Inf2 – Foundations of Data Science
S2 Week 1: Semester 2 Logistics

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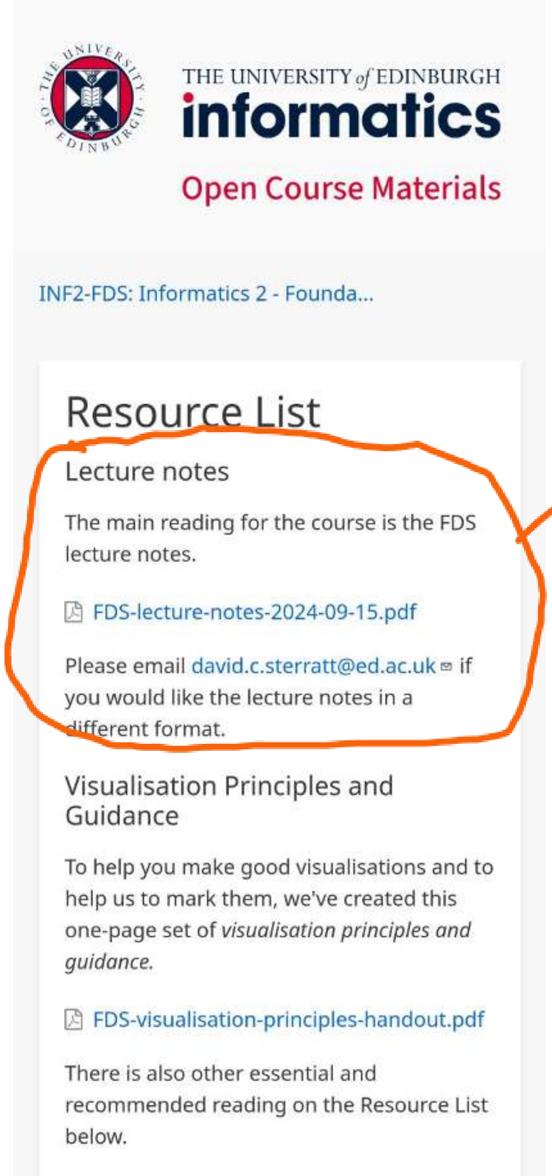
Semester 2 logistics

- **Lectures until week 6**
  - On **Statistical Inference**, **Maximum Likelihood and Regression**, **Ethics** and **Software Engineering**
  - Accompanying **Comprehension Questions** in Learn
- **Labs:** Lab notebooks for weeks 1, 2 and 4
  - No lab sessions – ask on Piazza
- **Workshops:** in weeks 2, 4 and 6
  - May be in a new group or at a different time
  - To change group, use Group Change in Timetabler; turn up if change not actioned.
- **CW1 – Project** from week 5 to week 10
  - **including opportunities to present in workshop sessions in weeks 8 and 10**
  - In response to feedback, earlier release than previous years

Resources



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Open Course Materials

INF2-FDS: Informatics 2 - Founda...

Resource List

Lecture notes

The main reading for the course is the FDS lecture notes.

FDS-lecture-notes-2024-09-15.pdf

Please email david.c.sterratt@ed.ac.uk if you would like the lecture notes in a different format.

Visualisation Principles and Guidance

To help you make good visualisations and to help us to mark them, we've created this one-page set of *visualisation principles and guidance.*

FDS-visualisation-principles-handout.pdf

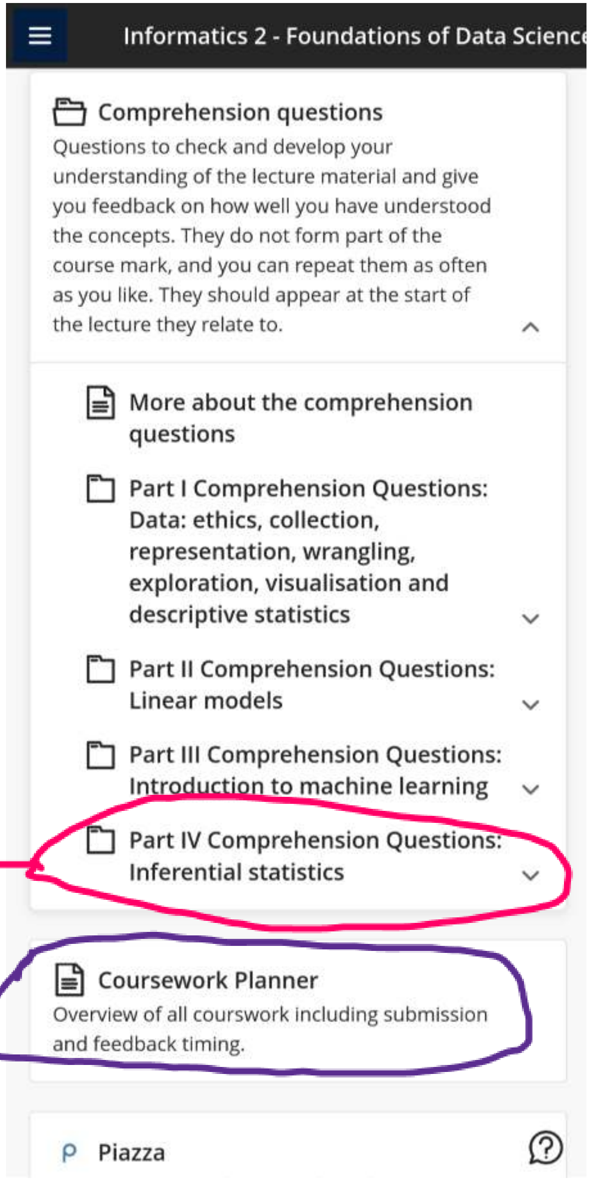
There is also other essential and recommended reading on the Resource List below.

