Data types & Vectors & For Loops

ds4owd - data science for openwashdata

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2023-12-05

Course calendar

Changes to the course calendar

- 19th December 2023: no class
- 23rd January 2024: openwashdata webinar: a data sharing workflow that may please the publishers
- 13th February 2024: submission of capstone project report

date	week	topic	module
31 October 2023	1	Welcome & get ready for the course	module 1
07 November 2023	2	Data science lifecycle & Exploratory data analysis using visualization	module 2
14 November 2023	3	Data transformation with dplyr	module 3
21 November 2023	4	Data import & Data organization in spreadsheets	module 4
28 November 2023	5	Conditions & Dates & Tables	module 5
05 December 2023	6	Data types & Vectors & For Loops	module 6
12 December 2023	7	Pivoting & joining data	module 7
19 December 2023	8	Break	module 8
26 December 2023	9	Break	NA
02 January 2024	10	Break	NA
09 January 2024	11	Work on Capstone project	NA
16 January 2024	12	Writing functions & Creating a website with Quarto and GitHub pages	module 9
23 January 2024	13	openwashdata webinar: a data sharing workflow that may please the publishers	NA
30 January 2024	14	Using AI for software development in R	module 10
06 February 2024	15	Work on Capstone project	NA
13 February 2024	16	Final submission date of Capstone project	NA

Learning Objectives (for this week)

1. Learners can identify different ways of idexing a vector
2. Learners can identify a for loop
3. Learners can list the four main atomic vector types in R.

Part 1: Cross-references

Cross references

- Help readers to navigate your document with numbered references and hyperlinks to entities like figures and tables.
- Cross referencing steps:
  - Add a caption to your figure or table.
  - Give an ID to your figure or table, starting with `fig-` or `tbl-`.
  - Refer to it with `@fig-...` or `@tbl-...`.

Table cross references

The presence of the caption (`A few penguins`) and label (`#tbl-penguins`) make this table reference-able:

See `@tbl-penguins` for data on a few penguins.

becomes:

See Table 1 for data on a few penguins.

```
```{r}
#| label: tbl-penguins
#| tbl-cap: A few penguins

head(penguins) |>
  gt()
```
```

Table 1:
A few penguins

species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex	year
Adelie	Torgersen	39.1	18.7	181	3750	male	2007
Adelie	Torgersen	39.5	17.4	186	3800	female	2007
Adelie	Torgersen	40.3	18.0	195	3250	female	2007
Adelie	Torgersen	NA	NA	NA	NA	NA	2007
Adelie	Torgersen	36.7	19.3	193	3450	female	2007

species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex	year
Adelie	Torgersen	39.3	20.6	190	3650	male	2007

Figure cross references

The presence of the caption (`A few penguins`) and label (`#fig-penguins`) make this figure reference-able:

See `@fig-penguins` for data on a few penguins.

becomes:

See Figure 1 for data on a few penguins.

````
```{r}
#| label: fig-penguins
#| fig-cap: A few penguins
#| fig-width: 6
#| fig-asp: 0.618

ggplot(penguins, aes(x = species, fill = species)) +
  geom_bar(show.legend = FALSE)
```
````

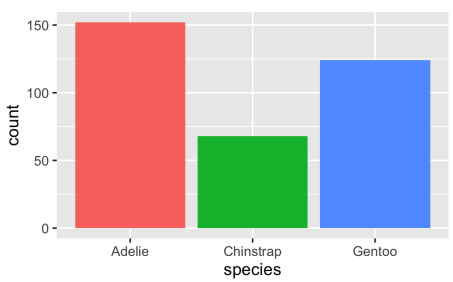


Figure 1: A few penguins

Your turn: md-06-exercises - cross-references

1. Open posit.cloud in your browser (use your bookmark).
2. Open the `ds4owd workspace` for the course.
3. In the File Manager in the bottom right window, locate the `md-06a-cross-references.qmd` file and click on it to open it in the top left window.
4. Follow instructions in the file

10:00

Part 2: Data types and vectors

Why care about data types?

Example: survey data

A survey about recycling behaviour in the city of Zurich:

- `job`: What is your occupation?
- `price_glass`: What monthly subscription would you be willing to pay for a metal/glass bin outside your home?

id	job	price_glass
1	Student	0
2	Retired	0
3	Other	0
4	Employed	10
5	Employed	See comment
6	Student	5-10
7	Student	0
8	Retired	0
9	Student	10

id	job	price_glass
10	Employed	0
11	Employed	20 (2chf per person with 10 people in the WG)
12	Student	10
13	Student	10
14	Employed	0
15	Student	10
16	Student	0
17	Employed	5-10
18	Other	0
19	Student	0
20	Employed	10
21	Employed	0
22	Employed	5

Oh why won't you work?!

```
survey_data_small |>
  summarise(mean_price_glass = mean(price_glass))
```

```
# A tibble: 1 × 1
  mean_price_glass
             <dbl>
1               NA
```

Oh why won't you still work??!!

```
survey_data_small |>
  summarise(mean_price_glass = mean(price_glass, na.rm = TRUE))
```

```
# A tibble: 1 × 1
  mean_price_glass
             <dbl>
1               NA
```

Take a breath and look at your data

id	job	price_glass
1	Student	0
2	Retired	0
3	Other	0
4	Employed	10
5	Employed	See comment
6	Student	5-10
7	Student	0
8	Retired	0
9	Student	10
10	Employed	0
11	Employed	20 (2chf per person with 10 people in the WG)
12	Student	10
13	Student	10
14	Employed	0 ds4owd-001.github.io/website/

id	job	price_glass
15	Student	10
16	Student	0
17	Employed	5-10
18	Other	0
19	Student	0
20	Employed	10
21	Employed	0
22	Employed	5

Take a breath and look at your data

```
# A tibble: 22 × 3
      id job      price_glass
   <int> <chr>    <chr>
 1     1 Student  0
 2     2 Retired  0
 3     3 Other    0
 4     4 Employed 10
 5     5 Employed See comment
 6     6 Student  5-10
 7     7 Student  0
 8     8 Retired  0
 9     9 Student  10
10    10 Employed 0
# ℹ 12 more rows
```

Very common data tidying step!

```
survey_data_small |>
  mutate(price_glass_new = case_when(
    price_glass == "5-10" ~ "7.5",
    price_glass == "05-Oct" ~ "7.5",
    str_detect(price_glass, pattern = "2chf") == TRUE ~ "20",
    str_detect(price_glass, pattern = "See comment") == TRUE ~ NA_character_,
    TRUE ~ price_glass
  ))
```

Very common data tidying step!

id	job	price_glass_new	price_glass
1	Student	0	0
2	Retired	0	0
3	Other	0	0
4	Employed	10	10
5	Employed	NA	See comment
6	Student	7.5	5-10
7	Student	0	0
8	Retired	0	0
9	Student	10	10
10	Employed	0	0
11	Employed	20	20 (2chf per person with 10 people in the WG)
12	Student	10	10
13	Student	10	10

id	job	price_glass_new	price_glass
14	Employed	0	0
15	Student	10	10
16	Student	0	0
17	Employed	7.5	5-10
18	Other	0	0
19	Student	0	0
20	Employed	10	10
21	Employed	0	0
22	Employed	5	5

Sumamrise? Argh!!!!

```
survey_data_small |>
  mutate(price_glass_new = case_when(
    price_glass == "5-10" ~ "7.5",
    price_glass == "05-Oct" ~ "7.5",
    str_detect(price_glass, pattern = "20") == TRUE ~ "20",
    str_detect(price_glass, pattern = "See comment") == TRUE ~ NA_character_,
    TRUE ~ price_glass
  )) |>
  summarise(mean_price_glass = mean(price_glass_new, na.rm = TRUE))
```

```
# A tibble: 1 × 1
  mean_price_glass
             <dbl>
1               NA
```

Always respect your data types!

