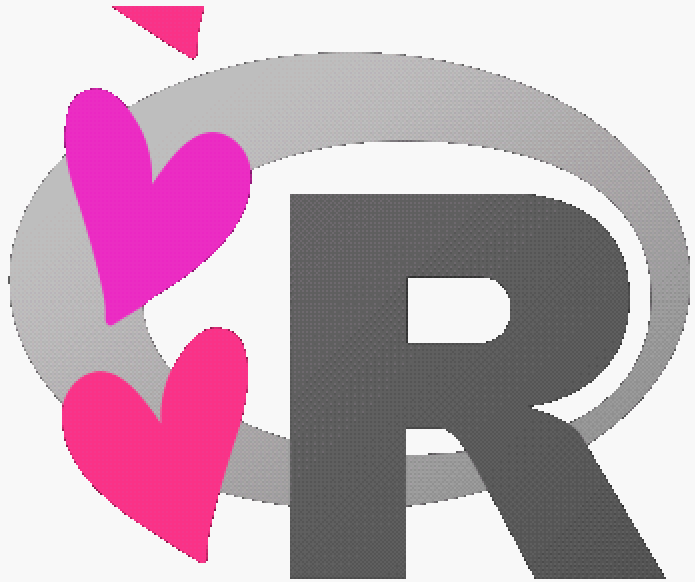
Thanks a lot for participating!



Artwork by Allison Horst

Bring your own data

Day 4 - Introduction to Data Analysis with R

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Freie Universität Berlin - Theoretical Ecology

March 10, 2025

Organization

Schedule of today

- **Now - 14** (or 14.30 if you are enthusiastic still): Work on the data set(s)
  - Take break(s) as best fits your needs
- **14 (14.30) - 15**: Short feedback round
  - What did you find out about your data set? Plots, summaries, …
  - Which methods did you use?
  - Did you learn something new?
  - Was there something you struggled with?
  - …
- **15-16**: Feedback, conclusion

Data set 1: What makes a good wine?

Physicochemical properties of wine and quality judgements

```
Error in loadNamespace(x): there is no package called 'EcoData'
```

Reference: P. Cortez, A. Cerdeira, F. Almeida, T. Matos and J. Reis. Modeling wine preferences by data mining from

Data set 1: What makes a good wine?

Ideas - know methods

- Plot of wine quality against chemical properties
- Plot of distribution of chemical properties
- Summary tables using `dplyr`

Ideas - new methods

- **Correlation plots**: How are the different wine properties correlated with each other?
- **PCA**: How are the wine properties related to each other?

Frederik Vandaele - originally posted to Flickr as Château Pétrus, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=5145286

Data set 1: What makes a good wine?

Hints

- Transform the quality column to a factor before plotting: use `dplyr::mutate` and `as.factor()` to tranform the column
- Try the `janitor::clean_names()` function

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Data set 2: Paralympic games from 1980-2016

Most important variables:

variable	class	description
gender	character	Binary gender
event	character	Event name
medal	character	Medal type
athlete	character	Athlete name (LAST NAME first name
abb	character	Country abbreviation
country	character	Country name
type	character	Type of sport
year	double	year of games

Data set 2: Paralympic games from 1980-2016

Get the data:

```
athletes <- readr::read_csv('https://raw.githubusercontent.com/rfordatascience/tidytuesday/master/data/2021/2021-08
```

Ideas - know methods

- Create **summaries** of medal counts for different groups with `dplyr`
- Did the ratio of men/women winning medals change over time?
- Which countries were the most successful ones? Does this differ between sports type?
  - Which types of sports accumulated the most medals?
- **Make plots** such as:
  - Age distribution of athletes winning gold, silver and bronze
  - Compare the total number of medals over the years between winter and summer Olympics

Data set 2: Paralympic games from 1980-2016

Hints

- To reduce complexity of the data, first filter only the athletes that won a medal (`!is.na(medal)`)

Data set 3: Crab data set

Atlantic marsh fiddler crab (*Minuca pugnax*)

- Crab from Florida is expanding northward due to ocean warming
- Data on 13 marshes across a range of latitude in the USA
- Recording of the size of of the crab
- Rather small and good to handle

Image by LTER under CC BY-SA 4.0

Source: Johnson, D. 2019. Fiddler crab body size in salt marshes from Florida to Massachusetts, USA at PIE and VCR

