

Data wrangling

Applied Data Science using R, Session 8

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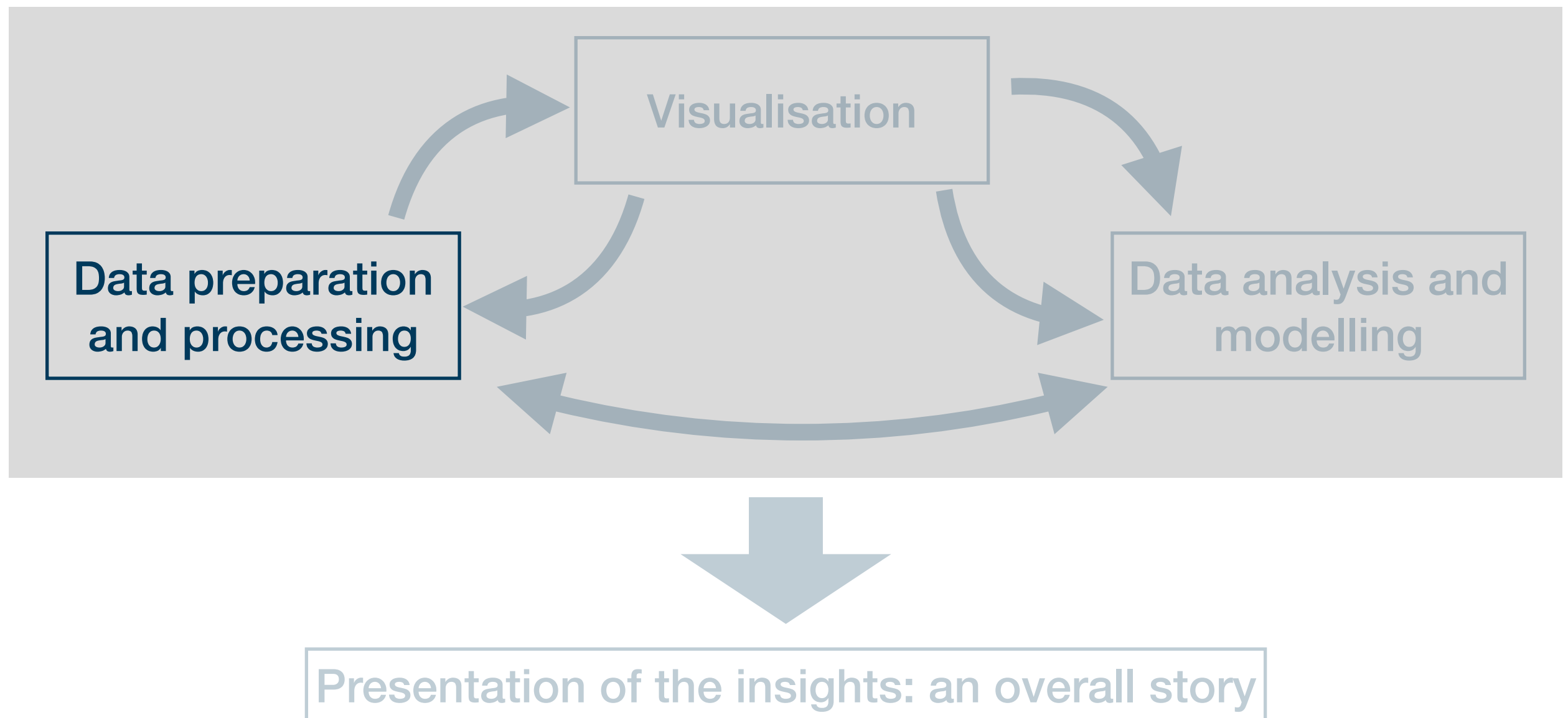
Goals for today

- I. Understand the concept of tidy data
- II. Get an overview over the most common transformation challenges
- III. Master a number of functions from the `tidyr` and `dplyr` packages to address some of these challenges

Data wrangling in R

The role of data preparation

- Importing and preparing is the most fundamental task in data science
 - It is also largely under-appreciated 🙄



What is tidy data?

The goal: tidy data

“ Tidy datasets are all alike, but every messy dataset is messy in its own way.