> ⚠ Taking the mean of vector with type **“character”** is not possible.

```
# A tibble: 22 × 4
      id job      price_glass price_glass_new
   <int> <chr>    <chr>       <chr>
 1     1 Student  0           0
 2     2 Retired  0           0
 3     3 Other    0           0
 4     4 Employed 10          10
 5     5 Employed See comment <NA>
 6     6 Student  5-10        7.5
 7     7 Student  0           0
 8     8 Retired  0           0
 9     9 Student  10          10
10    10 Employed 0           0
# ℹ 12 more rows
```

Always respect your data types!

```
survey_data_small |>
  mutate(price_glass_new = case_when(
    price_glass == "5-10" ~ "7.5",
    price_glass == "05-Oct" ~ "7.5",
    str_detect(price_glass, pattern = "20") == TRUE ~ "20",
    str_detect(price_glass, pattern = "See comment") == TRUE ~ NA_character_,
    TRUE ~ price_glass
  )) |>
  mutate(price_glass_new = as.numeric(price_glass_new)) |>
  summarise(mean_price_glass = mean(price_glass_new, na.rm = TRUE))
```

```
# A tibble: 1 × 1
  mean_price_glass
             <dbl>
1             4.76
```

My turn: Types of vectors & For loops

Sit back and enjoy!

25:00

Take a break

Please get up and move! Let your emails rest in peace.

ds4owd-001.github.io/website/

10:00

Your turn: md-06-exercises - types

1. Open posit.cloud in your browser (use your bookmark).
2. Open the ds4owd workspace for the course.
3. In the File Manager in the bottom right window, locate the `md-06b-types-your-turn.qmd` file and click on it to open it in the top left window.
4. Follow instructions in the file

35:00

Take a break

Please get up and move! Let your emails rest in peace.

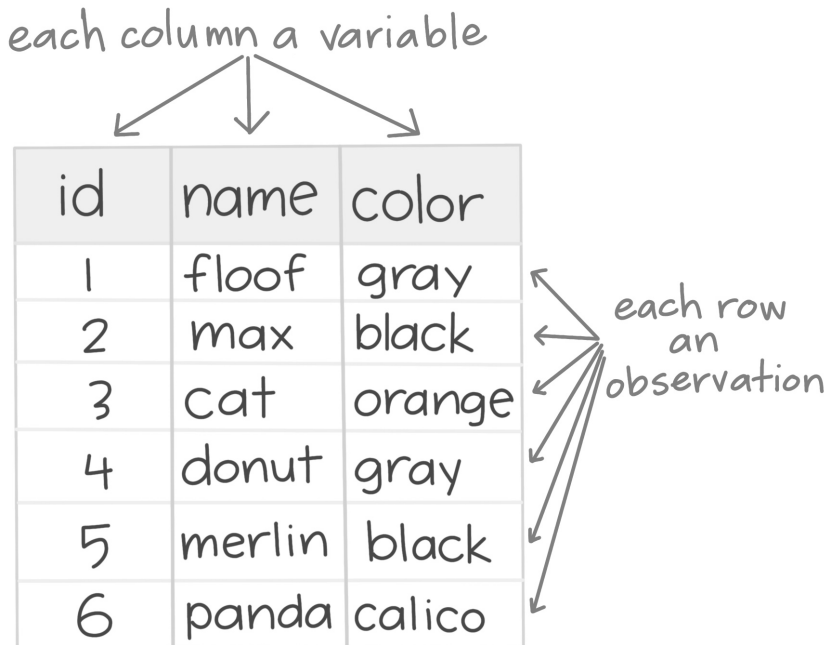
Part 3: tidyr - long and wide formats

TIDY DATA is a standard way of mapping the meaning of a dataset to its structure.

–HADLEY WICKHAM

In tidy data:

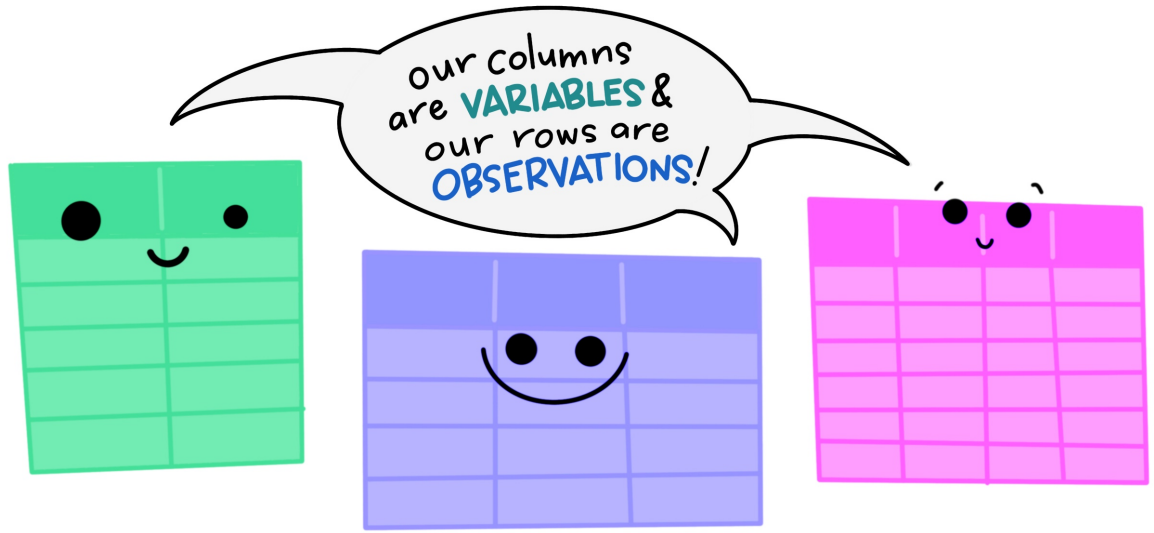
- each variable forms a column
- each observation forms a row
- each cell is a single measurement



Wickham, H. (2014). Tidy Data. Journal of Statistical Software *59* (10). DOI: 10.18637/jss.v059.i10

