Data science basics

Importing data

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The following content is based on Mine Çetinkaya-Rundel's excellent book Data Science in a Box

Reading rectangular data into R

readr
www.rstudio.com

readxl
www.rstudio.com

readr

- `read_csv()` - comma delimited files
- `read_csv2()` - semicolon separated files (common in countries where ; is used as the decimal place)
- `read_tsv()` - tab delimited files
- `read_delim()` - reads in files with any delimiter
- `read_fwf()` - fixed width files
- ...

readxl

- `read_excel()` - read xls or xlsx files
- ...

Reading data

```
nobel <- read_csv(file = "data/nobel.csv")
nobel
```

```
## # A tibble: 935 x 26
##      id firstname surname   year category affiliation city 
##   <dbl> <chr>     <chr>    <dbl> <chr>    <chr>       <chr>
## 1     1 Wilhelm … Röntgen   1901 Physics  Munich Uni… Muni…
## 2     2 Hendrik … Lorentz   1902 Physics  Leiden Uni… Leid…
## 3     3 Pieter    Zeeman    1902 Physics  Amsterdam … Amst…
## 4     4 Henri     Becque…   1903 Physics  École Poly… Paris
## 5     5 Pierre    Curie     1903 Physics  École muni… Paris
## 6     6 Marie     Curie     1903 Physics  <NA>        <NA> 
## # … with 929 more rows, and 19 more variables: country <chr>,
## #   born_date <date>, died_date <date>, gender <chr>,
## #   born_city <chr>, born_country <chr>,
## #   born_country_code <chr>, died_city <chr>,
## #   died_country <chr>, died_country_code <chr>,
## #   overall_motivation <chr>, share <dbl>, motivation <chr>,
## #   born_country_original <chr>, born_city_original <chr>,
## #   died_country_original <chr>, died_city_original <chr>,
## #   city_original <chr>, country_original <chr>
```

Writing data

- Write a file

```
df <- tribble(
  ~x, ~y,
  1,  "a",
  2,  "b",
  3,  "c"
)

write_csv(df, file = "data/df.csv")
```

- Read it back in to inspect

```
read_csv("data/df.csv")
```

```
## # A tibble: 3 x 2
##       x y
##   <dbl> <chr>
## 1     1 a
## 2     2 b
## 3     3 c
```

Your turn!

- RStudio Cloud > `AE 06 - Nobels and sales + Data import` > open `nobels-csv.Rmd` and knit.
- Read in the `nobels.csv` file from the `data-raw/` folder.
- Split into two (STEM and non-STEM):
  - Create a new data frame, `nobel_stem`, that filters for the STEM fields (Physics, Medicine, Chemistry, and Economics).
  - Create another data frame, `nobel_nonstem`, that filters for the remaining fields.
- Write out the two data frames to `nobel-stem.csv` and `nobel-nonstem.csv`, respectively, to `data/`.

Hint: Use the `%in%` operator when `filter()`ing.

Variable names

Data with bad names

```r
edibnb_badnames <- read_csv("data/edibnb-badnames.csv")
names(edibnb_badnames)
```

```
##  [1] "ID"                    "Price"
##  [3] "neighbourhood"         "accommodates"
##  [5] "Number of bathrooms"   "Number of Bedrooms"
##  [7] "n beds"                "Review Scores Rating"
##  [9] "Number of reviews"     "listing_url"
```

... but R doesn't allow spaces in variable names

```r
ggplot(edibnb_badnames, aes(x = Number of bathrooms, y = Price)) +
  geom_point()
```

```
## Error: <text>:1:40: unerwartetes Symbol
## 1: ggplot(edibnb_badnames, aes(x = Number of
##                                            ^
```

Option 1 - Define column names

```
edibnb_col_names <- read_csv("data/edibnb-badnames.csv",
                             col_names = c("id", "price",
                                           "neighbourhood", "accommodates",
                                           "bathroom", "bedroom",
                                           "bed", "review_scores_rating",
                                           "n_reviews", "url"))

names(edibnb_col_names)
```

```
##  [1] "id"                   "price"
##  [3] "neighbourhood"        "accommodates"
##  [5] "bathroom"             "bedroom"
##  [7] "bed"                  "review_scores_rating"
##  [9] "n_reviews"            "url"
```