Hadley Wickham



- Translation into plain English:
 - We find data sets in all kind of ***-up forms in the world
 - We must turn them into a form that's a good starting point for any further tasks
- Good thing: this form is unique – and its called **tidy**

The goal: tidy data

Every **column** corresponds to one and only one **variable**

```
# A tibble: 4 × 4
```

	c_code	year	exports	unemployment
--	--------	------	---------	--------------

	<chr>	<int>	<dbl>	<dbl>
--	-------	-------	-------	-------

1	AT	2013	53.4	5.34
2	AT	2014	53.4	5.62
3	DE	2013	45.4	5.23
4	DE	2014	45.6	4.98

Every **row**
corresponds to
one and only
one
observation

Every **cell** corresponds to one
and only one **value**

- Every data set that satisfies these three demands is called tidy
- Excellent start for basically any further task – but maybe not the best way to represent data to humans

The goal: tidy data

Every **row**
corresponds to one
and only one
observation



```
# A tibble: 2 × 4
  c_code variable `2013` `2014`
  <chr>   <chr>    <dbl> <dbl>
1 AT      unemployment  5.34   5.62
2 DE      unemployment  5.23   4.98
```

Every **column**
corresponds to one
and only one
variable



```
# A tibble: 4 × 4
  c_code year exports variable
  <chr>  <int>  <dbl> <chr>
1 AT      2013    53.4 exports
2 AT      2014    53.4 exports
3 DE      2013    45.4 exports
4 DE      2014    45.6 exports
```

Every **cell**
corresponds to
one and only one
value



```
# A tibble: 2 × 2
  country important_industries
  <chr>    <chr>
1 DE      Cars (25%) and meat (10%)
2 AT      Wine (5%) and milk (2%)
```

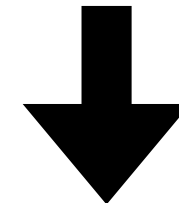
- The goal of data wrangling is to turn such untidy data into tidy data

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

Filter rows according to conditions

```
# A tibble: 4 × 4
  c_code year exports unemployment
  <chr>  <int>   <dbl>         <dbl>
1 AT      2013    53.4         5.34
2 AT      2014    53.4         5.62
3 DE      2013    45.4         5.23
4 DE      2014    45.6         4.98
```



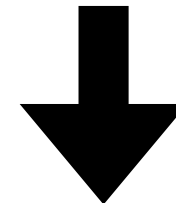
```
# A tibble: 2 × 4
  c_code year exports unemployment
  <chr>  <int>   <dbl>         <dbl>
1 DE      2013    45.4         5.23
2 DE      2014    45.6         4.98
```

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

```
# A tibble: 4 × 4
  c_code year exports unemployment
  <chr>  <int>   <dbl>         <dbl>
1 AT      2013    53.4         5.34
2 AT      2014    53.4         5.62
3 DE      2013    45.4         5.23
4 DE      2014    45.6         4.98
```

Select columns/variables

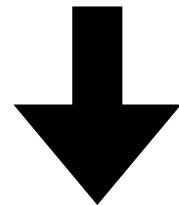


```
# A tibble: 4 × 3
  c_code year exports
  <chr>  <int>   <dbl>
1 AT      2013    53.4
2 AT      2014    53.4
3 DE      2013    45.4
4 DE      2014    45.6
```

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

```
# A tibble: 2 × 4
  c_code variable `2013` `2014`
  <chr>   <chr>     <dbl> <dbl>
1 AT      unemployment  5.34  5.62
2 DE      unemployment  5.23  4.98
```



```
# A tibble: 2 × 5
  c_code variable `2013` `2014` change
  <chr>   <chr>     <dbl> <dbl> <dbl>
1 AT      unemployment  5.34  5.62  0.285
2 DE      unemployment  5.23  4.98 -0.25
```

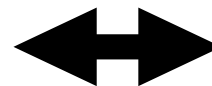
Mutate or create variables

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

Reshaping data from long to wide format (and vice versa)

```
# A tibble: 4 × 4
  c_code year exports unemployment
  <chr>  <int>   <dbl>         <dbl>
1 AT      2013    53.4          5.34
2 AT      2014    53.4          5.62
3 DE      2013    45.4          5.23
4 DE      2014    45.6          4.98
```