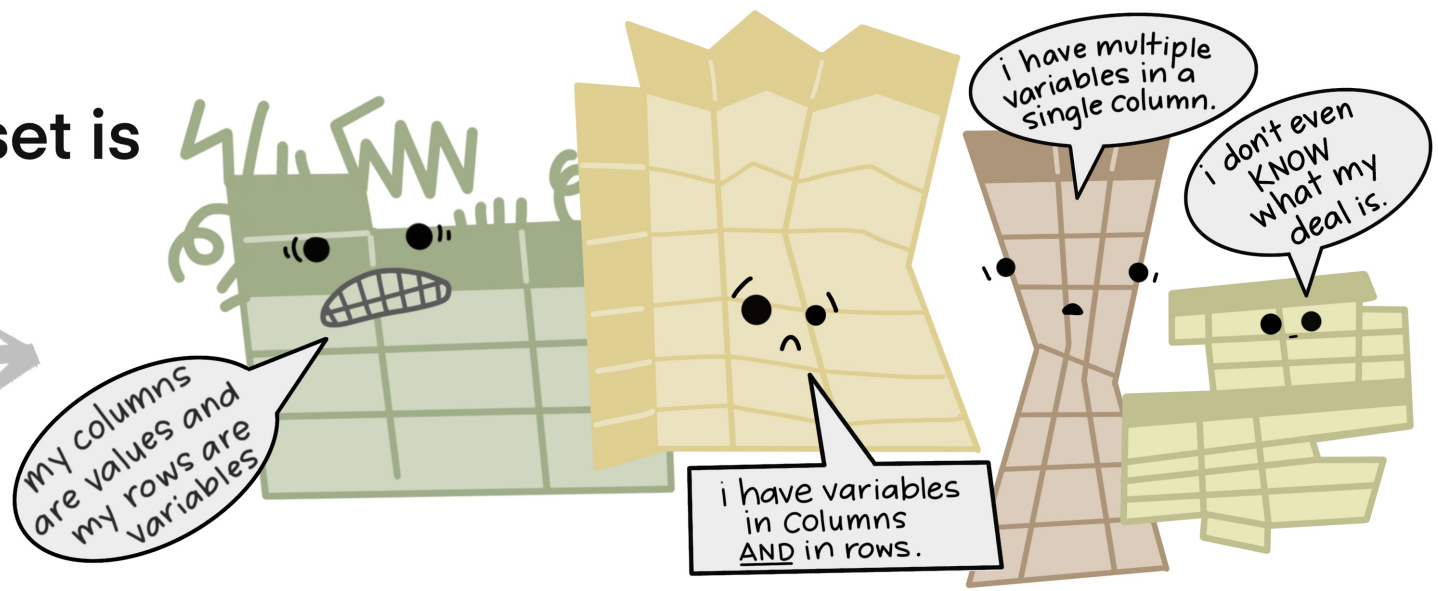
Illustrations from the Openscapes blog Tidy Data for reproducibility, efficiency, and ds4owd-001.github.io/website/

The standard structure of tidy data means that "tidy datasets are all alike..."



"...but every messy dataset is messy in its own way."

