Advanced R

Day 2

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Course Content - Advanced R (Day 2)

- Statistical tests & models

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- Simple linear regression

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- Data import & preparation

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- study design, ...

Statistical tests & models

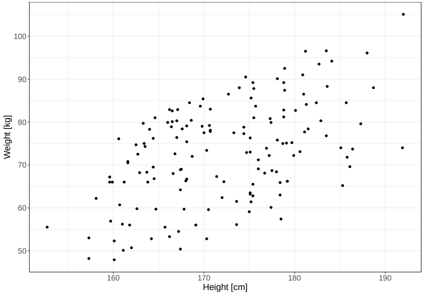
Which statistical tests and models are suitable for your research questions?

$\Rightarrow$ not easy to give an answer

Simple Linear Regression

Example - Height & Weight

What is the relationship between height and weight, respectively can height explain weight?



Regression analysis

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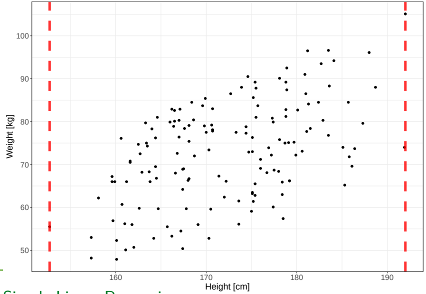
- Possibility of prognosis/prediction for an individual patient (incl. CI) within the value range of the predictor



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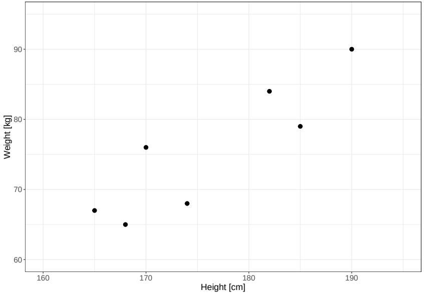
  - prediction, inference of x $\rightarrow$ y
- method
  - e.g. minimize deviation squares of the observed values from the regression line

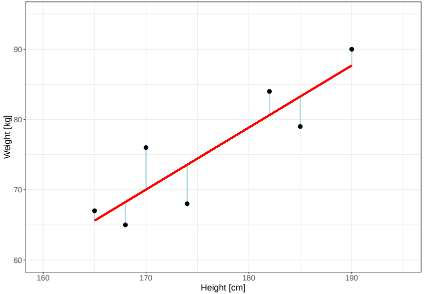
Simple linear regression

Find a straight line



Simple linear regression

- Problem: Find a straight line so that the vertical distance (residuals) between the data points and the straight line is minimized.
- Method, e.g., least squares method



Simple linear regression

As a statistical model

$Y = \beta_0 + \beta_1 * X$

Simple linear regression

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$Y = \beta_0 + \beta_1 * X$

As an empirical model with data

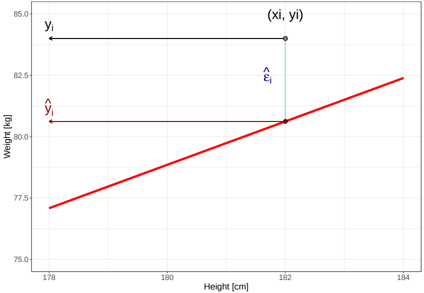
$y_i = \beta_0 + \beta_1 * x_i + \epsilon_i$

where ϵ_i describes the error (residual)

Simple linear regression

$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 * x_i$ are the predicted values of the regression

$\hat{\epsilon}_i = \hat{y}_i - y_i$ are the residuals of the regression



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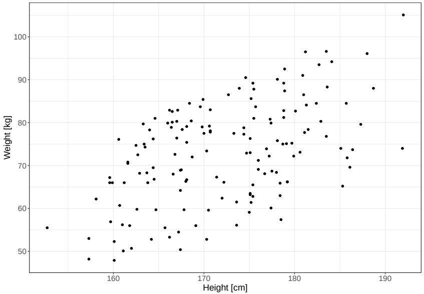
- For 1) study design question
- For 2) scatter plot
- For 3) & 4) looking at residuals

Coefficient of Determination R^2

R^2 specifies the proportion of variance in the data that is explained by the model

$R^2 = \frac{\sum(\hat{y}_i - \bar{y})^2}{\sum(y_i - \bar{y})^2}$ and $0 \leq R^2 \leq 1$

