# Data Science in Medicine

## Lecture 9: Course Outro

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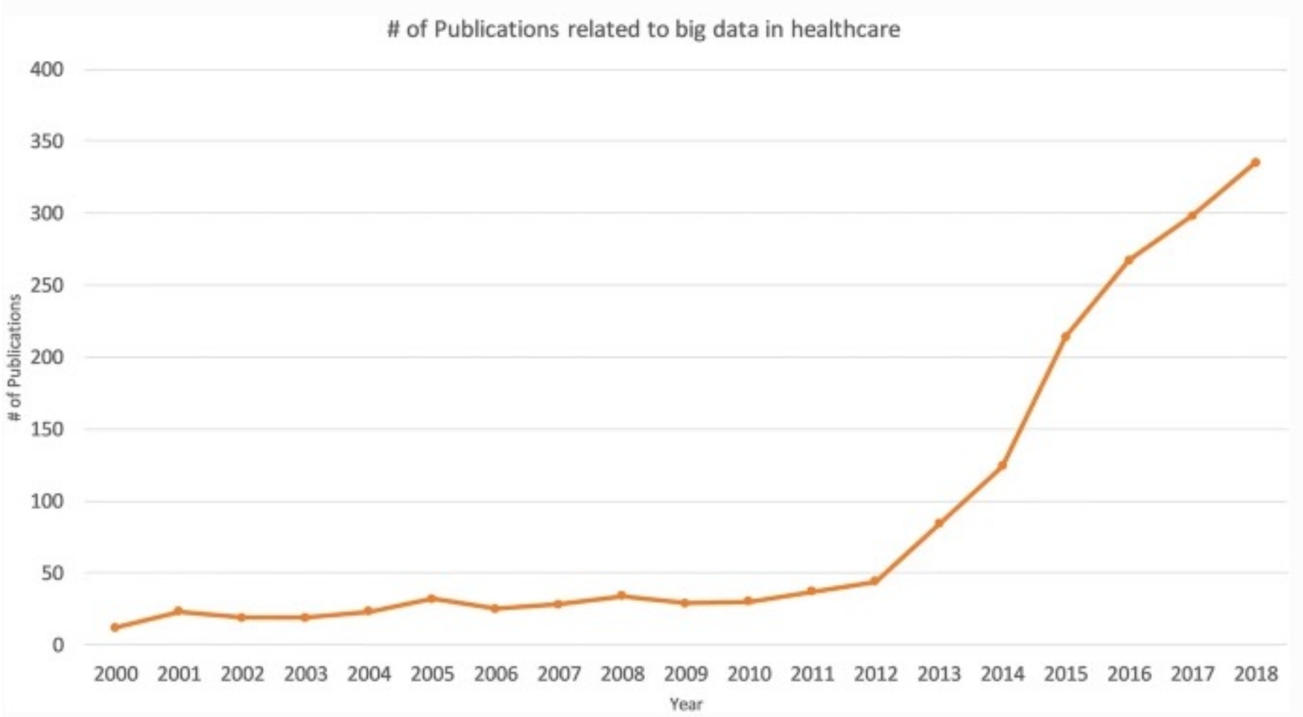
The University of Edinburgh

# Why this course?

# Preparing for the new era of data-intensive medicine

- Growing volume of data in medicine, healthcare and the life sciences
- Useful for your future studies:
  - Intercalation in Year 3
  - Research project in Year 5
- Useful for your future career:
  - Making sense of research findings
  - Doing research, which will most probably involve data
  - Understanding and improving the health of your patients and the way care is provided

# Preparing for the new era of data-intensive medicine




Publications associated with big data in healthcare. The numbers of publications in PubMed are plotted by year

*Image from Dash, S., Shakyawar, S.K., Sharma, M. et al. Big data in healthcare: management, analysis and future prospects. J Big Data 6, 54 (2019). https://doi.org/10.1186/s40537-019-0217-0*

# Preparing for the new era of data-intensive medicine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NEWS

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Technology

# Excel: Why using Microsoft's tool caused Covid-19 results to be lost

By Leo Kelion
Technology desk editor

5 October

*Image from https://www.bbc.co.uk/news/technology-54423988?utm_source=pocket-newtab-global-en-GB*

# What have we learnt?

# Data Science in Medicine – in a nutshell

How can we represent and interpret medical data?