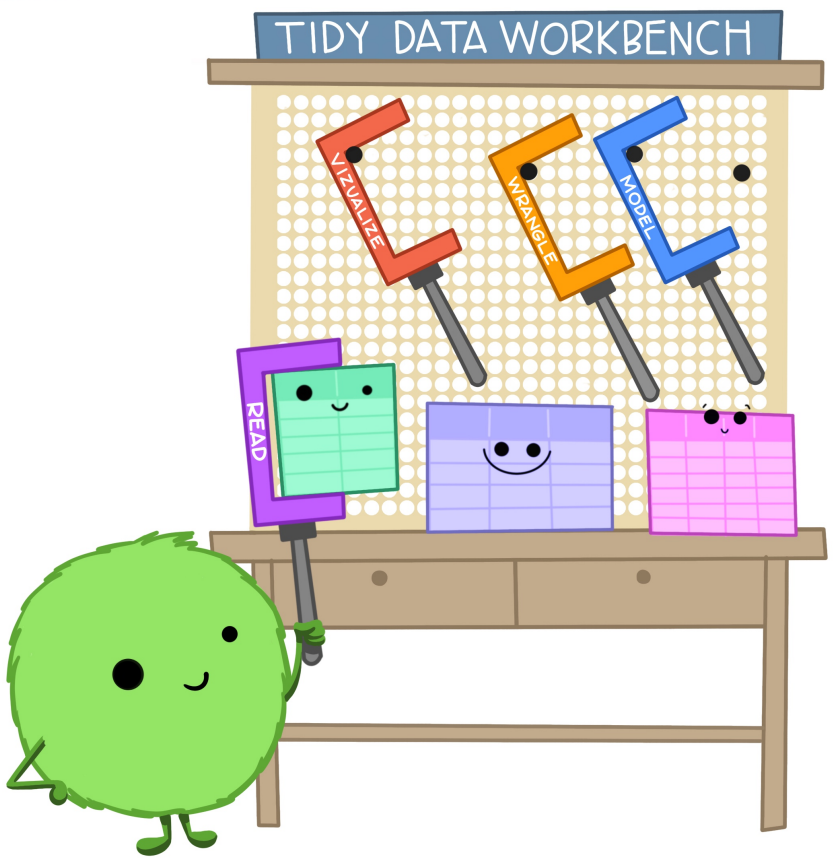
–HADLEY WICKHAM



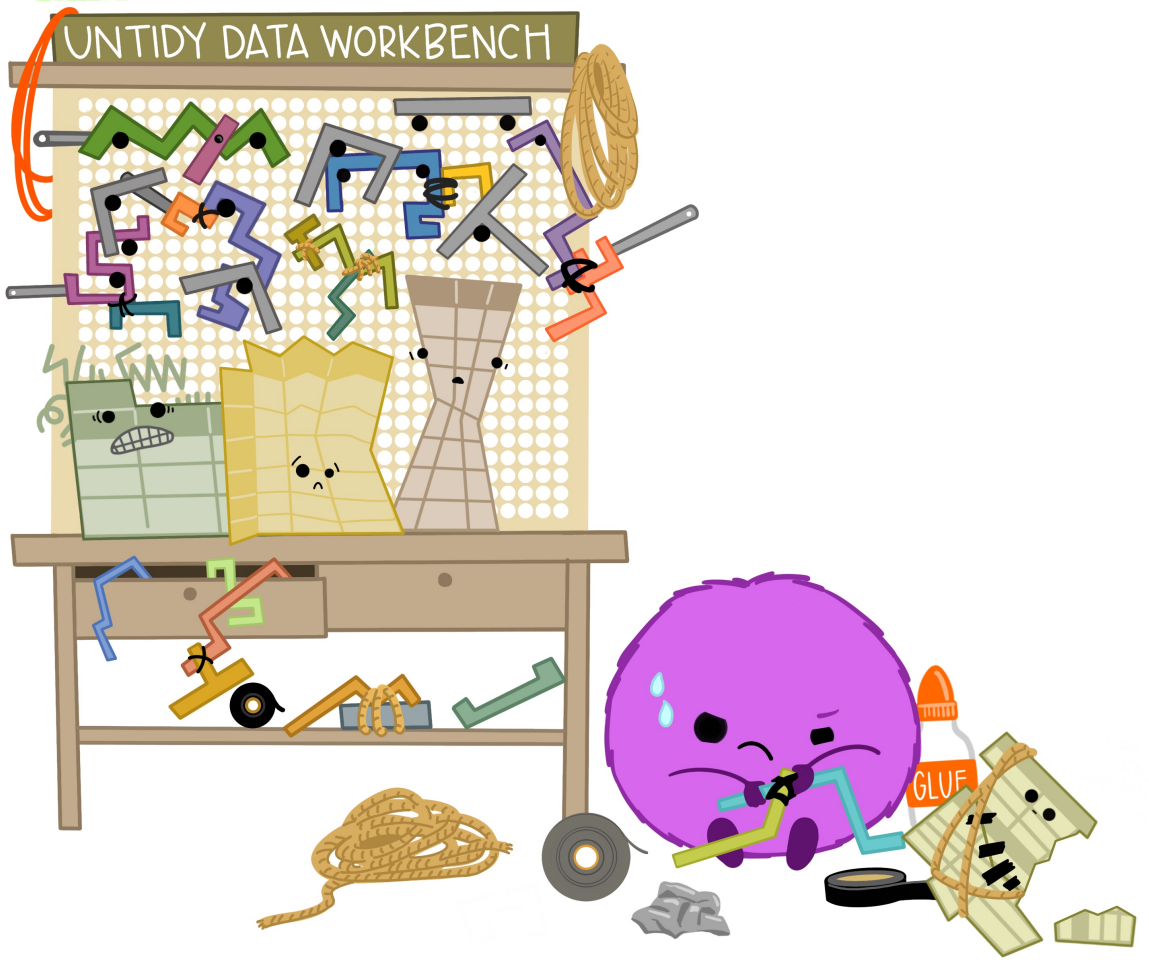
Illustrations from the Openscapes blog Tidy Data for reproducibility, efficiency, and

ds4owd-001.github.io/website/

When working with tidy data, we can use the same tools in similar ways for different datasets...

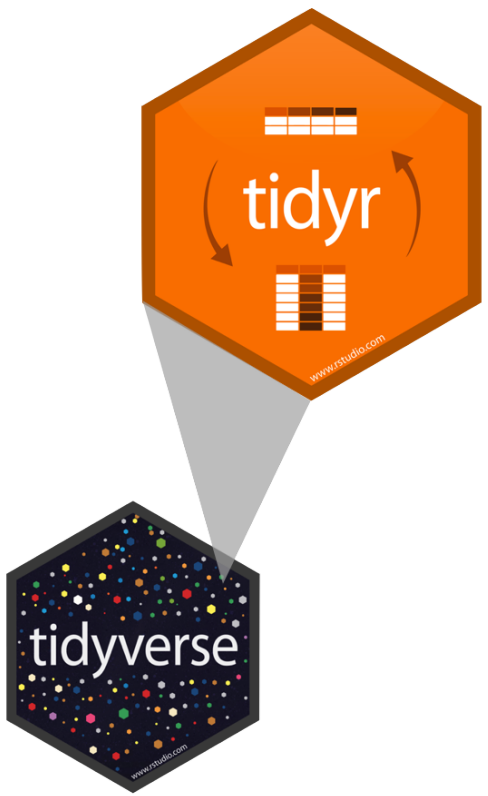


...but working with untidy data often means reinventing the wheel with one-time approaches that are hard to iterate or reuse.



Illustrations from the Openscapes blog Tidy Data for reproducibility, efficiency, and

A grammar of data tidying



The goal of tidyr is to help you tidy your data via

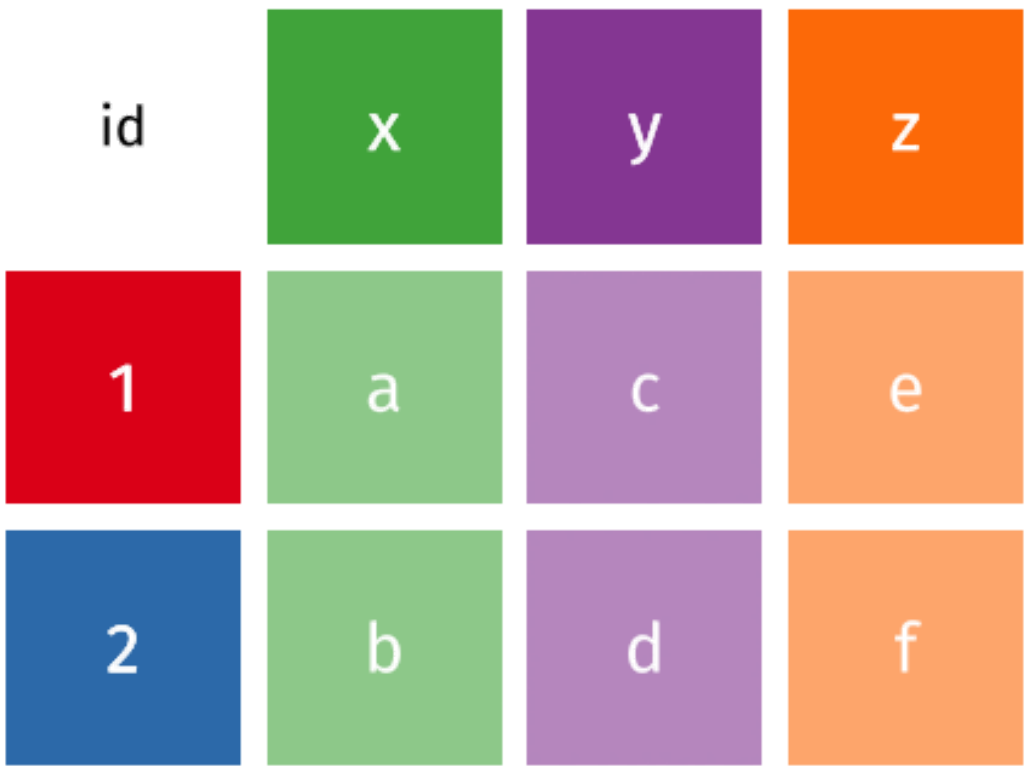
- pivoting for going between wide and long data
- splitting and combining character columns
- nesting and unnesting columns
- clarifying how NAs should be treated