Lecture notes:

- Read before each lecture
- Ask David for different formats
- Updated in response to queries!

Comprehension questions: Released each week, should all be do-able after Wednesday lectures

Coursework planner: includes link to show CW deadlines in your Outlook calendar



Informatics 2 - Foundations of Data Scienc

Comprehension questions

Questions to check and develop your understanding of the lecture material and give you feedback on how well you have understood the concepts. They do not form part of the course mark, and you can repeat them as often as you like. They should appear at the start of the lecture they relate to.

More about the comprehension questions

Part I Comprehension Questions: Data: ethics, collection, representation, wrangling, exploration, visualisation and descriptive statistics

Part II Comprehension Questions: Linear models

Part III Comprehension Questions: Introduction to machine learning

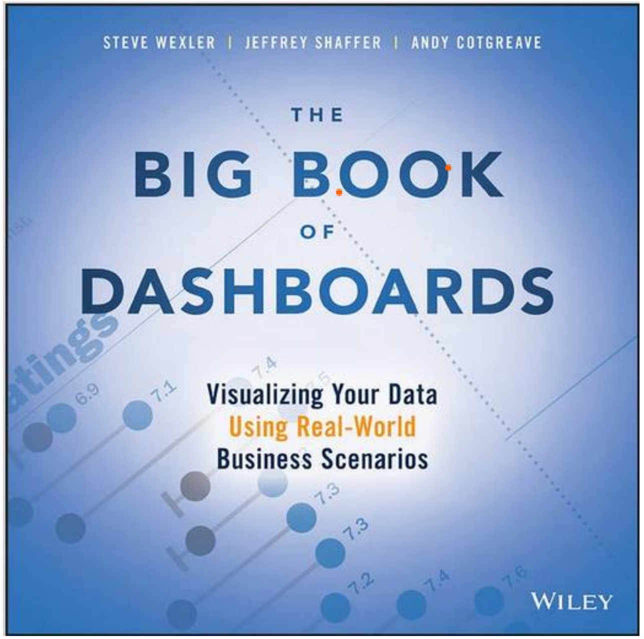
Part IV Comprehension Questions: Inferential statistics

Coursework Planner

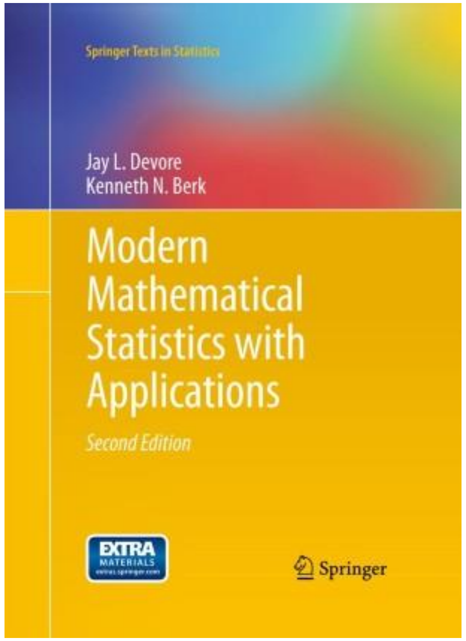
Overview of all coursework including submission and feedback timing.

Piazza

Other recommended reading


STEVE WEXLER | JEFFREY SHAFFER | ANDY COTGREAVE
THE BIG BOOK OF DASHBOARDS
Visualizing Your Data Using Real-World Business Scenarios
WILEY

The Big Book of Dashboards
Ch. 1: Data Visualization: A Primer
Wexler & al. (2017)
Essential reading – in Resource List


Springer Texts in Statistics
Jay L. Devore
Kenneth N. Berk
Modern Mathematical Statistics with Applications
Second Edition
EXTRA MATERIALS
Springer

Modern Mathematical Statistics with Applications
Devore & Berk
Buy softcover version via University Library for £25

