Statistics for Linguists
08 July 2022

10:00	Workshop introduction
10:15	Loading and exploring datasets
10:45	Data transformation and coding
11:15	Practical exercise
12:15	Review of practical
12:30 - 13:30	LUNCH BREAK
13:30	lmer and glmer
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15:00	Practical exercise
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16:15	Model building
17:00	End of workshop

Statistics for Linguists

Data transformation and coding

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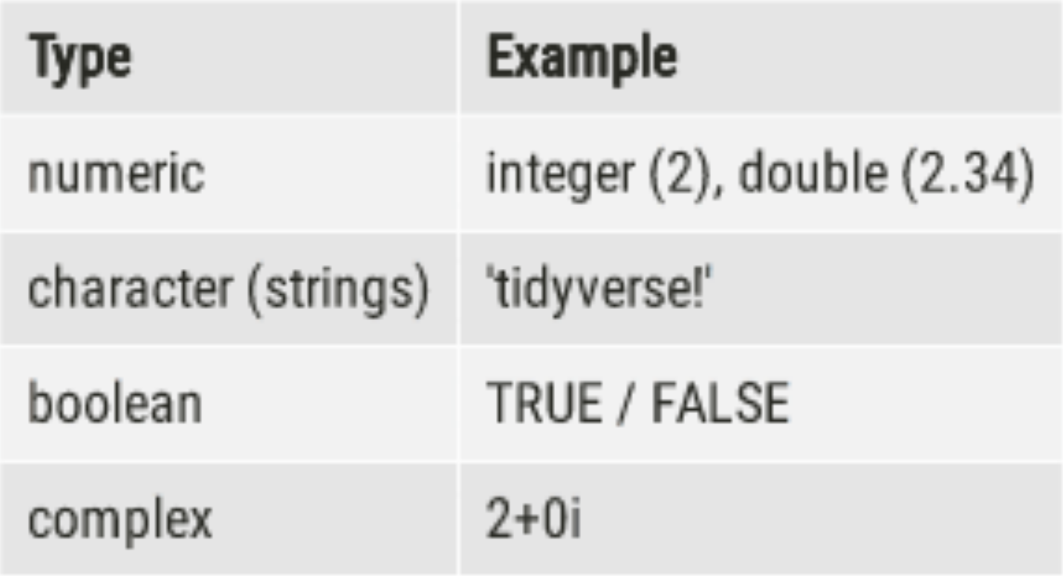
Learning objectives

- You will learn to load/import data
- Explore a dataset and create descriptive statistics
- **Transform a dataset (if needed)**
- **Code your factors**
- Build a mixed model
- Perform post-hoc statistics
- Visualize your data and your model

4 main types of data



Type	Example
numeric	integer (2), double (2.34)
character (strings)	'tidyverse!'
boolean	TRUE / FALSE
complex	2+0i

Special types:

NA	# missing data
NULL	# empty
-Inf/Inf	# infinite values
NaN	# Not a Number

4 main types of data

- But what if the automatic coding that R gives isn’t correct?
  - For example, participant 1, 2, 3, 4,… often seen as integers, which they are not