Option 2 - Format text to snake_case

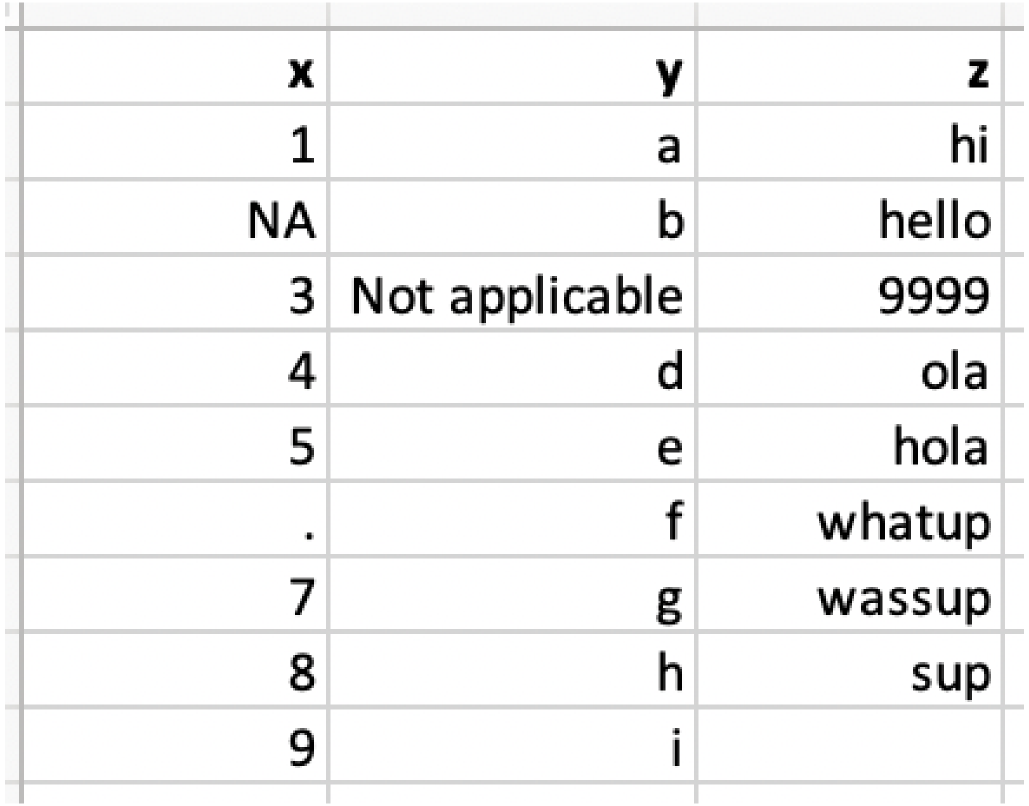
```
edibnb_clean_names <- read_csv("data/edibnb-badnames.csv") %>%
  janitor::clean_names()

names(edibnb_clean_names)
```

```
##  [1] "id"                  "price"
##  [3] "neighbourhood"       "accommodates"
##  [5] "number_of_bathrooms" "number_of_bedrooms"
##  [7] "n_beds"              "review_scores_rating"
##  [9] "number_of_reviews"   "listing_url"
```

Variable types

Which type is x? Why?