- See **Resource List** and **Schedule** for other essential and recommended reading, including
- Shannon Vallor's **An Introduction to Data Ethics**
- Berkley Data 8 **Inferential Thinking**
- Some recommended reading each week

Support

- Piazza
  - Please try to answer each other's content questions - it helps you all to learn
  - We will try to get to logistics questions and urgent questions by the next working day (not Saturdays or Sundays)
- Office hour
  - Now every Monday, 4pm in AT Cafe

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InfBase

student learning support

Appleton Tower 7.03
(7th floor)
Monday to Thursday
11:10-13:00

InfBase Semester 2

- Starting Wednesday 14th
- Drop-in support space for year 1 & 2 students
- Run by senior peers
- 1-on-1 support and advice to help work through problems with lab exercises
- Also just a nice place to work together just in case you need assistance
- Semester 2 courses covered:
  - Informatics 1 - Object Oriented Programming
  - Informatics 2 - Software Engineering and Professional Practice
  - Informatics 2D - Reasoning and Agents
  - Informatice 2 - Foundations of Data Science
  - Informatics 2 - Introduction to Algorithms and Data Structures

https://infbase-learningsupport.github.io/

Dataset suggestions for final project

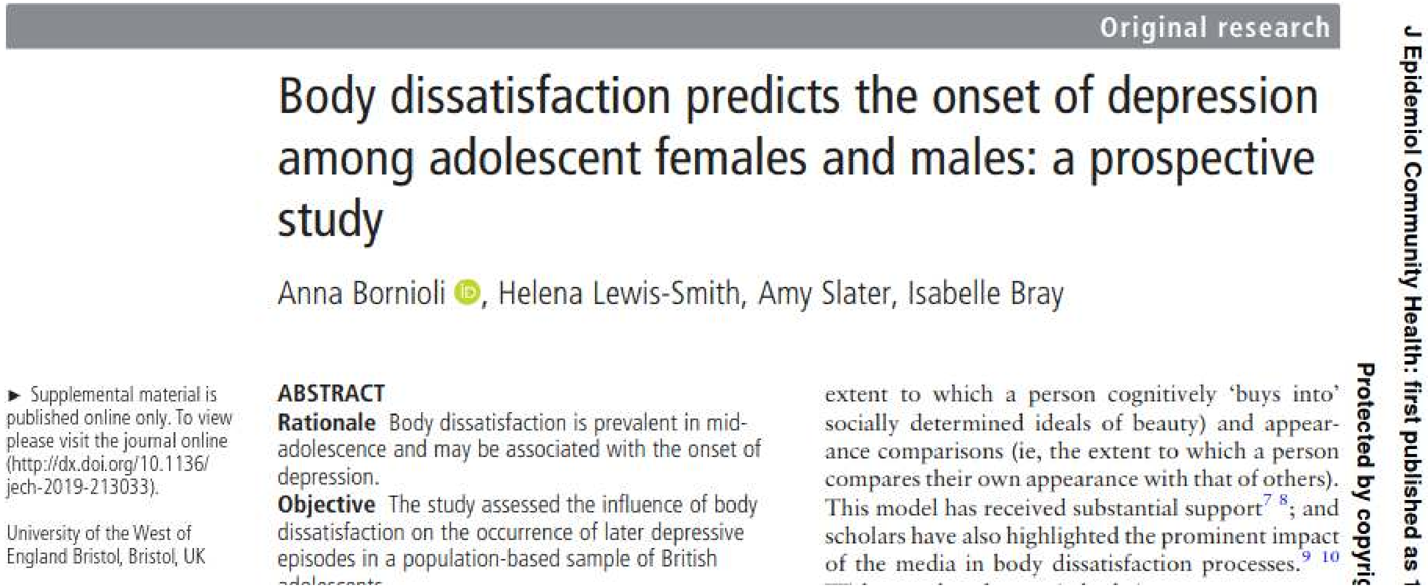
- Project:
  - Choose from one of three datasets to explore/analyse
  - Answer a few “seed” questions
  - Share the results in a written data science report
- Examples of datasets used in previous years:
  - Performance of Scottish A&E services
  - Worldwide trends in music streaming according to Spotify
  - Student learning on the EEdi educational platform
- Please add suggestions to the pinned Piazza post "**Request for Dataset suggestions for final project**"
- Deadline: end of week 2. We will then finalise the choices

What the exam (50%) will cover and how to do well

- Your knowledge of good practices for storing, manipulating, summarising and visualising data (Learning Outcome 1)
  - **Revise Semester 1 material, including comprehension questions**
- How well you can apply basic techniques from descriptive and inferential statistics and machine learning and interpret and describe the output from such analyses (Learning Outcome 3)
  - **Do statistical problems tasks and workshops this semester**
  - **Do comprehension questions**
  - **Do labs**
- How well you can evaluate claims made in case study and your understanding of ethical issues (Learning Outcome 4)
  - **Read target paper and attend workshop in which we'll get to grips with it**

Week 1 task / Week 2 workshop

- Critical reading of a data science study, which we will base at least some exam questions on
- Task for now: find and read the paper on OpenCourse
- You may want to read the associated media article too



Original research

Body dissatisfaction predicts the onset of depression among adolescent females and males: a prospective study

Anna Bornioli, Helena Lewis-Smith, Amy Slater, Isabelle Bray

► Supplemental material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/jech-2019-213033).