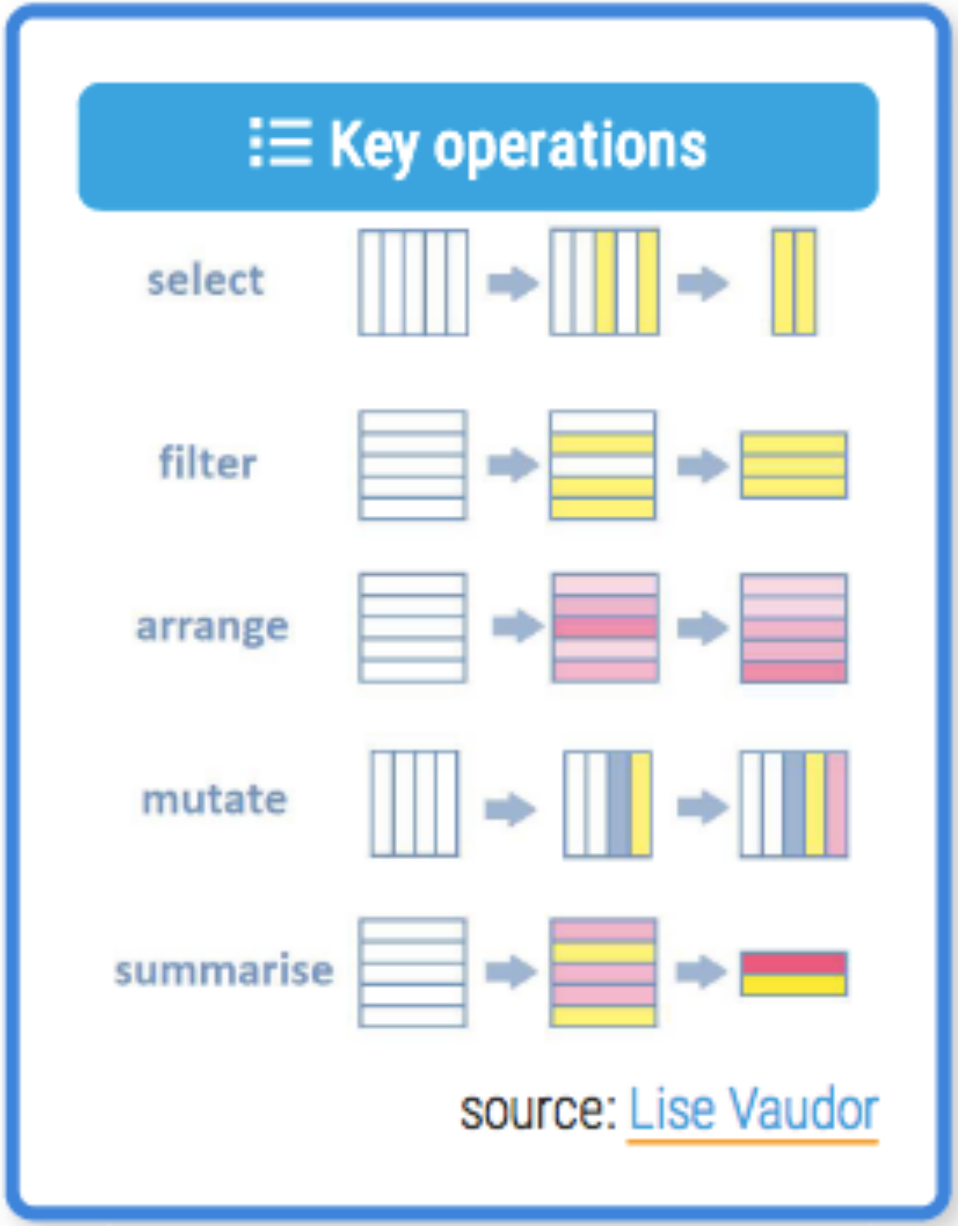
```
> as.character(c(2, TRUE, 'a string'))

> as.integer()

> as.factor() #or factor()
```

