "Master or equivalent (ISCED 7)" |
                                                education == "Doctoral or equivalent (ISCED 8)")

                                             .default = factor(education)))

table (wvs_clean_4$education)
```

```
Post-secondary Secondary or less
           290               221
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

```r
table(wvs_clean_4$violence_just)
```

```

  1   2   3   4   5   6   7   8   9 
330  69  51  25  32   5   9   2   2 
```

- Remove duplicate or irrelevant observations

- ***Handle (remove) unwanted outliers***

  Tabulate a variable to assess the distribution with `table()` from `{base}` 📦

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- ***Handle (remove) unwanted outliers***

  Dummy-code responses to violence justification `if_else()` from dplyr
- Handle (remove) missing data
- Validate

```r
wvs_clean_4 <- wvs_clean_4 %>%
               mutate (violence_just = if_else((violence_just >= 2),
                                               true = "Justified",
                                               false = "Never justified",
                                               missing = NA)) %>%
               mutate (violence_just = as.factor(violence_just))

table (wvs_clean_4$violence_just)
```

```
Justified Never justified
      195             330
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- ***Handle (remove) missing data***
- Validate

{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Check if there are any missing values in the data with `anyNA()` from `{base}`

- Validate

```r
anyNA(wvs_clean_4)
```

```
[1] TRUE
```

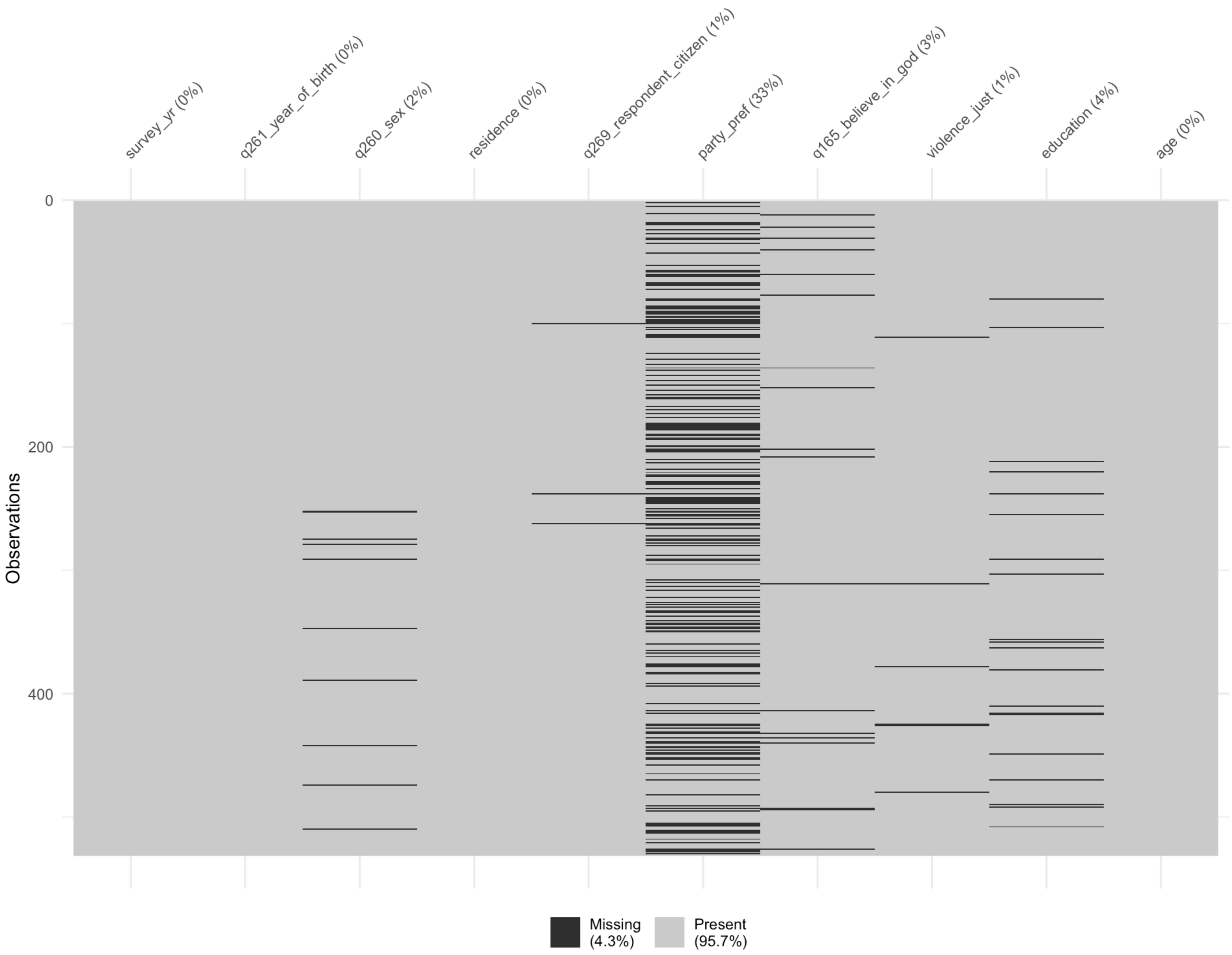
{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- ***Handle (remove) missing data***

  Visualise missing values across the dataset with `vis_miss()` from visdat 📦
- Validate

```
library (visdat)
vis_miss(wvs_clean_4)
```



{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Remove missing values in each column with `filter()` from dplyr 📦

- Validate

```
library (visdat)
vis_miss(wvs_clean_4)

wvs_clean_5 <-  wvs_clean_4 %>%
                filter (!is.na (q260_sex) &
                          !is.na(residence) &
                          !is.na(q269_respondent_citizen))
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Check whether a column has missing values with `is.na()` from `{base}` 📦

- Validate

```r
library (visdat)
vis_miss(wvs_clean_4)

wvs_clean_5 <-  wvs_clean_4 %>%
                filter (!is.na (q260_sex) &
                          !is.na(residence) &
                          !is.na(q269_respondent_citizen))
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

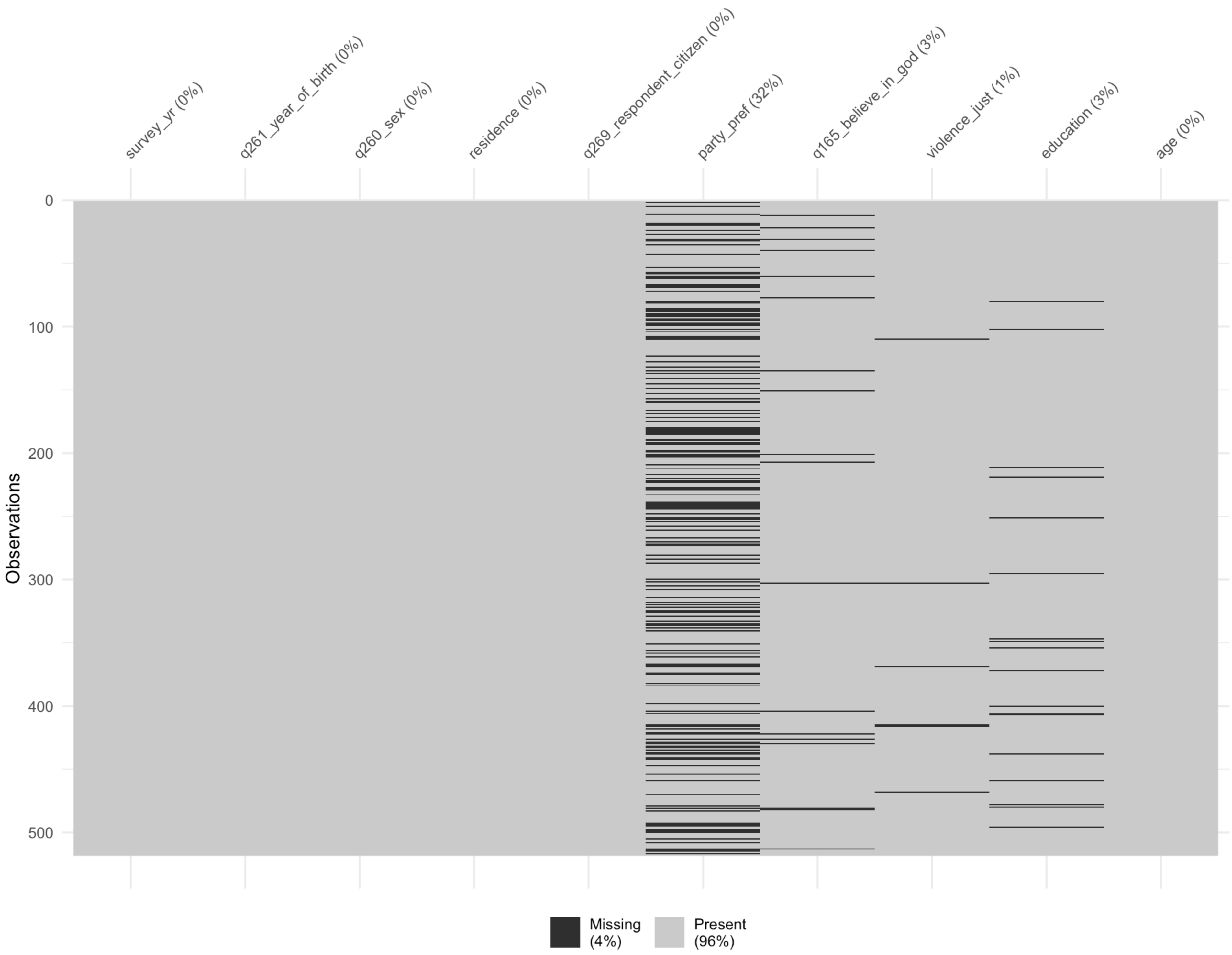
- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Visualise missing values across the dataset with `vis_miss()` from visdat

- Validate

```r
library (visdat)
vis_miss(wvs_clean_5)
```



{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Remove missing values in each column with `filter()` from dplyr 📦

- Validate

```r
library (visdat)
vis_miss(wvs_clean_4)

wvs_clean_5 <-  wvs_clean_4 %>%
                filter (!is.na (q260_sex) &
                          !is.na(residence) &
                          !is.na(q269_respondent_citizen))
```

{Tidy} data management:

A case study using the World Value Survey

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Remove missing values in each column with *`filter()`* *from dplyr* 📦

- Validate

```r
library (visdat)
vis_miss(wvs_clean_4)

wvs_clean_5 <-  wvs_clean_4 %>%
                filter (!is.na (q260_sex) &
                          !is.na(residence) &
                          !is.na(q269_respondent_citizen)) %>%
                filter (!is.na (party_pref) &
                          !is.na(q165_believe_in_god) &
                          !is.na(violence_just) &
                          !is.na(education))
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