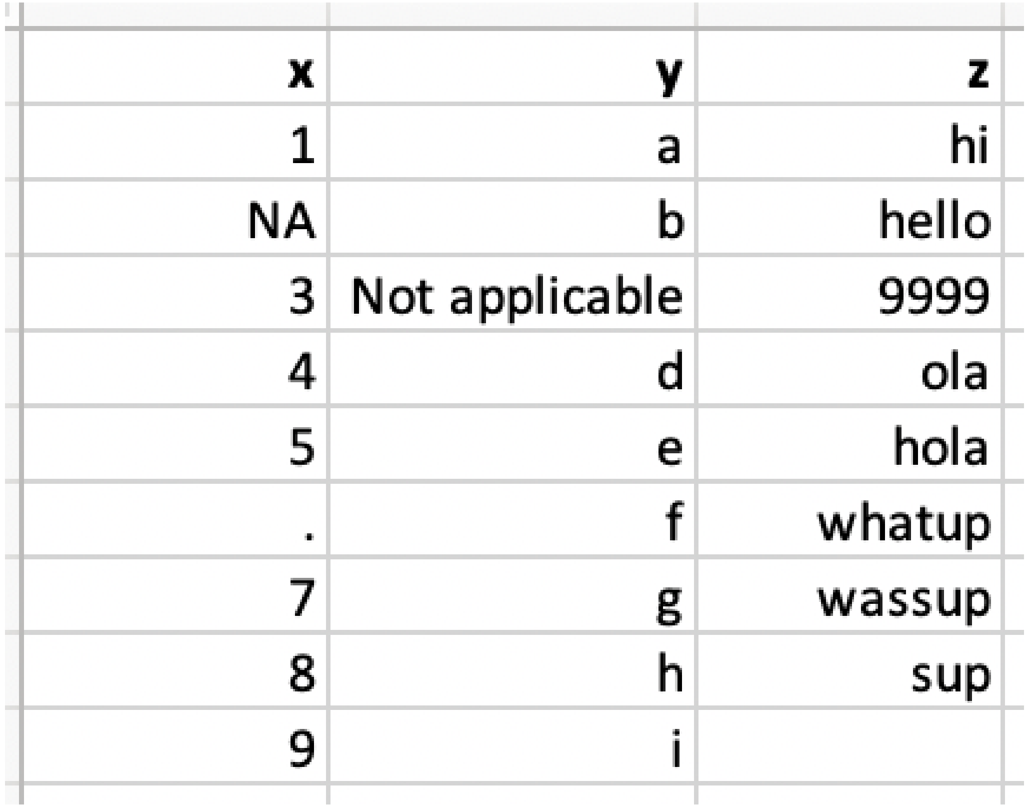
x	y	z
1	a	hi
NA	b	hello
3	Not applicable	9999
4	d	ola
5	e	hola
.	f	whatup
7	g	wassup
8	h	sup
9	i	

```
read_csv("data/df-na.csv")
```

```
## # A tibble: 9 x 3
##   x     y              z
##   <chr> <chr>          <chr>
## 1 1     a              hi
## 2 <NA>  b              hello
## 3 3     Not applicable 9999
## 4 4     d              ola
## 5 5     e              hola
## 6 .     f              whatup
## 7 7     g              wassup
## 8 8     h              sup
## 9 9     i              <NA>
```

Option 1. Explicit NAs

```r
read_csv("data/df-na.csv",
         na = c("", "NA", ".", "9999", "Not applicable"))
```



x	y	z
1	a	hi
NA	b	hello
3	Not applicable	9999
4	d	ola
5	e	hola
.	f	whatup
7	g	wassup
8	h	sup
9	i	

```
## # A tibble: 9 x 3
##       x y     z
##   <dbl> <chr> <chr>
## 1     1 a     hi
## 2    NA b     hello
## 3     3 <NA>  <NA>
## 4     4 d     ola
## 5     5 e     hola
## 6    NA f     whatup
## 7     7 g     wassup
## 8     8 h     sup
## 9     9 i     <NA>
```

Option 2. Specify column types

```
read_csv("data/df-na.csv", col_types = list(col_double(),
                                            col_character(),
                                            col_character()))
```

```
## Warning: 1 parsing failure.
## row col expected actual             file
##   6   x a double      . 'data/df-na.csv'

## # A tibble: 9 x 3
##       x y              z
##   <dbl> <chr>          <chr>
## 1     1 a              hi
## 2    NA b              hello
## 3     3 Not applicable 9999
## 4     4 d              ola
## 5     5 e              hola
## 6    NA f              whatup
## 7     7 g              wassup
## 8     8 h              sup
## 9     9 i              <NA>
```

Column types

type function	data type
`col_character()`	character
`col_date()`	date
`col_datetime()`	POSIXct (date-time)
`col_double()`	double (numeric)
`col_factor()`	factor
`col_guess()`	let readr guess (default)
`col_integer()`	integer
`col_logical()`	logical
`col_number()`	numbers mixed with non-number characters
`col_numeric()`	double or integer
`col_skip()`	do not read
`col_time()`	time