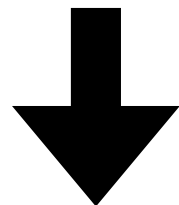


```
# A tibble: 8 × 4
  c_code year variable value
  <chr>  <int> <chr>    <dbl>
1 AT      2013 exports    53.4
2 AT      2013 unemployment  5.34
3 AT      2014 exports    53.4
4 AT      2014 unemployment  5.62
5 DE      2013 exports    45.4
6 DE      2013 unemployment  5.23
7 DE      2014 exports    45.6
8 DE      2014 unemployment  4.98
```

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

```
# A tibble: 4 × 4
  c_code year exports unemployment
  <chr>  <int>  <dbl>      <dbl>
1 AT      2013    53.4        5.34
2 AT      2014    53.4        5.62
3 DE      2013    45.4        5.23
4 DE      2014    45.6        4.98
```



```
# A tibble: 2 × 3
  c_code exports_avg unemployment_avg
  <chr>      <dbl>      <dbl>
1 AT          53.4          5.48
2 DE          45.5          5.11
```

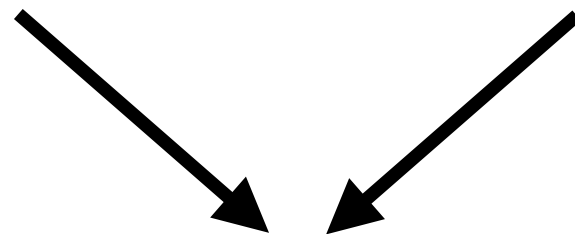
Group and summarise data

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

```
# A tibble: 4 × 3
  c_code year exports
<chr>   <int>   <dbl>
1 AT     2013    53.4
2 AT     2014    53.4
3 DE     2013    45.4
4 DE     2014    45.6
```

```
# A tibble: 4 × 3
  c_code year unemployment
<chr>   <int>         <dbl>
1 AT     2013         5.34
2 AT     2014         5.62
3 DE     2013         5.23
4 DE     2014         4.98
```



Merge several data sets

```
# A tibble: 4 × 4
  c_code year exports unemployment
<chr>   <int>   <dbl>         <dbl>
1 AT     2013    53.4         5.34
2 AT     2014    53.4         5.62
3 DE     2013    45.4         5.23
4 DE     2014    45.6         4.98
```

Typical challenges during data wrangling

- After having imported your data into R, you can usually make it tidy using a sequential combination of the following routines:

Reshaping data from long to wide format (and vice versa)

Filter rows according to conditions

Select columns/variables

Mutate or create variables

Group and **summarise** data

Merge several data sets

- In this, and a later session we will go through these operation
 - Then you are fit to tidy up raw data yourself
- This way you produce the inputs we used for visualisation...
 - ...and the inputs we will use for modelling

Addressing wrangling challenges

Session content

- We will go through the following challenges via direct demonstration:

Filter rows according to conditions

Reshaping data from long to wide format (and vice versa)

Select columns/variables

Mutate or create variables

Group and **summarise** data

Merge several data sets

- We will use functions from the packages **dplyr** and **tidyr** (both part of the **tidyverse**)
- For documentation purposes check out the lecture notes and the readings
 - The data sets used for the following exercises are all contained in **wrangling_exercises_data.zip**, which is available on the course homepage

Long and wide data

Rather wide data:

```
# A tibble: 4 × 4
  c_code year exports unemployment
  <chr>  <int>   <dbl>         <dbl>
1 AT      2013    53.4         5.34
2 AT      2014    53.4         5.62
3 DE      2013    45.4         5.23
4 DE      2014    45.6         4.98
```

Rather long data:

```
# A tibble: 8 × 4
  c_code year variable value
  <chr>  <int> <chr>      <dbl>
1 AT      2013 exports    53.4
2 AT      2013 unemployment 5.34
3 AT      2014 exports    53.4
4 AT      2014 unemployment 5.62
5 DE      2013 exports    45.4
6 DE      2013 unemployment 5.23
7 DE      2014 exports    45.6
8 DE      2014 unemployment 4.98
```

- Better understood as *relative* descriptions of data
 - It is more straightforward to speak of a data set that is *longer* relative to another

Exercise 1: filtering and reshaping

- Use the data set `exercise_1.csv` contained in `wrangling_exercises_data.zip`
- Import the data and ...
 - ...only consider data on Greece and Germany between 1995 and 2015
 - ...make it longer 🙏