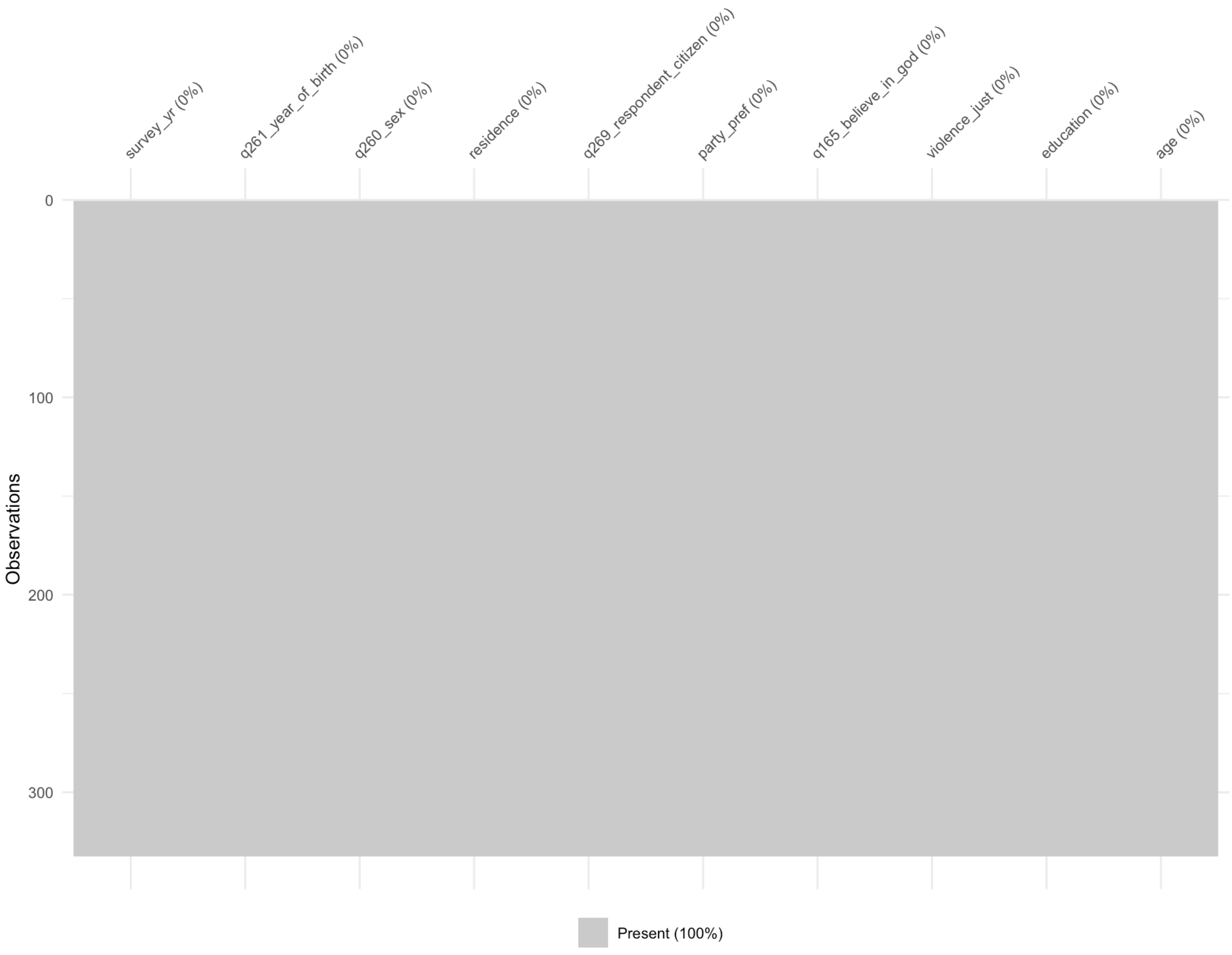
- Handle (remove) unwanted outliers

- ***Handle (remove) missing data***

  Visualise missing values across the dataset with `vis_miss()` from visdat

- Validate

```r
library (visdat)
vis_miss(wvs_clean_5)
```



{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- *Validate*

THAT FEELING WHEN YOU GET
WHEN YOU'VE SUCCESSFULLY CLEANED YOUR DATA
imgflip.com

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- ***Validate***
  Assess the data dimensions with `dim()` from `{base}`

```r
## Sample of young people with complete cases
dim(wvs_clean_5)
```

```
[1] 332  10
```

```r
## Full sample of young people with missing cases
dim(wvs_clean_4)
```

```
[1] 531  10
```

```r
## Full adult sample in the dataset with missing cases
dim(wvs_clean_3)
```

```
[1] 2609   10
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- ***Validate***
  Assess the data dimensions with `dim()` from `{base}` 📦

```r
## Sample of young people with complete cases
dim(wvs_clean_5)
```

```
[1] 332  10
```

```r
## Full sample of young people with missing cases
dim(wvs_clean_4)
```

```
[1] 531  10
```

```r
## Full adult sample in the dataset with missing cases
dim(wvs_clean_3)
```

```
[1] 2609   10
```

{Tidy} data management:

A case study using the `World Value Survey`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- ***Validate***
  Assess the data dimensions with `dim()` from `{base}` 📦

```r
## Sample of young people with complete cases
dim(wvs_clean_5)
```

```
[1] 332  10
```

```r
## Full sample of young people with missing cases
dim(wvs_clean_4)
```

```
[1] 531  10
```

```r
## Full adult sample in the dataset with missing cases
dim(wvs_clean_3)
```

```
[1] 2609   10
```

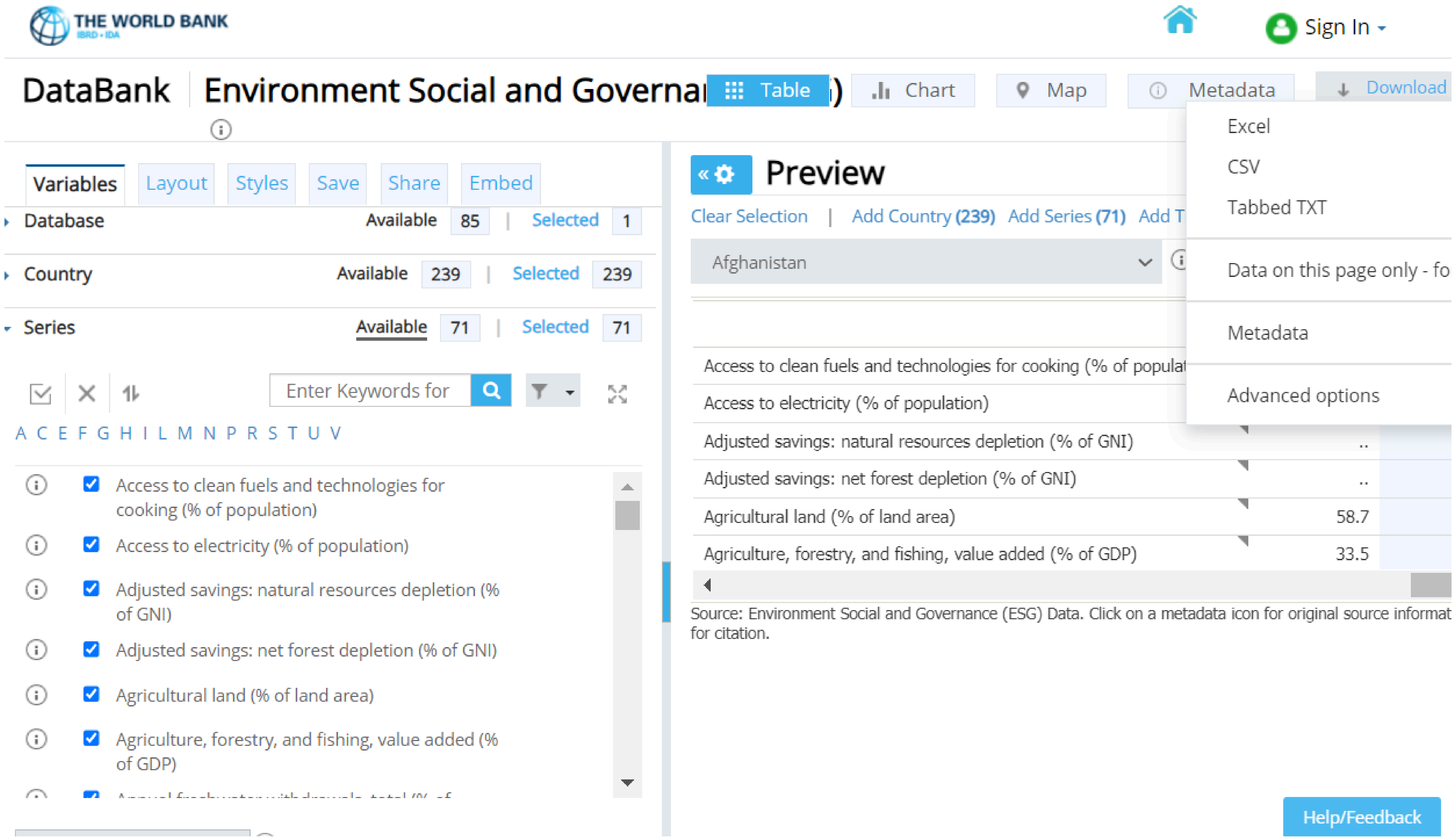
{Tidy} data management

A case study using the `World Bank Data`

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate



	Available	Selected
Database	85	1
Country	239	239
Series	71	71

- ☑ Access to clean fuels and technologies for cooking (% of population)
- ☑ Access to electricity (% of population)
- ☑ Adjusted savings: natural resources depletion (% of GNI)
- ☑ Adjusted savings: net forest depletion (% of GNI)
- ☑ Agricultural land (% of land area)
- ☑ Agriculture, forestry, and fishing, value added (% of GDP)

Afghanistan

Access to clean fuels and technologies for cooking (% of populat	
Access to electricity (% of population)	
Adjusted savings: natural resources depletion (% of GNI)	..
Adjusted savings: net forest depletion (% of GNI)	..
Agricultural land (% of land area)	58.7
Agriculture, forestry, and fishing, value added (% of GDP)	33.5

Source: Environment Social and Governance (ESG) Data. Click on a metadata icon for original source informat for citation.

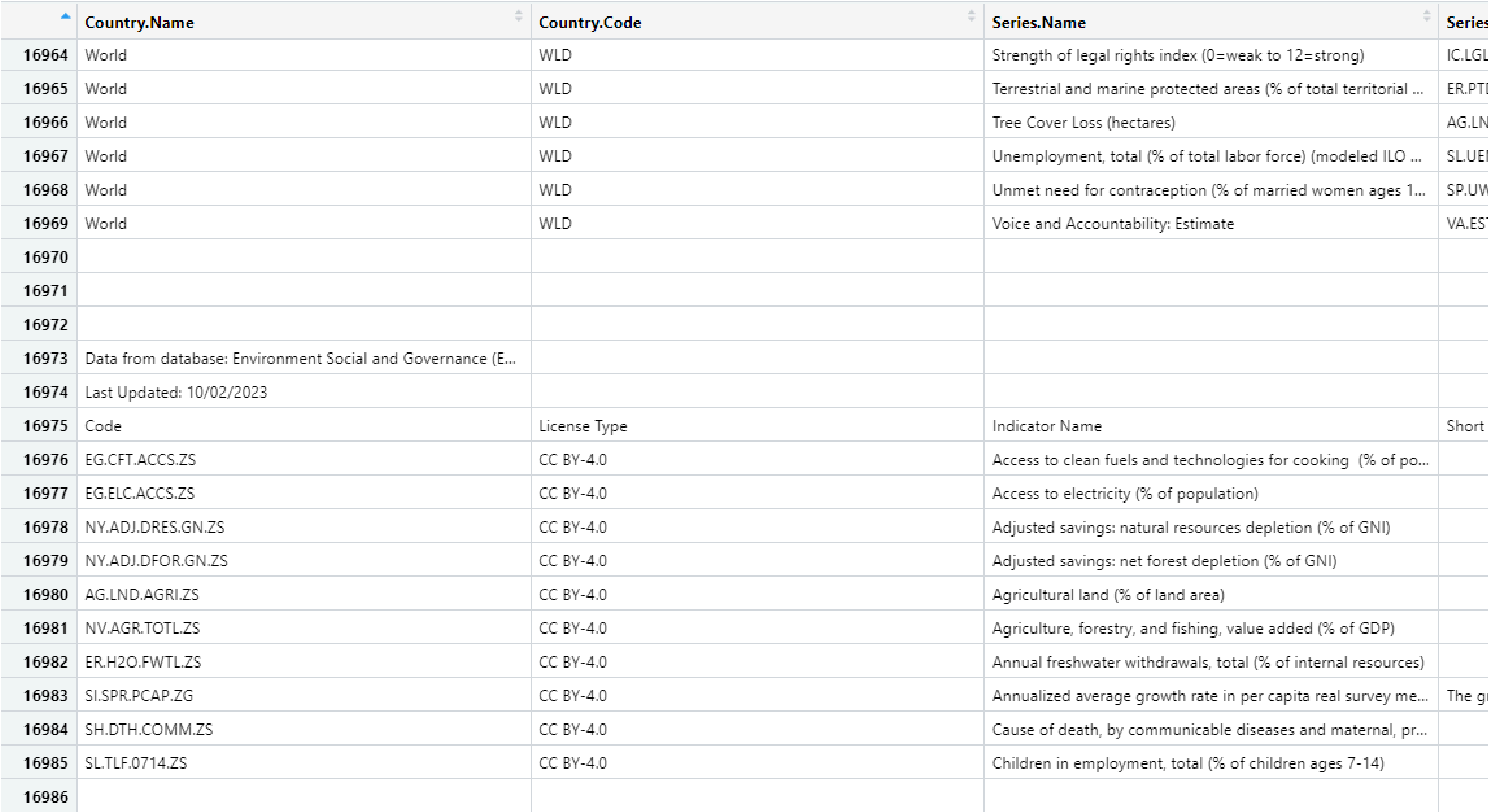
{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
library(dplyr)
wb_dt <- read.csv("wb_databank.csv")

head(wb_dt, 10)
tail(wb_dt, 10)
```