Data set 3: Crab data set

```
        date latitude site  size air_temp air_temp_sd water_temp water_temp_sd
1 2016-07-24       30  GTM 12.43   21.792       6.391     24.502         6.121
2 2016-07-24       30  GTM 14.18   21.792       6.391     24.502         6.121
3 2016-07-24       30  GTM 14.52   21.792       6.391     24.502         6.121
4 2016-07-24       30  GTM 12.94   21.792       6.391     24.502         6.121
5 2016-07-24       30  GTM 12.45   21.792       6.391     24.502         6.121
6 2016-07-24       30  GTM 12.99   21.792       6.391     24.502         6.121
                            name
1 Guana Tolomoto Matanzas NERR
2 Guana Tolomoto Matanzas NERR
3 Guana Tolomoto Matanzas NERR
4 Guana Tolomoto Matanzas NERR
5 Guana Tolomoto Matanzas NERR
6 Guana Tolomoto Matanzas NERR
```

Source: Johnson, D. 2019. Fiddler crab body size in salt marshes from Florida to Massachusetts, USA at PIE and VCR

Data set 3: Crab data set

Ideas - known methods

- Explore Bergmann's rule (organisms are large in higher latitudes)
- t-tests to compare size between locations
- Plot relationship between latitude and size
- Plot distributions of variables

Image by LTER under CC BY-SA 4.0

Source: Johnson, D. 2019. Fiddler crab body size in salt marshes from Florida to Massachusetts, USA at PIE and VCR

Data set 4: Ice cover and temperature

Temperature and ice duration on lakes since 19th century

- 2 data sets with measurements of
  - ice start, end and duration on 2 lakes in Wisconsin
  - daily air temperature since 1870
- Explore the effect of climate change on ice cover

Image by LTER under CC BY-SA 4.0

Source ice data: Magnuson, J.J., S.R. Carpenter, and E.H. Stanley. 2021. North Temperate Lakes LTER: Ice Duration - Madison Lakes Area 1853 - current ver 35. Environmental Data Initiative.

Data set 4: Ice cover and temperature

Ice data:

```
        lakeid     ice_on    ice_off ice_duration year
1 Lake Mendota       <NA> 1853-04-05           NA 1852
2 Lake Mendota 1853-12-27       <NA>           NA 1853
3 Lake Mendota 1855-12-18 1856-04-14          118 1855
4 Lake Mendota 1856-12-06 1857-05-06          151 1856
5 Lake Mendota 1857-11-25 1858-03-26          121 1857
6 Lake Mendota 1858-12-08 1859-03-14           96 1858
```

Temperature data:

```
  sampledate year ave_air_temp_adjusted
1 1870-06-05 1870                  20.0
2 1870-06-06 1870                  18.3
3 1870-06-07 1870                  17.5
4 1870-06-09 1870                  13.3
5 1870-06-10 1870                  13.9
6 1870-06-11 1870                  15.0
```

Data set 4: Ice cover and temperature

Ideas - known methods

- How did ice cover duration change over the years?
- How did air temperature change over the years?
  - Summarize mean annual temperature or mean temperature in winter
- How do ice duration on the lakes correlate with temperature (e.g. with mean winter temperature)

Image by LTER under CC BY-SA 4.0

Data set 4: Ice cover and temperature

Hints

- For some plots it might make sense to summarize annual means first
- Use `dplyr::left_join` to combined the tables with annual mean temperature and ice duration
    - Have a look at the last slides of the `dplyr` session or look at the help
    - Ask me if you need help with this