University of the West of England Bristol, Bristol, UK

ABSTRACT

Rationale Body dissatisfaction is prevalent in mid-adolescence and may be associated with the onset of depression.

Objective The study assessed the influence of body dissatisfaction on the occurrence of later depressive episodes in a population-based sample of British adolescents

extent to which a person cognitively 'buys into' socially determined ideals of beauty) and appearance comparisons (ie, the extent to which a person compares their own appearance with that of others). This model has received substantial support[7 8]; and scholars have also highlighted the prominent impact of the media in body dissatisfaction processes.[9 10]

J Epidemiol Community Health: first published as 1

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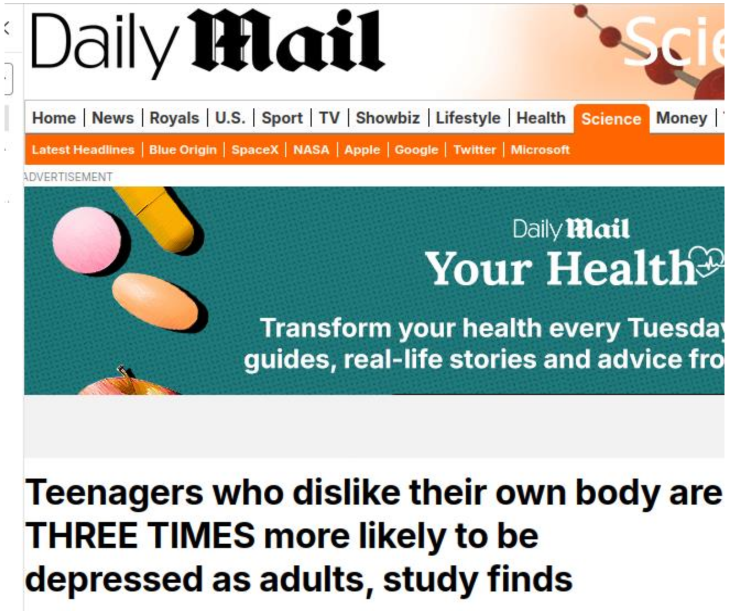

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Teenagers who dislike their own body are THREE TIMES more likely to be depressed as adults, study finds

Questions?

Inf2 - Foundations of Data Science: Introduction to statistical inference

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Where are we in the course?

I. Data: ethics, collection, representation, wrangling, exploration, visualisation and descriptive stats

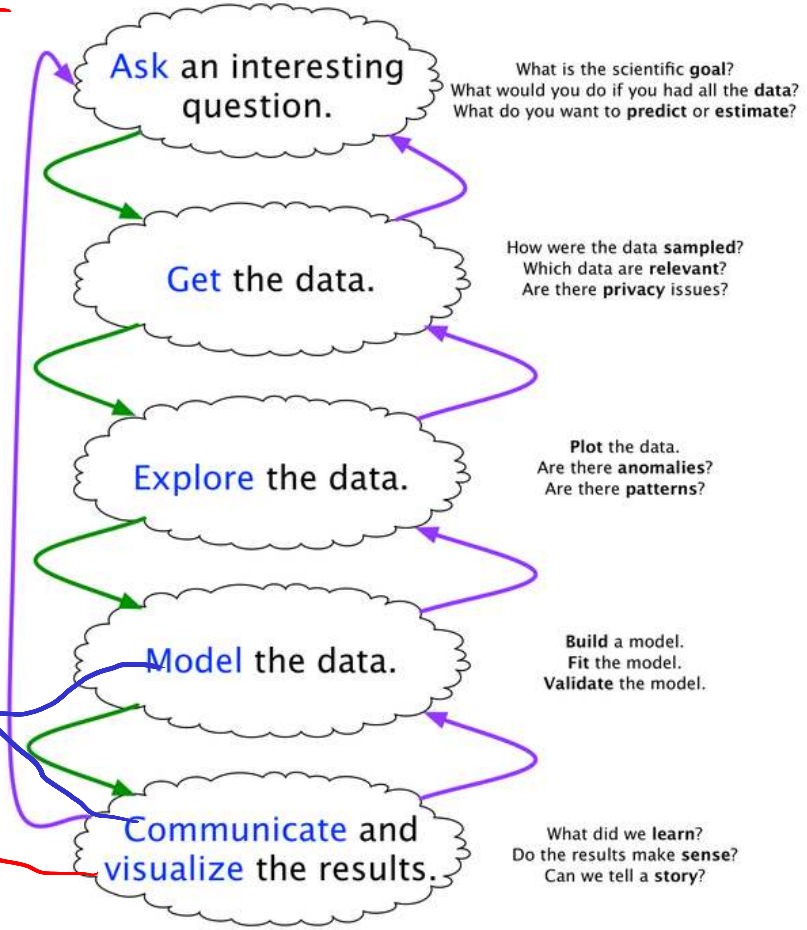
II. Intro to Machine Learning

III. Linear models

IV. Statistical inference

V. Regression and inference

The Data Science Process



Ask an interesting question.