ds4owd-001.github.io/website/

Slide taken from Data Science in a Box

Pivoting data

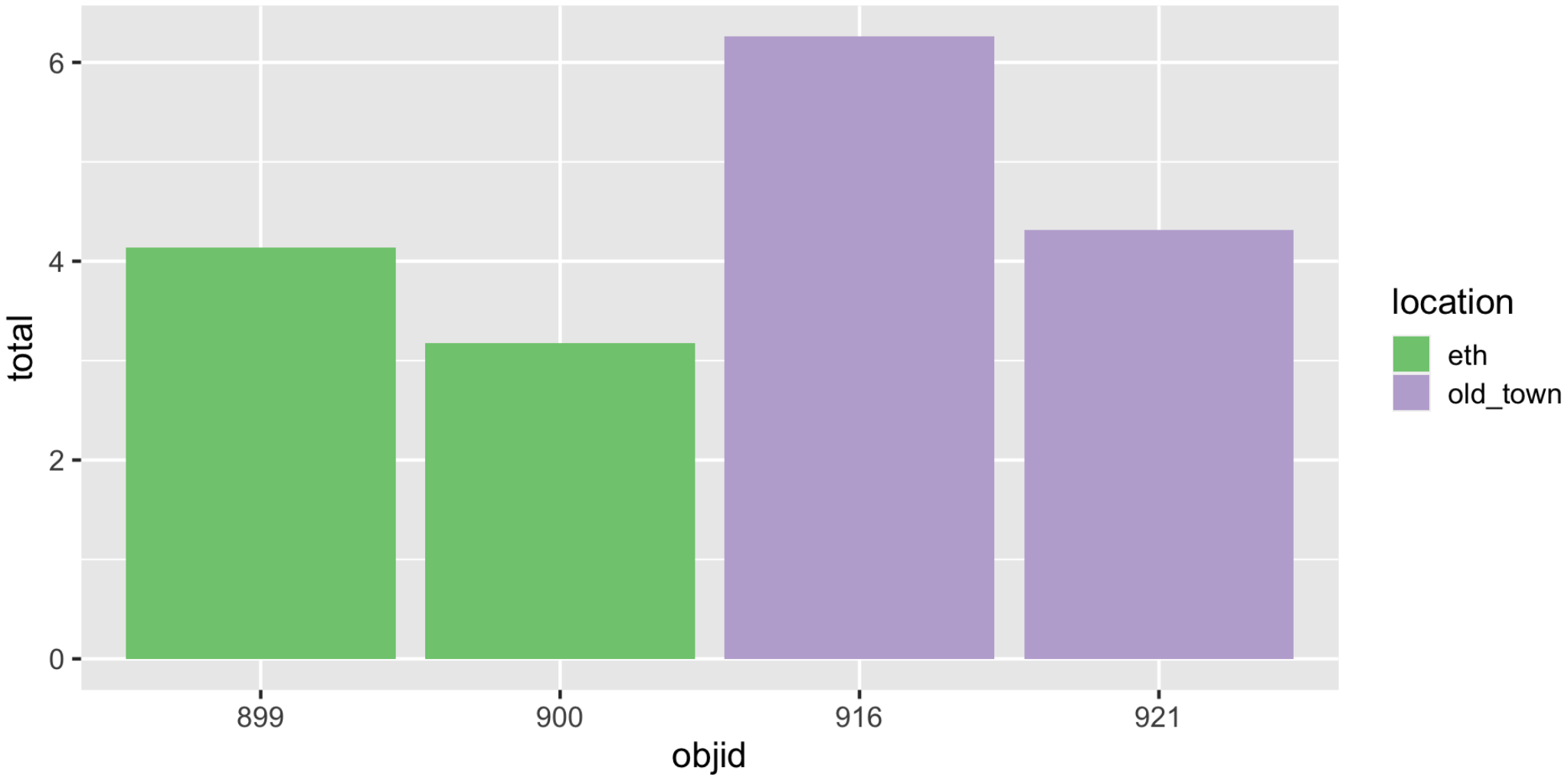
wide



Waste characterisation data

objid	location	pet	metal_alu	glass	paper	other	total
900	eth	0.06	0.06	0.58	0.21	1.14	2.05
899	eth	0.14	0.01	0.18	0.28	3.04	3.64
921	old_town	0.00	0.00	0.00	0.41	1.57	1.99
916	old_town	0.17	0.04	0.80	0.55	0.62	2.19
900	eth	0.10	0.04	0.00	0.40	0.58	1.12
899	eth	0.08	0.03	0.00	0.05	0.34	0.50
921	old_town	0.08	0.03	0.30	0.40	1.52	2.33
916	old_town	0.11	0.04	0.92	1.01	1.99	4.07

How would you plot this?