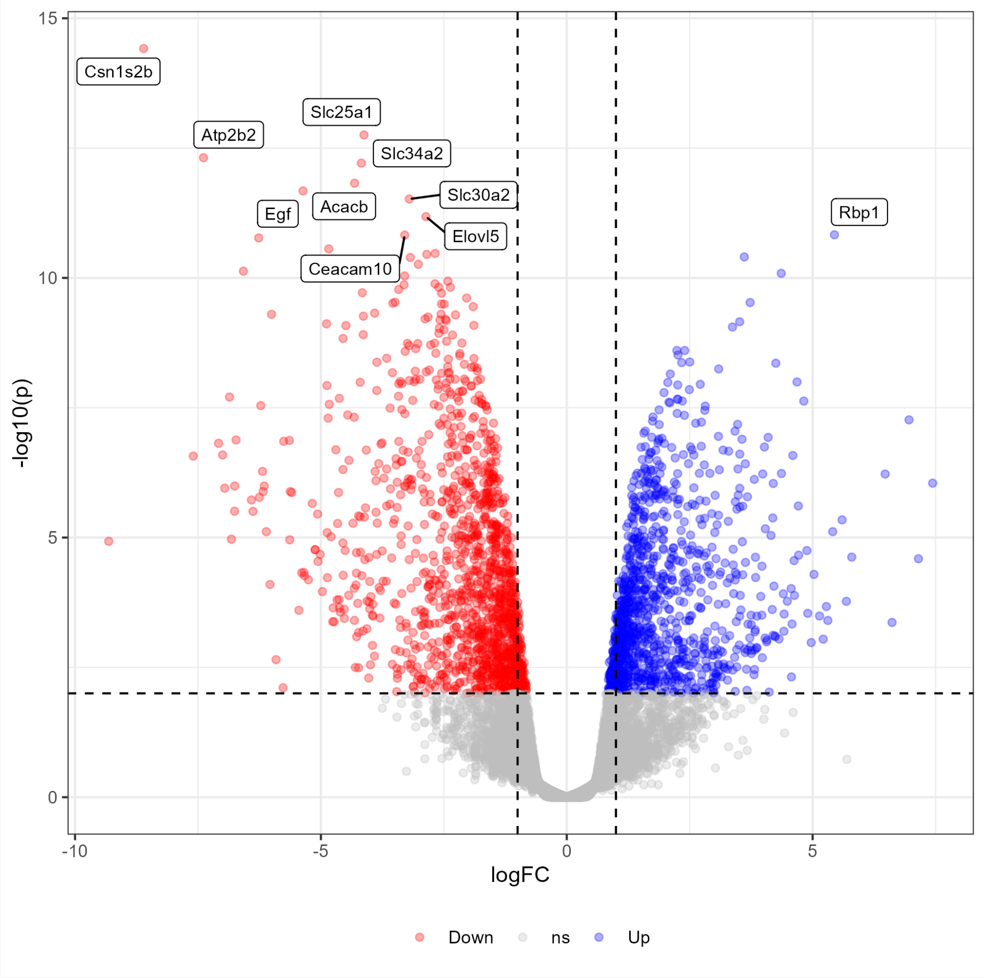
Data set 5: RNAseq data

- Data from FU et al. 2015, *Nature Cell Biology*
- Data found via Tutorial on heat maps using this data
- 3 csv files:
    - `heatmap_genes.csv`: A list of the names of interesting genes to look at (Genes used in Figure 6b in paper)
    - `DE_results.csv`: Gene expression in luminal cells in pregnant versus lactating mice
        - logFC, AveExpr, t, p-value
        - Also contains non-significantly expressed genes
    - `normalized_counts`: Normalized counts for genes for the different samples