Hands-on, practical experience

Topics covered:

- Statistical analysis of biomedical data
- Relational databases for medicine and healthcare
- Medical ontologies and graph data
- Epidemiology

# Part 1: Statistical analysis of data

- Data scales
- Summary statistics
- Visualising data
- Hypothesis testing

# Summary statistics

- Measures of central tendency

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} = \frac{69+70+86+42+54+79+69}{7} = \frac{469}{7} = 67$$

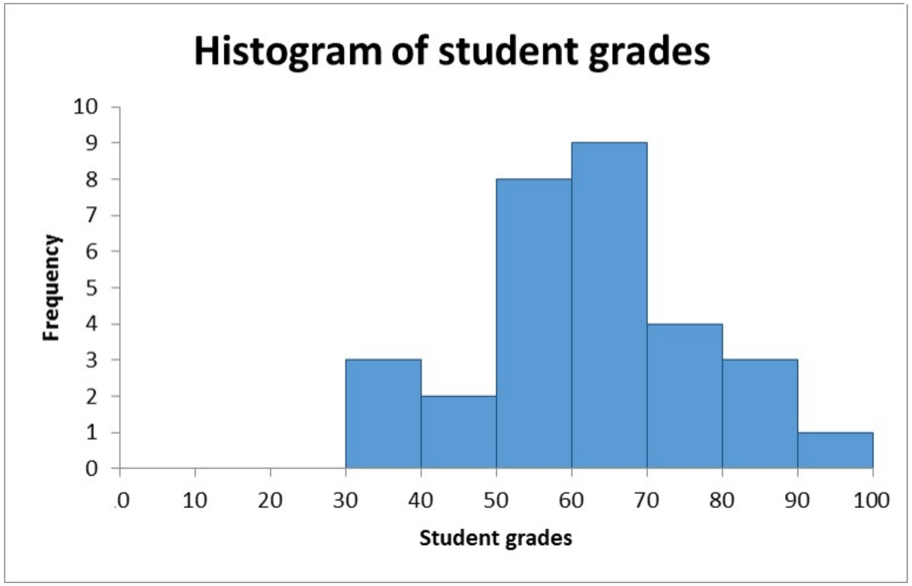
- Measures of dispersion

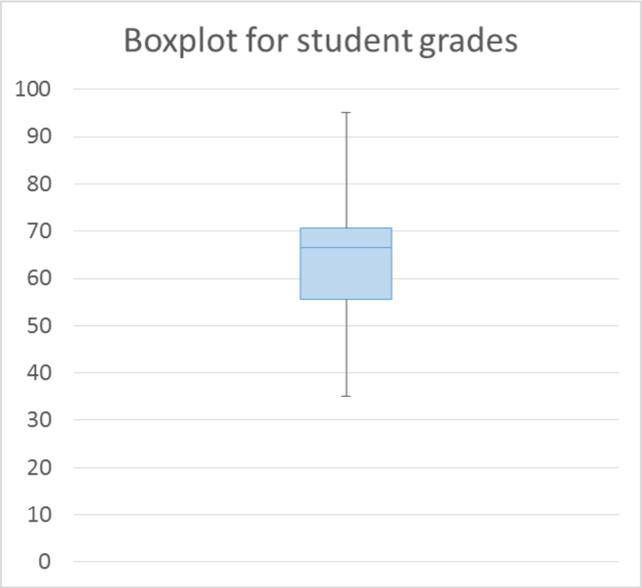
$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i-\mu)^2}{N}} = \sqrt{\frac{(69-67)^2 + (70-67)^2 + (86-67)^2 + (42-67)^2 + (54-67)^2 + (79-67)^2 + (69-67)^2}{7}}$$

$$= \sqrt{188} = 13.71$$

# Visualising data

- Qualitative data: bar charts, pie charts
- Quantitative data: histograms, box plots
- Bivariate: scatter plots, line graphs