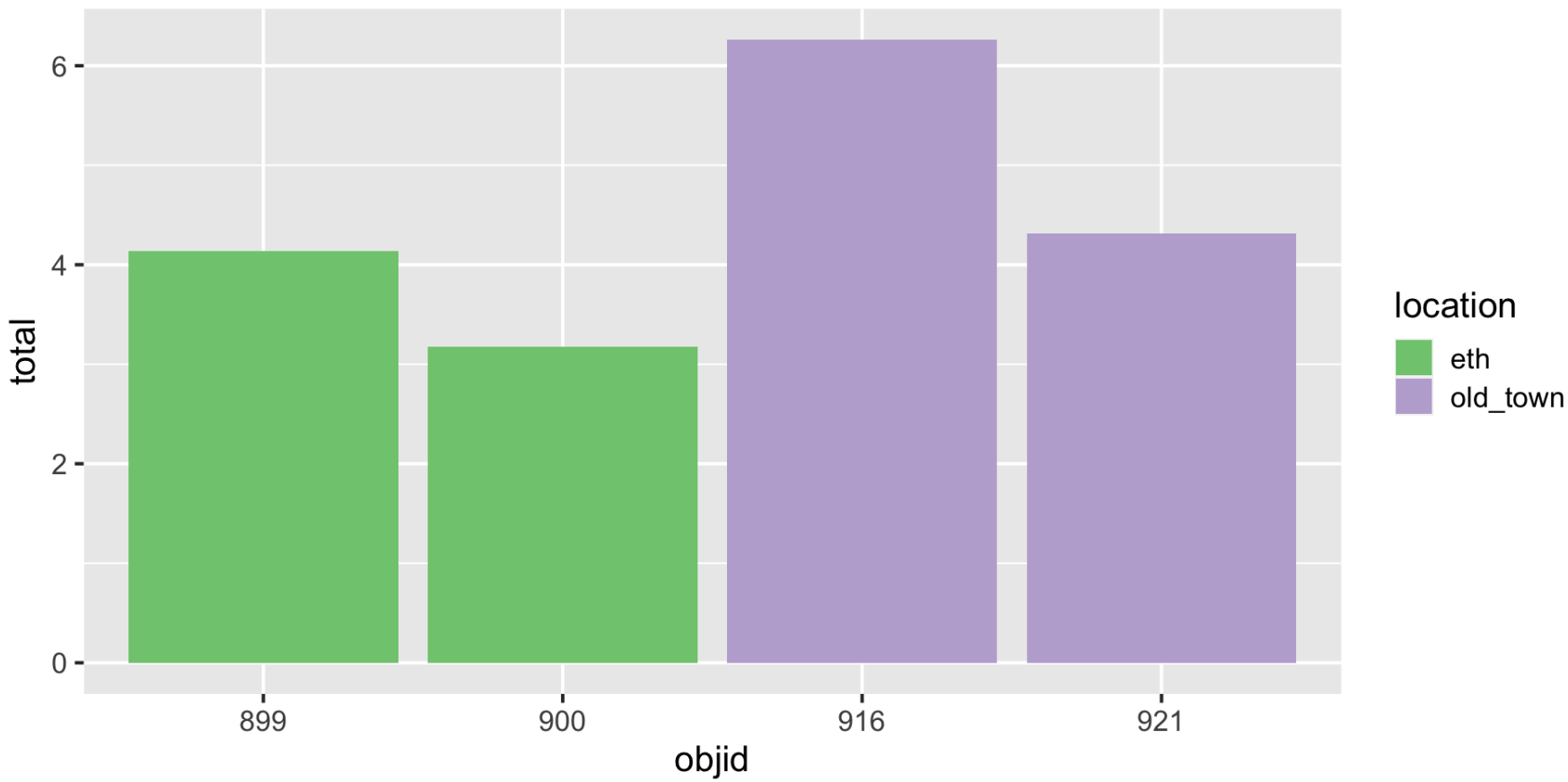


Three variables

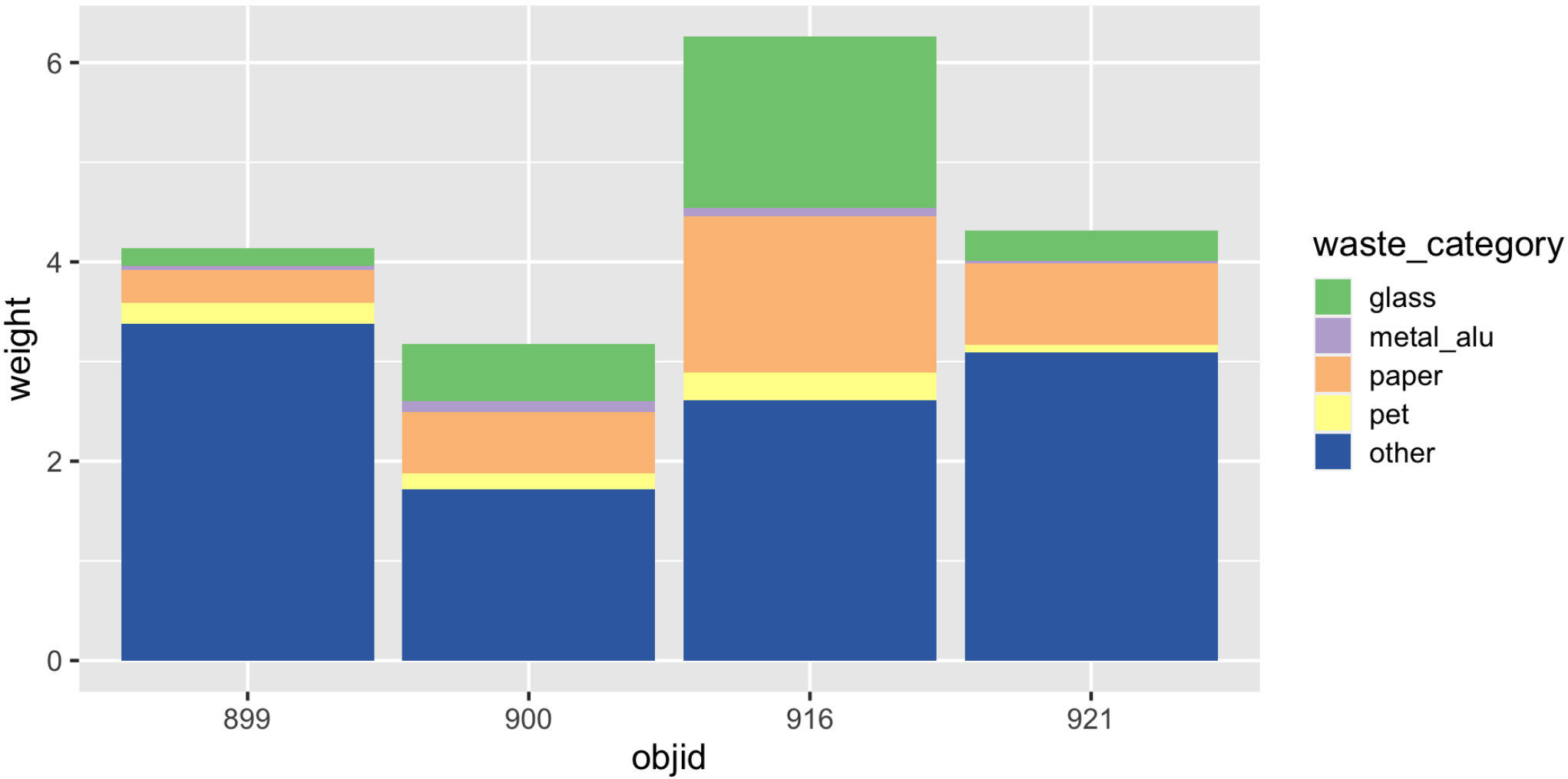
objid	location	total
900	eth	2.05
899	eth	3.64
921	old_town	1.99
916	old_town	2.19
900	eth	1.12
899	eth	0.50
921	old_town	2.33
916	old_town	4.07

Three variables -> three aesthetics

```
ggplot(data = waste_data_untidy,
       mapping = aes(x = objid,
                     y = total,
                     fill = location)) +
  geom_col() +
  scale_fill_brewer(type = "qual")
```



And how to plot this?



Reminder: Data (in wide format)

objid	location	pet	metal_alu	glass	paper	other
900	eth	0.06	0.06	0.58	0.21	1.14
899	eth	0.14	0.01	0.18	0.28	3.04
921	old_town	0.00	0.00	0.00	0.41	1.57
916	old_town	0.17	0.04	0.80	0.55	0.62
900	eth	0.10	0.04	0.00	0.40	0.58
899	eth	0.08	0.03	0.00	0.05	0.34
921	old_town	0.08	0.03	0.30	0.40	1.52
916	old_town	0.11	0.04	0.92	1.01	1.99