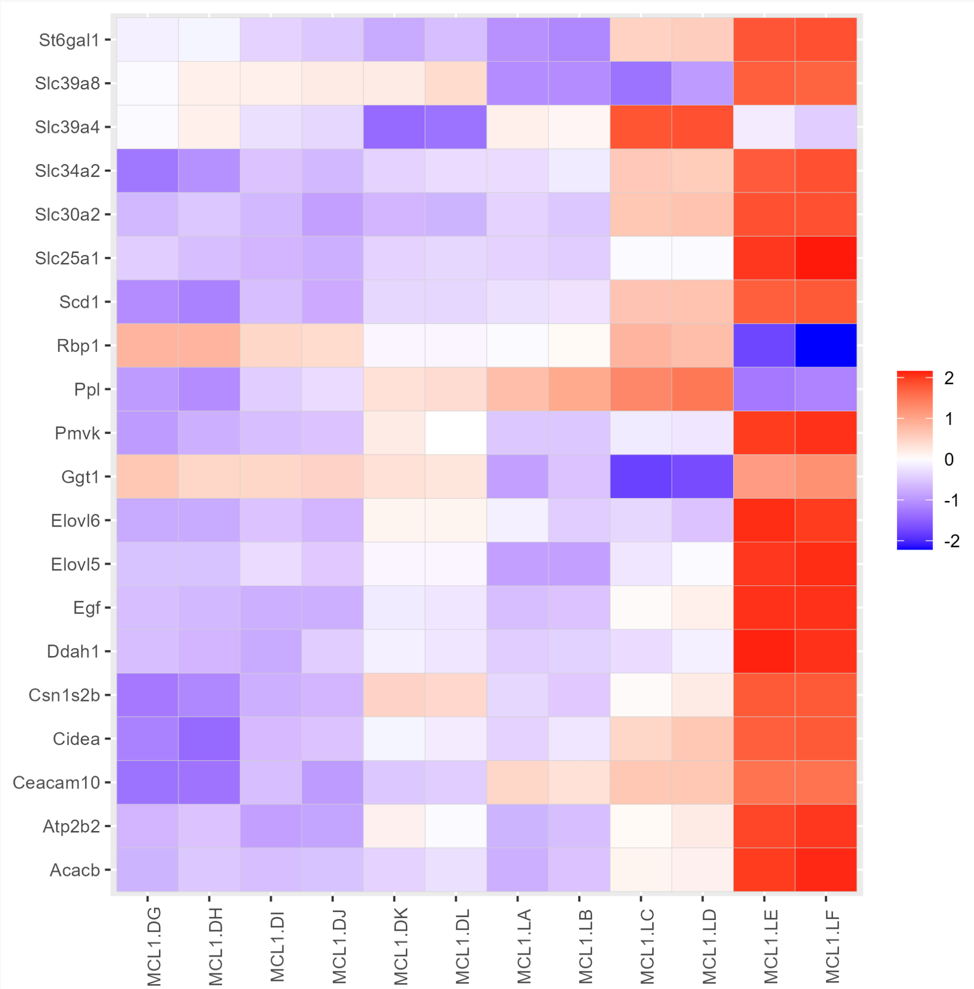
Data set 5: RNAseq data

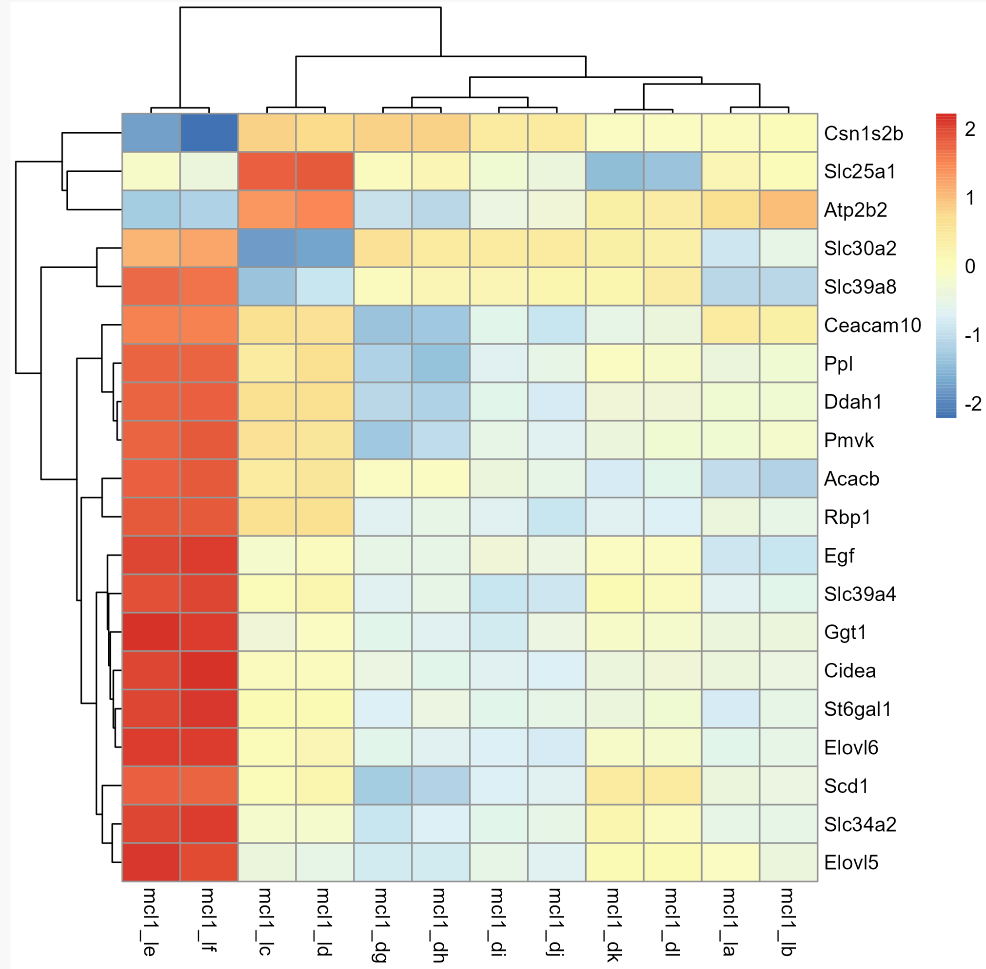
Ideas:

- Create a heatmap of the top 20 most significant genes (see plot in the tutorial)
- Create a heatmap of the interesting genes (see Fig. 6 in the paper)
- Create a volcano plot of the data similar to the one here



Data set 5: RNAseq data





Data set 5: RNAseq data

Some tips:

Data cleaning:

- Read in the data and then use the `janitor::clean_names` function to make the column headers nicer
- Join `DE_results` and `normalized_counts` by their shared columns
- Use `select` to remove columns you don't need for analysis to get a better overview
- Filter only significant genes (tutorial) defines them as `p_value < 0.01 & abs(logFC)` > 0.58)

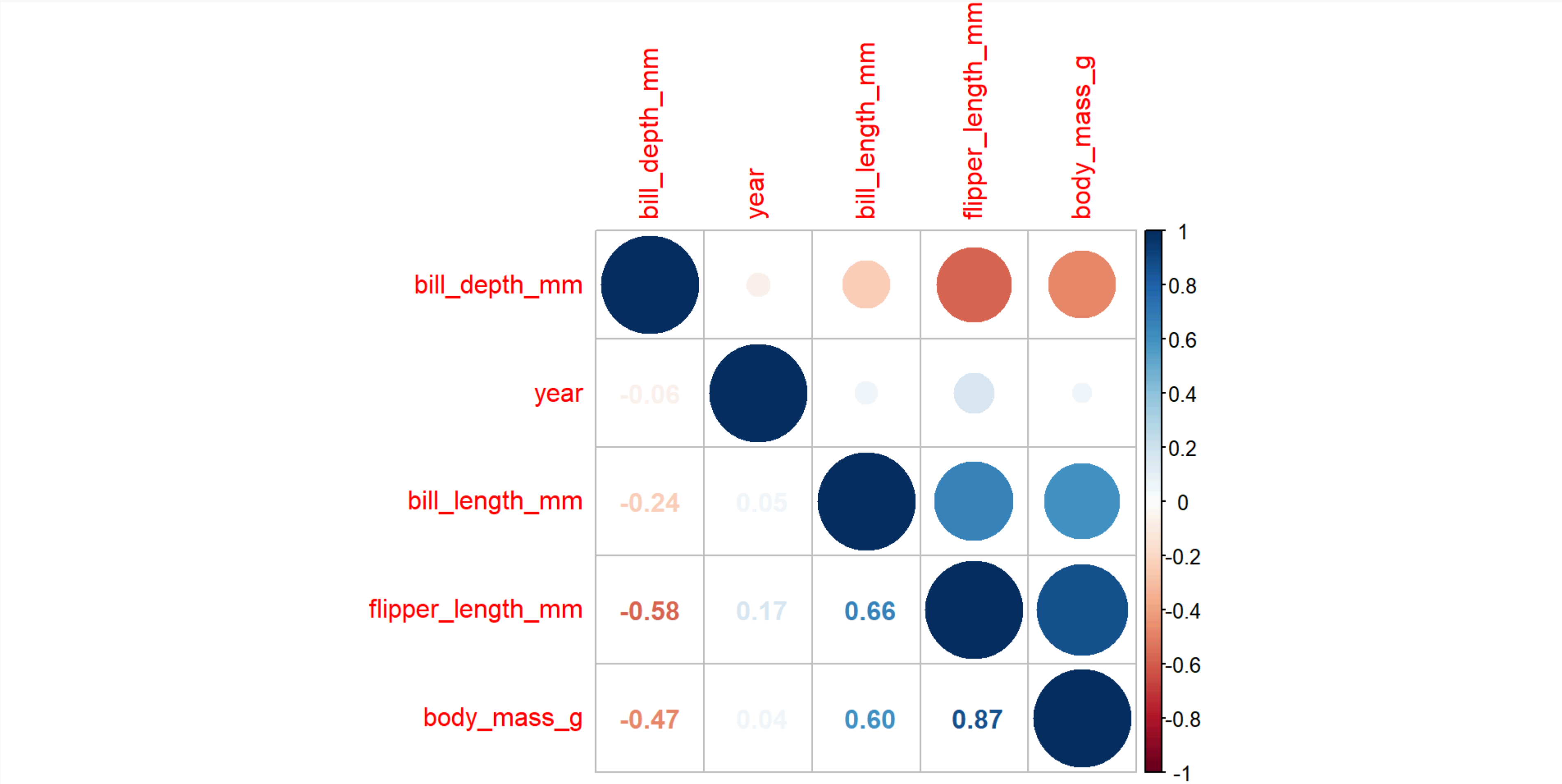
Data set 5: RNAseq data

Some tips:

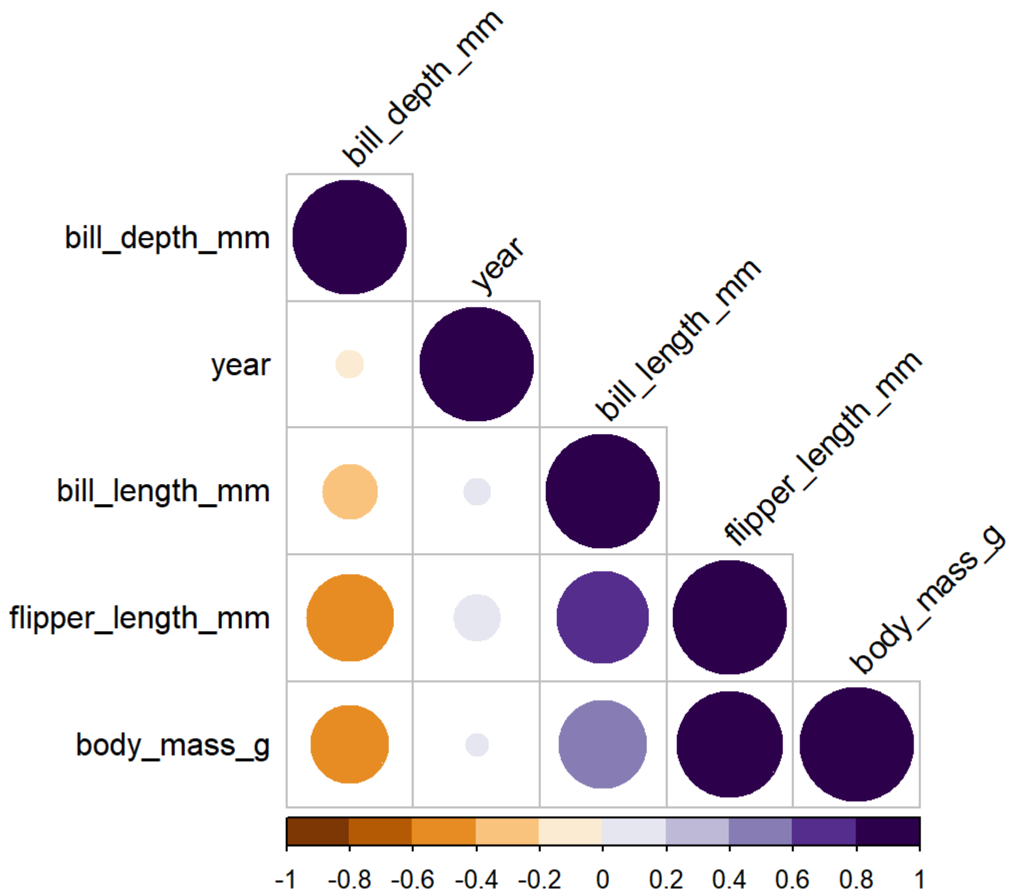
Data analysis:

- Heatmap with ggplot or with `pheatmap::pheatmap()`
  - `pheatmap` takes a matrix as input (use `as_matrix` on tibble to transform)
- scale the counts -> have a look at the `scale` function
  - `pheatmap` can scale but with ggplot you have to scale before plotting