Data transformation

Some tidyverse operations



source: Lise Vaudor

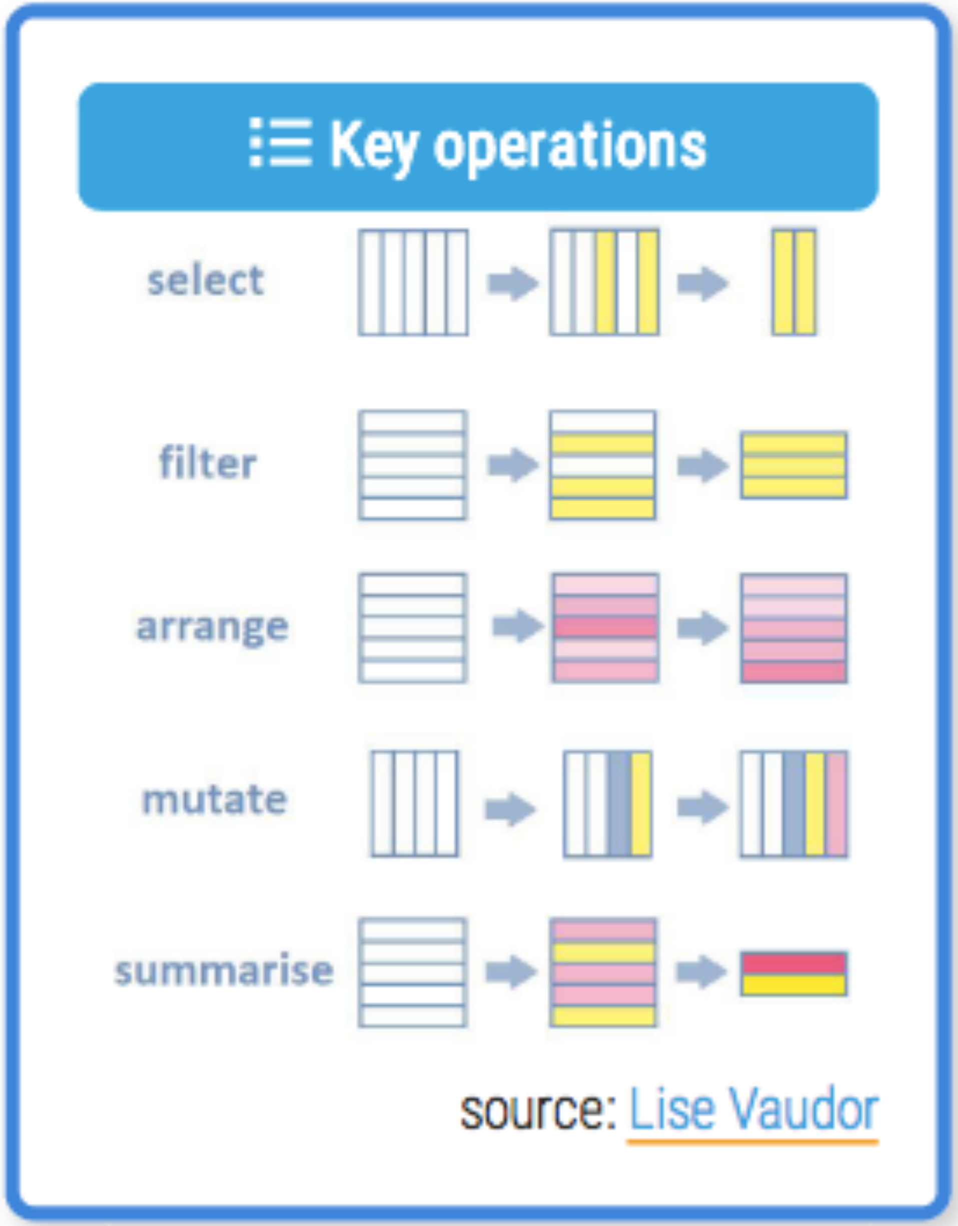
Data transformation

Some tidyverse operations

```
psycholinguistics_data %>%
                    select(-session, -list)
```

-> type `?select` for help

```
psycholinguistics_data %>%
                    filter(ReadingTime < 500)
```



source: Lise Vaudor

Data transformation

- Same filtering without tidyverse:

```
> psycholinguistics_data[psycholinguistics_data$ReadingTime < 500,]
```

- This can be useful for, for example, removing outliers

Data transformation

- Many different ways to select and exclude outliers
    - 2.5 * SD
    - Based on IQR (per participant?)
    - Based on predetermined values (e.g., an response time of < 200 ms is implausible)
    - we won’t go into details of what the best method is here