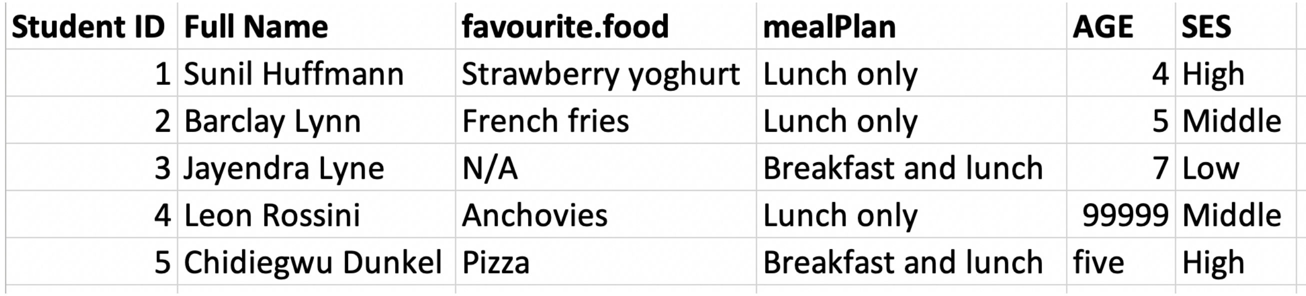
```r
read_csv("data/df-na.csv")
```

```
##
## ── Column specification ─────────────────────────────────────────
## cols(
##   x = col_character(),
##   y = col_character(),
##   z = col_character()
## )
```

```
## # A tibble: 9 x 3
##   x     y              z
##   <chr> <chr>          <chr>
## 1 1     a              hi
## 2 <NA>  b              hello
## 3 3     Not applicable 9999
## 4 4     d              ola
...
```

Case study: Favourite foods

Favourite foods



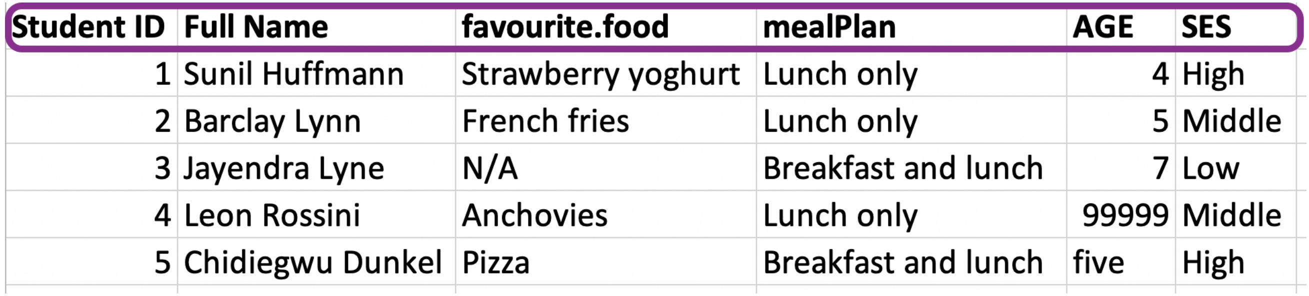
Student ID	Full Name	favourite.food	mealPlan	AGE	SES
1	Sunil Huffmann	Strawberry yoghurt	Lunch only	4	High
2	Barclay Lynn	French fries	Lunch only	5	Middle
3	Jayendra Lyne	N/A	Breakfast and lunch	7	Low
4	Leon Rossini	Anchovies	Lunch only	99999	Middle
5	Chidiegwu Dunkel	Pizza	Breakfast and lunch	five	High

```r
fav_food <- read_excel("data/favourite-food.xlsx")

fav_food
```

```
## # A tibble: 5 x 6
##   `Student ID` `Full Name`  favourite.food  mealPlan  AGE   SES
##          <dbl> <chr>        <chr>           <chr>     <chr> <chr>
## 1            1 Sunil Huffm… Strawberry yog… Lunch on… 4     High
## 2            2 Barclay Lynn French fries    Lunch on… 5     Midd…
## 3            3 Jayendra Ly… N/A             Breakfas… 7     Low
## 4            4 Leon Rossini Anchovies       Lunch on… 99999 Midd…
## 5            5 Chidiegwu D… Pizza           Breakfas… five  High
```

