DATA HANDLING AND ASSUMPTIONS

Making the Most of Your Data

AARHUS UNIVERSITY

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Center for Biodiversity and Dynamics in a Changing World (BIOCHANGE)
Aarhus University

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Why Care?

Biostatisticians often use 70% of their time to handle data and just 30% to actually analyse it.

Why care?

- Proper data collection and data handling ensure accurate results
- Proper data collection cuts down on data handling time
- Proper data handling will make reproducing an analysis much easier

What to consider?

- Which data format to use
- What kind of data to record
- How data values are recorded/stored
- What kind of data values are feasible

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Data Recording

Guidelines for data recording:

- When collecting categorical data, know what values the variables are allowed to take
- When collecting continuous data, know which range the variable values can fall into
- Make sure everyone involved in data collection is on the same page
- Make regular back-ups of your data set

I recommend:

- Preparing content-aware excel files for data entry
    - Only allow pre-defined values to be entered
    - Need some excel macro writing
- Using a cloud-service featuring version control for data storage

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Common Issues

The Decimals

Always use a *dot* to indicate decimals.

$\rightarrow$ It is the standard in science.

To NA **Or Not To** NA**?**

Never enter NA *values manually* into your data.

$\rightarrow$ They cause problems in R.

Redundancy Or Sparsity?

Don't clutter data with unnecessary data records.

$\rightarrow$ Reduces storage space and chances for errors.

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Data Storing

R works very well with:

- excel files (*.xls, .xlsx, .csv*)

$\rightarrow$ Easiest to handle outside of R, most storage-heavy

$\rightarrow$ Make sure to provide co-workers with a master file before data collection to avoid cell formatting issues on different computers

- text files (*.txt*)

$\rightarrow$ Difficult to handle outside of R, easy on storage

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- RDS files (*.rds*)

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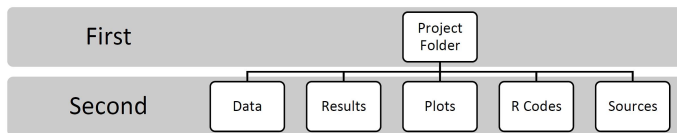$\rightarrow$ Impossible to handle outside of R, easy on storage

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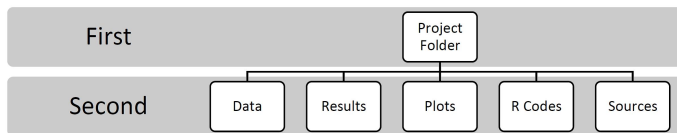
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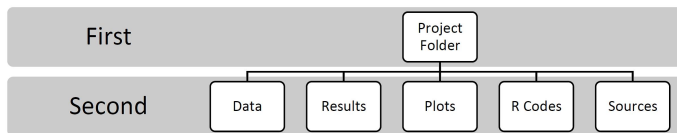- Manuscript master file

Additionally, make sure to **back-up your project folder frequently** and use **version control** on it.

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The README File

Using the **README file**, one can identify what information is contained within the data set and thus decide:

- What type/class a data record should be of
- Which variables may be redundant
- Which data records exceed their variable-specific feasible thresholds
- Where to get comparative data sets from

Data Mining should then focus on:

- *Identifying problems* within the data records
- *Explorative* data analyses

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For data mining, one may wish to enlist the use of Descriptive Statistics & Data Visualization:

Descriptive Statistics:
- summary()
- str()
- iterative sub-setting and inspection

Data Visualizations:
- Histograms (hist())
- Scatter plots (ggplot2 Package)

Holistic data mining is best **achieved using a combination** of data visualizations tools and parameters of descriptive statistics!

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Recording Data Collection - The README File

Documenting data recording is just as important as proper data collection!

To do so, one usually uses a **README** file containing the following:

- Project Name and Summary
- Primary contact information
- Your name and title (if you aren't the primary contact)
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Open science conduct is essential and you should (read *have to* as a student/employee of Aarhus University) share your data & coding to ensure **reproducibility** of your work:

Peer-to-Peer:
- Raw data
- Code
- You may just as well point your peers to public repositories

Public:
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- Html visualizations (`shiny`, `mapview`)
- Websites

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- **Normality**: Data follow a normal distribution
- **Randomness**: Data are truly random
- **Independence**: Data are independent
- **Homogeneity of variances**: Data from separate groups have same variance
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- Base assumption: The data is normally distributed
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The QQ Plot In Theory
- Method for comparing two probability distributions by plotting their quantiles against each other
- If the two distributions being compared are similar, the plot will show the line $y = x$.
- Compare the data distribution to the normal distribution

Independence

Theory:

- Even the smallest dependence in your data can turn into heavily biased results (which may be undetectable).

- A dependence is a connection between/within the data.

- The assumption of independence relies on the absence of any connection in your data that haven't been accounted for in your approach (accounting for it is difficult).

Independent data:

- *Between Groups*
  Groups of data records should be pulled from different individuals.

- *Within Groups*
  Data values within the same group are not to influence one another.

- *Within Individuals*
  Data values recorded for one individual should not influence each other. This is often an issue with repeated measurement approaches.

$\rightarrow$ Fixing this *after data collection* is **almost impossible**!

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- The assumption of independence relies on the absence of any connection in your data that haven't been accounted for in your approach (accounting for it is difficult).

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  Groups of data records should be pulled from different individuals.

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  Data values within the same group are not to influence one another.

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  Data values recorded for one individual should not influence each other. This is often an issue with repeated measurement approaches.

→ Fixing this *after data collection* is **almost impossible**!

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Homogeneity of Variances

Particularly important for t-Tests and ANOVAs

- **Assumption**: Data from separate groups have same variance
- **Test**: `leveneTest()` in the `car` package.
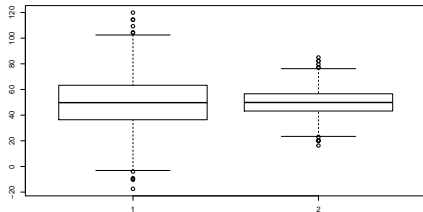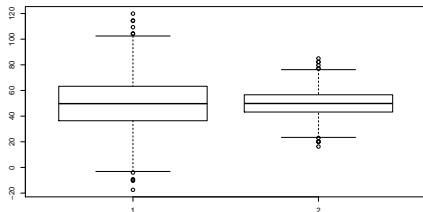


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##         Df F value Pr(>F)
## group    1     337 <2e-16 ***
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