Data transformation

- Many different ways to select and exclude outliers

- One simple way is through the boxplot function

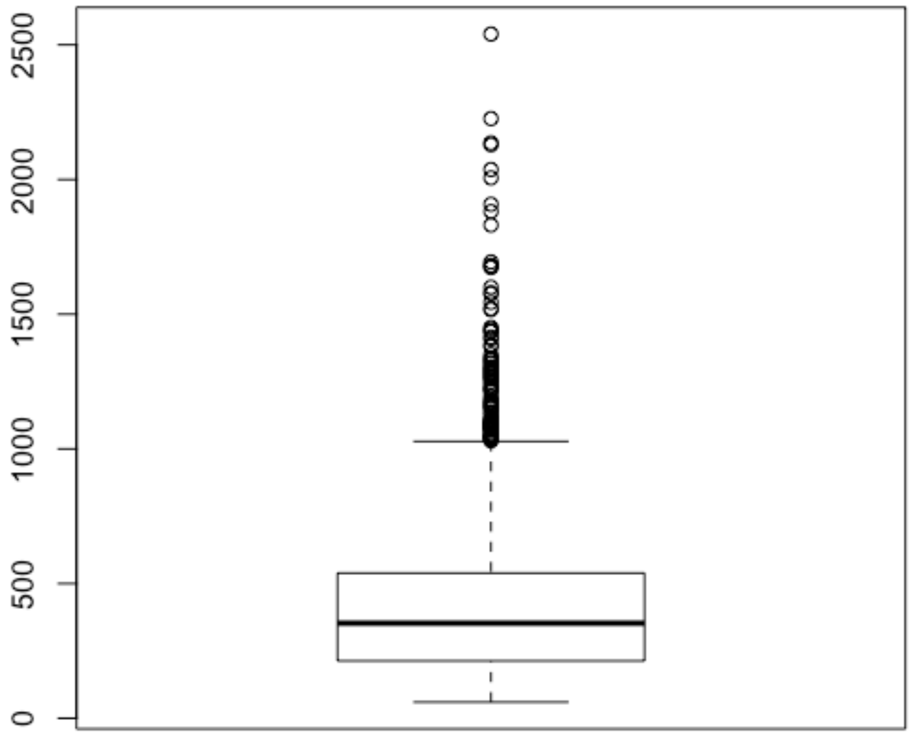
```
> boxplot()
> boxplot()$out
```

Data transformation

- Many different ways to select and exclude outliers
- One simple way is through the boxplot function

```
> boxplot()
> boxplot()$out
```

- See `?boxplot` for more information



Data coding

- For categorical variables, factors can be coded in different ways

- Linear models need a baseline: you are in control of setting the baseline for your analyses

- The default coding for factors is treatment or dummy coding: [0,1]

```
> contrasts(psycholinguistics_data$capitalization)
cap          0
nocap        1
```

Data coding

- Treatment coding compares each level of a categorical variable to a reference level. By default, the reference level is the first level of the categorical variable, in alphabetical order.
- You can change the baseline of your model:

```
> psycholinguistics_data$capitalization <-
        factor(psycholinguistics_data$capitalization,
        levels=c("nocap","cap"))
> psycholinguistics_data$capitalization <-
        factor(psycholinguistics_data$capitalization,
        levels=c("cap","nocap"))
> psycholinguistics_data$capitalization =
        relevel(psycholinguistics_data$capitalization, ref = "nocap")
```

Data coding

- You can always check your contrasts:

```
> contrasts(psycholinguistics_data$capitalization)
> levels(psycholinguistics_data$capitalization)
```

- Other contrasts possible. For example, sum or deviation coding compare each level to the grand mean. Compare:

```
> contr.sum(2)
> contr.treatment(2)
```

Data coding

- You can always check your contrasts:

```
> contrasts(psycholinguistics_data$capitalization)
> levels(psycholinguistics_data$capitalization)
```

- Other contrasts possible. For example, sum or deviation coding compare each level to the grand mean. Compare:

```
> contr.sum(2)
> contr.treatment(2)
```

- This can be useful when you have multiple factor levels or interactions. You can also try
```
> contr.sum(4)
```

Data coding

- More information:
  - https://stats.oarc.ucla.edu/r/library/r-library-contrast-coding-systems-for-categorical-variables/
  - https://marissabarlaz.github.io/portfolio/contrastcoding/
- Always check your coding to make sure you’re interpreting any model output correctly! This can become complicated when working with factors with multiple levels or interactions

Data corrections

- For non-categorical (i.e. continuous) variables, there are other considerations

- Centering variables is a common way to standardize them, so that the predictors have mean 0. This makes it easier to interpret model outcomes.