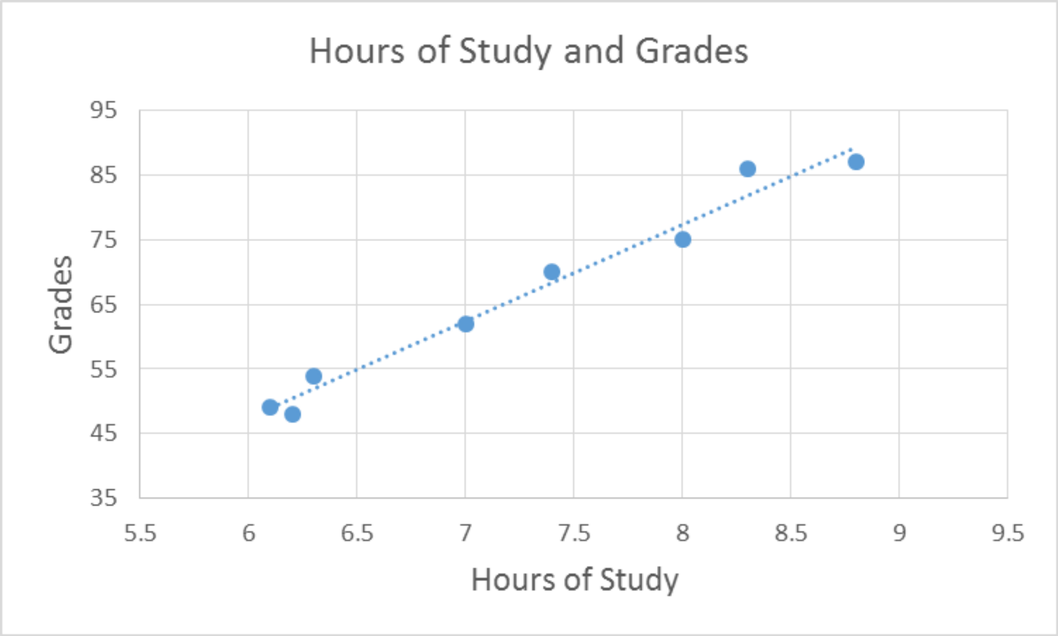



# Hypothesis testing

- Correlation between numerical variables
- Association between categorical variables
- Comparing the mean of a sample to a population with a known mean
- Comparing the means of two samples that were independently drawn

# Example: correlation between two numerical variables

| Weekly hours of study | Grades |
|---|---|
| 8 | 75 |
| 7.4 | 70 |
| 8.3 | 86 |
| 6.2 | 48 |
| 6.3 | 54 |
| 7 | 62 |
| 8.8 | 87 |
| 6.1 | 49 |