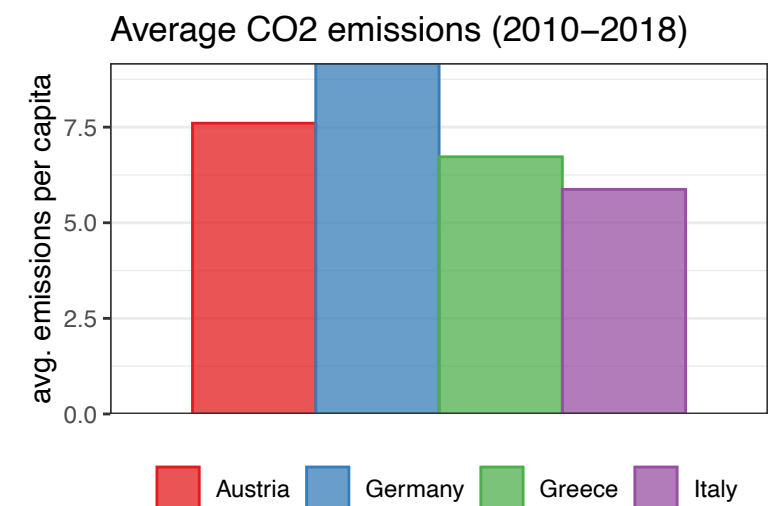
[Link to possible solution](#)

```
# A tibble: 12 × 4
  country year indicator value
  <chr>   <int> <chr>      <dbl>
1 Germany 2012  gdp    49872.
2 Germany 2012  co2      9.45
3 Germany 2013  gdp    49954.
4 Germany 2013  co2      9.64
5 Germany 2014  gdp    50846.
6 Germany 2014  co2      9.11
7 Greece  2012  gdp    28323.
8 Greece  2012  co2      7.25
9 Greece  2013  gdp    27811.
10 Greece 2013  co2      6.61
11 Greece 2014  gdp    28130.
12 Greece 2014  co2      6.39
```

Exercise 2: mutating, selecting & summarising

- Use the data set `exercise_2.csv` contained in `wrangling_exercises_data.zip`
- Import the data
 - Only keep the variables `gdp`, `share_indus`, and `co2`
 - Divide the industry share in GDP with 100
 - Only keep data between 2010 and 2018
 - Compute the averages over time for all countries
- Bonus:
 - Visualise the resulting CO2 average via a bar plot

```
# A tibble: 12 × 3
  country indicator  time_avg
  <chr>    <chr>      <dbl>
1 Austria co2        7.60
2 Austria gdp       53322.
3 Austria share_indus 0.254
4 Germany co2        9.17
5 Germany gdp       50781.
6 Germany share_indus 0.272
7 Greece  co2        6.72
8 Greece  gdp       29169.
9 Greece  share_indus 0.144
10 Italy   co2        5.87
11 Italy   gdp       41326.
12 Italy   share_indus 0.213
```



Data: World Bank.

Summary & outlook

Summary

- After importing raw data you usually must prepare them → make **tidy**
- Tidy data is the input to any visualisation/modelling task and defined as data where:
 - Every **column** corresponds to one and only one **variable**
 - Every **row** corresponds to one and only one **observation**
 - Every **cell** corresponds to one and only one **value**
- It is usually a good idea to write a script that imports raw, and saves tidy data
- Such script usually makes use of functions from the following packages:
 - `data.table`, `dplyr`, `tidyr`, and `here`

Summary

- These packages provide functions that help you to address some wrangling challenges that regularly await you:
 - Reshaping data: `tidyr::pivot_longer()` and `tidyr::pivot_wider()`
 - Filtering rows: `dplyr::filter()`
 - Selecting columns: `dplyr::select()` and the select helpers
 - Mutating or creating variables: `dplyr::mutate()`
 - Grouping and summarising: `dplyr::group_by()` and `dplyr::summarise()`
 - Merging data sets: `dplyr::*_join()`
- In later sessions we will learn also about some convenience shortcuts

Outlook

- We now covered the basics in all fundamental data science activities
 - We can now turn to the ‘funny’ part: modelling and analysis
- But before we will learn how to write reports using Quarto / R Markdown
 - Learn to communicate your R activities to others by combining them with text, and distributing them online

Tasks until next time:

1. Fill in the **quick feedback survey** on Moodle
2. Read the **lecture notes** posted on the course page and replicate them
3. Have a look at the mandatory readings (step the challenges we did not cover yet)
4. Do the **exercises** provided on the course page and **discuss problems** and difficulties via the Moodle forum