Class 1: Basics and experimental design

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Learning outcomes

- Know how to create and interpret a two-sample t-test
- Understand what a p-value means
- Be able to perform a simple sample size calculation
- Understand the basics of experimental design

General goal for the course: be able to create a statistical model for a medical test and check that it is robust

Course details

- Lectures in the morning (9:30 - 1pm), practical in the afternoon (2pm - 4:30pm). More details in the timetable.
- All course notes, code and data sets available on Github page
- All Slides available in pdf or RMarkdown (Rmd) fomat which can be opened in Rstudio

Some basic concepts:

- One way data can be separated is via *continuous* (e.g. age, weight), or *discrete* (disease state, Gleason grade, etc)
- You can divide continuous into *interval* (temperature) or *ratio* (age, weight)
- You can divide discrete into *ordinal* (e.g. Gleason grade) or *nominal* (disease state, eye colour)

The type of statistical model we fit is almost entirely dependent on the type of data we have

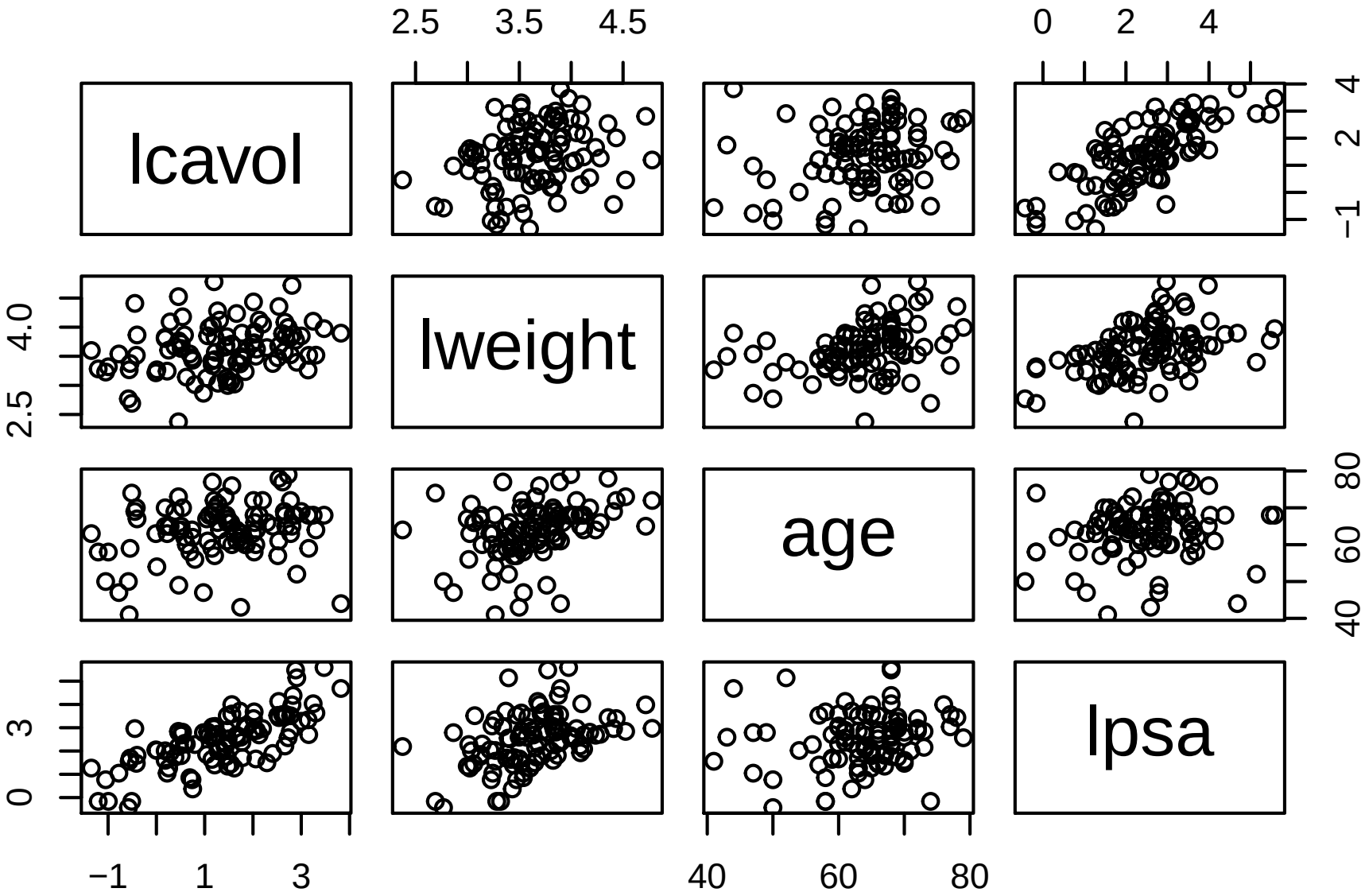
Two examples: prostate cancer (regression)