You need: A long format

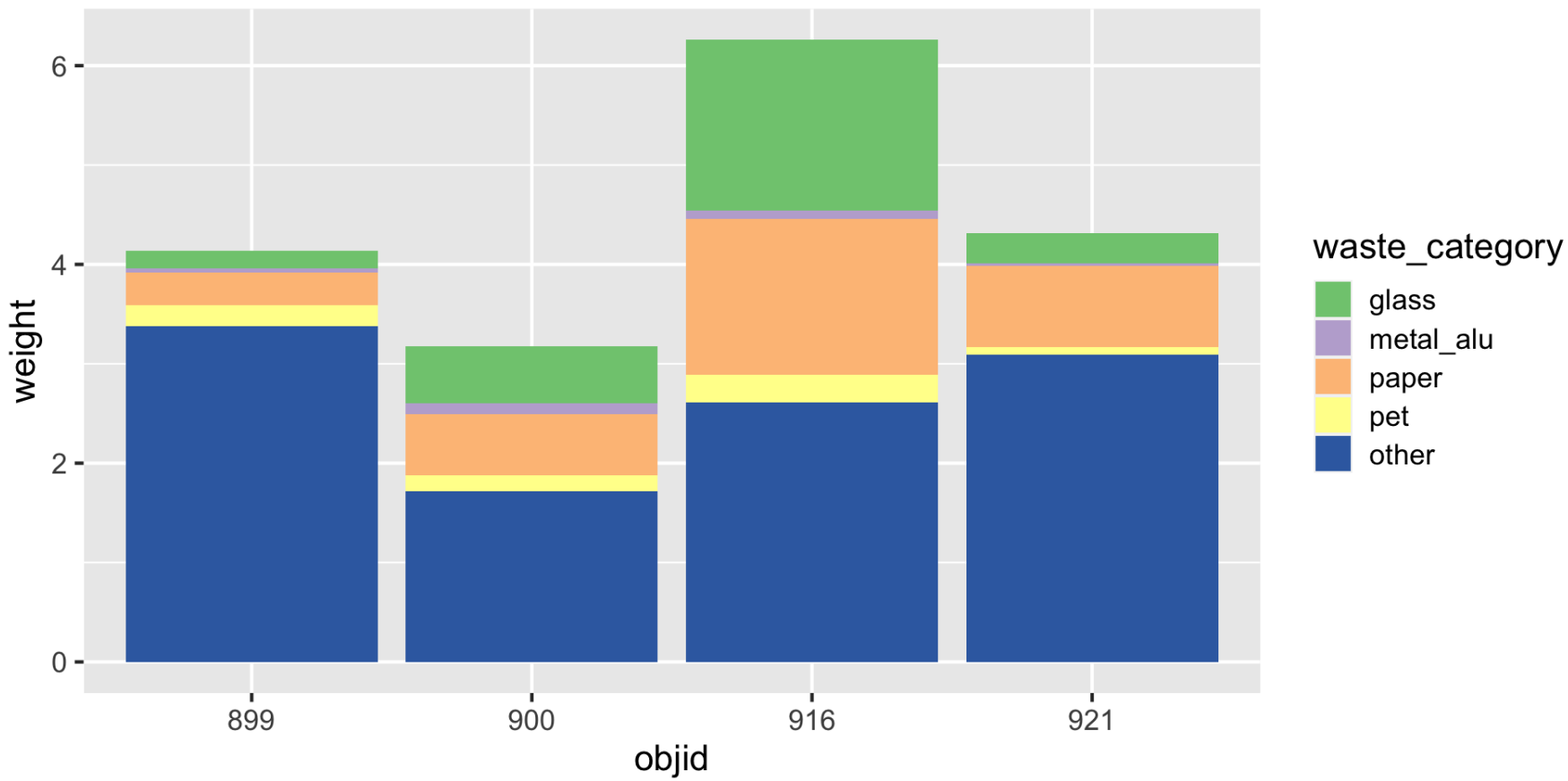
objid	location	waste_category	weight
900	eth	pet	0.06
900	eth	metal_alu	0.06
900	eth	glass	0.58
900	eth	paper	0.21
900	eth	other	1.14
899	eth	pet	0.14
899	eth	metal_alu	0.01
899	eth	glass	0.18
899	eth	paper	0.28
899	eth	other	3.04
921	old_town	pet	0.00
921	old_town	metal_alu	0.00
921	old_town	glass	0.00
921	old_town	paper	0.41

objid	location	waste_category	weight
921	old_town	other	1.57
916	old_town	pet	0.17
916	old_town	metal_alu	0.04
916	old_town	glass	0.80
916	old_town	paper	0.55
916	old_town	other	0.62
900	eth	pet	0.10
900	eth	metal_alu	0.04
900	eth	glass	0.00
900	eth	paper	0.40
900	eth	other	0.58
899	eth	pet	0.08
899	eth	metal_alu	0.03
899	eth	glass	0.00
899	eth	paper	0.05
899	eth	other	0.34

objid	location	waste_category	weight
921	old_town	pet	0.08
921	old_town	metal_alu	0.03
921	old_town	glass	0.30
921	old_town	paper	0.40
921	old_town	other	1.52
916	old_town	pet	0.11
916	old_town	metal_alu	0.04
916	old_town	glass	0.92
916	old_town	paper	1.01
916	old_town	other	1.99

Three variables -> three aesthetics

```
ggplot(data = waste_data_tidy,
       mapping = aes(x = objid,
                     y = weight,
                     fill = waste_category)) +
  geom_col() +
  scale_fill_brewer(type = "qual")
```



How to

```
1 waste_data_untidy
```

objid	location	pet	metal_alu	glass	paper	other
900	eth	0.06	0.06	0.58	0.21	1.14
899	eth	0.14	0.01	0.18	0.28	3.04
921	old_town	0.00	0.00	0.00	0.41	1.57
916	old_town	0.17	0.04	0.80	0.55	0.62
900	eth	0.10	0.04	0.00	0.40	0.58
899	eth	0.08	0.03	0.00	0.05	0.34
921	old_town	0.08	0.03	0.30	0.40	1.52
916	old_town	0.11	0.04	0.92	1.01	1.99

How to

```
waste_data_untidy |>
  pivot_longer(cols = pet:other,
               names_to = "waste_category",
               values_to = "weight")
```

objid	location	waste_category	weight
900	eth	pet	0.06
900	eth	metal_alu	0.06
900	eth	glass	0.58
900	eth	paper	0.21
900	eth	other	1.14
899	eth	pet	0.14
899	eth	metal_alu	0.01
899	eth	glass	0.18
899	eth	paper	0.28
899	eth	other	3.04
921	old_town	pet	0.00

objid	location	waste_category	weight
921	old_town	metal_alu	0.00
921	old_town	glass	0.00
921	old_town	paper	0.41
921	old_town	other	1.57
916	old_town	pet	0.17
916	old_town	metal_alu	0.04
916	old_town	glass	0.80
916	old_town	paper	0.55
916	old_town	other	0.62
900	eth	pet	0.10
900	eth	metal_alu	0.04
900	eth	glass	0.00
900	eth	paper	0.40
900	eth	other	0.58
899	eth	pet	0.08
899	eth	metal_alu	0.03

objid	location	waste_category	weight
899	eth	glass	0.00
899	eth	paper	0.05
899	eth	other	0.34
921	old_town	pet	0.08
921	old_town	metal_alu	0.03
921	old_town	glass	0.30
921	old_town	paper	0.40
921	old_town	other	1.52
916	old_town	pet	0.11
916	old_town	metal_alu	0.04
916	old_town	glass	0.92
916	old_town	paper	1.01
916	old_town	other	1.99

