# Introduction to Quantitative Research Methods Seminar

## Week 1

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# Who I Am & How This Seminar Works

- **James Rice** — PhD Candidate in Political Science at the University of Essex
- **My research interests**: quantitative methods, political economy, misinformation, climate change
- **Role**: Seminar tutor for POLS0008
- **Seminars**: Applied, hands-on, focused on building confidence with data and coding
- **Logistics**
  - Materials, readings, and updates on the course website
  - Email: `james.rice@ucl.ac.uk`
  - Office Hours: Thursdays, 3-4pm, 29-30 Tavistock Square, Room B17
  - Also possible to meet via Teams
  - Questions welcome before, during, and after class

# Quick Icebreaker

**Turn to the person next to you (2–3 minutes):**

- What degree are you studying?
- Have you used **data, statistics, or coding** before? (a lot / a little / not at all)
- One thing you hope this course will help you understand

We'll take a few responses together before we start.

# Brief Recap (1)

- Statistics is the art and science of collecting, presenting and analyzing data to answer an investigative question. Its ultimate goal is translating data into knowledge and an understanding of the world around us.

**Example: Using a Survey to investigate People Beliefs**

The General Social Survey (GSS) is a survey of a few thousand adult Americans provides data about opinions and behaviors of the American public ("Would you be willing to pay higher prices in order to protect the environment?" "How much TV do you watch per day")

**Elements of Statistical Analysis**

a) **Design:** Stating the goal and/or statistical question of interesting and planning how to obtain data that will adress them

b) **Description:** Summarizing and analyzing the data that are obtained

c) **Inference:** Making decisions and predictions based on the data for answering the statistical question

# Brief Recap (2)

When statisticians speak of data, they typically refer to the type of data that it is organized in a spreadsheet in rows and columns, forming a grid of cells.

**Example: All schools in London.csv**

| | SchoolName | Type | NumberBoys | NumberGirls | OfstedGrade |
|---|---|---|---|---|---|
| 1 | St Mary's Kilburn Church of England Primary School | Primary | 115 | 110 | 2 |
| 2 | De Beauvoir Primary School | Primary | 180 | 215 | 2 |
| 3 | Queensbridge Primary School | Primary | 250 | 220 | 1 |
| 4 | Princess May Primary School | Primary | 245 | 205 | 2 |
| 5 | Holy Trinity Church of England Primary School | Primary | 110 | 115 | 1 |
| 6 | Marlborough Primary School | Primary | 165 | 190 | 2 |
| 7 | Rush Green Primary School | Primary | 400 | 420 | 2 |
| 8 | Welldon Park Primary School | Primary | 140 | 125 | 2 |
| 9 | Elm Park Primary School | Primary | 185 | 190 | 3 |
| 10 | Davies Lane Primary School | Primary | 385 | 375 | 1 |
| 11 | City of London Academy (Southwark) | Secondary | 680 | 585 | 2 |
| 12 | Sir John Cass's Foundation Primary School | Primary | 125 | 115 | 1 |
| 13 | Argyle Primary School | Primary | 210 | 220 | 2 |

- An **observation** is the information collected from a particular individual or entity in the study (e.g. Schools). We refer to an observation by the row number in the dataframe
- A **variable** captures the values of a changing characteristic for the multiple individuals or entities in the study

# Brief Recap (3) - Creating Objects and Using Functions in R

In order to manipulate and analyze data, we need to load and store datasets. R stores information in what are known as objects. To create an object in R we use the assignment operator <-

`object_name <- object_contents` (e.g. the data we want to store)

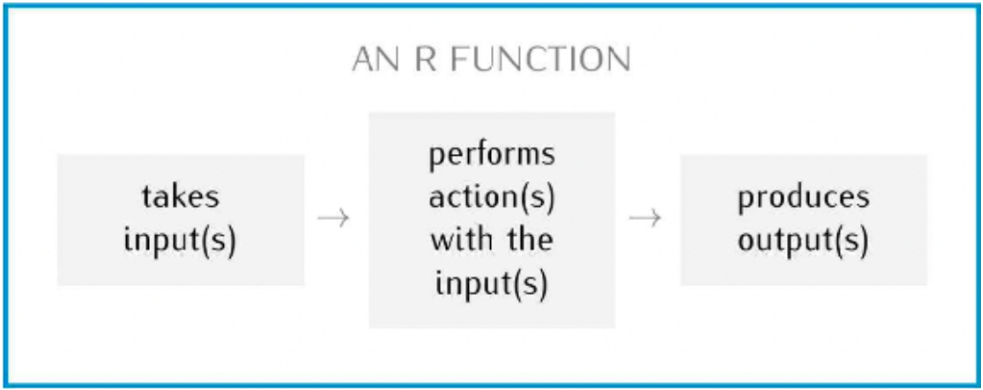
**Example:**

```
four <- 1 + 3
four
# 4
```