Inspect the last 10 rows in the data with `tail()` from `{utils}` 📦



	Country.Name	Country.Code	Series.Name	Series
16964	World	WLD	Strength of legal rights index (0=weak to 12=strong)	IC.LGL
16965	World	WLD	Terrestrial and marine protected areas (% of total territorial ...	ER.PTI
16966	World	WLD	Tree Cover Loss (hectares)	AG.LN
16967	World	WLD	Unemployment, total (% of total labor force) (modeled ILO ...	SL.UEI
16968	World	WLD	Unmet need for contraception (% of married women ages 1...	SP.UW
16969	World	WLD	Voice and Accountability: Estimate	VA.ES
16970				
16971				
16972				
16973	Data from database: Environment Social and Governance (E...			
16974	Last Updated: 10/02/2023			
16975	Code	License Type	Indicator Name	Short
16976	EG.CFT.ACCS.ZS	CC BY-4.0	Access to clean fuels and technologies for cooking (% of po...	
16977	EG.ELC.ACCS.ZS	CC BY-4.0	Access to electricity (% of population)	
16978	NY.ADJ.DRES.GN.ZS	CC BY-4.0	Adjusted savings: natural resources depletion (% of GNI)	
16979	NY.ADJ.DFOR.GN.ZS	CC BY-4.0	Adjusted savings: net forest depletion (% of GNI)	
16980	AG.LND.AGRI.ZS	CC BY-4.0	Agricultural land (% of land area)	
16981	NV.AGR.TOTL.ZS	CC BY-4.0	Agriculture, forestry, and fishing, value added (% of GDP)	
16982	ER.H2O.FWTL.ZS	CC BY-4.0	Annual freshwater withdrawals, total (% of internal resources)	
16983	SI.SPR.PCAP.ZG	CC BY-4.0	Annualized average growth rate in per capita real survey me...	The g
16984	SH.DTH.COMM.ZS	CC BY-4.0	Cause of death, by communicable diseases and maternal, pr...	
16985	SL.TLF.0714.ZS	CC BY-4.0	Children in employment, total (% of children ages 7-14)	
16986				

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```r
library(dplyr)

wb_dt <- read.csv("wb_databank.csv")

head(wb_dt, 10)

tail(wb_dt, 10)

wb_data <- wb_dt[1:16969,]
```

Subset the data with `[ ]` keeping only the valid rows.

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```r
wb_data <- wb_dt[1:16969,]

wb_data_2 <-  wb_data %>%
              janitor::clean_names()
```

Create a new data set `wb_data_2` with clean column names using `clean_names()` from janitor 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

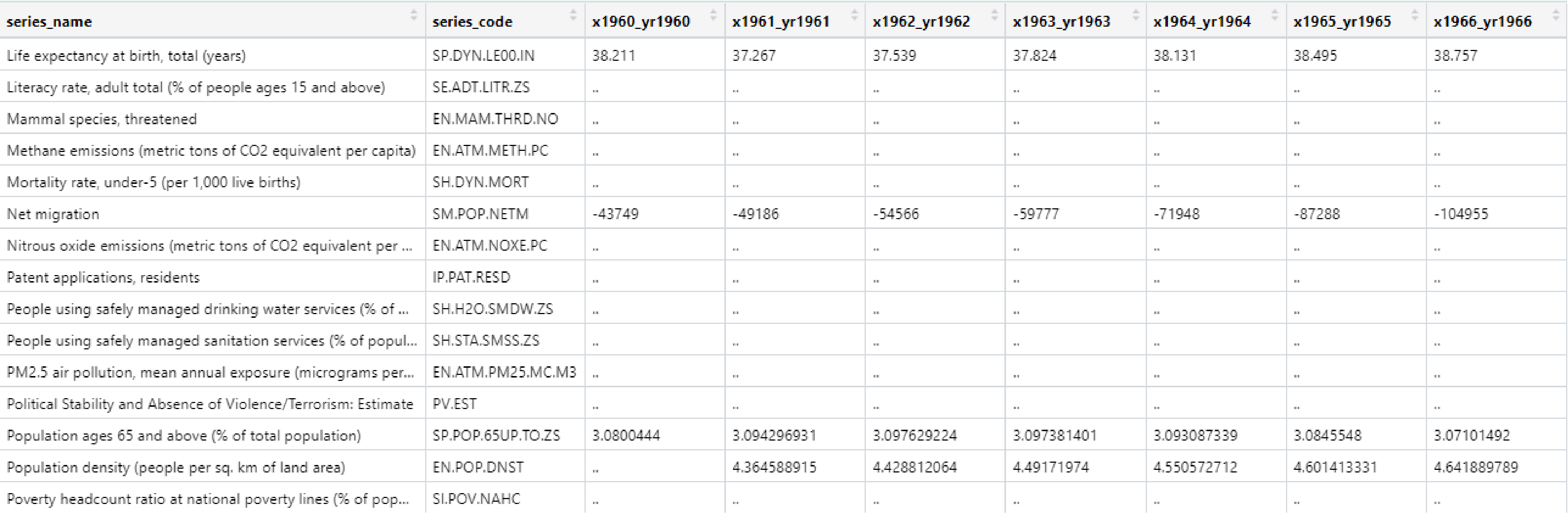
- Validate

{Tidy} data management:

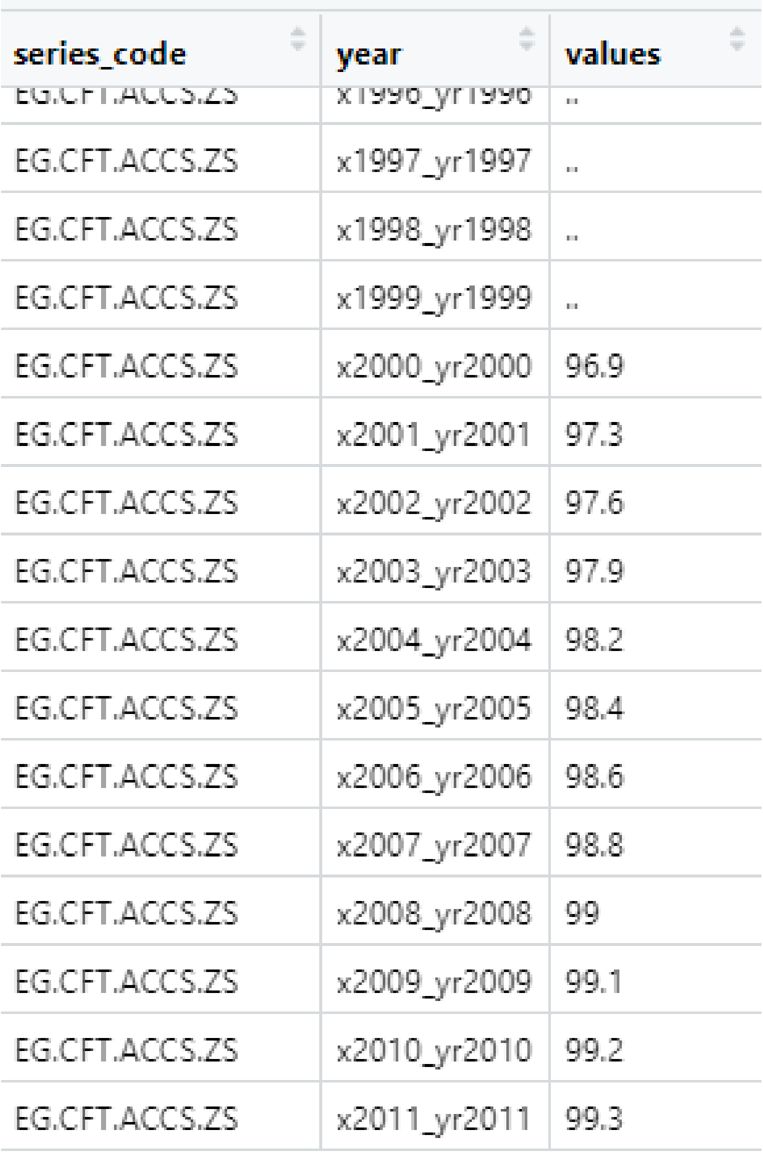
A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wb_data <- wb_dt[1:16969,]