What is the scientific **goal**?
What would you do if you had all the **data**?
What do you want to **predict** or **estimate**?

Get the data.

How were the data **sampled**?
Which data are **relevant**?
Are there **privacy** issues?

Explore the data.

Plot the data.
Are there **anomalies**?
Are there **patterns**?

Model the data.

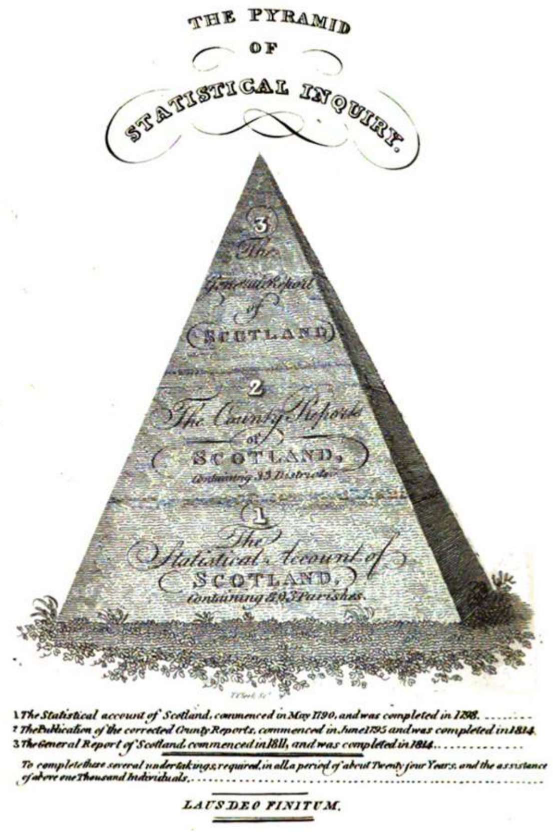
Build a model.
Fit the model.
Validate the model.

Communicate and visualize the results.

What did we **learn**?
Do the results make **sense**?
Can we tell a **story**?

Joe Blitzstein and Hanspeter Pfister, created for the Harvard data science course http://cs109.org/.