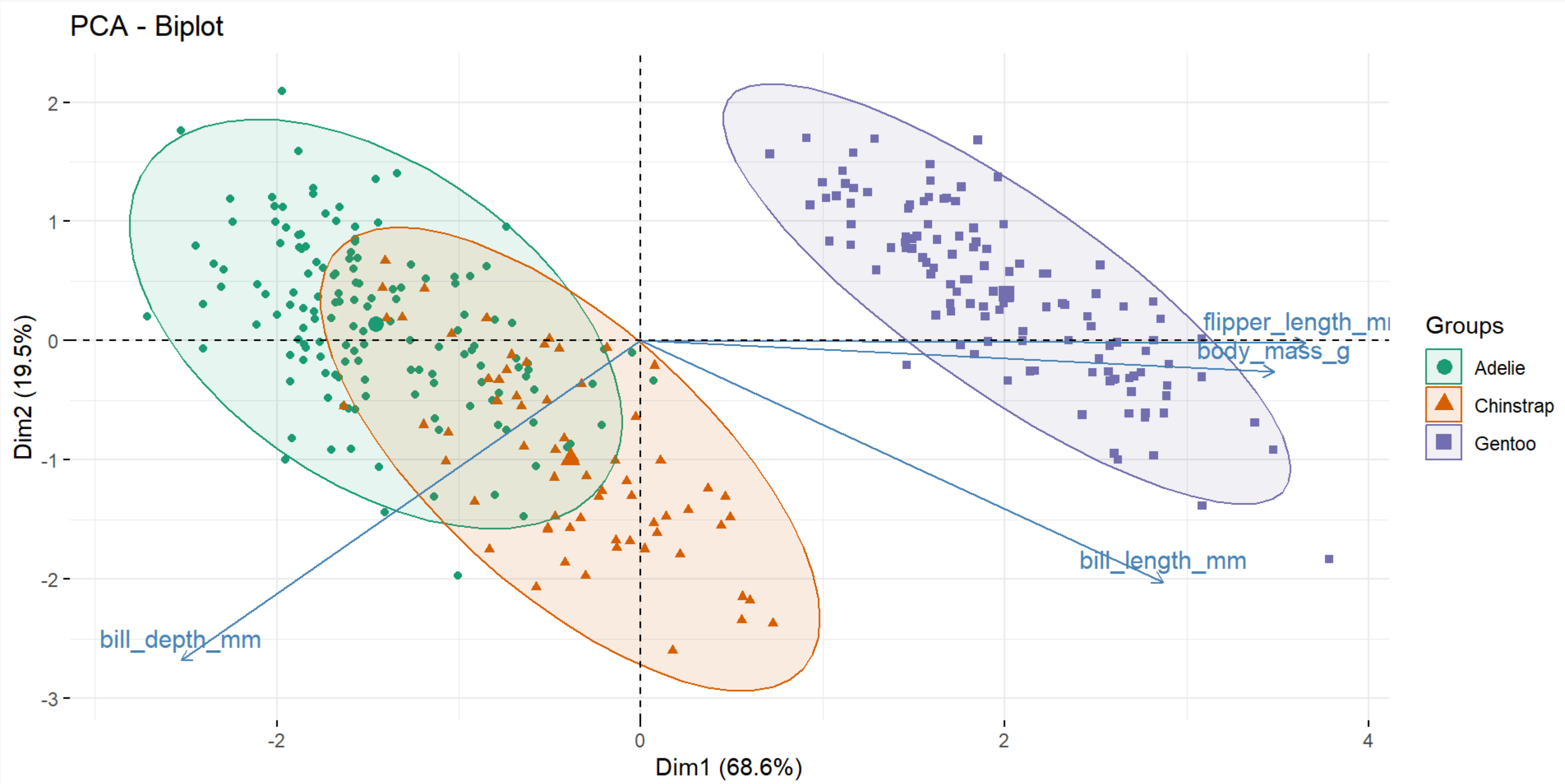
New methods: Correlation plots



New methods: Correlation plots



New methods: PCAS



New methods: Correlation plots and PCAS

- `corrplot` package for correlation plots
- `factoextra` package for PCA visualization
- Tutorial for PCAs in R, PCA tutorial for penguins
- Correlations and PCAs do not work with `NA` values: use `tidyr::drop_na()` to remove all `NA` values from the data first
- These plots work for: penguins, wine, piecrab dataset

Some general tips

- First make a plan:
  - What do you want to achieve and what are the steps?
  - Try to think in technical terms
  - Start with something small, e.g. reading in the data and bringing it into the right format.
  - If you want, stop by in general to discuss your plan or write me in the chat
- Google
- If you get stuck, ask in the chat or stop by in General
- Have a look at the package cheat sheets

Now you

Working with real research data

Meet in your group (if you want)
Work on your data set
Take breaks as you need and **be back at 2 p.m.**
Keep an eye on your **group and the general chat**

Sharing

In 1-2 mins:

- What was the highlight of your analysis?
  - Your favorite plot
  - Some cool code
  - A problem that you finally solved
  - Something new you learned
- What was difficult?
- If you want: Share a screenshot in the chat or share your screen