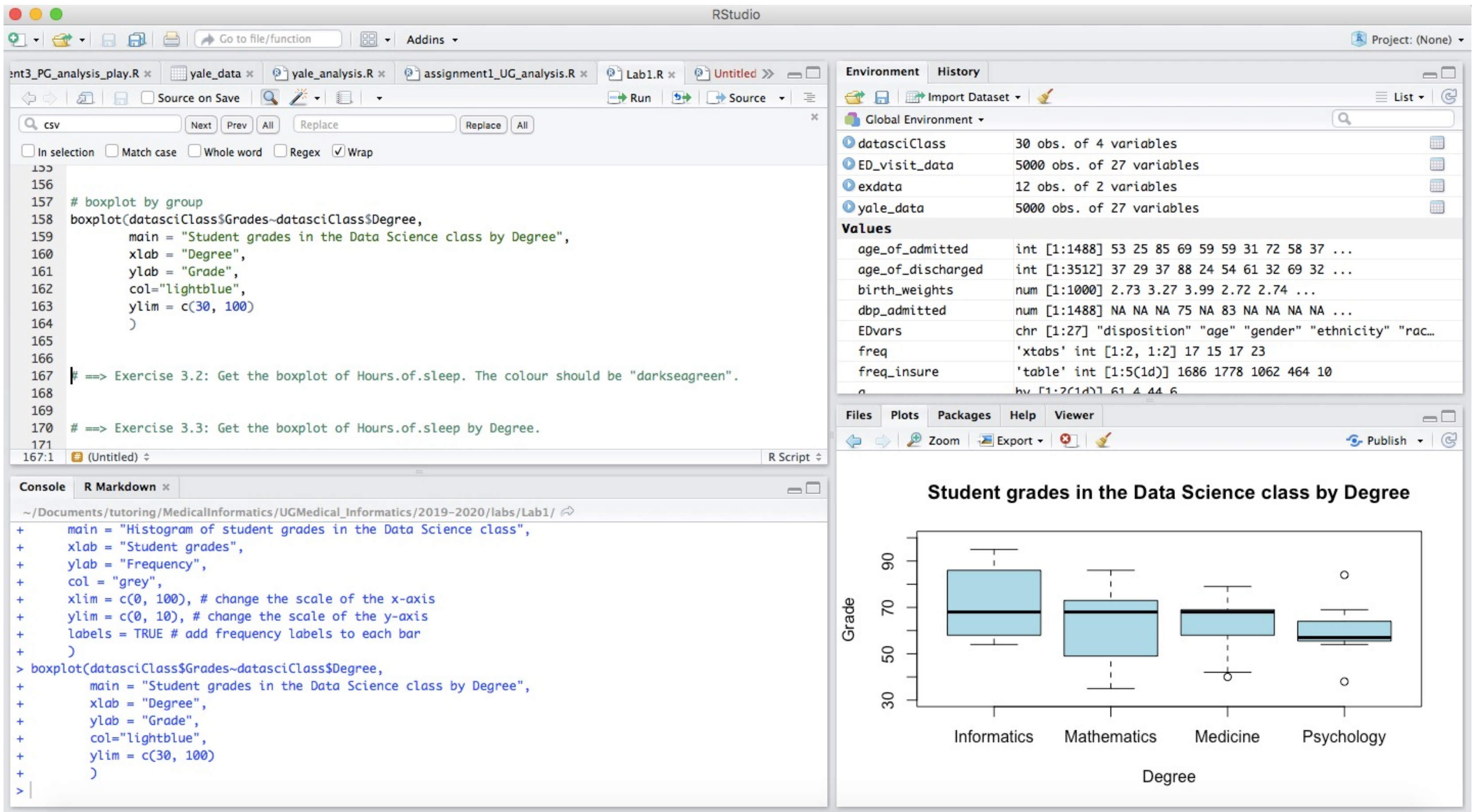


# Example: correlation between two numerical variables

- $\rho_{x,y} \simeq 0.988$
- Hypothesis testing:
  - H0: There is no correlation between weekly hours of study and final exam grades in Statistics.
  - H1: There is a correlation between weekly hours of study and final exam grades in Statistics

| $\rho$ | $p = 0.10$ | $p = 0.05$ | $p = 0.01$ | $p = 0.001$ |
|---|---|---|---|---|
| $N = 7$ | 0.669 | 0.754 | 0.875 | 0.951 |
| $N = 8$ | 0.621 | 0.707 | 0.834 | 0.925 |
| $N = 9$ | 0.582 | 0.666 | 0.798 | 0.898 |
| $N = 10$ | 0.549 | 0.632 | 0.765 | 0.872 |

# Analysing data with R



# Part 2: Relational databases

**Employee**

| nin | name | email |
|---|---|---|
| SK728468L | Kate Taylor | k.taylor@example.com |
| SJ547632B | John Smith | j.smith@example.com |
| JG623526A | Peter Ross | p.ross@example.com |
| AB213672C | Paul Martin | p.martin@example.com |

**Department**

| did | dname | budget |
|---|---|---|
| 51 | Information Technology | 80,000 |
| 56 | Human Resources | 50,000 |
| 60 | Accounting | 40,000 |

**Works_In**

| nin | did | since |
|---|---|---|
| AB213672C | 60 | 2003 |
| SJ547632B | 51 | 1996 |

# Part 2: Relational databases

- How to build a database: Relational model
- How to query a database: SQL

# Relational model

**Student**

| mn | name | email | age |
|---|---|---|---|
| s0785212 | Andrew | andrew@maths | 19 |
| s1253477 | Jenny | jenny@inf | 23 |
| s1456381 | Rhona | rhona@inf | 18 |
| s1489673 | Stuart | stuart@law | 34 |
| s1473612 | Alan | alan@law | 20 |

**Course**

| cid | title | credits |
|---|---|---|
| dbs | Database Systems | 20 |
| inf1 | Informatics 1 | 10 |
| sls | Scottish Legal System | 10 |
| lalg | Linear Algebra | 10 |

**Takes**

| mn | cid |
|---|---|
| s0785212 | lalg |
| s1253477 | dbs |
| s1253477 | inf1 |
| s1489673 | sls |

```
CREATE TABLE Takes (
    mn CHAR(8),
    cid CHAR(20),
    PRIMARY KEY (mn, cid),
    FOREIGN KEY (mn) REFERENCES Student,
    FOREIGN KEY (cid) REFERENCES Course
 )
```