How to

```
waste_category_levels <- c("glass", "metal_alu", "paper", "pet", "other")

waste_data_untidy |>
  pivot_longer(cols = pet:other,
               names_to = "waste_category",
               values_to = "weight") |>
  mutate(waste_category = factor(waste_category, levels = waste_category_levels))
```

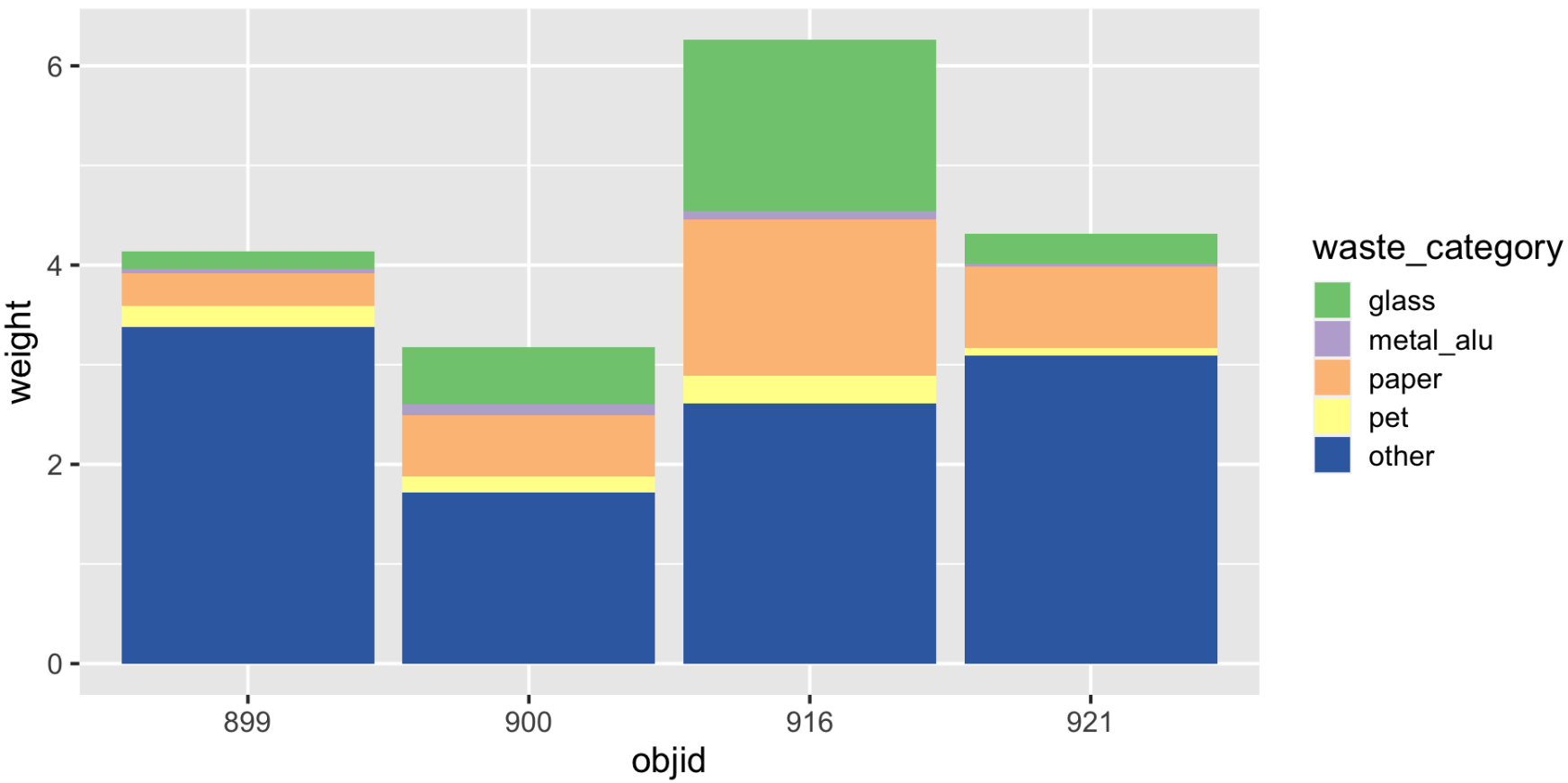
objid	location	waste_category	weight
900	eth	pet	0.06
900	eth	metal_alu	0.06
900	eth	glass	0.58
900	eth	paper	0.21
900	eth	other	1.14
899	eth	pet	0.14
899	eth	metal_alu	0.01
899	eth	glass	0.18
899	eth	paper	0.28
899	eth	other	3.04

objid	location	waste_category	weight
921	old_town	pet	0.00
921	old_town	metal_alu	0.00
921	old_town	glass	0.00
921	old_town	paper	0.41
921	old_town	other	1.57
916	old_town	pet	0.17
916	old_town	metal_alu	0.04
916	old_town	glass	0.80
916	old_town	paper	0.55
916	old_town	other	0.62
900	eth	pet	0.10
900	eth	metal_alu	0.04
900	eth	glass	0.00
900	eth	paper	0.40
900	eth	other	0.58
899	eth	pet	0.08

objid	location	waste_category	weight
899	eth	metal_alu	0.03
899	eth	glass	0.00
899	eth	paper	0.05
899	eth	other	0.34
921	old_town	pet	0.08
921	old_town	metal_alu	0.03
921	old_town	glass	0.30
921	old_town	paper	0.40
921	old_town	other	1.52
916	old_town	pet	0.11
916	old_town	metal_alu	0.04
916	old_town	glass	0.92
916	old_town	paper	1.01
916	old_town	other	1.99

Three variables -> three aesthetics

```
ggplot(data = waste_data_tidy,
       mapping = aes(x = objid,
                     y = weight,
                     fill = waste_category)) +
  geom_col() +
  scale_fill_brewer(type = "qual")
```



ds4owd-001.github.io/website/

Homework assignments module 6

Module 6 documentation

ds4owd-001.github.io/website/modules/md-06.html

Module 6

Concept of tidy data & Vectors in R

Learning Objectives

1. Learners can apply functions from the tidyr R Package to transform their data from a wide to a long format and vice versa.
2. Learners can explain the three characteristics of tidy data.
3. Learners can list the four main atomic vector types in R.

Slides

- In preparation

Readings

1. Read R for Data Science - Section 6 - Data tidying

Homework due date

- Homework assignment due: Monday, December 11th

Wrap-up

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Thanks! 🌻

Slides created via revealjs and Quarto: https://quarto.org/docs/presentations/revealjs/ Access slides as PDF on GitHub

References

Ben Aleya, Ali, Daniel Biek, Lin Boynton, Julia Jaeggi, Sebastian Camilo Loos, Chiara Meyer-Piening, Jonathan Olal Ogwang, et al. 2022. “Research Beyond the Lab, Spring Term 2022, Global Health Engineering, ETH Zurich. Raw Data and Analysis-Ready Derived Data on Waste Management in Public Spaces in Zurich, Switzerland.” Zenodo. https://doi.org/10.5281/ZENODO.7331120.