library (tidyr)
wb_data_2 <-   wb_data %>%
               janitor::clean_names()
```



series_name	series_code	x1960_yr1960	x1961_yr1961	x1962_yr1962	x1963_yr1963	x1964_yr1964	x1965_yr1965	x1966_yr1966
Life expectancy at birth, total (years)	SP.DYN.LE00.IN	38.211	37.267	37.539	37.824	38.131	38.495	38.757
Literacy rate, adult total (% of people ages 15 and above)	SE.ADT.LITR.ZS	..	..	..	..	..	..	..
Mammal species, threatened	EN.MAM.THRD.NO	..	..	..	..	..	..	..
Methane emissions (metric tons of CO2 equivalent per capita)	EN.ATM.METH.PC	..	..	..	..	..	..	..
Mortality rate, under-5 (per 1,000 live births)	SH.DYN.MORT	..	..	..	..	..	..	..
Net migration	SM.POP.NETM	-43749	-49186	-54566	-59777	-71948	-87288	-104955
Nitrous oxide emissions (metric tons of CO2 equivalent per ...	EN.ATM.NOXE.PC	..	..	..	..	..	..	..
Patent applications, residents	IP.PAT.RESD	..	..	..	..	..	..	..
People using safely managed drinking water services (% of ...	SH.H2O.SMDW.ZS	..	..	..	..	..	..	..
People using safely managed sanitation services (% of popul...	SH.STA.SMSS.ZS	..	..	..	..	..	..	..
PM2.5 air pollution, mean annual exposure (micrograms per...	EN.ATM.PM25.MC.M3	..	..	..	..	..	..	..
Political Stability and Absence of Violence/Terrorism: Estimate	PV.EST	..	..	..	..	..	..	..
Population ages 65 and above (% of total population)	SP.POP.65UP.TO.ZS	3.0800444	3.094296931	3.097629224	3.097381401	3.093087339	3.0845548	3.07101492
Population density (people per sq. km of land area)	EN.POP.DNST	..	4.364588915	4.428812064	4.49171974	4.550572712	4.601413331	4.641889789
Poverty headcount ratio at national poverty lines (% of pop...	SI.POV.NAHC	..	..	..	..	..	..	..



series_code	year	values
EG.CFT.ACCS.ZS	x1996_yr1996	..
EG.CFT.ACCS.ZS	x1997_yr1997	..
EG.CFT.ACCS.ZS	x1998_yr1998	..
EG.CFT.ACCS.ZS	x1999_yr1999	..
EG.CFT.ACCS.ZS	x2000_yr2000	96.9
EG.CFT.ACCS.ZS	x2001_yr2001	97.3
EG.CFT.ACCS.ZS	x2002_yr2002	97.6
EG.CFT.ACCS.ZS	x2003_yr2003	97.9
EG.CFT.ACCS.ZS	x2004_yr2004	98.2
EG.CFT.ACCS.ZS	x2005_yr2005	98.4
EG.CFT.ACCS.ZS	x2006_yr2006	98.6
EG.CFT.ACCS.ZS	x2007_yr2007	98.8
EG.CFT.ACCS.ZS	x2008_yr2008	99
EG.CFT.ACCS.ZS	x2009_yr2009	99.1
EG.CFT.ACCS.ZS	x2010_yr2010	99.2
EG.CFT.ACCS.ZS	x2011_yr2011	99.3

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

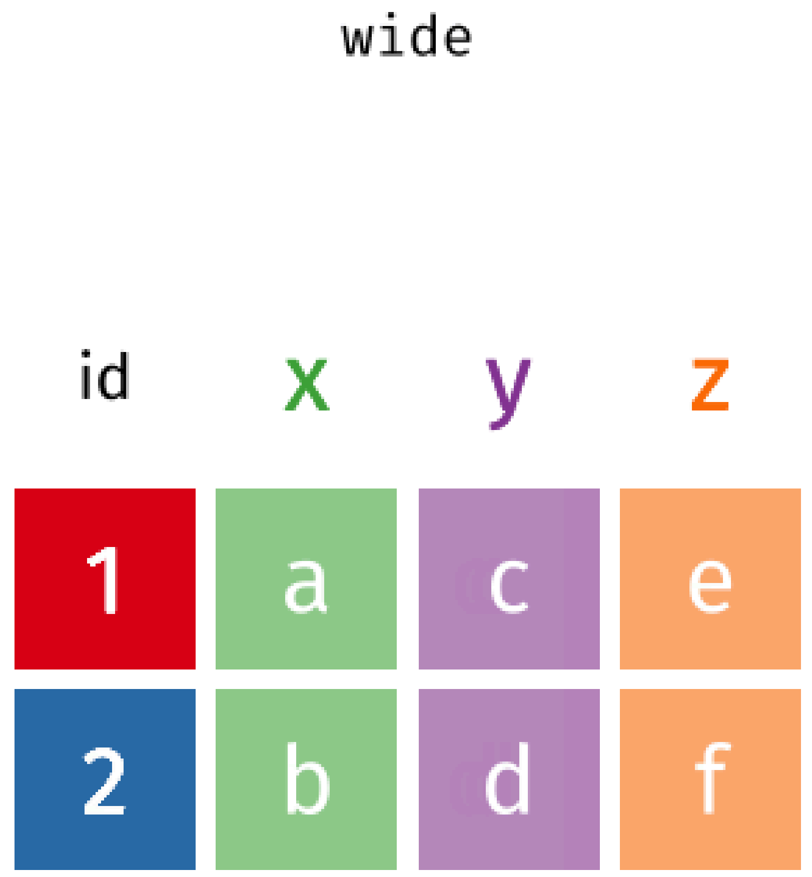
```r
wb_data <- wb_dt[1:16969,]

library (tidyr)
wb_data_2 <-  wb_data %>%
              janitor::clean_names()
```

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate



wide

id	x	y	z
1	a	c	e
2	b	d	f

Animation source: https://github.com/gadenbuie/tidyexplain

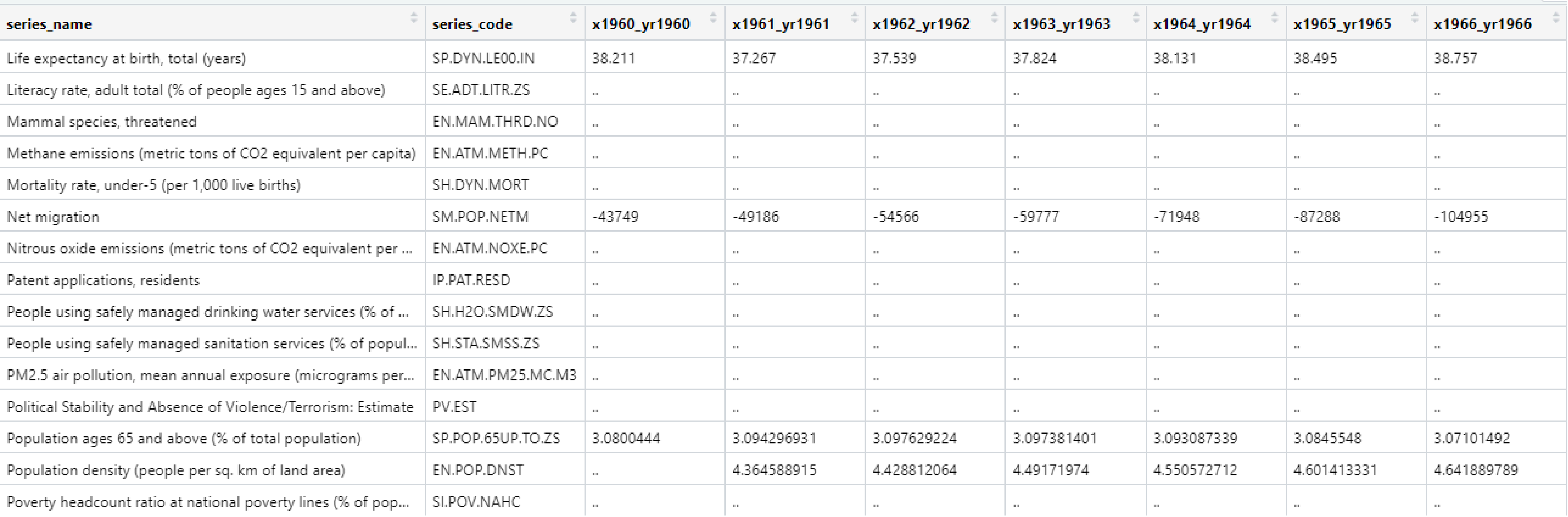
{Tidy} data management:

A case study using the `World Bank Data`

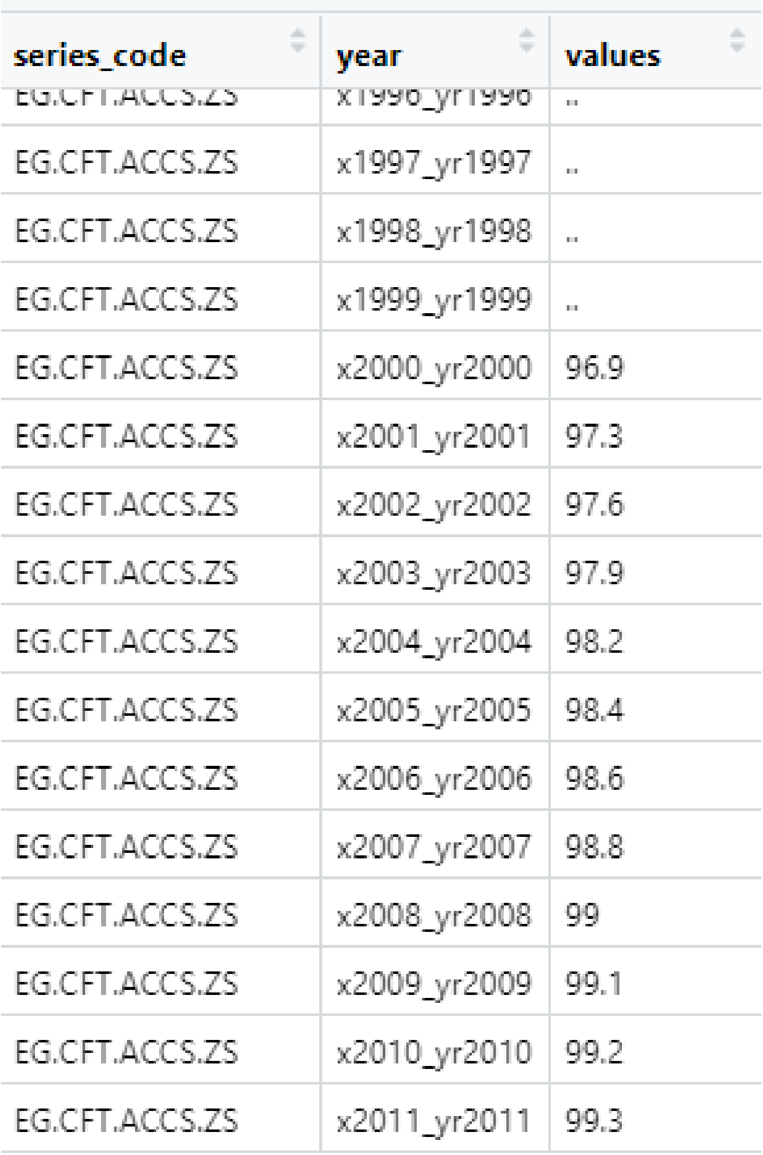
- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wb_data <- wb_dt[1:16969,]

library (tidyr)
wb_data_2 <-  wb_data %>%
              janitor::clean_names() %>%
              pivot_longer(cols = contains("_yr"),
                           values_to = "values",
                           names_to = "year")
```