**Example 2:**

```
school_data <- read.csv("All Schools in London.csv")
```

# Brief Recap (3) - Creating Objects and Using Functions in R



# Brief Recap (3) - Creating Objects and Using Functions in R

We use R to interact with data, which requires using functions. Example: request R to calculate the square root of 4

```
sqrt(4)
## [1] 2
```

- The name of the function is always followed by parentheses: `function_name()`
- Inside the parentheses, we specify the inputs to be used by the function, which we refer to as **arguments:** `function_name(argument)`
- Sometimes we want to do certain specifications to the function. For this we use an **optional argument:** `function_name(argument, optional_argument_name = optional_argument)`

# Brief recap (4) - Accessing Variables Inside Dataframes

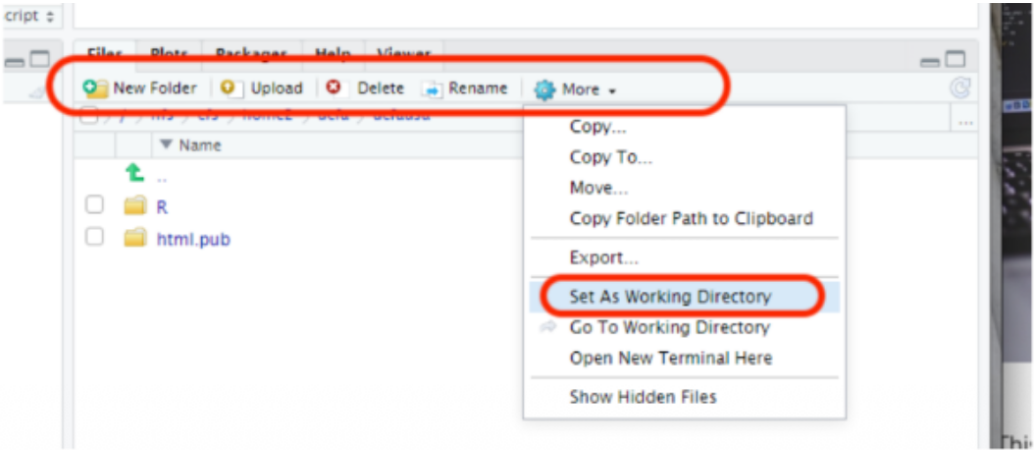
To access the values of a single variable in a dataframe, we use the $ character.

- To its left, we specify the name of the object where the dataframe is stored (without quotes)
- To its right, we specify the name of the variable (without quotes)

```
school_aux$NumberBoys
## [1] 120 340 975 425 120 85 75 175 250 210
```

# Before We Start

Make sure to upload data to RStudio Server and importing data into the environment



# Seminar Tasks and Questions

**Seminar Task:** Use the seminar data set `All Schools in London.csv` and import it into RStudio. Perform the following tasks:

1. Create a column called `TotalStudents` containing the total number of students for each school
2. Create a column called `PercentGirls` which contains the estimated percentage of girls attending each school.
3. Use the `tapply()` function to calculate the total number of student by subgroup or type of school

# 1. Create a Column Called TotalStudents With the Total Number of Students for Each School

```
school_data$TotalStudents <- school_data$NumberBoys + school_data$NumberGirls
## NumberBoys NumberGirls TotalStudents
## 115 110 225
## 180 215 395
## 250 220 470
## 245 205 450
## 110 115 225
## 165 190 355
## 400 420 820
## 140 125 265
## 185 190 375
```

# 2. Create a Column Called PercentGirls Containing the Estimated Percentage of Girls Attending Each School.

```
school_data$PercentGirls <- school_data$NumberGirls/school_data$TotalStudents *
    100
## SchoolName NumberGirls PercentGirls
## 1 St Mary's Kilburn Church of England Primary School 110 48.88889
## 2 De Beauvoir Primary School 215 54.43038
## 3 Queensbridge Primary School 220 46.80851
## 4 Princess May Primary School 205 45.55556
## 5 Holy Trinity Church of England Primary School 115 51.11111
## 6 Marlborough Primary School 190 53.52113
```

# 3. Use the tapply() Function to Calculate the Total Number of Student by Subgroup

The `tapply()` function it is a tool for applying a specific function (`FUN`) to a vector (dataframe) (`school_data`), segmented by one or more categories. It splits the data into groups based on the levels of the factors, applies the function to each group, and returns the results in a convenient format.

```
tapply(school_data$TotalStudents, school_data$Type, FUN = sum)
## All Through Primary Secondary
## 33040 687510 228610
```