- By using `scale(x)` you standardize that variable relative to a normal distribution. This is used when one variable has a scale very different from others

Data corrections

- Mixed models have similar assumptions compared to ANOVAs
- We won’t go into all of these in detail, but some normality assumptions may require corrections

- **Right (positive) skewed data:**
  - Logarithm log(x). Commonly used transformation
  - Reciprocal 1/x.
- **Left (negative) skewed data:**
  - Square x^2. Stronger with higher power
  - Exponential e^x. Stronger with higher base

Data corrections

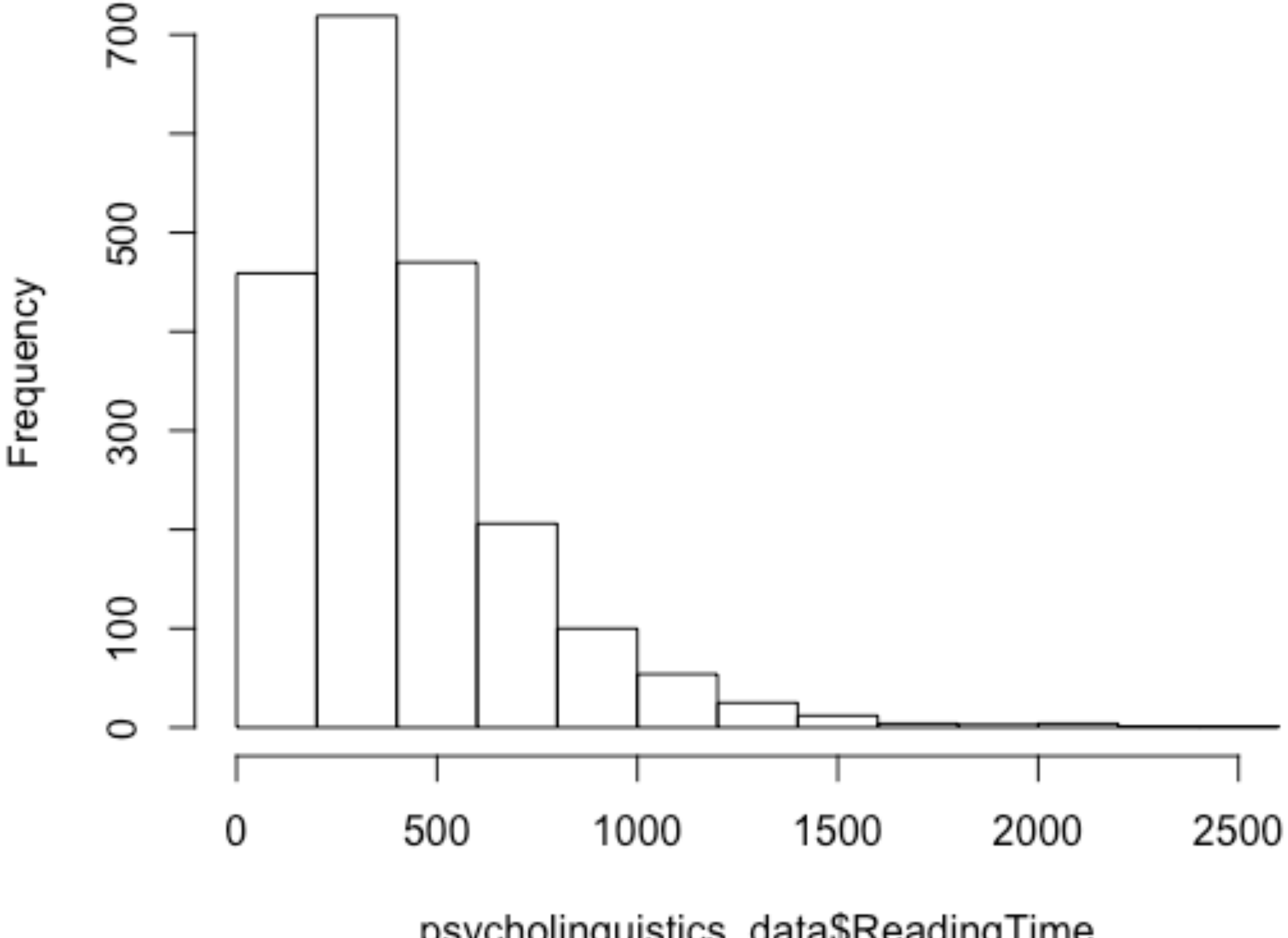
- Mixed models have similar assumptions compared to ANOVAs
- We won’t go into all of these in detail, but some normality assumptions may require corrections

- To display the distribution, you could use a histogram or a density plot

```
> hist(psycholinguistics_data$ReadingTime)
> plot(density(psycholinguistics_data$ReadingTime))

> ggplot(psycholinguistics_data, aes(x=ReadingTime))
      + geom_density()
```

Data corrections



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