Reshape the data to long format with `pivot_longer()` from tidyr



series_name	series_code	x1960_yr1960	x1961_yr1961	x1962_yr1962	x1963_yr1963	x1964_yr1964	x1965_yr1965	x1966_yr1966
Life expectancy at birth, total (years)	SP.DYN.LE00.IN	38.211	37.267	37.539	37.824	38.131	38.495	38.757
Literacy rate, adult total (% of people ages 15 and above)	SE.ADT.LITR.ZS	..	..	..	..	..	..	..
Mammal species, threatened	EN.MAM.THRD.NO	..	..	..	..	..	..	..
Methane emissions (metric tons of CO2 equivalent per capita)	EN.ATM.METH.PC	..	..	..	..	..	..	..
Mortality rate, under-5 (per 1,000 live births)	SH.DYN.MORT	..	..	..	..	..	..	..
Net migration	SM.POP.NETM	-43749	-49186	-54566	-59777	-71948	-87288	-104955
Nitrous oxide emissions (metric tons of CO2 equivalent per ...	EN.ATM.NOXE.PC	..	..	..	..	..	..	..
Patent applications, residents	IP.PAT.RESD	..	..	..	..	..	..	..
People using safely managed drinking water services (% of ...	SH.H2O.SMDW.ZS	..	..	..	..	..	..	..
People using safely managed sanitation services (% of popul...	SH.STA.SMSS.ZS	..	..	..	..	..	..	..
PM2.5 air pollution, mean annual exposure (micrograms per...	EN.ATM.PM25.MC.M3	..	..	..	..	..	..	..
Political Stability and Absence of Violence/Terrorism: Estimate	PV.EST	..	..	..	..	..	..	..
Population ages 65 and above (% of total population)	SP.POP.65UP.TO.ZS	3.0800444	3.094296931	3.097629224	3.097381401	3.093087339	3.0845548	3.07101492
Population density (people per sq. km of land area)	EN.POP.DNST	..	4.364588915	4.428812064	4.49171974	4.550572712	4.601413331	4.641889789
Poverty headcount ratio at national poverty lines (% of pop...	SI.POV.NAHC	..	..	..	..	..	..	..



series_code	year	values
EG.CFT.ACCS.ZS	x1996_yr1996	..
EG.CFT.ACCS.ZS	x1997_yr1997	..
EG.CFT.ACCS.ZS	x1998_yr1998	..
EG.CFT.ACCS.ZS	x1999_yr1999	..
EG.CFT.ACCS.ZS	x2000_yr2000	96.9
EG.CFT.ACCS.ZS	x2001_yr2001	97.3
EG.CFT.ACCS.ZS	x2002_yr2002	97.6
EG.CFT.ACCS.ZS	x2003_yr2003	97.9
EG.CFT.ACCS.ZS	x2004_yr2004	98.2
EG.CFT.ACCS.ZS	x2005_yr2005	98.4
EG.CFT.ACCS.ZS	x2006_yr2006	98.6
EG.CFT.ACCS.ZS	x2007_yr2007	98.8
EG.CFT.ACCS.ZS	x2008_yr2008	99
EG.CFT.ACCS.ZS	x2009_yr2009	99.1
EG.CFT.ACCS.ZS	x2010_yr2010	99.2
EG.CFT.ACCS.ZS	x2011_yr2011	99.3

{Tidy} data management:

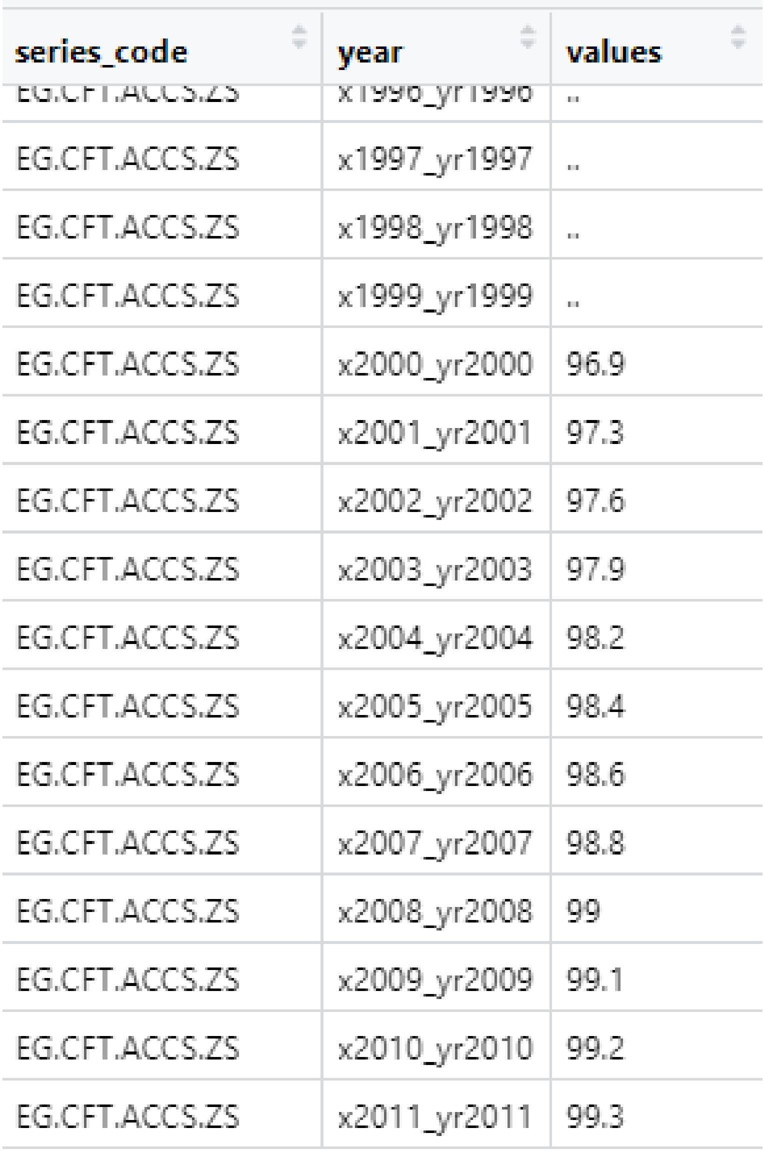
A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wb_data <- wb_dt[1:16969,]

library (tidyr)
wb_data_2 <-  wb_data %>%
              janitor::clean_names() %>%
              pivot_longer(cols = contains("_yr"),
                           values_to = "values",
                           names_to = "year") %>%
              mutate (values = ifelse(values == "..",
                                      NA, values)) %>%
              mutate (values = as.numeric(values))
```

Recode {..} in the data to missing (NA) with `ifelse()` from `{base}` 📦

Convert the values column to numeric with `as.numeric()` from `{base}` 📦



series_code	year	values
EG.CFT.ACCS.ZS	x1996_yr1996	..
EG.CFT.ACCS.ZS	x1997_yr1997	..
EG.CFT.ACCS.ZS	x1998_yr1998	..
EG.CFT.ACCS.ZS	x1999_yr1999	..
EG.CFT.ACCS.ZS	x2000_yr2000	96.9
EG.CFT.ACCS.ZS	x2001_yr2001	97.3
EG.CFT.ACCS.ZS	x2002_yr2002	97.6
EG.CFT.ACCS.ZS	x2003_yr2003	97.9
EG.CFT.ACCS.ZS	x2004_yr2004	98.2
EG.CFT.ACCS.ZS	x2005_yr2005	98.4
EG.CFT.ACCS.ZS	x2006_yr2006	98.6
EG.CFT.ACCS.ZS	x2007_yr2007	98.8
EG.CFT.ACCS.ZS	x2008_yr2008	99
EG.CFT.ACCS.ZS	x2009_yr2009	99.1
EG.CFT.ACCS.ZS	x2010_yr2010	99.2
EG.CFT.ACCS.ZS	x2011_yr2011	99.3

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wb_data <- wb_dt[1:16969,]

library (tidyr)
library (stringr)
wb_data_2 <-  wb_data %>%
              janitor::clean_names() %>%
              pivot_longer(cols = contains("_yr"),
                           values_to = "values",
                           names_to = "year") %>%
              mutate (values = ifelse(values == "..",
                                      NA, values)) %>%
              mutate (values = as.numeric(values)) %>%
              mutate (period = str_extract(year, "[0-9]+")) %>%
              mutate (year = as.numeric (period))
```

Extract only numeric values from year column with `str_extract()` from stringr

Convert the newly created period column to numeric with `as.numeric()` from `{base}`

{Tidy} data management:

A case study using the World Bank Data

- Fix structural errors

```r
new_dta <-  wb_data_2
```

Create a new object (`new_dta`) from the most cleaned version of our world bank data (`wb_data_2`)

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```
new_dta <-  wb_data_2 %>%
            filter (year >= 2000 & year <= 2020) %>%
            filter (!is.na (values))
```

Keep only data for the years 2000-2020 and valid data in values with `filter()` from dplyr 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```r
data_key <- new_dta %>%
            select (series_name, series_code)
```

Create a new data from the filtered data and keep only a few columns with `select()` from dplyr 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