Prostate cancer data set:

- `lcavol`: log(cancer volume)
- `lweight`: log(weight)
- `age`: age
- `lbph`: log(benign prostatic hyperplasia amount)
- `svi`: seminal vesicle invasion
- `lcp`: log(capsular penetration)
- `gleason`: grade of cancer
- `pgg45`: percentage Gleason scores 4 or 5
- `lpsa`: outcome variable - log prostate specific antigen
- `train`: whether the observation should be included in the training or test set

Task: predict `lpsa` based on other variables for the training set, and check performance on the test set

Prostate example matrix scatter plot



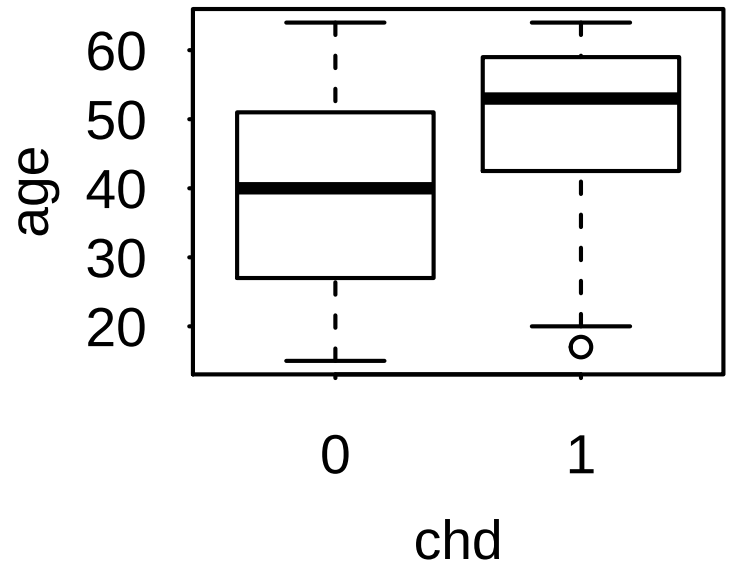
Example 2: South African Heart Rate data (classification)

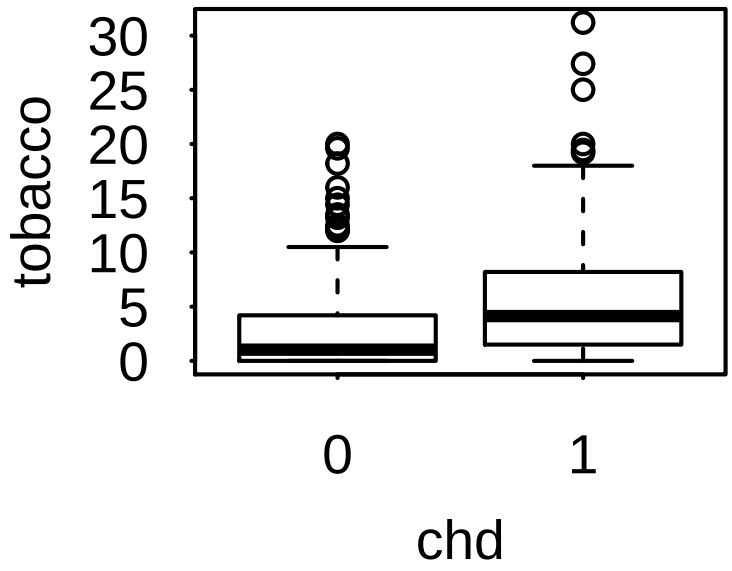
462 observations, with 10 variables:

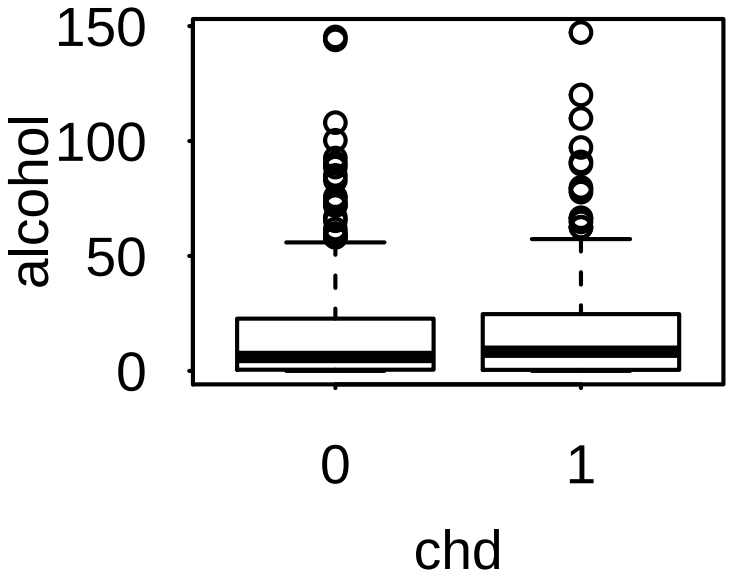
- `sbp` - systolic blood pressure
- `tobacco` - cumulative tobacco (kg)
- `ldl` - low densiity lipoprotein cholesterol
- `adiposity` - approx percentage body fat
- `famhist` - family history of heart disease (Present, Absent)
- `typea` - type-A behavior
- `obesity` - a measure of abesity
- `alcohol` - current alcohol consumption
- `age` - age at onset
- `chd` - output variable - coronary heart disease

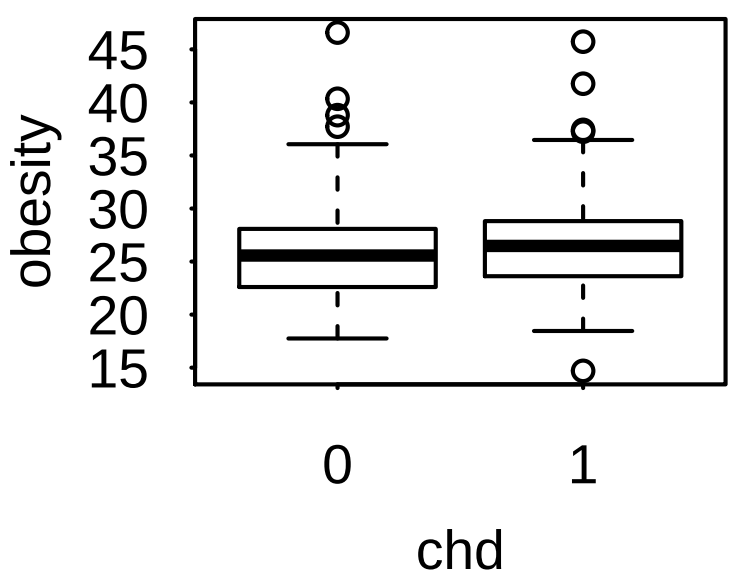
Task: predict probaility of `chd` based on other variables

Heart rate data plots









Testing differences between groups; the two-sample t-test

- Goal: test whether the mean of one group is equal to the mean of another group
- Obviously we only have a sample of data, not all the potential data (this is generally impossible)
- Use the mathematics of sampling distributions to determine whether the data look 'unlike' a situation where the two means are equal

Sampling distributions of data

- If we re-ran the experiment we would get different data. What might the sample means of these data sets look like?
- Incredibly,

Null and alternative hypotheses

Drawing pictures

Getting and understanding the p-value

What the p-value is not

Introduction to sample size calculations

Type 1 and Type 2 error

Drawing pictures

The magic formula

Getting the values to put in to the formula

Possible extensions

Design of Experiments

The golden rule of designing an experiment

Blocking

Randomisation

Replication

More complicated experiments