# SQL querying

```
SELECT *
FROM Student
WHERE age > 19
```

**Student**

| mn | name | email | age |
|---|---|---|---|
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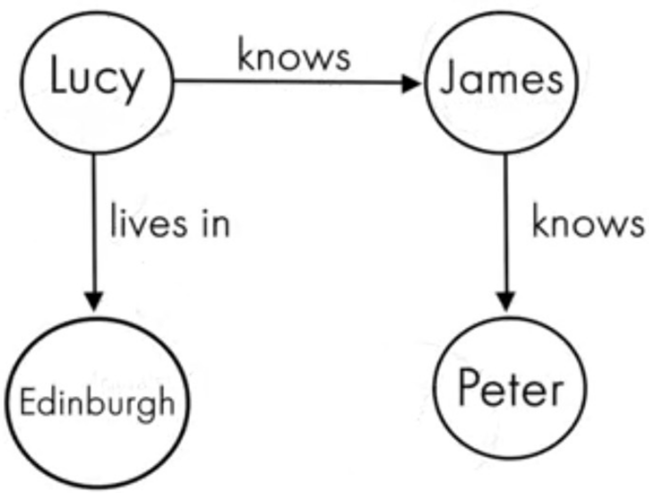
| s1253477 | dbs |
| s1253477 | inf1 |
| s1489673 | sls |

```
SELECT S.email
FROM Student S, Takes T, Course C
WHERE S.mn = T.mn
   AND T.cid = C.cid
   AND C.title = ‘Medical Informatics’
```

# Part 3: Medical ontologies and graph data

- Graph databases follow an alternative data representation approach to relational databases.
- The objective here is to easily integrate data.



# Part 4: Epidemiology

- Measuring the occurrence of disease
- Evaluating treatment and prognosis
- Assessing risk of disease
- Determining cause and reporting research

# Disease prevalence

## MEASURING THE OCCURRENCE OF DISEASE IN EPIDEMIOLOGY

### 1. Prevalence of disease

- Very simple measure
- Cross-sectional study results in prevalence estimates
- It can not be smaller than 0% or greater than 100%
- In theory, it is calculated as:

$$P = \frac{\text{Number of persons with disease}}{\text{Number of people checked for presence of disease}}$$

- What could possibly be more simple than prevalence?

## DIFFERENT WAYS TO EXPRESS THE MEASURED PREVALENCE IN A SAMPLE

1. **Point prevalence:** study can be conducted over a period of few months, but the result is still "point prevalence" – from the perspective of EACH SUBJECT, the information is on one point in time only, and counts only those with active symptoms of disease at that point in time;
2. **Period prevalence:** if we asked about presence of active symptoms within the past e.g. 6 months or 3 years;
3. **Lifetime prevalence:** if we asked whether there were ever any symptoms of schizophrenia, regardless of the status of disease in the present (e.g. medication or remission);
4. **Lifetime morbid risk:** if we followed everyone in the sample until they die, and then added all further new cases to the already noted lifetime prevalence

# Next steps, if of interest

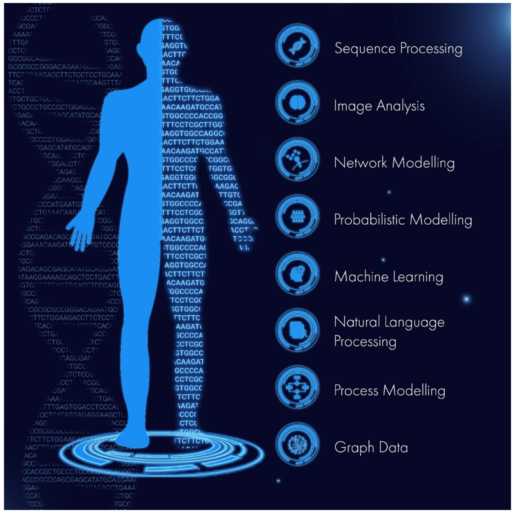
- Explore real data and practise further
  - WHO COVID-19 data: https://covid19.who.int/
  - Public Health Scotland open data: https://www.opendata.nhs.scot/
  - NHS England data: https://data.england.nhs.uk/
- Develop further skills in R programming
  - HealthyR book: https://argoshare.is.ed.ac.uk/healthyr_book/
  - Free online courses on Coursera, edX, Datacamp and other platforms

# Next steps, if of interest

- Engage with the Data-Driven Innovation programme
  - Innovative training
  - World-class data infrastructure

Data-Driven Innovation

- Free online course: Data Science in Stratified Healthcare and Precision Medicine
  - 5 weeks, self-paced, free
  - 11,900+ learners worldwide
  - https://www.coursera.org/learn/datascimed/



# Thank you!

## Time to play!

Enter our kahoot.it quiz to
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