- Remove duplicate or irrelevant observations

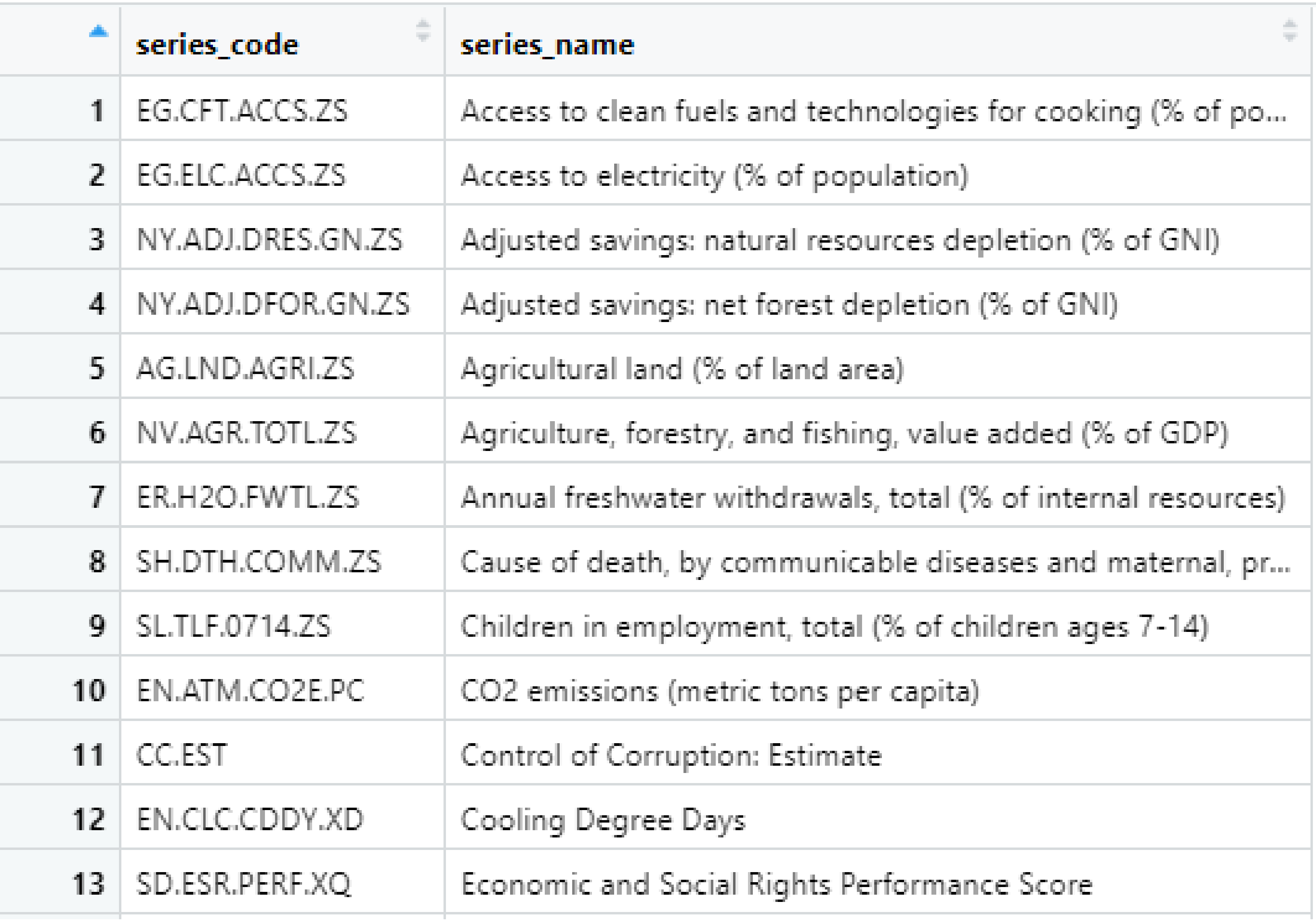
- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
data_key <- new_dta %>%
            select (series_name, series_code) %>%
            reframe(series_code = unique(series_code),
                    series_name = unique(series_name))
```

Create a data dictionary with a description for each unique series code

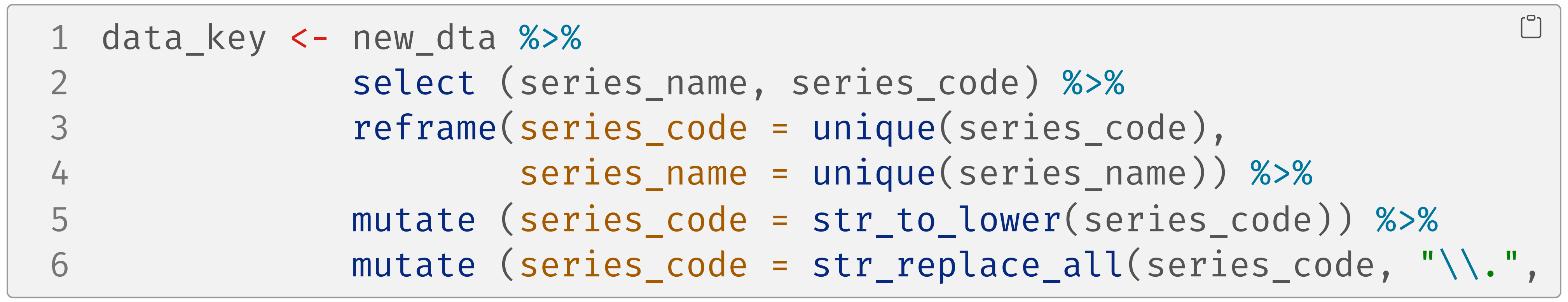


	series_code	series_name
1	EG.CFT.ACCS.ZS	Access to clean fuels and technologies for cooking (% of po...
2	EG.ELC.ACCS.ZS	Access to electricity (% of population)
3	NY.ADJ.DRES.GN.ZS	Adjusted savings: natural resources depletion (% of GNI)
4	NY.ADJ.DFOR.GN.ZS	Adjusted savings: net forest depletion (% of GNI)
5	AG.LND.AGRI.ZS	Agricultural land (% of land area)
6	NV.AGR.TOTL.ZS	Agriculture, forestry, and fishing, value added (% of GDP)
7	ER.H2O.FWTL.ZS	Annual freshwater withdrawals, total (% of internal resources)
8	SH.DTH.COMM.ZS	Cause of death, by communicable diseases and maternal, pr...
9	SL.TLF.0714.ZS	Children in employment, total (% of children ages 7-14)
10	EN.ATM.CO2E.PC	CO2 emissions (metric tons per capita)
11	CC.EST	Control of Corruption: Estimate
12	EN.CLC.CDDY.XD	Cooling Degree Days
13	SD.ESR.PERF.XQ	Economic and Social Rights Performance Score

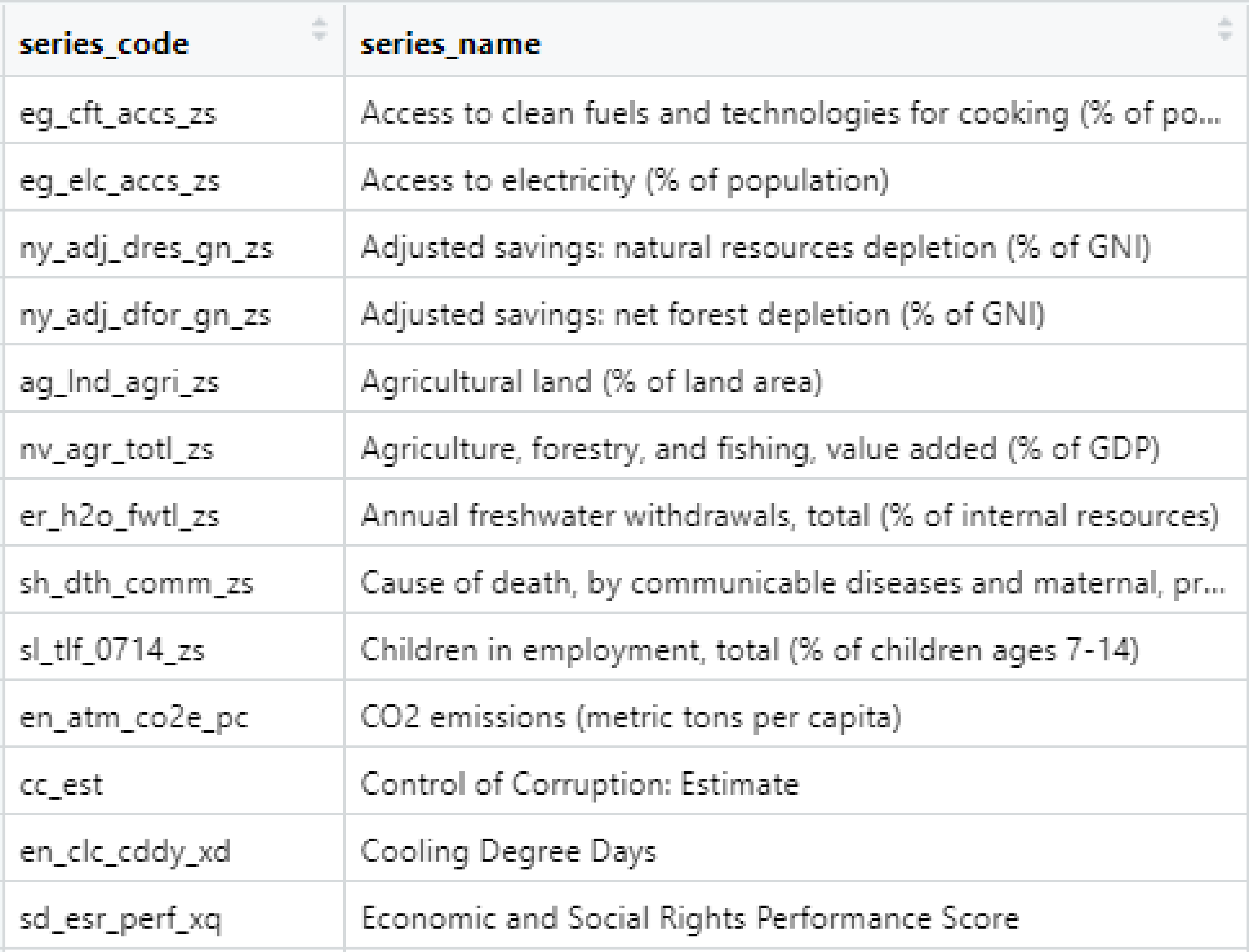
{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate



```r
data_key <- new_dta %>%
            select (series_name, series_code) %>%
            reframe(series_code = unique(series_code),
                    series_name = unique(series_name)) %>%
            mutate (series_code = str_to_lower(series_code)) %>%
            mutate (series_code = str_replace_all(series_code, "\\.",
```



series_code	series_name
eg_cft_accs_zs	Access to clean fuels and technologies for cooking (% of po...
eg_elc_accs_zs	Access to electricity (% of population)
ny_adj_dres_gn_zs	Adjusted savings: natural resources depletion (% of GNI)
ny_adj_dfor_gn_zs	Adjusted savings: net forest depletion (% of GNI)
ag_lnd_agri_zs	Agricultural land (% of land area)
nv_agr_totl_zs	Agriculture, forestry, and fishing, value added (% of GDP)
er_h2o_fwtl_zs	Annual freshwater withdrawals, total (% of internal resources)
sh_dth_comm_zs	Cause of death, by communicable diseases and maternal, pr...
sl_tlf_0714_zs	Children in employment, total (% of children ages 7-14)
en_atm_co2e_pc	CO2 emissions (metric tons per capita)
cc_est	Control of Corruption: Estimate
en_clc_cddy_xd	Cooling Degree Days
sd_esr_perf_xq	Economic and Social Rights Performance Score

Convert characters in the `series_code` column to lower with `str_to_lower()` from stringr 📦

Replace all `dots` with _ using `str_replace_all()` from stringr 📦

{Tidy} data management:

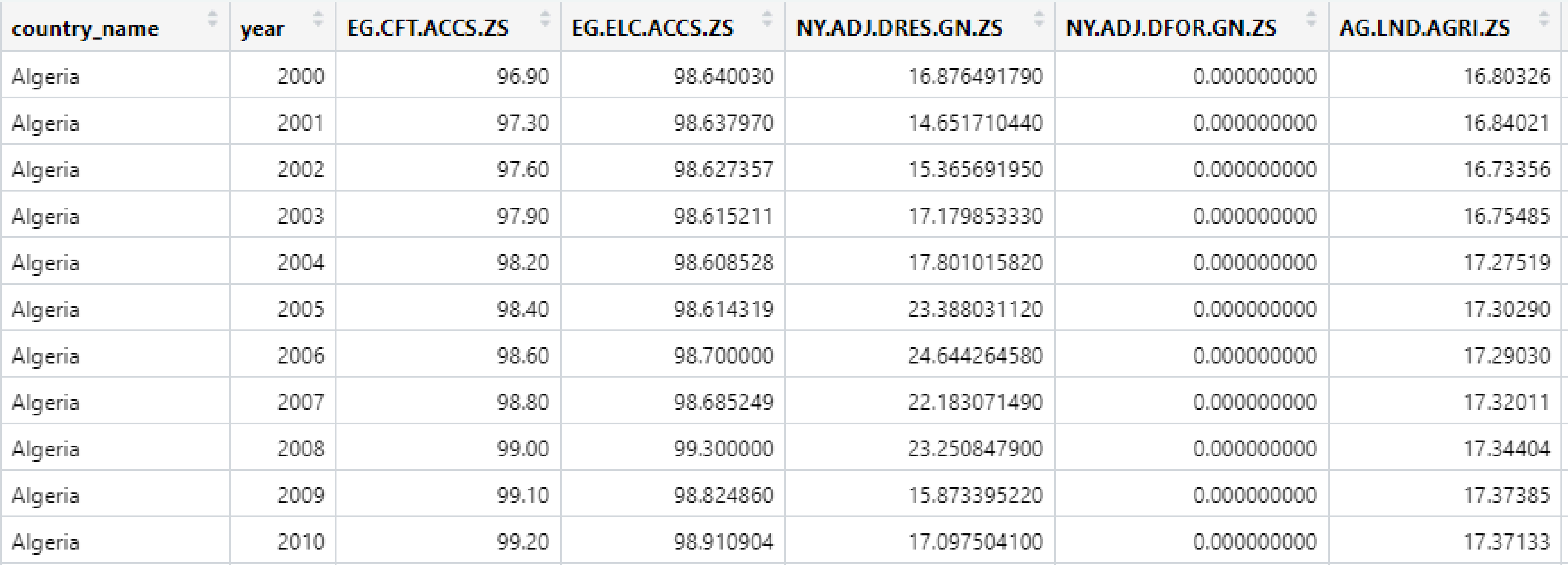
A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values)
```