Variable names



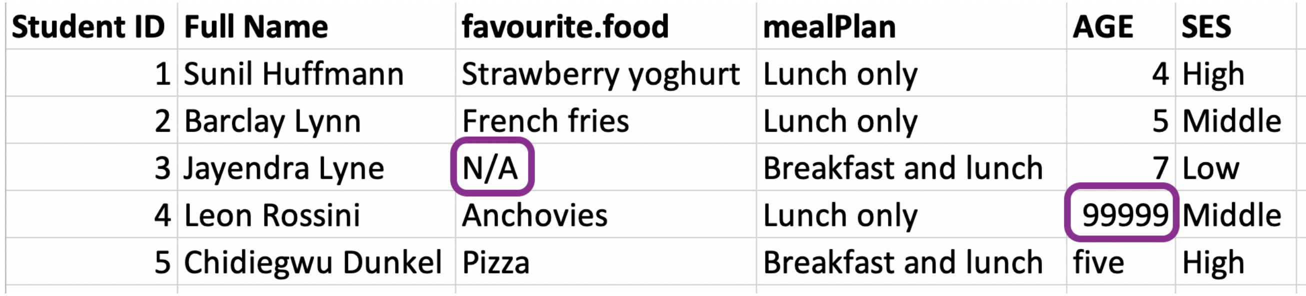
Student ID	Full Name	favourite.food	mealPlan	AGE	SES
1	Sunil Huffmann	Strawberry yoghurt	Lunch only	4	High
2	Barclay Lynn	French fries	Lunch only	5	Middle
3	Jayendra Lyne	N/A	Breakfast and lunch	7	Low
4	Leon Rossini	Anchovies	Lunch only	99999	Middle
5	Chidiegwu Dunkel	Pizza	Breakfast and lunch	five	High

```
fav_food <- read_excel("data/favourite-food.xlsx") %>%
  janitor::clean_names()

fav_food
```

```
## # A tibble: 5 x 6
##   student_id full_name   favourite_food   meal_plan   age   ses
##        <dbl> <chr>       <chr>            <chr>       <chr> <chr>
## 1          1 Sunil Huff… Strawberry yogh… Lunch only  4     High
## 2          2 Barclay Ly… French fries     Lunch only  5     Midd…
## 3          3 Jayendra L… N/A              Breakfast … 7     Low
## 4          4 Leon Rossi… Anchovies        Lunch only  99999 Midd…
## 5          5 Chidiegwu … Pizza            Breakfast … five  High
```

Handling NAs



Student ID	Full Name	favourite.food	mealPlan	AGE	SES
1	Sunil Huffmann	Strawberry yoghurt	Lunch only	4	High
2	Barclay Lynn	French fries	Lunch only	5	Middle
3	Jayendra Lyne	N/A	Breakfast and lunch	7	Low
4	Leon Rossini	Anchovies	Lunch only	99999	Middle
5	Chidiegwu Dunkel	Pizza	Breakfast and lunch	five	High

```
fav_food <- read_excel("data/favourite-food.xlsx",
                       na = c("N/A", "99999")) %>%
  janitor::clean_names()

fav_food
```

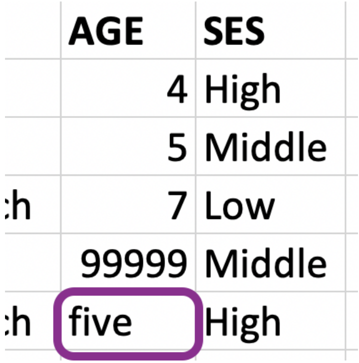
```
## # A tibble: 5 x 6
##   student_id full_name   favourite_food   meal_plan   age   ses
##        <dbl> <chr>       <chr>            <chr>       <chr> <chr>
## 1          1 Sunil Huff… Strawberry yogh… Lunch only  4     High
## 2          2 Barclay Ly… French fries     Lunch only  5     Midd…
## 3          3 Jayendra L… <NA>             Breakfast … 7     Low
## 4          4 Leon Rossi… Anchovies        Lunch only  <NA>  Midd…
## 5          5 Chidiegwu … Pizza            Breakfast … five  High
```

Make age numeric

```
fav_food <- fav_food %>%
  mutate(
    age = if_else(age == "five", "5", age),
    age = as.numeric(age)
    )

glimpse(fav_food)
```

```
## Rows: 5
## Columns: 6
## $ student_id     <dbl> 1, 2, 3, 4, 5
## $ full_name      <chr> "Sunil Huffmann", "Barclay Lynn", "Jaye…
## $ favourite_food <chr> "Strawberry yoghurt", "French fries", N…
## $ meal_plan      <chr> "Lunch only", "Lunch only", "Breakfast …
## $ age            <dbl> 4, 5, 7, NA, 5
## $ ses            <chr> "High", "Middle", "Low", "Middle", "Hig…
```



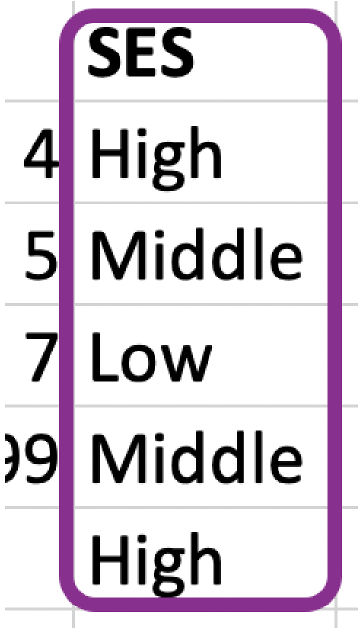
	AGE	SES
	4	High
	5	Middle
:h	7	Low
	99999	Middle
:h	five	High