Example - Height & Weight



1) **Independence** ✓
2) **Linearity** ✓

Example - Height & Weight (Residuals)

```r
res_model <- lm(weight ~ height, data = dt_regression)
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## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
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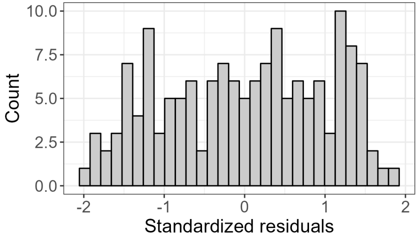

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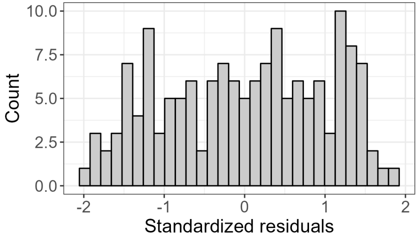

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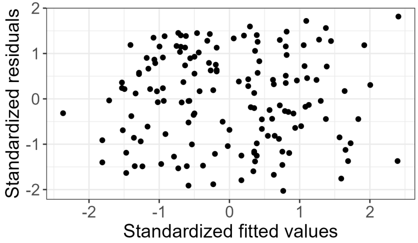

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- If a model accurately captures the structure in the data, then all that should remain after the model is through making its predictions is random noise!
- Why plot residuals vs. fitted values, and not observations?
  - Because residuals and fitted values are uncorrelated by construction
  - Residuals and observations may be correlated—they both depend on observations — which would make such plots harder to interpret

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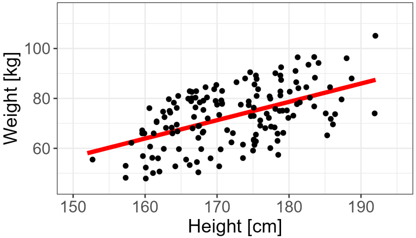

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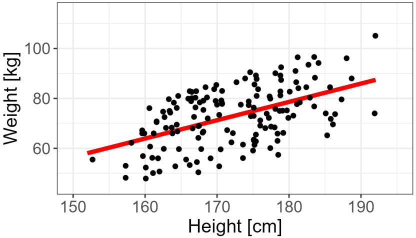

- intercept -53.49 (95% CI -87.3 to -19.69)
- slope 0.73 (95% CI 0.54 to 0.93)

- $R^2 = 0.27$
- $R^2_{adj} = 0.265$

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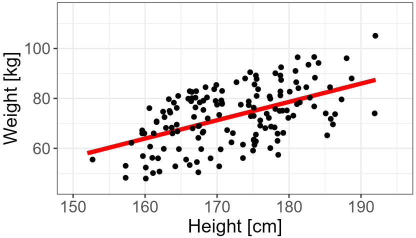

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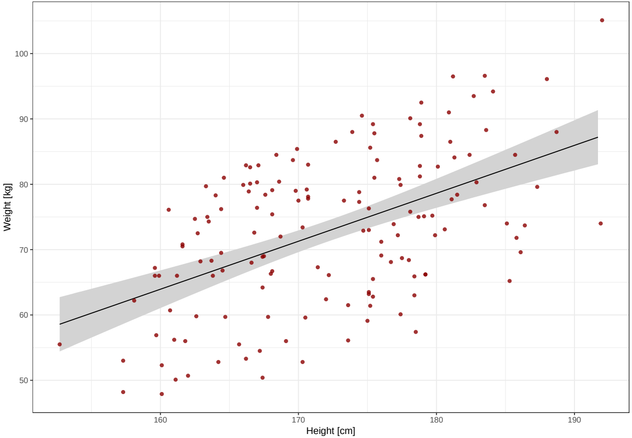
What weight can you expect from a 1.75 m tall person?

Example - Prediction

```r
predict(res_model, newdata = tibble(height = 175),
        interval = "confidence", level = 0.95)
```

```
##      fit   lwr   upr
## 1 74.95 73.25 76.65
```

Example - Uncertainty



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- R^2 tends to increase as more variables are added to the model (even if they don't improve the model significantly)
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- R^2, R^2_{adj}
  - does not indicate whether the model was specified correctly
  - low/high coefficient of determination $\neq$ bad/good model

Remarks (II)

Assumptions not fulfilled - What then?

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- Apply more complex or robust estimation methods
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- Multiple regression: further conditions must be checked (multicollinearity).

Data import

R packages for import

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- ... just search, e.g., import to R dat

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- file type $\rightarrow$ R package and function
- work with arguments in functions
  - e.g., first row contains column headers
  - e.g., type of parameters
  - e.g., which strings to interpret as missing values
  - ...

Data preparation with tidyverse

What is tibble?

*"A **tibble**, or **tbl_df** , is a modern reimagining of the data.frame, keeping what time has proven to be effective, and throwing out what is not. Tibbles are data."*

https://tibble.tidyverse.org/

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  - 'R for Data Science' (see slide with links)

Useful functions for data preparation

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- **filter()** picks cases based on their values
- **mutate()** adds new variables that are functions of existing variables

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```
dt_example %>%
  mutate(bmi = weight/(height^2)) %>%
  select(pat_id, sex, bmi)
```

What will we cover

- We will look at
  - importing data (example: .xlsx)
  - useful function for data preparation
  - save R environment (.Rdata)
- Data import and preparation in R file (.R)
  - input: dataset (e.g., .xlsx)
  - output: .Rdata
- We will work with .Rdata in a Rmarkdown file

Example supraclavicular

This data set contains 103 patients who were scheduled to undergo an upper extremity procedure suitable for supraclavicular anesthesia. Patients were randomly assigned to either

(1) combined group-ropivacaine and mepivacaine mixture; or
(2) sequential group-mepivacaine followed by ropivacaine.

A number of demographic and post-op pain medication variables (fentanyl, alfentanil, midazolam) were collected. The primary outcome is time to 4-nerve sensory block onset.

[Source: R package medicaldata]

Links

Links (I)

- Introduction to R
  - R for Data Science (https://r4ds.hadley.nz/)
- Plots using ggplot
  - Overview with further links to course material: https://ggplot2.tidyverse.org/
- Display tables using flextable
  - flextable bool https://ardata-fr.github.io/flextable-book/
  - Function references https://davidgohel.github.io/flextable/reference/index.html
- knit_child()
  - link (https://bookdown.org/yihui/rmarkdown-cookbook/child-document.html)

Links (II)

- Download R
  - CRAN (https://cran.r-project.org/)
- Download RStudio
  - RStudio Desktop (https://posit.co/download/rstudio-desktop/)