Create a new data `(wide_dta)` from `new_dta`

Keep only the relevant columns with `select()` from dplyr



country_name	year	EG.CFT.ACCS.ZS	EG.ELC.ACCS.ZS	NY.ADJ.DRES.GN.ZS	NY.ADJ.DFOR.GN.ZS	AG.LND.AGRI.ZS
Algeria	2000	96.90	98.640030	16.876491790	0.000000000	16.80326
Algeria	2001	97.30	98.637970	14.651710440	0.000000000	16.84021
Algeria	2002	97.60	98.627357	15.365691950	0.000000000	16.73356
Algeria	2003	97.90	98.615211	17.179853330	0.000000000	16.75485
Algeria	2004	98.20	98.608528	17.801015820	0.000000000	17.27519
Algeria	2005	98.40	98.614319	23.388031120	0.000000000	17.30290
Algeria	2006	98.60	98.700000	24.644264580	0.000000000	17.29030
Algeria	2007	98.80	98.685249	22.183071490	0.000000000	17.32011
Algeria	2008	99.00	99.300000	23.250847900	0.000000000	17.34404
Algeria	2009	99.10	98.824860	15.873395220	0.000000000	17.37385
Algeria	2010	99.20	98.910904	17.097504100	0.000000000	17.37133

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values)
```

Reshape the data to wide format with `pivot_wider()` from tidyr

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values) %>%
            janitor::clean_names()
```

Use clean column names with `clean_names()` from janitor 📦

- Remove duplicate or irrelevant observations

- Handle (remove) unwanted outliers

- Handle (remove) missing data

- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values) %>%
            janitor::clean_names() %>%
            select (country_name, year, eg_cft_accs_zs,
                    eg_elc_accs_zs, en_atm_co2e_pc,
                    en_clc_heat_xd, sp_dyn_tfrt_in )
```

Select only the relevant variables with `select()` from dplyr

- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the World Bank Data

- Fix structural errors

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values) %>%
            janitor::clean_names() %>%
            select (country_name, year, eg_cft_accs_zs,
                    eg_elc_accs_zs, en_atm_co2e_pc,
                    en_clc_heat_xd, sp_dyn_tfrt_in ) %>%
            mutate (eg_cft_accs_zs = round (eg_cft_accs_zs, 2),
                    eg_elc_accs_zs = round (eg_elc_accs_zs, 2),
                    en_atm_co2e_pc = round (en_atm_co2e_pc, 2),
                    en_clc_heat_xd = round (en_clc_heat_xd, 2),
                    sp_dyn_tfrt_in = round (sp_dyn_tfrt_in, 2))
```

Round all values in the selected columns to 2 decimal places with `round()` from `{base}` 📦

- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values) %>%
            janitor::clean_names() %>%
            select (country_name, year, eg_cft_accs_zs,
                    eg_elc_accs_zs, en_atm_co2e_pc,
                    en_clc_heat_xd, sp_dyn_tfrt_in ) %>%
            mutate (eg_cft_accs_zs = round (eg_cft_accs_zs, 2),
                    eg_elc_accs_zs = round (eg_elc_accs_zs, 2),
                    en_atm_co2e_pc = round (en_atm_co2e_pc, 2),
                    en_clc_heat_xd = round (en_clc_heat_xd, 2),
                    sp_dyn_tfrt_in = round (sp_dyn_tfrt_in, 2))

saveRDS(wide_dta, "data/wide_dta.rds")
save.image(file = "data/wide_dta.rdata")
```

Save single R object to a file with `saveRDS()` from `{base}`

Save entire workspace with `save.image()` from `{base}`

{Tidy} data management:

A case study using the `World Bank Data`

- Fix structural errors
- Remove duplicate or irrelevant observations
- Handle (remove) unwanted outliers
- Handle (remove) missing data
- Validate

```r
wide_dta <- new_dta %>%
            select (country_name, year,
                    series_code, values) %>%
            pivot_wider(names_from = series_code,
                        values_from = values) %>%
            janitor::clean_names() %>%
            select (country_name, year, eg_cft_accs_zs,
                    eg_elc_accs_zs, en_atm_co2e_pc,
                    en_clc_heat_xd, sp_dyn_tfrt_in ) %>%
            mutate (eg_cft_accs_zs = round (eg_cft_accs_zs, 2),
                    eg_elc_accs_zs = round (eg_elc_accs_zs, 2),
                    en_atm_co2e_pc = round (en_atm_co2e_pc, 2),
                    en_clc_heat_xd = round (en_clc_heat_xd, 2),
                    sp_dyn_tfrt_in = round (sp_dyn_tfrt_in, 2))

saveRDS(wide_dta, "data/wide_dta.rds")
save(file = "data/wide_dta.rdata")
```

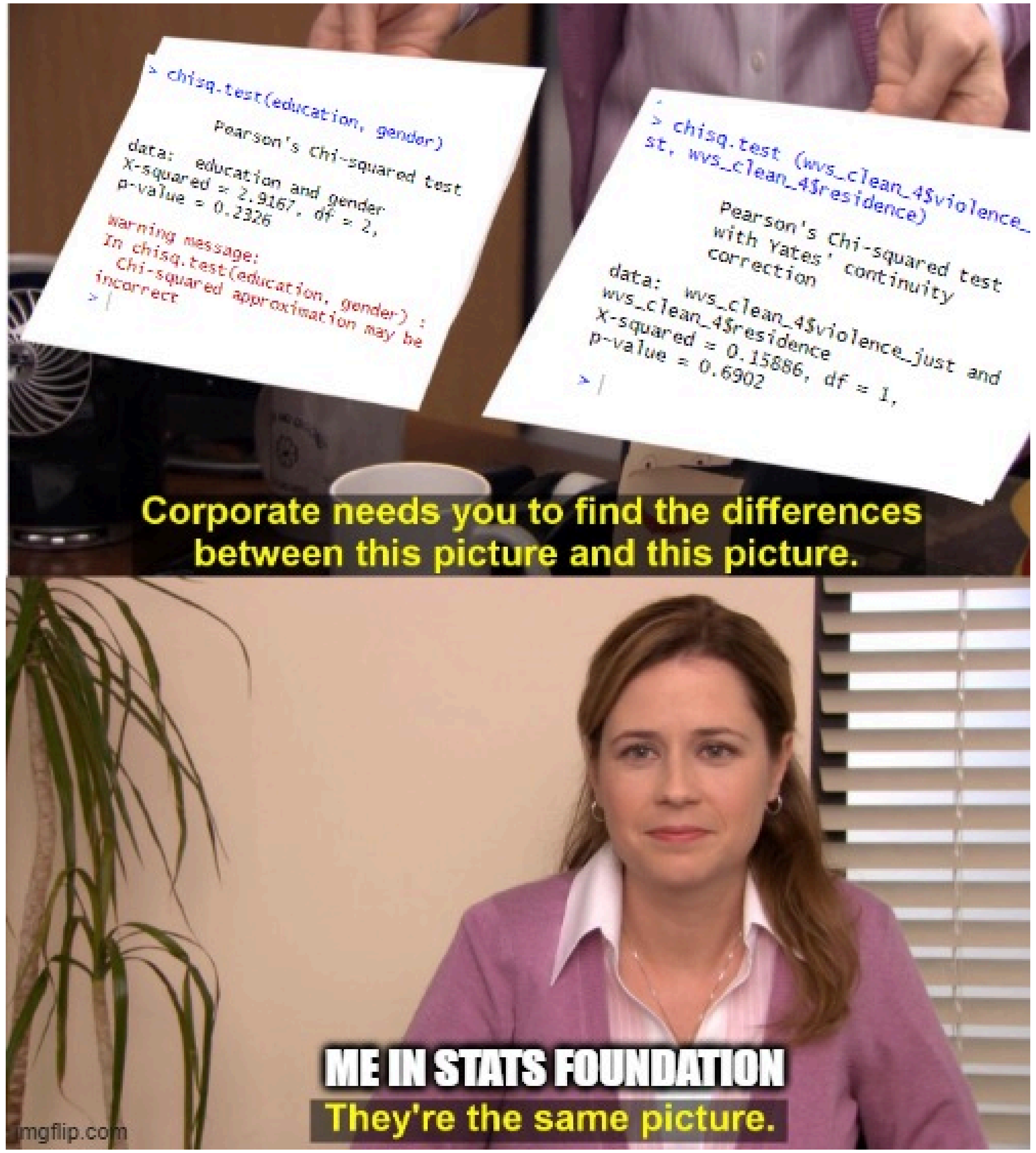
Save data to csv with *`write.csv()`* *from* *`{utils}`*

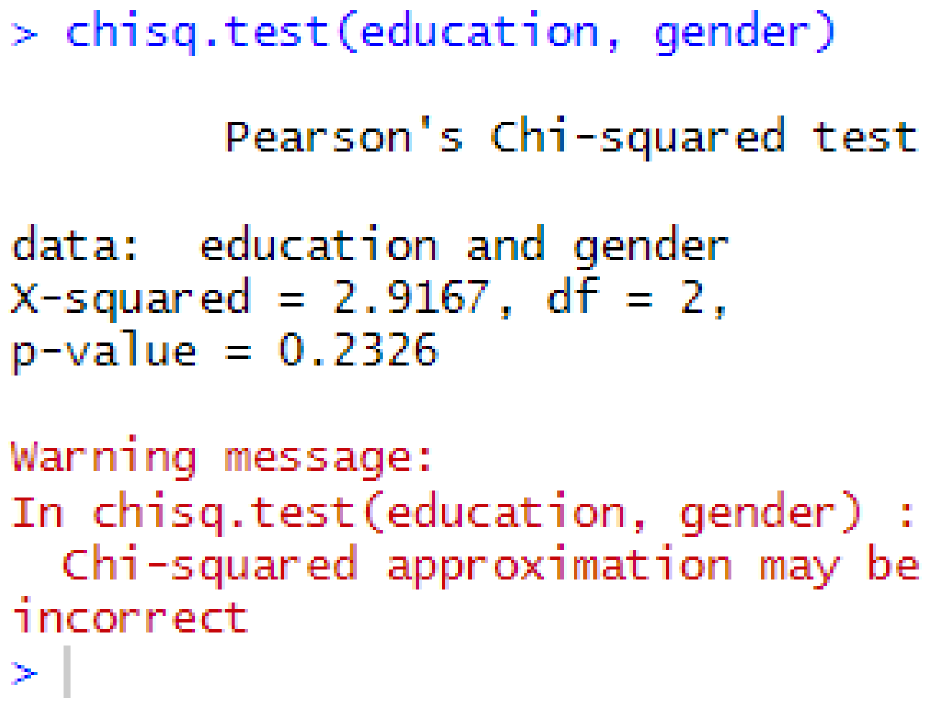
Save data to xlsx with *`write_xlsx()`* *from writexl*

Debugging

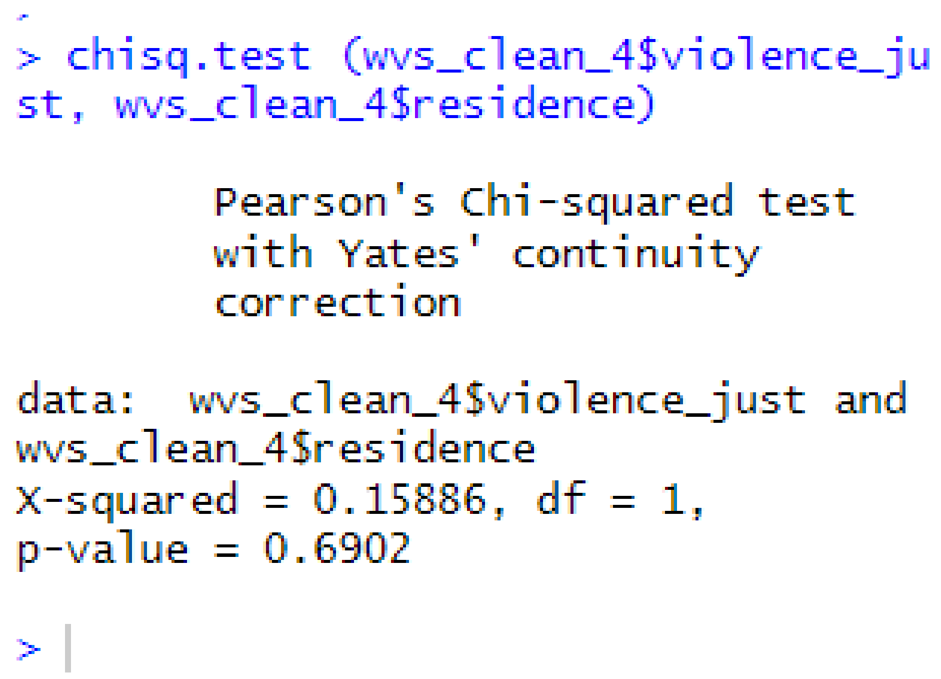
Errors and Warnings

Debugging Errors in R


Corporate needs you to find the differences between this picture and this picture.
ME IN STATS FOUNDATION
They're the same picture.
imgflip.com

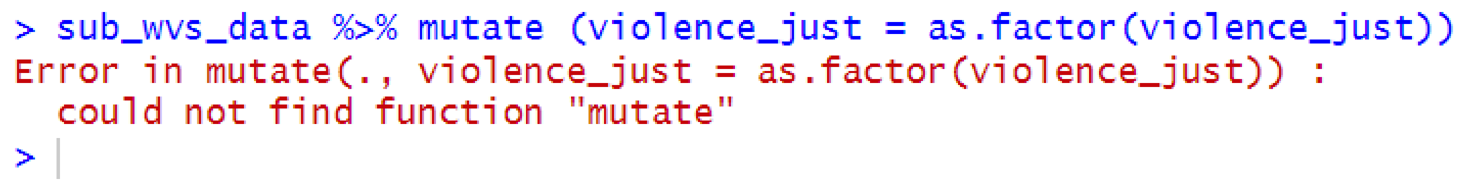