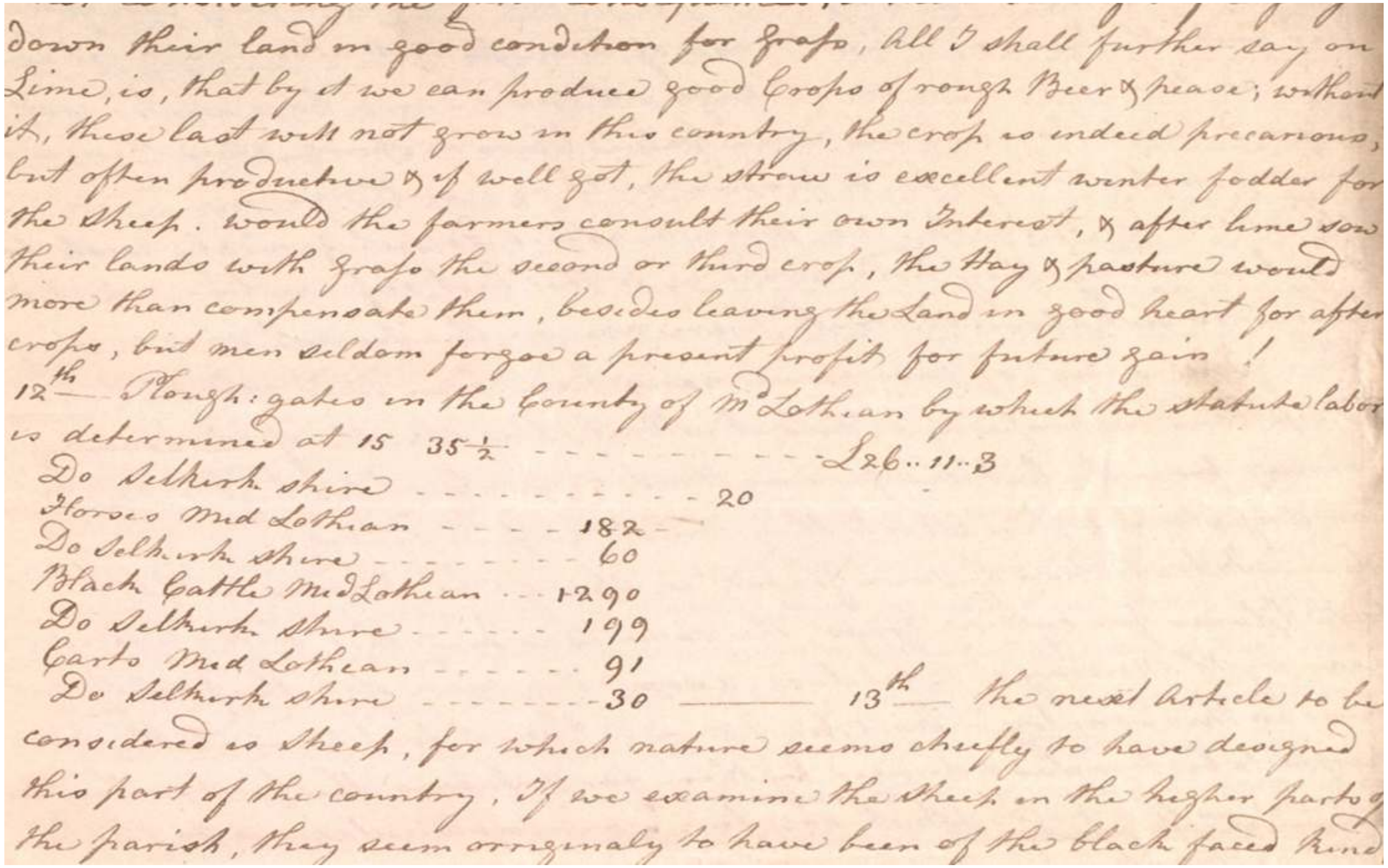
Descriptive statistics



1 The Statistical account of Scotland, commenced in May 1790, and was completed in 1798. ....
2 The Publication of the corrected County Reports, commenced in June 1795 and was completed in 1814.
3 The General Report of Scotland, commenced in 1811, and was completed in 1814. ....

To complete these several undertakings, required, in all, a period of about Twenty four Years, and the assistance of above one Thousand Individuals. ....

LAUS DEO FINITUM.



down their land in good condition for grass, All I shall further say on Lime, is, that by it we can produce good Crops of rough Beer & pease; without it, these last will not grow in this country, the crop is indeed precarious, but often productive & if well got, the straw is excellent winter fodder for the Sheep. would the farmers consult their own Interest, & after lime sow their lands with grass the second or third crop, the Hay & pasture would more than compensate them, besides leaving the Land in good heart for after crops, but men seldom forgoe a present profit for future gain !

12th — Plough: gates in the County of Md Lothian by which the statute labor is determined at 15 35½ ---------------- £26..11..3
Do Selkirk shire ------------- 20
Horses Mid Lothian ----- 182
Do Selkirk shire --------- 60
Black Cattle Mid Lothian --- 1290
Do Selkirk Shire ------ 199
Carts Mid Lothian ------ 91
Do Selkirk shire ---------30 ——— 13th — the next Article to be considered is Sheep, for which nature seems chiefly to have designed this part of the country, If we examine the sheep in the higher parts of the parish, they seem orriginaly to have been of the black faced kind

https://stataccscot.edina.ac.uk

Inferential statistics

Statistical inference is the process of drawing conclusions about quanties that are not observed

E.g. Wildcats

Wikipedia, Peter Trimming, CC BY 2.0

We observe the mean of a sample

We infer the mean of the population

E.g. "Manuscript on Deciphering Cryptographic Messages"
Al-Kindi, 9th Century, Baghdad

[illegible]

Wikipedia

We infer the meaning of the messages

Inferential statistics tasks

1. Estimation
2. Hypothesis testing
3. Comparing two samples (A/B testing)

Inferential statistics tasks: Estimation

How big is a quantity, and how certain are we about our answer?

