INTRODUCTION TO DATA ANALYSIS

Contents

Preface

The book introduces key concepts of data analysis from a frequentist and a Bayesian tradition. It uses R to handle, plot and analyze data. It relies on simulation to illustrate selected statistical concepts.

0.1 Testing / Showcasing

Don't pay too much attention to what is written here.

0.1.1 Quotes

This is a quote:

> Tidy datasets [. . .] have a specific structure: each variable is a column, each observation is a row, and each type of observational unit is a table.
>
> — Wickham (2014)

0.1.2 Infobox

At certain stages, possibly at the end of chapters or after important concepts, we might want to use a special infobox (see `.infobox` in `styles.css`) to summarise it or give food for thought. Like this:

A horse walks into a bar and orders a pint. The barkeep says "you're in here pretty often. Think you might be an alcoholic?", to which the horse says "I don't think I am.", and vanishes from existence.

See, the joke is about Descartes' famous philosophy of 'I think therefore, I am", but to explain that part before the rest of the joke would be to put Descartes before the horse.

We can have boxes with different icons for different purposes:

This might be useful for excercises or general questions. Do you like it?

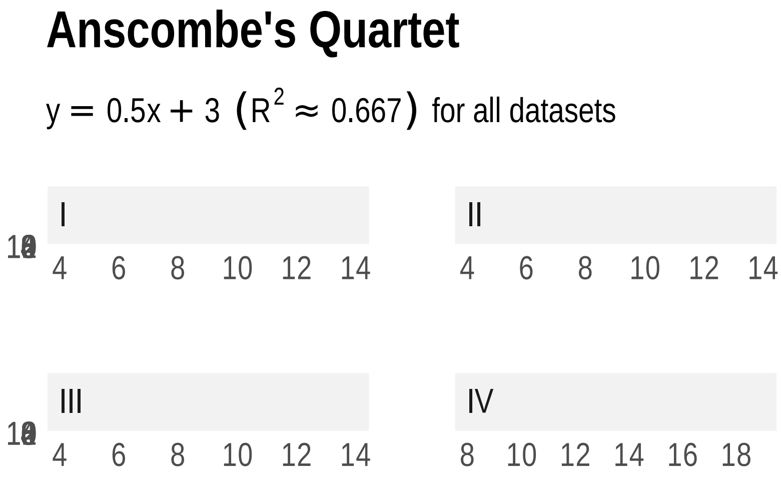
Sometimes there are things that are really important, like exceptions to general rules. This box might be appropriate for these.

“More research needs to be done” as an infobox.

0.1.3 Plots

This is a plot of quite a famous dataset (Anscombe, 1973):

```
tibble(
  grp = rep(c("I", "II", "III", "IV"), each = 11),
  x = c(anscombe$x1, anscombe$x2, anscombe$x3, anscombe$x4),
  y = c(anscombe$y1, anscombe$y2, anscombe$y3, anscombe$y4)
) %>%
  ggplot(aes(x, y)) +
    geom_smooth(method = lm, se = F) +
    geom_point(color = "orange", size = 2) +
    scale_y_continuous(breaks = scales::pretty_breaks()) +
    scale_x_continuous(breaks = scales::pretty_breaks()) +
    labs(title = "Anscombe's Quartet", x = NULL, y = NULL,
         subtitle = bquote(y == 0.5 * x + 3 ~ (R^2 %~~% .667) ~ "for all datasets")) +
    facet_wrap(~grp, ncol = 2, scales = "free_x") +
    theme(strip.background = element_rect(fill = "#f2f2f2", colour = "white"))
```



1
General Introduction

- what stats is about
- different practices
- learning goals

2
Data

learning goal: how to arrange, summarize and visualize (aspects of data) to address a question of interest ("hypothesis-driven data poking")

- different kinds of data
- summary statistics
- data wrangling
- data plotting

3
Basics of Probability Theory

To be covered: axiomatic definition, interpretation, joint distributions, marginalization, conditional probability & Bayes rule. Random variables: discrete and continuous, expected values & variance, examples.

learning goal: get comfortable with basic notions of probability theory

- probability distributions
- random variables
- conditional probability
- selected distributions

4
Models

learning goal: diagnosing the (conceptual) differences between kinds of statistical models

- priors & likelihood
- conceptual differences between frequentist and Bayesian approaches (revisited)
- notation (probabilistic causal networks)
- three example models:
  - "binomial model"
  - "factorial-design model"
  - simple linear regression model

5
Inference

- MLE vs posterior
- confidence intervals
- credible intervals
- briefly: algorithms for MLE & Bayesian inference

6
Hypothesis Testing

- binomial test
- t-test
- ANOVA
- linear regression

7
Model Comparison

- AIC
- likelihood ratio test
- Bayes factor

8
Generalized Regression Modeling

- applications

9
Bibliography

Anscombe, F. J. (1973). Graphs in statistical analysis. *The American Statistician*, 27(1):17–21.

Wickham, H. (2014). Tidy data. *Journal of Statistical Software, Articles*, 59(10):1–23.