Socio-economic status

> What order are the levels of `ses` listed in?

```
fav_food %>%
  count(ses)
```

```
## # A tibble: 3 x 2
##   ses        n
##   <chr>  <int>
## 1 High       2
## 2 Low        1
## 3 Middle     2
```



	SES
4	High
5	Middle
7	Low
99	Middle
	High

Make ses factor

```
fav_food <- fav_food %>%
  mutate(ses = fct_relevel(ses, "Low", "Middle", "High"))

fav_food %>%
  count(ses)
```

```
## # A tibble: 3 x 2
##   ses        n
##   <fct>  <int>
## 1 Low        1
## 2 Middle     2
## 3 High       2
```

Putting it altogether

```
fav_food <- read_excel("data/favourite-food.xlsx", na = c("N/A", "99999")) %>%
  janitor::clean_names() %>%
  mutate(
    age = if_else(age == "five", "5", age),
    age = as.numeric(age),
    ses = fct_relevel(ses, "Low", "Middle", "High")
  )

fav_food
```

```
## # A tibble: 5 x 6
##   student_id full_name   favourite_food   meal_plan      age ses
##        <dbl> <chr>       <chr>            <chr>        <dbl> <fct>
## 1          1 Sunil Huff… Strawberry yogh… Lunch only       4 High
## 2          2 Barclay Ly… French fries     Lunch only       5 Midd…
## 3          3 Jayendra L… <NA>             Breakfast …      7 Low
## 4          4 Leon Rossi… Anchovies        Lunch only      NA Midd…
## 5          5 Chidiegwu … Pizza            Breakfast …      5 High
```

Out and back in

```r
write_csv(fav_food, file = "data/fav-food-clean.csv")

fav_food_clean <- read_csv("data/fav-food-clean.csv")
```

What happened to ses again?

```
fav_food_clean %>%
  count(ses)
```

```
## # A tibble: 3 x 2
##   ses        n
##   <chr>  <int>
## 1 High       2
## 2 Low        1
## 3 Middle     2
```

`read_rds()` and `write_rds()`

- CSVs can be unreliable for saving interim results if there is specific variable type information you want to hold on to.
- An alternative is RDS files, you can read and write them with `read_rds()` and `write_rds()`, respectively.

```
read_rds(path)
write_rds(x, path)
```

Out and back in, take 2

```r
write_rds(fav_food, file = "data/fav-food-clean.rds")

fav_food_clean <- read_rds("data/fav-food-clean.rds")

fav_food_clean %>%
  count(ses)
```

```
## # A tibble: 3 x 2
##   ses        n
##   <fct>  <int>
## 1 Low        1
## 2 Middle     2
## 3 High       2
```

Other types of data

Other types of data

- **googlesheets4:** Google Sheets
- **haven**: SPSS, Stata, and SAS files
- **DBI**, along with a database specific backend (e.g. RMySQL, RSQLite, RPostgreSQL etc): allows you to run SQL queries against a database and return a data frame
- **jsonline**: JSON
- **xml2**: xml
- **rvest**: web scraping
- **httr**: web APIs
- **sparklyr**: data loaded into spark

Your turn!

- RStudio Cloud > `AE 06 - Nobels and sales + Data import` > `sales-excel.Rmd`.
- Load the `sales.xlsx` file from the `data-raw/` folder, using appropriate arguments for the `read_excel()` function such that it looks like the output on the left.
- **Stretch goal:** Manipulate the sales data such that it looks like the output on the right.

```
## # A tibble: 9 x 2
##   id      n    
##   <chr>   <chr>
## 1 Brand 1 n    
## 2 1234    8    
## 3 8721    2    
## 4 1822    3    
## 5 Brand 2 n    
## 6 3333    1    
## # … with 3 more rows
```

```
## # A tibble: 7 x 3
##   brand      id     n
##   <chr>   <dbl> <dbl>
## 1 Brand 1  1234     8
## 2 Brand 1  8721     2
## 3 Brand 1  1822     3
## 4 Brand 2  3333     1
## 5 Brand 2  2156     3
## 6 Brand 2  3987     6
## # … with 1 more row
```