# Seminar Questions

1. What are the names of schools that have the highest and lowest number of students? [HINT: use `max()`, `min()` and `View()` functions]
2. Generate a fully labeled `barplot()` and describe the distribution of schools by OFSTED scores.
3. Explore the frequency of schools in London based on the total number of students. Make a frequency table in R by creating the groups based on total students per school - starting from 0 to 2200, use the interval of 200 students to generate the groups as 0-200, 201-400, 401-600, ..., 2001-2200 and hence the number of schools falling into these groupings with these numbers of students
4. Create a histogram.
5. Create a cumulative frequency plot.
6. Create a relative cumulative frequency plot.
7. Provide an overall interpretation (see above example and those on slide 45 for Week 1's lecture).

# 1. What are the names of schools that have the highest and lowest number of students?

**[HINT: use `max()`, `min()` and `View()` functions]**

```
# Name of school with lowest value has only 40 students
min(school_data$TotalStudents)
## [1] 40

# Name of school with highest value has up to 2,065 students
max(school_data$TotalStudents)
## [1] 2065
```

# 1. What are the names of schools that have the highest and lowest number of students?

**Tip:** Use `View(school_data)` and filter/sort by `TotalStudents`.

| | SchoolName | Type | NumberBoys | NumberGirls | OfstedGrade | TotalStudents |
|---|---|---|---|---|---|---|
| 1988 | Denham Village Infant School | Primary | 20 | 20 | 2 | 40 |
| 1987 | Dorset Road Infant School | Primary | 45 | 20 | 2 | 65 |
| 1985 | Fulmer Infant School | Primary | 35 | 35 | 1 | 70 |
| 1986 | Chigwell Row Infant School | Primary | 30 | 40 | 2 | 70 |
| 1984 | Halstead Community Primary School | Primary | 40 | 35 | 3 | 75 |
| 1981 | Downe Primary School | Primary | 35 | 45 | 2 | 80 |
| 1982 | Sundridge and Brasted Church of England Voluntary C... | Primary | 40 | 40 | 1 | 80 |
| 1983 | Pratts Bottom Primary School | Primary | 35 | 45 | 2 | 80 |
| 1979 | St Peter and St Paul CofE Infant School | Primary | 45 | 40 | 1 | 85 |
| 1980 | Hawkedale Infants – A Foundation School | Primary | 45 | 40 | 2 | 85 |
| 1978 | Littleton CofE Infant School | Primary | 50 | 40 | 2 | 90 |
| 1976 | Bulphan Church of England Voluntary Controlled Prim... | Primary | 40 | 55 | 2 | 95 |
| 1977 | Chelsfield Primary School | Primary | 45 | 50 | 2 | 95 |
| 1972 | St John's CofE Primary School | Primary | 45 | 55 | 2 | 100 |

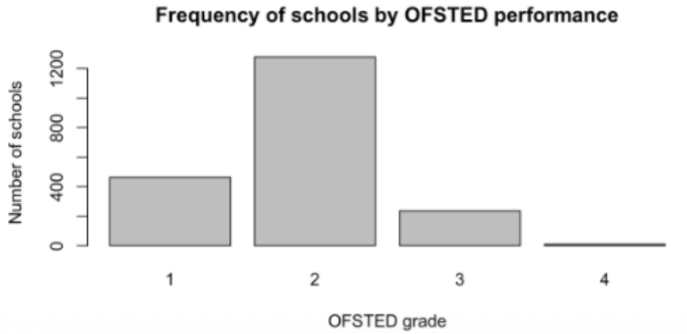
# 2. Generate a fully labeled barplot() and describe the distribution of schools by OFSTED scores.

```
# step 1: to create a barplot, use the table() function to
# tabulate number of schools based on ofsted grades
table(school_data$OfstedGrade)
##
## 1 2 3 4
## 463 1279 236 10

# step 2: pass the results from table() in an object called 'freq'
freq <- table(school_data$OfstedGrade)

# step 3
barplot(freq, main="Frequency of schools by OFSTED performance",
        xlab="OFSTED grade", ylab="Number of schools")
```

# 2. Generate a fully labeled barplot() and describe the distribution of schools by OFSTED scores.




**Description:** Most schools fall in OFSTED grade 2, followed by grade 1; relatively few are grade 3, and very few are grade 4 (as reflected by the frequency table above).