E.g. weight of a population of squirrels from sample of 20

Peter Trimming, CC BY 2.0, Wikipedia

Point estimates

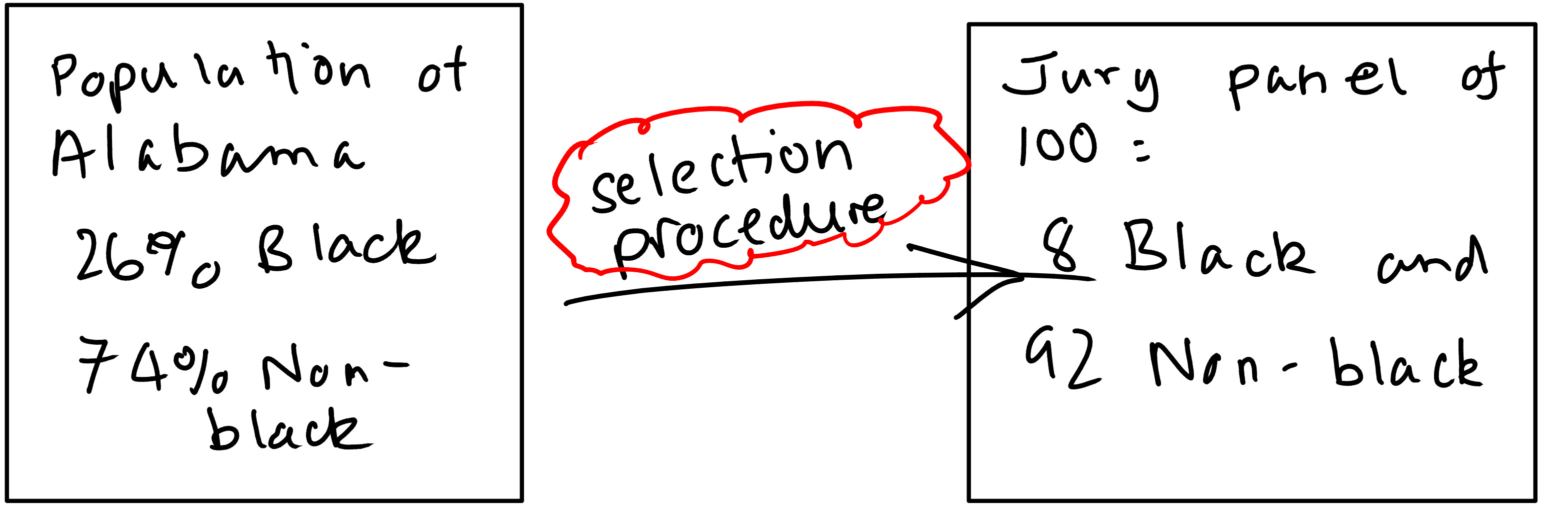
Confidence intervals: how confident are we in the estimate?

E.g. 2: Opinion polling

Inferential statistics tasks: Hypothesis testing

Yes/no questions: E.g. 1: "Is Chocolate good for you"

E.g. 2: Swain versus Alabama (1965).
Is this jury selection procedure biased?



Population of Alabama
26% Black
74% Non-black

selection procedure

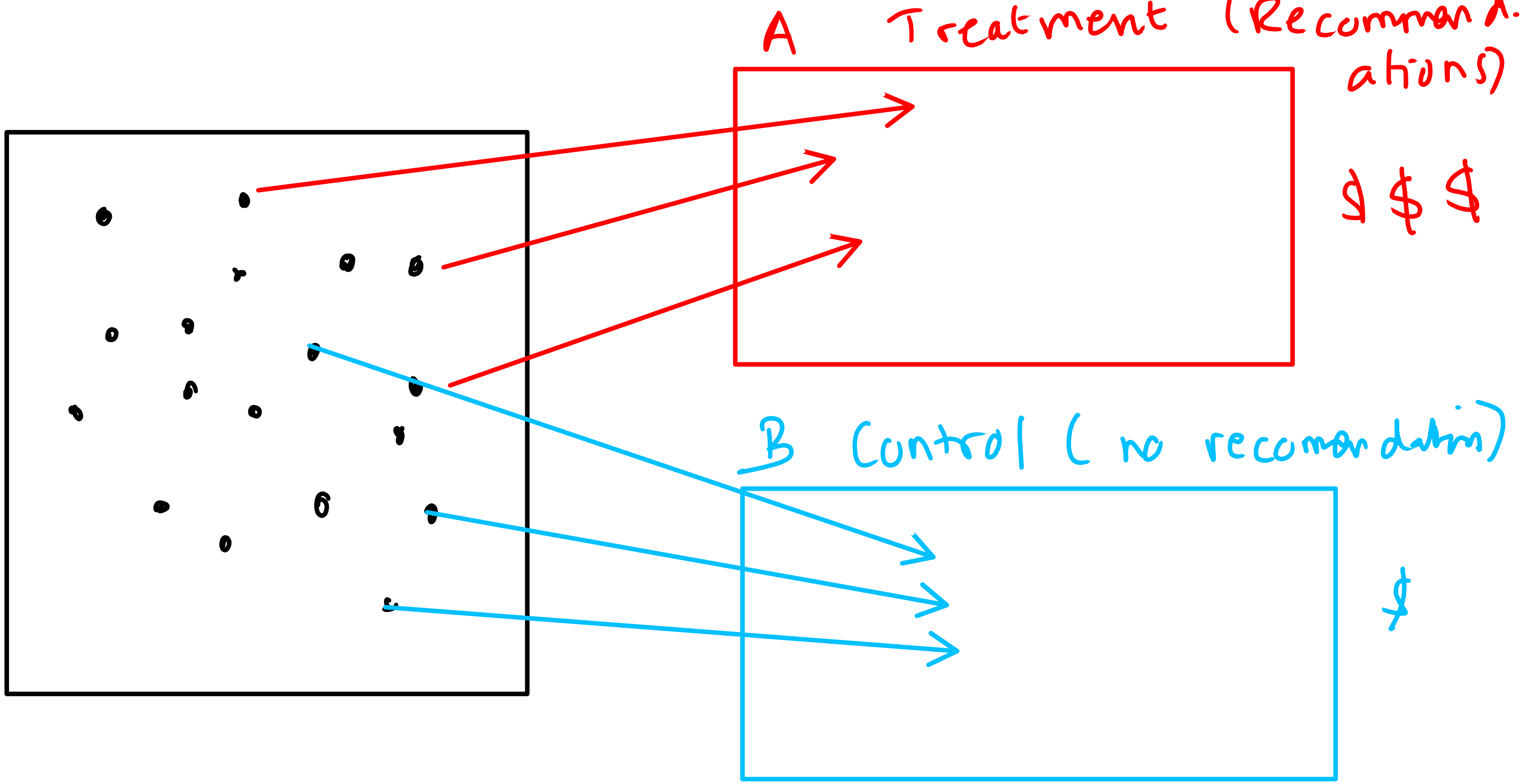
Jury panel of 100 :
8 Black and
92 Non-black