Feedback

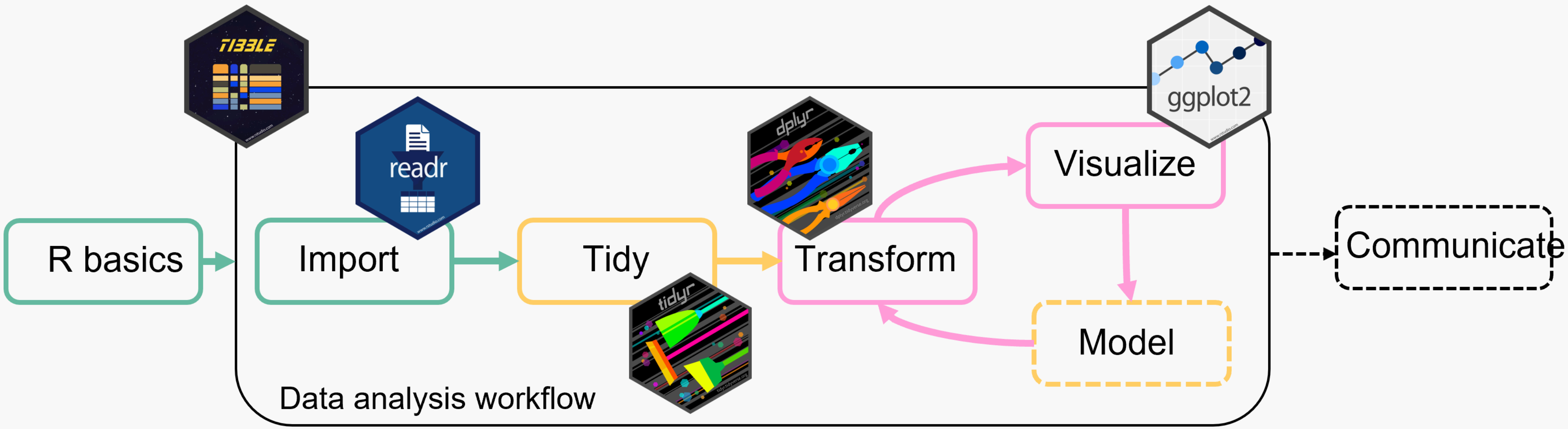
Please take 10 mins to complete the feedback survey for the Graduate center (don't use Internet Explorer)

https://votingo.cedis.fu-berlin.de/PCNLP3

Feedback

- Any other feedback or comments from your side?

Conclusion

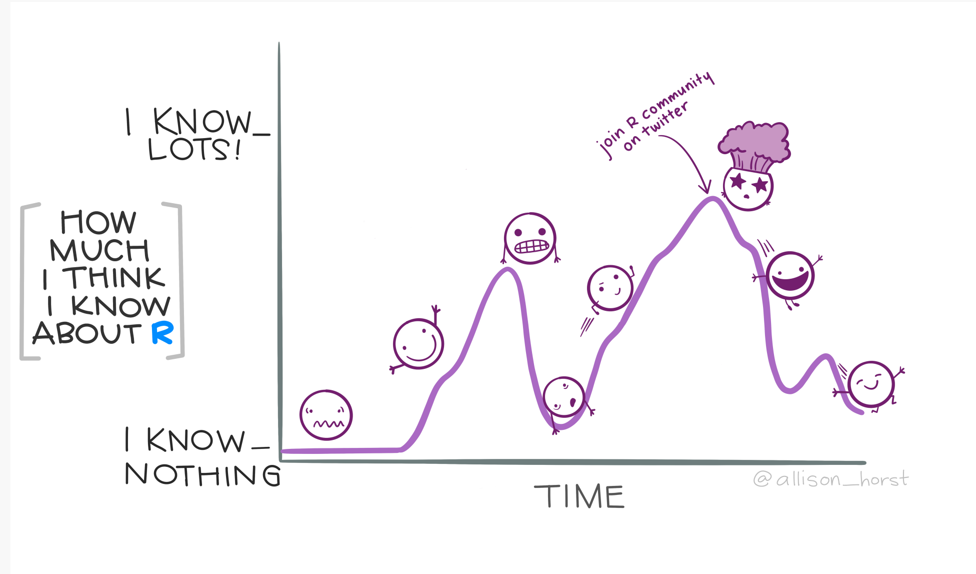


We learned a lot of stuff!

Conclusion

How to continue from here?

- Learning by doing!
- Have a look at some online ressoures, I recommend the R for Data Science book by Hadley Wickham
- If you like plotting: Consider participating in the tidytuesday
- FU statistical consulting for questions regarding statistical methods
- R Consulting by me
- Tools and Tips lecture



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The End