# 3. Explore the frequency of schools in London based on the total number of students(. . . )

```
# create this classes ingredient for the plots
classes <- seq(0, 2200, 200)
classes
## [1] 0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200

# apply the cut() function onto the TotalStudents column to create a groups column
# dig.lab removes scientific notation in interval
school_data$Groups <- cut(school_data$TotalStudents, breaks=classes, dig.lab = 5)

## SchoolName TotalStudents Groups
## 1 St Mary's Kilburn Church of England Primary ... 225 (200,400]
## 2 De Beauvoir Primary School 395 (200,400]
## 3 Queensbridge Primary School 470 (400,600]
## 4 Princess May Primary School 450 (400,600]
## 5 Holy Trinity Church of England Primary School 225 (200,400]
## 6 Marlborough Primary School 355 (200,400]
```

# 3. Explore the frequency of schools in London based on the total number of students(. . . )

```
frequency_results <- data.frame(table(school_data$Groups))
# this renames the columns
colnames(frequency_results)[1] <- "Groups"
colnames(frequency_results)[2] <- "Frequency"

# prints partial frequency table
frequency_results
## Groups Frequency
## 1 (0,200] 108
## 2 (200,400] 811
## 3 (400,600] 643
## 4 (600,800] 198
## 5 (800,1000] 87
## 6 (1000,1200] 60
## 7 (1200,1400] 41
## 8 (1400,1600] 24
```

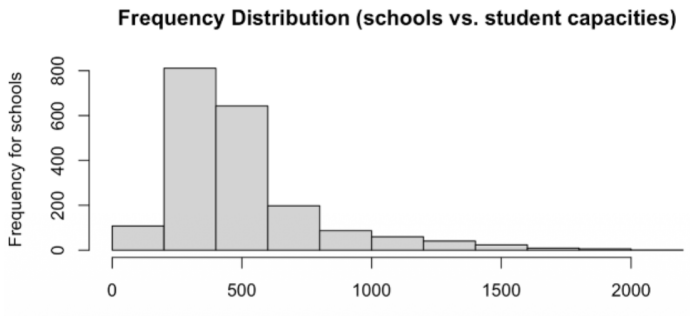
# 3. Explore the frequency of schools in London based on the total number of students(. . . )

```
# calculating the relative freq., cumulative freq., and cumulative relative
    frequency
frequency_results$RelativeFreq <- frequency_results$Frequency/sum(frequency_
    results$Frequency)
frequency_results$CumulativeFreq <- cumsum(frequency_results$Frequency)
frequency_results$CumulativeRelFreq <- cumsum(frequency_results$RelativeFreq)

# prints full frequency table (1 output)
frequency_results
## Groups Frequency RelativeFreq CumulativeFreq CumulativeRelFreq
## 1 (0,200] 108 0.0543259557 108 0.05432596
## 2 (200,400] 811 0.4079476861 919 0.46227364
## 3 (400,600] 643 0.3234406439 1562 0.78571429
## 4 (600,800] 198 0.0995975855 1760 0.88531187
## 5 (800,1000] 87 0.0437625755 1847 0.92907445
## 6 (1000,1200] 60 0.0301810865 1907 0.95925553
```

# 4. Create a histogram of frequency of schools in London based on total number of student

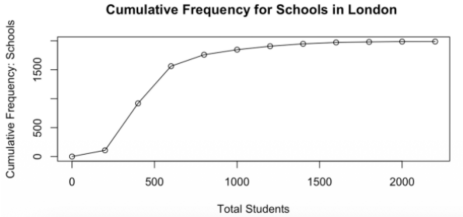
```
hist(school_data$TotalStudents, breaks = classes,
     ylab="Frequency for schools",
     xlab="Total students",
     main= "Frequency Distribution schools")
```



# 5. Create a cumulative frequency plot of schools in London based on total number of student

```
# create the plot with student values on x-axis vs
# cumulative frequency values (school number) on y-axis
plot(classes, cumulative.freq0, main="Cumulative Frequency",
     xlab="Total Students", ylab="Cumulative Frequency: Schools")

# connect the dots and BOOM
lines(classes, cumulative.freq0)
```



# 6. Create a relative cumulative frequency plot.

```
# extract the relative cumulative frequency from output frequency table
rel.cumulative.freq0 <- c(0, frequency_results$CumulativeRelFreq)

# create the plot with student values on x-axis vs cumulative frequency values
# (school number) on y-axis
plot(classes, rel.cumulative.freq0,
     main="Relative Cumulative Frequency distribution for Schools in London",
     xlab="Total Students",
     ylab="Relative Cumulative Frequency [%] for Schools")

# connect the dots and BOOM
lines(classes, rel.cumulative.freq0)
```

# Relative Cumulative Frequency Plot