Question: what if
(a) there had been 26 black and 74 non-black?
(b) there had been 20 black and 80 non-black?

Inferential statistics tasks:
Comparing two samples (A/B testing)

E.g. 1. Is a vaccine better than a placebo?

E.g. 2. Does providing recommendations lead to more sales?



Two approaches to statistical inference

1. Computational: "Statistical simulations"
   + Few assumptions => can be applied to many situations
   + Little theory required
   + Hopefully intuitive
   - Can be compute-intensive

2. Mathematical: Statistical theory
   + Not compute-intensive
   + Standard in scientific literature
   - Can depend on assumptions that aren't true (e.g. normal distributions)

Plan for statistical inference

1. Randomness, sampling and simulations (S2 Week 1)
2. Estimation, including confidence intervals (S2 Week 2)
3. Hypothesis testing (S2 Week 3)
4. A/B testing (S2 Week 3)

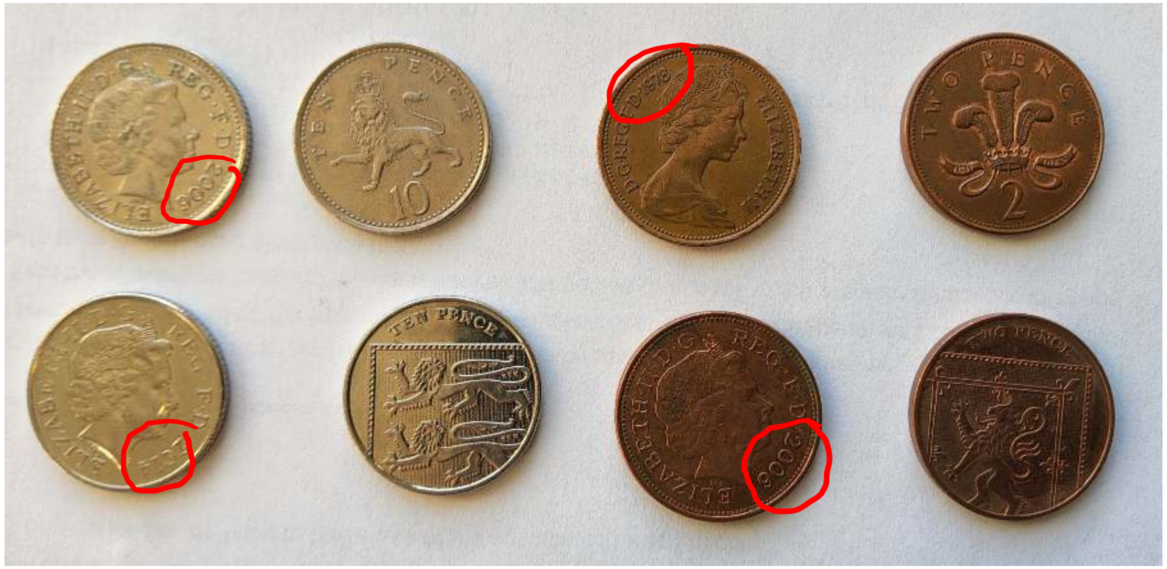
How can we address these questions?

1. What is the mean and median age of the population of all 2p and 10p coins in circulation?
2. Are tosses of 2p and 10p coins biased, i.e. is the probability of heads or tails different from 1/2 ?

Head Tail Head Tail

Old style

New style



Let's get sampling!

1. Go to the form at the right
2. Record the
   - denomination (2p/10p)
   - style (old/new)
   - year
3. Toss the coin 8 times and record the results
4. Submit the form

https://forms.office.com/e/SKNgiQmB4N

Results

How certain are we that the mean year is what we compute?

Do we think that the coins are biased or not?