```
> chisq.test(education, gender)

        Pearson's Chi-squared test

data:  education and gender
X-squared = 2.9167, df = 2,
p-value = 0.2326

Warning message:
In chisq.test(education, gender) :
  Chi-squared approximation may be
incorrect
> 
```



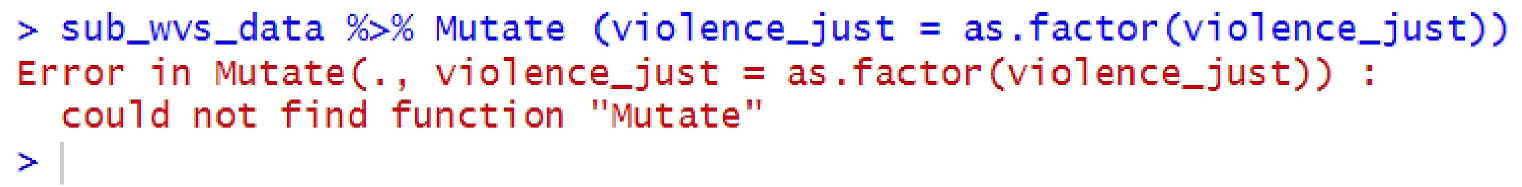
```
> chisq.test (wvs_clean_4$violence_ju
st, wvs_clean_4$residence)

        Pearson's Chi-squared test
        with Yates' continuity
        correction

data:  wvs_clean_4$violence_just and
wvs_clean_4$residence
X-squared = 0.15886, df = 1,
p-value = 0.6902

> 
```

Debugging Errors in R



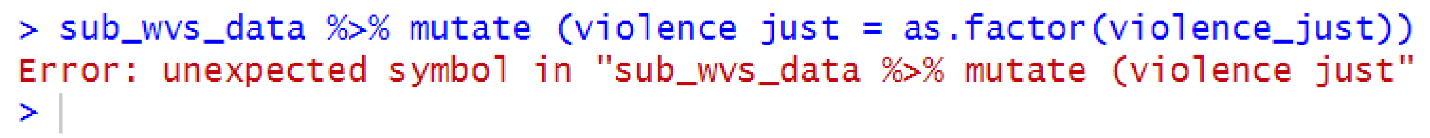
```
> sub_wvs_data %>% mutate (violence_just = as.factor(violence_just))
Error in mutate(., violence_just = as.factor(violence_just)) :
  could not find function "mutate"
> 
```

Check that the `dplyr` package has been installed and loaded.



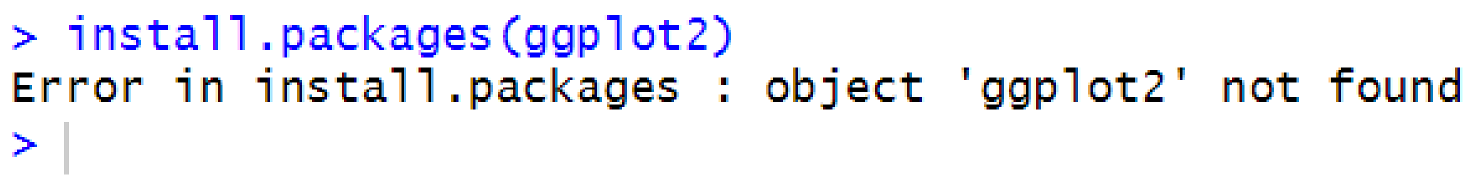
```
> sub_wvs_data %>% Mutate (violence_just = as.factor(violence_just))
Error in Mutate(., violence_just = as.factor(violence_just)) :
  could not find function "Mutate"
> 
```

Check that the `mutate ()` function has been spelt correctly



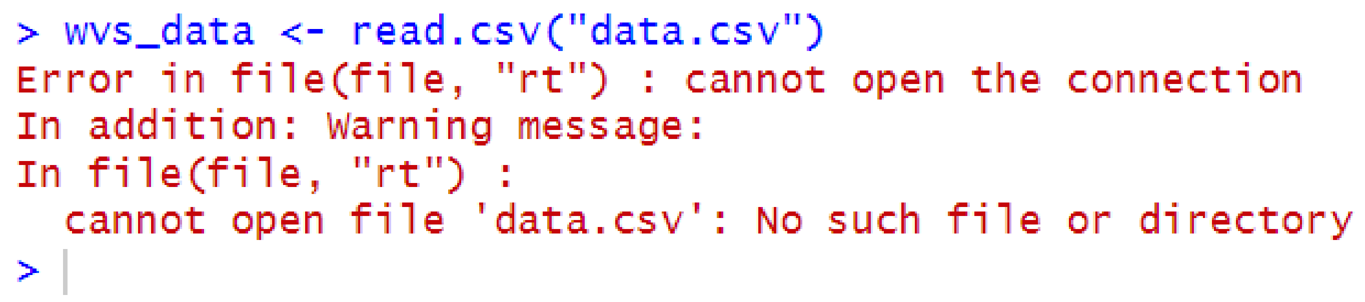
```
> sub_wvs_data %>% mutate (violence just = as.factor(violence_just))
Error: unexpected symbol in "sub_wvs_data %>% mutate (violence just"
> 
```

Check that the object 'Violence_just' has been spelt correctly or exist already.



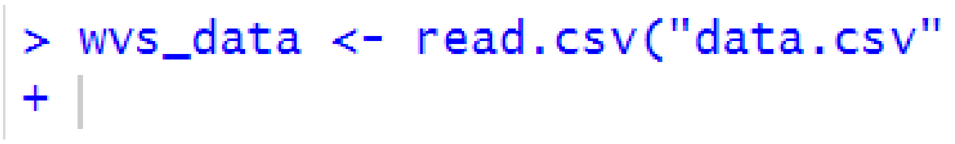
```
> install.packages(ggplot2)
Error in install.packages : object 'ggplot2' not found
> 
```

Check that the package name is in quote e.g. "ggplot2"



```
> wvs_data <- read.csv("data.csv")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") :
  cannot open file 'data.csv': No such file or directory
> 
```

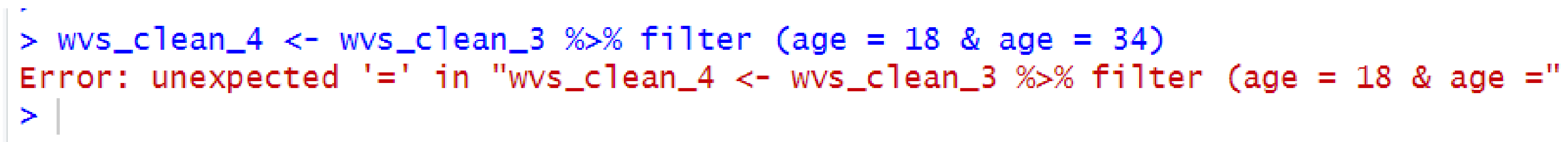
Check that the `data.csv` file is in the working directory and enter the correct file path



```
> wvs_data <- read.csv("data.csv"
+ 
```

Check that all opened quotes or parenthesis have been closed

Image source: imgflip.com/



```
> wvs_clean_4 <- wvs_clean_3 %>% filter (age = 18 & age = 34)
Error: unexpected '=' in "wvs_clean_4 <- wvs_clean_3 %>% filter (age = 18 & age ="
> 
```

Remember that R uses `=` or <- for assignments, and `==` for the equality sign